A new generation of music-making algorithms is here

Their most useful application may lie in helping human composers

IN THE DYSTOPIA of George Orwell's novel "1984", Big Brother numbs the masses with the help of a "versificator", a machine designed to automatically generate the lyrics to popular tunes, thereby ridding society of human creativity. Today, numerous artificial-intelligence (AI) models churn out, some free of charge, the music itself. Unsurprisingly, many fear a world flooded with generic and emotionally barren tunes, with human musicians edged out in the process. Yet there are brighter signs, too, that AI may well drive a boom in musical creativity.

AI music-making is nothing new. The first, so-called "rules-based", models date to the 1950s. These were built by painstakingly translating principles of music theory into algorithmic instructions and probability tables to determine note and chord progressions. The outputs were musically sound but creatively limited. Ed Newton-Rex, an industry veteran who designed one such model for Jukedeck, a London firm he founded in 2012, describes that approach as good for the day but irrelevant now.

The clearest demonstration that times have changed came in August 2023. That is when Meta, a social-media giant, released the source code for AudioCraft, a suite of large "generative" music models built using machine learning. AI outfits worldwide promptly set about using Meta's software to train new music generators, many with additional code folded in. One AudioCraft model, MusicGen, analysed patterns in some 400,000 recordings with a collective duration of almost 28 months to come up with 3.3bn "parameters", or variables, that enables the algorithm to generate patterns of sounds in response to prompts. The space this creates for genuinely new AI compositions is unprecedented.

Such models are also getting easier to use. In September Stability AI, a firm based in London at which Mr Newton-Rex worked until recently, released a model, Stable Audio, trained on some 800,000 tracks. Users guide it by entering text and audio clips. This makes it easy to upload, say, a guitar solo and have it recomposed in jazzy piano, perhaps with a vinyl playback feel. Audio prompts are a big deal for two reasons, says Oliver Bown of Australia's University of New South Wales. First, even skilled musicians struggle to put music into words. Second, because most musical training data are only cursorily tagged, even a large model may not understand a request for, say, a four-bar bridge in ragtime progression (the style familiar from Scott Joplin's "The Entertainer").

The potential, clearly, is vast. But many in the industry remain sceptical. One widespread sentiment is that AI will never produce true music. That's because, as a musician friend recently told Yossef Adi, an engineer at Meta's AI lab in Tel Aviv, "no one broke its heart". That may be true, but some AI firms reckon that they have found a way to retain and reproduce the "unique musical fingerprint" of their musician users, as LifeScore, a company founded near London, puts it. LifeScore's AI limits itself to recomposing the elements of a user's original recordings in ways that maintain the music's feel, rather than turning them into something radically new.

It takes about a day to plug into LifeScore's model the dozens of individually recorded vocal and instrumental microphone tracks, or stems, that go into producing an original song. Once that's done, however, the software, developed at a cost of some $10m, can rework each stem into a new tempo, key or genre within a couple of seconds. The song's artists, present during the process, choose which remixes to keep. Manually remixing a hit track has traditionally taken one or more highly paid specialists weeks.

LifeScore, says Tom Gruber, a co-founder, is "literally swamped with requests" from clients including Sony Music, Universal Music Group and Warner Music Group. An original release is typically turned into anywhere from a handful to a dozen remixes. But one client aims to release a dizzying 6,000 or so AI versions of an original track, each targeting a different market. Artists including Pink Floyd's David Gilmour and Tom Gaebel, a German pop singer, use LifeScore's AI to power websites that allow fans to generate, with a few clicks, new remixes adapted to personal tastes.

The beat of a different drum

If this seems like dizzying progress, it's worth noting that AI's impact on music is still in its early days. Legal uncertainties over the use of copyrighted recordings to train models have slowed development. Outfits that have coughed up for licensing fees note that this can get expensive. To save on that cost, MusicGen's training set mostly sidestepped hits, says Dr Adi. Though output is pretty good, he adds, the model is not yet "artistic enough" to generate narratively complete songs. Harmonic misalignments are common. OpenAI, a San Francisco firm, for its part, says its MuseNet model struggles to pull off "odd pairings", such as a Chopin style that incorporates bass and drums.

In time, bigger training sets of better music will largely overcome such shortcomings, developers reckon. A Stability AI spokesperson says that while Stable Audio's top duration for coherently structured music—"intro, development and outro"—is now about 90 seconds, upgrades will produce longer pieces with "full musicality". But judging music AI by its ability to crank out polished tracks mostly misses the point. The technology's greatest promise, for now at least, lies elsewhere.

Part of it is the empowerment of amateurs. AI handles technical tasks beyond many people's capabilities and means. As a result, AI is drawing legions of newbies into music-making. This is a boon for experimentation

by what Simon Cross, head of products at Native Instruments, a firm based in Berlin, calls "bedroom producers".

Consider RX, a Native Instruments AI "assistant" that corrects errors in things like pitch and timing. For the latter, software time-shifts notes by cutting out or inserting slivers of sound with matching timbre, a process called "dynamic time-warping". The company's AI also determines what mixing and mastering processes were performed on a song of a user's choosing. It then replicates, or at least approximates, the same expensive processing on the user's own creations. Boomy, an online "music automation" platform for what Alex Mitchell, its CEO, describes as "low-friction" song production with text prompts, has more than 2m users. The company, based in Berkeley, California, uploads users' (vetted) creations to streaming services and collects a cut of revenues.

AI serves professionals, too. The soundtracks to "Barbie" and "Oppenheimer" were cleaned up in post-production with RX, for example. Another application area is "style transfer", in which models transform music recorded with one instrument into sounds that seem to come from a different one, often with a twist or two requested by the user. Style transfers are also used for voice. A model developed by a startup in London called Voice-Swap slices up sounds sung by (remunerated) professional singers and rearranges the slivers into lyrics written by the service's users, who pay licensing fees for the rights to sell the resulting tracks. And AI tools already exist to recreate singers' voices in other languages. Vocaloid, a voice-synthesising tool from Yamaha, a Japanese instrument manufacturer, is one of many that can use a translation sung by a native speaker as a template for an AI to imitate as it rearranges, modifies and stitches together tiny snippets of the original singer's voice.

Accomplished musicians now widely tap MusicGen and its competitors as sources of "infinite inspirations", the better to alight upon promising

composition ideas, says Meta's Dr Adi. Whether such inspiration pays off will, ultimately, be up to the listener to decide. ■

新一代音乐制作算法流行

它们最大的用处可能是帮助人类作曲家【深度】

在乔治·奥威尔的小说《1984》所描写的反乌托邦世界中，"老大哥"利用"写诗器"来麻痹大众。这是一种可以自动为流行乐曲配词的机器，有了它，社会就再用不着人类的创造力。如今，许多人工智能（AI）模型都能自动生成乐曲，有些还是免费的。难怪许多人担心世界会充斥着情感贫瘠、千篇一律的曲调，而人类作曲家会在这个过程中被淘汰。不过，也有更光明的迹象，显示AI很可能会推动音乐创作力大爆发。

AI音乐制作并不是什么新鲜事。最早的所谓"基于规则"的音乐制作模型可以追溯到上世纪50年代。构建这些模型要费心费力地将音乐理论原理转化为算法指令和概率表，以确定音符与和弦进行。它们制作的音乐虽然悦耳动听，却没什么创造力。业内资深人士埃德·牛顿-雷克斯（Ed Newton-Rex）就曾为自己2012年在伦敦创办的公司Jukedeck设计过这样一个模型。他表示该方法在当时挺厉害，但现在已经不算什么了。

最能体现时代变化的事件发生在2023年8月。当时，社交媒体巨头Meta发布了AudioCraft的源代码，AudioCraft是用机器学习构建的一套大型"生成式"音乐模型。世界各地的AI公司立即开始使用Meta的软件来训练新的音乐生成器，其中许多还另外增加了代码。AudioCraft的模型之一MusicGen从约40万段总时长近28个月的录制音乐中分析模式，得出了33亿个"参数"（也叫变量），使得该算法能够对提示做出回应，生成不同模式的声音。这为真正全新的AI作曲创造了前所未有的空间。

这类模型也越来越容易使用。去年9月，伦敦公司Stability AI（牛顿-雷克斯不久前还在这家公司工作）发布了Stable Audio模型，使用大约80万首歌曲训练而来。用户输入文字和音频片段来引导它创作。这样就很容易上传譬如一段吉他独奏，将它改编为爵士风格的钢琴曲，或许还可以有几分黑胶唱片的感觉。澳大利亚新南威尔士大学（University of New South

Wales）的奥利弗·鲍恩（Oliver Bown）表示，能够输入音频提示之所以重要，有两个原因。首先，即使训练有素的音乐家也很难将音乐用语言表达出来。其次，因为大多数用于训练的音乐数据只做了粗略的标记，因此，即使是大型模型也可能不明白用户提出的一些需求，比如拉格泰姆曲式中的四小节间奏（斯科特·乔普林[Scott Joplin]的《The Entertainer》以这种风格著称）。

显然，AI音乐制作的潜力巨大。但许多业内人士仍持怀疑态度。一种普遍观点是，AI永远创作不出真正的音乐。这是因为"没有人伤过它的心"——Meta位于特拉维夫的AI实验室的工程师优素福·阿迪（Yossef Adi）说有一位作曲家朋友不久前这么告诉他。这话或许是对的，但一些AI公司认为自己已经找到了方法，可以保留并复制作曲家用户"独一无二的音乐指纹"，这是创立于伦敦附近的LifeScore的说法。LifeScore的AI限定自己，在改编用户原始音乐中的元素时须保留这段音乐原本的感觉，而不是把它们变成全新的东西。

制作一首原创歌曲需要数十个单独录制的人声和器乐音轨（也叫音源），而要将这些音轨或音源输入LifeScore的模型需要大约一天的时间。不过，这个过程一旦完成，耗资约1000万美元开发的LifeScore软件就能在几秒钟内对每个音源重新加工，赋予它们新的节奏、音调或风格。在场的艺术家可以选择保留哪些混音版本。用传统方式对一首热门音乐进行人工混音需要一个或几个收费不菲的行家里手花费几周时间。

LifeScore的联合创始人汤姆·格鲁伯（Tom Gruber）表示，公司对来自索尼音乐、环球音乐集团和华纳音乐集团等客户的"需求简直应接不暇"。一首已发行的原版音乐通常会被改编成几个到十几个混音版本。但有一个客户竟然打算为一首原创音乐发行6000个左右的AI版本——每个版本主打不同的市场。平克·弗洛伊德乐队（Pink Floyd）的大卫·吉尔摩（David Gilmour）和德国流行歌手汤姆·盖贝尔（Tom Gaebel）等音乐人使用LifeScore的AI来支持一些网站——粉丝只需在这些网站上点击几下，就能生成符合个人喜好的新混音版本。

如果说这样的进展似乎快到令人目眩，那么值得注意的是，AI对音乐的影响才刚刚开始。使用有版权的音乐来训练模型在法律上存在不确定性，这减缓了其进展。那些被迫支付了版权费的公司指出，模型训练可能因此变得很昂贵。阿迪表示，为节约这方面的成本，MusicGen的训练集大多避开了热门歌曲。他补充说，虽然生成的作品相当不错，但该模型还没有达到"足够的艺术性"，无法生成叙事完整的歌曲。和声不和谐是家常便饭。旧金山公司OpenAI则表示，它自己的模型MuseNet模型就很难完成"别扭的配对"，比如把低音吉他和鼓点与肖邦风格的乐曲混合在一起。

开发人员认为，假以时日，包含更优质音乐的更大训练集将在很大程度上克服这些缺陷。Stability AI的一位发言人表示，虽然目前Stable Audio制作的结构连贯的音乐（包括"前奏、主题展开和结尾"）最长可以到1分30秒左右，但升级后能制作出更长时间的"富有音乐性"的作品。不过，仅凭能否制作出优美的乐曲来判断音乐AI的未来基本上是不得要领。这项技术最大的前景——至少就目前而言——在其他地方。

其一是给业余音乐人赋能。AI所处理的技术工作是许多人凭自己的能力和财力无法完成的。因此，AI正吸引大批新手进入音乐制作领域。这对西蒙·克罗斯（Simon Cross）所称的"卧室制作人"的音乐制作尝试来说是一大福音。克罗斯是柏林公司Native Instruments的产品主管。

Native Instruments的AI"助手"RX可以纠正音高和时点等方面的错误。对于后者，软件会通过剪切或插入与原音色匹配的声音片段，对音符做时间位移，这一过程被称为"动态时间规整"。该公司的AI还能分辨用户所选的歌曲是如何进行混音和母带处理的，然后把这一成本高昂的操作复制到（或至少近似地复制到）用户自己的作品上。在线"音乐自动化"平台Boomy拥有逾200万用户，CEO亚历克斯·米切尔（Alex Mitchell）形容它根据提示词制作歌曲的过程"低摩擦"。这家加州伯克利的公司将用户（经过审核）的作品上传到流媒体服务平台，并从收入中抽成。

AI也为专业人士服务。例如，电影《芭比》和《奥本海默》在后期制作时

就使用RX修音。另一个应用领域是"风格转换"，即通过模型让一种乐器演奏的音乐变成好像是用另一种乐器演奏的，通常会根据用户的要求做一两处改动。风格转换还可用于人声。伦敦一家创业公司开发了一款名为Voice-Swap的模型，可以将专业歌手（有偿）演唱的声音分割成片段，然后按该公司用户写的歌词重新编排这些片段，用户支付版权费后就可以获得由此生成的歌曲的售卖权。现在已经有很多AI工具可以用其他语言再现歌手的声音。日本乐器制造商雅马哈公司推出的语音合成工具Vocaloid就是其中之一，它可以将母语歌手演唱的译文歌曲用作模版，供AI在重新编排、修改或拼接原唱者的声音片段时进行模仿。

Meta的阿迪表示，为了更好地激发创意，如今许多才华出众的音乐家都将MusicGen及类似的AI模型用作"无限灵感"的来源。至于这种灵感能否带来回报，最终还是要听众说了算。 ■

TikTok is not the only Chinese app thriving in America

What happens to them if the short-video sensation is banned?

WITH THE prospect of a ban hanging over TikTok, its 170m American users may start looking for an alternative time-sink. They could plump for Bigo Live, popular for TikTokish live-streaming. Or Likee, which offers similar video-editing and sharing options and has more than 100m users around the world. There is also Hago, which blends social media and video games, and which has clocked up some 500m downloads.

The three apps are similar to TikTok in another way, too. The firm that makes them, Joyy, is based in Singapore, just like TikTok. And like ByteDance, TikTok's parent firm, Joyy's controlling shareholder, called Huanju, is based in mainland China.

ByteDance and Huanju are among dozens of Chinese firms that are thriving on the free-wheeling Western internet, away from China's censors. They develop apps for everything from gaming and social media to fitness and photo-editing. Many have set up headquarters outside China, often in Singapore, and do not advertise their Chineseness. Plenty dispute the notion that they are Chinese at all.

According to Sensor Tower, a research firm, a Shanghainese video-gaming firm called MiHoYo last year outperformed even Tencent, a Chinese games powerhouse, when it came to foreign revenues from video games (unlisted MiHoYo does not disclose figures). The 30 biggest Chinese video-game makers account for 18% of the industry's global sales outside China. Chinese-linked e-commerce apps have been similarly successful. Shein, which sells cheap clothing, mainly to Americans, is thought to have sold garments worth tens of billions of dollars last year. Temu, which is based in

Boston but owned by a giant Chinese e-merchant, PDD, may have notched up several billion dollars. PDD, which is listed in New York, does not break out Temu's results, but on March 20th it reported that its overall sales more than doubled in the last quarter of 2023, to $12.5bn.

Other Chinese services are also pushing into America. Daily Yoga, an app popular with exercise aficionados, is owned by a company from the Chinese city of Xi'an. Bestie-Portrait, a photo-editor, has Chinese owners. CapCut, one of the world's most popular video-editing apps, is owned by ByteDance. So is Lemon8, a photo- and video-sharing app similar to Instagram. ReelShort, which serves up soap operas to American viewers in micro-episodes, is owned by Crazy Maple Studios, a Californian subsidiary of COL Digital Publishing, whose headquarters are in Beijing.

A ban on TikTok could open the door to many of these apps being consigned to the digital dustbin. They risk being accused, as TikTok has been, of sharing users' data with Chinese authorities, being a vehicle for propaganda, or both. TikTok denies these allegations, points to its efforts to ring-fence its American data and algorithm, and says that the Communist Party holds no sway over it. Other apps with Chinese roots may soon have to start issuing similar denials. ■

在美国走红的中国应用不止TikTok

如果这款热门短视频应用被禁，它们会怎么样?

TikTok也许会遭到封禁，它的1.7亿美国用户可能要开始另寻一样消磨时光的东西。他们可能会选择Bigo Live，它因类似Tiktok的直播而受到欢迎。或者选Likee，它提供类似Tiktok的视频编辑和分享功能，全球用户超过一亿。还有Hago，它将社交媒体和电子游戏合为一体，下载量达到约5亿次。

这三款应用在另一个方面也与TikTok相似。打造它们的公司Joyy总部设在新加坡，就像TikTok一样。而且和TikTok的母公司字节跳动一样，Joyy的控股股东欢聚集团的总部也在中国大陆。

字节跳动和欢聚是在自由的西方互联网上蓬勃发展、远离中国审查的数十家中国公司之一。它们开发各种应用，从游戏、社交媒体到健身和照片编辑。许多公司把总部设在中国境外，通常是在新加坡，而且不大肆声张自己的中国出身。很多人质疑它们能不能算中国公司。

根据研究公司Sensor Tower的数据，上海一家名为米哈游的电子游戏公司去年的海外游戏营收甚至超过了中国游戏巨头腾讯（未上市的米哈游没有披露数据）。中国最大的30家电子游戏公司占到该行业中国以外全球销售额的18%。和中国有关联的电子商务应用也取得了类似的成功。据信，主要向美国人销售廉价服装的Shein去年卖出了价值数百亿美元的服装。总部位于波士顿、但属中国电子商务巨头拼多多旗下的Temu可能已实现了数十亿美元的销售额。在纽约上市的拼多多没有单独公布Temu的业绩，但在3月20日，该公司报告称其2023年最后一个季度的总销售额翻了一番不止，达到125亿美元。

其他中国服务也在进军美国。每日瑜伽（Daily Yoga）是一款受到健身爱好者欢迎的应用，由中国西安的一家公司所有。照片编辑应用Bestie-

Portrait为中国公司所有。CapCut是全球最受欢迎的视频编辑应用之一，属于字节跳动。和Instagram类似的照片和视频分享应用Lemon8也属于这家公司。ReelShort面向美国观众播放微短肥皂剧，它的所有者枫叶互动（Crazy Maple Studios）是总部在北京的中文在线集团的加州子公司。

TikTok若遭封禁可能启动许多此类应用被扔进数字垃圾箱。它们可能会像TikTok一样，被指控与中国政府共享用户数据，或是成为宣传工具，或两者兼而有之。TikTok否认了这些指控，指出它努力保护自己的美国数据和算法，并表示自己不受共产党的控制。其他源自中国的应用可能很快也将不得不开始发表类似的否认声明。■

Can anything stop Nvidia's Jensen Huang?

He has become the generative-AI showman of our time

JENSEN HUANG is a man on a mission—but not so much that he does not have time to tell a good story at his own expense. Last spring, when his semiconductor company, Nvidia, was well on its way to becoming a darling of generative artificial intelligence (AI), he and his wife bought a new home in the Bay Area. Mr Huang was so busy he could not spare much time to visit it before the purchase was completed. Pity, he admitted later, sneezing heavily. It was surrounded by plants that gave him hay fever.

Mr Huang uses such self-deprecating humour often. When he took to the stage on March 18th for Nvidia's annual developers' conference, to be greeted by cheers, camera flashes and rock-star adulation from the 11,000 folk packed into a San Jose ice-hockey stadium, he jokingly reminded them it wasn't a concert. Instead, he promised them a heady mix of science, algorithms, computer architecture and mathematics. Someone whooped.

In advance, Nvidia's fans on Wall Street had dubbed it the "AI Woodstock". It wasn't that. The attendees were mostly middle-aged men wearing lanyards and loafers, not beads and tie-dyes. Yet as a headliner, there was a bit of Jimi Hendrix about Jensen Huang. Wearing his trademark leather jacket, he put on an exhilarating performance. He was a virtuoso at making complex stuff sound easy. In front of the media, he improvised with showmanship. And for all the polished charm, there was something intoxicating about his change-the-world ambition. If anyone is pushing "gen AI" to the limits, with no misgivings, Mr Huang is. This raises a question: what constraints, if any, does he face?

The aim of the conference was to offer a simple answer: none. This is the

start of a new industrial revolution and, according to Mr Huang, Nvidia is first in line to build the "AI factories" of the future. Demand for Nvidia's graphics-processing units (GPUs), AI-modellers' favourite type of processor, is so insatiable that they are in short supply. No matter. Nvidia announced the launch later this year of a new generation of superchips, named Blackwell, that are many times more powerful than its existing GPUs, promising bigger and cleverer AIs. Thanks to AI, spending on global data centres was $250bn last year, Mr Huang says, and is growing at 20% a year. His company intends to capture much of that growth. To make it more difficult for rivals to catch up, Nvidia is pricing Blackwell GPUs at $30,000-40,000 apiece, which Wall Street deems conservative.

In order to reap the fruits of this "accelerated-computing", Nvidia wants to vastly expand its customer base. Currently the big users of its GPUs are the cloud-computing giants, such as Alphabet, Amazon and Microsoft, as well as builders of gen-AI models, such as OpenAI, maker of ChatGPT. But Nvidia sees great opportunity in demand from firms across all industries: health care, retail, manufacturing, you name it. It believes that many businesses will soon move on from toying with ChatGPT to deploying their own gen AIs. For that, Nvidia will provide self-contained software packages that can either be acquired off the shelf or tailored to a user's needs. It calls them NIMs, Nvidia Inference Microservices. Crucially, they will rely on (mostly rented) Nvidia GPUs, further tying customers into the firm's hardware-software ecosystem.

So far, so star-spangled. But it is not all peace and love at Woodstock. You need only to recall the supply-chain problems of the pandemic, as well as the subsequent Sino-American chip wars, to see that dangers lurk. Nvidia's current line-up of GPUs already faces upstream bottlenecks. South Korean makers of high-bandwidth memory chips used in Nvidia's products cannot keep up with demand. TSMC, the world's biggest semiconductor manufacturer, which actually churns out Nvidia chips, is struggling to

make enough of the advanced packaging that binds GPUs and memory chips together. Moreover, Nvidia's larger integrated systems contain around 600,000 components, many of which come from China. That underscores the geopolitical risks if America's tensions with its strategic rival keep mounting.

Troubles may lie downstream, too. The AIchips are energy-hungry and need plenty of cooling. There are growing fears of power shortages because of the strain that GPU-stuffed data centres will put on the grid. Mr Huang hopes to solve this problem by making GPUs more efficient. He says the mightiest Blackwell system, known pithily as GB200NVL72, can train a model larger than ChatGPT using about a quarter as much electrical power as the best available processors.

But that is still almost 20 times more than pre-AI data-centre servers, notes Chase Lochmiller, boss of Crusoe Energy Systems, which provides low-carbon cloud services and has signed up to buy the GB200NVL72. And however energy-efficient they are, the bigger the GPUs, the better the AIs trained using them are likely to be. This will stoke demand for AIs and, by extension, for GPUs. In that way, as economists pointed out during a previous industrial revolution in the late 19th century, efficiency can raise power consumption rather than reduce it. "You can't grow the supply of power anything like as fast as you can grow the supply of chips," says Pierre Ferragu of New Street Research, a firm of analysts. In a sign of the times Amazon Web Services, the online retailer's cloud division, last month bought a nuclear-powered data centre.

'Scuse me while I kiss AI

Mr Huang is not blind to these risks, even as he dismisses the more typical concerns about gen AI—that it will destroy work or wipe out humanity. In his telling, the technology will end up boosting productivity, generating profits and creating jobs—all to the betterment of humankind. Hendrix

famously believed music was the only way to change the world. For Mr Huang, it is a heady mix of science, engineering and maths. ■

还有什么能阻挡英伟达的黄仁勋？

他已经成了这个时代的生成式人工智能表演艺术家

黄仁勋当然是重任在肩，不过也还没忙到没空自嘲一把。去年春天，他的半导体公司英伟达正冉冉升起为生成式AI的宠儿，他和妻子在旧金山湾区买了新房。他太忙了，都没去好好看房就买了下来。失算啊，后来他一边大打喷嚏一边承认。房子周围全是让他花粉过敏发作的植物。

黄仁勋常常玩这种自黑式的幽默。3月18日，他登上英伟达年度开发者大会的舞台，迎接他的是欢呼声、相机闪光，以及挤满了圣何塞一座冰球馆的11000名观众犹如对摇滚明星的崇拜——他开玩笑地提醒大家这不是在开演唱会。他承诺呈献给他们的是融合了科学、算法、计算机架构和数学的炫目科技。台下有人欢呼叫好。

大会之前，华尔街的英伟达粉就把这场大会称为"AI界的伍德斯托克音乐节"。倒也不是那个样子。与会者大多是脖子上挂着入场证、脚蹬乐福鞋的中年男，而非一身扎染服饰、挂珠戴串的人。不过作为压轴主讲人，黄仁勋确有几分美国摇滚歌手吉米·亨德里克斯（Jimi Hendrix）的风范。他身穿标志性的皮夹克，给出了一场令人振奋的表演。他极擅长以浅显易懂的语言表述复杂难懂的概念。面对媒体，他信手拈来，控场力十足。除了这份从容老练的魅力，他改变世界的雄心壮志也令人沉醉。如果说有谁在把"生成式AI"推向极限，那无疑是黄仁勋。这就引出一个问题：他面对什么制约（如果有的话）？

这次大会就是要给出一个简单的答案：没有制约。这是一场新工业革命的开端，按黄仁勋的话说，英伟达走在打造未来"AI工厂"的最前列。英伟达的图形处理器（GPU）最受AI建模人员的青睐，已经供不应求。没关系。英伟达宣布将在今年晚些时候推出新一代超级芯片Blackwell，性能将比现在的这些GPU强大许多倍，有望造就更大更智能的AI系统。黄仁勋表示，为了发展AI，去年全球用于数据中心的支出达到2500亿美元，并正以每年

20%的速度增长。英伟达一心要抢占这些增长的大头。为了让竞争对手更难追赶，英伟达把Blackwell GPU的价格定在每片三至四万美元，华尔街认为这定价保守了。

为收获这轮"算力加速"的果实，英伟达希望大幅扩大客户群。目前，其GPU的主要用户是Alphabet、亚马逊和微软等云计算巨头，以及开发ChatGPT的OpenAI等构建生成式AI模型的公司。但英伟达从各行各业的企业需求中看到了巨大商机：医疗保健、零售、制造业，应有尽有。英伟达相信，许多企业很快就会从尝鲜ChatGPT转向部署自己的生成式AI。为此，英伟达将提供可以即买即用或根据用户需求定制的独立软件包，名为NIM（Nvidia Inference Microservices）。至关重要的是，这些软件将依赖英伟达GPU（主要是租用），进一步把客户绑定在该公司的硬件—软件生态系统中。

目前为止，一切璀璨光明。但在"伍德斯托克"，并非只有一片祥和友爱。只要回想一下疫情期间的供应链问题以及随后的中美芯片战，就会知道有种种风险潜伏。英伟达目前的GPU产品线已面临上游瓶颈。英伟达产品要用到韩国生产的高带宽内存芯片，而那些韩国制造商无法跟上需求。负责代工生产英伟达芯片的是全球最大半导体制造商台积电，目前其集成GPU和内存芯片的先进封装产能也非常紧张。此外，英伟达更大的集成系统包含约60万个零部件，其中许多来自中国。如果美国与这个战略对手的紧张关系持续升级，其中的地缘风险就会突显。

下游可能也有麻烦。AI芯片能耗很高，需要做大量冷却。由于装载大量GPU的数据中心将给电网带来压力，人们越来越担心会出现电力短缺。黄仁勋希望通过提高GPU的效率来解决这个问题。他说，相比现有最好的处理器，代号为GB200NVL72的最强大Blackwell系统可以只用约四分之一的电力来训练比ChatGPT更大的模型。

但这仍是传统非AI数据中心服务器能耗的近20倍，克鲁索能源系统（Crusoe Energy Systems）的老板切斯·洛克米勒（Chase Lochmiller）指出。他的公司提供低碳云服务，已签约购买GB200NVL72。而无论能效

如何，GPU越多，训练出的AI模型往往表现越好。这将刺激对AI的需求，进而刺激对GPU的需求。结果，正如在19世纪末上一次工业革命时经济学家所指出的，效率的提高可能增加而非减少能耗。"你不可能像增加芯片供应那样快速增加电力供应。"分析公司新街研究（New Street Research）的皮埃尔·费拉古（Pierre Ferragu）说。亚马逊的云计算部门亚马逊云科技（AWS）在3月收购了一家核动力数据中心，很能说明时代趋势。

等等，让我先亲亲AI

黄仁勋并非看不到这些风险，不过他不在意那些更常见的担忧——生成式AI可能消灭就业或毁灭人类。在他看来，这项技术最终会提高生产率，创造利润并创造就业机会，所有这些都将造福人类。亨德里克斯有一个广为人知的信仰：音乐是改变世界的唯一方式。对黄仁勋而言，改变世界的是融合了科学、工程与数学的炫目新技术。■

Just how rich are businesses getting in the AI gold rush?

Nvidia and Microsoft are not the only winners

BARELY A DAY goes by without excitement over artificial intelligence (AI) sending another company's market value through the roof. Last month the share price of Dell, a hardware-maker, jumped by over 30% in a day because of hopes that AI will boost sales. Days later Together AI, a cloud-computing startup, raised new funding at a valuation of $1.3bn, up from $500m in November. One of its investors is Nvidia, a maker of AI chips that is itself on an extended bull run. Before the launch in November 2022 of ChatGPT, a "generative" AI that responds to queries in uncannily humanlike ways, its market value was about $300bn, similar to that of Home Depot, a home-improvement chain. Today it is $2.3trn, $500bn or so shy of Apple's.

The relentless stream of AI headlines makes it hard to get a sense of which businesses are real winners in the AI boom—and which will win in the longer run. To help answer this question The Economist has looked where value has accrued so far and how this tallies with the expected sales of products and services in the AI "stack", as technologists call the various layers of hardware and software on which AI relies to work its magic. On March 18th many companies up and down the stack descended on San Jose for a four-day jamboree hosted by Nvidia. With talks on everything from robotics to drug discovery, the shindig showed off the latest AI innovations. It highlighted furious competition between firms within layers of the stack and, increasingly, between them.

We examined four of these layers and the firms that inhabit them: AI-powered applications sold outside the stack; the AI models themselves, such as GPT-4, the brain behind ChatGPT, and repositories of them (for example, Hugging Face); the cloud-computing platforms which host many

of these models and some of the applications (Amazon Web Services, Google Cloud Platform, Microsoft Azure); and the hardware, such as semiconductors (made by firms such as AMD, Intel and Nvidia), servers (Dell) and networking gear (Arista), responsible for the clouds' computing power (see chart 1).

Technological breakthroughs tend to elevate new tech giants. The PC boom in the 1980s and 1990s propelled Microsoft, which made the Windows operating system, and Intel, which manufactured the chips needed to run it, to the top of the corporate pecking order. By the 2000s "Wintel" was capturing four-fifths of the operating profits from the PC industry, according to Jefferies, an investment bank. The smartphone era did the same to Apple. A few years after it launched the iPhone in 2007, it was raking in more than half of handset-makers' global operating profits.

The world is still in the early days of the generative-AI epoch. Even so, it has already been immensely lucrative. All told, the 100 or so companies that we examined have together created $8trn in value for their owners since its start—which, for the purposes of this article, we define as October 2022, just before the launch of ChatGPT (see chart 2). Not all these gains are the result of the AI frenzy—stockmarkets have been on a broader tear of late—but many are.

At every layer of the stack, value is becoming more concentrated. In hardware, model-making and applications, the biggest three companies have increased their share of overall value created by a median of 14 percentage points in the past year and a half. In the cloud layer Microsoft, which has a partnership with ChatGPT's maker, OpenAI, has pulled ahead of Amazon and Alphabet (Google's parent company). Its market capitalisation now accounts for 46% of the cloud trio's total, up from 41% before the release of ChatGPT.

The spread of value is uneven between layers, too. In absolute terms the most riches have accrued to the hardware-makers. These include semiconductor firms, companies that build servers and those that make networking equipment. In October 2022 the 27 public hardware companies in our sample were worth around $1.5trn. Today that figure is $5trn. This is what you would expect in a technology boom: the underlying physical infrastructure needs to be built first in order for software to be offered. In the late 1990s, as the internet boom was getting going, providers of things like modems and other telecoms gubbins, such as Cisco and WorldCom, were the early winners.

So far the host of the San Jose gabfest is by far the biggest victor. Nvidia accounts for some 57% of the increase in the market capitalisation of our hardware firms. The company makes more than 80% of all AI chips, according to IDC, a research firm. It also enjoys a near-monopoly in the networking equipment used to yoke the chips together inside the AI servers in data centres. Revenues from Nvidia's data-centre business more than tripled in the 12 months to the end of January, compared with the year before. Its gross margins grew from 59% to 74%.

Nivdia's chipmaking rivals want a piece of these riches. Established ones, such as AMD and Intel, are launching rival products. So are startups like Groq, which makes superfast AI chips, and Cerebras, which makes supersized ones. Nvidia's biggest customers, the three cloud giants, are designing their own chips, too—as a way to reduce reliance on one provider and to steal some of Nvidia's juicy margins for themselves. Lisa Su, chief executive of AMD, has forecast that revenues from the sale of AI chips could balloon to $400bn by 2027, from $45bn in 2023. That would be far too much for Nvidia alone to digest.

As AI applications become widespread, a growing share of demand will shift from chips required for training models, which consists of analysing

lots of data in order to teach algorithms to predict the next word or pixel in a sequence, to those needed to use them to respond to queries ("inference", in tech-speak). In the past year two-fifths of Nvidia's AI revenues came from customers using its chips for inference. Experts expect some inference to start moving from specialist graphics-processing units (GPUs), which are Nvidia's forte, to general-purpose central processing units (CPUs) like those used in laptops and smartphones, which are AMD's and Intel's. Before long even some training may be done on CPUs rather than GPUs.

Still, Nvidia's grip on the hardware market seems secure for the next few years. Startups with no track record will struggle to convince big clients to reconfigure corporate hardware systems for their untested technology. The cloud giants' deployment of their own chips is still limited. And Nvidia has CUDA, a software platform which allows customers to tailor chips to their needs. It is popular with programmers and makes it hard for customers to switch to rival chips, which CUDA does not support.

Whereas hardware wins the value-accrual race in absolute terms, it is the independent model-makers that have enjoyed the biggest proportional gains. The collective value of 11 such firms has jumped from $29bn to about $138bn in the past 16 months. OpenAI is thought to be worth $100bn, up from $20bn in October 2022. Anthropic's valuation rose from $3.4bn in April 2022 to $18bn. Mistral, a French startup founded less than a year ago, is worth $2bn or so. Some of that value is tied up in hardware. The startups buy piles of chips, mostly from Nvidia, to train models. Imbue, which like OpenAI and Anthropic is based in San Francisco, has 10,000 such semiconductors. Cohere, a Canadian rival, has 16,000. These chips can sell for tens of thousands of dollars apiece. More sophisticated models need more chips. GPT-4 reportedly cost about $100m to train. Some suspect that training its successor could cost OpenAI ten times as much.

Yet the model-makers' true worth lies in their intellectual property and the

profits it may generate. The extent of those profits will depend on just how fierce competition among model providers will get—and how long it will last. Right now the rivalry is white-hot, which may explain why the layer has not gained as much dollar value.

OpenAI seized an early lead, but challengers have been catching up. They are able to tap the same data as the maker of ChatGPT (which is to say text and images on the internet) and, also like it, free of charge. Anthropic's Claude 3 is snapping at GPT-4's heels. Four months after the release of GPT-4, Meta, Facebook's parent, released Llama 2, a powerful rival that, in contrast to OpenAI's and Anthropic's proprietary models, is open and can be tinkered with at will. In February Mistral, which has fewer than 40 staff, wowed the industry with an open model that almost rivals GPT-4, despite requiring much less computing power to train and run.

Even smaller models now offer good performance at a low price, says Stephanie Zhan of Sequoia, a venture-capital (VC) firm. Some are designed for specific tasks. A startup called Nixtla developed TimeGPT, a model for financial forecasting. Another, Hippocratic AI, has trained its model on data from exams to enter medical school, to give accurate medical advice.

The abundance of models has spurred the growth of the application layer. The value of the 19 listed software firms in our application group has jumped by $1.1trn, or 35%, since October 2022. This includes big software providers that are adding generative AI to their services. Zoom uses it to summarise video calls. ServiceNow, which provides tech and human-resources support to companies, has introduced chatbots to help resolve customers' IT queries. Adobe, maker of Photoshop, has an app called Firefly, which uses AI to edit pictures. Newcomers are adding more variety. "There's An AI For That", a website, counts over 12,000 applications, up from fewer than 1,000 in 2022. DeepScribe helps transcribe doctors' notes. Harvey AI assists lawyers. Thirty-two chatbots promise "sarcastic

conversation" and 20 generate tattoo designs. But fierce competition and low barriers to entry mean that many apps may struggle to capture value.

Then there is the cloud layer. The combined market value of Alphabet, Amazon and Microsoft has jumped by $2.5trn during the AI boom. Counted in dollars, that is less than three-quarters of the growth of the hardware layer, and barely a quarter in percentage terms. Yet compared with actual revenues that AI is expected to generate for the big-tech trio in the near term, this value creation far exceeds that in the other layers. It is 120 times the $20bn in revenue that generative AI is forecast to add to the cloud giants' sales in 2024. The comparable ratio is about 40 for the hardware firms and around 30 for the model-makers.

This implies that investors believe that the cloud giants will be the biggest winners in the long run. The companies' ratio of share price to earnings, another gauge of expected future profits, tells a similar story. The big three cloud firms average 29. That is about 50% higher than for the typical non-tech firm in the S&P 500 index of large American companies—and up from 21 in early 2023 (see chart 3).

Investors' cloud bullishness can be explained by three factors. First, the tech titans possess all the ingredients to develop world-beating AI systems: troves of data, armies of researchers, oodles of computing power and plenty of spare cash. Second, the buyers of AI services, such as big corporations, prefer to do business with established commercial partners than with untested upstarts (see chart 4).

Third, and most important, big tech has the greatest potential to control every layer of the stack, from chips to applications. Besides designing some of their own chips, Amazon, Google and Microsoft are investing in models and apps. Of the 11 model-makers in our sample, nine have the support of at least one of the giants. That includes the Microsoft-backed OpenAI,

Anthropic (Google and Amazon) and Mistral (Microsoft again). On March 19th Microsoft announced that it had hired Mustafa Suleyman, founder of Inflection AI, another model-maker, to head a new consumer-AI division—and with him many of Inflection's staff. (Mr Suleyman sits on the board of The Economist's parent company.)

The promise of profits from controlling more layers is leading hitherto layer-specific firms to branch out. OpenAI's VC arm has invested in 14 companies since its launch in January 2021, including Harvey AI and Ambience Healthcare, a medical startup. Sam Altman, boss of OpenAI, is reportedly seeking investors to bankroll a pharaonic $7trn chipmaking venture. Nvidia is becoming more ambitious, too. It has taken stakes in seven of the model-makers, and now offers its own AI models. It has invested in Together AI and CoreWeave, both of which compete with its big cloud customers. In San Jose it unveiled a new superchip and tools from other layers of the stack. The AI boom's biggest single value-creator is in no mood to cede its crown. ■

AI淘金热，企业挖到了多少？

英伟达和微软不是唯一的赢家【深度】

几乎每天都会有一次这样的兴奋时刻——又一家公司的市值因人工智能（AI）而飙升。因预期AI将提升销售额，硬件制造商戴尔的股价在3月的一天之内猛涨超过30%。几天后，云计算创业公司Together AI完成了新一轮融资，估值已从去年11月时的5亿美元上升到了13亿美元。英伟达是其投资者之一，这家生产AI芯片的公司自己的股价也在一路上涨。2022年11月，ChatGPT这个回应查询直逼真人的"生成式"AI问世，此前英伟达的市值约为3000亿美元，与家居装修连锁店家得宝（Home Depot）相当，而今它的市值已经达到2.3万亿美元，只比苹果公司低了大约5000亿美元。

AI频频登上新闻头条，让人很难辨别哪些企业是这轮AI热潮中真正的赢家——以及哪些企业会获得更长远的成功。为帮助回答这个问题，本刊研究了到目前为止价值在哪里增长最多，以及这种增长与AI"堆栈"（技术专家对AI运行所依赖的各种硬件和软件层的称法）中产品和服务的预期销售量是否相符。3月18日，AI堆栈中的众多公司齐聚圣何塞（San Jose），参加了由英伟达主办的为期四天的大会，探讨从机器人技术到药物发现的各种议题并展示了最新的AI创新。它突显出堆栈各层内部公司之间的激烈竞争，以及各层之间日益激烈的竞争。

我们研究了四个堆栈层以及其中的公司：面向栈外销售的由AI驱动的应用；AI模型本身，例如ChatGPT的大脑GPT-4，以及它们的存储库（如Hugging Face）；托管许多此类模型和一些应用的云计算平台（亚马逊云科技、谷歌云平台、微软Azure）；以及实现云计算能力的硬件，例如半导体（由AMD、英特尔和英伟达等公司制造）、服务器（戴尔）和网络设备（Arista）（见图表1）。

技术突破往往会催生新的科技巨头。上世纪80年代和90年代个人电脑的繁荣推动微软（开发Windows操作系统）和英特尔（制造运行该系统所需的

芯片）成为业界翘楚。根据投资银行杰富瑞（Jefferies）的数据，到了2000年代，"Wintel"拿走了PC行业营业利润的五分之四。智能手机时代也同样造就了苹果的至高地位。在2007年推出iPhone不过几年后，苹果的营业利润就已经占到全球手机制造商的一半以上。

生成式AI世代仍处在发展早期。尽管如此，它已经带来了巨大的获利。总体而言，自AI时代开启以来（本文将AI时代的起点划定在ChatGPT发布前夕的2022年10月），我们研究的约100家公司已为公司所有者创造了8万亿美元的价值（见图表2）。这些增长并不全是AI热潮的结果——近期股市普遍上涨，但其中很多确实是拜AI所赐。

在技术堆栈的每一层，价值都变得更为集中。过去一年半中，前三大公司在硬件、模型创建和应用层的总价值占比中位数增加了14个百分点。在云层，与ChatGPT的开发商OpenAI合作的微软已经超过了亚马逊和Alphabet（谷歌的母公司），其市值现在占到这三家云巨头总市值的46%，高于ChatGPT发布之前的41%。

价值在各层之间也分布不均。从绝对值看，价值增长最多的是硬件制造商，这包括半导体公司、服务器制造商和网络设备制造商。在2022年10月，我们调查的27家硬件上市公司的总价值约为1.5万亿美元，而今这个数字为5万亿美元。在技术发展繁荣期，这样的增长是符合预期的，因为要提供软件首先要建设底层实体基础设施。在上世纪90年代末，随着互联网繁荣期的开始，思科和世通（WorldCom）等提供调制解调器和其他电信设备的公司成了早期的赢家。

到目前为止，圣何塞大会的主办方是毫无争议的最大赢家。在我们所调查的硬件公司中，英伟达约占了市值增长的57%。市场研究公司IDC称，英伟达生产了80%以上的AI芯片。在将数据中心中AI服务器内的芯片连接在一起的网络设备方面，它也享有近乎垄断的地位。在截至1月底的12个月内，英伟达的数据中心业务的收入相比前一年增长了两倍以上。其毛利率从59%增长到了74%。

英伟达的芯片制造竞争对手希望能从这些财富中分一杯羹。AMD和英特尔这样的老牌公司正在推出竞品。像Groq这样制造超快速AI芯片的创业公司以及像Cerebras这样制造超大型芯片的公司也一样。作为英伟达最大的客户，三大云计算巨头也正在设计它们自己的芯片，以减少对单一供应商的依赖，同时也是为了从英伟达丰厚的利润中撬走一块。AMD的首席执行官苏姿丰（Lisa Su）预测，到2027年，AI芯片销售额可能会从2023年的450亿美元飙升到4000亿美元。这样的增长远非英伟达一家能独自消化。

随着AI应用的普及，越来越多的需求将从训练模型（包括分析大量数据以教会算法预测序列中的下一个单词或像素）所需的芯片转向响应查询（用技术术语来说就是"推理"）所需的芯片。在过去一年中，英伟达AI业务收入的五分之二来自于拿它的芯片用于推理的客户。专家预计，部分推理将从使用专用图形处理单元（GPU）转向使用通用中央处理单元（CPU），例如笔记本电脑和智能手机中的CPU，前者是英伟达的强项，后者则是AMD和英特尔的地盘。不久以后，甚至一些训练可能也会使用CPU而非GPU。

尽管如此，英伟达对硬件市场的控制在未来几年里看起来依然稳固。还没有什么成绩的创业公司将难以说服大客户重新配置企业硬件系统去适应它们未经检验的技术。云巨头对自家芯片的使用仍然有限。此外，英伟达还拥有CUDA软件平台，让客户能够根据自己的需求定制芯片。这一平台受到程序员的广泛欢迎，同时也让客户难以转向竞争对手的芯片，因为CUDA不支持这些芯片。

虽然从绝对值的角度看，硬件在价值增长的竞赛中胜出，但增长幅度最大的是独立模型开发商。过去16个月中，11家这类公司的总价值从290亿美元增加到约1380亿美元。据信OpenAI的估值已从2022年10月的200亿美元上升至1000亿美元。Anthropic的估值从2022年4月的34亿美元增至180亿美元。成立不到一年的法国创业公司Mistral的估值约为20亿美元。这些价值的一部分与硬件紧密相关。这些创业公司购买大量主要来自英伟达的芯片用于训练模型。和OpenAI及Anthropic一样来自旧金山的Imbue拥有1万块这样的芯片。它的加拿大竞争对手Cohere有1.6万块。这些芯片的售价可

以高达到几万美元一块。更复杂的模型需要更多芯片。据报道，GPT-4的训练成本约为1亿美元。一些人认为训练后续版本可能会让OpenAI花费十倍的成本。

然而，模型开发商真正的价值在于它的知识产权和可能产生的利润。这些利润的多少将取决于模型开发商之间的竞争会有多激烈、会持续多长时间。目前竞争白热化，这或许可以解释为什么这一层没有获得更多的绝对值增长。

推出了ChatGPT的OpenAI在早期抢得先机，但挑战者已经在迎头赶上。它们能够获得同样的数据（也就是互联网上的文本和图片），而且同样免费。Anthropic的Claude 3正在紧追GPT-4。在GPT-4发布四个月后，Facebook的母公司Meta发布了强大的竞品Llama 2。与OpenAI和Anthropic的专有模型不同，Llama 2是开源的，可以随意修改使用。2月，员工不到40人的Mistral以一款几乎能媲美GPT-4的开源模型令整个行业惊叹，而且它训练和运行模型所需的算力要少得多。

风投公司红杉资本（Sequoia）的斯蒂芬妮·詹（Stephanie Zhan）表示，现在即使更小的模型也能以低价提供良好的性能。一些模型为特定任务而设计。创业公司Nixtla开发了名为TimeGPT的金融预测模型。另一家名为Hippocratic AI的公司用医学院入学考试数据训练其模型来提供准确的医疗建议。

模型的丰富多样促进了应用层的扩张。自2022年10月以来，我们应用组中的19家上市软件公司的价值已经跃升了1.1万亿美元，增幅达35%。这其中包括将生成式AI添加到其服务中的大型软件供应商。Zoom用该技术生成视频通话内容概要。向公司提供技术和人力资源支持的ServiceNow已经推出了聊天机器人来帮助回答客户在IT方面的问题。开发Photoshop的Adobe推出了一款名为Firefly的应用，使用AI编辑图片。新进者正在把应用库变得更加丰富多彩。一个名为"There's An AI For That"的网站统计有超过1.2万个应用，而2022年时还只有不到1000个。DeepScribe帮助转录医生的证明。Harvey AI为律师提供协助。32个聊天机器人声称可以进行"讽刺性对

话"，还有20个可以生成纹身图样。然而，激烈的竞争和低准入门槛意味着许多应用可能会难以捕获价值。

然后是云层。在这轮AI热潮中，Alphabet、亚马逊和微软的总市值增长了2.5万亿美元，按绝对值计算不到硬件层增长的四分之三，按百分比算几乎只有硬件层增长的四分之一。然而，如果是相比AI在短期内预计将为这三大科技公司带来的实际收入，那么这一层的价值创造远远超过了其他层。预计在2024年生成式AI将为这些云巨头增加200亿美元的销售额；2.5万亿美元的市值增长是这个数字的120倍。相应地，硬件层公司的这一倍数约为40倍，模型开发商约为30倍。

这意味着投资者相信从长远来看，云巨头将是头号赢家。另一个衡量公司未来预期利润的指标市盈率也传达了类似的信息。三大云计算公司的平均市盈率为29。这比标准普尔500指数中的那些非科技类大公司高出约50%，也高于它们自己在2023年初时21的平均市盈率（见图表3）。

投资者看好云计算可以从三方面解释。首先，科技巨头拥有开发世界领先AI系统所需的所有要素：海量数据资源、大批研究人员、强大计算能力和大笔可用现金。其次，大公司等AI服务的买家更愿意与成熟的商业合作伙伴打交道，而不是与未经检验的新兴公司合作（见图表4）。

第三点，也是最重要的原因，大型科技公司最有潜力控制堆栈中从芯片到应用的每一层。亚马逊、谷歌和微软除了自己设计一些芯片外，还在投资模型和应用。在我们调查的11家模型开发商中有9家至少有三巨头其一的支持。其中包括微软投资的OpenAI、Anthropic（谷歌和亚马逊投资）和Mistral（也是微软投资）。3月19日，微软宣布已聘请另一家模型开发商Inflection AI的创始人穆斯塔法·苏莱曼（Mustafa Suleyman）来负责一个新的消费AI部门，他还带来了许多Inflection的员工。（苏莱曼是《经济学人》母公司的董事会成员。）

控制更多堆栈层可能带来利润，这让一些原本专注某一层的公司开始跨层拓展。自2021年1月成立以来，OpenAI的风投部门已经投资了14家公司，

包括Harvey AI和医疗创业公司Ambience Healthcare。据报道，OpenAI的老板山姆·奥尔特曼（Sam Altman）正在寻求投资者支持一个高达7万亿美元的芯片制造大计。英伟达的野心也在扩张。它已经持有七家模型开发商的股份，现在又推出了自己的AI模型。它还投资了与其大型云客户竞争的Together AI和CoreWeave。在圣何塞，英伟达推出了一款新的超级芯片和其他堆栈层的工具。作为AI热潮中创造价值最多的一家公司，英伟达可不打算把桂冠拱手让人。■

Why is it so hard to write a good book about the tech world?

Blame insularity, secrecy and timing

Burn Book. By Kara Swisher. Simon & Schuster; 320 pages; $30. Piatkus; £25

Filterworld. By Kyle Chayka. Doubleday; 304 pages; $28. Heligo Books; £22

WHEN PEOPLE ask Michael Moritz, a former journalist and prominent tech investor, what book they should read to understand Silicon Valley, he always recommends two. "They are not about Silicon Valley, but they have everything to do with Silicon Valley," he says.

One is "The Studio" (1969) by John Gregory Dunne, an American writer who spent a year inside 20th Century Fox watching films get made and executives try to balance creativity with profit-seeking. The other, "Swimming Across" (2001) by Andy Grove, a former boss of Intel, a chipmaker, is a memoir about surviving the Holocaust. It shows how adversity can engender grit, which every entrepreneur needs.

That Sir Michael does not suggest a book squarely about the tech business says a lot. Silicon Valley has produced some of the world's most gargantuan companies, but it has not inspired many written accounts with a long shelf life. Wall Street, by contrast, claims a small canon that has stood the test of time, from chronicles of meltdowns ("Too Big to Fail"), to corporate greed ("Barbarians at the Gate") to a fictionalised account ("The Bonfire of the Vanities") that popularised the term "masters of the universe".

Why not the masters of Silicon Valley? Part of the problem is access, as is often the case when writing about the powerful. Tech executives may let their guards down at Burning Man, but they have been painstakingly

trained by public-relations staff not to get burned by writers. This has been the case for a while. When John Battelle was writing "The Search" (2005), about online quests for information, he spent over a year asking to interview Google's co-founder, Larry Page. The firm tried to impose conditions, such as the right to read the manuscript in advance and add a footnote and possible rebuttal to every mention of Google. He declined. Google ended up granting the interview anyway.

Journalists who manage to finagle access can feel they owe a company and its executives and, in turn, write meek and sympathetic accounts rather than penetrating prose. Or they cannot break in—or do not even try—and write their book from a distance, without an insider's insights.

Two new books demonstrate how hard it is to write well about Silicon Valley. "Filterworld" is an outsider's account of the Valley's impact, which reads as if it was entirely reported and written in a coffee shop in Brooklyn. The book laments how "culture is stuck and plagued by sameness" and blames Silicon Valley's algorithms, "the technological spectre haunting our own era of the early 21st century".

This is the sort of tirade against tech that has spread as widely as Silicon Valley's apps. It is not wrong, but nor is it insightful. The author, Kyle Chayka, who is a journalist for the New Yorker, never reconciles the tension between the cultural "sameness" he decries and the personalisation everyone experiences, with online users possessing individual feeds and living in separate information bubbles. Nor is this a wholly new phenomenon. People have been complaining about globalisation eroding local culture since "recorded civilisation" began, the author concedes. In 1890 Gabriel Tarde, a French sociologist, lamented the "persistent sameness in hotel fare and service, in household furniture, in clothes and jewellery, in theatrical notices and in the volumes in shop windows" that spread with the passenger train.

"Burn Book" is a better, though imperfect, read. Kara Swisher, a veteran chronicler of Silicon Valley, is both an insider and an outsider. She has attended baby showers for tech billionaires' offspring and even hosted Google's top brass for a sleepover at her mother's apartment. But she has a distaste for the Valley's "look-at-me narcissists, who never met an idea that they did not try to take credit for".

In delicious detail, she offers her verdict on the techies who have become household names, such as Facebook's founder: "As sweat poured down Mark Zuckerberg's pasty and rounded face, I wondered if he was going to keel over right there at my feet." That was in 2010, before he had gone through media-training galore. Much as Truman Capote, an American writer, was willing to skewer the socialite swans of New York, Ms Swisher delights in prodding some of her subjects to make readers smile and squirm, such as media mogul Rupert Murdoch ("Uncle Satan") and Amazon's Jeff Bezos (who has "a genuinely infectious maniacal laugh").

Ms Swisher does not have Capote's élan, but her book succeeds where many fail because she explores the relationship between subject and writer, which lurks in the background of most tech books. In detailing her interactions with tech bosses over three decades, she shows how the industry became more furtive and destructive, less free and fun.

While Ms Swisher uses her memoir to hold up a mirror, unfortunately she does not gaze at it long. After chronicling the internet for the Washington Post, Wall Street Journal and her own outfit, Recode, she moved from the Valley to the swamp—Washington, DC—acknowledging that "I had become too much a creature of the place" and "part of the scene in a way that was starting to feel uncomfortable".

Still, she declines to tease out some of the more complicated aspects of covering the Valley, such as the thin line between source, friend and

adviser, and exactly how she covered the Valley dispassionately when her then-wife was a Google executive. Despite her journalistic ferocity, the reality was that Ms Swisher could not eviscerate many of her subjects, because she depended on them accepting her invitation to speak at her annual conference, one of her major sources of income, and on her podcast. She was not just "part of the scene"—she played a leading role.

Of course, journalists are not the only ones who deal with personal conflicts that affect how and what they write about tech. Too many in the Valley pursue books to buttress their personal brand, like a website or résumé that just happens to have a spine (but reads as spineless). This explains why so many venture capitalists have ventured into book-writing. The best of the lot is "Zero to One" (2014) by Peter Thiel, an early investor in Facebook, and Blake Masters, a student who took a class taught by Mr Thiel at Stanford. However, explaining how to build a monopoly, as it does with welcome and rare frankness, is probably something Mr Thiel and his peers regret, considering the scrutiny Silicon Valley has since elicited from regulators. Monopolies are not so in vogue these days.

Yet the simplest explanation for why it is so hard for a book about Silicon Valley to hit the mark is probably the most obvious: timing. The snail's pace of research and publishing is badly suited to Silicon Valley's speed. Today's pressing book idea is next year's stale one. Innovation cycles and companies' futures often pivot too quickly.

Take Adam Lashinsky, a journalist who wrote a book about Uber. He watched as the company faltered and tried to keep his text up to date. His aptly titled "Wild Ride" was published in 2017, a month before the dramatic firing of Uber's boss, Travis Kalanick. Mr Lashinsky has since sworn off writing about tech. His next book is about William Safire, a dead newspaper columnist. It is a subject that will not go out of date—and not try to control the narrative. ■

写一本关于科技圈的好书为什么这么难？

这要怪偏狭、保密和速度【《看完请销毁》和《过滤世界》书评】

《看完请销毁》，卡拉·斯维什尔著。西蒙与舒斯特出版社，320页；30美元。Piatkus出版社，25英镑。

《过滤世界》，凯尔·恰卡著。道布尔代出版社，304页；28美元。海力高出版社，22英镑。

每次有人问前记者、著名科技投资人迈克尔·莫里茨（Michael Moritz）应该读什么书来了解硅谷时，他总会推荐这么两本书。"它们与硅谷无关，但又与硅谷息息相关。"他说。

一本是美国作家约翰·格雷戈里·邓恩（John Gregory Dunne）的《制片厂》（The Studio，1969）。他在20世纪福克斯电影公司待了一年，观察电影的制作过程以及高管们如何努力在鼓励创意与追逐利润之间取得平衡。另一本是芯片制造商英特尔的前老板安迪·格罗夫（Andy Grove）所著《横渡生命湖》（Swimming Across，2001），这是一本大屠杀幸存者的回忆录。它向读者展示了逆境如何催生勇气和毅力，而这种品质是每个企业家都需要的。

莫里茨并没有推荐直接以科技行业为主题的书，这很说明问题。硅谷诞生了一些全球最庞大的公司，但并没有激发出很多经久不衰的相关著述。相比之下，华尔街倒是有一些经受住了时间考验的经典作品，从梳理经济崩溃历程的《大到不能倒》（Too Big to Fail），到描述商界贪婪的《门口的野蛮人》（Barbarians at the Gate），再到让"宇宙之王"一词流行起来的小说《虚荣的篝火》（The Bonfire of the Vanities）。

为什么"硅谷之王"这样的词没能流行起来呢？原因之一是作家们缺少接近科技大佬的机会，这是在写大人物时常见的难题。科技高管在火人节

（Burning Man）上可能会放松警惕，但他们受过公关人员的悉心培训，知道要避开写东西的人以免引火上身。很长时间以来都是这样。在约翰·巴特尔（John Battelle）撰写有关网上信息查询的《搜索》（The Search，2005年）时，他花了一年多的时间请求采访谷歌的联合创始人拉里·佩奇。谷歌提出了一些条件，例如提前阅读书稿、以及在书中每次提及谷歌时有权加脚注或可能的辩驳。巴特尔拒绝了。不过，谷歌最终还是同意了让他采访。

那些使点计谋取得近身机会的记者有时会觉得对这家公司和它的高管有所亏欠，结果写出来的内容可能温和并抱有同情，而不是犀利尖锐的。或者，他们打不进内部（甚至试都不试），只是从远处观望着著书，也就不可能有对内情的洞察。

两本新书展示了要写好一本关于硅谷的书有多难。《过滤世界》（Filterworld）是一个圈外人对硅谷影响力的描述，读起来仿佛完全是在布鲁克林的一家咖啡馆里调研写就的。这本书哀叹"文化受到同质化的困扰，停滞不前"，并指责硅谷的算法"是困扰21世纪初这一时代的技术幽灵"。

这种对科技长篇累牍的批评已经和硅谷的应用一样广泛传播。所言不虚，但也没什么深刻的见解。作者凯尔·恰卡（Kyle Chayka）是《纽约客》的记者，他没有解释他所贬斥的文化"同质化"与每个人体验到的个性化（在线用户有各自的信息流，活在相互隔离的信息茧房中）又是如何并存的。而且同质化也不是一个全新现象。作者承认，自"有记载的文明"开始以来，人们一直都在抱怨全球化侵蚀本地文化。1890年，法国社会学家加布里埃尔·塔德（Gabriel Tarde）慨叹，随着客运列车的普及，"酒店菜肴和服务、家具、服装和珠宝、戏剧通告和书店橱窗中陈列的书籍始终千篇一律"。

《看完请销毁》（Burn Book）更值得一读，尽管也不完美。卡拉·斯维什尔（Kara Swisher）是一位资深的硅谷记述者，她是圈内人，又不尽是。她参加过给科技亿万富翁家的孩子举办的迎接新生儿派对，甚至还在

她母亲的公寓里招待过谷歌高层彻夜聚会。但她厌恶硅谷那些"满脸都写着'快看我'的自恋狂，这些人碰到什么点子都想算到自己头上"。

通过生动有趣的细节描述，她对那些已经家喻户晓的科技牛人做出了自己的评判，比如Facebook的创始人。"当汗珠从马克·扎克伯格那苍白的圆圆脸上不断流淌下来，我心想他会不会突然昏倒在我脚边。"这个场景发生在2010年，当时扎克伯格还没有经受过大量来自媒体的试炼。就像美国作家杜鲁门·卡波特（Truman Capote）乐于辛辣讽刺纽约的社交名媛一样，斯维什尔也喜欢调侃她的一些描写对象，比如媒体大亨默多克（"撒旦大叔"）和亚马逊的贝索斯（他有"一种真正具有感染力的疯狂笑声"），让读者会心一笑或是尴尬不安。

斯维什尔的文字没有卡波特那种张扬的活力，但她的书成功做到了其他许多作者没能做到的，因为她探索了写作对象和作者之间的关系，而这在大多数科技业书籍中从不挑明。在详细描述三十年来她与科技大佬们的互动时，她展示了这个行业如何变得更遮遮掩掩也更具破坏性，越来越缺乏自由和乐趣。

斯维什尔用她的回忆录竖起了一面镜子。可惜，她没有长时间凝视它。在为《华盛顿邮报》、《华尔街日报》和她自己的播客Recode记录了互联网的历史后，她从硅谷搬到了华盛顿"沼泽地"。她认识到"我已经过度融入那个地方了"，"成了舞台的一分子，开始感到不舒服"。

然而，她没能反思梳理自己报道硅谷的过程中更复杂的一些层面，比如消息源、朋友和顾问的一线之隔，以及在她当时的妻子担任谷歌高管时，她对硅谷的报道如何能做到客观冷静。尽管她有新闻人的犀利彪悍，在现实中却无法真正去深入剖析她的许多报道对象，因为她还要指望他们受邀到她的年会（她的主要收入来源之一）和她的播客上谈话聊天。她岂止是"舞台的一分子"，她是主角之一。

当然，并非只有新闻记者会面对影响他们如何描写硅谷的个人利益冲突。硅谷有太多人通过写书来支撑他们的个人品牌，书无异于个人网页或

简历长了个书脊（但读起来却觉得作者没长脊梁）。这也解释了为什么有这么多风投家试水写书。这其中最好的一本是彼得·蒂尔与布莱克·马斯特斯（Blake Masters）合著的《从0到1》（2014），蒂尔是Facebook的早期投资者，马斯特斯在斯坦福大学读书时听过蒂尔的课。然而，尽管这本书以难得一见的坦率解释如何建立垄断并深受读者的欢迎，鉴于在这之后监管机构就开始重点关照硅谷，蒂尔和他的同行们可能是后悔做这种吐露的。今天，垄断可不那么流行了。

但是，写一本关于硅谷的好书如此之难的最简单原因可能也是最显而易见的——时机。调研和出版的龟速完全赶不上硅谷的节奏。一个今天难以抗拒的写作创意到明年就过时了。创新周期和公司的未来往往都转向太快了。

比如曾就优步写过一本书的记者亚当·拉辛斯基（Adam Lashinsky）。他一路追踪观察这家公司如何开始掉头向下，努力让自己的记述跟上最新动向。这本书有一个贴切的书名《狂野之旅》（Wild Ride），它于2017年出版，但就在上架一个月后，优步老板特拉维斯·卡兰尼克（Travis Kalanick）突然被踢出了这家公司。这以后，拉辛斯基发誓再也不碰科技题材。他的下一本书写的是已故报纸专栏作家威廉·萨菲尔（William Safire）。这个主人公不会过气，也不会试图控制作者怎么写他。■

How to train your large language model

A new technique is speeding up the process

IT IS NO secret that building a large language model (LLM) requires vast amounts of data. In conventional training, an LLM is fed mountains of text, and encouraged to guess each word before it appears. With each prediction, the LLM makes small adjustments to improve its chances of guessing right. The end result is something that has a certain statistical "understanding" of what is proper language and what isn't.

But an LLM that has only undergone this so-called "pretraining" is not yet particularly useful. When asked for a joke to cheer your correspondent up, for instance, the pretrained model GPT-2 just repeated the question back three times. When asked who the American president was, it responded: "The answer is no. The president is not the president." Clearly, teaching an LLM to do what humans want requires something more.

One way to align such models with users' expectations is through reinforcement learning from human feedback (RLHF). OpenAI, an American startup, introduced this technique in a preprint published in March 2022. It was a major ingredient in its recipe for ChatGPT, which was released eight months later.

RLHF normally involves three steps. First, human volunteers are asked to choose which of two potential LLM responses might better fit a given prompt. This is then repeated many thousands of times over. This data set is then used to train a second LLM to, in effect, stand in for the human being. This so-called reward model, designed to assign higher scores to responses a human would like, and lower scores to everything else, is then used to train the original LLM. As a final touch, a machine-learning

technique called reinforcement learning tweaks the knobs and levers of the original LLM to help reinforce the behaviours that earn it a reward.

This way of doing RLHF is quite involved—using two separate LLMs takes time and money, and the algorithm used for reinforcement learning is, to quote Rafael Rafailov at Stanford University, "quite painful". This has meant that, outside of OpenAI, Google and their rivals, nobody has really exploited its full potential.

It now turns out that the same results can be achieved for a fraction of the effort. Dr Rafailov and his colleagues, including Archit Sharma and Eric Mitchell, presented this alternative in December 2023 at NeurIPS, an AI conference. Their method, Direct Preference Optimisation (DPO), relies on a satisfying mathematical trick.

This trick hinges on the observation that for every reward model there is a specific theoretical LLM that would get full marks, and every LLM likewise has a theoretical reward model that would give it flying colours. (Just as, more prosaically, every pair of trousers has a theoretical person on whom they would sit perfectly, and every person has a theoretical pair of trousers that would best fit.) This observation that each LLM conceals an implicit reward model allowed the researchers to tinker with this model directly. In the old regime, the LLM learned from the reward model, which learned from the data. Now, the LLM can learn directly from the data.

According to the authors, removing the middleman makes DPO between three and six times more efficient than RLHF, and capable of better performance at tasks such as text summarisation. Its ease of use is already allowing smaller companies to tackle the problem of alignment, says Dr Sharma. A year ago only a few world-leading models, such as Google's Gemini and OpenAI's GPT-4, could afford to use RLHF. But as of March 12th eight out of the ten highest-ranked LLMs on an industry leaderboard used

DPO. Mistral, the French startup seeking to rival OpenAI, uses it. Meta, a social-media giant, has integrated it into a home-grown LLM.

Further improvements are sure to come. For one thing, the consensus view is that the big AI labs have made improvements to their proprietary algorithms since they stopped publishing details in 2022. But the problem of getting an LLM to do what a human would want and expect is far from done and dusted. After all, even other humans occasionally struggle. ■

如何训练大语言模型

一种新方法正在加快这一过程

构建大语言模型（LLM）需要大量数据，这已不是什么秘密。在传统的训练中，要给大语言模型灌输大量文本，并鼓励它猜测下一个该出现的单词。针对每次猜测，模型都会进行一些小调整以提高猜对的几率。最终结果是，对于什么是恰当的语言，什么不是，模型有了某种统计意义上的"理解"。

但是，只经过这种"预训练"的大语言模型还不是非常好用。例如，当被要求开个玩笑来给笔者提提神时，预训练模型GPT-2只是把这条提问重复说了三遍。当被问及美国总统是谁时，它回答说："答案是'不'。总统不是总统。"显然，要教会大语言模型按人类的需要做事还需要做更多工作。

要让此类模型对齐用户的期望，一种方法是"基于人类反馈的强化学习"（RLHF）。美国创业公司OpenAI在2022年3月发布的预印本论文中介绍了这种方法。这是八个月后发布的ChatGPT的主要支持技术之一。

RLHF通常包括三步。首先，请人类志愿者从大语言模型给出的两个可能回应中选择更符合提示词的那一个。如此重复成千上万次。然后再使用这个数据集训练第二个大语言模型，实际上就是代替了人类的角色。这种所谓的奖励模型会给人类会喜欢的回应分配更高的分数，给其他所有回应分配更低的分数，然后用于训练原始的大语言模型。最后，用一种称为强化学习的机器学习技术调整原始大语言模型的参数，以帮助强化那些为它赢得奖励的行为。

用这种方法来做RLHF相当费劲。使用两个独立的大语言模型耗时费钱，而用于强化学习的算法——用斯坦福大学的拉斐尔·拉斐洛夫（Rafael Rafailov）的话来说——"非常麻烦"。这意味着，除了OpenAI、谷歌以及和他们同档次的对手之外，还没有人能真正完全做好。

现在，人们发现，不用花那么多功夫也可以获得同样的结果。2023年12月，在AI界大会NeurIPS 上，拉斐洛夫和阿奇特·夏尔马（Archit Sharma）、埃里克·米切尔（Eric Mitchell）等同事提出了替代方案。他们的方法叫做直接偏好优化（Direct Preference Optimisation，DPO），依赖一个合用的数学技巧。

这个技巧取决于这样的观察，即对于每个奖励模型，理论上都存在一个大语言模型总能从它那里得到满分，同样对于每个大语言模型，理论上也有一个奖励模型总会给它打出满分。（用更通俗的话说就是，每条裤子理论上都能找到一个人完全合身地穿上，而每个人理论上也都能找到一条完全合身的裤子。）每个大语言模型都隐藏了一个隐性奖励模型，根据这一观察结果，研究人员能够直接修补这个隐性模型。在原来的方法中，大语言模型从奖励模型中学习，奖励模型从数据中学习。现在，大语言模型可以直接从数据中学习。

根据作者们的说法，去掉中间人使DPO的效率达到RLHF的三到六倍，并且能够在做文本摘要等任务中有更好的表现。夏尔马说，它的易用性已经使较小的公司能够解决对齐问题。一年前，只有少数几个世界领先的模型，如谷歌的Gemini和OpenAI的GPT-4，能够用得起RLHF。但到3月12日，在一个行业排行榜上排名最高的10个大语言模型中有8个使用了DPO。想要与OpenAI竞争的法国创业公司Mistral也使用了它。社交媒体巨头Meta已将其整合到自家研发的大语言模型中。

未来肯定还会有更多改进。一方面，人们普遍都认为，自2022年停止发布详细信息以来，大型AI实验室已经对其专有算法做了改进。但是，如何让大语言模型做一个人想要和期望的事情，这个问题还远未尘埃落定。毕竟，即使是其他人有时也做不到。■

Oil's endgame could be highly disruptive

The oil shocks of the future will be driven by demand, not supply

FOR DECADES, the biggest fears about oil centred on its supply. The lesson was first learnt half a century ago, when the Arab members of OPEC banned exports to America and other supporters of Israel in the Arab-Israeli war. Today you might think that the link between energy and geopolitics has been mercifully severed. Even as war has returned to the Middle East and Russia's invasion of Ukraine has made it a pariah to the West, oil markets have been largely quiescent. In fact, however, a new phase is beginning—one in which oil demand, not supply, will be the primary influence on energy markets. This shift will bring with it profound geopolitical consequences.

Governments everywhere are designing policies to reduce the demand for oil and boost alternative sources of energy, as they seek to fight climate change. Technologies such as those behind electric vehicles are only becoming cheaper and more advanced. The coming peak and subsequent decline of global demand for oil will determine prices and production over the decades to come.

Perversely, this shift will grant some producers more market power. The biggest, least carbon-intensive and cheapest reserves of petroleum by far are found in Saudi Arabia and its immediate OPEC neighbours in the Persian Gulf. As the market for oil shrinks, their share of production will soar. Depending on the pace of the energy transition, this cabal could command a market share of half or even two-thirds of global output by 2050, according to BP, an oil firm, compared with less than 40% today. Already places such as Kuwait, Saudi Arabia and the United Arab Emirates are home to some of the world's largest sovereign wealth funds and are

busily deploying capital and influence in their neighbourhood and beyond. Their piles of capital, and their desire to project their strength abroad, will only intensify.

Meanwhile, other oil powers will be left behind. Today national oil firms in several dozen countries in Africa, Latin America and Asia are pumping oil that is higher-cost and more carbon-intensive than the oil in the Gulf. By one measure, some $1.2trn of the $1.8trn in investments planned for the next decade by national oil companies could turn out to be unprofitable if countries make good on their official pledges to achieve net-zero emissions by 2050. Nigeria's NNPC, Mexico's Pemex and Indonesia's Pertamina are among those most at risk of being stuck with stranded assets. Because governments in many producing countries are often unduly reliant on commodity revenues, the failure of some national oil firms could lead to debt crises, bankruptcies and a decade of lost development. This would be a mirror-image of the debt crises that engulfed Latin America in the 1980s, after rising oil prices widened importing countries' trade deficits and crippled their ability to repay their debts.

How to manage this disruption? Speeding up the energy transition is necessary to tackle climate change, but the faster the transition, the worse the concentration of market power, and the greater the shock to high-cost producers. In the meantime coping mechanisms such as governments' strategic petroleum reserves could help to reduce volatility for oil consumers. These should be expanded to include the big developing countries in Asia and Africa, which will soon surpass China to become the biggest contributors to oil demand growth. The International Energy Agency, an official body created in the wake of the first oil shock, already co-ordinates strategic stocks kept by advanced economies. Its new negotiations with India should be expanded to include other big emerging economies, too.

For the unlucky producers, meanwhile, the priority must be to diversify while oil prices are relatively high and demand still strong. A few, ranging from Colombia's Ecopetrol to Malaysia's Petronas, are already spending a hefty share of their capital budgets on low-carbon technologies including renewables, hydrogen and carbon capture that could provide a hedge against an oil collapse. On average, however, national oil firms allocate barely 5% of their capital spending towards diversification; the West's oil majors, by contrast, spend 15%. Governments, too, must seek to ensure that economies can diversify away from oil, by setting business-friendly rules and spending on things like infrastructure and education, to allow private enterprise to thrive. Even so, some countries may nonetheless eventually require bail-outs, putting multilateral institutions under further strain. The supply-led oil shocks of the past half-century were a frequent source of geopolitical tumult. Unless the coming transition is approached with more foresight, the next-half century will be no less fraught. ■

石油的终局之战可能极具破坏性

未来的石油危机将由需求而非供应驱动

几十年来，对石油最大的忧虑主要集中在其供应上。这个教训始于半个世纪以前，当时欧佩克（OPEC）的阿拉伯成员国对在阿以战争中支持以色列的美国和其他国家实施石油禁运。今天，你可能认为能源和地缘之间的联系已经被幸运地切断了。在中东战火重燃、俄罗斯入侵乌克兰后受到西方的排斥之时，石油市场大体上风平浪静。不过事实上，一个新的阶段已经开启。在这个阶段，影响能源市场的主要因素将是石油需求而非供应。这种转变将带来深远的地缘后果。

为了应对气候变化，各国政府眼下纷纷制定政策以求减少对石油的需求，促进替代能源的发展。电动汽车等相关技术只会变得越来越便宜、越来越先进。全球石油需求将会达峰继而下降，这将决定未来几十年的油价和产量。

有悖直觉的是，这种转变将赋予一些产油国更大的市场支配力。沙特阿拉伯及其在波斯湾的欧佩克近邻拥有的石油储量无疑是规模最大、碳强度最低、成本也最便宜的。随着石油市场萎缩，它们的产量份额将大幅增加。根据BP的数据，到2050年，该集团可能占据全球石油产量的一半甚至三分之二（取决于能源转型的速度），而当前的占比不到40%。科威特、沙特阿拉伯和阿联酋等国的主权财富基金已位列世界最大，正积极在周边及更远地区部署资本、发挥影响力。它们的资本积累以及向海外投射实力的愿望只会不断加强。

与此同时，其他产油大国将被抛在后面。如今，非洲、拉丁美洲和亚洲几十个国家的国有石油公司开采石油的成本和碳强度均高于海湾地区。根据一项测算，如果各国兑现到2050年实现净零排放的官方承诺，那么国有石油公司未来十年计划投资的1.8万亿美元中约有1.2万亿美元可能无利可图。尼日利亚国家石油公司（NNPC）、墨西哥国家石油公司（Pemex）

和印尼国家石油公司（Pertamina）等都最有可能受困于搁浅资产。由于许多产油国的政府往往过度依赖石油收入，一些国有石油公司的经营失败可能导致债务危机、破产和长达十年的发展停滞。这将与1980年代席卷拉美的债务危机如出一辙，当时油价上涨导致进口国贸易逆差扩大，重创了它们的偿债能力。

如何应对这种混乱？加快能源转型是应对气候变化的必由之路，但转型越快，市场支配力的集中度就越高，对高成本产油国的冲击也越大。与此同时，政府的战略石油储备等应对机制有助于减少石油消费国面临的波动。这些机制应该扩大到亚洲和非洲的发展中大国，这些国家将很快超过中国成为石油需求增长的最大来源。在第一次石油危机之后成立的官方机构国际能源署（IEA）已经在协调发达经济体的战略储备。它与印度的新一轮谈判也应该扩大到其他大型新兴经济体。

| 原油觉醒

与此同时，对那些不幸的产油国来说，当务之急是在油价相对较高、需求依然强劲之际实现多元化。从哥伦比亚国家石油公司（Ecopetrol）到马来西亚国家石油公司（Petronas）的少数几家公司已经将资本预算相当大的一部分投入到低碳技术，包括可再生能源、氢能和碳捕获，以求对冲石油需求暴跌的风险。然而，平均而言，国有石油公司用于多元化的资本支出占比还不到5%；相比之下，西方石油巨头为15%。产油国的政府也必须努力确保经济能在石油之外实现多元化，为此制定有利于营商的规则并投资于基础设施和教育等领域，以让私营企业蓬勃发展。即便如此，一些国家最终可能还是需要救助，这将使多边机构承受更大压力。过去50年来，由供应引发的石油危机频繁掀起地缘动荡。除非以更有远见的态度应对即将到来的转型，否则未来50年的麻烦也不会少。■

How to harvest moisture from the atmosphere

New technologies could provide water to Earth's most arid climates

EVEN IN THE most speculative reaches of science fiction, there is no escaping humanity's dependence on liquid water. Luke Skywalker, the hero of the original "Star Wars" trilogy, grows up on his uncle's moisture farm, extracting water from Tatooine's arid atmosphere. The residents of the desert world Arrakis, accessible to anyone with a copy of Frank Herbert's novel "Dune" (or with three hours to kill at their nearest cinema), likewise use windtraps to steal precious liquid from the air.

Engineers on Earth, too, are increasingly looking to the atmosphere for water. They have good reason to do so. Even in the depths of Chile's Atacama Desert, often called the driest place on Earth, estimates suggest that fog and dew can generate some 200ml of water per square metre. Elsewhere, the atmosphere is even more generous. Worldwide, it is estimated to contain 12,900 cubic kilometres of water, roughly the volume of Lake Superior. Moreover, models indicate that evaporation driven by global warming will increase these levels by 27% over the course of the next 50 years.

Tapping this invisible reservoir is a priority. As Earth's temperatures rise and its population grows, ever more people are likely to run short of water. More than 2.3bn are currently living in water-stressed countries and analysts predict that further droughts will force roughly a third of these to move from their homes by 2030.

Collecting water from the air is nothing new. The Inca, who are widely thought to have invented the technique, placed buckets under trees to collect the condensation from heavy fog drifting in off the sea. On the

Canary Islands laurels, junipers and pines have come to be known as "fountain trees" for their association with fog harvesting. People dwelling in the arid mountains of Oman have long built cisterns under trees for the same reason.

Modern atmospheric water harvesting follows many of the same principles. Instead of using leaves as condensation traps, however, which drip over an impractically large area, modern traps instead consist of sheets of very fine polymer mesh. As fog flows through the sheets, tiny droplets of water stick to the polymer fibres. These droplets grow until gravity pulls them into a compact trough and, thence, a reservoir. While collectors vary in size, a 40-metres-square collector in a reasonably foggy area yields around 200 litres a day, enough to supply 60 people with drinking water.

Further improvements are possible. A team led by Urszula Stachewicz at AGH University of Krakow in Poland found that the sheet could be made even more productive by changing the way in which its polymer threads were manufactured. Dr Stachewicz theorised that careful manufacture via a process known as electrospinning could lend the sheet a slight electrical charge that would prove attractive to water droplets in fog. In experiments conducted in 2021 she and a team of colleagues found that such sheets yielded 50% more water.

This past August, she and Gregory Parisi, a PhD student at Rensselaer Polytechnic Institute in New York reported yet further improvements by adding titanium dioxide (TiO_2) to the mesh. Previous work had shown that titanium dioxide could be rendered superhydrophilic (intensely attractive to water) upon exposure to ultraviolet light—a hindrance under extremely foggy conditions, as water would stick to the mesh rather than trickle into the cistern. When fog was light, however, Dr Stachewicz and Mr Parisi found that a TiO_2-enhanced mesh became 30% more effective. Her fog collectors are now being used at sites on three continents.

Further inland, where fog is scarce, other solutions are needed. One effective approach involves harnessing the water already present in the air. When the temperature drops, the water-carrying-capacity of air decreases with it. This leads to excess water condensing onto surfaces, a process most often seen as dew. It is common in water-saturated places like Britain, but anywhere with little wind and an average relative humidity of 70% or greater can cajole water out of the air.

A key way to do this is with radiative cooling, a phenomenon that occurs at night when certain materials (like aluminium) radiate enough heat to cool below the ambient temperature of their surroundings. After sunset, water condenses on these materials, forms droplets and trickles off. Chambers built of these radiative materials sometimes include adsorbent inner surfaces to which water in the air readily sticks. When humid air drifts into such chambers, it loses its water upon exposure to the cool conditions before drifting out. One big benefit is that such techniques work best in places like deserts, with clear skies, high daytime temperatures and cool nights.

An important limitation of radiative cooling has long been its relative ineffectiveness by day. That changed in 2021 when Dimos Poulikakos and his then-doctoral-student Iwan Haechler, at ETH Zurich, crafted a piece of glass with a layer of silver at the bottom and a layer of silicon polymer, sandwiched between layers of chromium, at the top. The silver layer reflected away the incoming sunlight while the sandwiched polymer allowed the device to shed heat in the form of infrared radiation. This cooled the glass by up to 15°C below ambient temperatures, driving condensation even during the heat of the day. Paired with a heat shield, a condensation chamber built with this glass helped produce 1.2 litres of water per square metre a day.

Another challenge posed by radiative cooling systems is that water needs to

be wiped off the surface of the collection chambers. This requires power, typically from nearby turbines or solar panels, which can be expensive. To cut costs, Dr Poulikakos and Dr Haechler applied a superhydrophobic coating to the surface of the chamber, forcing water droplets off the surface and making it possible for the device to function without electricity.

Such technology is indeed affordable, with the prototype itself costing less than $50. But in many regions where water is desperately needed, humidity levels are too low for dew harvesting to be feasible. In places like these, the most promising options are those that make use of superabsorbent materials.

Many salts, chemical cousins of the familiar sodium chloride, will readily snatch water out of the air. With this in mind, an engineering team led by Peng Wang at King Abdullah University of Science and Technology in Saudi Arabia studied the effectiveness of hollow nanocarbon capsules filled with lithium chloride. In 2020 the researchers reported that these capsules could capture more than double their weight in water vapour from ambient air when relative humidity was below 60%. Similar techniques using other salts have proved capable of gathering water in humidity levels as low as 10%.

The findings are promising, but the technology has yet to advance beyond the prototype stage. The problem is inefficiency; even Dr Wang's world-leading capsules can only produce 1.6 litres of water per kilogram of lithium chloride over the course of ten hours in very arid conditions. Better than nothing, but inadequate for sustaining a community.

Between them, though, these technologies suggest a brighter future is possible. Areas so dry as to have gone without rainfall since modern records began may one day yield enough water to sustain settlement. And not just on a fictional planet. ■

水，水，到处有水

如何从空气中取水

新技术可为地球上最干旱的地区提供水源【深度】

即使在最具想象力的科幻小说中，人类也同样离不开液态水。《星球大战》正传三部曲的主角卢克·天行者（Luke Skywalker）在他叔叔的湿气农场长大，他们从塔图因星球（Tatooine）干燥的空气中提取水分。只要你有一本弗兰克·赫伯特（Frank Herbert）的小说《沙丘》（Dune）（或者在离你最近的电影院消磨三个小时），就可以走近沙漠星球阿拉基斯（Arrakis），那里的居民同样使用捕风器从空气中收集宝贵的液态水。

如今，地球上的工程师也越来越多地转向从空气中取水。他们这么做是有充分理由的。据估计，即使在有地球最干燥地区之称的智利阿塔卡马沙漠（Atacama Desert）的腹地，雾气和露水也可以产生每平方米约200毫升的水。而在其他地方，空气能提供的水分就更多了。据估计，全世界空气中的含水量达12,900立方公里，相当于一个苏必利尔湖。此外，多个模型显示，在接下来的50年里，全球变暖导致的水体蒸发会让空气中的含水量增加27%。

利用这个看不见的水库是当务之急。随着地球温度的上升和人口的增长，将会有越来越多的人面临缺水问题。目前有超过23亿人生活在水资源短缺的国家，分析人士预测，到2030年，他们中约有三分之一的人会因更严重的缺水问题而背井离乡。

从空气中收集水分并不是什么新鲜事。印加人被公认为是这项技术的鼻祖——他们在树下放置水桶，从海上飘来的浓雾中收集凝结的水滴。在加那利群岛，月桂树、杜松和松树因能聚集雾气中的水而被称为"喷泉树"。出于同样的原因，居住在阿曼干旱山区的人们也很早就开始在一些树底下建造蓄水池。

现代大气集水技术遵循许多相同的原理。不过由于树叶的过水面积较大，不适合用作凝结水的收集器，因此新型集水器由非常细密的聚合物网片构成。当雾气飘过这些网片时，细小水滴会附着在聚合物纤维上。这些水滴不断增大，直到在重力作用下滴落到一个小水槽中，然后流入蓄水池。虽然集水器的大小各不相同，但在雾气浓度尚可的地区，一个40平方米的集水器每天可以收集200升左右的水，足够60人饮用。

这项技术还有改进的空间。波兰的克拉科夫AGH科技大学（AGH University of Krakow）由乌尔苏拉·斯塔切维奇（Urszula Stachewicz）领导的研究小组发现，通过改变网片中聚合物单丝的制造方法，可以提高网片的集水效率。斯塔切维奇推断，利用一种被称为静电纺丝的工艺精心制造的网片能带有少量电荷，应该能吸引雾气中的水滴。在2021年进行的实验中，她和同事发现这种网片让集水量增加了50%。

去年8月，她和纽约的伦斯勒理工学院（Rensselaer Polytechnic Institute）的博士生格雷戈里·帕里西（Gregory Parisi）发布报告称，通过在网片材料中添加二氧化钛（TiO_2），能进一步提高吸水能力。之前的研究显示，二氧化钛在紫外线的照射下，可以产生超亲水性（对水具有超强的吸引力），这在雾气非常大的情况下是一种不利条件，因为水会粘在网片上，而不是流淌到蓄水池中。不过，斯塔切维奇和帕里西发现，当雾气不大时，添加了二氧化钛的网片的集水效率提高了30%。目前她的雾水收集器在三大洲的多个地点都有使用。

在雾气稀少的内陆则需要其他办法。一种有效方法是利用空气中已经看得到的水。当温度下降时，空气的携水能力会随之减弱。这会让多余的水分凝结在物体表面，形成我们常见的露水。这种情况在英国等空气含水量饱和的地方很普遍，但只要一个地方风少、且平均相对湿度达到或超过70%，就可以从空气中提取水。

这方面的一个关键方法是辐射冷却，这是一种发生在夜间的现象——当某些材料（比如铝）发散足够的热量，让自己的温度低于周围环境温度时，就会产生辐射冷却。日落之后，水分凝结在这些材料上形成水滴，然后滴

落下来。用这些辐射冷却材料建造的冷凝室有时会配备具有吸附功能的内壁，这样空气中的水分就很容易附着在上面。当潮湿的空气飘入这样的冷凝室，就会在它温度较低的环境中失去水分后再飘出去。这种方法有一大优势，就是在沙漠等天气晴朗、昼夜温差大的地方效果最好。

辐射冷却长期以来的一大局限性是，相对于夜间，它在白天基本不起作用。这种情况在2021年得到改变。当时苏黎世联邦理工学院（ETH Zurich）的迪莫斯·普利卡科斯（Dimos Poulikakos）和他的博士生伊万·哈伊奇勒（Iwan Haechler）制作了一块玻璃。这块玻璃的底层是一层银，上层是夹在两层铬之间的硅聚合物。银层能反射掉射入的阳光，而夹层中的硅聚合物可以让玻璃以红外线辐射的方式散热。这样一来，这种玻璃的温度可以比周围环境温度低最多15℃，即使是炎热的白天也会有水汽凝结。用这种玻璃建造的冷凝室再配上隔热罩，每天每平方米就能产生1.2升水。

辐射冷却系统面临的另一个挑战是，需要刮取冷凝室表面的水分。这需要用电，通常是由附近的风力涡轮发电机或太阳能电池板供电，这些设备可能造价不菲。为了降低成本，普利卡科斯和哈伊奇勒给冷凝室表面涂上超疏水涂层，让水滴能从表面滴落，从而让收集室不用电也能运转。

这种技术在价格上切实可行，原型机本身的成本不到50美元。但在许多极度缺水的地区，由于空气湿度太低，露水收集不太可行。在这种地方，最有前景的方法是使用超吸水性材料。

有很多与我们熟悉的氯化钠同族的盐类化合物可以轻易吸收空气中的水分。基于这一特性，沙特阿拉伯的阿卜杜拉国王科技大学（King Abdullah University of Science and Technology）的王鹏领导的一个工程团队研究了填充有氯化锂的空心碳纳米胶囊的吸水性能。2020年，他们发布报告称，当相对湿度不到60%时，这些胶囊可以从周围空气中捕获相当于自身重量两倍多的水汽。使用其他盐类化合物的类似方法已被证明能在相对湿度低至10%的情况下收集水分。

这类研究成果有很好的前景，但这项技术还处于原型阶段。目前的问题是效率低下：即使是王鹏发明的全球领先的胶囊，在非常干旱的环境下，每公斤氯化锂在1o小时内也只能收集1.6升水。虽说好过一无所获，但这样的集水量还不足以供应一个社区。

不过，如果上述技术一起发力，就有可能带来更光明的前景。自有现代记录以来滴雨未下的干旱地区有朝一日也可能产生足够的水让人类定居下来。而且这可不是发生在一个虚构的星球上。■

Making sense of the gulf between young men and women

It's complicated. But better schooling for boys might help

MEN AND women have different experiences, so you would expect them to have different worldviews. Nonetheless, the growing gulf between young men and women in developed countries is striking. Polling data from 20 such countries shows that, whereas two decades ago there was little difference between the share of men and women aged 18-29 who described themselves as liberal rather than conservative, the gap has grown to 25 percentage points. Young men also seem more anti-feminist than older men, bucking the trend for each generation to be more liberal than its predecessor. Polls from 27 European countries found that men under 30 were more likely than those over 65 to agree that "advancing women's and girls' rights has gone too far because it threatens men's and boys' opportunities". Similar results can be found in Britain, South Korea and China. Young women were likely to believe the opposite.

Unpicking what is going on is not simple. A good place to start is to note that young women are soaring ahead of their male peers academically. In the European Union fully 46% of them earn degrees, versus 35% of young men, a gap that has doubled since 2002. One consequence is that young women are more likely than men to spend their early adulthood in a cocoon of campus liberalism. Meanwhile, boys outnumber girls at the bottom end of the scholastic scale. Across rich countries, 28% of them fail to learn to read to a basic level. That is true of only 18% of girls.

Another big change is that, to varying degrees across the developed world, immense progress has been made in reducing the barriers to women having successful careers. College-educated men are still thriving, too—often as one half of a double-high-income heterosexual couple. Many

men welcome these advances and argue for more. However, those among their less-educated brothers who are struggling in the workplace and the dating market are more likely to be resentful, and to blame women for their loss of relative status. And young women, by and large, are glad of past progress but are keenly aware that real threats and unfairness remain, from male violence to the difficulty of juggling careers and children. In short, most young women and worryingly large numbers of young men complain that society is biased against their own sex.

Young women tend to vote for parties of the liberal left. Angry young men, sometimes dismissed as toxically masculine by those parties, are being shrewdly wooed by politicians from the right and the far right. In South Korea their support helped an overtly anti-feminist president win power. In America polls are muddy but some pollsters think young men are souring on the Democrats. In Europe, where many countries offer a kaleidoscope of political choices, young male votes have helped fuel the rise of reactionary outfits such as the AfD in Germany, Confederation in Poland and Chega, which surged at Portugal's election on March 10th.

There is no easy solution to any of this. But clearly, more should be done to help boys lagging behind at school to do better. Some policies that might work without harming their female classmates include hiring more male teachers (who are exceptionally scarce at primary schools in rich countries), and allowing boys to start school a year later than girls, to reflect the fact that they mature later. Better vocational training could encourage young men to consider jobs they have traditionally shunned, from nursing to administration. Schooling boys better would not only help boys. Increasing the supply of educated and (one hopes) less angry men would be good for the women who must share the same world. ■

理解年轻男女之间的分歧

这很复杂。但改善对男孩的学校教育成效可能会有帮助

男人和女人有不同的经历体验，所以你能想到他们的世界观会不一样。尽管如此，发达国家年轻男女之间日益扩大的分歧还是让人惊讶。来自20个发达国家的民意调查数据显示，20年前自称自由派而非保守派的18至29岁的男性和女性在比例上几乎没有差别，但现在这一比例的差距已经扩大到25个百分点。年轻男性似乎也比年长男性更反对女权主义，这与一代比一代更倾向自由主义的趋势背道而驰。来自27个欧洲国家的民意调查发现，30岁以下的男性比65岁以上的男性更有可能同意"提升女性和女孩的权利已经过头了，因为威胁到了男性和男孩的机会"。类似的调查结果也出现在英国、韩国和中国。而年轻女性的看法往往恰恰相反。

要搞清楚这到底是怎么回事并不简单。可以先来看看这样一个事实：年轻女性在学业上的成就正迅速领先于同龄男性。在欧盟足足有46%的年轻女性获得了学位，而年轻男性为35%，这一差距自2002年以来已经翻了一倍。一个结果是年轻女性比年轻男性有更高的比例在校园自由主义的茧房里度过她们成年的早期时光。同时，学业成绩垫底的学生里，男孩比女孩多。在整个富裕世界，有28%的男孩不具备基本的阅读能力，这样的女孩只占18%。

另一个重大变化是，发达国家在减少女性通向事业成功的障碍方面取得了不同程度的巨大进步。受过大学教育的男性仍然过得顺风顺水，他们往往会与一位同样高收入的女性结为伴侣。许多这样的男性欢迎这些进步，并且支持更进一步。但是，他们那些学历更低、在职场和婚恋市场中频频碰壁的兄弟们更有可能感到不满，并认为是女性造成了他们相对地位的下降。总的来说，年轻女性对过去的进步感到高兴，但也敏锐地意识到真正的威胁和不公平仍然存在，从男性暴力到难以兼顾事业和孩子等等。简而言之，大多数年轻女性和数量多到令人担忧的年轻男性都抱怨社会对自己的性别存有偏见。

年轻女性倾向于投票给自由主义左翼政党。而愤怒的男青年——他们有时被那些政党斥为"直男癌"——正在被来自右翼和极右翼的政客们不失时机地拉拢。在韩国，他们的支持帮助一位公开反对女权主义的总统赢得了权力。在美国，民调结果含混复杂，但一些民调专家认为，年轻男性对民主党渐生反感。在欧洲，许多国家存在多种多样的政治选择，年轻男性的选票帮助推动了极端保守政党抬头，如德国的选择党（AfD）、波兰的联邦党（Confederation）和在3月10日葡萄牙大选中异军突起的"够了"（Chega）党。

这些问题都没有简单的解决办法。但很明显，应该采取更多措施来帮一把学校里落后的男生。一些可能有用而又不会损害女同学的政策包括：聘请更多男教师（在富裕国家的小学里，男教师非常稀缺），以及考虑到男孩比女孩更晚熟的现实，允许男孩晚一年上学。更好的职业培训可以鼓励年轻男性考虑他们以往会绕道的工作，从护理到行政等。提升对男孩的学校教育成效不仅对男孩有益。多一些受教育程度高且（希望是）不那么愤怒的男性，对于必须和他们共享同一个世界的女性也是好事。■

Could there be a US-Mexico trade war?

The bilateral trade deficit has exploded since Donald Trump was president

MEXICAN AND US officials were cheered by trade data released in February. It showed that Mexico overtook China in 2023 to become the number-one exporter to the United States (see chart). The value of goods sold has been rising steadily, and reached almost $476bn for the year; the equivalent figure for Chinese goods fell sharply, from $536bn in 2022 to $427bn in 2023.

The last time Mexico overtook China, in 2002, it was a blip (and Canada held the top spot). Today its rise has the whiff of a new order for global trade. Data for January 2024 show the trend remains strong. United States' efforts to decouple from China and bring supply chains closer to home are intensifying, pushing trade through other countries. An updated free-trade agreement between the United States, Mexico and Canada, known as USMCA, has been in force since 2020. It supports Mexican exports of car parts, medical supplies and agricultural products to the United States.

But the third side of this trade triangle, between Mexico and China, is creating tension. China's firms did not sit idle while incentives were created for companies to look beyond its shores. They have been pushing into the same markets where the US aims to supplant China, including Mexico. This means many Chinese exports are simply taking "a slightly longer road to get to the same place", says Ana Gutiérrez of IMCO, a think-tank in Mexico City.

China appears to be promoting this strategy. In December the country's leaders said it was a priority to export products that are used to make finished goods, rather than the finished goods themselves. Mexico is an

attractive beachhead into the United States because USMCA gives tariff-free access for goods made with enough North American content.

Mexico's official customs data show no sustained influx of goods from China. But some US officials and industrialists believe Chinese inflows are being undercounted, whether deliberately or not. The suspicion is that Mexico turns a blind eye to imports from China, and that those are then re-exported to the United States.

Steel and aluminium are the main concern. In February Katherine Tai, the United States Trade Representative (USTR), noted a "lack of transparency regarding Mexico's steel and aluminium imports from third countries". In December Mexico imposed tariffs of up to 80% on some steel imports from China, but US officials remain frustrated. Setting tariff levels is one thing; actually enforcing them is another.

"What we've seen is that USMCA has really become a US, China and Mexico deal, where China is trans-shipping a lot of product through Mexico," says Jeff Ferry of the Coalition for a Prosperous America, a group that represents manufacturers.

Electric vehicles are a looming concern. The price of the average EV in China is roughly half that in the United States, and China produces more than half the world's output. Without hefty tariffs in place, Chinese EV sales in the United States would probably boom, much as they have in other countries. President Joe Biden's administration is mulling raising tariffs on the vehicles above their current level of 25%.

USMCA has rules against unfair subsidies and market practices, which are common among Chinese companies. But in many cases no law or rule is being breached. Mexico offers Chinese automakers a path around the tariff wall because USMCA's rules of origin contain what one US official calls

"loopholes" that allow for the integration of Chinese components. An importer can assemble Chinese components in Mexico and label Mexico as the country of origin, obscuring Chinese involvement. "New tools may be needed," says the official.

There is already a large car-manufacturing industry in Mexico, and Chinese money is pouring in, especially to northern states that are the biggest exporters to the United States. In February BYD, China's most successful EV manufacturer, said it would make 150,000 vehicles a year in Mexico. BYD says that production will serve the local market, but many companies are eyeing the larger, wealthier market north of the border.

Chinese foreign direct investment in Mexico hit $2.5bn in 2022. Margaret Myers, of the Inter-American Dialogue, a think-tank in Washington, notes the "remarkable growth" of sophisticated manufacturing by Chinese companies in Mexico.

No China in the chain

What might the United States do about this? In the case of steel and aluminium imports, it could copy its approach with the EU and Japan, where there are limits on the volumes that can be imported at lower tariff rates. Higher tariffs kick in after those limits have been reached. When the Trump administration lifted steel and aluminium tariffs on Mexico in 2019, it was on the condition that Mexico restrain export surges into the United States.

Electric vehicles are trickier. Some would like new rules to cut China out of supply chains entirely. "If you want to be a trading partner with the United States, we're not going to allow your country to be a stopping point for goods from China," says Mr Ferry. That would mean restrictive rules of origin and a tighter enforcement regime. It would also raise thorny questions about how to treat production by Chinese-owned factories in

Mexico.

Robert Lighthizer, who was the lead trade negotiator during Donald Trump's presidency, has said that a first step would be to strip China of its most-favoured-nation status. That would automatically ratchet up tariffs on Chinese products across the board. Enrique Dussel of UNAM, a university in Mexico City, says this would unmoor the world trade system. "The United States [would be] saying 'adopt my rules or you're against me'."

If Mr Trump wins in November, he is likely to adopt a harder stance toward Mexico. As well as Chinese trade, there is also the issue of migration. But perhaps most importantly Mr Trump loathes trade imbalances. The United States' trade deficit with Mexico rose to $152bn in 2023, up 17% from 2022. In 2026 Mexico and the United States, along with Canada, have to discuss whether to extend USMCA's validity by another 16 years, to expire in 2052 instead of 2036. Mr Trump signed USMCA, but that is no guarantee that he would not scrap it, or use its extension as leverage to extract concessions from Mexico. He has already talked of a 10% import tariff on goods from all countries, which is not possible for Mexico and Canada under USMCA's rules.

Mexico seems unprepared, says Mr Dussel. Claudia Sheinbaum, who is expected to be elected Mexico's next president in elections on June 2nd, is promoting "nearshoring" to raise Mexico's economic growth to 5% of GDP annually. "Mexico has an enormous sign reading 'Welcome China'," says Mr Dussel.

The question confronting Mexico is the extent to which it is willing to risk its vital relationship with the United States, to keep that welcome sign shining. ■

会爆发美墨贸易战吗？

自特朗普任期以来，美墨双边贸易逆差呈爆炸式增长

二月公布的贸易数据令墨西哥和美国的官员欢欣鼓舞。数据显示，墨西哥在2023年超过中国，成为对美最大出口国（见图表）。所销售商品的价值稳步上升，全年达到近4760亿美元；而中国商品的相应数字则大幅下降，从2022年的5360亿美元降至2023年的4270亿美元。

墨西哥上一次超过中国是在2002年，当时只是昙花一现（占据榜首的是加拿大）。如今，墨西哥的崛起露出一丝全球贸易新秩序的苗头。2024年1月的数据显示，这一趋势依然强劲。美国正加紧努力与中国脱钩，使供应链更靠近本土，推动贸易通过其他国家进行。美国、墨西哥和加拿大之间新修订的《美墨加协定》（USMCA）已于2020年生效。该协定支持墨西哥向美国出口汽车零部件、医疗用品和农产品。

但是，这个贸易三角的第三条边——由墨西哥和中国构成——正在制造紧张拉力。中国企业受到激励要放眼海外，它们没有闲着。它们一直在向美国希望拿来取代中国的那些市场推进，包括墨西哥。智库墨西哥竞争力研究所（IMCO）的安娜·古铁雷斯（Ana Gutiérrez）说，这意味着许多中国出口商品只不过是"多走了一点点路，到达的还是同一个地方"。

中国似乎正在提倡这种战略。去年12月，中国领导层表示，要优先出口用于制造成品的产品，而不是成品本身。墨西哥是进入美国的一个有吸引力的滩头堡，因为《美墨加协定》为含有足够北美成分的产品提供免关税准入。

墨西哥的官方海关数据没有显示中国货物持续流入。但一些美国官员和实业家认为，无论有意无意，中国货物的流入量被少计了。他们怀疑，墨西哥对从中国进口的商品睁一只眼闭一只眼，而这些商品随后转口到了美国。

钢铁和铝是关切的焦点。2月，美国贸易代表戴琪指出，"墨西哥从第三国进口的钢铁和铝缺乏透明度"。去年12月，墨西哥对从中国进口的部分钢材征收最高80%的关税，但美国官员仍然沮丧。制定关税水平是一回事，实际执行又是另一回事。

代表制造商的团体"繁荣美国联盟"（Coalition for a Prosperous America）的杰夫·费里（Jeff Ferry）说："我们看到的是，《美墨加协定》实际上已经成了《美墨中协定》，中国正通过墨西哥转运大量产品。"

电动汽车是一个日益引人关切的问题。中国普通电动汽车的价格大约是美国的一半，而中国产电动汽车占全球产量的一半以上。如果不征收高额关税，中国电动汽车在美国可能会像在其他国家一样热销。拜登政府正在酝酿对中国电动汽车加征关税，使之高于目前25%的水平。

《美墨加协定》有针对不公平补贴和不公平市场行为的条规，这样的补贴和操作在中国公司中很常见。但在许多案例中并没有哪条法律或规则被违反。墨西哥为中国汽车制造商提供了绕过关税墙的途径，是因为该协定的原产地规则存在一位美国官员所说的"漏洞"，让整合中国零部件的操作钻了空子。进口商可以在墨西哥组装中国零部件，并将墨西哥标为原产国，从而掩盖中国参与其中的痕迹。"可能需要新的应对办法了。"这位官员说。

墨西哥已经有了一个庞大的汽车制造业，而中国的资金也在不断涌入，特别是流向对美国出口量最大的北部各州。2月，中国最成功的电动汽车制造商比亚迪表示将在墨西哥年产15万辆汽车。比亚迪表示这部分生产将服务当地市场，但许多公司瞄准的都是边境以北那个更大、更富裕的市场。

2022年，中国在墨西哥的外国直接投资达到了25亿美元。华盛顿智库美洲对话（Inter-American Dialogue）的玛格丽特·迈尔斯（Margaret Myers）指出，中国公司在墨西哥的尖端制造业取得了"显著增长"。

| 产业链中没中国

美国对此可能会如何应对？在钢铁和铝进口方面，美国或许会复制对欧盟

和日本的做法，限制以较低关税税率进口的数量。达到这些上限后，就会征收更高的关税。特朗普政府曾在2019年取消对墨西哥的钢铝关税，其条件就是墨西哥克制对美钢铝出口激增。

电动汽车的问题要更棘手。一些人希望制定新规则，将中国完全排除在供应链之外。费里说："如果你想当美国的贸易伙伴，那我们是不会允许你的国家充当中国商品中转站的。"这就需要出台限制性的原产地规则和加大规则执行力度。这也会引发如何对待墨西哥中资工厂产品的麻烦问题。

曾在特朗普任总统期间担任首席贸易谈判代表的罗伯特·莱特希泽（Robert Lighthizer）说过，第一步将是剥夺中国的最惠国待遇。这将自动全面提高对中国产品的关税。位于墨西哥城的墨西哥国立自治大学（UNAM）的恩里克·杜塞尔（Enrique Dussel）说，这会松动世界贸易体系。"美国相当于在说，'采用我的规则，否则就是跟我对着干'。"

如果特朗普在11月胜选，他很可能会对墨西哥采取更强硬的立场。除了中国贸易问题，美国与墨西哥还存在移民问题。但最重要的或许还是特朗普厌恶贸易失衡。2023年，美国与墨西哥的贸易逆差上升到1520亿美元，比2022年增长了17%。2026年，两国加上加拿大必须讨论是否将《美墨加协定》的有效期从2036年再延长16年至2052年。特朗普签署了该协定，但这并不能保证他不会废除它，或利用延期为筹码迫使墨西哥做出让步。他已经谈到要对来自所有国家的商品征收10%的进口关税，而《美墨加协定》的存在令他不可能对墨加两国做到这一点。

杜塞尔说，墨西哥似乎并无准备。预计将在6月2日的选举中当选墨西哥下一任总统的克劳迪娅·希恩鲍姆（Claudia Sheinbaum）正在推动"近岸外包"，要将墨西哥的年经济增长提高到GDP的5%。杜塞尔说："墨西哥亮出了一块写着'欢迎中国'的巨大招牌。"

墨西哥面临的问题是，为了让这块欢迎招牌闪闪发亮，它愿意拿自己与美国的这份重要关系冒险到何种程度。 ■

America's extraordinary economy keeps defying the pessimists

Both Donald Trump and Joe Biden have ideas that endanger it

YOU HAVE to marvel at America's economy. Not long ago it was widely thought to be on the brink of recession. Instead it ended 2023 nearly 3% larger than 12 months earlier, having enjoyed one of the boomier years of the century so far. And it continues to defy expectations. At the start of this year, economists had been forecasting annualised growth in the first quarter of 1%; that prediction has since doubled. The labour market is in rude health, too. The unemployment rate has been below 4% for 25 consecutive months, the longest such spell in over 50 years. No wonder Uncle Sam is putting the rest of the world to shame. Since the end of 2019 the economy has grown by nearly 8% in real terms, more than twice as fast as the euro zone's and ten times as quickly as Japan's. Britain's has barely grown at all.

America's expansion is all the more striking when you consider the many things that could have killed it. As the Federal Reserve has fought inflation the economy has endured the sharpest rise in interest rates since Jimmy Carter was in the White House. The covid-19 pandemic, an intensifying trade war with China and the fight against climate change have together reshaped supply chains, labour markets and consumer preferences. Wars in Ukraine and Gaza have aggravated geopolitical tensions and worsened the strains on the global trading system.

Can America's remarkable strength persist? Threats to growth still hang over the economy. The longer interest rates stay high, for instance, the more damage they could do. Although inflation has fallen, it remains sticky above the Fed's 2% target, meaning that the Fed may be unable to fulfil investors' hopes for interest-rate cuts starting in June. Geopolitical

tensions, meanwhile, look likely to spur economic fragmentation. Yet the biggest threat of all stems from November's presidential election. Neither Joe Biden nor Donald Trump seems likely to nurture the economic expansion should they return to the White House. Instead, their plans would endanger it.

To understand this, consider the reasons for the economy's extraordinary performance. A key plank was generous pandemic stimulus, which at 26% of GDP was more than double the rich-world average. This largesse fuelled inflation but also ensured fast growth: consumers have yet to spend all the cash they received in "stimmy" cheques. Even as the covid crisis passed, the government continued to borrow away. The underlying deficit over the past year was nearly 8% of GDP. That supported demand even as rates went up.

Strong demand has been met by growing supply. America has 4% more workers than it did at the end of 2019, thanks in part to rising workforce participation, but mainly owing to higher immigration. The foreign-born population is up by 4.4m, a figure which may undercount those who arrived illegally. And the expanding workforce is being put to productive use. America's flexible labour market has almost certainly made it easier for the economy to adapt fast to a changing world.

Other long-standing strengths have made America enviably placed to cope with geopolitical tumult. Its vast internal market encourages innovation and means it depends less on foreign trade than smaller rich economies do. Because the shale boom of the 2010s made America a net energy exporter, it has in aggregate benefited rather than suffered from the high energy prices that hit the wallets of Europeans.

The trouble is that each of the ingredients for growth can no longer be relied upon. It may be tempting for politicians to extrapolate from America's recent success and juice the economy with further stimulus. But

that is becoming unsustainable. Official forecasts show that America will this year spend more on debt interest than national defence. More borrowing risks building up financial perils in the future.

At the same time, both Mr Trump and Mr Biden harbour populist and protectionist instincts that will only harm America's growth potential. The sugar-rush of stimulus helped mask the damaging effects of such policies during each president's first term. This time, however, the damage will not be disguised.

Mr Trump poses the graver threat. He has entertained a blanket 10% tariff on imports, which some of his advisers see as a mere starting-point. That would triple America's existing levies on goods imports, worsen inflation and raise the cost of imported parts for manufacturers. At the same time, Mr Trump has promised the mass deportation of illegal immigrants. This goes well beyond trying to secure the border against new unauthorised entrants—a reasonable goal—and poses a risk to the labour supply: in 2021 America's 10.5m irregular migrants made up an estimated 5% of its workforce.

A Trump presidency would also threaten the Fed's independence. Mr Trump says he would not reappoint its chairman, Jerome Powell, whose term expires in 2026, and whom he often criticised when in office. A pliant Fed at a time of big deficits—which Mr Trump might increase with more tax cuts—could threaten America's macroeconomic stability.

A second Biden term promises nothing as potentially catastrophic. Mr Biden has let the Fed get on with fighting inflation, and wants to raise taxes to reduce deficits. Yet he is also an economic nationalist. His State of the Union address on March 7th was littered with protectionist promises that the government would "Buy American", and statist ideas about controlling the price of everything from housing to Snickers bars.

| Muscle memory

Both Mr Biden and Mr Trump harbour a misplaced nostalgia for the 1950s and '60s, and justify their policies by painting today's economy as weaker than it is. Mr Trump thinks trade and immigration have made the country poorer; Mr Biden is deeply distrustful of big business. And where they do acknowledge America's strengths, both men attribute it to their own misguided interventionism. In fact, they are chipping away at the free markets which are the ultimate source of the country's wealth.

The truth is America has thrived as its companies and workers have innovated and adapted to a rapidly changing world. If the next president does not recognise that, America's pumped-up economy will eventually deflate. ■

美国经济的非凡表现不断打破悲观预期

特朗普和拜登的计划都可能破坏这一势头

你不得不惊叹美国经济的表现。不久前，人们普遍认为美国经济濒临衰退。但相反，在2023年结束之际，美国经济总量较12个月前增长近3%，成为本世纪较繁荣的年份之一。美国经济还在打破预期，今年年初，经济学家预测第一季度的年化增长率为1%，现在预测已翻了一番。就业市场同样强劲，失业率已连续25个月低于4%，创下50多年来最长纪录。难怪美国让世界其他国家相形见绌。自2019年底以来，美国经济实际增长近8%，是欧元区的两倍多，是日本的十倍。而英国几乎没有增长。

考虑它面对的诸多不利因素，美国的经济增长更显惊人。为对抗通胀，美联储实施了自卡特执政时期以来最大力度的加息。新冠疫情、与中国日益激烈的贸易战，以及应对气候变化的努力共同重塑了供应链、劳动力市场和消费者偏好。乌克兰和加沙的战争加剧了地缘紧张态势，给全球贸易体系带来了更大压力。

美国能否维持这非凡的强韧？威胁增长的因素依然挥之不去。例如，高利率维持的时间越久，可能造成的损害就越大。尽管通胀已有所下降，但依旧高于美联储2%的目标，这意味着美联储可能无法像投资者预期的那样在6月开始降息。与此同时，地缘紧张局势很可能刺激经济碎片化。然而，最大的威胁源自11月的总统大选。不管是拜登还是特朗普执掌白宫，似乎都不会促进美国经济增长。相反，他们的计划可能危及美国经济。

要理解这一点，来看看美国经济表现出众的原因。一大关键是美国在疫情下推出的慷慨刺激政策，规模达到GDP的26%，是富裕国家平均水平的两倍多。如此大手笔的支出推高了通胀，但也确保了快速增长：消费者到现在还没有花光从"纾困"支票里收到的钱。即使疫情危机已过，美国政府继续举债。过去一年，美国的基础赤字占GDP之比接近8%，这使得美国在持续加息之时，需求仍能得到支撑。

需求强劲又恰逢供给增加。相比2019年底，美国就业人口增加了4%，这里有劳动参与率上升的因素，不过主要原因还是移民增加。外国出生人口增加了440万，这可能还没完全计入非法移民的数量。不断扩大的劳动人口正在进入经济生产。美国灵活的劳动力市场无疑让经济能更好地快速适应这个变化中的世界。

其他长期优势也让美国在应对地缘动荡时处于令人艳羡的有利位置。美国广阔的国内市场鼓励创新，使得它相比较小的富裕经济体更少依赖对外贸易。2010年代的页岩油革命使美国成为净能源出口国，总体而言这让美国成为能源价格高涨的受益者，而不是像欧洲人那样受到冲击。

但问题是，这些推动增长的因素没有哪个可被继续依赖。政客们可能会根据美国近期的成功得出经验，再推出刺激政策来提振经济。但这已变得不可持续。官方预测显示，今年美国在债务利息上的支出将超过国防开支。进一步举债可能推高未来的金融风险。

与此同时，特朗普和拜登都带有民粹主义和保护主义倾向，而这只会危害美国的增长潜力。在这两位总统的首个任期内，刺激措施的即时强效提振都帮助掩盖了这些政策的破坏性影响。然而这一次，这种破坏将无从隐身。

两人当中，特朗普的破坏力更大。他提出对进口商品全面征收10%的关税，他的一些顾问认为这只是个起点。这将使美国的商品进口关税升至原来的三倍，加剧通胀，推高部分制造商进口零部件的成本。同时，特朗普承诺大规模驱逐非法移民。相比保护边境避免更多人非法入境这一合理目标，这种做法非常过火，可能危及劳动力供给：2021年，美国有1050万非法移民，约占其劳动人口的5%。

特朗普当选总统也可能威胁美联储的独立性。他表示不会再次任命自己在任时经常批评的鲍威尔（任期将于2026年结束）继续担任美联储主席。目前赤字高企，而特朗普还可能会通过更多减税措施来增加赤字，如果这时美联储对白宫言听计从，可能会威胁美国宏观经济的稳定。

如果拜登连任，应该不会带来灾难性后果。拜登已放手让美联储继续打击通胀，同时打算增税来降低赤字。然而他也是个经济民族主义分子。他于3月7日发表的国情咨文充斥着政府"买美国货"的保护主义承诺，以及要控制从住房到士力架等一切商品的价格的国家主义思想。

肌肉记忆

拜登和特朗普都对上世纪五六十年代有一种不合时宜的怀念，并把当前经济描绘得比实际更疲弱，以此为自己的政策辩护。特朗普认为贸易和移民让美国更穷；拜登对大公司深怀疑虑。而在确实承认美国拥有的优势时，两人又都归功于自己那些错谬的干预主义政策。实际上，他们正在削弱自由市场这一美国财富的终极源泉。

事实是，美国经济欣欣向荣，是因为美国公司和工人不断创新并积极调整来适应这急速变化的世界。如果下一任总统没有意识到这一点，美国膨胀的经济终将泄气。■

The history of the West is not quite what you learned in school

Josephine Quinn's new book re-examines what people think they know about civilisations

How the World Made the West. By Josephine Quinn. Random House; 592 pages; $38. Bloomsbury; £30

ASKED WHAT he thought of Western civilisation, Mahatma Gandhi is said to have quipped that such a thing "would be a good idea". (The West, he suggested, was not so enlightened.) But as Josephine Quinn makes clear in her new book, Western civilisation has always been a bad idea, or at any rate a wrong-headed one. To compartmentalise history into a set of distinct and essentially self-contained civilisations is a misguided quest that has dangerously distorted our understanding of the world, Ms Quinn asserts: "It is not peoples that make history, but people, and the connections that they create with one another."

Ms Quinn, a historian and archaeologist who teaches at Oxford, does not spend 500-odd pages trashing what generations of schoolchildren have been taught to take pride in as European achievements. Instead, she demolishes the underlying concept of what she calls "civilisational thinking". Her argument is simple, persuasive and deserving of attention.

The idea of civilisation, Ms Quinn points out, is relatively recent. The word was first used only in the mid-18th century and did not take hold of Western imaginations until the late 19th century. In that imperialist age, historians found that Greek, Roman and Christian civilisations made nice building blocks that could be stacked into a grand-looking construct, which they labelled "Western" or "European" civilisation. To this they attributed a host of inherited "classical" virtues: vigour, rationality, justice, democracy

and courage to experiment and explore. Other civilisations, by contrast, were regarded as inferior.

It does not take much unpacking by Ms Quinn to expose the folly of this approach. Behold, for instance, John Stuart Mill, a philosopher in the 19th century, claiming that the Battle of Marathon, Persia's first invasion of Greece in 490BC, was more important to English history than William the Conqueror's triumph at Hastings in 1066. (Without an Athenian victory, the logic goes, the magical seed of Greek civilisation might never have grown into Western civilisation.) Or consider "The Clash of Civilisations" (1996) by Samuel Huntington, an American historian, who declared it impossible to understand history without classifying humanity into mutually hostile civilisations between which, "during most of human existence", contact has been "intermittent or non-existent".

What is non-existent is any truth to that notion. Ms Quinn's brisk, scholarly romp across the arc of European history shows that, far from being rare, contact across and between cultures, often over surprisingly long distances, has been the main motor of human advancement in every age. Rather than being prickly and inward-looking, most societies have proved receptive to ideas, fashions and technologies from their neighbours.

Ancient Greece, for example, was less a place of origins than of transmission from Egyptian, Sumerian, Assyrian and Phoenician cultures, which themselves had mixed and exchanged ideas. And rather than being the wellspring of democracy, Athens was "something of a latecomer" to a form of governance that appears to have been first tried in Libya and on the islands of Samos and Chios. Persians, eternally cast as Greeks' polar opposites, actually imposed democracy on the Greek cities they ruled, suggesting "considerable Persian faith in popular support for their own hegemony", Ms Quinn notes.

This retelling of the West's story scintillates with its focus on the unexpected and on the interstices between realms and eras rather than on history's big, solid bits. But it is also an admirable work of scholarship. Ms Quinn's 100-plus pages of footnotes reveal that she relied not only on a wide range of primary sources, but also on scientific studies on climate change and very recent archaeological research.

Even seasoned history buffs will find much that is new and fascinating. "How the World Made the West" joins a growing sub-canon of works that explores the broad sweep of history using new intellectual framings, such as Yuval Noah Harari's "Sapiens" (2011), Peter Frankopan's "The Silk Roads" (2015) and "Fall of Civilisations", a forthcoming book by Paul Cooper, a British journalist, based on his popular podcast. Anyone who thought history was passé could not be more wrong. ■

西方历史跟你从课堂上学到的不太一样

约瑟芬·奎恩的新书重新审视了人们对文明的认知【《世界如何缔造了西方》书评】

《世界如何缔造了西方》，约瑟芬·奎恩著。兰登书屋，592页，38美元；布鲁姆斯伯里出版社，30英镑。

据说圣雄甘地在被问及如何看待西方文明时，曾经打趣道，这东西真要有，"倒也不赖"。（在他看来，西方并没有那么文明。）不过，正如约瑟芬·奎恩（Josephine Quinn）在她的新书中阐述的那样，"西方文明"这个概念从来就不好，或至少也是有误的。试图将历史划分为一系列各不相同、本质上自成一体的文明是一种误入歧途的做法，它扭曲了我们对世界的理解，这很危险。奎恩主张："历史的创造者不是各种人群，而是所有人，以及他们彼此间建立的联系。"

奎恩是任教于牛津大学的历史学家和考古学家。她没有花500多页的篇幅驳斥一代代学童被教导要以之为荣的"欧洲成就"，而是推翻了她称之为"文明思维"的底层概念。她的论据简明有力，值得关注。

奎恩指出，"文明"是一个相对较新的概念。这个词在18世纪中期才被首次使用，直到19世纪后期才引起了西方人的兴趣。在那个帝国主义时代，历史学家发现，希腊、罗马和基督教文明是一块块好砖，可以搬来砌成一座他们标榜为"西方"或"欧洲"文明的宏伟建筑。他们为这种文明披挂上一系列承继下来的"传统"美德：活力、理性、正义、民主，以及尝试和探索的勇气。相比之下，其他文明则被视为劣等文明。

无需过多拆解，奎恩就揭示了这种观点的荒谬性。比如，19世纪哲学家约翰·密尔曾声称，论对英国历史的重要性，公元前490年波斯首次入侵希腊的马拉松战役要胜过征服者威廉在1066年黑斯廷斯战役中取得的胜利。（这里面的逻辑是，如果没有雅典人的胜利，希腊文明的神奇种子可能永远不会成长为西方文明。）再比如，美国历史学家塞缪尔·亨廷顿

（Samuel Huntington）在其1996年出版的《文明的冲突》（The Clash of civilizations）中宣称，如果不把人类划分为相互敌对的文明，就不可能理解历史，"在人类存在的大部分时间里"，各种文明之间的交往"断断续续或者根本不存在"。

这种观点根本站不住脚。透过奎恩对欧洲历史脉络专业而利落的梳理，我们可以看到，不同文化之间的交往一点也不罕见，甚至常常跨越了难以置信的遥远距离，成为每个时代人类进步的主要动力。事实证明，大多数社会都愿意接受来自邻居的思想、时尚和技术，而不是抵触和自我封闭。

例如，古希腊与其说是西方文明的发源地，不如说是埃及、苏美尔、亚述和腓尼基文化的传播地，而这些文化本身也经历了各种思想的融合与交流。雅典与其说是民主的源泉，不如说有点像民主的"后进者"——这种治理方式似乎最早试行于利比亚，以及希腊的萨摩斯岛和希俄斯岛等地。总是被视为与希腊人截然不同的波斯人，事实上却在当年统治的希腊城邦中强制推行了民主，这表明"波斯人对民众支持自己的统治地位相当有信心"，奎恩指出。

这本书对西方历史的重述让人眼前一亮——它所关注的是人们意想不到的东西，以及不同领域和不同时代之间的断层，而不是历史上那些重大而完整的阶段。但它同时也是一部令人钦佩的学术著作。书中有100多页附有脚注，从中可以看出奎恩的论据不仅来自各种一手资料，还来自有关气候变化的科研成果和最新的考古研究。

即使是见多识广的历史爱好者也会从中发现很多让人耳目一新、饶有兴味的东西。《世界如何缔造了西方》是又一部用新思想框架探索浩瀚历史的另类力作，这个内容不断丰富的类别包括尤瓦尔·诺亚·赫拉利（Yuval Noah Harari）的《智人》（Sapiens，2011年）、彼得·弗兰科潘（Peter Frankopan）的《丝绸之路》（The Silk Roads，2015年），以及英国记者保罗·库珀（Paul Cooper）根据自己的热门播客改编的新书《文明的衰落》（Fall of Civilisations，即将出版）等等。那些认为历史学已经过时的人真是大错特错了。■

How can firms pass on tacit knowledge?

The problem of knowing what your co-workers know

LAST MONTH Odysseus became the first American spacecraft to land on the surface of the Moon in more than 50 years. The mission, a collaboration between NASA and a private firm called Intuitive Machines, can be counted a partial success: the craft did send back images even though its landing did not go to plan. Things might have gone better still if it had not been so long since NASA last visited the Moon. Experience usually makes things go more smoothly.

NASA does have an archive of materials from the Apollo missions. Sometimes, however, knowledge is lost for good. Gino Cattani of NYU Stern School of Business and his co-authors have looked at the violin-making family dynasties of Antonio Stradivari and others in Cremona, in Italy, in the 17th and 18th centuries. Modern players still laud the sound of the instruments made by these craftsmen. But there was a gap of about a century between the heyday of these dynasties and the rise of the public performances that showcased the instruments' qualities. In that time the techniques of the Cremonese luthiers were lost.

Most organisations do not routinely blast into orbit or wait a century for customer feedback. But all organisations face the problem of storing and transferring knowledge so that newcomers know what's what, lessons are learned from successes and failures, and wheels are not constantly being reinvented. An ageing workforce adds to the urgency of training inexperienced hires before the old hands leave the building.

Some knowledge is easier to codify than other. In the 1960s Corning, a glassmaker, had developed a particularly strong glass that was christened

Chemcor. Plans to commercialise this material faltered—among other reasons, it turned out that this was not a great windscreen for motorists to hit at speed—and Chemcor was put on the shelf.

There it remained until 2005, when the firm started to wonder whether mobile phones might provide a use for Chemcor, which was renamed Gorilla Glass. In 2007 the boss of Corning took a call from Steve Jobs, who was hunting for the right kind of glass for a new smartphone. You presume that no one at Corning has since questioned the value of keeping good records.

The tougher task is capturing "tacit knowledge". This is the know-how born of experience, which cannot easily be documented in the manuals and is not much thought about by those who have it.

Working alongside experienced colleagues is the best way to transfer tacit knowledge but it is not always possible. Sometimes you only want your very best people working on something, especially if the stakes are high. The most valuable employees are usually the ones with the least time to mentor others. When NASA was working on a Mars rover programme in the 2010s, it gave younger engineers a smaller, parallel project: to build a rover for use in educational programmes on Earth. It wasn't the real thing, but it was a way to give them some hands-on experience. NASA also has an emeritus programme that gets retired veterans to mentor junior staff.

Technology is both an answer and a barrier to the transfer of tacit knowledge. It is easier than ever to record and disseminate the wisdom of older hands. Unfortunately, it is easier than ever to record and disseminate the wisdom of older hands: the podcast episodes proliferate, the hours of unwatched training videos pile up. Watching someone on a screen is often less stimulating than hearing from them face-to-face. A recent study by Niina Nurmi and Satu Pakarinen, two Finnish researchers, found that

participants in virtual meetings feel drowsier than those meeting in person, which is saying something.

Christopher Myers of Johns Hopkins University is a fan of informal storytelling as a way of passing on tacit knowledge. He spent time with the crews on an air medical transport team in America, whose jobs include flying patients by helicopter from the scene of an emergency to a hospital. Crew members routinely shared stories—on shift changes, at mealtimes and at weekly meetings—in order to learn how to respond to unusual situations. (Top tip: in the event of a poisonous-snake bite, the local zoo is a good bet to get antivenom.)

Some stories are more gripping than others: people don't sit round camp fires telling each other how to get the printer to work. But managers everywhere should think about how to capture tacit knowledge. That starts by recognising the importance of retaining workers. You can't share experience if no one has any. ■

企业如何传承隐性知识？

知道你的同事都知道些什么是个难题

上个月，奥德修斯号（Odysseus）成为50多年来第一艘登陆月球表面的美国航天器。这次任务由美国国家航空航天局（NASA）和一家名为"直觉机器"（Intuitive Machines）的私营公司合作完成，可以说取得了部分成功：尽管飞船的着陆没有按计划进行，但它确实发回了图像。要不是距离NASA上次访问月球的时间实在隔得太久，结果说不定还会更好。经验通常会让事情进行得更加顺利。

NASA确实有阿波罗计划的资料档案。然而有些时候，知识永久地丢失了。纽约大学斯特恩商学院的吉诺·卡塔尼（Gino Cattani）及合著者研究了17和18世纪意大利克雷莫纳的安东尼奥·斯特拉迪瓦里（Antonio Stradivari）等人的小提琴制造家族王朝。现代的演奏家们仍对出自这些工匠之手的乐器的音色赞不绝口。但是，从这些家族的鼎盛时期到一展乐器品质的公开表演兴起，中间相隔了大约一个世纪。在那期间，克雷莫纳制琴师的技艺失传了。

大多数组织并不会定期将产品送入轨道或花一百年等客户的反馈，但所有组织都面临知识存储和传递的问题。有了存储和传承，新人才能知道什么是什么，才能从成功和失败中吸取经验教训，才不会一直浪费时间从头做起。鉴于员工队伍的老龄化，在老员工离职前培训好经验欠缺的员工愈发紧迫。

有些知识比其他知识更容易整理归档。20世纪60年代，玻璃制造商康宁（Corning）研发出一种特别坚固的玻璃，并给它取名Chemcor。这种材料的商业化计划失败了，原因之一它用作挡风玻璃时耐不住驾车者在高速行驶时发生撞击，于是Chemcor被束之高阁。

它就这么被搁置，直到2005年。康宁开始琢磨手机也许能用得上

Chemcor，它也有了个新名字：大猩猩玻璃。2007年，康宁的老板接到了史蒂夫·乔布斯的电话。当时乔布斯正在给一款新的智能手机寻找合适的玻璃。可以想见，自那以后在康宁没人会质疑认真记录留档的价值。

更艰巨的任务是捕捉"隐性知识"。这类专门技能源于经验，不容易记录在册，掌握这些知识的人也不怎么思考琢磨它们。

与经验丰富的同事并肩工作是传授隐性知识的最佳途径，但这并非总是可行。有时，你只想把某项工作交给最优秀的人去做，尤其是在事关重大的情况下。最有价值的员工通常也最没有工夫指导他人。2010年代NASA在开展火星探测器计划时，曾给年轻的工程师们安排了一个规模更小的并行项目：建造一个探测器，用于在地球上的科教项目。这不是真的火星探测器，但也是个让他们上手获得些许实战经验的办法。NASA还设有荣誉退休职位，请已退休的老将来指导初级工作人员。

在如何传递隐性知识的难题上，技术既是解决方案，也是障碍。记录和传播前辈的智慧从未如此容易。不幸的是，记录和传播前辈的智慧从未如此容易：播客数量激增，未观看的培训视频迅速累积。在屏幕上看一个人往往不如面对面听一个人说话那么能启迪人心。两名芬兰研究人员尼娜·努尔米（Niina Nurmi）和萨图·帕卡里宁（Satu Pakarinen）最近的一项研究发现，参加虚拟会议的人比亲身参加会议的人更容易昏昏欲睡，这说明了一些问题。

约翰·霍普金斯大学的克里斯托弗·迈尔斯（Christopher Myers）推崇的一种传承隐性知识的方法是轻松随意地讲故事。他曾与美国一支空中医疗运输队的机组人员共处过一段时间，他们的工作包括用直升机将病人从急救现场送往医院。机组人员经常在换班、用餐和每周例会时分享故事，从而学习如何应对不寻常的情况（重要小提示：如果被毒蛇咬伤，可以去当地动物园注射抗毒血清）。

有些故事比别的故事更扣人心弦，比如人们就不会围坐在篝火旁交流如何使用打印机。但天底下的管理者都应该思考如何留存隐性知识。首先就要

认识到留住员工的重要性。如果员工都是"零经验"，还谈何分享。■

Bitcoin's price is surging. What happens next?

The cryptocurrency is up by 63% this year

FOR A BRIEF moment, everyone who owned bitcoin had made money from it. On March 5th the crypto token rose to an all-time high of just above $69,000—a level sure to delight the meme-loving crypto-crowd—before slipping back a little. The record capped a remarkable comeback from the dark days of November 2022, when interest-rate rises were crushing risk appetite and FTX, a crypto exchange, had just gone bust. Buying bitcoin on such exchanges seemed like little more than a fun and novel way to get robbed.

Bitcoin is hardly rallying in isolation: everything is going up. Stockmarkets all over the world are near record highs. So are gold prices. Even bond prices are climbing after a miserable two-year stretch. The catalyst is a combination of hype about artificial intelligence, joy at the state of the global economy and expectations of looser monetary policy to come.

Still, bitcoin is doing better than most assets. On January 10th the Securities and Exchange Commission, an American regulator, approved applications by 11 investment firms, including BlackRock and Fidelity, to create bitcoin exchange-traded funds (ETFs). These make it easier for everyday investors to buy the cryptocurrency. Rather than setting up an account with a specialist exchange, creating a crypto wallet, making a bank transfer and then finally buying bitcoin, people can now simply log on to their brokerage accounts and purchase an ETF. Assets in the ten largest bitcoin ETFs now come to around $50bn. And the activity appears to be self-reinforcing: the more money is poured in, the higher the price goes, the more people chatter about bitcoin ETFs, the more money pours in and so on and so on.

Bitcoin has been in existence for 14 years. The elegant mechanism by which it validates itself and supply grows has never been hacked, meaning that the token is not going anywhere. Yet it is now obvious that it is of pretty limited use for payments, as it is restricted by both the high costs and slow speed of transactions. Those trying to build applications on top of blockchains are not doing so using bitcoin either. With the creation of ETFs, bitcoin's future looks to be as an investment asset and nothing more. So after this initial surge of interest, what will its returns look like?

It would be foolish to extrapolate from bitcoin's entire history. Over the past 14 years the cryptocurrency has morphed from a niche cyberpunk idea into something approaching a mainstream financial asset. Its more recent price movements might provide some clues, however. There are two explanations for them. One is that purchases are basically a broad bet on technological progress, with variations that reflect prospects for crypto itself. For instance, even as tech stocks soared in the middle of 2021, bitcoin slumped after Elon Musk posted negative tweets about crypto payments. Prices were depressed in late 2022, too, even as stockmarkets were rallying, owing to FTX's failure.

The other theory is that bitcoin is a kind of digital gold. After all, supply is inherently limited, just as gold supply is restricted by the amount of the metal in the ground. Neither asset pays a yield nor earns profits. This theory fell out of favour in 2021 and 2022, as inflation soared and bitcoin collapsed, but last year the cryptocurrency once again moved in line with gold.

Perhaps both theories contain elements of truth. And a hybrid tech-stock-crypto-vibes-gold-bet asset could be useful in even pedestrian portfolios, especially if it is only somewhat correlated with other assets an investor might hold. Diversification among uncorrelated assets is the foundational principle of portfolio management. Reallocating, say, 1% of a fund to

bitcoin would be a low-stakes hedge.

If investors buy this argument, bitcoin's price is likely to rise for a while yet. What happens, then, when the cryptocurrency's transition into a standard financial asset is complete? Assume that bitcoin has been added to most investor portfolios. Also assume that crypto tech does not really catch on. In this world, bitcoin's returns probably do come to resemble those of gold: there is a fixed amount of it, and its price would rise over the long term roughly in line with the stock of money. That implies steady single-digit returns. The creation of a bitcoin ETF may have set off a frenzy of eye-popping gains—but the future it portends could be slower and steadier. ■

比特币价格飙升。接下来会发生什么？

今年比特币上涨了63%

有那么一小会儿，每个持有比特币的人都从中赚到了钱。3月5日，比特币一度涨破6.9万美元，创历史新高，之后略有回落。这一高点自然让喜欢玩梗的加密爱好者感到欣喜。该纪录标志着比特币在2022年11月那段黑暗时期后强势回归，当时利率上涨压制了风险偏好，加密交易所FTX刚刚破产，在这些交易所购买比特币似乎不过是以一种新颖有趣的方式被割韭菜。

上涨的不只有比特币，一切都在涨。世界各地的股市都接近创纪录高位。黄金价格也是如此。即使是惨淡了两年的债券价格也在涨。对人工智能的炒作、对全球经济现状的欣喜之情，以及对未来货币政策更加宽松的预期结合在一起，催化了这一波行情。

然而，比特币的表现要好于大多数资产。1月10日，美国监管机构证券交易委员会（SEC）批准了包括贝莱德（BlackRock）和富达（Fidelity）在内的11家投资公司的申请，允许它们创建比特币交易所交易基金（ETF）。这让普通投资者更容易购买这种加密货币。以前，人们需要在专门的交易所开设账户、创建加密钱包、进行银行转账，然后才能购买比特币，现在他们只需登录证券账户就可以购买这些ETF。目前，前十大比特币ETF的资产总额约达到500亿美元。这种投资方式似乎形成了一个自我强化的循环：越多资金涌入，价格就越高，就有越多人关注比特币ETF，继而吸引越多资金涌入，周而复始。

比特币已经存在了14年。它验证自身并增加供应的精妙机制从未被攻破，意味着这种代币还会这样存在下去。然而，现在显而易见的是，由于受交易成本高、速度慢的限制，它在支付方面的用途相当有限。那些试图在区块链上构建应用的人也不使用比特币。随着ETF的创建，未来比特币除了是一种投资资产外似乎没有更多用途。因此，当刚开始的兴趣高涨过后，

它的回报将会如何呢？

试图从比特币的整个历史去推断是荒诞的。在过去的14年里，这种加密货币已经从一个小众的赛博朋克理念变成了一种接近主流金融资产的东西。然而，它近期的价格波动也许能提供一些线索。关于这些波动有两种解释。一种是，买进比特币基本上反应的是整体上对技术进步的押注，其变化反映了加密货币本身的前景。例如，2021年年中，在马斯克发布了有关加密货币支付的负面推文后，尽管科技股不断飙升，比特币仍然大幅下跌。2022年底，尽管股市在上涨，但由于FTX破产，比特币价格依然低迷。

另一种理论是，比特币是一种数字黄金。毕竟，比特币的供应在本质上是有限的，就像黄金供应受到储量的限制一样。这两种资产都不产生收益，也不赚取利润。然而在2021年和2022年，由于通胀飙升和比特币崩溃，这种理论不再流行，但去年比特币的走势再次与黄金一致。

也许两种理论都有一定道理。而一种兼具科技股、加密货币、黄金投资等特点的资产即使在普通投资组合中都很有用，如果它与投资者可能持有的其他资产只在一定程度上有关联的话就更有用了。在不相关的资产中分散投资是投资组合管理的基本原则。比如，将一只基金中的1%重新配置到比特币会是一种低风险对冲。

如果投资者认同这种观点，比特币的价格很可能还会再涨一阵子。那么，到比特币完成向标准金融资产的转变时会怎样？假设比特币已被添加到大多数投资者的投资组合中，再假设加密技术并没有真正流行起来，那么在这种情况下，比特币的回报可能确实将与黄金相似：其总数是固定的，而其价格涨势从长远看将大致与货币存量一致。这意味着回报将是稳定的个位数。比特币ETF的诞生可能引发了令人瞠目结舌的疯狂上涨，但它也预示未来的上涨趋势可能会更慢、更稳定。■

How medical gloves will help launch satellites

Graphene rises to new heights

GRAPHENE IS strong, lightweight, flexible and an excellent conductor of electricity. In the 20 years since it was first isolated at the University of Manchester, however, it has also proved dispiritingly light in useful applications. That is slowly beginning to change, as its remarkable properties keep researchers well-stocked with inspiration. For Krzysztof Koziol at Cranfield University in Britain, for example, what began as a covid-era plan to use graphene to improve surgical gloves has now morphed into a project to use high-altitude balloons to launch satellites into space.

Graphene, which consists of monolayers of carbon atoms bonded in a repeating hexagonal pattern, can be made in a number of ways, mostly by stripping flakes of carbon from mined graphite (sticky tape and pencil lead will do). Levidian Nanosystems, a Cambridge firm, uses a more sustainable process. It captures methane, a potent greenhouse gas, from various industrial sources, and then zaps it with microwaves inside a reaction chamber. This cracks the gas into its constituent parts, with hydrogen emerging at the top and graphene flakes at the bottom.

Dr Koziol leads a team of researchers who work with Levidian on a variety of graphene-based applications, from reinforcing aircraft, cars and wind turbines to lining gas pipelines. In 2019, they also worked with Meditech Gloves, a Malaysian firm, to improve its surgical and examination gloves. The company makes these from latex, a mixture of water and natural rubber tapped from the bark of rubber trees. As some people are allergic to proteins found in latex, most medical gloves tend to be made from petroleum-based nitrile rubber instead. As covid took hold, some 80m pairs

of gloves were being used by health workers every month, with the nitrile ones ending up in landfill. There, they could take roughly 100 years to decompose.

Cranfield helped Meditech speed up production. It developed a new latex formula to make the firm's gloves hypoallergenic and then added graphene for a version that is lighter and stronger. Both types are currently being certified for medical use. They are more sustainable than nitrile gloves because natural rubber absorbs carbon dioxide rather than producing it, and they should biodegrade in about a year.

Testing the integrity of surgical gloves involves filling them with air and looking for leaks. Treating them, in other words, like balloons. For Dr Koziol, the parallel was particularly intriguing. Most balloons used in aerospace applications (to conduct high-altitude monitoring, for example, or for communications) are produced with synthetic plastics and filled with helium, which is becoming scarce on Earth. A graphene balloon, however, could carry heavier payloads and be filled with hydrogen instead. The hydrogen might also power any on-board devices through a fuel cell.

The Cranfield team are working with Levidian and others to produce graphene-infused natural rubber aerospace balloons to operate at altitudes of 30km. Satellites could one day be sent into orbit from here on rocket-powered launch vehicles, which would need only a small amount of fuel having been lifted to a thinner atmosphere with lower gravity. The researchers are now investigating 3D-printing to make medical gloves and balloons. For safety reasons, rockets tend to be launched over remote areas or the sea. Balloons offer greater flexibility and Dr Koziol wants to build a launch pad at Cranfield, in the heart of the English countryside. There is plenty of room: as a former aeronautical college, it still operates an active airfield. ■

医用手套如何帮助发射卫星

石墨烯升上新高度【新知】

石墨烯坚固、轻质、柔韧，是一种优秀的电导体。不过，自20年前它在曼彻斯特大学被首次分离出来后，它在实际应用上的无足轻重也令人扫兴。这种情况正慢慢开始改变，因为它的卓越特性不断带给研究人员丰富的灵感。例如，对于英国克兰菲尔德大学（Cranfield University）的克日什托夫·科齐奥尔（Krzysztof Koziol）来说，一个最初在新冠疫情期间利用石墨烯改进手术手套的方案现在已经演变成了利用高空气球将卫星发射到太空的项目。

石墨烯是由单层碳原子以六边形模式重复键合而成，可以通过多种方式制成，主要是从开采的石墨中剥离碳片（就像用胶带从铅笔芯上粘一些石墨下来一样）。位于剑桥的Levidian Nanosystems公司采用了一种更加可持续的工艺。它从各种工业排放源中捕获甲烷（一种强效温室气体），然后在反应室内用微波将其分解。这会让甲烷裂解成其组成元素，顶部生成氢，底部是石墨烯薄片。

科齐奥尔领导的研究团队和Levidian合作探索各种基于石墨烯的应用，从加固飞机、汽车和风力涡轮机，到用于天然气管道内衬等。2019年，他们还与马来西亚公司Meditech Gloves合作，改进其手术和检查用手套。Meditech Gloves用乳胶生产这些产品，乳胶是水和从橡胶树树皮中提取的天然橡胶的混合物。有些人对乳胶中的蛋白质过敏，所以大多数医用手套往往由石油基的丁腈橡胶制成。在新冠疫情蔓延期间，医疗工作者每月用掉约8000万双手套，其中的丁腈手套最终被填埋。而它们可能需要大约100年才能分解。

克兰菲尔德大学团队帮助Meditech加快了生产速度。它开发了一种新的乳胶配方，让该公司生产的手套具有低过敏性，后来又通过添加石墨烯制成了一种更轻、更坚韧的手套。这两种手套目前正在申请医用认证。它们比

丁腈手套更具可持续性，因为天然橡胶吸收二氧化碳而不是产生二氧化碳，而且它们大约一年内就能生物降解。

测试手术用手套的完好性需要给它们充气并找寻漏气点。也就是像吹气球一样。对于科齐奥尔来说，这样的类比尤其有意思。用于航空航天（例如进行高空监测或通信）的大多数气球都是用合成塑料制成的，充的是氦气，而地球上的氦气正日益稀缺。石墨烯气球则能携带更多的有效载荷，还可以充氢气。氢气或许还能通过一组燃料电池为气球携带的所有设备供电。

克兰菲尔德大学团队正与Levidian等公司合作，开发添加了石墨烯的天然橡胶航空气球，能在30千米的高空运行。有朝一日也许可以从这个位置用运载火箭把卫星发射到轨道上，由于这里的大气层更稀薄、重力更小，只需要少量燃料就能发射入轨。研究人员目前正在尝试用3D打印技术制造医用手套和气球。出于安全考虑，火箭往往在偏远地区或海上发射，而气球提供了更大的灵活性。科齐奥尔想在位于英国乡村腹地的克兰菲尔德大学建立一个发射台。空间是足够的：该大学之前是一所航空学院，现在还有一个仍在运行的机场。■

A new technique to work out a corpse's time of death

AI could make the work of pathologists more accurate

IN FICTION, hard-pressed pathologists presented with a corpse are able to take a bite of their sandwich and instantly pronounce a time of death. Reality is, of course, a lot messier, and the results—or lack of them—can make or break a case.

Now artificial intelligence is offering a helping hand. By analysing thousands of deaths and what follows, the technology can offer the best estimates so far of the post-mortem interval (PMI).

Working out when a person has died is the most basic (but frustratingly imprecise) part of a forensic investigator's work. For decades these specialists have had to rely on intuition, combined with observations of the state of the deceased and clues such as temperature, both of the dead body and the environment. Different bodies decay at different rates, however, and individual circumstances can throw off the most careful PMI calculations. A body found in a ditch in northern England in 2004, for example, was given an erroneously late time of death because the ditch was shielded from sunlight and the colder-than-expected conditions had helped preserve the corpse.

Forensic-science journals are full of such cases—some routine, others bizarre—while the potentially useful details of thousands more investigations are buried in case files around the world. Now forensic researchers in America are working to access and compile these valuable write-ups, and to use machine learning to analyse them. The result is an AI-powered tool, called geoFOR, that could offer the most reliable estimates of PMI so far. Sandwiches are not included.

Developed by a research team led by Katherine Weisensee at Clemson University in South Carolina, the model is based on data pooled from more than 2,500 death investigations, with more added each week. About 1,800 of these are real-world cases involving the discovery of a body. The rest are drawn from forensic experiments at so-called "body farms" in Texas and Tennessee, in which corpses are left to decay for weeks and months under varied circumstances.

For this second group, the precise PMI is known. So photos and descriptions of their various states of decomposition over time, along with information about temperature, humidity, wind, soil type and other conditions, have all helped train the AI model. Like many good detectives, the algorithm can spot patterns and make connections between the clues.

To use the tool, forensic investigators attempting to date a body simply enter some specifics of their case into an app. Entering the location allows the AI model to factor in local weather conditions. The investigators then add observations about the deceased, such as whether they were obese, whether insects have moved in and whether dogs or rats have gnawed on the body. They must also add any indications of "purging"—a particularly grim scenario in which foul-smelling fluid oozes from the nose and ears of the corpse. In return, the AI compares the case with those in its training data and offers a likely PMI and, therefore, an estimated date of death.

At present the model offers a range of days within which it is 80% confident the true PMI lies, according to Dr Weisensee's team. This confidence level should improve as experts and investigators around the world continue to add their own cases and examples to the database.

The results could be used to check alibis and help solve crimes, but they have other uses too. Madeline Atwell, a forensic anthropologist at Clemson University who works on the project (and serves as a deputy coroner for

Richland County, South Carolina), says the model has already helped close several missing-person cases. Combining time of death with when people were last seen alive is very useful in identifying human remains. "You match it with missing-person records, and that helps narrow your time frame," she says.

And sometimes a more reliable PMI simply gives bereaved families a better sense of a loved one's last moments. "It helps with that process of understanding," says Dr Atwell. ∎

确定尸体死亡时间的新方法

人工智能让病理学家的工作更精确

在虚构作品中，被追着要答案的病理学家面对一具尸体，咬一口三明治，就能立即宣布死亡时间。现实里自然是要难办得多，而且得出什么结果——或者没能得出什么结果——可以决定案件的成败。

现在，人工智能可以来助一臂之力。通过分析成千上万起死亡及其后续状况，这项技术可以给出迄今为止最准确的死后间隔时间（PMI）估计。

确定一个人的死亡时间是法医最基本的工作之一（但准确度低得令人沮丧）。几十年来，这些专家只能结合对死者状态的观察，以及尸体与环境的温度等线索，依靠直觉做出判断。然而，不同的尸体腐烂的速度不尽相同，最仔细的PMI计算也会因为具体情况而失准。例如，2004年在英格兰北部的一条沟渠里发现了一具尸体，对其死亡时间的估计就偏晚了，这是因为沟渠遮挡了阳光，而低于预期的环境温度有助于保存尸体。

法医学期刊里充斥着这样的案例——有的平平无奇，有的匪夷所思。同时，世界各地的案件卷宗里还写有成千上万起调查，当中可能埋藏着有用的细节。现在，美国的法医学研究人员正在努力获取和整理这些有价值的记录，使用机器学习加以分析。其成果是一个名为geoFOR的AI工具，可以提供迄今为止最可靠的PMI估计。三明治可不在内。

该模型由南卡罗来纳州的克莱姆森大学（Clemson University）的凯瑟琳·魏森西（Katherine Weisensee）带领的研究团队开发，其基础是从2500多起死亡调查中汇集的数据，而且每周都在添加更多数据。其中约1800起是发现了尸体的真实案件。其余则来自得克萨斯州和田纳西州名为"尸体农场"的法医实验，在那里，尸体会被放置在不同的环境下，在数周或数月内观察其腐烂情况。

第二组尸体的确切PMI是已知的。因此，对尸体随时间推移的腐烂情况的照片记录和描述，以及相应的温度、湿度、风力情况、土壤类型和其他环境信息，都帮助训练了这个AI模型。正如许多优秀的侦探一样，算法可以发现规律，把各种线索联系起来。

使用该工具时，试图确定尸体死亡日期的法医只需在应用中输入案件的一些具体参数。输入地点位置后，AI模型就可以将该地点的局部天气状况考虑在内。然后，法医可以输入对死者的观察结果，例如是否肥胖，有无昆虫开始寄生，有无被狗或老鼠啃咬。他们还必须输入任何"净化"的迹象——这是一种格外恐怖的情况，尸体的鼻子和耳朵会渗出恶臭的液体。然后，AI会将这起案例比对其训练数据中的案例，给出可能的PMI，从而推算出死亡日期。

据魏森西团队表示，目前该模型可以给出一个天数范围，真正的PMI落在这个范围内的可信度为80%。随着世界各地的专家和调查人员不断向数据库添加自己的案件和实例，其可信度应该还会提高。

这些结果可以用来核对不在场证明和帮助破案，不过它们也有其他用途。克莱姆森大学的法医人类学家玛德琳·阿特韦尔（Madeline Atwell，也是南卡罗来纳州里奇兰县[Richland County]的副验尸官）参与了这个项目，她表示该模型已经帮助侦破了几起人口失踪案。将死亡时间与生前最后一次被看到的时间结合起来，对辨认遗骸非常有用。"将死亡时间与失踪人口记录进行比对，有助于缩小时间范围。"她说。

有时，更可靠的PMI只是为了让丧亲家属更好地了解亲人的最后时刻。"这可以帮助实现这种了解。"阿特韦尔说。■

The world is in the midst of a city-building boom

Everyone, from Donald Trump and Peter Thiel to Abdel Fattah el-Sisi, is getting involved

AFRICA'S TALLEST building is rising under empty skies. Beneath the Iconic Tower in northern Egypt sits a city that officials expect to one day house 6.5m people. For now, though, it is mostly empty—like the desert that came before it.

Egypt's "New Administrative Capital" is part of a rush of city-building. Firms and governments are planning more settlements than at any time in the post-war period, with many already under construction. Ninety-one cities have been announced in the past decade, with 15 in the past year alone. In addition to its new capital in the north, Egypt is building five other cities, with plans for dozens more. India is considering eight urban hubs. Outside Baghdad, Iraq, workers have just broken ground on the first of five settlements.

And it is not just emerging economies that are building. Investors in America have spent years secretly buying land for a new city in California. To the east, the deserts of Arizona and Nevada have lured Bill Gates and Marc Lore, two billionaires, each with plans for their own metropolis. Even Donald Trump, in his bid for re-election, has proposed ten "freedom cities". In their early stages, many of these projects will attract derision. History suggests that plenty will fail. But the number and diversity of settlements under construction suggests some will triumph.

That is a great thing. Edward Glaeser of Harvard University has lauded cities as mankind's greatest invention. He notes that agglomerations of money and talent make societies richer, smarter and greener. Since companies move closer to their customers and people closer to their jobs, growing

cities beget economic growth. Economists think that doubling a city's population provides a boost to productivity of 2-5%. Given both the pressing need for new urban areas and the constraints on physical growth in existing ones, starting afresh is sometimes a shrewd decision.

In much of the poor world, land disputes, shantytowns and poor infrastructure choke development. The problem will worsen as urban areas swell by an extra 2.5bn inhabitants by 2050, according to projections by the United Nations, with the new urbanites appearing in regions where cities are already under extreme stress. Builders hope that new metropolises will help relieve the pressure. In Nairobi, near where Stephen Jennings, a former private-equity boss, is building a new city called Tatu, public-transport commutes run to over an hour for most jobs. Construction is progressing nicely in Kenya's newest settlement, where 5,000 residents already live and work in a gated village. Mr Jennings is building seven other cities across five countries in the region.

Rich-world cities have problems of their own. The push for a new town outside San Francisco—a project that goes by the label of "California Forever"—came from an "epic housing shortage" on America's west coast, says Jan Sramek, who leads a group of Silicon Valley investors making it happen. The group, which includes Laurene Powell Jobs, Steve's widow; Reid Hoffman, a co-founder of LinkedIn; and Sir Michael Moritz, a venture capitalist, will put their plans for "homes, jobs and clean energy" to a public vote in November. If approved, the city will house up to 400,000 residents on 60,000 acres of what is now farmland. Starting again is a necessary part of the solution to housing shortfalls, says Mr Sramek, citing the high costs of revamping existing infrastructure.

California Forever is among a clutch of planned towns that also aim to improve urban living. The developer is promoting high-density neighbourhoods in which residents can reach schools, jobs and shops

without a car. Today's city-builders have decided that walkability—or what is sometimes called a "15-minute city"—is a crucial selling point. Some, like Dholera in India and Bill Gates's Belmont in Arizona, are pitching so-called "smart cities", which use sensors to direct residents away from traffic or tell them the most environmentally friendly time for a shower.

A few projects double as social experiments. Mr Lore's Telosa city (adapted from the Greek word for "highest purpose") will do away with private ownership of land, which will instead be held in a communal trust, with money generated from leasing it spent on public services. Praxis (another Greek word, meaning "theory in practice") has raised $19m and collected a waiting list of potential residents who want to "create a more vital future for humanity" in the Mediterranean. A private company is building Próspera, a cryptocurrency-accepting, libertarian special economic zone in the Honduras, with a mission to "maximise human prosperity". Praxis and Próspera are funded in-part by Pronomos, a venture-capital fund established in 2019 to invest in new cities, which is run by Patri Friedman (grandson of Milton) and counts Marc Andreessen and Peter Thiel, two billionaire investors, among its supporters.

Messrs Andreessen, Lore and Thiel are among a crop of wealthy folk with ideas about how to run cities. But governments also want to experiment. Abundant capital and low interest rates in the 2010s allowed politicians to borrow cheaply. Although rates are now higher, enthusiasm for building remains, as countries copy one another. Leaders are keen on using state finances to reshape domestic economies—and believe that new cities will help.

Houses built on sand

Muhammed bin Salman of Saudi Arabia hopes that several gleaming new metropolises will attract industries that his country lacks, such as financial services, manufacturing and tourism. NEOM, a city made up of a 170km-

long building in the desert, is to be the jewel in the crown. Egypt's New Administrative Capital is purpose-built for the state's bureaucratic machinery; the government hopes it will reduce congestion in Cairo. The city already includes the Ministry of Defence's imposing Octagon—not to be confused with America's Pentagon—which spreads over a square kilometre. In Indonesia workers are clearing forests for a new capital, Nusantara. For leaders such as Joko Widodo of Indonesia and Abdel Fattah el-Sisi of Egypt, a new capital promises a legacy, lots of jobs and the ability to keep voters at arm's length.

In other countries, rulers have slightly more esoteric ambitions. El Salvador is planning to sell bonds that pay out in bitcoin in order to fund a crypto-city. The Kingdom of Bhutan said in December that it would build a "mindfulness city", with neighbourhoods designed on the repeating geometric patterns of a mandala, a Buddhist symbol. The emergence of the China State Construction Engineering Corporation, whose workers are building cities in Africa, South-East Asia and the Middle East, has lowered the costs of all megaprojects, whether fanciful or prosaic.

How many of these cities will prosper? Some infrastructure, such as electricity, internet and roads, must be in place before the first resident arrives, which means that upfront costs can be staggeringly large. Mr Sramek's company has already sunk $1bn into buying land for California Forever and will need an additional $1bn-2bn for just the first stage of construction. Mr Lore expects to marshal $25bn in initial investment for his city in the desert. Prince Muhammed will lean on his kingdom's oil riches to pay for NEOM at an initial cost of $319bn. But enthusiasm, and money, can run out; grandiose projects can become white elephants. Work on Egypt's $60bn capital city has slowed as the country's economy falters. The Chinese developer behind Malaysia's Forest City defaulted in 2023, before residents had even moved in.

History points to characteristics shared by successful projects. State institutions can help anchor cities, as Brasília (in Brazil) and Chandigarh (in India) showed in the 20th century. Although both have had problems, people in Brazil and India are voting with their feet. Brasília's population is growing at 1.2% a year, more than double the national average. Chandigarh, a state capital, is now India's fourth-richest region on a per-person basis.

The future is less certain for cities that cannot rely on taxpayers to provide jobs and pay the bills, but California Forever and Tatu seem to be based on sensible ideas. As Mr Jennings puts it, the crucial thing is to focus on getting the "boring stuff", such as roads and sewerage, right in order to create a city that is walkable and green, but not especially smart. In addition to being what he calls "a dumb city", Mr Sramek's California Forever shares another advantage with Tatu: both will piggy-back on neighbouring economies. "We are five miles away from cities on both sides," says the Californian developer. "The strength of the demand makes a big difference to how fast you can grow." In Britain, Milton Keynes—a city established in the 1960s, less than an hour by train from London—is thriving. Reston, a planned town outside Washington, DC, is another success.

Sensible city-builders are wary of taking on debt. Developers have instead started to sell stakes in projects, demonstrating buy-in for what are long-term ventures. "You are looking at a 50-year time horizon," says Mr Jennings, who admits that it "sounds insane". He has tapped friends for capital, avoiding private-equity backers and their investment horizons, which normally come in at under a decade. California Forever is entirely funded by equity investments. If the two new settlements succeed, their investors will be rewarded. But so will many others. That is the glory of cities. ■

全世界掀起城市建设热潮

从特朗普、彼得·蒂尔到阿卜杜勒·法塔赫·塞西，每个人都参与其中【深度】

非洲最高的建筑在空旷的天空下拔地而起。这座位于埃及北部的标志塔（Iconic Tower）俯瞰着一座城市，官员们预计有朝一日这里将容纳65o万人口。不过现在，这座城市基本上还是空无人烟——一如它出现之前的那片沙漠。

埃及的这个"新行政首都"（New Administrative Capital）是一轮城市建设热的一部分。企业和政府正在规划的定居点比战后任何时候都多，其中许多定居点已经在建设中。在过去十年中已经宣布了91个城市建设计划，仅去年一年就宣布了15个。除了北部的新首都，埃及还在建设其他五个城市，并计划再建几十个。印度正在考虑建立八个城市中枢。在伊拉克巴格达郊外，工人们刚刚破土开建五个定居点中的第一个。

而且不仅仅是新兴经济体在大兴土木。美国的投资者花了数年时间悄悄购买土地，要在加州建设一个新城市。在美国东部，亚利桑那州和内华达州的沙漠吸引了比尔·盖茨和马克·洛尔（Marc Lore）这两位亿万富翁，每个人都有自己的大都市计划。甚至特朗普在再次竞选时也提出建十个"自由之城"的计划。在早期阶段，其中许多项目会招致嘲笑。从历史经验来看，它们很多都会失败。但是，正在建设的定居点的数量和多样性表明，其中一些将取得成功。

这是件大好事。哈佛大学的爱德华·格莱泽（Edward Glaeser）称赞城市是人类最伟大的发明。他指出，资金和人才的聚集使社会更富裕、智能和环保。由于公司搬到离客户更近的地方、人们搬到离工作地点更近的地方，城市的扩张带来了经济增长。经济学家认为，城市人口增加一倍可以让生产率提高2%到5%。鉴于对新城区有迫切需求而同时现有城市的物理扩张又受到限制，另建新城有时是一个精明的决定。

在许多贫穷国家，土地纠纷、棚户区和基础设施薄弱抑制了发展。根据联合国的预测，到2050年，随着城市人口增加25亿，问题将进一步恶化，因为新居民将出现在本就处于极端压力之下的城市里。建筑商希望新建的大城市将有助于缓解压力。在内罗毕，大多数人的公共交通通勤时间超过一个小时；前私募股权老板斯蒂芬·詹宁斯（Stephen Jennings）正在该市附近建设一座名为塔图（Tatu）的新城。肯尼亚最新一个定居点的建设进展顺利，5000名居民已经在一个封闭式村庄里生活和工作。詹宁斯正在该地区的五个国家建设另外七座城市。

富裕世界的城市也有自己的问题。在旧金山郊外建造一个新城镇的"永远加州"（California Forever）计划便是受美国西海岸"惊人住房短缺"的推动，扬·斯拉梅克（Jan Sramek）说。他牵头一群硅谷投资者来促成这个项目，其中包括乔布斯的遗孀劳伦·鲍威尔·乔布斯（Laurene Powell Jobs）、LinkedIn的联合创始人里德·霍夫曼（Reid Hoffman）、风险投资家迈克尔·莫里茨（Michael Moritz），他们将于11月把"住房、就业和清洁能源"计划递交公开投票。如果获通过，这个新城将在现在的60,000英亩农田上容纳多达40万居民。斯拉梅克说，另建新城是解决住房短缺的必要措施之一，他指出改造现有基础设施的成本很高。

除了"永远加州"，还有一系列也意在改善城市生活的新城规划。开发商正在推广高密度社区，居民不需要用车就能到达学校、工作地点和商店。如今的城市建设者已经判定，可步行性——或者有时被称为"15分钟城市"——是一个关键的卖点。一些城市，如印度的托莱拉（Dholera）和比尔·盖茨要在亚利桑那州打造的贝尔蒙特（Belmont），正在营销所谓的"智能城市"，这些城市使用传感器引导居民避开交通拥堵，或者告诉他们最环保的淋浴时间。

一些项目同时也是社会实验。洛尔的特洛萨（Telosa，源自希腊语中"最高目标"一词）将取消土地私有，取而代之的是一个公共信托，把出租土地带来的资金用于公共服务。普莱克西斯（Praxis，另一个希腊词，意思是"付诸实践的理论"）已经筹集了1900万美元，并收集了一份潜在居民的等候名单，这些人都希望在地中海"为人类创造更有活力的未来"。一家私营

公司正在洪都拉斯建设普洛斯佩拉（Próspera），这是一个接受加密货币的自由意志主义经济特区，其使命是"充分实现人类繁荣"。普莱克西斯和普洛斯佩拉的部分资金来自Pronomos，这家成立于2019年的风险投资基金专注投资新城市，由帕特里·弗里德曼（Patri Friedman，经济学家米尔顿·弗里德曼的孙子）经营，其支持者包括两位亿万富翁投资者马克·安德森（Marc Andreessen）和彼得·蒂尔（Peter Thiel）。

包括安德森、洛尔和蒂尔在内的一群富人对如何管理城市有自己的想法。但政府也想开展实验。2010年代充裕的资本和低利率使政客们能够低成本借债。尽管现在的利率更高，但随着各国相互仿效，建设热情依旧高涨。领导人渴望利用国家财政来重塑国内经济，并相信新城市会发挥作用。

建在沙子上的房子

沙特王储穆罕默德·本·萨勒曼希望几座熠熠生辉的崭新大都市能够吸引来自己国家缺乏的产业，如金融服务业、制造业和旅游业。新城NEOM是沙漠中一座170公里长的建筑，将成为皇冠上的明珠。埃及的新行政首都是专门为国家的官僚机构建设的，政府希望它能减轻开罗的拥堵。这里已经建成了雄伟的八角形国防部大楼——可不要与美国的五角大楼搞混——占地超过一平方公里。在印度尼西亚，工人们正在为新首都努桑塔拉（Nusantara）清理森林。对于印尼总统佐科·维多多和埃及总统阿卜杜勒·法塔赫·塞西等领导人来说，新首都有望成为千秋功业、带来大量就业，并能与选民保持距离。

在其他国家，统治者的宏图大计要更晦涩深奥一些。萨尔瓦多正计划发行以比特币支付的债券来为一座加密城市提供资金。不丹在去年12月表示，它将建造一座"正念之城"，其城区设计采用佛教符号曼荼罗重复的几何图案。中建集团的工人在非洲、东南亚和中东建造城市，它的出现降低了所有大型项目的成本，无论是奇特的还是平淡无奇的。

这些城市中有多少能繁荣发展？一些基础设施，如电力、互联网和道路，必须在第一批居民入住之前就位，这意味着前期成本可能高得惊人。斯拉梅克的公司已经投入了10亿美元为"永远加州"买地，而且仅第一阶段的建

设就还需要1o亿至2o亿美元。洛尔预计将为他的沙漠城市筹集25o亿美元的初始投资。穆罕默德王子将依靠沙特的石油财富为NEOM支付319o亿美元的初始成本。但是热情和金钱可能会耗尽，宏伟的项目可能沦为面子工程。随着埃及经济陷入衰退，它耗资6oo亿美元的首都工程也已经放缓。马来西亚的森林城市（Forest City）背后的中国开发商在2o23年违约，当时居民甚至还没有搬进来。

纵观历史，可以看到成功项目的一些共同特征。身为政府机构所在地可以帮助稳固新城，正如2o世纪的巴西利亚（Brasília，巴西）和昌迪加尔（Chandigarh，印度）所彰显的。尽管两者都曾遭遇问题，但巴西和印度的人们正在用脚投票。巴西利亚的人口以每年1.2%的速度增长，是全国平均水平的两倍多。昌迪加尔是邦首府，按人均计算现在是印度第四富有的地区。

对于那些不能依靠纳税人提供就业和支付账单的城市来说，未来更不确定，但"永远加州"和塔图的思路似乎是明智的。正如詹宁斯所说，关键是要专注于做好"乏味的事情"，例如道路和污水处理系统，以创造一个适合步行和绿色的城市，而不需要特别智能。除了成为他所说的"愚钝城市"之外，斯拉梅克的"永远加州"还有另一个优势，塔图也是：两者都可以借邻近经济体的东风。"我们距离两边的城市都只有五英里远，"这位加州开发商说，"需求强度对你的增长速度有很大影响。"在英国距离伦敦不到一个小时火车车程的地方，建于196o年代的城市米尔顿凯恩斯（Milton Keynes）正在蓬勃发展。美国华盛顿特区附近的规划城镇雷斯顿（Reston）是另一个成功案例。

明智的城市建设者对举债态度谨慎。开发商转而开始出售项目的股份，以表明对这些长期项目的认同。"你要把眼光放到5o年。"詹宁斯说，他承认这"听起来很疯狂"。他从朋友那里获得资金，没有去找私募股权投资者，也就避开了他们对投资期限的要求——通常不到十年。"永远加州"的资金全部来自股权投资。如果这两个新城取得成功，它们的投资者将获得回报。但其他众多人也会受益。这就是城市的荣耀。■

Apple is right not to rush headlong into generative AI

One day the Vision Pro could exploit the technology to the full

IF YOU THINK Tim Cook has always led a charmed life at the helm of Apple, think again. The years straight after the death of Steve Jobs in 2011 were a trial by fire. First there was antitrust: America's Department of Justice (DoJ) sued Apple for conspiring to fix e-book prices. Then there was competition: Samsung, a South Korean rival, went to war with the iPhone with bigger, sleeker models. Then came broader concerns. Apple's new voice assistant, Siri, made rookie errors. Ditto Apple Maps, which went as far as relocating the Washington Monument to the Potomac river. At the time, the question hanging over the company was existential: could Apple's creative spark survive the death of its founder? One of Mr Cook's lieutenants was so miffed at the criticisms that he publicly retorted in 2013: "Can't innovate any more, my ass!"

A decade or so later, Mr Cook may be feeling déjà vu. On all three counts—antitrust, Asian competition, the existential question of innovation and growth—there are parallels between then and now. Competition watchdogs in the EU are demanding compliance from March 7th with rules that for the first time breach the "walled garden" which keeps users and developers bound within Apple's playpen. On March 4th they fined the company €1.8bn ($2bn) for allegedly stifling competition in music streaming. In America the DoJ may soon launch a case against Apple. In China, Huawei, a domestic mastodon, is seizing market share. Hanging over everything is the nagging concern, amid a levelling off in iPhone sales, that Mr Cook is missing the chance to pull another rabbit out of the hat with generative artificial intelligence (gen AI).

In short, with its market value down by 10% since mid-December, and

Microsoft, thanks to gen AI, vaulting past it to become the world's most valuable company, sceptics wonder if Apple is now so dominant it has lost its mojo. So jaded is the narrative that many pay little heed to the buzz about the Vision Pro, Apple's snazzy—though lavishly priced—mixed-reality headset. What hopes they have are pinned on the company's annual developer conference in June, when they want Mr Cook to announce whizzy gen-AI upgrades proving that Apple can join the chatbot hypefest. That, though, is not how the company does things. Nor should it be.

Go back to the threat from Samsung in Mr Cook's early days. Back then investors pestered Apple to come up with a bigger phone, just as now they want it to match Samsung's models with gen-AI bells and whistles. But Apple doesn't rush things. It wasn't until the launch of the iPhone 6 in 2014 that it produced a large-screen device. When it came, it was a smash hit. Its modus operandi remains the same. It is rarely first with a product. It seeks to improve what is already out there, learning from others' mistakes and eventually trouncing the competition. Of course, that poses a risk. In theory, a scrappy upstart may produce new technology products cheaper and faster, pulling the rug from under the market leader. Perhaps a young company building a killer gadget for the gen-AI era already has Apple in its sights.

Yet you do not have to be a true believer to see why Apple may be right to take its time. First, there will be more to gen AI than chatbots. They appear revolutionary. But so far they are just a better (and accident-prone) way of putting in a query and getting an answer. That is not Apple's forte. "They are features, not products," as Horace Dediu, an expert on Apple, puts it. Nor does Apple compete with other tech giants, such as Microsoft, Amazon and Alphabet, to run cloud-computing platforms with AI models on which customers can build gen-AI apps. Instead of relying on the cloud, it seems to be working on ways to embed gen AI in its own devices, bolstering its ecosystem. Since 2017 it has been using homemade chip technology called

neural engines to handle machine-learning and AI functions its gadgets use behind the scenes.

In late February it emerged that it was scrapping its ten-year project to build an Apple car and redirecting the engineers towards gen AI. No doubt it is moving up a gear—though not from an idle start. Apple will reveal nothing about its intentions. But one of the options it has is hiding in plain sight: the Vision Pro. The most recent gen-AI launches, such as OpenAI's Sora, which converts text to video, and Groq, which speaks at humanlike speed in response to questions, suggests that eventually something other than written words could be the main gateway to gen AI. The Vision Pro is all about sounds and images.

Known unknowns

In the short term none of this will resolve the growth question. In fact, the regulatory onslaught in the EU via the Digital Markets Act, which will henceforth apply to big-tech "gatekeepers" including Apple, could potentially crimp its biggest growth engine, services. For the first time Apple will be forced to allow third-party app marketplaces and alternative payment systems outside its App Store on devices in Europe. It has made no secret of its disdain for the rules. It calls them a threat to safety and privacy, and has introduced complex new fees for those who dare bypass its protective walls. Some developers have slammed its compliance measures, but they are likely to work: inertia means that many will probably stick with the status quo. As for a possible DoJ antitrust case, it would be a headache. But its scope is not yet clear.

China is a bigger problem with no clear solution. Huawei has become a formidable competitor, though in the long run it may be constrained by an America-led ban on sales to it of high-end chips. However big the geopolitical risks, Apple and China are so co-dependent that they may be stuck with one another.

Still, don't give up on Mr Cook yet. Apple is bound to be working on gen-AI products that do not leave egg on its face—just, as is its way, not in the open. At this stage, the vast sums needed to train AI models favour deep-pocketed incumbents over scrappy upstarts, which will work to Apple's advantage. You can almost hear Cupertino muttering, "Can't innovate anymore, my ass!" ■

苹果不急于扎进生成式AI是对的

有朝一日Vision Pro可能会充分利用这项技术

如果你以为库克执掌苹果的日子从来都一帆风顺，那再想想吧。2011年乔布斯去世后的那几年，库克就像是被架在火上烤。先是反垄断官司：美国司法部起诉苹果合谋操纵电子书价格。再有是竞争挑战：韩国对手三星推出更大更时尚的机型，与iPhone争夺市场。然后是更大方向上的担忧。苹果彼时新推出的语音助手Siri出现低级错误。苹果地图也有同样的问题，竟错把华盛顿纪念碑标记到波托马克河上。当时，围绕苹果的是一个生死攸关的问题：创始人去世后，它的创造力火花还能继续闪耀吗？库克的一位副手对这些批评感到非常恼火，在2013年公开反驳道："再没法创新了？去你的吧！"

十来年过去了，今天的情形可能让库克有似曾相识之感。反垄断、来自亚洲的竞争、事关存亡的创新与增长问题——在这三方面，眼下的处境和当年都有相似之处。欧盟的竞争监督机构制定了新规则，首次打破了苹果把用户和开发者限制在自家花园里的围墙，要求苹果从3月7日起遵守这些规定。3月4日，它们对苹果处以18亿欧元（20亿美元）的罚款，理由是该公司涉嫌在音乐流媒体领域压制竞争。在美国，司法部可能很快会对苹果提起诉讼。在中国，本地巨头华为正在抢占市场份额。在iPhone销量停滞不前之际，悬于一切之上的还有那挥之不去的担忧：库克正在错失利用生成式AI创造另一次奇迹的机会。

自去年12月中旬以来，苹果的市值下跌了10%，而微软则凭借生成式AI超越苹果，晋身全球价值最高的公司。简单来说，怀疑者们猜疑现在的苹果是否因为地位过于稳固而失去了自己的魔力。这个说法听得人们耳朵都要起茧了，连苹果新推出的时髦新潮却也价格不菲的混合现实头显Vision Pro都挑不起他们的兴致。他们的希望都寄托在6月召开的年度开发者大会上，想看看库克会宣布什么生成式AI方面的新奇进展，证明苹果也能加入聊天机器人的热潮。不过这并不是、也不该是苹果的行事风格。

我们来回头看看库克在掌舵苹果之初面对三星的威胁时的做法。当时投资者催促苹果推出尺寸更大的手机，就像现在他们要苹果跟上三星那些配备了各种花哨AI功能的机型一样。但苹果一向不会贸然行事。直到2014年的iPhone 6，苹果才开始生产大屏幕设备，一经推出便大受欢迎。苹果的行事方式依然如故。它很少率先推出全新产品，而是力求改进市场上已有的产品，从别人的错误中吸取教训，最终击败对手。当然，这存在风险。理论上，斗志旺盛的后起之秀可能会以更低的成本和更快的速度生产出新款科技产品，把市场领导者拉下马。也许志在打造AI时代杀手级设备的年轻公司早已经瞄上了苹果。

但即便你不是果粉，也能明白为什么苹果不急于出手可能是对的。首先，生成式AI将不仅局限于聊天机器人。它可能带来革命性的改变。但迄今为止，人们得到的只是一种输入查询并获得答案的更好（也很容易出问题的）方式而已。这非苹果的强项。"这些只是功能，不是产品。"专门研究苹果的霍拉斯·德迪欧（Horace Dediu）说。苹果也不会与微软、亚马逊和Alphabet等其他科技巨头竞争，去运营AI模型的云平台，让客户可以在上面构建生成式AI应用。苹果似乎并不依赖云计算，而是在研究如何把生成式AI嵌入自己的设备中以增强自己的生态系统。自2017年以来，苹果一直在使用自家名为神经引擎的芯片技术来处理在设备后台运行的机器学习和AI功能。

2月底，有消息称苹果放弃了历时十年的造车项目，把工程师转移到了生成式AI领域。毫无疑问，苹果正在升档加速，但并不是从怠速状态启动。苹果不会透露自己的意图，但其中一个选项已昭然若揭：Vision Pro。OpenAI推出了能根据文字生成视频的Sora，还有能像人一样迅速作答的Groq，这些最新的生成式AI产品表明，最终一些书面文字以外的东西可能成为接入生成式AI的主要途径。Vision Pro就是主攻声音和图像。

已知的未知

短期内，这些都无法解决增长问题。事实上，欧盟通过《数字市场法案》（Digital Markets Act，今后将适用于包括苹果在内的大型科技"守门人"）带来的监管打压有可能削弱苹果最大的增长引擎——服务。破天荒

地，苹果将被迫允许欧洲的苹果设备使用其应用商店以外的第三方应用市场和其他支付系统。苹果毫不掩饰对这些规则的鄙视，称它们对安全和隐私构成威胁，并对那些胆敢绕过围墙的用户引入了复杂的新收费。一些开发者抨击苹果的合规方式，但这些措施很可能奏效：惰性可能会促使很多人选择维持现状。至于美国司法部可能提起的反垄断诉讼，则会是令人头疼的问题，但其规模尚不明确。

更大的问题是中国，而且没有明确的解决方案。华为已成为强大的竞争对手，尽管长远来看它可能受到美国主导的高端芯片销售禁令的限制。无论地缘风险有多大，苹果和中国相互依赖的程度可能令它们继续捆绑在一起。

不过，不要就此对库克丧失信心。苹果多半是在开发不会让自己丢脸的生成式AI产品，只是按其一贯作风暂不公开而已。在现阶段，训练AI模型耗资巨大，更适合资金雄厚的老牌公司而非跃跃欲试的新公司，这将对苹果有利。你几乎都听到库比蒂诺在念叨了："再没法创新了？去你的吧！"■

Can a dozen shipwrecks tell the history of the world?

Historical listicles are in vogue

A History of the World in 12 Shipwrecks. By David Gibbins. St Martin's Press; 304 pages; $32. W&N; £25

A SPECTRE IS haunting history—the listicle. You know the formula: a history of something enormous in an intriguingly specific number of unexpected things. In 2023 alone readers were met with new books about the history of baseball in 50 moments, the West in 14 lives, the information age in five hacks, women in 101 objects and the world in eight plagues, ten dinners or 50 lies. Call it history-by-numbers, or, if you must, the "histicle".

The oldest histicle of all may be the seven wonders of the world, a list of marvels from around 300BC. But the modern vogue for history-by-numbers began in 2010, when Neil MacGregor's "A History of the World in 100 Objects" became a bestseller. Mr MacGregor, who was then director of the British Museum, highlighted treasures from the collection.

Breaking down history is appealingly accessible—no need to read a tome to understand the Silk Road, just look at this Korean roof tile. But without care and a certain amount of panache, it risks giving the impression that history is merely, as Arnold Toynbee, a historian, characterised the views of less diligent colleagues, "One damned thing after another." Or one damned roof tile after another.

Fortunately "A History of the World in 12 Shipwrecks" does not fall into that trap. The book works in no small part because it is more modest than its title suggests, sailing between the Scylla of exaggeration and the Charybdis of triviality and avoiding a wreck along the way. For starters, it is not a

history of the world. Rather, it is a series of interconnected essays on notable shipwrecks. But in recounting maritime misadventure, David Gibbins paints a picture of how various people—from sailors in Britain in 2500BC, to Muslims in the ninth century and British merchant mariners in the 20th—pushed the borders of their known worlds.

The book's itinerary through the flotsam and jetsam of history is avowedly idiosyncratic and makes no claim to objectivity or completeness. Mr Gibbins is best known for writing historical fiction, but he is also a professional maritime archaeologist. The skeleton of the book mirrors Mr Gibbins's own career: he has worked on more than half of the 12 wrecks he writes about. His descriptions of snaking through kelp and sucking up sand to fish out lost treasure are vivid. Shipwrecks are "catastrophic events", he writes, but the challenge of diving them is "life-affirming". (After he swims into the "dead pool" off the Cornish coast, though, you may prefer to take him at his word.)

The sailors' misfortune aside, a shipwreck serves as a lucky stroke for a historian, especially if it is left intact. Each wreck is a microcosm of a lost world. As Mr Gibbins writes of the Mary Rose,Henry VIII's flagship vessel that sank off the Isle of Wight in 1545, a wreck "can be seen as an unfolding series of contexts", giving details not just of how ships were run, but of what its sailors took with them, and, in the cargo hold, what its culture needed or prized. For King Henry's sailors, it might have been the wooden tankards in which they drank their gallon of weak beer a day.

In the case of the Santo Cristo di Castello, a Genoese ship that sank in 1667 on the way from Amsterdam to England, Mr Gibbins discovered that the precious cargo included the studies for two paintings by Rembrandt—an artist who himself benefited from maritime trade and the wealthy class of collectors it created.

Ships are not just miniatures of the worlds they sailed from. Many were the engines of history themselves, carrying not just people and goods but ideas, religions and technologies. The wreck of an Arabic ship near Indonesia disclosed a cargo of Tang porcelain, as well as an inkstone, suggesting the ship might have been carrying early paper back from China.

Diving for shipwrecks, then, is an extreme version of what any historian does: plunging into the darkness to discover the missing links between events and cultures. And what is history if not a network of wrecks, accidents, hidden treasures and unexpected consequences? At its best, history-by-numbers embraces the fact that historical narratives, like history itself, are always somewhat arbitrary. This is history not "as it actually happened", as Leopold von Ranke, a German historian, famously put it, but history as it happened to happen.

This vision of the past as a loosely connected chain of events lacks the storybook comfort of beginning, middle and end. But, at the same time, the historical list offers solace: it suggests that history is finite, knowable and manageable. The list does not just appeal to modern brains, fed on news from BuzzFeed. It also appeals to a desire for control, promising that history can be broken down into discrete parts and understood, and that five or 100 things is all you need to know. This approach to the past suits the present perfectly. ■

十二艘沉船能否讲述世界历史？

清单体史书正时兴（《十二艘沉船中的世界史》书评）

《十二艘沉船中的世界史》，大卫·吉宾斯著。圣马丁出版社；304页；32美元。W&N出版社，25英镑

一个幽灵正徘徊于历史海洋中，那就是清单体。大家都知道这个套路：找到一个意想不到的事物，给它设定一个有趣的数量，以此来讲述某段宏大的历史。仅在2023年，读者就迎来了诸多这类新书:《50个瞬间看棒球史》，《14段生命述说西方历史》，《五次黑客攻击讲述信息时代》，《从101件物品看女性》，《八场瘟疫、十次晚餐和五十个谎言中的世界》。我们可以称之为数字讲史，如果你非要给它造一个词的话，也可以叫"清单体史书"。

最古老的清单体史书可能是"世界七大奇迹"，列举了公元前300年左右的一批建筑和雕塑奇观。现代这股数字讲史风尚则始于2010年，时任大英博物馆馆长的尼尔·麦克格雷格（Neil MacGregor）以该馆部分馆藏为视角著成的《大英博物馆100件文物中的世界史》（A History of the World in 100 Objects）成了畅销书。

分解讲述让历史通俗易懂，读来轻松愉快——要了解丝绸之路，无需死啃大部头，看看这块韩国的瓦片就行。但如果不用心，没有一定的派头气势，清单体史书有可能给人留下这样的印象：历史不过是"一件破事接着另一件"——按历史学家阿诺德·汤因比（Arnold Toynbee）所述，他那些不太勤奋的同行们便是持这样的见解。也可以说是一片破瓦叠着另一片。

幸好，《十二艘沉船中的世界史》（A History of the World in 12 Shipwrecks）没有落入这一窠臼。这本书之所以成功，很大程度上是因为它的内容比书名要谦和，在夸夸其谈和鸡毛蒜皮之间恰到好处地航行而能不翻船。首先，这并非一部世界史，而是一系列关于著名沉船事件的相互

关联的文章。但在对海难的叙述中，大卫·吉宾斯（David Gibbins）描绘了其中各色人物（从公元前2500年的英国船员到公元9世纪的穆斯林以及20世纪的英国商船船员）如何突破他们已知世界的边界。

这本书在历史海洋中漂浮的残骸和弃物间展开叙事，毫不掩饰个人色彩，也未声称要做到客观或全面。吉宾斯最为人称道的是他的历史小说，但他也是专业的海洋考古学家。该书的框架正是吉宾斯自己职业生涯的写照：书中写到的12艘沉船中，他亲自参与了其中半数以上的考古工作。他活灵活现地描述了在海藻中蜿蜒穿行和淘沙寻宝的过程。沉船是"灾难性事件"，他写道，但在沉船中潜水的挑战却是"振奋生命的"。（在他游进康沃尔海岸附近的"死亡水域"后，你可能更愿意相信他的话）。

撇开船员的不幸不谈，沉船对历史学家来说是件幸事，尤其是当沉船得以完整保存下来。每艘沉船都是一个失落世界的缩影。正如吉宾斯谈到1545年在怀特岛（Isle of Wight）附近沉没的亨利八世舰队的旗舰"玛丽玫瑰号"（Mary Rose）时所写的，沉船"可被视作一系列背景故事在徐徐展开"，不仅透露了船只运作的细节，还有船员携带的物品，以及货舱中的货物其文化所需要或珍视的东西。对亨利八世的船员而言，那可能是他们每天喝掉一加仑淡啤酒所用的木制大啤酒杯。

说到其他船上的宝物，1667年，一艘名为"圣克里斯托·迪卡斯特洛号"（Santo Cristo di Castello）的热那亚船只在从荷兰阿姆斯特丹驶往英国的途中沉没。吉宾斯发现，这艘沉船的珍贵货物中有伦勃朗两幅画作的草图，而这位画家本身就受益于海上贸易和由此产生的富裕收藏家阶层。

船只不仅仅是它们所属世界的微缩模型。许多船只本身就是历史的引擎，不仅运载人员和货物，还传送思想、宗教和技术。在印尼附近一艘阿拉伯船只的残骸中，人们发现了一批中国唐代瓷器，还有一方砚台，表明这艘船可能是从中国运回早期纸张。

因此，沉船潜水是历史学家工作的极限状态：潜入黑暗中，发现事件和文化之间缺失的关联。而如果历史不是由沉船、事故、隐藏的宝藏和意想不

到的后果交织而成的网络，那它又是什么？"数字讲史"的方式最为极致地展现了一个事实：历史叙事，正如历史本身，总归带有某种程度的主观随意性。它所记述的不是德国历史学家利奥波德·冯·兰克（Leopold von Ranke）所谓的"如实发生"的历史，而是碰巧如是的历史。

这种把过去视为一连串松散关联的事件的方式缺乏人们习惯了的那种有头有尾有经过的故事书叙事。但是，与此同时，这种历史的清单也给人们以慰藉：它暗示历史是有限的、可知的、可掌握的。这样的清单不仅吸引从BuzzFeed上获取新闻的现代人大脑，也迎合了控制欲，承诺人们历史可被分解成独立的部分而被理解，只需要知道五件或一百件事物就行了。这种看待过去的方式完美契合了当下。■

Why you should lose your temper at work

Sometimes. And without throwing anything

AWARENESS DAYS are meant to remind people of important causes and desirable behaviour. Among other things, February sees the International Day of Human Fraternity, World Day of Social Justice and—everyone's favourite until it became a bit too commercialised—World Pulses Day. International Day of Happiness falls in March; you have to wait until November for World Kindness Day.

Anger is far too objectionable to be celebrated with a special day of its own. There is an anger-awareness week in Britain, but the emphasis is on controlling tempers, not giving in to them. Yet in the workplace, as elsewhere, anger is more ambiguous than it seems.

Its destructive side is obvious. Furious people are not much fun to work with, and less fun to work for. A short-fused boss is likely to instil fear among employees and to discourage people from speaking up. Anger can also engender poor performance. Anyone who has ever been riled by a rude email or uncivil colleagues knows how in such circumstances suddenly nothing else matters. Every spare bit of cognitive power is redirected to thinking of devastating put-downs from which the offender will never recover; other tasks can wait.

In one paper on the effects of rudeness on medical professionals, Arieh Riskin of Bnai Zion Medical Centre in Haifa and his co-authors describe a training exercise in which teams of Israeli physicians and nurses treated a mannequin of a baby. The teams were joined by someone billed as a visiting expert from America, who offered studiously neutral comments to some groups and made unprompted and disparaging remarks about the

quality of medical care in Israel to others. The teams that had suffered rudeness performed significantly worse.

Being angry all the time is bad news for individuals and organisations alike. But so is being tremendously satisfied by everything all the time. Jeffrey Pfeffer, a professor at Stanford University who teaches a course on how to acquire power, reckons that displaying anger is an important skill for those who want to rise up the corporate ladder. It is associated with decisiveness and competence (though angry women are more likely to evoke negative emotions among other people than angry men do). Doctors who get angry if they are challenged about their medical advice are not judged to be less competent; if they show shame, patients take a dimmer view.

Anger can have a galvanising effect in specific circumstances. A study by Barry Staw of the University of California, Berkeley, and his co-authors analysed half-time team talks by college and high-school basketball coaches in America, and found that expressions of negative emotions such as anger and disappointment were associated with better second-half outcomes—up to a point. When coaches reached the bulging-eyeballs stage, rage started to have the opposite effect.

There are similar nuances in negotiations. A paper by Hajo Adam of Rice University and Jeanne Brett of Northwestern University found that as people got more upset, they were more likely to extract concessions. But being too angry was seen as inappropriate. And although displays of anger can work in one-off negotiations, they also invite retaliation in subsequent interactions.

Anger has different effects on different types of people. Agreeableness is one of the "Big Five" personality traits recognised by most psychologists. Agreeable sorts value co-operation and courtesy; disagreeable ones are more cynical and more comfortable with conflict.

In an experiment by Gerben Van Kleef of the University of Amsterdam and his co-authors, teams comprised of agreeable and disagreeable people were given feedback on their performance by an actor. The words were the same each time, but in some instances the actor looked and sounded happy and in others they looked and sounded angry. An angry evaluation spurred the more disagreeable teams to do better than a happy (or poker-faced) one; the reverse applied to the more agreeable teams.

By now the problem should be obvious. Anger involves a loss of control. But to be effective in the workplace, it needs to be carefully modulated. That means volcanic people need to find ways to rein themselves in before they spew invective everywhere. It also means that equable people need to learn to let fly occasionally. If there is room in the calendar for International Jazz Day, then there is certainly a case for World Calibrated Displays of Anger Day. ■

职场发火有理

偶尔为之。而且不能扔东西

宣传日是为了提醒人们记得重要的事业和理想的行为。2月里有很多这样的日子，比如国际人类博爱日、世界社会公正日，以及大家原本最喜欢的世界豆类日——可惜它已经有点过于商业化了。国际幸福日在3月；世界友善日则要等到11月。

发脾气实在令人不快，不配拥有一个专属节日。英国有"愤怒情绪意识周"，但强调的是控制脾气，而不是乱发脾气。然而在职场上，就和在其他地方一样，发脾气并不是表面看起来那么简单。

它破坏性的一面是显而易见的。和容易发脾气的人共事没多少乐趣可言，在他们手下工作就更没意思了。脾气暴躁的老板可能会让员工心生恐惧，不敢直言不讳。发脾气也会导致工作表现不佳。任何曾被无礼的电邮或粗鲁的同事惹恼的人都知道，在这个时候，其他事情突然间都变得无关紧要了。那点残存的认知力全都被用来琢磨这些令人万分难堪的奚落，冒犯者将永远无法收回；其他事情都得靠边站。

在一篇关于粗鲁言行对医护人员的影响的论文中，以色列海法市（Haifa）布纳伊锡安医疗中心（Bnai Zion Medical Centre）的阿里耶·里斯金（Arieh Riskin）等人描述了一次培训活动，由一些以色列医生和护士小组对婴儿假人进行治疗操作。一位自称是美国客座专家的人加入了活动，他刻意对一些小组给出客观中立的点评，但在另外一些小组那里则无端地贬低了以色列的医疗质量。受到无礼对待的小组接下来的表现要差得多。

随时随地发脾气对个人和组织来说都是个麻烦。但对任何事情都总是心满意足也不是件好事。斯坦福大学教授杰弗里·普费弗（Jeffrey Pfeffer）有一门关于如何获得权力的课程，他认为，想要在公司晋升，发脾气是一项

重要的技能。它被认为是果断和能力的体现（不过，脾气大的女性比脾气大的男性更容易引起别人的负面情绪）。如果医生因其医嘱受到质疑而发怒，病人并不会认为他们的能力不足；但如果他们表现出羞愧，就会受到病人的质疑。

在特定情况下，发脾气可能激发人的斗志。加州大学伯克利分校的巴里·斯托（Barry Staw）等人分析了美国大学和高中篮球教练在中场休息时的训话，发现愤怒和失望等负面情绪表达与下半场更好的战绩有关——但仅限于一定程度。当教练达到怒目圆睁的阶段时，愤怒就会开始产生反作用。

在谈判中也存在类似的程度问题。莱斯大学的哈乔·亚当（Hajo Adam）和西北大学的珍妮·布雷特（Jeanne Brett）的一篇论文发现，人们越生气，就越有可能获得对方的让步。但过于愤怒也被认为是不适宜的。而尽管发脾气在一次性的谈判中可能奏效，在随后打交道时也会招致报复。

愤怒会给不同类型的人造成不同的影响。亲和性是大多数心理学家公认的"五大"性格特质之一。随和的人注重合作和礼貌；坏脾气的人更加愤世嫉俗，更适应冲突。

在阿姆斯特丹大学的赫尔本·范克里夫（Gerben Van Kleef）等人所做的实验中，由一名演员向几个团队的表演提出反馈意见。一些团队的成员性格随和，另一些脾气暴躁。演员每次说的话都一样，但有时表情和语气显得愉快，有时表现得生气。对于坏脾气的团队，愤怒的评价比愉快（或面无表情）的评价更刺激了他们表现得更好；而在较为随和的团队中，情况刚好相反。

现在，难点应该很清楚了。发脾气是一种失控。但要在职场有效地发脾气，其程度却需要小心调校。这意味着那些行走的活火山们需要在动辄破口大骂之前设法控制自己。而那些平心静气的人则需要学会偶尔放飞一下脾气。如果国际爵士乐日都能出现在日历上，那么当然也有理由设立一个世界校准发怒日。■

AI models make stuff up. How can hallucinations be controlled?

It is hard to do so without also limiting models' power

IT IS AN increasingly familiar experience. A request for help to a large language model (LLM) such as OpenAI's ChatGPT is promptly met by a response that is confident, coherent and just plain wrong. In an AI model, such tendencies are usually described as hallucinations. A more informal word exists, however: these are the qualities of a great bullshitter.

There are kinder ways to put it. In its instructions to users, OpenAI warns that ChatGPT "can make mistakes". Anthropic, an American AI company, says that its LLM Claude "may display incorrect or harmful information"; Google's Gemini warns users to "double-check its responses". The throughline is this: no matter how fluent and confident AI-generated text sounds, it still cannot be trusted.

Hallucinations make it hard to rely on AI systems in the real world. Mistakes in news-generating algorithms can spread misinformation. Image generators can produce art that infringes on copyright, even when told not to. Customer-service chatbots can promise refunds they shouldn't. (In 2022 Air Canada's chatbot concocted a bereavement policy, and this February a Canadian court has confirmed that the airline must foot the bill.) And hallucinations in AI systems that are used for diagnosis or prescription can kill.

All the leaves are brown

The trouble is that the same abilities that allow models to hallucinate are also what make them so useful. For one, LLMs are a form of "generative" AI, which, taken literally, means they make things up to solve new problems. They do this by producing probability distributions for chunks of

characters, or tokens, laying out how likely it is for each possible token in its vocabulary to come next. The mathematics dictate that each token must have a non-zero chance of being chosen, giving the model flexibility to learn new patterns, as well as the capacity to generate statements that are incorrect. The fundamental problem is that language models are probabilistic, while truth is not.

This tension manifests itself in a number of ways. One is that LLMs are not built to have perfect recall in the way a search engine or encyclopedia might. Instead, because the size of a model is much smaller than the size of its training data, it learns by compressing. The model becomes a blurry picture of its training data, retaining key features but at much lower resolution. Some facts resist blurring—"Paris", for example, may always be the highest-probability token following the words "The capital of France is". But many more facts that are less statistically obvious may be smudged away.

Further distortions are possible when a pretrained LLM is "fine-tuned". This is a later stage of training in which the model's weights, which encode statistical relationships between the words and phrases in the training data, are updated for a specific task. Hallucinations can increase if the LLM is fine-tuned, for example, on transcripts of conversations, because the model might make things up to try to be interesting, just as a chatty human might. (Simply including fine-tuning examples where the model says "I don't know" seems to keep hallucination levels down.)

Tinkering with a model's weights can reduce hallucinations. One method involves creating a deliberately flawed model trained on data that contradict the prompt or contain information it lacks. Researchers can then subtract the weights of the flawed model, which are in part responsible for its output, from those of the original to create a model which hallucinates less.

It is also possible to change a model's "temperature". Lower temperatures make a model more conservative, encouraging it to sample the most likely word. Higher temperatures make it more creative, by increasing the randomness of this selection. If the goal is to reduce hallucinations, the temperature should be set to zero. Another trick is to limit the choice to the top-ranked tokens alone. This reduces the likelihood of poor responses, while also allowing for some randomness and, therefore, variety.

Clever prompting can also reduce hallucinations. Researchers at Google DeepMind found that telling an LLM to "take a deep breath and work on this problem step-by-step" reduced hallucinations and improved problem solving, especially of maths problems. One theory for why this works is that AI models learn patterns. By breaking a problem down into smaller ones, it is more likely that the model will be able to recognise and apply the right one. But, says Edoardo Ponti at the University of Edinburgh, such prompt engineering amounts to treating a symptom, rather than curing the disease.

Perhaps, then, the problem is that accuracy is too much to ask of LLMs alone. Instead, they should be part of a larger system—an engine, rather than the whole car. One solution is retrieval augmented generation (RAG), which splits the job of the AI model into two parts: retrieval and generation. Once a prompt is received, a retriever model bustles around an external source of information, like a newspaper archive, to extract relevant contextual information. This is fed to the generator model alongside the original prompt, prefaced with instructions not to rely on prior knowledge. The generator then acts like a normal LLM and answers. This reduces hallucinations by letting the LLM play to its strengths—summarising and paraphrasing rather than researching. Other external tools, from calculators to search engines, can also be bolted onto an LLM in this way, effectively building it a support system to enhance those skills it lacks.

Even with the best algorithmic and architectural antipsychotics available, however, LLMs still hallucinate. One leaderboard, run by Vectara, an American software company, tracks how often such errors arise. Its data shows that GPT-4 still hallucinates in 3% of its summaries, Claude 2 in 8.5% and Gemini Pro in 4.8%. This has prompted programmers to try detecting, rather than preventing, hallucinations. One clue that a hallucination is under way lies in how an LLM picks words. If the probability distribution of the words is flat, ie many words have similar likelihoods of being chosen, this means that there is less certainty as to which is most likely. That is a clue that it might be guessing, rather than using information it has been prompted with and therefore "knows" to be true.

Another way to detect hallucination is to train a second LLM to fact-check the first. The fact-checker can be given the "ground truth" along with the LLM's response, and asked whether or not they agree. Alternatively, the fact-checker can be given several versions of the LLM's answer to the same question, and asked whether they are all consistent. If not, it is more likely to be a hallucination. NVIDIA, a chipmaker, has developed an open-source framework for building guardrails that sit around an LLM to make it more reliable. One of these aims to prevent hallucinations by deploying this fact-checking when needed.

Although such approaches can decrease the hallucination rate, says Ece Kamar, head of the AI frontiers lab at Microsoft, "it is unclear whether any of these techniques is going to completely get rid of hallucinations." In many cases, that would be akin to self-sabotage. If an LLM is asked to generate ideas for a fantasy novel, for example, its output would be disappointing if limited to the world as it is. Consequently, says Dr Kamar, her research aims not to get rid of all hallucinations, but rather to stop the model from hallucinating when it would be unhelpful.

The hallucination problem is one facet of the larger "alignment" problem in the field of AI: how do you get AI systems to reliably do what their human users intend and nothing else? Many researchers believe the answer will come in training bigger LLMs on more and better data. Others believe that LLMs, as generative and probabilistic models, will never be completely rid of unwanted hallucinations.

Or, the real problem might be not with the models but with its human users. Producing language used to be a uniquely human capability. LLMs' convincing textual outputs make it all too easy to anthropomorphise them, to assume that LLMs also operate, reason and understand like humans do. There is still no conclusive evidence that this is the case. LLMs do not learn self-consistent models of the world. And even as models improve and the outputs become more aligned with what humans produce and expect, it is not clear that the insides will become any more human. Any successful real-world deployment of these models will probably require training humans how to use and view AI models as much as it will require training the models themselves. ■

人工智能模型有时胡言乱语。如何控制幻觉？

不限制模型的能力很难做到【深度】

我们已经越来越熟悉这样的情形。向OpenAI的ChatGPT这样的大语言模型提问时，模型会马上给出言之凿凿、流畅连贯却完全错误的回复。在AI模型中，这种倾向通常被称为幻觉。不过还有一个更通俗的说法：其实就是胡说八道，满嘴放炮。

当然，也有更委婉的说法。OpenAI在给用户的说明中警告ChatGPT"可能会出错"。美国AI公司Anthropic表示，其大语言模型Claude"可能会展示不正确或有害的信息"，谷歌的Gemini则提醒用户"要复核它给出的回复"。总的主题就是，无论AI生成的文本有多流利自信，你都不能轻易相信。

幻觉让人们很难在现实世界中依赖AI系统。生成新闻的算法中的错误可能会传播不实信息。图像生成器生成的画作可能会侵犯版权，即使指令明确要求不能侵权。客户服务聊天机器人可能会在没有权限的情况下向客户承诺退款。（2022年，加拿大航空公司的聊天机器人自己编造了一项丧亲机票优惠政策。今年2月，加拿大的一个法院最终判决该航空公司必须承担这笔承诺退款。）此外，用于诊断或开药的AI系统产生的幻觉还可能害死人。

树叶已枯黄

麻烦在于，让模型产生幻觉的能力也正是模型能发挥巨大作用的原因。具体来说，大语言模型是一种"生成式"AI，顾名思义就是它们通过生成内容来解决新问题。具体做法是预测大量字符块也就是"token"的概率分布，列出其词汇库中每一个可能的字符块接下来出现的概率。数学原理决定了每个字符块被选中的概率都不会是零，这让模型具备了灵活性，能够学习新模式，但同时也能生成不正确的内容。这里的根本问题是语言模型是基于概率的、或然的，而事实不是。

这种矛盾表现在多个方面。其中之一是大语言模型没有搜索引擎或百科全书那样的完美查全率。相反，由于模型的大小要比其训练数据小得多，它是通过压缩来学习的。模型这样就成了其训练数据的一张模糊化的图片，保留了原图的关键特征，但分辨率要低得多。有些事实不容易受模糊化的影响——例如在"法国的首都是"之后，"巴黎"可能总是出现概率最高的字符块。但许多统计概率没那么高的事实可能会被模糊掉。

在对预训练的大语言模型做"微调"时，可能会出现更多扭曲。微调是训练的后期阶段，在此阶段，要根据拟完成的任务更新模型的权重（对训练数据中单词和短语之间的统计关系所做的编码）。举例来说，如果大语言模型的微调是基于对话笔录，幻觉可能就会增加，因为模型可能会凭空捏造一些内容来让自己显得风趣，就像一个爱聊天的人可能会信口开河那样。（只需增添模型表示"我不知道"的微调示例，似乎就能减少幻觉的出现。）

调整模型权重可以减少幻觉，一种方法是使用与提示相矛盾或包含其所缺乏的信息的数据，特意训练出一个缺陷模型。研究人员随后可以从原始模型中剔除掉缺陷模型的权重（这些权重对输出有一定影响），从而创造出幻觉更少的模型。

另外，也可以通过调整模型的"温度"来减少幻觉。降低温度会鼓励模型选择出现概率最高的词语，让它更保守。提高温度会提高模型选择的随机性，让它更具创造性。如果目标是减少幻觉，那么温度应该设定为零。另一种做法是将模型的选择范围限于概率最靠前的字符块。这样可以降低出现低质量回复的可能性，同时也能允许一定的随机性，进而也就有了多样性。

此外，巧妙的提问也可以减少幻觉。谷歌DeepMind的研究人员发现，告诉一个大语言模型"深呼吸，一步步地解决这个问题"减少了幻觉，提高了问题解决能力，尤其是数学问题。这种方法之所以奏效，一种猜测是AI模型会学习模式。通过将问题分解成小问题，模型更有可能识别并应用正确的模式。但是，爱丁堡大学的爱德华多·庞蒂（Edoardo Ponti）认为，像

这样优化提示是治标不治本。

那么，问题也许在于，希望大语言模型自己来保证准确性是要求太高了。其实它们应该作为一个更大的系统的一部分——它们是引擎而不是整辆车。一种解决方案是检索增强生成（RAG），它把AI模型的任务分成检索和生成两个部分。一旦接收到提示，检索器模型就会马上从诸如报刊档案的外部信息源中提取相关的情境信息。这些信息与原始提示一起输入到生成器模型，还要在开头加上不要依赖先验知识的指示。接下来生成器就像一个普通大语言模型那样回答问题。RAG让大语言模型发挥自身强项——总结和转述，而非研究，从而减少了模型的幻觉。计算器和搜索引擎等其他外部工具也可以以这种方式附加到大语言模型上，相当于构建了一个支持系统来增强模型所缺乏的技能。

然而，即使有了最好的算法和架构设计来防范，大语言模型仍然会出现幻觉。美国软件公司Vectara制作的排行榜追踪不同模型出现这类错误的频率。排行数据显示，GPT-4在做摘要时的幻觉率为3%，Claude 2为8.5%，Gemini Pro为4.8%。这已经促使程序员更关注发现幻觉而不是阻止幻觉的发生。幻觉可能出现的一个线索是大语言模型选择词语的方式。如果概率分布曲线平坦（即多个词语被选中的可能性相近），这时模型不太确定最应该选择哪个词语。这个线索表明模型可能正在猜答案，而不是根据所提示的信息而"知道"正确答案。

发现幻觉的另一种方法是训练另一个负责核查事实的大语言模型。可以将"基准事实"和第一个大语言模型的回复一起输入给第二个模型，并询问它们是否相一致。或者，也可以把第一个大语言模型对同一个问题的多个回复输入给第二个，询问它这些回复彼此是否统一。如果不一致，那么第一个大语言模型就很可能产生了幻觉。芯片制造商英伟达开发了一个开源框架，给大语言模型安装"护栏"以提高其可靠性。目标之一就是在需要时做这样的事实核查，防止模型产生幻觉。

微软AI前沿实验室（AI frontiers）的负责人艾斯·卡玛（Ece Kamar）认为，尽管这些方法可以降低幻觉率，但"尚不清楚是否其中任何一种方法

能够完全消除幻觉"。在许多情况下，完全消除幻觉无异于自我破坏。例如，假设让一个大语言模型为一部奇幻小说提供思路，如果限制它只能依据现实世界提供输出，其结果将会令人失望。因此，卡玛说她的研究目的不是为了消除所有幻觉，而是在幻觉无益时阻止模型产生幻觉。

安全又温暖

幻觉问题是AI领域更大的"对齐"问题的一个方面，"对齐"指如何让AI系统可靠地执行人类用户的意图，而不会擅作主张。许多研究人员认为用更多更好的数据训练更大的大语言模型能为这个问题提供答案。其他人则认为大语言模型作为生成和概率模型，将永远无法完全消除无用的幻觉。

或者，真正的问题可能不在于模型，而在于人类用户。产生语言曾经是人类独一无二的能力。大语言模型颇具说服力的文本输出使它们很容易被赋予人性，让人以为它们也像人类那样运作、推理和理解。但目前还没有确凿证据表明事情确实如此。大语言模型并不学习关于整个世界的自洽模型。而且，在模型得到改进、其输出越来越对齐人类的产出结果和期望的同时，并不清楚模型内部是否会变得更富人性。要在现实世界中成功部署大语言模型，可能不仅需要训练模型本身，还需要训练人类如何使用和看待模型。■

Car shows in the West are in terminal decline

Chinese firms are keeping them on life support

SHIFTING TRENDs in the car industry are best illustrated by the plight of Geneva's hoteliers. Securing a place to stay during the city's annual motor show once required booking at least a year ahead and paying an extortionate rate for even basic accommodation. This year rooms in the city were plentiful. Organisers' hopes for 200,000 visitors seem optimistic. An event that once no car firm could afford to miss, and that attracted crowds of over 700,000, was attended sparsely—chiefly, it seemed, by journalists who got a preview before the show opened to the paying public on February 28th. The few companies that turned up were characterised by one car executive as "China, China, China and Renault". They occupied less than a quarter of the floor space of previous years.

Geneva is not the only big car event in decline. Frankfurt and Paris, which took it in turns to host Europe's other big annual show, have dramatically downsized. The Paris jamboree of 2022 was a shadow of its former self. The German bash moved to Munich and became smaller. In both cases domestic firms were outshone by Chinese rivals such as BYD and Great Wall Motor.

America's premier event in Detroit has also suffered an exodus of firms. A scheduling shift from the depths of Michigan's harsh winter to the summer months has failed to revive interest. It will now revert to its winter date in 2025. But the changing nature of cars, which rely on software to lure buyers as much as sleekly bent metal, makes events such as the Consumer Electronics Show in Las Vegas more appealing showcases for manufacturers.

Reduced relevance makes the high price tag of turning up at shows harder for carmakers to stomach. Elaborate stands cost millions to build and then reconstruct at the next event halfway across the world. Car firms started to question the logic of competing to unveil the latest models at a single event when they could command more attention with dedicated launches or significant announcements at a time and place of their choosing.

Often such occasions now coincide with motor shows. On the eve of Geneva's opening, Fiat (part of Stellantis, whose biggest shareholder part-owns The Economist's parent company) released a video of its new Panda concept cars. (Reports on February 27th that Apple was abandoning its ten-year effort to build an electric car were probably not intended as a spoiler.) As a way of attracting buyers, cash can these days be far more effectively spent on marketing through other means, especially on social media.

In the absence of prominent Western marques—many of which still bitterly resent the Swiss organisers for calling off the show in 2020 at the last minute as covid-19 was spreading and then refusing to issue refunds—the atmosphere in Geneva this year was dull even by Switzerland's exacting standards. Renault drummed up some buzz with its new electric Renault 5, an affordable, neatly styled runaround. Another company to make a splash was BYD, with the European debut of the Yangwang U8, a luxury hybrid SUV with the amphibious ability to move on water. These days it is mostly Chinese carmakers that are keeping Europe's big shows afloat. ■

西方车展正无可挽回地走向衰落

中国车企正在为它们"续命"

日内瓦酒店经营者的窘境最能说明汽车行业的变化趋势。过去，要在日内瓦一年一度的车展期间找到一个住处至少需要提前一年预订，即使是最基本的住宿也价格高昂。今年，日内瓦的客房却非常充裕。组织者们对20万参观者的预期已是显得乐观。曾经这个任何车企都不容错过的盛会能吸引70多万人，今年却乏人问津——来的人似乎主要是记者，他们在展会于2月28日向公众收费开放之前已先睹为快。寥寥几家参展公司按一位汽车行业高管的描述是"中国、中国、中国和雷诺"。它们所占的展厅面积还不到往年的四分之一。

日内瓦车展并不是唯一走向衰落的汽车盛会。法兰克福和巴黎曾轮流主办欧洲另一个大型年度车展，如今也大幅缩减了规模。2022年的巴黎车展大不如前。而德国将车展移师慕尼黑，规模也变得更小。在这两个展会上，本土企业都被比亚迪和长城汽车等中国竞争对手盖过了风头。

在底特律举行的美国顶级车展也遭遇了车企流失。车展将举办时间从密歇根州的严冬改到了夏季月份，仍未能让人们重燃兴趣。如今，该车展将于2025年恢复到冬季举办。但是，由于汽车的性质正在发生变化，要吸引买家不仅要靠线条优美流畅的金属车身，也要靠软件，这就使得拉斯维加斯消费电子展等活动对制造商来说更具吸引力了。

车展热度降低，汽车制造商也就更难接受参展的高昂费用。精心布置的展台要耗费数百万美元，下一次跨越半个地球参加另一场展会时又要重新搭建。车企开始质疑竞相在同一个展会上发布最新车型是否明智，因为它们大可自行选择时间和地点举行专门的发布会或宣布重大消息，这样能吸引更多关注。

这样的活动如今常与车展撞期。在日内瓦车展开幕前夕，菲亚特

（Stellantis旗下品牌，Stellantis的最大股东部分持股本刊母公司）发布了新款熊猫概念车的视频。（2月27日有报道称苹果公司将放弃十年来研发电动汽车的努力，可能并不是有意抢戏吧。）如今要吸引买家，把钱花在其他营销手段上（尤其是社交媒体）效果可能要好得多。

由于西方著名品牌的缺席（它们当中有许多仍对2020年瑞士主办方因新冠肺炎蔓延而在最后一刻取消车展并拒绝退款的做法极其反感），即使以瑞士的严格标准来看，今年日内瓦车展的气氛也堪称沉闷。雷诺推出的新款电动车雷诺5引起了一些反响，这款小轿车价格实惠、造型简洁。另一家引起轰动的公司是比亚迪，它首次向欧洲消费者展示了仰望U8车型，这款具水陆两栖能力的豪华混合动力SUV能在水上行进。如今，主要还是靠着中国车企这跟浮木，欧洲的大型车展才不至于全沉了。■

Why recorded music will never feel as good as the real thing

The answer, according to neuroscience

IN A WORLD of music streaming services, access to almost any song is just a few clicks away. Yet, the live gig lives on. People still fill sweaty basements, muddy fields and gilded concert halls to hear their favourite musicians play. And now neuroscientists might know why: live music engages the brain's emotion centres more than its recorded counterpart.

Concerts are immersive social experiences in which people listen to and feel the music together through crescendos, key changes and drops. They are also dynamic—artists can adapt their playing according to the crowd's reaction.

It was this last difference that led neuroscientists, based at the Universities of Zurich and Oslo, to study the brain responses of people listening to music. In the "live" experiment, participants lay in an MRI scanner listening to the music through earphones, while a pianist was positioned outside the room. The pianist was shown the participant's real-time brain activity as a form of feedback. In the recorded condition, participants listened to pre-recorded versions of the same tunes.

The scientists were interested in how live music affected the areas of the brain that process emotions. In the live condition pianists were instructed to try and modulate their playing in order to drive the activity in one of these regions known as the amygdala, an almond-shaped area deep inside the brain.

The results, just published in the journal PNAS, showed that live music had far more emotional impact. Whether the music was happy or sad, listening

to the pianist playing in a dynamic way generated more activity in both the amygdala and other parts of the brain's emotion processing network. The researchers also found that participants' brain activity tracked the acoustic features of the music, like tempo and pitch, far more closely when it was played live.

The study was far from replicating the real experience of a gig, and the authors noted that the live music ended up sounding quite different from the recorded tracks, which may have driven some of the differences in participant's brain activity. But the results indicate that the ability of artists to change the way they play in response to the audience may be one aspect of what makes live music special. Some musical acts now attempt to recreate the real gig experience with everything but the artist—ABBA Voyage is a social, immersive show performed entirely by pre-recorded hologram avatars. But without Benny's ability to read the mood of the room, it will never quite match the real thing. ■

为什么听录制音乐的感受永远比不上听现场

来自神经科学的答案

在一个音乐流媒体服务大行其道的世界里，点几下鼠标就能听到几乎任何歌曲。但现场演出仍在继续。人们仍然挤在闷热的地下室、泥泞的户外和金碧辉煌的音乐厅里欣赏他们钟爱的音乐家演奏。现在神经科学家可能找到了原因：现场音乐比录制音乐更能调动大脑的情感中心。

音乐会是一种沉浸式的社交体验，在声音渐强、音调变化和高潮部分的变换之中，人们共同聆听并感受音乐。音乐会还是动态的——艺术家可以根据听众的反应调整他们的演奏。

正是这最后一个不同促使苏黎世大学和奥斯陆大学的神经科学家们研究人们听音乐时大脑的反应。在"现场"实验中，参与者躺在核磁共振扫描仪中，戴着耳机听音乐，同时一位钢琴家坐在房间外面演奏。参与者的实时大脑活动作为反馈被展示给钢琴家。在录音组，参与者听的是预先录好的相同的曲子。

科学家们对现场音乐如何影响大脑中处理情绪的区域很感兴趣。在现场组，研究人员指示钢琴家试着调整演奏来驱动这些区域中一个叫做"杏仁核"的部分，这是大脑深处一个杏仁状的区域。

这一刚刚发表在《美国国家科学院院刊》（PNAS）上的研究结果表明，现场音乐的情感冲击力要大得多。无论音乐是快乐还是悲伤，钢琴家的动态演奏都会让杏仁核和大脑情绪处理网络的其他部分产生更多的活动。研究人员还发现，在听现场演奏时，参与者的大脑活动对音乐声学特征的追踪要紧密得多，比如对节奏和音高。

这项研究离复制演出的真实体验还差得远，而且作者指出，现场版音乐最终听起来与录音室版本差异很大，这可能也导致参与者的大脑活动产生了

一些不同。但研究结果表明，艺术家能够根据观众的喜好改变演奏方式可能是令现场音乐与众不同的一个方面。现在，有些音乐演出试图"再造"真实的演出体验，它们具备现场演出的一切要素，独独省去了艺术家真身——ABBA乐队的Voyage演唱会是一场联欢式的沉浸式演出，完全由预先录制的全息图像作为替身表演。但没了乐队主唱班尼体察现场气氛的能力，它永远没法跟真人演出相比。■

How businesses are actually using generative AI

Some experiments with chatbots are more useful than others

IT HAS BEEN nearly a year since OpenAI released GPT-4, its most sophisticated artificial-intelligence model and the brain-of-sorts behind ChatGPT, its groundbreaking robot conversationalist. In that time the market capitalisation of America's technology industry, broadly defined, has risen by half, creating $6trn in shareholder value. For some tech firms, growing revenue is starting to match sky-high share prices. On February 21st Nvidia, which designs chips used to train and run models like GPT-4, reported bumper fourth-quarter results, sending its market value towards $2trn. AI mania has also lifted the share prices of other tech giants, including Alphabet (Google's corporate parent), Amazon and Microsoft, which are spending big on developing the technology.

At the same time, big tech's sales of AI software remain small. In the past year AI has accounted for only about a fifth of the growth in revenues at Azure, Microsoft's cloud-computing division, and related services. Alphabet and Amazon do not reveal their AI-related sales, but analysts suspect they are lower than those of Microsoft. For the AI stockmarket boom to endure, these firms will at some point need to make serious money from selling their services to clients. Businesses across the world, from banks and consultancies to film studios, have to start using ChatGPT-like tools on a large scale. When it comes to real-world adoption of such "generative" AI, companies have trodden gingerly. Yet even these baby steps hint at the changing nature of white-collar work.

Previous technological breakthroughs have revolutionised what people do in offices. The spread of the typewriter put some workers out of a job: "With the aid of this little machine an operator can accomplish more

correspondence in a day than half a dozen clerks can with the pen, and do better work," said an observer in 1888. The rise of the computer about a century later eliminated some low-level administrative tasks even as it made highly skilled employees more productive. According to one paper, the computer explains over half the shift in demand for labour towards college-educated workers from the 1970s to the 1990s. More recently the rise of working from home, prompted by the covid-19 pandemic and enabled by video-conferencing, has changed the daily rhythms of white-collar types.

Could generative AI prompt similarly profound changes? A lesson of previous technological breakthroughs is that, economywide, they take ages to pay off. The average worker at the average firm needs time to get used to new ways of working. The productivity gains from the personal computer did not come until at least a decade after it became widely available. So far there is no evidence of an AI-induced productivity surge in the economy at large. According to a recent survey from the Boston Consulting Group (BCG), a majority of executives said it will take at least two years to "move beyond the hype" around AI. Recent research by Oliver Wyman, another consultancy, concludes that adoption of AI "has not necessarily translated into higher levels of productivity—yet".

That is unsurprising. Most firms do not currently use ChatGPT, Google's Gemini, Microsoft's Copilot or other such tools in a systematic way, even if individual employees play around with them. A fortnightly survey by America's Census Bureau asks tens of thousands of businesses whether they use some form of AI. This includes the newfangled generative sort and the older type that companies were using before 2023 for everything from improving online search results to forecasting inventory needs. In February only about 5% of American firms of all sizes said they used AI. A further 7% of firms plan to adopt it within six months (see chart). And the numbers conceal large differences between sectors: 17% of firms in the information

industry, which includes technology and media, say they use it to make products, compared with 3% of manufacturers and 5% of health-care companies.

When the Census Bureau began asking about AI in September 2023, small firms were likelier to use the technology than big ones, perhaps because less form-ticking made adoption easier for minnows. Today AI is most prevalent in big companies (with more than 250 employees), which can afford to enlist dedicated AI teams and to pay for necessary investments. A poll of large firms by Morgan Stanley, a bank, found that between the start and end of 2023 the share with pilot AI projects rose from 9% to 23%.

Some corporate giants are frantically experimenting to see what works and what doesn't. They are hiring AI experts by the thousand, suggest data from Indeed, a job-search platform (see chart). Last year Jamie Dimon, boss of JPMorgan Chase, said that the bank already had "more than 300 AI use cases in production today". Capgemini, a consultancy, says it will "utilise Google Cloud's generative AI to develop a rich library of more than 500 industry use cases". Bayer, a big German chemicals company, claims to have more than 700 use cases for generative AI.

This "use-case sprawl", as one consultant calls it, can be divided into three big categories: window-dressing, tools for workers with low to middling skills, and those for a firm's most valuable employees. Of these, window-dressing is by far the most common. Many firms are rebranding run-of-the-mill digitisation efforts as "gen AI programmes" to sound more sophisticated, says Kristina McElheran of the University of Toronto. Presto, a purveyor of restaurant tech, introduced a gen-AI assistant to take orders at drive-throughs. But fully 70% of such orders require a human to help. Spotify, a music-streaming firm, has rolled out an AI disc-jockey which selects songs and provides inane banter. Recently Instacart, a grocery-delivery company, removed a tool that generated photos of vendors' food,

after the AI showed customers unappetising pictures. Big tech firms, too, are incorporating their own AI breakthroughs into their consumer-facing offerings. Amazon is launching Rufus, an AI-powered shopping assistant that no shopper really asked for. Google has added AI to Maps, making the product more "immersive", whatever that means.

Tools for lower-skilled workers could be more immediately useful. Some simple applications for things like customer service involve off-the-shelf AI. Most customers' questions are simple and concern a small number of topics, making it easy for companies to train chatbots to deal with them. A few of these initiatives may already be paying off. Amdocs produces software to help telecoms companies manage their billing and customer services. The use of generative AI, the company says, has reduced the handling time of customers' calls by almost 50%. Sprinklr, which offers similar products, says that recently one of its luxury-goods clients "has seen a 25% improvement" in customer-service scores.

Routine administrative tasks likewise look ripe for AI disruption. The "top examples" of Bayer's 700 use cases include mundane jobs such as "easily getting data from Excel files" and "creating a first draft in Word". Some companies are using generative AI as cleverer search. At Nasdaq, a financial-services firm, it helps financial-crime sleuths gather evidence to assess suspicious bank transactions. According to the company, this cuts a process which can take 30-60 minutes to three minutes.

Giving AI tools to a firm's most valuable workers, whose needs are complex, is less widespread so far. But it, too, is increasingly visible. Lawyers have been among the earliest adopters. Allen & Overy, a big law firm, teamed up with Harvey, an AI startup, to develop a system that its lawyers use to help with everything from due diligence to contract analysis. Investment banks are using AI to automate part of their research process. At Bank of New York Mellon an AI system processes data for the bank's analysts overnight and

gives them a rough draft to work with in the morning. "So rather than getting up at four in the morning to write research, they get up at six," the bank says. Small mercies. Sanofi, a French drugmaker, uses an AI app to provide executives with real-time information about many aspects of the company's operations.

Some companies are using the technology to build software. Microsoft's GitHub Copilot, an AI coding-writing tool, has 1.3m subscribers. Amazon and Google have rival products. Apple is reportedly working on one. Fortive, a technology conglomerate, says that its operating companies "are seeing a greater-than-20% acceleration in software-development time through the use of gen AI". Chirantan Desai, chief operating officer of ServiceNow, a business-software company, has said that GitHub Copilot produces "single-digit productivity gains" for his firm's developers. With the help of AI tools, Konnectify, an Indian startup, went from releasing four apps per month to seven. Surveys from Microsoft suggest that few people who start using Copilot want to give it up.

Pinterest, a social-media company, says it has improved the relevance of users' search results by ten percentage points thanks to generative AI. On a recent earnings call its boss, Bill Ready, said that new models were 100 times bigger than the ones his firm used before. L'Oréal, one of the world's largest cosmetics firms, has caught the eye of investors as it improves BetIQ, an internal tool to measure and improve the company's advertising and promotion. L'Oréal claims that generative AI is already generating "productivity increases of up to 10-15% for some of our brands that have deployed it".

This does not mean that those brands will need 10-15% fewer workers. As with earlier technological revolutions, fears of an AI jobs apocalypse look misplaced. So far the technology appears to be creating more jobs than it eliminates. A survey published in November by Evercore ISI, a bank, found

that just 12% of corporations believed that generative AI had replaced human labour or would replace it within 12 months. Although some tech firms claim to be freezing hiring or cutting staff because of AI, there is little evidence of rising lay-offs across the rich world.

Generative AI is also generating new types of white-collar work. Companies including Nestlé, a coffee-to-cat-food conglomerate, and KPMG, a consultancy, are hiring "prompt engineers" expert at eliciting useful responses from AI chatbots. One insurance firm employs "explainability engineers" to help understand the outputs of AI systems. A consumer-goods firm that recently introduced generative AI in its sales team now has a "sales-bot manager" to keep an eye on the machines.

Though such developments will not translate into overall productivity statistics for a while, they are already affecting what white-collar workers do. Some effects are clearly good. AI lets firms digitise and systematise internal data, from performance reviews to meeting records, that had previously remained scattered. Respondents to surveys conducted by Randy Bean, a consultant, reported big improvements in establishing an internal "data and analytics culture", which plenty of businesses find stubbornly difficult to nurture.

AI adoption may also have certain unpredictable consequences. Although AI code-writing tools are helping software engineers do their jobs, a report for GitClear, a software firm, found that in the past year or so the quality of such work has declined. Programmers may be using AI to produce a first draft only to discover that it is full of bugs or lacking concision. As a result, they could be spending less time writing code, but more time reviewing and editing it. If other companies experience something similar, the quantity of output in the modern workplace may go up—as AI churns out more emails and memos—even as that output becomes less useful for getting stuff done.

Polling by IBM, a tech firm, suggests that many companies are cagey about adopting AI because they lack internal expertise on the subject. Others worry that their data is too siloed and complex to be brought together. About a quarter of American bosses ban the use of generative AI at work entirely. One possible reason for their hesitance is worry about their companies' data. In their annual reports Blackstone, a private-equity giant, and Eli Lilly, a pharmaceutical one, have warned investors about AI-related risks such as possible leakage of intellectual property to AI model-makers. Last year Marie-Hélène Briens Ware, an executive at Orange, a telecoms company, explained that the firm had put data guardrails in place before commencing a trial with Microsoft's Copilot.

Ultimately, for more businesses to see it as an open-and-shut case, generative AI still needs to improve. In November Microsoft launched a Copilot for its productivity software, such as Word and Excel. Some early users find it surprisingly clunky and prone to crashing—not to mention cumbersome, even for people already adept at Office. Many bosses remain leery of using generative AI for more sensitive operations until the models stop making things up. Recently Air Canada found itself in hot water after its AI chatbot gave a passenger incorrect information about the airline's refund policy. That was embarrassing for the carrier, but it is easy to imagine something much worse. Still, even the typewriter had to start somewhere. ■

企业对生成式AI的实际使用情况如何

一些运用聊天机器人的尝试比其他的更有用【深度】

距OpenAI发布GPT-4已将近一年，GPT-4是其最先进的人工智能模型，也是其开创性的聊天机器人ChatGPT背后的机器大脑。在那段时间里，广义上的美国科技业的市值增长了一半，创造了6万亿美元的股东价值。对于一些科技公司来说，不断增长的收入开始与天价股价相匹配。2月21日，设计芯片供训练和运行GPT-4等模型的英伟达公布了出色的第四季度业绩，将其市值推至近2万亿美元。AI热潮也推高了其他科技巨头的股价，包括Alphabet（谷歌的母公司）、亚马逊和微软，它们正在砸巨资开发这项技术。

与此同时，科技巨头卖出的AI软件仍然不多。过去一年里，AI仅贡献了微软云计算部门Azure和相关服务收入增长的五分之一左右。Alphabet和亚马逊没有透露其与AI相关的销售额，但分析师怀疑都要低于微软。要想让AI带来的股市繁荣持续下去，这些公司到了某个时间点将必须要能从向客户出售相应服务中赚到可观的收入。从银行和咨询公司到电影制片厂，世界各地的企业都必须开始大规模使用类似ChatGPT的工具。对于在现实世界里应用这种"生成式"AI，各类公司小心翼翼地迈出了步子。但即使是这些婴儿学步也暗示了白领工作的性质在发生变化。

以往的技术突破变革了办公室工作。打字机的普及使一些人失业："借助这台小机器，一个打字员一天完成的信件比六个文员用笔写的更多，并且做得更好。"一位观察家在1888年说。大约一个世纪后，计算机的兴起消除了一些低级行政管理工作，同时也提高了高技能员工的产出。一篇论文发现，劳动力需求在1970年代到1990年代向受过大学教育的工人转移，其中一半以上是受计算机的推动。最近，在新冠疫情的推动和视频会议的助力下，居家办公兴起，改变了白领员工的日常节奏。

生成式AI能否引发类似的深刻变化？从以往的技术突破中得到的一个教训

是，从整体经济的角度来看，它们需要很长时间才能得到回报。普通公司的普通工人需要时间来适应新的工作方式。个人电脑在普及至少十年后才带来了生产率提升。到目前为止还没有迹象表明AI在经济总体中引发了生产率的大幅提升。波士顿咨询公司最近的一项调查显示，大多数高管表示，至少需要两年时间，AI才能"走出炒作阶段"。另一家咨询公司奥纬咨询（Oliver Wyman）最近的研究认为，AI的使用"未必已然转化为更高水平的生产力"。

这并不让人意外。大多数公司目前没有系统地使用ChatGPT、谷歌的Gemini、微软的Copilot或其他此类工具，即使有个别员工在摆弄它们。美国人口普查局每两周进行一次调查，询问数以万计的企业是否使用某种形式的AI。这包括新型的生成式AI，也包括那些旧式AI工具——企业在2023年前使用这些旧工具来改进在线搜索结果、预测库存需求等各种工作。今年2月，在各种规模的美国公司中，只有约5%表示它们使用了AI；另有7%的公司计划在六个月内使用AI（见图表）。这些数字掩盖了行业之间的巨大差异：在包括科技和媒体在内的信息产业中，有17%的公司表示在用AI制造产品，而制造业和医疗保健行业中的比例分别为3%和5%。

当人口普查局在2023年9月开始询问AI的使用情况时，小公司比大公司更有可能使用这项技术，这可能是因为小公司内部的管理程序更精简，因而更便于使用AI。如今，AI在大公司（拥有超过250名员工）中最为普遍，这些公司有能力招募专门的AI团队并做出必要的投资。摩根士丹利对大公司的一项调查发现，从2023年初到年底，有AI试点项目的公司比例从9%上升到了23%。

一些企业巨头正在疯狂地实验，看看哪些做法有效，哪些无效。求职平台Indeed的数据显示，它们正在招聘数以千计的AI专家（见图表）。去年，摩根大通的老板杰米·戴蒙（Jamie Dimon）表示，该银行"目前在经营中已经有了300多个AI用例"。咨询公司凯捷（Capgemini）表示，它将"利用谷歌云的生成式AI来开发一个有500多个行业用例的丰富案例库"。德国大型化工公司拜耳声称拥有700多个生成式AI用例。

有顾问称之为"用例大扩张"。它可以分为三大类：装点门面、为中低技能员工提供工具，以及为公司里最有价值的员工提供工具。其中，最常见的绝对是装点门面。多伦多大学的克里斯蒂娜·麦克赫兰（Kristina McElheran）说，许多公司正在将普通的数字化工作重新包装成"生成式AI程序"，好让它听起来更高端些。餐厅科技供应商Presto推出了一个生成式AI助手，让人们不用下车就能点单，但足足70%的此类点单需要人工帮助。音乐流媒体公司Spotify推出了一个AI DJ，可以选择歌曲并开些无聊的玩笑。最近，杂货配送公司Instacart删除了一个能生成供应商食物照片的AI工具，因为它向顾客展示了倒人胃口的照片。科技巨头们也在将自己的AI突破融入到面向消费者的产品中。亚马逊推出了Rufus，这是一款AI驱动的购物助手，但实际上并没有购物者找它帮忙。谷歌在谷歌地图中添加了AI功能，使这个产品更加"身临其境"，天知道这是什么意思。

为低技能工人提供的工具可能有更直接的用处。客户服务等一些简单的应用程序用到了现成的AI。大多数客户的问题很简单，只是围绕少量主题，这使得公司很容易训练聊天机器人来处理这些问题。其中一些举措可能已经取得了成效。Amdocs开发软件来帮助电信公司管理计费和客户服务。该公司表示，生成式AI的使用将客户来电的处理时间缩短了近50%。提供类似产品的Sprinklr表示，最近它的一家奢侈品客户的客户服务得分"提高了25%"。

日常行政管理工作看起来也是时候被AI颠覆了。拜耳的700个用例中的"顶级示例"包括单调的工作，例如"轻松从Excel文件中获取数据"和"在Word中创建初稿"。一些公司正在使用生成式AI进行更聪明的搜索。在金融服务公司纳斯达克，生成式AI帮助金融犯罪侦探收集证据以评估可疑的银行交易。该公司称，这能把需要30到60分钟的过程缩短到3分钟。

公司里最有价值的员工有着复杂的需求，到目前为止，向这些人提供AI工具还不那么普遍，但也越来越常见了。律师是最早的使用者之一。大型律师事务所安理国际（Allen & Overy）与AI创业公司Harvey合作开发了一个系统，可以辅助其律师完成从尽职调查到合同分析等各种工作。投资银行正在使用AI来自动化一部分研究工作。在纽约梅隆银行（Bank of New

York Mellon），一个AI系统在夜间为银行分析师处理数据，为他们提供一份草稿，以便在早上使用。"这样他们就不用早上四点起床写研报了，现在六点起床就行了。"该银行说。能多睡会儿，你就偷着乐吧。法国制药公司赛诺菲（Sanofi）使用一个AI应用为高管提供有关公司运营的方方面面的实时信息。

一些公司正在使用该技术来构建软件。微软的AI编程工具GitHub Copilot拥有130万订阅用户。亚马逊和谷歌都有与之竞争的产品。据报道，苹果也在开发一个类似的产品。科技集团Fortive表示，它旗下公司"使用生成式AI，把软件开发时间加快了20%以上"。商业软件公司ServiceNow的首席运营官齐兰坦·德赛（Chirantan Desai）表示，GitHub Copilot为该公司的开发人员带来了"几个百分点的生产率提升"。在AI工具的帮助下，印度创业公司Konnectify从每月发布四个应用提升到七个。微软的调查表明，很少有人在开始使用Copilot后会想放弃它。

社交媒体公司Pinterest表示，依靠生成式AI，它已经将用户搜索结果的相关性提高了10个百分点。在最近的一次财报电话会议上，该公司的老板比尔·雷迪（Bill Ready）表示，新模型比他的公司以前使用的模型大100倍。全球最大化妆品公司之一的欧莱雅改进了它衡量和改善广告促销效果的内部工具BetIQ，引起了投资者的注意。欧莱雅声称，生成式AI已经为它"旗下部署了该技术的一些品牌带来了高达10%到15%的生产率提升"。

这并不意味着这些品牌需要的员工也会减少10%到15%。与之前的技术革命一样，对AI毁灭就业的担忧似乎是过虑了。到目前为止，这项技术创造的就业似乎多于消除的就业。投资银行Evercore ISI在去年11月发布的一项调查发现，只有12%的公司认为生成式AI已经取代或将在12个月内取代人类劳动。尽管一些科技公司声称会因为AI而冻结招聘或裁员，但几乎没有证据表明富裕国家的裁员正在增多。

生成式AI也正在催生新型白领工作。包括食品企业集团雀巢和咨询公司毕马威在内的公司正在聘请"提示工程师"，以从AI聊天机器人那里获得有用的回应。一家保险公司聘请了"可解释性工程师"来帮助理解AI系统的输

出。一家消费品公司最近在其销售团队中引入了生成式AI，现在它有一个"销售机器人经理"来监督这些机器。

尽管这些进展一时半会儿还不会体现在整体生产率的统计数据上，但它们已经影响了白领员工的工作。有一些效果显然是好的。AI使公司能够将从绩效评估到会议记录的内部数据数字化和系统化，这些数据以前一直散布在组织架构的各个角落。在咨询公司Randy Bean进行的调查中，受访者表示在建立内部"数据和分析文化"方面取得了巨大进步，许多企业都认为这种文化向来很难培养。

使用AI也可能产生某些不可预测的后果。尽管AI编程工具正在帮助软件工程师完成工作，但软件公司GitClear的一份报告发现，在过去一年左右的时间里，此类工作的质量下降了。程序员可能在使用AI生成初稿后，却发现其中满是错误或不够简洁。也因此，他们编写代码的时间可能是减少了，但审查和修改代码的时间却增加了。如果其他公司也遇到类似的情况，那么当今职场里的产出的数量可能会增加——因为AI大量生成更多的电子邮件和备忘录，而同时这些产出对于完成工作却变得不那么有用了。

科技公司IBM的调查显示，许多公司对使用AI持谨慎态度，因为它们内部缺乏这方面的专业能力。其他公司则担心它们的各类数据过于彼此孤立和复杂，无法整合在一起。大约四分之一的美国老板完全禁止在工作中使用生成式AI。他们犹豫不决的一个原因可能是担心自己公司的数据安全。私募股权巨头黑石集团（Blackstone）和制药巨头礼来（Eli Lilly）在年度报告中警告投资者注意与AI相关的风险，例如知识产权可能被泄露给AI模型开发者。去年，电信公司Orange的高管玛丽-伊莲娜·布里恩斯·韦尔（Marie-Hélène Briens Ware）解释说，该公司在开始试用微软的Copilot之前就已经设置了数据护栏。

归根结底，若要让更多企业将其视为一个简单易用的工具，生成式AI仍然需要改进。去年11月，微软在Word和Excel等生产率软件中推出了Copilot。一些早期用户发现它出奇地笨拙且容易崩溃——更别说用起来还很繁琐，即使对于已经熟练使用Office的人来说也是如此。许多老板仍然

对使用生成式AI进行更敏感的操作持怀疑态度，除非这些模型完全不会再胡说八道。最近，加拿大航空公司（Air Canada）碰到了麻烦，因为它的AI聊天机器人就其退款政策向一位乘客提供了错误信息。这让加拿大航空很尴尬，但不难想象完全可能发生比这糟糕得多的事。不过话说回来，凡事总有个开始，打字机当年也是从小范围开始被使用的。■

A golden age for stockmarkets is drawing to a close

Share prices may be surging, but even AI is unlikely to drive a repeat of the past decade's performance

STOCKMARKETS TEND to rise gradually; recently they have soared. American stocks are up by 21% since the end of October and stand roughly 5% above their vertiginous peak in January 2022. On February 22nd Europe's equities set a new record for the first time in two years. India has been enjoying a multi-year boom as optimism about its economy abounds. Even Japanese stocks—a byword for stagnation—have at last exceeded the level they reached in 1989 before a decades-long slump. It has been an extraordinary run. Since 2010, the S&P 500 index of American stocks has returned 11% a year in real terms.

These profits are all the more striking given what markets have had to contend with. The age of free money has been followed by two years of interest-rate rises—and even now bond investors are betting against imminent cuts. A trade war is raging between America and China; actual wars are raging in Ukraine, the Middle East and parts of Africa. Around the world, governments are turning away from free markets and globalisation in favour of industrial policy and protectionism. If all that has not extinguished this rally, whatever will?

One conclusion might be that a bubble is waiting to pop, especially in America. On Wall Street, valuations—the multiple by which profits are scaled up—are on average 80% as high as they were during the dotcom mania of the late-1990s and 90% as high as they climbed during 2021, before rock-bottom interest rates rose. Similar extremes are also to be seen in other measures, including concentration (the share of the stockmarket that is made up by the top firms) or value spreads (the valuation of the most

expensive companies compared with the cheapest). The value of the top 10% of American firms as a proportion of the whole market has not been as high since the crash that was one cause of the Depression in the 1930s. And don't forget the frothiest corner of the financial markets: bitcoin is trading around $60,000 again, just shy of its peak in 2021.

Yet there are also reasons to see markets' exuberance as rational. As central banks all over the world tightened monetary policy at a pace not seen for a generation, many analysts warned about the danger of recessions and falling corporate profits. At the start of 2023 Wall Street savants predicted that in the year to come America's economy would grow by just 0.7%. In the event it achieved more than three times that amount. A broad range of firms are publishing strong results, including retailers, such as Walmart, and Japanese carmakers, such as Toyota.

The economy continues to defy gravity. A popular regular forecast of annualised American economic growth, published by the Federal Reserve Bank of Atlanta, stands at 3.2% for the first quarter of this year. Despite a slowdown in China—whose sagging markets are an exception to the global trend—the IMF has been nudging up its global growth forecasts, too.

Adding to investors' bullishness is their optimism about artificial intelligence (AI). This is not a ChatGPT-like hallucination. The event that propelled stocks into the stratosphere was the publication on February 22nd of earnings by Nvidia, which has an iron grip on the market for chips that are critical for training AI models. In October 2022, just before OpenAI released its now-celebrated chatbot, Nvidia earned around $3bn in gross profits each quarter, mostly from selling graphics cards to gamers. In the three months to the end of January 2024 Nvidia earned $17bn in gross profits while enjoying a margin of 76%. The company's share price has climbed five-fold over that time, but its earnings have grown even faster. In other words the enthusiasm that has lifted Nvidia close to a stockmarket

value of $2trn is not built on dotcom-like hype, but cold, hard profit.

Judging the boom to be justified, though, does not make it wise to rush out and buy stocks. What happens next is unlikely to fill investors with glee. That is partly because the extreme excitement about AI extends beyond Nvidia to other members of the "Magnificent 7" group of tech stocks, such as Microsoft, whose eventual commercial strategies in the AI era are still far from clear. These firms are hoarding Nvidia's chips in the belief that, one way or another, their AI businesses will boom. However, it remains to be seen how they will resolve basic issues with their large language models. Plenty of startups want to eat the Big 7's lunch, and competition will keep profits in check—even, eventually, at Nvidia.

Techno-optimism is also the basis, in some quarters, for bullishness about economy-wide productivity growth. The lesson from other fundamental technologies is that it takes time to work out how to exploit them. Businesses talk non-stop about generative AI but it remains at the experimental stage. As a result, even if AI is destined to transform societies utterly, today's investors may struggle to pick which companies will make money. Believers in the dotcom boom were not wrong about the transformative power of the internet—but they still lost their shirts.

If things stay sane this time, valuations will not climb much further. The trend of rising profits, as a share of the economy, also looks spent. Their outsize growth in recent decades was a one-off, caused by the falling cost of borrowing and taxes. As inflation lingers and government finances remain stretched, that fall cannot be repeated; it may even be reversed.

Under realistic assumptions about what will happen to valuations, interest and taxes, to generate even modest real equity returns of 4% a year over the next decade, America's firms would need to increase their underlying profits by around 6% a year, close to their best ever post-war performance.

No wonder Warren Buffett, a veteran investor, sees "no possibility" of super returns for his fund.

| *The long and grinding road*

Equities could underwhelm in many ways. Perhaps AI-exhilaration will cause a dotcom-style bubble that pops. Another war or crisis could lead to a crash. Or prices may stagnate in a gentle bear market that takes years to reverse. Whatever the path to disappointment, in ten years' time nobody will be repeating the obvious conclusion of today: that investors in equities—especially American ones—have enjoyed a golden age. ∎

股市的黄金时代即将结束

股价可能还在飙升，但即便是AI也不太可能让股市重现过去十年的辉煌

股市通常是逐步上涨的，近年却是一路狂飙。自去年10月底以来，美国股市上涨了21%，比2022年1月令人目眩的峰值还要高出约5%。2月22日，欧洲股市两年来首次创下新高。而在印度，投资者对经济的乐观情绪已经令股市连涨了好几年。就连被视为"停滞"代名词的日本股市也终于超过了1989年的水平（那一年之后它便经历了长达数十年的低迷）。这一轮上涨非同寻常。自2010年以来，美股标普500指数的实际年回报率达到了11%。

鉴于市场遭遇了一系列麻烦，这样的利润水平愈显惊人。廉价资本时代之后是两年的利率上涨——即使到了现在债券投资者还在押注利率短期内不会下调。中美贸易战正酣，乌克兰、中东和非洲部分地区则在真枪实弹地激战。纵观全球，各国政府正在放弃自由市场和全球化，转而支持产业政策和贸易保护主义。如果这一切都没能压制股市的这波反弹，那还有什么能做到呢？

一个可能的结论是，泡沫早晚会破裂，尤其是在美国。在华尔街，市值（利润的倍数）平均而言达到了上世纪90年代末互联网狂热期的80%，以及2021年（利率触底反弹之前）的90%。类似的极端情况还体现在其他指标上，比如集中度（少数头部企业所占的股市份额）或价值差（估值最高与最低公司之间的差距）等。美国前10%公司的价值占整个市场的比例非常之高，仅次于上世纪30年代股市暴跌前的水平，那次暴跌正是大萧条的成因之一。金融市场中泡沫最严重的一块也不能不提：比特币的交易价格重回六万美元左右，仅略低于2021年时的峰值。

不过，也有理由认为市场是理性繁荣。随着世界各国央行以二三十年来未曾见过的速度收紧货币政策，许多分析师警告称未来存在经济衰退和企业利润下降的风险。2023年初，华尔街的专家们预测，未来一年美国经济的

增长率只有0.7%。实际结果却是这一预测值的三倍多。包括沃尔玛等零售商和丰田等日本汽车制造商在内的一大批公司公布的业绩都很强劲。

经济仍然以无视地心引力的势头增长。亚特兰大联储定期发布的对美国经济年化增长率的预测广受认可，该预测认为今年第一季度美国的经济增长率为3.2%。尽管中国经济放缓（其股市是全球走势中的例外），国际货币基金组织也在小幅上调自己对全球经济增长的预测。

此外，对人工智能（AI）前景看好也增强了投资者的信心。这不是ChatGPT那种幻觉。英伟达牢牢控制着训练AI模型所用关键芯片的市场，它在2月22日发布的财报让股市一飞冲天。2022年10月，就在OpenAI发布其如今广受追捧的聊天机器人ChatGPT之前，英伟达每个季度的毛利润约为30亿美元——主要来自向游戏玩家出售显卡。而在截至2024年1月底的三个月里，它的毛利润达170亿美元，利润率高达76%。在此期间，英伟达的股价上涨了五倍，但利润增长得更快。换句话说，推动英伟达市值升至接近两万亿美元的投资热情并非建立在类似互联网泡沫的炒作之上，而是建立在真金白银的利润上。

不过，就算认为市场的繁荣合乎情理，也并不意味着匆匆入市购买股票是明智之举。接下来发生的事情可能并不会让投资者欢天喜地。原因之一是，对AI的过分狂热已经从英伟达蔓延到了科技股"七巨头"中的其他几家公司，比如微软，而它们还远未明确自己在AI时代的最终商业战略。它们囤积英伟达的芯片，深信自己的AI业务不管怎样总会兴旺起来。不过，它们将如何利用自己的大语言模型解决各种基本问题还有待观察。很多创业公司都想从七巨头那里抢食，而竞争也会压低利润——就算是英伟达，最终也不能幸免。

在某些群体中，技术乐观主义也是看好整个经济生产率增长的基础。其他基础性技术的发展历程告诉我们，弄清楚如何利用这些技术需要时间。虽然企业对生成式AI津津乐道，但它仍处于实验阶段。因此，即使AI注定会彻底改变社会，今天的投资者可能还是难以辨别哪些公司能赚到钱。当年相信互联网泡沫的人确实没有看错互联网的变革力量，但他们还是赔得血

本无归。

如果这一次市场保持理性，估值将不会再大幅上涨。利润占经济总规模之比不断增长的趋势似乎也后继无力。借贷成本下降和减税造就了过去几十年来这种绝无仅有的超速增长。但随着通胀挥之不去、政府财政依然捉襟见肘，那样的降息减税不但不可能重来，甚至还可能逆转。

依据对估值、利率和税收等因素未来变化的合理假设，未来十年内，美国企业即使想要让实际股本回报率达到每年4%这个不起眼的水平，也需要将基本利润每年提高6%左右——接近它们二战以来的最好表现。难怪投资大师巴菲特都认为自己的基金"绝不可能"获得超高回报。

道阻且长

股市可能会以多种方式令人失望。AI狂欢或许会引发像当年互联网泡沫一样的虚假繁荣，泡沫终会破裂。如果再来一场战争或者危机，股市可能崩溃；或者股价可能在温和的熊市中停滞不前，需要多年时间才能扭转。无论通往失望的大路是哪一条，十年后都不会有人再念叨今天这个显而易见的结论：股票投资者——尤其是美股投资者——经历了一个黄金时代。■

A secret room in Florence boasts drawings by Michelangelo

The artist's fingerprints are all over the walls—or are they?

STANDING IN THE mausoleum of the Medici Chapel in Florence, among tombs and elegant sculptures designed by Michelangelo, you could be excused for failing to notice the doorway to the left. It leads to a cloakroom, where a trap door opens to a flight of narrow steps. At the bottom is a small vaulted room. The eggshell-white walls are covered with graceful nude figures, a falling Phaethon (son of the sun god), a looming horse's head and several shapely legs drawn in shadowy charcoal—sketches, the museum claims, by the great Renaissance artist himself.

This stanza segreta (secret room) had long been closed. Only scholars and bigwigs like King Charles III and Leonardo DiCaprio were allowed entry by the National Museum of the Bargello, of which the chapel is a part. But in November the basement room was opened for a trial period of four months to 100 pre-booked visitors a week; they are allowed in for 15 minutes in groups of four. Tickets sold out. Officials recently extended the experiment until July.

Entering the room, which is bare except for ankle-level strips of LED lighting, is like stepping back in time—not just into the Renaissance, but also into an earlier era of tourism, when attractions lacked explanatory placards and were free from madding crowds. Most of all, it feels like entering someone's head, or their notebook, filled with drafts and doodles, some finely wrought, some cartoonish. You can imagine the middle-aged master in here, perhaps drawing by night. In several places, the walls appear to be scorched with black soot from a burning torch. Near a rendering of a muscular figure, there is even a smudged handprint.

Legend has it that Michelangelo holed up in this stanza segreta for a few months in 1530. Following a popular uprising three years before, the artist sided with those who preferred a republic to rule by the Medicis, Italy's wealthiest family, even though he had designed the mausoleum that bears their name. When the Medicis returned, the artist was in danger. This small room, conveniently furnished with a well, might have seemed like a safe haven.

The drawings were rediscovered in 1975 by the Medici Chapel's then director, who suspected that what was then a coal-storage room might be hiding something. Paola D'Agostino, director of the Bargello until mid-January, felt it was important to finally make the room accessible to the public. It shows "Michelangelo's human aspect", she says, though she admits that it is impossible to attribute the drawings securely to the master and concedes that some of the doodles are probably not his work.

Other experts doubt it was Michelangelo's hand who drew them. Antonio Forcellino, who has written two biographies of the artist, believes that none of the drawings is of high enough quality to merit firm attribution. William Wallace, a professor at Washington University in St Louis and a leading expert on Michelangelo, thinks that only a couple may be by the artist—a head that resembles the famous Laocoon statue Michelangelo had seen in Rome, as well as a standing male figure gracing a whole wall near the stairs—and that most were made by some of the 50 or so workmen employed to build the chapel above.

As for Michelangelo hiding in the room? "That's totally bogus," according to Mr Wallace. The already-famous artist is more likely to have been protected by a friend. Yet Mr Wallace argues that the room is a landmark finding nonetheless, because Michelangelo's workmen "are in some ways equal in importance to Michelangelo" himself. Greatness does not exist in isolation.

Just as the little guys are often overshadowed by the old masters they worked for, drawing often loses out to flashier forms like painting and sculpture. But the humble medium communicates the presence of hands, and minds, in motion.

Looking at these walls, you feel as if the artists who adorned them nearly five centuries ago—perhaps hiding from the summer heat, or taking a drink from the well—have just left. Even if this is not the work of Michelangelo, it evokes his world. ■

佛罗伦萨密室展出疑似米开朗基罗的画作

这位艺术大师的指纹遍布墙面——确定是他的吗?

置身于佛罗伦萨美第奇礼拜堂的墓室区，周围都是米开朗基罗设计的墓室和优雅的雕塑，你很容易注意不到左边的出口。它通向一个衣帽间，那里有一扇活板门连着一段狭窄的台阶。沿台阶走到底是一个带拱顶的小房间。蛋壳白色的墙壁上画满了姿态优美的裸体人物、正在坠落的法厄同（太阳神的儿子)、一个若隐若现的马头和几条匀称的腿。博物馆称，这些略显模糊的炭笔素描草图都是这位伟大的文艺复兴艺术家本人绘制的。

这个密室长期关闭。管理礼拜堂的巴杰罗国家博物馆（National Museum of the Bargello）过去只允许学者和像英国国王查尔斯三世和莱昂纳多·迪卡普里奥这样的大人物进入。但去年11月起，这个地下室开始了为期四个月的试开放，每周允许100位提前预约过的游客前来参观；每四人一组，可以观看15分钟。门票销售一空。最近官员们将试开放延长到了7月。

走进这个除了脚踝高度的LED灯条之外什么都没有的房间，就像回到了过去——不仅回到了文艺复兴时期，还回到了早期的旅游年代，那时候景点没有说明牌，也没有喧嚣的人群。最重要的是，感觉就像进入了某人的大脑，或是打开了他们的笔记本，里面满是草稿和涂鸦，有些是精雕细琢的，有些只是随手画就。你可以想象那位年届中年的大师就在这里，可能正在夜间作画。墙壁有几处似乎被燃烧的火炬产生的黑烟熏黑了。在一幅肌肉发达的人物草图旁边甚至有个模糊的掌印。

传说1530年米开朗基罗在这间密室里躲了好几个月。在三年前的一场民众起义之后，有一派人支持成立共和国、反对意大利最富有的家族美第奇的统治，这位艺术家站在了他们一边，尽管是他设计了以美第奇家族命名的墓室。当美第奇家族卷土重来时，这位艺术家就陷入了险境。这个小房间里正好有一口水井，或许看起来是一处安全的藏身之地。

1975年，美第奇礼拜堂当时的负责人怀疑一个原本放煤的储藏室里可能藏着什么东西，于是发现了这些画作。保拉·达戈斯蒂诺（Paola D'agostino）在今年1月中旬刚卸任巴杰罗博物馆的馆长，她认为最终能让公众参观这个房间很重要。这里展现了"米开朗基罗人性化的一面"，她说，尽管她承认无法确认这些画就是这位大师的亲笔，也承认其中一些涂鸦可能并不是他画的。

其他专家则怀疑这并非米开朗基罗所绘。安东尼奥·福切利诺（Antonio Forcellino）为这位艺术家写过两本传记，他认为这些画作的质量都不够高，不足以确定出处。圣路易斯华盛顿大学（Washington University in St Louis）教授、米开朗基罗研究权威威廉·华莱士（William Wallace）认为，可能只有两幅画出自米开朗基罗之手——一幅头像画，类似米开朗基罗在罗马看过的著名的拉奥孔雕像，还有楼梯附近画满整面墙的一幅男性立像——而大多数画是由建造上方的礼拜堂的五十多名工人中的一些人创作的。

那么米开朗基罗是躲在这个房间里吗？"这纯粹是瞎说。"华莱士表示。这位当时已经功成名就的艺术家更有可能是被一位朋友保护起来了。不过华莱士认为，这个房间仍然是个里程碑式的发现，因为米开朗基罗的工人们"在某些方面与米开朗基罗本人同样重要"。伟大不是孤立存在的。

正如小人物常常被带领他们工作的年长大师的光芒遮蔽，素描也往往不及油画或雕塑等更加华丽的艺术形式耀眼。但这样朴素的艺术创作展现了手和意识的运动。

看着这些墙壁，你会觉得好像近五个世纪前在上面作画的艺术家们才刚走开——他们在这里也许是为了躲避酷暑，也许是为了从井里打口水喝。即使这不是米开朗基罗的作品，也让人们感受到他身处的世界。■

Refik Anadol's use of AI has made him the artist of the moment

His work seems to be everywhere, blurring the boundaries between art and engineering

HE IS IN high demand. Last year Refik Anadol projected luminous images of coral on to a wall at the World Economic Forum in Davos and covered the exterior screen of the Sphere, a new concert venue in Las Vegas, with animated, tumbling blue blocks. In October the Museum of Modern Art (MoMA) in New York acquired "Unsupervised—Machine Hallucinations", in which a machine-learning model generates artworks based on those in the museum's collection. On February 16th "Echoes of the Earth", his largest-ever show in Britain, opened at the Serpentine North Gallery in London.

Mr Anadol, a 38-year-old Turk who lives in Los Angeles, is riding widespread public interest in artificial intelligence to become the most visible digital artist of his generation. His work reflects the innovation and anxieties of the current moment. As Mr Anadol sees it, AI is a powerful creative tool. In a world where so much of life happens in a digital realm, he argues, data has become a new "pigment".

He is steeped in both art and science, having completed several arts degrees and a residency at Google focused on machine learning. Mr Anadol trains AI models on massive troves of data, often publicly available, to create raucously colourful animations that he calls "dreams" or "hallucinations". They swirl on superbright screens (creating what he calls "data paintings") and wiggle on walls ("data sculptures"); sometimes the pieces illuminate buildings, as at the Sphere.

One artwork, displayed at the Venice Architecture Biennale, drew on 70 terabytes of brain scans, allowing AI models to imagine the organ's development. Another piece used an archive of the Los Angeles

Philharmonic's performances to imitate dreaming. A third assimilated more than 138,000 images and pieces of metadata from MoMA's collection (pertaining to provenance, for instance), along with local weather and data about noise levels. The results are churning clouds and waves, as well as abstractions evocative of Mark Rothko, a celebrated painter.

To undertake work on this scale Mr Anadol employs around 30 people, including architects, designers and engineers, half of whom work in his studio in Los Angeles. Public projects with institutions and companies have boosted his profile, but some private collectors have bought pieces, too. Mr Anadol also mints non-fungible tokens, digital artefacts that sometimes come with physical works.

The animations have proved popular: around 2.4m people came to see an exhibition of his work at MoMA in 2022. Mr Anadol's style is accessible and often beguiling. Understanding how machine learning works may help you fathom the process behind the "data paintings", but it is not essential. (In some installations, a control panel pops up to explain the model, giving the illusion of glancing under the bonnet but mostly evoking the futurism of "The Matrix".) You can be swept along by the crashing tides of colour, or watch a rose turn into a lily, without wondering whether you are "getting it".

Naturally Mr Anadol has critics as well as admirers. Some compare his animations to glorified screensavers and lava lamps, more spectacular than substantial. (Some do look as if they belong at a hotel in Las Vegas or at Burning Man.) Like anything generated by an AI model, Mr Anadol's animations raise questions about originality and whether such creations simply recycle the work of others.

Some worry that he glorifies AI while ignoring its risks, by presenting a rosy (or deep purple or yellow) view of the tech's potential. Casey Reas, one of

Mr Anadol's former teachers, says many in the art world are prejudiced against digital art, as they once were against photography, but concedes that "sometimes Refik's work can appear to have a utopian view of technology". The artist has appeared twice at TED and is fluent in the breathless Silicon Valley idiolect of "breakthroughs" and "inclusivity".

Wearing all black, in an all-black room in his studio, illuminated only by high-definition screens, Mr Anadol acknowledges that AI is changing everything—and not always for the better. But he is indeed excited about what the technology can do in the right hands. "I don't see the problem there," he says. "I see possibilities."

His latest project, on display at the Serpentine, is "Living Archive: Large Nature Model", which trained AI models on photographs, sounds and other kinds of scientific information collected at 16 rainforests across the globe. In addition to his usual sponsors, Google and Nvidia, institutions including the Natural History Museum in London and the Smithsonian have also furnished Mr Anadol with images and data.

Photo synthesis

Mr Anadol prompts the model to create his trademark abstractions, as well as hyper-realistic creatures. Eagles morph into owls, which turn into toucans; the overarching point is the connectivity of the natural world. AI offers "a new brush, a thinking brush", he says.

He hopes that his work will educate people and help them "discover new worlds". A viewer might prompt a model with the name of a plant, and it will generate a new one right in front of them. The artist's ultimate goal is a place called Dataland: a fully immersive experience, including sounds and smells.

Hans Ulrich Obrist, the Serpentine's artistic director, says that Mr Anadol

"makes the invisible visible"; he captures the power of technology as he turns AI from an abstraction in the cloud into art before the eyes. Whether that art looks like a dream or a beautiful banality is up to viewers. But like it or not, people will be seeing a lot more of Mr Anadol's work. ■

用AI创作艺术，雷菲克·安纳多尔爆火

他的作品似乎无处不在，模糊了艺术和工程之间的界限

他现在炙手可热。去年，雷菲克·安纳多尔（Refik Anadol）在达沃斯世界经济论坛上将五光十色的珊瑚影像投射到了一面墙上，还给拉斯维加斯新建成的音乐场馆Sphere的外部屏幕设计了满屏翻滚的蓝色色块。去年10月，纽约现代艺术博物馆（MoMA）收藏了他的作品《无人监督——机器幻觉》（Unsupervised—Machine Hallucinations），它用机器学习模型基于该馆的馆藏不断生成新的艺术作品。2月16日，他迄今最大规模的作品《地球的回声》（Echoes of the Earth）在英国伦敦的北蛇形画廊（Serpentine North Gallery）揭幕。

现年38岁的土耳其人安纳多尔住在洛杉矶，他利用公众对人工智能的广泛兴趣进行艺术创作，成为他这一代人中最引人注目的数字艺术家。他的作品反映了当下的锐意创新和焦虑不安。在安纳多尔看来，AI是一种强大的创作工具。他认为，如今人们生活的很大一部分都是在数字领域中开展，数据已经成为一种新的"颜料"。

他深谙艺术和科学，拥有多个艺术学位，并在谷歌做过机器学习项目驻场艺术家。安纳多尔用大量数据（通常是公开数据）来训练AI模型，创作出他称之为"梦境"或"幻觉"的炫彩动画。这些动画有的在超亮屏幕上旋转涌动（创造出他称之为"数据绘画"的作品），有的在墙上摇摆不定（"数据雕塑"），有的装点建筑物，比如显示在Sphere的外屏上。

他有一件在威尼斯建筑双年展上展出的作品，利用70TB的脑部扫描数据，让AI模型想象大脑发育的过程。另一件作品用洛杉矶爱乐乐团（Los Angeles Philharmonic）的演出资料模拟梦境。还有一件作品吸纳了MoMA的13.8多万张图像和元数据（例如作品来源信息等），并加入了本地天气和噪音水平数据，最终呈现翻腾的云海和波涛，以及会让人联想到著名画家马克·罗斯科（Mark Rothko）的抽象作品。

为完成这么大规模的作品，安纳多尔雇用了包括建筑师、设计师和工程师在内的约30名员工，其中一半在他位于洛杉矶的工作室里耕耘。与机构和公司合作的公共项目提升了他的知名度，但也有一些私人收藏家购买了他的作品。安纳多尔还发行非同质化代币，有时这种数字作品也附带实体作品。

他的动画作品非常受欢迎，约有240万人参观了他2022年在MoMA的作品展。安纳多尔的风格易于理解，经常令人着迷。了解机器学习的工作原理可能有助于理解"数据绘画"背后的过程，但这并非必不可少。（一些作品展示会弹出控制面板来解释模型的创作过程，给人以参透其中玄机的幻觉，但更多是唤起了《黑客帝国》的那种未来主义感。）观众可以沉浸在翻涌不休的五彩斑斓的浪潮之中，或看着一朵玫瑰变成百合，而无需纠结于自己是否"看懂了"。

自然，对于安纳多尔既有人赞赏，也有人批评。一些人将他的动画作品比作华而不实的屏保和熔岩灯，徒有其表。（有些的确看起来像是拉斯维加斯某个酒店的展示，或者是火人节上的作品。）和任何由AI模型生成的东西一样，安纳多尔的动画引发了关于这些作品的原创性以及它们是否只是在重复他人作品的问题。

一些人担心，他以玫红（也可能是深紫或明黄）这样的明媚色调呈现AI技术的潜力，美化了AI，却忽略了风险。安纳多尔曾经的一位老师凯西·列阿斯（Casey Reas）表示，许多艺术界人士对数字艺术有偏见，就像过去的艺术界人士对摄影技术的态度，但他承认"有时雷菲克的作品会呈现出一种乌托邦式的科技观"。安纳多尔曾两次在TED上亮相，熟稔硅谷那一套自我沉浸的话术，大谈特谈"突破"和"包容"。

一身黑衣的安纳多尔身处工作室的一个漆黑房间里，仅有的光亮来自几个高清屏幕。他承认AI正在改变一切，而结果并不总是更好。但他确实因AI技术在得到善用时可能发挥的作用感到振奋。"在这方面我不觉得有问题，"他说，"我看到的是可能性。"

他在蛇形画廊展出的最新作品是《鲜活档案：大型自然模型》（Living Archive: Large Nature Model），该作品用收集自全球16处雨林的照片、声音和其他类型的科学信息训练AI模型。除了平时赞助他的谷歌和英伟达外，伦敦自然历史博物馆和史密森尼博物馆（Smithsonian）等机构也向安纳多尔提供了图像和数据。

图像合成

安纳多尔通过给AI模型提示词来创作他标志性的抽象图案及超现实主义的生物。雄鹰变成猫头鹰，又变成巨嘴鸟。总的主题就是大自然万物相通。AI提供了"一支新画笔，一支会思考的画笔"，他说。

他希望自己的作品能够教育并帮助人们"发现新世界"。观众可以用植物的名字做提示词输入给模型，模型当场就能生成一种新植物。安纳多尔最终的目标是创建一个数据之地（Dataland），这是一种完全沉浸式的体验，用户能听到声音，闻到气味。

蛇形画廊的艺术总监汉斯·乌尔里奇·奥布里斯特（Hans Ulrich Obrist）表示，安纳多尔"将无形变为有形"，在将云端中抽象的AI变成眼前的艺术，体现了科技的力量。至于这种艺术形式看起来像是梦幻之境还是只是虚浮俗物，则取决于观众。但不论喜欢与否，人们看到安纳多尔的作品的频率都会大增。■

The age of the unicorn is over

Don't expect AI to bring it back

BUSINESS HAS never been better for America's tech giants. After slumping in 2022, the combined market value of Alphabet, Amazon, Apple, Meta and Microsoft has surged by 70%, to over $10trn, since the start of 2023 amid the hype over artificial intelligence (AI). The technology has also propelled others into the industry's upper echelons. On February 21st Nvidia, an AI-chip champion, reported that its sales rocketed by 265%, year on year, in the quarter to January. Its market value has risen from around $500bn a year ago to $1.7trn, making it America's fifth-most-valuable firm. OpenAI, the maker of ChatGPT, and other AI builders such as Anthropic have shot to fame, scooping up billions of dollars in funding.

Thousands of smaller AI firms have popped up, too. Enough that a small Caribbean island called Anguilla, whose internet domain suffix is ".ai", now generates around a third of its government's budget from licensing it out, according to Rest of World, an online publication. In the latest sign of madness returning to Silicon Valley Adam Neumann, the ousted founder of WeWork, an office-sharing firm that declared bankruptcy in November after years of losses, made a bid on February 5th to retake the reins of the firm.

Yet it would be a mistake to think America's startup scene is returning to its former exuberance. For one, the reception from WeWork's management and creditors to Mr Neumann's gambit has been lukewarm. Venture-capital (VC) firms invested only $170bn in the country last year, down by half from 2021, according to PitchBook, a research firm. Bar a few high-profile exceptions, such as OpenAI, investors have been especially wary of signing cheques at lofty valuations. Throughout the 2010s the number of

unicorns—private companies with valuations above $1bn—soared in America. Fully 344 of them were minted in 2021. Last year's figure was 45.

The end of the era of cheap money is largely to blame. In the go-go years, as investors raced to get a piece of the buzziest startups, tech firms had little need to tap public markets for capital. Crossover investors such as Tiger Global and Coatue, which operate in both public and private markets, flooded into Silicon Valley. Dharmesh Thakker of Battery Ventures, a VC firm, recalls that founders could "raise money on a Zoom call". In 2021 crossover investors accounted for over half of startup funding. They have since retreated, last year contributing less than a third.

Now investors are mulling how to sell their stakes in the unicorns of yesteryear. Most VC funds operate on a ten-year clock, backing startups in the first five and cashing out in the second. With over 700 unicorns, at a combined valuation of $2.4trn, a sizeable amount of money is at stake.

The first way to exit is through an initial public offering (IPO). Yet the IPO market remains at a standstill, with 83 VC-backed listings in 2023, down from 309 in 2021. Many of those that listed last year, including Instacart, a grocery-delivery business, and Klaviyo, a software firm, are trading below their initial price. Arm, a chip designer whose share price has more than doubled since its listing in September, is a rare exception. Firms that are planning for an IPO this year are often doing so at a reduced valuation: Reddit, a meme-sharing website, plans to list at $5bn, down from a private valuation of $10bn in 2021.

The second path to an exit—a sale to a corporate buyer—is also partly blocked. Only 698 VC-backed firms were purchased by companies last year, according to PitchBook, down from 1,311 in 2021. Trustbusters have kept big tech, once a serial acquirer, on the sidelines. Last month Amazon abandoned its bid to acquire iRobot, a maker of robo-vacuum-cleaners,

following scrutiny from European regulators.

Selling to another private investor—the third option—is not too attractive, either. Private valuations in the so-called secondary market are below those at the latest fundraising round for more than four-fifths of unicorns, according to Caplight, a data provider. Discord, a chat service popular with gamers, was most recently valued in the secondary market at $6bn, down from a nearly $15bn valuation when it last raised funds in 2021.

Amid the drought, some unicorns have simply collapsed. Convoy, a logistics startup that last raised funds in 2022 at a nearly $4bn valuation, shut down in October. Veev, a unicorn dedicated to disrupting home-building, closed its doors in November and is liquidating its assets. Samir Kaji of Allocate, a firm that connects investors with VC funds, believes that many unicorns will "quietly get acquired for parts".

Back to the garage

That is a sad fate for the founders, employees and investors of those once-promising firms. But others need not be overly worried. Tom Tunguz of Theory Ventures, another VC firm, reckons the drop in funding since 2021 is merely a return to a long-run trend that was thrown off course by the pandemic. And there is plenty to celebrate in the newfound sobriety of Silicon Valley.

It is rare these days to find a startup that espouses growth at all costs. Founders have rediscovered the concept of frugality. Many are being cautious with their hiring, a striking contrast to the race for talent during the pandemic. It helps that the industry's giants have flooded the market with thousands of techies following a bout of layoffs. Over the past two years Alphabet, Amazon, Meta and Microsoft have fired more than 75,000 staff between them.

What's more, AI is providing American startups not just with new business ideas, but also ways to do more with less. Startups burn roughly half their cash on selling their products and a third on engineering. AI assistants for salesmen and coders are raising productivity by more than a third at some startups, lowering the amount of capital they need to raise. In time, the age of the unicorn may not be missed. ■

独角兽时代落幕

别指望它借人工智能之势回归

美国科技巨头的生意从未如此红火。经过2022年的低迷后，在人工智能（AI）概念大热之下，自2023年初以来，Alphabet、亚马逊、苹果、Meta和微软的总市值飙升70%，突破十万亿美元。AI技术还助推其他公司跻身行业前列。2月21日，AI芯片领军者英伟达发布报告称，截至1月的财季其销售额同比飙升265%，市值从一年前的约5000亿美元上升至1.7万亿美元，成为美国市值第五高的公司。开发ChatGPT的OpenAI以及Anthropic等其他AI公司一举成名，收获数十亿美元融资。

同时另有成千上万小型AI公司涌现。据线上科技媒体Rest of World报道，加勒比海上一个名叫安圭拉（Anguilla）的小岛因为互联网域名后缀是".ai"而受益，现在其政府预算约有三分之一来源于授权该域名的收入。办公室共享公司WeWork在多年亏损后于去年11月宣布破产，被赶下台的创始人亚当·诺伊曼（Adam Neumann）于2月5日出价回购该公司——这是硅谷再陷疯狂的最新例证。

但要是就此以为美国创业圈正恢复昔日盛景，那就错了。首先，WeWork管理层和债权人对诺伊曼的出价反应冷淡。研究公司PitchBook的数据显示，风投公司去年在美国仅投资1700亿美元，比2021年减少一半。除了OpenAI等少数几个吸人眼球的例外，投资者对于按高昂估值开出支票尤其谨慎。整个2010年代，美国独角兽公司（估值超过十亿美元的私人公司）的数量激增。在2021年的一年里就新增了足足344家，而去年的数字是45家。

廉价资金时代的终结是主要原因。在那些兴旺的年头，投资者争抢最热门创业公司的股份，科技公司几乎不需要从公开市场融资。老虎环球（Tiger Global）和Coatue等同时在公开市场和私人市场运作的交叉投资者涌入硅谷。巴特利风投公司（Battery Ventures）的达梅什·塔克尔（Dharmesh

Thakker）回忆说，创始人当时"通过Zoom电话就能融到资金"。2021年，交叉投资者为创业公司贡献了超过一半的融资。自那以后，他们的投资减少了，去年只占不到三分之一。

如今投资者正琢磨如何卖掉昔日买进的独角兽股份。大多数风投基金以十年为一个周期，前五年支持创业公司，后五年变现退出。目前美国有700多家独角兽，总估值达2.4万亿美元，其中牵扯的资金规模很可观。

第一条退出途径是IPO。但IPO市场仍处于停滞状态，2023年只有83家由风投支持的公司上市，相比之下2021年有309家。食品杂货配送公司Instacart和软件公司Klaviyo等许多去年上市的公司目前股价都低于发行价。芯片设计公司安谋（Arm）是个少有的例外，自去年9月上市以来，它的股价翻了一倍多。计划今年IPO的公司大多准备降低估值上市：网络梗分享网站Reddit计划以50亿美元的价格上市，低于2021年私人融资时100亿美元的估值。

第二条退出途径是出售给其他公司，这条路同样不好走了。PitchBook的数据显示，去年只有698家由风投支持的公司被其他公司收购，低于2021年的1311家。大型科技公司以往收购成风，如今受制于反垄断机构，改持观望态度。今年1月，在受到欧洲监管机构的审查后，亚马逊放弃收购扫地机器人制造商iRobot。

第三条途径是出售给其他私人投资者，但也不太有吸引力。数据供应商Caplight指出，在所谓的二级市场上，超过五分之四的独角兽的私人收购估值低于上一轮融资时的估值。游戏玩家热捧的聊天软件Discord最近在二级市场上的估值为60亿美元，低于2021年最近一次融资时近150亿美元的估值。

资金枯竭之下，一些独角兽直接就崩塌了。物流创业公司Convoy在去年10月倒闭，它上一次融资是在2022年，当时估值近40亿美元。致力颠覆住宅建设的独角兽Veev于11月关门，正在清算资产。为投资者和风投基金牵线搭桥的公司Allocate的萨米尔·卡吉（Samir Kaji）认为，许多独角兽公司

将"悄无声息地被分割收购"。

回到车库

对于这些曾经前景大好的公司的创始人、员工和投资者来说，这是悲惨收场。但其他人不必过于担心。另一家风投公司Theory Ventures的汤姆·通古斯（Tom Tunguz）认为，2021年以来的融资减退只不过是回归了因新冠疫情而偏离轨道的长期趋势。硅谷回归清醒很值得庆贺。

如今，不惜代价追求增长的创业公司已不多见。创始人重拾节俭理念。许多人在招聘时很是谨慎，这与疫情期间的人才争夺战形成鲜明对比。行业巨头的一轮裁员潮过后，成千上万技术人员涌入市场，这也让创业公司得以捡漏。在过去两年内，Alphabet、亚马逊、Meta和微软共解雇了超过75,000名员工。

此外，AI不仅为美国创业公司提供了新的商业理念，还让它们能少花钱多办事。创业公司有一半的资金会烧在产品销售上，三分之一在工程设计上。目前，在一些创业公司里，销售和编程人员能凭借AI助手把生产率提高三分之一以上，这降低了所需的融资额。假以时日，人们或许会不再怀念独角兽时代。■

Podcasts got their name 20 years ago this month

A once-fringe medium has gone mainstream, but many wonder what the future holds

IN FEBRUARY 2004 Ben Hammersley, a British journalist, noticed a new kind of digital media: "downloadable radio" produced by geeky amateurs or public broadcasters. Mr Hammersley suggested a few names for it. Fortunately "audioblogging" and "GuerillaMedia" did not catch on. But a third did: podcasting, a portmanteau of "iPod" and "broadcasting".

At a tech conference the next year, Steve Jobs, Apple's boss, asked how many people in the audience had heard of podcasting, which he described as "'Wayne's World' for radio". Not a single person raised their hand. But today, 20 years after they got their name, podcasts are mainstream. Around 43% of American internet users and 30% of Britons listen to at least one a month (including some from The Economist). You can open Apple, Spotify and, increasingly, YouTube to find some 4m shows by everyone from ex-convicts to duchesses. Podcasting has turned anyone with a microphone into a talking head who can talk straight into people's earbuds.

Like butt-dialling and doom-scrolling, the podcasting boom was facilitated by the smartphone. The iPhone was released in 2007; the first standalone podcast apps came out between 2010 and 2012. In 2014 "Serial", a binge-worthy investigation into the botched murder trial of a teenager in Maryland, arrived; it was the first show to gain attention in mainstream American culture. (The first season has been downloaded more than 300m times.) The number of monthly podcast listeners in America doubled in the five years after 2014.

Since "Serial", podcasting has been in a "hyper-charged, hyper-capitalist, hyper-speculative period", says Nicholas Quah, a podcast critic. Tech

companies swooped in, such as Spotify, which was hungry for new customers and audio content it could have royalty-free. (Spotify has invested $1bn in podcasting since 2018.)

But last year—cue the "record scratch" sound effect—the music stopped. Economic headwinds were one factor. But advertisers and investors also realised that they know relatively little about how many people actually listen to podcasts: "downloads", the standard industry metric for engagement, do not always equate to listening. Spotify eliminated 200 podcasting jobs; others followed suit. Many well-regarded shows were cancelled, including "Stolen", which won the Pulitzer prize for audio journalism in 2023. Podcasters learned that "excellence won't save you", says Neil Verma, a media-studies scholar.

Although producers are struggling to turn a profit, podcasting is in the ascendant. Advertising spending and listening time are predicted to rise. But the medium "is growing in a direction that is hard for a lot of the podcast originalists to accept", says Ariel Shapiro, who writes Hot Pod, an industry newsletter.

What does the future hold? Some think the future of podcasting lies in video. Many podcasts, including a talk show hosted by Joe Rogan (pictured), the most popular podcast globally, now employ video to increase their audience. "We will be watching podcasts, we will be skipping chapters of podcasts, and you will be commenting on them at the end," predicts Will Page, Spotify's former chief economist.

Betting that some people want visual entertainment while listening, Spotify started supporting video podcasts in 2020. Already the black microphone icon has become omnipresent on YouTube and TikTok, functioning as a visual signal for podcast-like straight talk. Video will help podcasts' further spread; rarely does audio alone go viral.

Whatever happens to the industry, its impact on audio storytelling will endure. Podcasts offer something traditional formats often work hard to leave out, but which, as trust in media has fallen, audiences crave: transparency. Instead of formal interviews, listeners get sprawling conversations. Instead of radio features measured in minutes, listeners are led through whole investigations over hours. "In exposing the vulnerabilities of the reportorial process, the news product becomes more credible and trustworthy," writes David Dowling in "Podcast Journalism", a forthcoming book. Podcasts often set out to explain things—and they always end up explaining themselves. ■

二十年前的二月，播客这个名字诞生了

曾经的边缘媒体已经成为主流，但许多人想知道未来会怎样

二〇〇四年二月，英国记者本·哈默斯利（Ben Hammersley）注意到了一种新型数字媒体：由极客业余爱好者或公共广播公司制作的"可下载的广播"。哈默斯利给它起了几个名字。还好，"音频博客"（audioblogging）和"游击媒体"（GuerillaMedia）这两个名字没有流行起来。但是第三个名字火了：播客（podcasting），一个由"iPod"和"broadcasting"组成的合成词。

在次年的一次科技会议上，苹果公司的老板乔布斯问听众中有多少人听说过播客，他形容播客是"广播界的'反斗智多星'（Wayne's World）"。没有一个人举手。但是今天，播客这个名字诞生20年之后，它成了主流。大约43%的美国网民和30%的英国网民每月至少听一次播客（包括本刊发布的一些）。你可以打开Apple播客、Spotify，以及越来越多地从YouTube上找到大约400万个节目，主播形形色色，从公爵夫人到前科犯什么人都有。有了播客，只要有麦克风，你就能成为在别人耳机里说话的主播。

和不小心自动拨出了电话以及狂刷坏消息停不下来这些现象一样，这股播客繁荣也是智能手机带来的结果。iPhone于2007年发布，而第一个独立的播客应用出现在2010年到2012年之间。2014年一档名为《连载》（Serial）的播客节目横空出世，讲述了对马里兰州一桩青少年谋杀案拙劣审判的调查，很值得一口气听完，是第一个获得美国主流文化关注的播客。（第一季的下载量已超过3亿次。）2014年之后的五年间，美国每月收听播客的人数翻了一番。

播客评论家尼古拉斯·奎阿（Nicholas Quah）说，自《连载》出现以来，播客便处于"高度兴奋、高度资本主义、高度投机的时期"。科技公司蜂拥而至，比如渴望获得新客户和免版税音频内容的Spotify。（自2018年以来，Spotify已在播客上投资了10亿美元。）

但到了去年——此处应配上"刮擦唱片"音效——音乐戛然而止。经济逆风是一个原因。但广告主和投资者也意识到，他们对实际上有多少人收听播客知之甚少："下载量"——衡量用户参与度的标准行业指标——并不总是等同于收听量。Spotify在播客部门裁员200人，其他公司也纷纷效仿。许多备受好评的节目被取消，包括2023年获得普利策音频报道奖的《被盗》（Stolen）。媒体研究学者尼尔·维尔马（Neil Verma）表示，播客主播们认识到"节目做得棒并不能拯救你"。

虽然制作人还在为实现盈利犯愁，但播客仍处在上行通道中。预计广告支出和收听时长还会增加。但行业简报《热门播客》（Hot Pod）的作者艾莉儿·夏皮罗（Ariel Shapiro）表示，这一媒介"正朝着许多播客原教旨主义者难以接受的方向发展"。

未来会怎样？有些人认为播客的未来要走向视频。包括乔·罗根（Joe Rogan，见图）主持的全球最受欢迎的脱口秀在内的许多播客现在都用视频来吸引更多听众。"我们会观看播客，跳过它们的一些章节，在结尾处发表评论。"Spotify的前首席经济学家威尔·佩奇（Will Page）预测说。

Spotify认定有些人想在听节目的同时享受视觉娱乐，从2020年开始支持视频播客。在YouTube和TikTok上，黑色麦克风图标已经无处不在，表明这是像播客那样畅所欲言的视频节目。视频将有助于播客的进一步传播；单靠音频很少能大火。

无论这个行业发生了什么，它对音频叙事的影响会持续下去。播客提供了一种传统媒体形式常常极力排除的东西：透明度。而随着人们对媒体信任度的下降，他们越发渴望透明度。听众听到的不是正式的采访，而是信马由缰的漫谈。不同于以分钟为单位的广播节目，听众花几小时在主播的带领下了解整个调查过程。戴维·道林（David Dowling）在即将出版的《播客新闻学》（Podcast Journalism）一书中写道："通过把报道过程中的漏洞弱点直接呈现给受众，新闻产品变得更加可信可靠。"播客常常是为了解释什么事情而制作的——但最终却总是在解释自己。∎

New treatments are emerging for type-1 diabetes

The trick is to outsmart the immune system

"WHERE ARE the islets of Langerhans?" is a trick question that pops up from time to time in quizzes. The answer is to be found not in atlases of geography, but rather in those of anatomy, for the so-called islets are in fact clusters of cells scattered through the pancreas. There they synthesise and release a range of hormones, including insulin, which regulates glucose levels and thus metabolism.

The islets' insulin producers are called beta cells. (Cell types alpha, gamma, delta and epsilon perform other tasks.) They are the only bodily sources of that hormone. So, if their number declines, trouble looms. And decline it does, in the condition known as type-1 diabetes. This happens when, in a phenomenon called autoimmunity, the body's own immune system attacks its complement of beta cells, wiping out as many as 80%.

Without an alternative supply of insulin, someone with type-1 diabetes will die. (In type-2 diabetes, insulin continues to be produced but the body's cells acquire resistance.) Supplementary insulin can be administered by injection or via a device called an insulin pump. But a better way might be to replace the missing beta cells and somehow protect them from immune attack.

A few lucky patients do indeed have their beta cells replaced—by transplantation from human donors. And Vertex Pharmaceuticals, a firm in Boston, is testing beta cells grown from stem cells for the same purpose. But neither approach includes immune protection. This means both require the administration of immunosuppressive drugs to prevent the rejection that follows any transplant, let alone one where autoimmunity is

at play. One of the sessions at this year's meeting of the American Association for the Advancement of Science in Denver therefore looked into how transplanted beta cells might be made hypoimmunogenic—in other words, invisible to a patient's immune system.

Sonja Schrepfer, who works for the University of California, San Francisco (UCSF), and also at Seattle-based Sana Biotechnology, proposes a twofold approach, to deal with the fact that the immune system has two arms. One, the adaptive arm, is the basis of tissue rejection. This adaptive arm can recognise the signature of "selfness" provided by an individual's HLA proteins. These molecules contain so-called hypervariable regions, which differ from individual to individual. If the immune system comes across non-self HLA proteins, it recognises the cells displaying them as interlopers and attacks, using shock troops called killer T-cells and antibodies.

The first part of Dr Schrepfer's approach is therefore to prevent the production of HLA proteins in laboratory-grown beta cells destined for transplant. This can be done by editing two genes involved in their production, theoretically rendering the cells in question invisible to the adaptive arm.

Lack of HLA proteins does, however, bring a cell to the attention of immunity's other arm, the innate system. Its troops are called NK (natural killer) cells and macrophages, and one of the red flags it reacts to is an absence of any sort of HLA. It can, however, be warded off by over-expression of a protein called CD47, something that Dr Schrepfer's team also achieved by genetic manipulation of their beta cells.

It seems to work. In an experiment whose results were announced just before the meeting, the team first induced diabetes in a laboratory monkey and then injected their modified beta cells into one of its muscles. The

diabetes went away, and stayed away for more than six months. Now they have moved on to people. In a trial about to start at Uppsala University Hospital, in Sweden, human versions of the modified cells will be transplanted into the forearm of a single patient.

Disrupting beta cells' HLA expression is not the only possible approach to deflecting the adaptive immune system. Hasna Maachi of the Technical University of Munich, in Germany, described to the meeting how she and her mentor, Matthias Hebrok, are trying to develop an alternative. This introduces a third party, called a suppressor cell, to do the warding off.

Suppressor cells "talk" to the killer T-cells, and calm them down. Dr Hebrok's group is therefore working with Wendell Lim of UCSF, who is engineering suppressor cells specifically activated by a protein on the surface of beta cells, to devise some beta-cell protection. In this case there is no need to build in a level of protection against the innate immune system, since it will not notice anything wrong.

The Hebrok group is also, Dr Maachi explained, working on a way to turbocharge beta cells. This involves a protein called MAFA, which regulates expression of the insulin gene. Suppressed levels of MAFA are a symptom of type-1 diabetes, so boosting its presence seemed a promising approach. So far, the researchers have shown that raising MAFA levels in beta cells derived from stem cells seems to increase the amount of insulin produced.

Figures presented by Lori Sussel of the University of Colorado suggest that type-1 diabetes affects one in 500 Americans. The global average may be closer to one in 1,000. That is both a great deal of human suffering and a tempting market for whoever can come up with something which resembles a cure, rather than a treatment. Though there is a way to go yet, hypoimmunogenic beta cells might, just possibly, bring that closer. ■

一型糖尿病的新疗法

诀窍在于骗过免疫系统

知识问答中时不时会出现这么一个刁钻问题："朗格汉斯岛在哪里？"答案不在地理地图中，而在解剖学图册里，因为朗格汉斯岛实际上是散布在胰腺中的细胞团，也称为胰岛。胰岛合成并释放多种激素，包括调节葡萄糖水平继而调节新陈代谢的胰岛素。

胰岛中分泌胰岛素的细胞称为beta细胞。（alpha、gamma、delta和epsilon等其他类型的细胞执行别的任务。）它们是人体内唯一的胰岛素来源。因此，如果beta细胞数量减少，就会出现麻烦。而它确实会减少，患上一型糖尿病就会这样。这种糖尿病的发病是因为自身免疫现象：人体的免疫系统攻击自己的beta细胞，会消灭多达80%的这种细胞。

如果没有另外的胰岛素补充，一型糖尿病患者将会死亡。（在二型糖尿病中，胰岛素仍然继续分泌，但人体细胞对其产生了抵抗。）可以通过注射或使用名为胰岛素泵的装置来补充胰岛素。但更好的方法也许是替换缺失的beta细胞，并想办法保护它们免受免疫攻击。

少数幸运的患者确实通过人类供体移植替换了beta细胞。而波士顿的Vertex Pharmaceuticals正在测试由干细胞培养的beta细胞，以便能做同样的替换。但这两种方法都没有免疫保护。这意味着它们都需要使用免疫抑制药物以避免排斥反应——任何移植手术后都会有排斥反应，更不用说还有自身免疫性现象在发挥影响了。因此，今年在丹佛举行的美国科学促进会（American Association for the Advancement of Science）年会上，就有一个专场讨论如何让移植的beta细胞具有低免疫原性——换句话说，就是在患者的免疫系统面前隐形。

在加州大学旧金山分校和西雅图的Sana Biotechnology工作的索尼娅·施雷普弗（Sonja Schrepfer）提出了一种双管齐下的方法，以应对免疫系统

的两个部分。其一是后天性免疫系统，也是组织排斥的基础。这种适应性免疫系统能够识别人体HLA蛋白表达的"自我"特征。这些分子包含有名为超变异区的部分，每个人都各不相同。如果免疫系统遇到非自身的HLA蛋白，它就会将表达这种蛋白的细胞视为入侵者，并使用杀伤性T细胞和抗体作为突击部队对其发起攻击。

因此，施雷普弗的方法首先要避免在实验室培养的用于移植的beta细胞产生HLA蛋白。要做到这一点，可以对参与产生HLA蛋白的两个基因进行编辑，理论上可以让这些细胞在后天性免疫系统面前隐身。

然而，缺少HLA蛋白又会引起免疫系统的另一个部分——先天性免疫系统的注意。它的部队称为自然杀伤细胞和巨噬细胞，缺乏任何一类HLA都是一个危险信号，会让它做出反应。然而，通过一种CD47蛋白的过度表达可以避免它的攻击，施雷普弗的团队也通过对其beta细胞进行基因编辑实现了这一点。

这种方法似乎奏效了。在会议前不久公布的实验结果显示，研究团队首先在一只实验猴身上诱发了糖尿病，然后在它的一块肌肉中注入改造过的beta细胞。糖尿病消失了，而且持续了六个多月。现在，他们已经进入人体试验阶段。在瑞典乌普萨拉大学医院（Uppsala University Hospital）即将开展的一项试验中，经过改造的人体beta细胞将被移植到一名患者的前臂。

干扰beta细胞的HLA表达并不是唯一一种可能躲避后天性免疫系统的方法。德国慕尼黑工业大学的哈斯娜·马奇（Hasna Maachi）在会上介绍了她和导师马蒂亚斯·赫布鲁克（Matthias Hebrok）正在研究的另一种方法。该方法引入了一个称为抑制细胞的第三方来规避免疫系统。

抑制细胞能与杀伤性T细胞"对话"，使它们平静下来。因此，赫布鲁克的团队正与加州大学旧金山分校的林行健合作，他正在改造抑制细胞，让它们可以专门被beta细胞表面的一种蛋白激活，从而设计出一些保护beta细胞的方法。在这种情况下，无需针对先天性免疫系统建立起某种保护，因

为它不会察觉到任何问题。

马奇解释说，赫布鲁克团队还在研究一种增强beta细胞的方法。这涉及到一种称为MAFA的蛋白，它能调节胰岛素基因的表达。MAFA水平受到抑制是一型糖尿病的症状之一，因此提高其表达似乎是一种很有前景的方法。到目前为止，研究人员已经证明，在干细胞培育的beta细胞中提高MAFA水平，似乎可以增加胰岛素的分泌。

科罗拉多大学的洛里·苏塞尔（Lori Sussel）展示的数据显示，每500个美国人中就有一人患有一型糖尿病。全球平均患病率可能接近千分之一。这既是人类的巨大苦难，也是诱人的市场——只要有人能开发出更能治本而非仅仅治标的方法。虽然还有一段路要走，但低免疫原性的beta细胞或许为接近这个目标提供了一些可能。■

The world's biggest maker of spectacles wants to be a tech firm

It is experimenting with smart glasses and built-in hearing aids

OVER THE course of six decades Leonardo Del Vecchio, an Italian entrepreneur who died in 2022, built Luxottica into the world's largest maker of spectacles and sunglasses. In 2018 he merged his firm with Essilor, a French lens manufacturer, to create a Franco-Italian corporate giant that is today worth over $90bn and employs some 200,000 people. The group owns iconic eyewear labels from Ray-Ban to Oliver Peoples, and also produces glasses using the brands of European luxury houses such as Armani and Chanel. On February 14th the company reported that its sales grew by 7% last year, at constant exchange rates, faster than at many other luxury businesses.

Now Francesco Milleri, a close confidant of Mr Del Vecchio's who was appointed chief executive of Luxottica in 2017 and of the combined group in 2020, is looking for the company's next act. He has two big ideas. First is to become the leader in smart glasses. The ambition is not entirely new: the firm partnered with Google, a tech giant, on its Google Glass—an unambiguous flop thanks in part to its clunky interface and dorky design. The device was discontinued in 2015.

Yet there are plenty of optimists who think that the moment for smart spectacles has arrived. In 2021 Snap, a social-media firm, unveiled a pair of augmented-reality glasses. Last month Apple began shipping its augmented-reality headset, the Vision Pro. It reportedly pre-sold 200,000 of the devices, despite a price tag of $3,499. "I believe we are at the dawn of a product revolution akin to what we saw in the early 90s in mobile phones," reckons Luca Solca of Bernstein, a broker.

EssilorLuxottica's latest foray into the technology is through Ray-Ban, in partnership with Meta, another tech giant. The first iteration it launched in 2021 had only modest success. It will be hoping that a new version it began selling in September, which has a snazzier camera and a longer battery life, will do better. The device can capture and relay what the wearer sees. An in-built virtual assistant can hear and respond to their requests.

Mr Milleri's second idea is the one in which he seems most invested. "We have become a med-tech company," he declares. Central to that is the development of spectacles with built-in hearing aids, which it will launch in August, for those with moderate hearing loss. It reckons that is a group of some 1.25bn people worldwide, many of whom shy away from the perceived stigma and high price of conventional hearing aids. The company's spectacles, by contrast, will look no different from other glasses and cost well below the price of a regular hearing aid, says Mr Milleri.

The thinking is not altogether original. The Beltone "Hear-N-See", one such device, first debuted in 1956. Audiofon, a German maker of hearing aids, has also dabbled in spectacles. But the idea has never been adopted en masse. Mr Milleri is counting on better technology to change that. Last year his company acquired Nuance Hearing, an Israeli startup founded in 2015. Its technology uses an algorithm to detect where sounds are coming from based on when they are picked up by different microphones. The spectacles it has developed then isolate and process the voice of the person the wearer is speaking to and transmit it through tiny built-in speakers. Nothing goes in the wearer's ear.

Mr Milleri's enthusiasm for the concept is personal. Mr Del Vecchio, who was 87 when he died, suffered from hearing loss and often lamented that hearing aids were uncomfortable to wear with glasses. That inspired Mr Milleri and Leonardo Maria Del Vecchio, one of the founder's sons, who is also the firm's strategy chief, to pursue the idea. Whether they prove to be

farsighted remains to be seen. ■

全球最大的眼镜制造商希望变身科技公司

它正在研发智能眼镜和内置助听器的眼镜

二〇二二年去世的意大利企业家莱昂纳多·德尔维奇奥（Leonardo Del Vecchio）生前用了60年的时间将陆逊梯卡（Luxottica）打造成全球最大的光学眼镜和太阳镜制造商。2018年，他将陆逊梯卡与法国镜片制造商依视路合并，创建了一家法意企业巨头。如今，这家名为依视路陆逊梯卡（EssilorLuxottica）的集团价值超过900亿美元，雇有约20万名员工。它旗下不仅拥有雷朋、奥利弗-皮珀兹（Oliver Peoples）等一些知名眼镜品牌，还为阿玛尼、香奈儿等欧洲奢侈品牌生产眼镜。2月14日，依视路陆逊梯卡公告称，其去年的销售额（按固定汇率计算）增长了7%，增速超过许多其他奢侈品企业。

如今，德尔维奇奥生前的密友弗朗西斯科·米勒里（Francesco Milleri）正在谋划这家公司的下一步发展。米勒里于2017年和2020年先后被任命为陆逊梯卡和依视路陆逊梯卡的CEO。他有两个宏伟计划。第一是成为智能眼镜的领军者。这一雄心并非前所未有：陆逊梯卡曾与科技巨头谷歌合作开发谷歌眼镜，但以完全失败告终——难用的操作界面和不够自然的外观设计都是其槽点。谷歌眼镜于2015年停售。

不过也有很多乐观主义者认为，智能眼镜的时代已经到来。2021年，社交媒体公司Snap推出了一款增强现实AR眼镜。今年2月，苹果开始发售其AR头显Vision Pro。尽管售价高达3499美元，但据说已经预售了20万台。"我相信，我们正处于一场产品革命的开端，就像我们在上世纪90年代初经历的手机革命一样。"经纪公司盛博（Bernstein）的卢卡·索尔卡（Luca Solca）认为。

依视路陆逊梯卡最近一次进军该技术领域是它的雷朋与另一家科技巨头Meta合作推出智能眼镜。它在2021年推出的第一代产品只算小有成就。它希望今年9月开售的新一代产品会有更出色的表现。新一代产品配备了更

时尚的摄像头，电池续航也更久。它可以拍摄并转播佩戴者看到的东西。内置的虚拟助手可以听到佩戴者的指令并做出回应。

米勒里投入最多的似乎是他的第二个计划。他宣称："我们已经成为一家医疗科技公司。"研发内置助听器的眼镜是该计划的核心。这种专为轻中度听力损失人群所打造的眼镜将于今年8月推出。依视路陆逊梯卡估计，全球约有12.5亿人患有轻中度听力损失，其中许多人因为自感羞耻以及价格昂贵而对传统助听器望而却步。米勒里表示，相比之下，依视路陆逊梯卡的助听眼镜看起来就像一副寻常眼镜，价格又远低于普通助听器。

这种思路并非全新。贝尔通（Beltone）1956年问世的"Hear-N-See"就是一款这样的设备。德国助听器制造商Audiofon也曾涉足眼镜领域。只不过这一想法从未被广泛采用过。米勒里希望更先进的技术能够改变这种状况。去年，依视路陆逊梯卡收购了2015年成立的以色列创业公司Nuance Hearing。Nuance Hearing的技术使用的算法可以根据不同麦克风的拾声时间来识别声音的来源。依视路陆逊梯卡研发的眼镜又会把佩戴者交谈对象的声音分离出来处理，并通过内置的微型扬声器传输给佩戴者。佩戴者的耳朵里不用放置任何东西。

米勒里热衷于这一想法是出于个人原因。德尔维奇奥87岁去世前听力已经很不好了，他经常抱怨同时戴着助听器和眼镜很不舒服。这激发了米勒里和莱昂纳多·玛丽亚·德尔维奇奥（Leonardo Maria Del Vecchio，创始人的一个儿子、同时也是公司的战略主管）去探索内置助听器的眼镜的想法。他们此举是否有远见尚待分晓。■

As the Nikkei 225 hits record highs, Japan's young start investing

Will more now favour domestic stocks?

SAITO MARI, a 28-year-old nurse, was frustrated. Her pay, at just ¥160,000 ($1,100) a month, was meagre; after bills, rent, shopping and a few holidays, she had little left over. So in 2020 she decided to buy some stocks. "I used to think it was too risky," says Ms Saito, who learned about investing via books and YouTube. "But it was amazing to see my assets grow."

Although Ms Saito's story would be unremarkable anywhere else, it is part of a sea change in Japan. According to surveys by the Investment Trusts Association, 23% of people in their twenties invested in mutual funds last year, up from 6% in 2016. So did 29% of people in their thirties, up from 10%—a bigger rise than in any other age group. Those with exposure to the Nikkei 225, which on February 22nd passed a record high set in 1989, are reaping the rewards.

Japan's officials, who want to boost economic growth, have long desired such a shift. The public's previous aversion to retail investing dates back to the early 1990s, when a stockmarket bubble burst. In the ensuing decades, with inflation minimal or non-existent, low-risk saving came to be seen as virtuous. Some 54% of Japanese household assets are in cash or deposits, against 31% in Britain and 13% in America.

Kishida Fumio, Japan's prime minister, outlined an "Asset Income Doubling Plan" in 2022. This aims to create a virtuous cycle: companies will grow by making use of funds from retail investors; individuals will enjoy the benefits of their growth. As part of the initiative, in January the government improved the terms of its NISA programme, modelled on Britain's ISA, which exempts retail investors from capital-gains taxes. The same month

900,000 new NISA accounts were opened with the country's five biggest investment platforms.

Mr Kishida's push has been given extra oomph by economic developments. Under Japan's zero-interest-rate policy, hoarding cash in a bank brings almost no return. This has been true for a while, but inflation now stands at around 3%—a three-decade high—meaning the value of cash not put to work is being eroded. Young generations, who do not share the trauma of the burst bubble, are more inclined to act.

The number of students at ABCash, a financial school in Tokyo targeting millennials, has doubled since 2022, reaching 40,000. Shinjo Sayaka joined after seeing an influencer mention it on Instagram. "It's hard to talk about money with my family," she reports. One problem for Mr Kishida is that many youngsters favour international markets over domestic ones. For instance, Ms Saito's investments include Apple (an American tech giant), the S&P 500 (an index of big American firms) and BioNTech (a German vaccine-maker). Yet perhaps she and others will change their approach if the Nikkei continues to soar. ■

随着日经225指数创下历史新高，日本的年轻人开始投资股市

接下来会有更多日本人青睐本国股票吗？

28岁的护士斋藤真理有些沮丧。她工资很低，每个月只有16万日元（1100美元）；付完各种账单和房租，再买点东西、度几次假，便所剩无几了。所以在2020年，她决定买些股票。她通过书籍和YouTube学习如何投资。"我过去认为股票风险太高，"斋藤说，"但看到自己的资产在增长，真的很惊喜。"

尽管斋藤的情况在其他任何地方都可能稀松平常，但它却反映了日本的一些重大转变。日本投资信托协会（Investment Trusts Association）的调查显示，去年，20多岁人群有23%投资了共同基金，而2016年这一比例为6%；30多岁人群中做此投资的有29%，而2016年这一比例为10%——增幅高于其他年龄段。2月22日，日经225指数突破了1989年创下的历史最高点，那些持有该指数基金的投资者正在收获回报。

长期以来，希望促进经济增长的日本官员一直就想要这种转变。民众之前对散户投资的排斥可以追溯到上世纪90年代初股市泡沫破裂的时候。而在随后几十年，通胀率极低或者为零，低风险储蓄开始被视为正途。日本家庭大约54%的资产是现金或存款，而英国和美国这一比例分别为31%和13%。

日本首相岸田文雄在2022年提出了"资产收入倍增计划"。此举想要创造一种良性循环：企业可以利用散户投资者的资金获得发展，而个人则可以享受企业发展带来的好处。日本先前仿效英国的ISA（免除散户投资者的资本利得税）推出了少额投资非课税制度（NISA）。今年1月，作为资产收入倍增计划的一部分，日本政府修改了NISA的部分条款。当月，日本五大投资平台上就新开了90万个NISA账户。

经济形势为岸田文雄的努力提供了额外的助力。在日本的零利率政策下，

将现金存在银行几乎没有收益。这种情况在日本已有时日，但现在的通胀率达到3%左右，为30年来的最高水平，这意味着如果钱放着不用，就等于在贬值。没有经历过股市泡沫破裂创伤的年轻一代更愿意投资。

东京一家理财学校ABCash向千禧一代传授投资理财知识，自2022年以来它的学员数量翻了一番，达到四万人。新条沙也加在Instagram上看到一个网红提到该学校后，也成为了它的学员。"我很难和家里人谈论怎么管钱。"她说。岸田文雄面临的一个问题是，许多年轻人喜欢投资国际市场胜过国内市场。例如，斋藤的投资包括美国科技巨头苹果、美国大公司指数标普500以及德国疫苗制造商BioNTech等。不过，如果日经指数继续飙升，她和其他日本年轻人或许就会改变做法。■

Do not expect America's interest rates to fall just yet

The risk of a second wave of inflation remains too great

HAS INFLATION been vanquished, or is it bouncing back? The question grips bond markets and governs the world's economic prospects. At the turn of the year, after the Federal Reserve all but declared victory over America's excessive price rises, bond yields collapsed in expectation of several interest-rate cuts. Today that bet looks premature. Over the past three months core consumer prices, which exclude food and energy, have risen at an annual rate of 4%, up from 2.6% in the three months to August. Producer prices have risen more than expected and consumers' expectations of inflation over the next year have gone up, too. Inflation is much lower than at its peak, but it has not yet been defeated. As a result, Treasury yields are roughly back to where they were before the Fed's doveish turn. Yields on long-dated bonds are higher still.

Inflation is also proving stickier elsewhere. The euro zone recorded large price rises in January, Swedish inflation rose in January and the Reserve Bank of Australia recently warned that inflation will take time to become "sustainably low and stable". Everywhere, and especially in America, a resurgence of inflation threatens to delay cuts to interest rates.

To understand what is going on, look at the pattern of demand. The covid-19 pandemic led to lockdowns and generous handouts, which fuelled the demand for goods and overwhelmed supply chains. In 2021 in America the price of a washing machine rose by 12%. After Russia invaded Ukraine, energy and food prices soared. Today, by contrast, global goods prices are falling, despite being buffeted by disruptions to shipping in the Red Sea. Food and energy prices are moderate. The source of today's problem is rises in the price of global services.

Inflation in services is tightly linked to local conditions. If haircuts are in short supply, you cannot import them. It is, therefore, no surprise that the cost of services is rising in America. Over the past three months its booming jobs market has created an average of 289,000 jobs a month, more than double estimates of the sustainable rate. Wages are growing at an annual pace of more than 4.5%. GDP rose by an annualised 4.1% in the second half of 2023 and real-time indicators suggest that the expansion remains healthy. Such is the economy's strength that, even if there had been no inflation in the past two years, forecasters would be expecting it to break out.

Elsewhere, the situation is more finely balanced. In Europe unemployment is low but growth less strong. Britain fell into recession at the end of 2023. Business surveys in the euro zone are gloomy. Inflation fears are limited by sharply lower natural-gas prices. That will reduce inflation and raise the rate of sustainable, non-inflationary economic growth. The Chinese economy is in a funk and prices are falling. In Japan interest rates are still below zero. It would be considered a victory if inflationary pressures stayed strong enough to let the central bank raise rates.

If a disruptive second wave of inflation is likely to strike anywhere it is in America. That means monetary policy is likely to diverge, with the Fed keeping interest rates high even as the rest of the rich world cuts them to revive growth. Such a pattern would boost the value of the dollar, which is already climbing. When America's money markets offer high returns for little risk, the many poorer countries struggling to borrow in dollars suffer most.

If interest rates do not fall there could be nasty surprises on Wall Street, too. The stockmarket appears to have barely noticed the danger that monetary policy will stay tight this year. By contrast, rising rate expectations in 2022 and 2023 often caused sell-offs as investors adjusted the discounted value

of future profits. Neither is there much sign that America's small and midsize banks have resolved the threats that high rates pose to their balance-sheets. The inflation problem is not what it was a year ago, but the world is not yet clear of the danger. ■

先别指望美国的利率会下降

第二轮通胀的风险仍然很大

通货膨胀是被征服了，还是在反弹？这个问题牵动着债券市场，也关系着世界经济的前景。岁末年初，在美联储近乎要宣布已经战胜了美国过高的物价上涨之后，债券收益率因人们预期会多次降息而暴跌。今天看来，这样下注似乎还为时过早。在过去三个月里，不包括食品和能源的核心消费者价格以年化4%的速度上涨，高于去年6月至8月的2.6%。生产者价格涨幅超过预期，消费者对明年通胀的预期也有所上升。通胀虽已远低于峰值，但尚未被击败。美国国债收益率随之又大致回到了美联储转向鸽派之前的水平。长期债券的收益率还要更高。

事实证明，其他地方的通胀也更具粘性。欧元区在1月录得物价大幅上涨，瑞典的通胀在1月上升，澳大利亚央行最近警告说，通胀要"持续走低并稳定"还需要时间。在各个地方，尤其是在美国，通胀的回升都有可能导致推迟降息。

要理解现在的情况，来看看需求模式。新冠疫情导致了封锁和慷慨的补贴，这刺激了对商品的需求并让供应链不堪重负。2021年，美国的洗衣机价格上涨了12%。俄罗斯入侵乌克兰后，能源和食品价格飙升。相比之下，尽管受到红海航运中断的冲击，如今全球的商品价格正在下跌。食品和能源价格适中。今天问题的根源是全球服务价格上涨。

服务业通胀与本地状况密切相关。如果理发服务供不应求，那是没法进口的。因此，美国的服务价格上升也就不足为奇了。过去三个月里，美国火热的就业市场平均每月创造28.9万个工作岗位，是估计的可持续数字的两倍多。工资以每年超过4.5%的速度增长。2023年下半年GDP的年化增长率为4.1%，实时指标显示这样的增长依旧健康。经济如此强劲，即使过去两年没有出现通胀，预测人员也会预计通胀将会爆发。

在其他地方，现状是一种更加微妙的平衡。欧洲的失业率较低，但增长不那么强劲。英国在2023年底陷入衰退。欧元区的企业景气调查结果令人沮丧。天然气价格大幅下跌限制了对通胀的担忧。这将降低通胀，提升可持续的无通胀经济增长。中国经济阴霾密布，物价正在下跌。在日本利率仍低于零，如果通胀压力持续而足以促使日本央行加息，这会被视为一场胜利。

如果说具扰乱性的第二波通胀可能会袭击什么地方，那就是美国。这意味着货币政策可能会分化：美联储把利率维持在高位，而同时其他富裕国家降息以重振经济增长。这种模式将进一步推高本已在攀升的美元价值。当美国的货币市场以很小的风险提供高回报时，许多难以借入美元贷款的较贫穷国家就会承受最大的损失。

如果利率不降，华尔街也可能出现恼人的意外。美国股市看起来几乎还没有留意到今年货币政策将保持紧缩的危险。相比之下，在2022年和2023年加息预期往往导致抛售，因为投资者调整了未来利润的贴现价值。也没有太多迹象表明美国的中小型银行已经解决了高利率对其资产负债表构成的威胁。通胀问题已不同于一年前，但世界尚未摆脱这一危险。■

How to benefit from the conversations you have at work

Stop thinking about your next point and listen to the one being made

SUCCESSFUL WORKPLACES are usually characterised by good communication. Bosses provide a clear sense of where they want the firm to go; employees feel able to voice disagreements; colleagues share information rather than hoarding it. But being a good communicator is too often conflated with one particular skill: speaking persuasively.

In a paper published in 2015, Kyle Brink of Western Michigan University and Robert Costigan of St John Fisher College found that 76% of undergraduate business degrees in America had a learning goal for presentation skills, but only 11% had a goal related to listening. Business students were being schooled to give TED talks rather than have conversations. That may have costs. Another study, conducted by Dotan Castro of the Hebrew University of Jerusalem and his co-authors, found that when people felt listened to by those in supervisory roles their creativity and sense of psychological safety improved.

A focus on talking is understandable. The set-piece moments of careers, like job interviews and big presentations, are about transmitting information. The boss gets to be at the podium, the minions get to be in the audience. Videos of someone giving a speech are much more shareable than someone silently nodding. But interest in what makes everyday communication tick has also risen, as the importance of teams grows and as conceptions of leadership increasingly emphasise softer skills.

Recent research by Beau Sievers of Stanford University and his co-authors asked groups of MBA students to discuss the meaning of ambiguous film clips. The presence of people perceived to be of high status seemed to

impede consensus: these folk spoke more and were readier to reject the explanations of others. Groups that reached consensus were more likely to have a different character in them: people who were well-connected but not dominant, who asked lots of questions and who encouraged interaction. They made everything align—even the neural activity of their groups.

Mr Sievers's research features in "Supercommunicators", a new book by Charles Duhigg, a journalist at the New Yorker. Mr Duhigg looks at how some people forge stronger connections with others and at the techniques for having better conversations. His canvas ranges more widely than the workplace but some of its lessons are applicable there.

One chapter tells the story of the Fast Friends Procedure, a set of 36 increasingly intimate questions that are particularly effective at turning strangers into friends. The questions were first put together in the 1990s by Elaine and Arthur Aron, two psychologists at the State University of New York at Stony Brook. Their survey was designed for the lab, not the workplace. You should not suddenly start asking new colleagues what their most terrible memory is or how they feel about their mother. But if it is important to build team connections fast, then—Britain, look away now—reciprocal moments of vulnerability do seem to help.

Another chapter looks at ways to bring together people with diametrically opposed views, in this case Americans on either side of the debate over gun control. The difficulty here was in persuading people that they were genuinely being listened to, not dismissed as gun-toting loons or lily-livered liberals. Mr Duhigg describes an approach called "looping for understanding", in which people ask questions and then repeatedly distil their understanding of what they have heard back to their interlocutor.

Polarised beliefs of this sort are rare inside firms. But looping techniques still have their place: when there are long-running conflicts between

individual employees, say, or in negotiations and mediation processes.

Mr Duhigg's advice can seem obvious at times. And his examples do not always translate to the workplace. Sometimes it is more important to make a decision than to excavate everyone's point of view. Reaching consensus is vital on a jury but less necessary in a corporate hierarchy. There really is a limit to how much vulnerability you want from a leader.

But his book is a useful reminder that demonstrable curiosity about other people's experiences and ideas can benefit everyone. Asking questions, not cutting people off, pausing to digest what someone has said rather than pouncing on breaks in a discussion to make your own point: these are not enough to qualify someone as a supercommunicator. But in plenty of organisations they would still represent good progress. ■

如何从职场交谈中获益

不要只顾自己滔滔不绝，也听听别人说了什么

成功工作场所的一个常见特征是良好的沟通。老板清楚指明公司的发展方向，员工可以自如表达不同意见，同事间分享信息而不是互有隐瞒。但是，人们往往将优秀的沟通能力与另一种技能混为一谈：说话有说服力。

西密歇根大学（Western Michigan University）的凯尔·布林克（Kyle Brink）和圣约翰费舍尔学院（St John Fisher College）的罗伯特·科斯蒂根（Robert Costigan）在2015年发表的一篇论文中指出，美国76%的商科本科都有关于演讲技巧的学习目标，但只有11%设置了与倾听相关的目标。商科学生接受的教育是去做TED演讲，而不是交谈。这也许是有代价的。耶路撒冷希伯来大学的多坦·卡斯特罗（Dotan Castro）及其他人进行的另一项研究发现，当人们感到自己的意见得到管理者的倾听时，他们的创造力和心理安全感都会提高。

看重讲话能力不难理解。许多职业生涯的关键时刻，例如求职面试和大型演讲，都需要传递信息。老板可以站上讲台，下属则坐在观众席中。某人演讲的视频远远比某人默默点头的视频更容易得到传播。但是，随着团队的重要性与日俱增，且领导力的概念越来越强调软技能，如何做好日常沟通也引起了更多兴趣。

在斯坦福大学的博·西弗斯（Beau Sievers）等人近期所做的研究中，他们让几组MBA学生讨论一些模棱两可的电影片段的含义。如果有公认地位更高的人在场，似乎更难达成共识：这些人说的更多，而且动辄否定别人的解释。达成共识的小组更可能包含另一种人：这些人的人脉很广但不盛气凌人，他们经常提问并鼓励互动。这些人的存在让一切都步调一致——甚至是小组成员的神经活动。

《纽约客》记者查尔斯·杜希格（Charles Duhigg）的新书《超级沟通

者》（Supercommunicators）介绍了西弗斯的研究。杜希格观察了一些人如何与他人建立更紧密的联系，以及实现更顺畅交谈的技巧。他观察的范围不只限于职场，但其中一些经验教训也适用于职场。

其中一章介绍了"快速交友程序"，这是一套36个逐渐变得私人的问题，能够特别有效地将陌生人变成朋友。纽约州立大学石溪分校（State University of New York at Stony Brook）的两位心理学家伊莱恩·阿伦（Elaine Aron）和亚瑟·阿伦（Arthur Aron） 在1990年代首次整理出了这套问题。他们的研究是面向实验室的，而不是职场。你可不要突然开始询问新同事他们最可怕的记忆是什么，或者他们对自己母亲的感觉如何。但是，如果必须要快速建立团队连结的话，那么——你要是在英国，就不用看了——相互坦诚自己的脆弱时刻似乎确实有用。

另一章探讨了如何让观点截然相反的人能够共处，所举的例子是因控枪争论而分为两派的美国人。这里的难点是要让对方相信自己的意见确实得到了倾听，而不是被蔑视为舞枪弄炮的疯子或者内心柔弱的自由主义者。杜希格描述了一种名为"循环理解"的方法——先提出问题，听到对方回答后把自己对其内容的理解提炼出来，反馈给对方，如此不断反复。

在公司里，这种观念两极分化的情况并不多见。但这种循环法仍有用武之地：例如个别员工之间长期闹矛盾时，或者在谈判和调解的过程中。

杜希格的建议有时似乎就是明摆着的。他举出的例子也并不总能延伸到职场上。有些时候，做出决定比征求每个人的意见更重要。在陪审团中，达成共识是至关重要的，但在公司层级制度中就没那么必要。你确实也不想看到你的上司展现出太多的脆弱。

但他的书给出了有益的提醒：对别人的经历和想法表现出好奇心对每个人都有好处。要提出问题，不打断别人，要停下来消化别人说的话，而不是抓住讨论的每个间隙表达自己的观点：这些都不足以让一个人成为超级沟通者。但在许多组织中，这已经是很大的进步了。■

Scientists have trained an AI through the eyes of a baby

"Chair" and "ball" were among little AI's first words

FOR DECADES linguists have argued over how children learn language. Some think that babies are born as "blank slates" who pick up language simply from experience—hearing, seeing and playing with the world. Others argue that experience is not enough and that babies' brains must be hardwired to make acquiring language easy.

AI models such as GPT-4 have done little to settle the debate. The way these models learn language—by trawling through reams of text data from millions of web pages—is vastly different to the experiences of babbling babies.

A team of scientists at New York University examined the question by training an AI model on the experiences of a single infant. Between the ages of six and 25 months, a toddler called Sam wore a head-mounted camera for an hour a week—around 1% of his waking hours. The camera recorded everything he saw and heard while he played with toys, enjoyed days at the park and interacted with his pet cats. The recordings and transcribed audio were fed into an AI, which was set up to know that images and words that appeared at the same time were related, but was otherwise left to make sense of the mess of colours and speech that Sam experienced.

Despite the limited training data, the AI was able to pick out objects and learn the matching words. The researchers tested the model by asking it to identify objects that Sam had seen before, such as a chair from his home or one of his toy balls. Given a list of four options the model picked the correct word 62% of the time, far above the chance level of 25%. To the researchers' surprise, the model could also identify chairs and balls that Sam had never

seen. The AI learnt at least 40 different words, but it was far from matching Sam's vocabulary and language abilities by the end of the experiment.

The researchers, published recently in the journal Science, argue that, to match words to objects, learning from experience may well be enough. Sceptics, however, doubt that the AI would be able to learn abstract nouns or verbs, and question how similar the learning processes really are. The mystery of language acquisition lives on. ■

科学家通过婴儿的视角训练AI

"椅子"和"球"是这个宝宝AI学会的首批词汇之一

几十年来，语言学家对儿童是如何习得语言的争论不休。一些人认为婴儿生来"白纸一张"，仅凭体验（听、看和与外界互动）来学习语言。其他人则认为体验还不够，婴儿的大脑必然天生具备一些条件，能让语言习得变得容易。

GPT-4等AI模型在解决这个争论方面作用甚微。这些模型通过搜罗千百万网页上的海量文本数据来学习语言，这与婴儿咿呀学语的过程截然不同。

纽约大学的一个科学家团队对这个问题做了研究，他们根据一个婴儿的学语过程来训练AI模型。在一个名叫山姆的幼儿从6个月至25个月大的这段时间里，科学家让他佩戴头戴式摄像机，记录下他玩玩具、去公园以及与家中宠物猫互动时的情景，每周共戴一小时（约占他醒着的时间的1%）。摄像机记录下来的场景和根据音频转写的文字被输入到一个AI模型中，AI根据设定知道同时出现的图像和单词有关联，但它要自己理解山姆看到的各色图案和听到的话语。

尽管训练数据有限，AI模型仍能够辨别出物体，并学习对应的单词。研究人员要求模型识别山姆曾看到过的物体，以此测试它的学习效果，比如要求它识别山姆家里的一把椅子或者他的一个玩具球。面对四个备选词，模型的选择准确率达到了62%，远高于25%的随机水平。让研究人员惊讶的是，模型还能识别山姆从未见过的椅子和球。AI模型至少学会了40个单词，但在实验结束时，它的词汇和语言能力与山姆相去甚远。

这项研究最近发表在《科学》杂志上，研究人员认为，要将单词与物体匹配起来，仅凭体验学习可能已经足够。然而，持怀疑态度的人认为AI无法学习抽象名词或动词，并质疑AI这一学习过程与幼儿学语真有多少相似性。语言习得的谜团仍然未解。■

Ancient, damaged Roman scrolls have been deciphered using AI

The new techniques could help rediscover lost works from antiquity

"I CAN'T BELIEVE it worked!" says Nat Friedman, co-founder of the Vesuvius Challenge, which offered $1m in prizes to anyone who could use artificial intelligence (AI) to decipher papyrus scrolls carbonised by the eruption of Mount Vesuvius in 79AD. But work it did. On February 5th Mr Friedman announced that a three-person team had been awarded $700,000 for successfully extracting four passages of text, each at least 140 characters long, and with at least 85% of the characters legible, from a scroll known as Banana Boy. The three winners, Luke Farritor, Youssef Nader and Julian Schilliger, are all computer-science students.

The scroll is one of hundreds found in the library of a Roman villa in Herculaneum, which is thought to have belonged to the father-in-law of Julius Caesar. Along with hundreds of other scrolls in the villa's library, it was damaged by scorching gases that engulfed the town during the same eruption that also buried the nearby town of Pompeii.

Reading text from the scrolls is difficult because the heat turned them into brittle charcoal logs; all efforts to unroll them physically caused them to disintegrate. So attention shifted towards finding ways to unwrap them virtually, through computer analysis of 3D scans of the scrolls made using X-rays. This turned deciphering the scrolls into a software problem—but a very complex one.

Virtual unrolling is a two-stage process pioneered by W. Brent Seales, a computer scientist at the University of Kentucky. The first stage, called segmentation, involves tracing the edges of the rolled-up papyrus sheet inside the 3D scan, then extracting 2D images of the scroll's surface. The

second stage, ink detection, analyses the resulting images to pluck the ink of the scroll's text from the papyrus background. This is particularly tricky for the Herculaneum scrolls, which are written in carbon-based ink, so there is very little contrast with the background of carbonised papyrus.

Dr Seales, along with Mr Friedman and Daniel Gross, two technology entrepreneurs, thought AI techniques might fruitfully be brought to bear on these two problems, and launched a prize challenge to find out. A community of thousands of enthusiasts has since developed a range of tools and tricks to speed up the fiddly process of segmentation, and to detect the ink of individual letters, and then whole words. In October 2023 Mr Farritor and Mr Nader were awarded smaller prizes for independently extracting the first legible word ("porphyras", which means "purple" in ancient Greek) from the Banana Boy scroll (so named because of its size and shape).

The two students then teamed up and, joined by Mr Schilliger, further improved the machine-learning technique involved in ink detection. By manually labelling areas known to be ink, they could train a neural network to find more of them; these were fed back into the model to improve its detection abilities. Mr Nader also switched the neural network to a novel architecture called a TimeSformer, which produced sharper results. Mr Schilliger, meanwhile, devised a tool to automate more of the segmentation process (much of which must still be done manually).

The deadline to submit results for the grand prize was at the end of December, and the trio was awarded the prize after an assessment of the entries by a team of papyrologists. (Three runners up will receive smaller prizes of $50,000 each.) The winning entry revealed 15 columns of text, written in Greek. Reading it was "mind-blowing", says Federica Nicolardi, a papyrologist at the University of Naples Federico II, who was one of the judges. The text is thought to be a previously unknown work on pleasure by

Philodemus, an Epicurean philosopher who lived in Herculaneum.

Mr Friedman now wants to scale up the whole process. With ink detection solved, he says, "the bottleneck is now segmentation". Mr Schilliger's auto-segmentation tool is a big step forward, and he has agreed to make it open source, and to collaborate with others to improve it. Further prizes are being offered as an incentive. Mr Friedman, meanwhile, aims to scan more scrolls using the Diamond Light Source, a particle accelerator in Britain, and to standardise the scanning process.

That will cost money. Having given out $1.2m in prizes, some of it from his own pocket, Mr Friedman is looking for other backers to help support the project. He hopes that deciphering ancient scrolls will lead to the rediscovery of lost works from antiquity—"each scroll is a mystery box", he says—and, ultimately, revive interest in further excavating the villa in Herculaneum, which may contain thousands more of them. ■

利用AI成功破译烧毁的古罗马卷轴

这种新方法能帮助重新发现失传的古代作品

"难以置信啊！它真的成功了！"维苏威火山挑战赛（Vesuvius Challenge）的发起人之一纳特·弗里德曼（Nat Friedman）说。该挑战赛设有多个奖项，奖金总计100万美元，只要能够利用人工智能（AI）破译在公元79年维苏威火山喷发中碳化的莎草纸卷轴，就能获得相应奖项。举办挑战赛的做法确实奏效了。2月5日，弗里德曼宣布一个三人团队获得了70万美元的奖金，因为他们从一个叫作"香蕉小子"（Banana Boy）的卷轴中成功辨认出四段文本——每段至少包含140个字母，且至少辨认出85%的字母。三位获奖者卢克·法里托（Luke Farritor）、尤瑟夫·纳德（Youssef Nader）和朱利安·席利格（Julian Schilliger）都是计算机科学专业的学生。

香蕉小子是在赫库兰尼姆（Herculaneum）一座古罗马庄园的藏书楼中发现的，人们认为这座庄园的主人是凯撒大帝的岳父。它和庄园藏书楼里的其他数百个卷轴一道，被火山喷发时吞没了整个赫库兰尼姆的灼热气体毁坏。也正是这场火山喷发埋葬了附近的庞贝城。

由于高温把卷轴变成了易碎的炭木，要阅读上面的文字并非易事；任何试图展开卷轴的举动都会让它们变成碎片。因此，人们转而想办法虚拟打开卷轴，也就是用X射线对卷轴进行3D扫描，再做电脑分析。这就把破译卷轴变成了一个软件问题，不过这个软件问题非常复杂。

最先采用两步法虚拟展开卷轴的是肯塔基大学的计算机科学家布伦特·西尔斯（W. Brent Seales）。第一步称为分割，勾画出3D扫描图里卷起的莎草纸的边缘，然后生成卷轴表面的2D图像。第二步是墨迹识别——分析生成的图像，从莎草纸底色中提取卷轴文本的墨迹。这对于赫库兰尼姆卷轴来说尤为棘手，因为它们是用碳基墨水书写的，与碳化的莎草纸底色几乎没有差别。

西尔斯与两位科技企业家弗里德曼、丹尼尔·格罗斯（Daniel Gross）都认为，AI技术或许可以有效解决这两个问题，为此他们发起了一项有奖挑战赛来一探究竟。此后，数千名爱好者陆续开发了一系列工具和方法来加快繁琐的分割过程，以及识别单个字母的墨迹，进而识别整个单词。去年10月，法里托和纳德不约而同地从香蕉小子卷轴（因其大小和形状类似香蕉而得名）中发现了第一个可辨认的单词（"porphyras"，在古希腊语中意为"紫色"），分别赢得一个金额较小的奖项。

这两名学生随后联手，席利格也加入其中，他们三人进一步改进了墨迹识别中使用的机器学习技术。通过人工标记已知是墨迹的区域，他们可以训练一个神经网络来找到更多墨迹区域；这些信息被投喂回模型中，以提高其识别能力。纳德还将这个神经网络转换成生成更清晰结果的新架构TimeSformer。与此同时，席利格设计了一种工具，让分割过程更加自动化（大量分割目前仍须人工完成）。

竞逐大奖作品的最后提交日期是去年12月底，经过一个莎草纸古文稿专家小组对参赛成果的评选，大奖最终花落这个三人团队。（三名亚军将分别获得五万美元的奖项。）获奖的成果辨认出了15列用希腊语书写的文本。其中一名评委、意大利那不勒斯费德里科二世大学（University of Naples Federico II）的莎草纸古文稿专家费代丽卡·尼古拉迪（Federica Nicolardi）表示，读到这些文字"令人无比兴奋"。这些文本被认为是居住在赫库兰尼姆的伊壁鸠鲁派哲学家菲洛德摩斯（Philodemus）先前一部不为人知的有关快乐的著作。

弗里德曼现在想要扩大整个项目的规模。墨迹识别问题得以解决后，他表示，"现在的瓶颈是分割"。席利格的自动分割工具是一大进步，他已经同意将其开源，并与他人合作来改进它。作为激励，还有更多的奖项虚位以待。与此同时，弗里德曼的目标是使用英国的一种叫作钻石光源（Diamond Light Source）的粒子加速器来扫描更多卷轴，并让扫描过程标准化。

这需要资金。弗里德曼已经发放了120万美元的奖金，其中一些是他自掏

腰包，目前他正在寻找其他赞助人来帮助支持这个项目。他希望通过破译这些古卷轴，能够重新发现一些失传的古代作品——"每幅卷轴都是个盲盒"，他表示——并最终重新唤起人们对进一步发掘赫库兰尼姆庄园的兴趣，那里可能还埋藏有成千上万部作品。■

Why you should never retire

Pleasure cruises, golf and tracing the family tree are not that fulfilling

IN AN EPISODE of "The Sopranos", a popular television series which started airing in the 1990s, a gangster tells Tony, from the titular family, that he wants to retire. "What are you, a hockey player?" Tony snaps back. Non-fictional non-criminals who are considering an end to their working lives need not worry about broken fingers or other bodily harm. But they must still contend with other potentially painful losses: of income, purpose or, most poignantly, relevance.

Some simply won't quit. Giorgio Armani refuses to relinquish his role as chief executive of his fashion house at the age of 89. Being Italy's second-richest man has not dampened his work ethic. Charlie Munger, Warren Buffett's sidekick at Berkshire Hathaway, worked for the investment powerhouse until he died late last year at the age of 99. Mr Buffett himself is going strong at 93.

People like Messrs Armani, Buffett or Munger are exceptional. But in remaining professionally active into what would historically be considered dotage, they are not unique. One poll this year found that almost one in three Americans say they may never retire. The majority of the nevers said they could not afford to give up a full-time job, especially when inflation was eating into an already measly Social Security cheque. But suppose you are one of the lucky ones who can choose to step aside. Should you do it?

The arc of corporate life used to be predictable. You made your way up the career ladder, acquiring more prestige and bigger salaries at every step. Then, in your early 60s, there was a Friday-afternoon retirement party, maybe a gold watch, and that was that. The next day the world of meetings,

objectives, tasks and other busyness faded. If you were moderately restless, you could play bridge or help out with the grandchildren. If you weren't, there were crossword puzzles, TV and a blanket.

Although intellectual stimulation tends to keep depression and cognitive impairment at bay, many professionals in the technology sector retire at the earliest recommended date to make space for the younger generation, conceding it would be unrealistic to maintain their edge in the field. Still, to step down means to leave centre stage—leisure gives you all the time in the world but tends to marginalise you as you are no longer in the game.

Things have changed. Lifespans are getting longer. It is true that although the post-retirement, twilight years are stretching, they do not have to lead to boredom or to a life devoid of meaning. Once you retire after 32 years as a lawyer at the World Bank, you can begin to split your time between photography and scrounging flea markets for a collection of Americana. You don't have to miss your job or suffer from a lack of purpose. If you are no longer head of the hospital, you can join Médecins Sans Frontières for occasional stints, teach or help out at your local clinic. Self-worth and personal growth can derive from many places, including non-profit work or mentoring others on how to set up a business.

But can anything truly replace the framework and buzz of being part of the action? You can have a packed diary devoid of deadlines, meetings and spreadsheets and flourish as a consumer of theatre matinees, art exhibitions and badminton lessons. Hobbies are all well and good for many. But for the extremely driven, they can feel pointless and even slightly embarrassing.

That is because there is depth in being useful. And excitement, even in significantly lower doses than are typical earlier in a career, can act as an anti-ageing serum. Whenever Mr Armani is told to retire and enjoy the

fruits of his labour, he replies "absolutely not". Instead he is clearly energised by being involved in the running of the business day to day, signing off on every design, document and figure.

In "Seinfeld", another television show of the 1990s, Jerry goes to visit his parents, middle-class Americans who moved to Florida when they retired, having dinner in the afternoon. "I'm not force-feeding myself a steak at 4.30 just to save a couple of bucks!" Jerry protests. When this guest Bartleby entered the job market, she assumed that when the day came she too would be a pensioner in a pastel-coloured shirt opting for the "early-bird special". A quarter of a century on, your 48-year-old columnist hopes to be writing for The Economist decades from now, even if she trundles to her interviews supported by a Zimmer frame; Mr Seinfeld is still going strong at 69, after all. But ask her again in 21 years. ■

为何你应当永不言退

乘游船、打高尔夫和研究家谱的生活并不够充实

在1990年代首播的热剧《黑道家族》（The Sopranos）的一集里，一个黑帮分子对该家族的老大托尼说自己想退休了。"你当自己是什么人，冰球运动员吗？"托尼厉声斥道。在现实中，不混黑帮的人在考虑结束自己的职业生涯时，不必担心手指被人折断或遭受其他身体伤害。但他们仍必须应对其他可能令人痛苦的损失：收入、目标，或者最令人心酸的——社会存在感。

有些人干脆就不退下来。已经89岁的乔治·阿玛尼（Giorgio Armani）仍然拒绝辞去在自己时装公司首席执行官的职务。他是意大利第二大富豪，但这并不折损他的工作热情。巴菲特在伯克希尔哈撒韦公司（Berkshire Hathaway）的副手查理·芒格（Charlie Munger）一直为这家投资巨头工作，直至去年年底去世，享年99岁。巴菲特本人也已93岁高龄，仍然干劲十足。

像阿玛尼、巴菲特或芒格这样的人物不是一般人。但是，在以往被认为是老态龙钟的年龄仍然活跃于职场这一点上，他们并非特例。今年的一项民意调查发现，近三分之一的美国人表示自己可能永远不会退休。大部分"永不退休者"表示，他们负担不起放弃全职工作的后果，尤其是当通胀正让本就微薄的社会保障金缩水。但假设你是可以选择退位的幸运儿之一，你该退休吗？

过去，职场人生是有章可循的。你在事业的阶梯上步步攀升，每一步都获得更高的声望和薪水。然后，在你60岁出头的时候，在某个周五下午参加了一场退休派对，也许还领到了一块金表，事情就这样结束了。第二天，充满会议、目标、任务和其他繁杂的世界就离你远去了。如果你多少有点闲不住，可以打打桥牌或给带娃的子女搭把手。如果能闲得下来，陪伴你的有填字游戏、电视和毛毯。

尽管智力刺激往往可以避免抑郁和认知障碍，但科技圈里的许多专业人士都会尽早按建议退休，以便为年轻一代腾出位置；他们承认要在这个领域里保持住自己的优势是不现实的。尽管如此，退休意味着离开中心舞台——休闲给了你无尽的时间，但往往会使你在这个世界上边缘化，因为你已经"出局"了。

现在非同以往。人的寿命越来越长。诚然，退休后暮年的不断延长不一定就意味着百无聊赖或人生失去意义。在世界银行当了32年律师的你一旦退休，就可以开始花一半时间搞摄影，花另一半时间在跳蚤市场淘一整套《大美百科全书》。你不必怀念自己的工作，也不必为没了目标而痛苦。如果你不再是医院院长，你可以加入无国界医生组织做点零散的工作，在本地诊所带带新医生或帮点忙。很多地方都可以实现自我价值和个人成长，包括非营利工作或指导他人创业。

但是，有什么能真正取代参与某种事业或行动带给人的体系感和兴奋感吗？你可以把日程排得满满当当，没有最后期限、会议和电子表格，可以尽情享受午后剧场、艺术展览和羽毛球课。对很多人来说，投入兴趣爱好挺不赖的。但对于那些极为进取的人来说，兴趣爱好可能是漫无目的、毫无意义的事情，甚至略显尴尬。

这是因为做"有用"之人带来一种严肃性和厚重感。而即使兴奋感已经远远没有职业生涯早期那么强烈，它仍然是一剂抗衰老的良药。每当有人劝阿玛尼退休，好好享受自己的劳动成果时，他的回答都是"绝不"。相反，他参与到公司的日常运营，签批每一个设计、文件和数字，这显然给他带来了源源活力。

在另一部90年代电视剧《宋飞正传》（Seinfeld）中，杰瑞去看望他的父母。这对美国中产老夫妇在退休后迁居佛罗里达，下午就开始早早地吃晚饭。"我可不会为了省几块钱在4点半逼着自己吃牛排！"杰瑞抗议道。当笔者初入职场时，她以为自己有朝一日也会成为一个穿着粉彩衬衫、选用"早鸟优惠"的退休人士。四分之一个世纪过去了，48岁的笔者希望几十年后还能继续为本刊撰稿，哪怕她得推着一台助行架蹒跚着前去采访；毕

竟，69岁的宋飞都还劲头十足呢。不过，不妨21年后再问她一次吧。■

The Economist Group will close down the Global Business Review app

From February 28th, you will not be able to renew your subscription or start a new subscription

We are writing to make you aware that The Economist Group will be closing the Global Business Review (GBR). We wish to thank our valued subscribers and readers, as well as our GBR colleagues for their hard work and dedication.

The GBR app will be updated as normal until May 31st. From February 28th, you will not be able to renew your subscription or start a new subscription. All GBR subscribers will have continued access to the app until their next renewal, or until May 31st, whichever is soonest, at which point the app will close.

If your subscription is due to renew between February 28th and May 31st, your subscription will end at your next renewal.

If your expiration date for current subscription is after May 31st, you will receive a prorated refund to your existing payment method within 30 days of May 31st and your subscription will end on this date.

If someone currently pays for your subscription for you, the subscription will end on the next renewal date or May 31st, whichever is soonest.

If you have questions or require assistance, you can reach us via WeChat (Please search WeChat ID: ecogbr) or scan the QR code below:

通知

经济学人集团将关闭《经济学人·全球商业评论》APP

自2月28日起，您将无法续订或开始新的订阅

我们在此通知您，经济学人集团将关闭《经济学人·全球商业评论》。我们藉此向我们尊贵的订户和读者，以及《全球商业评论》同事们的辛勤工作和奉献表示感激。

《全球商业评论》APP将正常更新至5月31日。 自2月28日起，您将无法续订或开始新的订阅。所有《全球商业评论》订户都可以继续使用该APP，直至下个续订日或5月31日APP停止运营之日（以较早者为准）。

如果您的订阅到期日是在2月28日至5月31日之间，您的订阅将在下次续订时终止。

如果您当前的订阅将在5月31日之后到期，您将在5月31日之后的30天内收到按比例退还至您现有付款方式的订阅款项，您的订阅也将在5月31日终止。

如果目前由他人为您代付订阅费用，您的订阅将在下一个续订日或5月31日终止，以较早者为准。

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Japan's semiconductor toolmakers are booming

How long will it last?

CORPORATE JAPAN, long snubbed by investors, has been the source of much attention lately. That is especially so for the country's manufacturers of chipmaking tools. On February 13th Tokyo Electron's share price jumped by 13% after it reported higher profits than expected for the final quarter of last year, pushing its market value above $100bn, roughly ten times what it was worth a decade ago. It is now Japan's fourth-most-valuable company, trouncing better-known peers such as Mitsubishi, Nintendo and SoftBank Group.

Tokyo Electron is the largest among a crowd of Japanese purveyors of chipmaking tools for which business has been booming. The combined market capitalisation of the five most valuable—Tokyo Electron, Advantest, DISCO, Lasertec and SCREEN Holdings—has doubled, in dollar terms, over the past year (see chart). These companies, which suffered from a post-pandemic slump in sales of electronics that caused chipmakers to slash investments, are now on the up. The Semiconductor Equipment Association of Japan, an industry body, expects a 27% increase in sales of machinery this year and a further 10% rise in 2025, more than reversing the fall of 19% in 2023.

The latest rally is about more than the ups and downs of a notoriously cyclical industry. Demand for increasingly complex chips capable of handling artificial-intelligence functions means demand for more equipment to make them. One estimate from McKinsey, a consultancy, puts the cost to build and equip a factory that produces five-nanometre (nm) chips at around six times the cost of one that produces 28nm chips, which were cutting-edge a decade ago.

Japanese toolmakers have long played dominant roles in niche areas of the semiconductor supply chain. Tokyo Electron controls roughly 90% of the market for tools which apply photoresist coating—a light-sensitive chemical applied to a semiconductor wafer in the manufacturing process. DISCO holds a similarly dominant share of the precise cutting and grinding tools needed for chipmaking.

The revenues of these firms have thus far not been crimped by new export controls introduced by America on the sale of certain types of advanced chipmaking machinery to China. In fact, as China has raced to develop its own chipmaking capacity, sales of equipment to its neighbour to the east have surged. Almost half of Tokyo Electron's sales in the final quarter of last year came from China.

Yet that also points to risks ahead. If relations between Beijing and Washington worsen, the Japanese government could be prodded into implementing broader restrictions on the sale of its chipmaking tools to China. Meanwhile, China is expanding its effort not only to make its own chips, but also the machinery that produces them, which could squeeze out Japanese firms. For Tokyo Electron and its peers, the deteriorating relationship between America and China is a boon for business today. In the future, though, it may become a strain. ■

日本的半导体设备制造商生意兴隆

这种情况能持续多久？

长期以来一直被投资者冷落的日本企业近来备受关注，尤其是芯片设备制造商。2月13日，就在东京电子公布了高于预期的去年第四季度利润后，其股价暴涨了13%，市值也因此超过1000亿美元，大约是十年前的十倍。如今东京电子已成为日本价值第四高的公司，超越了三菱、任天堂和软银集团等名气更大的日本企业。

日本众多芯片设备供应商近来生意红火，东京电子是其中最大的一家。价值前五大公司——包括东京电子、爱德万测试、迪思科、Lasertec和斯库林集团——以美元计的总市值在过去一年中翻了一番（见图表）。新冠疫情过后，电子产品销量骤降，导致芯片制造商大幅削减投资，令这些公司受挫，但现在它们正在企稳向好。行业组织日本半导体制造装置协会预计，今年半导体设备的销售额将增长27%，2025年将再增长10%，轻松扭转2023年下降19%的局面。

最近的反弹不仅仅源于以周期性著称的芯片行业的起伏。为实现各种AI功能需要越来越复杂的芯片，也就需要更多制造这些芯片的设备。咨询公司麦肯锡估计，建设和装备一家5纳米芯片制造工厂的成本大约是28纳米芯片工厂的六倍，而后者在十年前还是最先进的芯片。

长期以来，日本设备制造商一直在半导体供应链的细分领域占据主导。东京电子控制着光刻胶（芯片制造过程中一种涂在半导体晶片上的光敏化学物质）涂布设备市场大约90%的份额。迪思科在芯片制造所需的精密切割和研磨工具市场占有同样压倒性的份额。

美国就向中国出售某些先进的芯片制造设备实施了新的出口管制。但到目前为止，这些日本公司的收入还没有受到很大影响。事实上，随着中国急于发展自己的芯片制造能力，它从东边邻国日本购买的芯片制造设备数量

激增。东京电子去年第四季度的销售额近一半来自中国。

然而，这也预示着未来的风险。如果中美关系恶化，日本政府可能会被迫对中国实施更广泛的芯片制造设备出口限制。与此同时，中国不仅在加大力度研发自己的芯片，也在探索自己的芯片制造设备，这可能会将日本公司挤出市场。对于东京电子及其同行来说，中美关系恶化目前是生意上的一大利好。但在未来，它可能会成为一种难以承受之重。■

As San Francisco builds the future of technology, can it rebuild itself?

People feared a doom loop. Reality has been more surprising

SAN FRANCISCO has long been a byword for municipal failure. Even as its techies minted money and transformed the world, its government was incapable of providing residents with basic shelter and security. Homelessness, drug overdoses and property crime were rife. Then covid-19 struck. The rise of remote work threatened to sound the city's death knell, as the tech industry took to its heels. As things have turned out, however, San Francisco has become host to an artificial-intelligence boom. Having been granted this piece of good fortune, the city must seize the opportunity to reform. This might be the best chance it gets.

Only a few years ago social disorder, toxic politics, eye-watering housing costs and the pandemic were driving people away. Venture capitalists (VCs) were splashing more of their cash beyond the Bay Area. Tech workers abandoned their offices, and sometimes the city entirely. As the downtown streets emptied of workers, homelessness and public drug use became more conspicuous and intrusive. "Retail for lease" signs covered the city like wallpaper.

People keen to write San Francisco's obituary warned of a "doom loop". Abandoned downtown property would lead to budget cuts and the erosion of public services, which would in turn accelerate the exodus. Many people worried that the city could go the way of Detroit, which suffered a painful bust when America's car industry started to build more plants in the suburbs and the South.

But the power of agglomeration is such that San Francisco has been given a fresh lease on life. The strides in artificial intelligence (AI) have only

strengthened its claim to be the innovation capital of the world. Its proximity to Stanford and the University of California, Berkeley, two AI centres of excellence, has helped infuse its startup scene with companies that deal in the technology. No other place in the world has as many AI firms or as much tech talent: from OpenAI and Anthropic to Databricks and Scale AI, almost all the big startups are based in the Bay Area. Venture funding is on the rise again, and last year the vast majority of funding for firms in the region went to startups in the city itself. Despite San Francisco's problems, and there are many, it remains a magnet for capital and talent.

All this offers the city an opportunity to fix how it is run. It helps that voters are fed up with their city's inane politics (owing to oppressive permit rules, the cost of one public toilet ballooned to $1.7m). From their posh neighbourhoods and their Silicon Valley headquarters, techies used to be content to watch San Francisco putrefy. Today, by contrast, the wealthy who live in the city feel a need to enter the political fray.

The first signs that San Francisco's residents were revolting against the status quo came in 2022 when voters ousted three members of their school board and recalled their ultra-progressive district attorney. They are not done yet. Local elections this year will be overshadowed by national races, obviously, but city contests in March and November will offer voters in San Francisco the prospect of real change.

Moderate Democrats, such as London Breed, the current mayor, are often stymied by left-wingers who resist building houses, cutting business taxes, shrinking the bloated budget or funding the police. Electing more moderates to the board of supervisors, San Francisco's name for the city council, could make all those things easier to accomplish.

Even if sensible folk get into office, making big changes will be hard. The

local NIMBY movement is entrenched, and corruption has long been a problem. And yet second chances are rare. Young people want to live and work in the City by the Bay and to be part of a technological revolution that is changing the world. San Francisco can either capitalise on their excitement and set about fixing its problems—or sink back into complacency and squander an unforeseen opportunity. ■

打造明日科技的旧金山能否重建自身？

人们曾担心它深陷厄运循环。现实却更出人意料

长期以来，旧金山就是市政失败的代名词。这里的科技狂人创造财富、改变世界，而政府这一边却无力为居民提供基本的安身之处和安全保障。无家可归、吸毒过量和财产犯罪很常见。接着，新冠来了。远程工作兴起，科技产业随之撤退，这座城市的丧钟仿佛就要敲响。然而，结果却是旧金山迎来了一波人工智能热潮。既然交上了如此好运，旧金山必须抓住机遇进行改革。这可能是它最好的机会了。

仅仅几年前，社会失序、有毒政治、令人瞠目的房价和疫情促使人们纷纷逃离。风险资本家（VC）将更多现金投向了湾区以外的地方。科技工作者放弃了他们的办公室，有时甚至干脆放弃了这座城市。随着市中心街道上的上班族越来越少，无家可归和公共场所吸毒越发惹眼和猖獗。"商铺出租"的招贴像墙纸一样糊满了整个城市。

那些等不及要给旧金山写讣告的人警告说，旧金山将陷入一个"厄运循环"。市中心房产遭废弃将导致预算削减和公共服务质量下降，这反过来又会加速人口外流。许多人担心旧金山可能会重蹈底特律的覆辙，当年美国的汽车工业开始在郊区和南部建造更多工厂时，底特律遭遇了惨痛的萧条。

但是，产业集聚的效应如此强大，旧金山又重获新生。人工智能领域的长足进步进一步巩固了它作为世界创新之都的地位。旧金山毗邻斯坦福大学和加州大学伯克利分校这两个卓越的人工智能中心，这让该市的创业圈涌现出大量人工智能技术相关公司。世界上再没哪个地方能有如此多的人工智能公司或科技人才：从OpenAI和Anthropi到Databricks和Scale AI，几乎所有的大型创业公司都位于湾区。风险投资再次兴起，去年该地区企业的绝大部分融资都流向了旧金山本地的创业公司。尽管旧金山有它的问题，而且问题还不少，但它仍然是吸引资金和人才的磁石。

这一切为旧金山提供了一个修复自身治理的机会。选民们已经受够了这座城市愚蠢空洞的政治运作（由于高压苛刻的许可规定，一个公共厕所的造价竟高达170万美元），这一点会提供助力。过去，科技从业者自己栖身高尚社区和硅谷总部，眼看着旧金山溃烂下去，心中毫无波澜。而如今，生活在这座城市的富人们却觉得有必要参与政治角力了。

旧金山居民反抗现状的最初迹象出现在2022年，当时选民们罢免了三名学校董事会成员和极端进步派的地区检察官。他们的行动还没有结束。今年的地方选举显然会被全国性选举抢去风头，但3月和11月的市政选举将有望为旧金山选民带来真正的变革。

现任市长伦敦·布里德（London Breed）这样的温和派民主党人常受到左翼人士的阻挠，后者反对建造房屋、削减商业税、缩减膨胀的预算或为警力提供资金。选举更多温和派人士进入监事会（旧金山对市议会的称呼）可能会让这些事情都更容易实现。

即使是明智务实的人当选了，要做出大的改变也会有难度。当地的邻避运动根深蒂固，腐败问题年深日久。但第二次机会不常见。年轻人想在旧金山生活和工作，希望投身一场正在改变世界的技术革命浪潮。旧金山要么善加利用他们的这股热忱，着手解决自身问题，要么就又回到沾沾自喜的状态，挥霍掉一个不期而至的良机。■

How worried should Amazon be about Shein and Temu?

Dirt-cheap products and marketing splurges are catching clicks

"SHOP LIKE a billionaire." With that enticing slogan Temu touted itself to Americans watching the Super Bowl on February 11th. Football fans had been treated to a similar advert from the e-commerce company at last year's event. But this time the message was hammered home. In all, Temu's ad played five times. That won't have been cheap. A 30-second slot during this year's Super Bowl cost around $7m. JPMorgan Chase, a bank, reckons the company will spend $3bn on marketing this year, up from $1.7bn in 2023.

Temu, based in Boston, is an offshoot of Pinduoduo, a Chinese e-commerce firm. It is attempting to replicate the success of Shein, a Chinese fast-fashion seller, which shot to success in America in 2021 helped by clever marketing and ultra-low prices. In their bid to win over American shoppers the duo are spending so lavishly on digital ads that their footprints show up in big tech companies' earnings. On February 1st Susan Li, the chief financial officer of Meta, a social-media giant, said that Chinese advertisers contributed 10% of her firm's revenue last year and five percentage points to its worldwide revenue growth. In November Josh Silverman, the boss of Etsy, an online marketplace for artisan knick-knacks, blamed Temu and Shein for pushing up the price of digital advertising.

All that spending has bought some brand recognition. Last year Temu was the most downloaded app in America, Britain, France and Germany, according to Business of Apps, a research firm. Shein is already a shopping sensation among American teenagers. But can the firms win over American shoppers en masse?

Although Temu stocks a broader range of items, from children's toys to

industrial tools, than Shein, which mostly sells clothing, they have similar business models. For both, the main advantage is price. Michael Morton of MoffettNathanson, a research firm, estimates that the same items of women's clothing on Temu are two to four times dearer on American websites. Temu offers electric toothbrushes, sunglasses and backpacks for about $1 each.

The pair keep costs low in many ways. One is to cut out middlemen and deal directly with Chinese factories. Another is to charge merchants lower fees than American rivals do. They also eschew enormous logistics operations in America like Amazon's. Instead they ship products from warehouses in China and have them delivered to shoppers in America by UPS, FedEx or the post. Customers thus get low prices, but not speedy delivery. Packages can take weeks to arrive.

For now, Temu is focused on market share rather than profit. Bernstein, a broker, reckons that it loses around $10 per item sold in America. It may be able to keep this up for a while, bankrolled by Pinduoduo's domestic success. Last year the parent firm generated $12bn in cash from operations. Shein, by contrast, is looking to raise more funds. In November it filed for an initial public offering in America. If the listing happens, it will be huge: at its most recent funding round in May 2022 the company was valued at $66bn.

So far the pair have made only small inroads into America's e-commerce market. Temu and Shein both have shares of about 1%, according to Bernstein. Amazon has 38%. Even so, the local giant is taking them seriously. In December Amazon said it would cut merchants' fees for clothing priced under $15, probably in response to the twin threat. In September it rolled out an end-to-end supply-chain service in which it picks up goods from merchants' factories and ships them to customers, mirroring what its Chinese rivals do.

But Amazon is unlikely to be hurt first, or most. Clothing and accessories account for only 16% of its sales, according to eMarketer, a research firm, so Shein is probably a bigger threat to fast-fashion labels such as Forever 21. And for Temu, the absence of a local logistics network will make it difficult to compete with Amazon when it comes to goods customers want quickly, such as dishwasher tablets. It is probably a bigger threat to eBay or Etsy.

That may eventually change. Both firms have bought warehouse space in America and struck partnerships with local logistics firms. Shein is reportedly poaching supply-chain specialists from Amazon. Temu may also start to sell dearer goods, such as smartphones, a shift its parent pulled off in China. That would put it into more direct competition with Amazon and the similarly mighty Walmart.

Cheap shots

Plenty could still go wrong for the two. Each must compete both with American incumbents and with each other. TikTok Shop, a marketplace run by the social-media firm that launched in America in September last year, may also get in their way. Geopolitics may hurt them, too. A committee of American senators is probing their alleged links to forced labour. (Both firms deny any such connections.) Analysis by Morgan Stanley, another bank, suggests that Americans' willingness to shop at Temu may already be waning, perhaps as the novelty has worn off.

That said, Mark Shmulik of Bernstein argues that increasing market share from zero to 1% is more difficult for new e-commerce firms than raising it from 1% to 5%. Getting consumers to first take notice is tricky. Once a brand is familiar, it is easier to sell customers more things—and more expensive ones, too. Temu and Shein may have already done the hardest part of making it in America. ■

亚马逊应该多担心Shein和Temu？

廉价产品和大手笔营销正在收获点击量

"像亿万富翁那样购物。"在2月11日的超级碗比赛中，Temu向美国观众打出了这个诱人的口号来宣传自己。这家电商公司在去年的超级碗比赛中也向球迷展示过类似的广告。但这一次，它火力全开。Temu的广告播放了五次。这必然价格不菲：今年超级碗的30秒广告收费约700万美元。根据摩根大通的估计，Temu今年将在营销上支出30亿美元，而2023年的支出为17亿美元。

总部位于波士顿的Temu是中国电商公司拼多多的子公司。它试图复制中国快时尚电商Shein于2021年在美国的异军突起，后者的成功得益于巧妙的营销和超低的价格。为了赢得美国消费者的青睐，这两家公司在数字广告上大手笔撒钱，在美国科技巨头的财报上留下了明显印记。2月1日，社交媒体巨头Meta的首席财务官苏珊·李（Susan Li）表示，中国广告主去年贡献了Meta营收的10%，以及5个百分点的全球收入增长。去年11月，在线手工艺品市场Etsy的首席执行官约什·希弗曼（Josh Silverman）认为是Temu和Shein推高了数字广告的价格。

大笔支出换来了一定的品牌认知度。根据研究公司Business of Apps的数据，Temu是美国、英国、法国和德国去年下载量最高的应用。Shein已经成为备受美国青少年青睐的购物应用。但这两家公司能否赢得广大美国消费者的青睐呢？

Shein主要销售服装，Temu的商品种类更多，从儿童玩具到工业工具等。但两家公司的商业模式相似。主要优势都是价格。研究公司MoffettNathanson的迈克尔·莫顿（Michael Morton）估计，同类女装在美国购物网站的价格是Temu的两到四倍。Temu上出售每件约1美元的电动牙刷、太阳镜和背包。

两家公司靠很多方法来保持低价。其一是省去中间商，直接从中国工厂进货。另一个是对商家收取的佣金比美国竞争对手收取的少。它们也没有像亚马逊那样在美国建立庞大的物流业务，而是选择从中国的仓库发货，通过UPS、联邦快递或邮政将产品送到美国消费者手中。因此顾客能享受到低价，但无法快速收货。等待包裹运抵可能需要几周。

目前而言，Temu专注于市场份额而非利润。经纪公司盛博（Bernstein）估计，Temu在美国每销售一件商品约亏损10美元。有拼多多在中国的成功提供资金支持，这种状况或许还可以维持一段时间；去年，这家母公司的经营现金流达120亿美元。相比之下，Shein正在寻求筹集更多资金。去年11月，它在美国申请上市。如果成功，上市规模将非常庞大。在2022年5月的最新一轮融资中，该公司的估值为660亿美元。

到目前为止，Temu和Shein在美国电子商务市场上的份额都还很小。根据盛博的数据，两家公司都仅有约1%的份额。亚马逊则占了38%。即便如此，这个本地巨头并没有不把它们当回事。去年12月，可能是出于一种战略应对，亚马逊宣布将减少对价格低于15美元的服装收取的佣金。9月，它推出了一项端到端的供应链服务，模仿两家中国公司的做法，从工厂提货直接运送给顾客。

但亚马逊不太可能是首当其冲受冲击的，也不大会是受冲击最大的。研究公司eMarketer的数据显示，服装和配饰仅占亚马逊销售额的16%，因此Shein对Forever 21等快时尚品牌的威胁可能更大。至于Temu，缺乏本地物流网络将使它难以在洗碗片等顾客需要快速送达的商品上与亚马逊竞争。它对eBay或Etsy的威胁可能更大。

局面最终可能会改变。两家公司都在美国购买了仓库空间，并与当地物流公司达成了合作关系。据报道，Shein正在从亚马逊的供应链专家队伍里挖人。Temu也可能开始销售智能手机等价格更高的商品，其母公司在中国就成功实现了这样的转变。这将让它与亚马逊及同样强大的沃尔玛展开更直接的竞争。

两家公司仍然面临诸多风险。在与美国老牌企业竞争的同时，它们相互之间也要竞争。社交媒体公司TikTok去年9月在美国推出的在线市场TikTok Shop也可能来掺一脚。地缘因素也可能对它们造成损伤。它们被指控牵涉强迫劳动（两家公司均予以否认），美国一些参议员组成的委员会正在展开相关调查。另一家银行摩根士丹利的分析表明，美国消费者在Temu购物的意愿可能已经下降，也许是因为新鲜劲过去了。

尽管如此，盛博的马克·舒米利克（Mark Shmulik）认为，对于新的电子商务公司来说，实现市场份额从零到1%的增长要比从1%到5%更难。要让消费者首先能注意到自己不容易。一旦他们熟悉了一个品牌，就更容易向他们卖出更多产品了——也能卖出更贵的。Temu和Shein可能已经跨过了在美国立足的最艰难阶段。■

From Napoleon to Vladimir Putin, disease has shaped history

A sacked New York Times reporter takes a global view of disease

The Wisdom of Plagues. By Donald McNeill. Simon & Schuster; 384 pages; $28.99 and £20

EARLY ONE morning a New York Times reporter was shaken roughly awake. He was sleeping in a tiny hut, deep in the Cameroonian rainforest. Some local criminals were coming to kidnap him, his guide warned. Both men fled, just in time.

The reporter was Donald McNeill, who started at the New York Times as a copy boy in 1976 and later spent decades covering global health, especially the diseases that afflict the poor. He did so with courage, compassion and an eye for unexpectedly important details. The story he was pursuing in Cameroon was about hunting great apes and how their extinction might harm understanding of diseases that have crossed from other primates to humans. As a scientist told him, killing chimpanzees "is like burning a library full of books you haven't read yet".

Mr McNeill's reportorial adventures prepared him for the biggest story of his career: he and colleagues won a Pulitzer prize for their coverage of covid-19. Times readers no longer have the benefit of his insights, however. He was pushed out in 2021 because of complaints that he had uttered a racial slur when referring to a conversation about someone else using it. On the plus side, Mr McNeill then had time to write a cracking book on pandemics.

"The Wisdom of Plagues" puts the struggle against pestilence in historical context, noting how the shift from hunter-gathering to farming made it

easier for bugs to jump from livestock to people. Mr McNeill explains how plagues have shaped history, from the typhus that crippled Napoleon's invasion of Russia to the covid-induced isolation that, he speculates, might have aggravated Vladimir Putin's paranoia.

Fear of disease has long led to scapegoating. Syphilis was "the French pox" to the English, "the Turkish disease" to Poles and "the Christian disease" to Turks. Mr McNeill recounts how a chest of gold and silver coins was recently found in the old Jewish quarter of Erfurt, Germany. The last king depicted on the coins had ruled in 1349, the year the Black Death struck the city. Locals blamed the Jews, as they did all over western Europe. The owner of the chest never got to dig it up.

With fear comes falsehood. If it is not ethnic minorities supposedly spreading plagues, it is evil tycoons profiting from them in convoluted ways. A century before Bill Gates was accused of using covid jabs to plant chips in people, John D. Rockefeller funded a campaign to urge Americans to wear shoes to stop hookworm burrowing into their bare feet. Rumours spread that "the oil magnate had secretly bought up shoe companies".

Misinformation is a huge obstacle to fighting disease. Mr McNeill saw close-up some of the estimated 300,000 extra deaths caused by a South African president, Thabo Mbeki, who concluded after surfing the internet that HIV did not cause AIDS. He watched the global campaign to eradicate polio stumble because so many Muslims believe the vaccine is a Western plot to sterilise them. Convincing them otherwise grew harder, Mr McNeill fumes, when the CIA used a fake vaccination campaign to try to trace Osama bin Laden in 2011. In one month the next year, Pakistani jihadists shot dead nine polio vaccinators.

To fight pandemics, accurate information must be rapidly disseminated. That means bureaucracies need to move faster. "I can't think of a single

serious outbreak I learned of first" from the World Health Organisation (WHO), complains Mr McNeill. It is part of the UN, and like "a London gentleman's club", defers to its members. ProMED, an unofficial disease-alert network, sounded the alarm about covid-19 four days before the much better-resourced WHO.

Accurate information must also be believed. Too often, it is not, because of a breakdown of public trust in authorities. When experts make mistakes, which is inevitable when grappling with a new disease, many people conclude that the professionals are useless or self-serving.

In this, they are encouraged by reckless pundits and politicians. "The storm of rumours surrounding covid was by far the most intense I ever covered—for an obvious reason: many of them were spread by the president of the United States," Mr McNeill writes. He deplores the way masks became political badges in America, with Republicans shunning them and Democrats sporting them even when cycling outdoors without helmets. Tribalism makes for poor risk assessment.

Mr McNeill brims with ideas for curbing the next pandemic, including sampling sewage for viruses. He would, controversially, end religious exemptions to public-health rules. He omits some important things, such as the mystery of why Sweden coped reasonably well with covid despite very loose lockdown rules. But overall, this is a fascinating, ferocious fusillade against humanity's two deadliest enemies: disease and itself. ■

从拿破仑到普京，疾病塑造了历史

一位被《纽约时报》解雇的记者用全球视野看疾病

《瘟疫的学问》，唐纳德·麦克尼尔著。西蒙与舒斯特出版社；384页；28.99美元，20英镑。

一天清晨，《纽约时报》的一名记者被猛地摇醒。他正睡在喀麦隆雨林深处的一座小屋里。当地一些罪犯来绑架他了，他的向导警告说。两人差一点就来不及逃脱了。

这名记者是唐纳德·麦克尼尔（Donald McNeill）。他在1976年进入《纽约时报》，起先递送稿件和跑腿，后来几十年里一直报道全球健康议题，尤其是那些困扰穷人的疾病。他怀着勇气和同情心工作，而且善于发现意料之外的重要细节。他在喀麦隆追踪报道了对类人猿的猎杀，以及它们的灭绝如何可能影响人们了解那些从其他灵长类动物传播给人类的疾病。正如一位科学家告诉他的，杀死黑猩猩"就如同烧掉一座满是你还没读过的书籍的图书馆"。

麦克尼尔惊险的记者经历为他职业生涯中最重大的报道做了铺垫：他和同事们因报道新冠肺炎而获得了普利策奖。然而，《纽约时报》的读者不会再读到他富洞察力的报道了。2021年，有人投诉他在提及某个人使用一个种族歧视字眼的对话时自己也说了这个词，他被迫离开。好的一面是，这让他接下来有时间撰写一本关于大流行病的精彩书籍。

《瘟疫的学问》（The Wisdom of Plagues）在历史大背景下探讨人类对抗疫病的斗争，指出从狩猎采集到农耕的转变如何让病菌更容易从牲畜传播到人。麦克尼尔阐释了瘟疫如何塑造历史，从斑疹伤寒让拿破仑对俄国的入侵受挫，到他推测新冠隔离可能加剧了普京的偏执妄想。

长久以来，对疾病的恐惧促使人们迁怒于人。梅毒在英国人眼中是"法国

疮"，在波兰人眼中是"土耳其病"，在土耳其人眼中是"基督教病"。麦克尼尔记述道，多年前在德国埃尔福特市（Erfurt）的老犹太社区发现了一箱金币和银币。硬币上描画的最后一位国王1349年时在位，而在那一年黑死病袭击了这座城市。当地人像全西欧的人那样把这归咎于犹太人。箱子的主人再没有机会把它挖出来。

随恐惧而来的是谣言。要么是说少数族裔传播了瘟疫，要么就是邪恶的大亨通过各种迂回曲折从瘟疫中获利。比尔·盖茨被指利用新冠疫苗给人体注射芯片。而在一个世纪前，约翰·洛克菲勒资助了一场运动，敦促美国人穿鞋以阻止钩虫钻进他们赤裸的双脚。谣言四处流传，称"这位石油大亨秘密收购了鞋业公司"。

不实信息是对抗疾病的巨大阻碍。南非总统塔博·姆贝基在上网浏览信息后得出HIV不会导致艾滋病的结论，造成了大约30万人的额外死亡，麦克尼尔见证了其中一些悲剧。他目睹了全球根除小儿麻痹症的运动难以推进，因为许多穆斯林相信疫苗是西方的阴谋，目的是给他们绝育。麦克尼尔愤怒地指出，当美国中情局在2011年试图通过虚假的疫苗接种活动追踪本·拉登时，说服他们的难度就更大了。第二年的一个月里，巴基斯坦圣战分子射杀了九名小儿麻痹病疫苗接种人员。

要对抗大流行病，准确的信息必须能迅速传播出去。这就需要官僚机构加快行动。麦克尼尔抱怨说："我想不出有哪一次严重疫情我是从世卫组织那里首先得知的。"世卫组织是联合国下属机构，就和"一家伦敦绅士俱乐部"一样，唯其成员马首是瞻。非官方的疾病预警网络ProMED比资源充足得多的世卫组织早四天发出了有关新冠肺炎的警报。

准确的信息还必须能让人相信。太多时候人们都不信，因为公众对权威机构的信任崩塌了。当专家犯错时——这在试图弄明白一种新疾病时是不可避免的——许多人判定这些专业人士毫无用处或自私自利。

在这一点上，他们受到了轻率鲁莽的"名嘴"和政客的鼓动。"围绕新冠病毒的谣言风暴是我所报道过的最激烈的，原因显而易见：其中许多是由美国

总统传播的。"麦克尼尔写道。他谴责口罩在美国如何成为了政治标志——共和党人避而不戴，而民主党人在户外骑车时就算不戴头盔也要戴着口罩。部落主义导致了糟糕的风险评估。

至于如何遏制下一次大流行病，麦克尼尔有很多点子，包括对污水做病毒采样。必然引发争议的是，他主张结束对公共卫生规则的宗教豁免。他漏掉了一些重要的事情，比如为什么尽管瑞典的封锁规则非常宽松，却令人费解地相当好地应对了新冠。但总的来说，这本书引人入胜而猛烈地炮轰了人类的两个最要命的敌人：疾病和人类自己。■

Could AMD break Nvidia's chokehold on chips?

Taking on the top AI chipmaker will be hard—but maybe not impossible

"IT IS THE most advanced AI accelerator in the industry," boasted Lisa Su, boss of Advanced Micro Devices (AMD), at the launch in December of its new MI300 chip. Ms Su rattled off a series of technical specifications: 153bn transistors, 192 gigabytes of memory and 5.3 terabytes per second of memory bandwidth. That is, respectively, about 2, 2.4 and 1.6 times more than the H100, the top-of-the-line artificial-intelligence chip made by Nvidia. That rival chipmaker's prowess in the semiconductors fuelling the AI boom has, over the past year, turned it into America's fifth-most-valuable company, with a market capitalisation of $1.5trn. Yet most experts agreed that the numbers and Ms Su weren't lying: the MI300 does indeed outshine the H100. Investors liked it, too—AMD's share price jumped by 10% the next day.

On January 30th, in its quarterly earnings call, AMD announced that it expected to sell $3.5bn-worth of MI300s this year. It also reported strong revenues of $23bn in 2023, four times what they had been in 2014, when Ms Su became chief executive. Its market value is up 100-fold on her watch, to $270bn. Relative to forecast profits in the next 12 months, its valuation is richer even than Nvidia's. Last year it displaced Intel, which once ruled American chipmaking, as the country's second-most-valuable semiconductor company. Now it is taking aim at the biggest.

Such ambition would have seemed fanciful a decade ago. Back then, recalls Mark Papermaster, AMD's technology chief, AMD was facing an "existential crisis". In 2008 it had spun off its chip-fabrication business to focus on designing processors, outsourcing manufacturing to contract chipmakers such as TSMC of Taiwan. The idea was to be better able to compete on

blueprints with Intel, whose vast fabrication capacity AMD could not hope to match.

It didn't work. Several of AMD's chips flopped. Sales of its central processing units (CPUs), mostly for personal computers, were collapsing. In 2013 it sold and leased back its campus in Austin to raise cash. A year later Ms Su inherited a net-debt pile of more than $1bn, a net annual loss of $400m and a market value of less than $3bn, down from $20bn in 2006.

She realised that the only way for AMD to get back in the game was to steer it away from the sluggish PC market and focus on more promising areas like CPUs for data-centre servers and graphics processing units (GPUs, which make video-game visuals lifelike) for gaming consoles. She and Mr Papermaster took a gamble on a new CPU architecture designed to beat Intel not just on price, but also on performance.

When the going got tough

The idea was to use a Lego-like approach to chip building. By breaking a chip up into smaller parts, AMD could mix and match blocks to assemble different types of chip, at a lower cost. When the first such composite chips were released in 2017, they were zippier and cheaper than rival offerings from Intel, possibly in part because Intel was distracted by its own problems (notably repeated manufacturing slip-ups as it moved to ever tinier transistors). In the past ten years AMD's market share in lucrative server CPUs has gone from nothing to 30%, breaking Intel's monopoly.

Having faced down one giant, AMD now confronts another. The contest with Nvidia is different. For one thing, it is personal—Ms Su and Jensen Huang, Nvidia's Taiwanese-born boss, are distant relatives. In contrast to Intel, Nvidia is, like AMD, a chip designer and thus less prone to production missteps. More importantly, the stakes are higher. Nvidia's market value of $1.5trn is predicated on its dominance of the market for GPUs—not because

of their usefulness in gaming but because they also happen to be the best type of chip to train AI models. Ms Su expects global sales of AI chips to reach $400bn by 2027, up from perhaps $40bn last year. Does she stand a chance against Nvidia?

Nvidia is a formidable rival. Both its revenues and operating margins are nearly three times AMD's. According to Jefferies, an investment bank, the company dominates the market for AI accelerator chips, accounting for 86% of such components sold globally; before the launch of the MI300, AMD barely registered. Nvidia also offers network gear that connects clusters of chips, and software, known as CUDA, to manage AI workloads. Nvidia has dominated AI chipmaking because it has offered the best chips, the best networking kit and the best software, notes Doug O'Laughlin of Fabricated Knowledge, a research firm.

AMD's new processor shows it can compete with Nvidia on semiconductor hardware. This, Mr Papermaster says, is the result of a ten-year investment. AMD is spending nearly $6bn a year on research and development, nearly as much as its larger rival—and twice as much as a share of sales (see table). This has enabled it to adapt its Lego approach to GPUs. Combining a dozen blocks—or "chiplets"—into a single chip lets AMD put processors and memory close to each other, which boosts processing speed. In December OpenAI, maker of ChatGPT and the world's hottest AI startup, said it would use the MI300s for some of its training.

To outdo Nvidia on networking and software, AMD is teaming up with other firms. In December it announced a partnership with makers of networking gear, including the two largest, Broadcom and Cisco. It is also supporting an open-source initiative for chip-to-chip communication called Ultra Ethernet Consortium as an alternative to InfiniBand, a rival championed by Nvidia.

Nvidia's lead in software will be harder to close. It has been investing in CUDA since the mid-2000s, well before the current AI wave. AI developers and researchers love the platform, which allows them to fine-tune the performance of Nvidia processors. AMD hopes to tempt customers away from Nvidia by making its software, ROCm, open-source and providing tools to make the switch smoother, by translating CUDA programs into ROCm ones.

Beating Nvidia at its own game will not be easy. Mr Huang's firm is not standing still. It recently announced plans to bring out a new chip every year instead of every two years. The tech giants with the grandest AI ambitions—Alphabet, Amazon, Meta and Microsoft—are busily designing their own accelerator chips. Despite AMD's robust sales, investors were disappointed with its forecast for MI300 shipments. Its share price dipped by 3% the day after it reported its latest results.

Still, AMD has one big thing going for it. It is not Nvidia. AI companies are desperate for an alternative to its larger rival, whose dominant position allows it to charge steep prices and, with demand outstripping supply, ration chips to buyers. Despite efforts to design their own hardware, big tech firms will rely on chipmakers for a while, and AMD gives them options, notes Vivek Arya of Bank of America. Microsoft and Meta have already announced plans to use AMD's GPUs in their data centres. And if Nvidia slips up, AMD will be there to pick up the Lego pieces. Just ask Intel.
■

AMD能否打破英伟达的芯片垄断？

挑战AI芯片老大绝非易事，但未必不可能

"这是目前业界最先进的AI加速器。"去年12月，AMD的老板苏姿丰在MI300芯片的新品发布会上夸耀道。苏姿丰一气说出了这款芯片的一系列技术参数：1530亿个晶体管、192GB的内存、每秒5.3TB的内存带宽。这分别是其竞争对手英伟达制造的顶级AI芯片H100的大约2倍、2.4倍和1.6倍。英伟达凭借其在半导体领域的实力推动了AI的繁荣，并在过去一年时间里以1.5万亿美元的市值晋身美国第五大公司。不过，大多数专家都认为AMD的这些参数是真实的，苏姿丰也没有夸大其词：MI300确实比H100更胜一筹。投资者也乐见其成——AMD的股价在第二天大涨了10%。

1月30日，AMD在季度财报电话会议上宣布，预计今年MI300的销售额会达到35亿美元。它还报称2023年营收表现强劲，达到230亿美元，是2014年苏姿丰出任CEO时的四倍。在她的执掌下，AMD的市值增长了100倍，达到2700亿美元。相对于未来12个月的预期利润而言，AMD的估值甚至超过了英伟达。去年，它取代了曾是美国芯片制造业霸主的英特尔，成为美国市值第二高的半导体公司。现在它的目标是成为美国第一。

这样的雄心壮志要放在十年前会是异想天开。AMD的技术主管马克·佩珀马斯特（Mark Papermaster）回忆道，当时的AMD正面临着一场"生存危机"。2008年，为全力投入处理器设计，AMD剥离了芯片制造业务，将制造外包给台积电等芯片代工厂。AMD希望能借此在芯片的设计上更好地与英特尔竞争，毕竟英特尔强大的制造能力是自己望尘莫及的。

然而事与愿违。AMD的几款芯片都以失败告终。其主要用于个人电脑的中央处理器（CPU）的销售一落千丈。2013年，为筹集资金，AMD出售了位于得州奥斯汀的办公园区，然后再回租。一年后，苏姿丰接手AMD，当时它的净债务超过十亿美元，年净亏损四亿美元，市值已从2006年的200亿美元下跌到不足30亿美元。

苏姿丰意识到，要想打翻身仗，AMD只有从低迷的个人电脑市场转移到更有前途的领域，比如面向数据中心服务器的CPU或者游戏机的图形处理器（GPU，可以生成逼真的游戏画面）。她和佩珀马斯特把赌注押在新的CPU架构上——不仅要在价格上、还要在性能上战胜英特尔。

| 道阻且长

他们的想法是像搭乐高那样搭建芯片。通过将芯片分解成更小的单元，AMD可以把不同的模块混搭在一起，以更低的成本组装不同类型的芯片。2017年AMD推出了第一批这样的组合芯片，它们比英特尔的竞品速度更快、成本更低——一定程度上可能也是因为英特尔被自己的问题分散了精力（尤其是在转向更小的晶体管时一再出现制造上的失误）。过去十年里，在利润丰厚的服务器CPU市场上，AMD的份额从零增长到30%，打破了英特尔的垄断。

在击败了一个巨头之后，AMD现在面对另一个巨头。与英伟达的这场竞争有所不同。首先，这涉及私人关系——苏姿丰和出生于台湾的英伟达老板黄仁勋是远亲。其次，与英特尔不同，英伟达和AMD一样也只是芯片设计公司，因此不太容易在制造上出错。更重要的是，这次竞争的押注更大。英伟达1.5万亿美元的市值是基于它在GPU市场的主导地位，而这并不是因为GPU在游戏中的用处，而是因为这种芯片恰好还最适合用来训练AI模型。苏姿丰预计，到2027年，AI芯片的全球销售额将达到4000亿美元，远高于去年的约400亿美元。她有机会战胜英伟达吗？

英伟达是一个强大的对手。它的收入和营业利润率都是AMD的近三倍。投资银行杰富瑞（Jefferies）称，英伟达主导着AI加速芯片的市场，占全球此类组件销量的86%；在MI300推出之前，AMD在这个市场几乎没有份额。英伟达还提供连接多芯片集群的网络设备，以及用来管理AI工作负载的CUDA软件。研究公司Fabricated Knowledge的道格·奥劳克林（Doug O'laughlin）指出，英伟达之所以能在AI芯片制造领域占据主导，是因为它提供了最好的芯片、最好的网络设备以及最好的软件。

AMD新的处理器表明，它有能力在半导体硬件上与英伟达一较高下。这是

十年投资的结果，佩珀马斯特说。AMD每年的研发支出接近60亿美元，与比它体格更大的对手不相上下；这部分支出占销售额的比例是英伟达的两倍（见表）。这让它能够将它的乐高搭建法应用到GPU上。由于能将12个模块（或者说"小芯片"）整合到单块芯片上，AMD可以将多个处理器和内存紧密地放置在一起，从而提高处理速度。去年12月，开发了ChatGPT的全球最热门的AI创业公司OpenAI表示，将使用MI300进行部分模型训练。

为了在联网和软件方面超越英伟达，AMD正在与其他公司展开合作。去年12月，它宣布与多家网络设备制造商建立合作，其中包括博通和思科这两个巨无霸。它还支持一个叫作"超以太网联盟"（Ultra Ethernet Consortium）的组织，这是个芯片间通信的开源项目，可以取代英伟达旗下的竞争产品InfiniBand。

跃跃欲试

要在软件上赶上英伟达会更难。自2000年代中期以来，英伟达就一直在投资CUDA平台，彼时当前的AI浪潮还远远没有到来。该平台让AI开发人员和研究人员能够微调英伟达处理器的性能，深受他们欢迎。AMD希望通过将自己的ROCm软件开源、并且提供更便捷的切换工具（把CUDA程序转译为ROCm程序），将英伟达的客户吸引过来。

要在英伟达的主场击败它绝非易事，黄仁勋的公司并没有按兵不动。它在不久前宣布计划每年推出一款新芯片，而不再是每两年出一款。Alphabet、亚马逊、Meta和微软等在AI上最雄心勃勃的科技巨头都在忙着设计自己的加速芯片。尽管AMD的销售强劲，但投资者对它的MI300的预测出货量感到失望。在它公布最新业绩的第二天，股价下跌了3%。

尽管如此，AMD仍有一大优势：它不是英伟达。一家独大的英伟达要价过高，而且因其芯片供不应求，英伟达常常对买家实行限量供应，因此AI企业都迫切希望在英伟达之外还能另有选择。美国银行（Bank of America）的维韦克·阿雅（Vivek Arya）指出，尽管科技巨头都在下大力气设计自己的硬件，但在一段时间内，它们仍会依赖芯片制造商，而AMD让它们多

了一个选择。微软和Meta已经宣布，计划在自己的数据中心使用AMD的GPU。如果英伟达出了差错，它们可以用AMD的乐高来救场。看看英特尔就知道了。■

Hard times for China's micro-industrialists

A rural hub for children's bicycle-making adjusts to a world with fewer kids

THERE ARE lots of upsides to making bikes for kids, explains Mr Li, a young entrepreneur from Pingxiang, a scruffy county in northern China that has become a centre for the children's bicycle industry. For one thing, they are easy to build, he says, nodding at a toddler-sized machine parked near his desk, held upright by tiny stabilisers. Teenage mountain bikes are a bit fiddly, but smaller ones "need no special machinery at all". Also, he grins, children grow. Sell a three-year-old their first ride and two years later their parents have to buy a bigger one, and so it goes on for years to come. The downside? China is running out of children.

Pingxiang, in the province of Hebei some 400km south of Beijing, is a revealing place to see the country's demographic future playing out today. Like many industrial clusters in China, it grew over decades as businesspeople forged networks, helped by local officials offering tax breaks and other subsidies. Initially, small firms assembled frames, pedals and other parts bought from established manufacturers in coastal cities. Over time complete supply chains were created in Pingxiang. Today, the county is a sprawl of large industrial plants linked to smaller suppliers, many of them tucked away in rural sheds and barns. There are traffic jams as lorries and three-wheelers piled high with bicycle cartons inch down narrow village lanes.

County officials report that 10m bicycles a year are built there, by thousands of firms. Official media credit Pingxiang with supplying 40% of the children's bicycles sold worldwide. It also produces half the wheeled toys sold inside China, including bicycles, tricycles, scooters and ride-along toy cars. This targeted approach to globalisation made Pingxiang

prosperous, if not lovely. The county is a drab, dusty spot, though officials have painted cycling-themed murals on walls and erected a giant sculpture of a bicycle wheel in a public square. Then came China's fertility crash.

In 2023 the number of Chinese newborns hit a record low of just over 9m, after falling for seven years in a row. That compares with nearly 19m babies born in 2016. Mr Li quit his job as a quality controller in a big factory a few years ago, and began selling hand-assembled bikes in street markets. Today he rents a small factory with a former colleague. He employs 15 people who can make hundreds of bicycles a day, when orders are good. Orders are not good right now and his staff are on short hours. Huddled in a freezing office in one corner of their steel-walled factory, he and his business partner look anxious. This is understandable, given that their main customer base—namely, Chinese toddlers—has shrunk by half over the past decade. The change "started slowly, a few years ago", he recalls. Now the impact on sales is unmistakable.

Mr Li's plight reveals a lot about the large forces that are battering China's private sector, and about the solutions being proposed by officials in both the local and central governments. Coverage of China's economy often focuses on a handful of national champions making world-class products, from smartphones to electric vehicles. But small firms with fewer than 300 employees accounted for 79% of China's job creation and 68% of exports, the OECD, a club of mostly rich countries, reported in 2022. Though the Communist Party puts great stock in large state-owned enterprises and groundbreaking technology, China needs its backyard entrepreneurs, too. The supreme leader, Xi Jinping, calls China's mastery of the complete array of industrial sectors a source of national strength. Last year he urged officials to upgrade, not eliminate, industries deemed "low-end".

Sluggish domestic demand, notably since the end of the covid-19 pandemic, has led officials to urge manufacturers of all types to seek new

markets abroad. Still, exports are not a cure-all. A bicycle-industry veteran in Beijing notes that China's manufacturers saw roaring domestic and foreign sales during the pandemic, as people abandoned public transport for their own two wheels. The industry now faces a hangover, as inventories are cleared and many covid-era riders lose interest. In ageing societies, e-bikes for adults are selling well. But even in markets that still have children, many want to play video games, not play outdoors. Chinese consumers lack the confidence to spend but demand is weak in many foreign markets too, says the veteran. "In some of our enterprises, production is down by a third."

| *A slowing China bets on exports*

Back in Pingxiang, Mr Li is struggling to survive. During pandemic lockdowns, many Chinese consumers had bills to pay but no income. They have not yet shaken the fear that they felt then, he says. Compared with last year, his firm's sales are down by more than half. Local officials urge businesses like his to look abroad, with a focus on countries signed up to China's Belt and Road Initiative. In 2020 less than a tenth of the firm's sales went abroad. Now exports account for 40-50% of turnover, with customers in Russia, Malaysia and Indonesia. He is grateful to county officials who subsidised his stand at a trade fair in Shanghai, where he met foreign buyers. But exports are hard work. The Russians are from that country's far east near the Chinese border, he thinks. They ask for more time to pay when the rouble is weak, though helpfully they settle their bills in Chinese yuan. Europe and America are richer markets, but the firm cannot meet their product standards.

After lunch, Chaguan is taken to a nearby village to see Plan B. In a farmyard workshop guarded by honking geese, Mr Li's business partner has a team assembling pedal tricycles for old people. These are built to order in batches of 50, which middlemen sell to domestic customers online.

Compared with children, who need new bikes as they grow, the disadvantage is that pensioners "stop riding" when they get older, says the partner earnestly. But at least China will have more and more of them. A larger tricycle-assembly line is planned for next year. These are grim times for China's micro-industrialists. Their resilience is a wonder to behold. ■

中国小微实业家的艰难时日

一个位于农村的童车制造中心正在调整，以适应一个孩子越来越少的世界

中国北方有一个乱糟糟的县城平乡，如今已成为儿童自行车产业的中心。当地的年轻企业家李先生解释说，给小孩子造自行车有很多有利之处。首先，童车容易造，他朝桌子旁停着的一台家伙努了努下巴，这辆幼儿尺寸的车有小小的平衡轮作支撑。制造青少年骑的山地车需要点技术，但更小的童车"根本不需要特殊的机械"。还有，他咧嘴一笑道，孩子总归要长大。三岁时买了第一辆车，两年后父母就要再买辆更大的，就这样持续好些年。不利的一面呢？中国的孩子越来越少了。

隶属河北省的平乡位于北京以南约400公里，从这里可以窥见中国的人口发展趋势。和中国的许多产业集群一样，在地方官员提供税收减免和其他补贴的帮助下，商人们打造的这个产业网络在几十年里不断发展壮大。起初，小公司组装从沿海城市的老牌制造商那里购买的车架、踏板和其他部件。渐渐地，完整的供应链在平乡建立起来。如今，这里到处都是串联着较小供应商的大型工厂，其中许多供应商栖身在农村的棚屋和谷仓里。满载着装有自行车的纸箱的卡车和三轮车在狭窄的乡间小路上缓慢挪动，造成拥堵。

县里的官员报告说，数千家公司每年在这里生产一千万辆自行车。官方媒体称，平乡制造的儿童自行车占全球销量的40%。在中国国内销售的各式玩具车中，有一半是在平乡生产的，包括自行车、三轮车、滑板车和乘坐式玩具车。这种目的明确的全球化让平乡繁荣起来，虽然不够美好有趣。这个县城单调乏味、尘土飞扬，尽管官员们在墙上画了以自行车为主题的壁画，还在公共广场上竖起了一个巨大的自行车车轮造型的雕塑。后来就碰上了中国生育率暴跌。

在连续下跌七年之后，2023年中国新生儿数量创下了历史新低，仅有900多万。相比之下，2016年有近1900万婴儿出生。几年前，李先生辞去了在

一家大工厂担任质控员的工作，开始在街市上销售手工组装的自行车。如今，他和一位前同事租下了一间小厂房。他雇了15名员工，订单多的时候，他们每天可以生产数百辆自行车。现在订单少，他的员工早早就下班了。他和生意伙伴两人蜷在钢结构厂房一角的一间冰冷的办公室里，神色焦虑。这不难理解，因为他们的主要顾客群，也就是中国的幼儿，在过去十年里少了一半。他回忆说，这种变化"在几年前就慢慢开始了"。现在这对销售的影响已经确凿无疑。

李先生的困境充分揭示了正在重创中国私营部门的那些强大力量，以及地方和中央官员提出的解决方案的影响。对中国经济的报道往往聚焦于少数几家制造世界级产品的本国领军企业，从智能手机到电动汽车等。但是，成员主要为富裕国家的经合组织（OECD）在2022年的报告中称，雇员少于300人的小企业创造了中国79%的就业，68%的出口。虽然共产党非常重视大型国有企业和突破性技术，但中国也需要自己的后院型企业家。最高领导人习近平称中国门类齐全的产业体系是国家实力的源泉。去年，他敦促官员们升级而不是淘汰被视为"低端"的行业。

国内需求低迷，新冠疫情结束以来尤其如此，导致官员们敦促各行各业的制造商寻求海外新市场。不过，出口并不能包治百病。北京一位自行车产业资深人士指出，疫情期间人们放弃了公共交通工具，骑上了自己的自行车，中国制造商由此迎来了国内外销量飙升。随着库存被清空，加上许多疫情时期骑车的人又失去了兴趣，眼下整个行业正在体验宿醉。在老龄化社会，成人的电动自行车卖得很好。但即便在仍有大量儿童的市场，许多孩子还是更想玩电子游戏，而不是在户外玩耍。这位资深人士表示，中国消费者缺乏消费信心，而许多外国市场的需求也很疲软。"在我们的一些企业，产量下降了三分之一。"

经济放缓的中国押注出口

回看平乡，李先生正在为生存而挣扎。在疫情封锁期间，许多中国消费者入不敷出。他说，他们如今仍心有余悸。与去年相比，他公司的销售额下降了一半不止。当地官员鼓励像他这样的企业将目光投向海外，重点关注中国"一带一路"倡议的共建国。2020年时他的公司只有不到一成销售额来

自海外，而现在出口占营业额的40%至50%，客户来自俄罗斯、马来西亚和印度尼西亚。他很感谢县里的官员资助他参加上海的一个展销会，在那里他遇到了国外的买家。但出口不好做。他觉得俄罗斯客户来自俄罗斯靠近中国边境的远东地区。当卢布疲软时，他们要求延长付款时间，尽管他们用人民币结算这点挺好。欧洲和美国市场更富裕，但他的公司无法达到那里的产品标准。

午饭后，笔者被带到附近的一个村子去看备选方案。在一个由嘎嘎叫的鹅群守护着的农家院子里有一个车间，李先生的商业伙伴有个团队在这里为老年人组装脚踏三轮车。这些产品按50辆一批订购，由中间商在网上卖给国内客户。相比小孩子一路长大要换新车，不利之处是老人年纪再往上去就"不骑车了"，这位合伙人一脸诚恳地说道。但至少中国会有越来越多老人。一条更大的三轮车装配线计划于明年建成。对于中国的小微实业家来说，这是一个艰难的时期。他们的韧性令人惊叹。■

Companies run to their own annual rhythms

Seasonality in firms, from budgeting cycles to bonus rounds

SEASONALITY IS A big part of business. For some industries, seasonal patterns are a defining feature. Agriculture is one obvious example; tourism another. Western toymakers notch up a huge proportion of their annual sales in the run-up to Christmas. Construction is harder during cold weather, which is why that industry employs fewer people in the winter.

Firms that are less obviously tied to the seasons can still be deeply affected by them, as a recent review by Ian Hohm of the University of British Columbia and his co-authors makes clear. An analysis of social-media posts on Twitter, now X, found that dieting-related tweets peak in the spring, as the season of body dysmorphia (ie, summer) approaches. Condom sales and online searches for pornography in America tend to rise in the summer and around Christmas.

Even when overall demand does not vary greatly between the seasons, preferences change. Beef-eaters buy diced meat and roasts in the slow-cooking winter season and plump for steaks during the summer grilling months. Starbucks is among those firms that make seasonality a marketing event. The pumpkin-spiced latte is a reliable sign that autumn is on its way, along with falling leaves and glum faces at condom manufacturers.

Seasonality also leaves a less obvious imprint inside organisations. Just as there are daily and weekly patterns of activity, from slumps in concentration during the late afternoons to the ebb and flow of hybrid workers coming to the office, so annual cycles leave their mark.

One is occurring this week, with the World Economic Forum's annual

shindig in Davos. Public holidays aside, in no other week in the working year are so many CEOs of large organisations reliably away. The corporate world is briefly without a government, a concentrated version of Belgium in the early 2010s. This may well be Davos's real contribution to improving the state of the world: with so many bosses stuck on a mountain for a few days, productive employees can get on with some work and lazy ones can relax.

School holidays offer an obvious form of seasonality, although in that case people throughout the organisation are off. Mass absences make it hard to schedule meetings in Brazil in the period between Christmas and the start of Carnival; it is a similar story in August in Europe.

These patterns of clustered absences show up inside organisations in big ways and small. Second-fiddle employees are more likely to get their chance to run the show; fewer big initiatives are likely to be launched when the holidays are in full swing. Employees without children are resentful that they are covering for colleagues on holiday; colleagues on holiday are resentful that they have children.

There is some evidence that people feel more creative after returning from holiday—but you need to schedule that brainstorming session quickly. A paper from 2010 by Jana Kühnel of Goethe University and Sabine Sonnentag of Universität Mannheim reckoned that the benefits of a break fade within a month.

Set-piece events mark the corporate calendar, too. Some are public: annual general meetings and shareholder letters, say. Others are internal. At many companies the annual budgeting process involves a gathering organisational effort, in which more and more people spend more and more time arguing about numbers that are certain to be wrong. It is almost a season in itself. A pre-pandemic estimate from APQC, a benchmarking

organisation, reckoned that the median firm spends around 30 days on this effort; at plenty of firms, it takes an awful lot longer.

Pay decisions are seasonal events, too. The time when employees find out their salary rises and bonuses sets off ripples of disappointment and happiness in all workplaces. In some, they are more like tsunamis. The bonus round on Wall Street, when bankers find out what they will get for their work the previous year, is under way now and is predated by months of internal wrangling and gossip. The actual date on which bonuses are paid matters, too—once the money is safely deposited in the bank, people are more likely to move jobs.

There are other forms of corporate seasonality. The office Christmas party signals another wind-down in activity. Some firms shorten the workweek during the summer months. Yearly calendars are punctuated by sales conferences and leadership retreats. There is not much research on the impact of seasonality within firms. That they have their own annual rhythms is indisputable. ■

公司有自己的年度律动

企业里的季节性——从预算周期到奖金发放

季节性是商业的重要部分。对于某些行业来说，季节性模式更是一个典型特征。农业就是显然易见的例子，旅游业也是。西方玩具制造商在圣诞节前夕的销售额占其全年销售的很大部分。建筑业在寒冷的天气里较难施工，因此在冬季也会减少用工。

不列颠哥伦比亚大学（University of British Columbia）的伊恩·霍姆（Ian Hohm）及其合著者最近发表的一篇报告认为，看起来与季节没有明显关联的公司也仍可能深受季节的影响。一项对推特（Twitter，现已更名为X）上社交媒体帖子的分析发现，随着体型恐惧高发季（也就是夏季）即将来临，与节食减肥相关的推文在春季达到高峰。美国的避孕套销量和网上色情搜索量在夏季和圣诞前后趋于上升。

即使总需求量在不同季节间波动不大，人们的偏好也会发生变化。爱吃牛肉的人会在冬天的慢炖季购买牛肉粒和烤牛肉，在夏天的烧烤季选购牛排。许多公司会开展季节性营销活动，星巴克便是其中之一。南瓜拿铁一出，就知道秋天要来了，正如落叶和避孕套厂商阴郁的脸色告诉你的那样。

虽然不那么明显，季节性在企业内部也存在。人员活动在每天和每周都有一定的规律，从近傍晚时分人们开始心不在焉，到混合办公的员工去办公室的人流增减。同样，一些年度周期也会留下印记。

其中一个周期刚刚上演，那就是每年在达沃斯举行的盛大的世界经济论坛。除了公共假期以外，在工作时间里没有哪一个星期会有这么多大型机构的CEO肯定不在公司。企业界短暂地进入了无政府状态，就像2010年代初的比利时的浓缩版。这很可能是达沃斯论坛对改善世界状况的真正贡献：这么多老板在一座山上待几天，勤快的员工可以继续干活，懒惰的员

工则可以放松一下。

学校假期带来了一种明显的季节性，尽管在这种情况下，企业里上上下下的人都在休假。在巴西，从圣诞节到狂欢节开始前的时间里，大规模缺勤让安排会议变得异常困难；8月的欧洲也是类似的情况。

这种成群缺席的模式在企业内部或多或少都会出现。二把手们更有可能得到主持大局的机会；大家都去度假的时候，就不太可能搞出大动作。没有孩子的员工因为要替休假的同事顶班而不爽；休假的同事又因为自己有孩子而不爽。

一些证据表明，人们度假回来后会感觉更有创造力——但你需要尽快安排头脑风暴活动。歌德大学（Goethe University）的贾娜·库内尔（Jana Kühnel）和曼海姆大学（Universität Mannheim）的萨宾·索恩塔格（Sabine Sonnentag）在2010年发表的论文中指出，休假的好处在一个月内就会消失。

公司日历上也标注着定期的活动。有些是对外界公开的：比如年度股东大会和股东信。还有一些是内部活动。在许多公司，年度预算编制是一个举全公司之力的过程，越来越多的人花越来越多的时间来争论一些肯定会错掉的数字。这本身几乎就是一个季节。根据基准测试机构APQC在疫情前的估计，公司在预算编制上花费的中位数时间为30天左右；很多公司花的时间还要长得多。

薪酬调整也是季节性事件。随着员工得知自己的加薪和奖金，所有职场里都会掀起失望和喜悦的涟漪。在有些地方，这更像是一场海啸。华尔街的奖金发放正在进行，此时银行家将会得知他们前一年工作的回报，而在此之前，内部争吵和流言蜚语早已持续了数月之久。发放奖金的实际日期也很重要——奖金落袋为安之后，员工就更有可能跳槽。

公司季节性还有其他形式。办公室圣诞晚会预示着公司活动将再次逐渐减少。一些公司在夏季缩短了每周的工作时间。每年的日历上都穿插着各种销售会议和领导务虚会。关于公司内部季节性影响的研究并不多，但它们

都有自己的年度律动是个不争的事实。■

The end of the social network

As Facebook turns 20, social apps are being transformed

FACEBOOK MAY be turning 20 on February 4th, but it is just as much of a magnet for controversy and cash today as when it was a brash, break-everything teenager. On January 31st Mark Zuckerberg, the social network's founder, was harangued by American senators over the spread of harmful material. The next day, as we published this, he was poised to announce another set of glittering results for Meta, Facebook's parent company, which is now valued at $1trn. Yet even as social media reliably draw vast amounts of attention from addicts and critics alike, they are undergoing a profound but little-noticed transformation.

The weird magic of online social networks was to combine personal interactions with mass communication. Now this amalgam is splitting in two again. Status updates from friends have given way to videos from strangers that resemble a hyperactive TV. Public posting is increasingly migrating to closed groups, rather like email. What Mr Zuckerberg calls the digital "town square" is being rebuilt—and posing problems.

This matters, because social media are how people experience the internet. Facebook itself counts more than 3bn users. Social apps take up nearly half of mobile screen time, which in turn consumes more than a quarter of waking hours. They gobble up 40% more time than they did in 2020, as the world has gone online. As well as being fun, social media are the crucible of online debate and a catapult for political campaigns. In a year when half the world heads to the polls, politicians from Donald Trump to Narendra Modi will be busy online.

The striking feature of the new social media is that they are no longer very

social. Inspired by TikTok, apps like Facebook increasingly serve a diet of clips selected by artificial intelligence according to a user's viewing behaviour, not their social connections. Meanwhile, people are posting less. The share of Americans who say they enjoy documenting their life online has fallen from 40% to 28% since 2020. Debate is moving to closed platforms, such as WhatsApp and Telegram.

The lights have gone out in the town square. Social media have always been opaque, since every feed is different. But TikTok, a Chinese-owned video phenomenon, is a black box to researchers. Twitter, rebranded as X, has published some of its code but tightened access to data about which tweets are seen. Private messaging groups are often fully encrypted.

Some of the consequences of this are welcome. Political campaigners say they have to tone down their messages to win over private groups. A provocative post that attracts "likes" in the X bear pit may alienate the school parents' WhatsApp group. Posts on messaging apps are ordered chronologically, not by an engagement-maximising algorithm, reducing the incentive to sensationalise. In particular, closed groups may be better for the mental health of teenagers, who struggled when their private lives were dissected in public.

In the hyperactive half of social media, behaviour-based algorithms will bring you posts from beyond your community. Social networks can still act as "echo chambers" of self-reinforcing material. But a feed that takes content from anywhere at least has the potential to spread the best ideas farthest.

Yet this new world of social-media brings its own problems. Messaging apps are largely unmoderated. For small groups, that is good: platforms should no more police direct messages than phone companies should monitor calls. In dictatorships encrypted chats save lives. But Telegram's

groups of 200,000 are more like unregulated broadcasts than conversations. Politicians in India have used WhatsApp to spread lies that would surely have been removed from an open network like Facebook.

As people move to closed groups, the open networks left behind are less useful because of the decline in public posting. During the covid-19 pandemic, scientists and doctors contributed to an online debate which contained real insight as well as misinformation. Open-source intelligence flowed when Russia invaded Ukraine. Today those conversations are disappearing or moving to closed channels, slowing the spread of ideas. The people still weighing in on the public networks, meanwhile, are disproportionately male and likely to describe themselves as very left- or right-wing: bores, in plain English.

What's more, the open-network algorithms driven by users' behaviour seem primed to spread the spiciest videos. For something to go viral on a social network, people had to choose to share it. Now they endorse it simply by watching, as the algorithm rewards content that attracts the most engagement. Deliberate curation has been replaced by a system that taps straight into the id. Provocateurs like Mr Trump or Nayib Bukele, the favourite in this week's election in El Salvador, stand to benefit, as do misinformation merchants. Platforms say they are better at weeding out fakes. Taylor Swift, the latest high-profile victim of a deepfake, might disagree.

More urgent even than the rise of fake news is a lack of the real sort. Mr Zuckerberg once said he wanted Facebook to be like a personalised newspaper. But since the network's pivot to entertainment, news makes up only 3% of what people see on it. Across social media only 19% of adults share news stories weekly, down from 26% in 2018. Publications like BuzzFeed News, which relied on social distribution, have perished. That is their lookout (and ours). But it is everyone's problem when nearly half of

young people say that, just as the platforms decide news is no longer interesting, social media are their main source of news.

| *WhatsApp and WhatsDown*

Some people argue that social networks' defects can be fixed by better governance, clever coding or a different business model. Such things can help. But the problems raised by the new generation of apps suggest that social media's flaws are also the result of the trade-offs built into human communication. When platforms swing back towards private groups, they inevitably have less oversight. When people escape their echo chambers, they may well face more extreme content. When users embrace harmless entertainment, they see less news. As social networks wither, platform operators and users should devote less time to the old battles and more to grappling with the new. ■

社交网络的终结

在Facebook年满20之际，社交应用正在转型

虽说Facebook在2月4日这天年满20了，但它如今吸引争议和金钱的能力丝毫不亚于自命不凡、肆无忌惮的少年时期。1月31日，Facebook的创始人扎克伯格因该平台传播有害信息的问题被美国参议员围攻。翌日，也就是本文发表之时，他会宣布Facebook母公司Meta的又一轮辉煌业绩，该公司目前的市值已达1万亿美元。然而就在社交媒体一如既往地吸引成瘾者和批评者的目光的同时，它们也在经历一场深刻却鲜有人注意的变革。

在线社交网络的奇特魔力在于将人际互动与大众传播结合起来。现在这个结合体再次一分为二。陌生人的视频就像一档极度活跃的电视节目，已经取代了朋友们的状态更新。公开发帖越来越多地转移到封闭的群组，就像电子邮件一样。扎克伯格所称的数字"城市广场"正在重建，同时也带来了问题。

这很重要，因为人们是通过社交媒体来体验互联网的。Facebook本身就拥有30多亿用户。社交应用占据了近一半的手机屏幕时间，而人们清醒时有超过四分之一的时间在看手机。整个世界都已经走上网络，与2020年相比，社交应用所吞噬的时间增加了40%。除了有趣之外，社交媒体还是在线讨论的大熔炉和政治竞选的弹射器。今年世界半数人口都将参加选举投票，从特朗普到莫迪等一众政客都会忙着在网上拉票。

新社交媒体的显著特征是它们不再具有强烈的社交性。受TikTok的启发，Facebook等应用也越来越多地由人工智能根据用户的观看行为而非社交关系挑选短视频推给他们。与此同时，人们发帖也越来越少了。自2020年以来，称自己喜欢在网上记录生活的美国人比例从40%降至28%。论辩的场所正在转向封闭平台，例如WhatsApp和Telegram。

城市广场的灯光已经熄灭。社交媒体向来是不透明的，因为每条信息流都

不一样。但对研究人员来说，TikTok这个来自中国的现象级视频应用就是个黑箱。更名为X的推特公布了部分代码，但收紧了关于展示哪些推文的数据的访问权限。私人消息群组常常是完全加密的。

这些变化的某些结果是值得欢迎的。政治竞选人表示，他们必须缓和自己的调门来赢得私人群组的支持。一条挑衅性帖子可以在喧嚣的X上赢得"点赞"，却可能会遭到WhatsApp学校家长群的排斥。即时通讯应用上的发言是按时间顺序排列的，而不是依据要让参与度最大化的算法，这就减少了炒作的动力。特别值得一提的是，封闭群组可能更有利于青少年的心理健康，因为他们极不适应自己的私生活被公开解读。

在社交媒体中超级活跃的那一半区域，基于行为的算法将让你看到自己的交际圈子以外的帖子。社交网络仍然可以成为观点自我强化的"回音室"。但是，能够从任何地方获取内容的信息流至少有可能将最好的想法传播得最远。

然而，这个社交媒体的新世界也带来了自己的问题。即时通讯应用基本上是不受监督的。这对于小群组来说是件好事：正如电话公司不该监督通话一样，平台也不该监督私聊信息。在独裁国家，加密聊天可以拯救生命。但Telegram的20万个群组更像是不受监管的广播，而不是对话。印度政客曾使用WhatsApp传播谎言，而这种谎言在Facebook这样的开放网络上肯定会被移除。

随着人们转向封闭群组，公开发帖减少了，被抛下的开放网络的用处也就不如从前。在新冠疫情期间，科学家和医生参与了在线辩论，其中既有真知灼见，也有不实信息。俄罗斯入侵乌克兰时，公开网络上的情报信息源源不断。如今这些对话要么消失，要么转到封闭渠道，思想传播因而减缓。与此同时，仍然在公共网络上发表意见的人当中男性占比过高，并且多数自称很左或很右：说白了就是话痨。

此外，由用户行为驱动的开放网络算法似乎特别适合传播劲爆的视频。以前一段内容要在社交网络上走红，必须靠人们主动分享。现在，他们只需

要观看就能提供支持，因为算法会奖励那些观众沉浸度最高的内容。以前还需要精心策划，而现在的系统会直接利用用户的身份。特朗普或纳伊布·布克尔（Nayib Bukele，萨尔瓦多大选的获胜者）等煽动者将从中受益，散布谣言的信息贩子也将获利。各平台表示，它们已经在剔除虚假信息上取得了进展。最近成为AI深度造假受害者的名人泰勒·斯威夫特（Taylor Swift）对此恐怕不敢苟同。

与假新闻满天飞相比，更紧迫的问题是真新闻的匮乏。扎克伯格曾表示，他希望Facebook能像一份个性化的报纸。但自从这一社交网络转向娱乐以来，现在新闻只占人们看到内容的3%。在所有社交媒体中，只有19%的成年人每周分享新闻报道，低于2018年的26%。BuzzFeed News等依赖社交传播的新闻媒体已经销声匿迹。那是它们（也是我们）面对的问题。然而，随着平台认为新闻不再是有趣的内容，而同时现在近一半的年轻人表示社交媒体是他们的主要新闻来源，这就成为所有人的问题了。

社交网络的兴与衰

有人认为，社交网络的这些弊端可以通过更好的治理、巧妙的编程或换一种商业模式来修补。这些或许都有一定帮助。但新一代应用所引发的问题表明，社交媒体的缺陷也是人类交流中固有的取舍的结果。当交流从平台转回私人群组时，它们受到的监督不可避免会减少。当人们逃离自己的回音室时，他们很可能会面对更极端的内容。当用户沉溺于无害的娱乐内容时，他们看的新闻就会减少。随着社交网络的衰落，平台运营商和用户不该再纠结于旧的问题，而是应该勇于应对新的问题。■

AI could accelerate scientific fraud as well as progress

Hallucinations, deepfakes and simple nonsense: there are plenty of risks

IN A MEETING room at the Royal Society in London, several dozen graduate students were recently tasked with outwitting a large language model (LLM), a type of AI designed to hold useful conversations. LLMs are often programmed with guardrails designed to stop them giving replies deemed harmful: instructions on making Semtex in a bathtub, say, or the confident assertion of "facts" that are not actually true.

The aim of the session, organised by the Royal Society in partnership with Humane Intelligence, an American non-profit, was to break those guardrails. Some results were merely daft: one participant got the chatbot to claim ducks could be used as indicators of air quality (apparently, they readily absorb lead). Another prompted it to claim health authorities back lavender oil for treating long covid. (They do not.) But the most successful efforts were those that prompted the machine to produce the titles, publication dates and host journals of non-existent academic articles. "It's one of the easiest challenges we've set," said Jutta Williams of Humane Intelligence.

AI has the potential to be a big boon to science. Optimists talk of machines producing readable summaries of complicated areas of research; tirelessly analysing oceans of data to suggest new drugs or exotic materials and even, one day, coming up with hypotheses of their own. But AI comes with downsides, too. It can make it easier for scientists to game the system, or even commit outright fraud. And the models themselves are subject to subtle biases.

Start with the simplest problem: academic misconduct. Some journals

allow researchers to use LLMs to help write papers, provided they say as much. But not everybody is willing to admit to it. Sometimes, the fact that LLMs have been used is obvious. Guillaume Cabanac, a computer scientist at the University of Toulouse, has uncovered dozens of papers that contain phrases such as "regenerate response"—the text of a button in some versions of ChatGPT that commands the program to rewrite its most recent answer, presumably copied into the manuscript by mistake.

The scale of the problem is impossible to know. But indirect measures can shed some light. In 2022, when LLMs were available only to those in the know, the number of research-integrity cases investigated by Taylor and Francis, a big publisher of scientific papers, rose from around 80 in 2021 to about 2,900. Early figures from 2023 suggest the number was on course to double. One possible telltale is odd synonyms: "haze figuring" as another way to say "cloud computing", for example, or "counterfeit consciousness" instead of "AI".

Even honest researchers could find themselves dealing with data that has been polluted by AI. Last year Robert West and his students at the Swiss Federal Institute of Technology enlisted remote workers via Mechanical Turk, a website which allows users to list odd jobs, to summarise long stretches of text. In a paper published in June, albeit one that has not yet been peer-reviewed, the team revealed that over a third of all the responses they received had been produced with the help of chatbots.

Dr West's team was able to compare the responses they received with another set of data that had been generated entirely by humans, leaving them well-placed to detect the deception. Not all scientists who use Mechanical Turk will be so fortunate. Many disciplines, particularly in the social sciences, rely on similar platforms to find respondents willing to answer questionnaires. The quality of their research seems unlikely to improve if many of the responses come from machines rather than real

people. Dr West is now planning to apply similar scrutiny to other crowdsourcing platforms he prefers not to name.

It is not just text that can be doctored. Between 2016 and 2020, Elisabeth Bik, a microbiologist at Stanford University, and an authority on dodgy images in scientific papers, identified dozens of papers containing images that, despite coming from different labs, seemed to have identical features. Over a thousand other papers have since been identified, by Dr Bik and others. Dr Bik's best guess is that the images were produced by AI, and created deliberately to support a paper's conclusions.

For now, there is no way to reliably identify machine-generated content, whether it is images or words. In a paper published last year Rahul Kumar, a researcher at Brock University, in Canada, found that academics could correctly spot only around a quarter of computer-generated text. AI firms have tried embedding "watermarks", but these have proved easy to spoof. "We might now be at the phase where we no longer can distinguish real from fake photos," says Dr Bik.

Producing dodgy papers is not the only problem. There may be subtler issues with AI models, especially if they are used in the process of scientific discovery itself. Much of the data used to train them, for instance, will by necessity be somewhat old. That risks leaving models stuck behind the cutting edge in fast-moving fields.

Another problem arises when AI models are trained on AI-generated data. Training a machine on synthetic MRI scans, for example, can get around issues of patient confidentiality. But sometimes such data can be used unintentionally. LLMs are trained on text scraped from the internet. As they churn out more such text, the risk of LLMs inhaling their own outputs grows.

That can cause "model collapse". In 2023 Ilia Shumailov, a computer scientist at the University of Oxford, co-authored a paper (yet to be peer-reviewed) in which a model was fed handwritten digits and asked to generate digits of its own, which were fed back to it in turn. After a few cycles, the computer's numbers became more or less illegible. After 20 iterations, it could produce only rough circles or blurry lines. Models trained on their own results, says Dr Shumailov, produce outputs that are significantly less rich and varied than their training data.

Some worry that computer-generated insights might come from models whose inner workings are not understood. Machine-learning systems are "black boxes" that are hard for humans to disassemble. Unexplainable models are not useless, says David Leslie at the Alan Turing Institute, an AI-research outfit in London, but their outputs will need rigorous testing in the real world. That is perhaps less unnerving than it sounds. Checking models against reality is what science is supposed to be about, after all. Since no one fully understands how the human body works, for instance, new drugs must be tested in clinical trials to figure out whether they work.

For now, at least, questions outnumber answers. What is certain is that many of the perverse incentives currently prevalent in science are ripe for exploitation. The emphasis on assessing academic performance by how many papers a researcher can publish, for example, acts as a powerful incentive for fraud at worst, and for gaming the system at best. The threats that machines pose to the scientific method are, at the end of the day, the same ones posed by humans. AI could accelerate the production of fraud and nonsense just as much as it accelerates good science. As the Royal Society has it, nullius in verba: take nobody's word for it. No thing's, either. ■

AI可能会在推动科学进步的同时助长学术不端

幻觉、深度造假和无稽之谈：其中风险多多【深度】

最近，在伦敦的英国皇家学会（Royal Society）的一个会议室里，几十名研究生被安排与一个大语言模型（LLM）斗智。LLM是一种用于进行有用对话的AI，通常会在编程时给它们设置护栏，以防它们给出被认为有害的回答，比如教人在浴缸里制造塞姆汀塑料炸药（Semtex），或者言之凿凿地给出实际上并不真实的"事实"。

此次活动是皇家学会与美国非营利组织"人道智能"（Humane Intelligence）联合组织的，目的是要冲破这些护栏。有些结果纯属搞笑。在一名研究生的引导下，聊天机器人声称鸭子可以用作空气质量的指标（据说鸭子很能吸收铅）。在另一名研究生的提示下，聊天机器人声称多国卫生部门支持使用薰衣草油治疗长新冠（实际上并没有这回事）。但最成功的一例是通过提示让机器生成了根本不存在的学术文章的标题、发表日期和期刊。"这是我们设定的最容易的挑战之一。"人道智能的朱塔·威廉姆斯（Jutta Williams）说道。

AI有可能成为科学发展的一大利好。乐观主义者大谈机器如何对复杂研究领域的著述生成易懂的摘要，不知疲倦地分析海量数据以提出新药或新材料的建议，甚至有朝一日能够自己提出假设。但AI也有不利的一面。它有可能让科学家更容易钻系统的空子，甚至彻头彻尾地搞学术欺诈。而且这些模型本身也受到不易察觉的偏见的影响。

先看看最简单的问题：学术不端。一些期刊允许研究人员利用LLM来辅助撰写论文，前提是他们必须对此作出声明。但并不是每个人都愿意承认自己有这么做。有时一望便知作者使用了LLM。图卢兹大学（University of Toulouse）的计算机科学家纪尧姆·卡巴纳克（Guillaume Cabanac）发现数十篇论文中包含诸如"重新生成回复"（regenerate response）之类的短语，这是ChatGPT某些版本中按钮上的文字，点击这个按钮可以命令该

程序重新编写其最近一次的回答，作者应该是不小心把它复制到了文本中。

无法确定这类问题有多普遍。但间接指示物可以透露一二。大型科学论文出版集团泰勒弗朗西斯（Taylor and Francis）调查的学术诚信案件数量从2021年的约80起增加到2022年的约2900起，而在2022年还只有内行人能够用上LLM。2023年早些时候的数据显示这个数字将要翻倍。一个可能的线索是奇怪的同义词：例如，把"云计算"也称作"霾计算"（haze figuring），或者用"伪意识"（counterfeit consciousness）代替"AI"。

即使是诚信的研究人员也可能遇到被AI污染的数据。去年，瑞士联邦理工学院（Swiss Federal Institute of Technology）的罗伯特·韦斯特（Robert West）和他的学生们通过Mechanical Turk（一个用户可以发布零工机会的网站）雇用了一些人远程工作，为长段文字撰写摘要。在一篇于6月发表的论文中（尚未经过同行评审），该团队公布的数据显示，他们收到的所有摘要中超过三分之一是在聊天机器人的帮助下生成的。

韦斯特的团队得以将收到的摘要与另一组完全由人工生成的摘要做比较，轻而易举地发现了这种造假行为。并非所有使用Mechanical Turk的科学家都能如此幸运。许多学科依赖此类平台寻找愿意回答问卷调查的受试者，特别是社会科学。如果许多答复来自机器而不是真实的人，他们的研究质量似乎不太可能提升。韦斯特现在计划对其他众包平台进行类似的检视，但他不愿透露平台的具体名称。

能造假的不仅是文本。斯坦福大学的微生物学家伊丽莎白·比克（Elisabeth Bik）是识别科学论文中的可疑图像方面的权威，她在2016年至2020年期间发现，有几十篇论文中的图像尽管来自不同的实验室，却带有相同的特点。比克和其他人随后又识别出一千多篇有问题的论文。比克猜测，最有可能的情况是这些作者是为了支持论文结论，有意借助AI生成了这些图像。

目前还没有识别计算机生成内容（无论是图像还是文字）的可靠方法。加

拿大布鲁克大学（Brock University）的研究员拉胡尔·库马尔（Rahul Kumar）在去年发表的一篇论文中发现，学术界只能正确识别出约四分之一的计算机生成文本。AI公司试图在生成内容上嵌入"水印"，但这些其实很容易绕过。比克说："我们现在可能已经到了无法区分照片真假的阶段。"

生成造假论文并不是唯一的问题。AI模型可能带有更不易觉察的问题，尤其是在把它们用到科学发现过程中时。例如，用于训练这些模型的许多数据不可避免地会有些过时。这可能导致模型在快速发展的领域中滞后于前沿。

用AI生成的数据训练AI模型带来了另一个问题。例如，训练机器识别合成磁共振成像扫描可以解决患者隐私问题。但有时这些数据可能会被随意使用。训练LLM的文本从互联网抓取。随着这些模型大量产生更多这样的文本，它们吸收自己的输出的可能性也增加了。

这可能会导致"模型崩溃"。2023年，牛津大学的计算机科学家伊利亚·舒迈洛夫（Ilia Shumailov）与他人合著了一篇论文（尚未经过同行评审），其中一个模型被输入手写数字，要求它识别后自己生成数字，然后再将它生成的数字输入模型。经过几轮循环后，计算机生成的数字已变得差不多无法辨认。20轮循环之后，它只能生成粗略的圆圈或模糊的线条。舒迈洛夫表示，基于自产自用的结果进行训练的模型所生成的输出在丰富性和多样性上明显不如其训练数据。

有人担心，计算机生成的内容可能来自于内部运作方式未被理解的模型。机器学习系统是难以被人类解构的"黑盒子"。伦敦的AI研究机构艾伦·图灵研究所（Alan Turing Institute）的大卫·莱斯利（David Leslie）表示，无法解释的模型并非无用，但它们的输出将需要在现实世界中经过严格的测试。这或许没有听起来那么令人不安。毕竟，在现实中验证模型正是科学研究的目标。例如，鉴于没有人完全理解人体的工作机制，新药必须通过临床试验来确定是否有效。

至少在目前，问题比答案多。已经可以肯定的是，当前科学界普遍存在的许多不合理的激励机制都很容易被利用。例如，将评估学术成就与研究人员发表的论文数量挂钩，在最坏的情况下会刺激造假，在最好的情况下也会助长操纵系统。归根到底，计算机对科研方法构成的威胁与人类构成的威胁是相同的。AI可能会加速造假和无稽之谈的生成，正如它加速了有益的科学进步一样。英国皇家学会的会训是"不人云亦云"（Nullius in verba）。同样，我们也不应该物云亦云。■

The false promise of friendshoring

America, China and Europe appear to be trading less with their geopolitical rivals

EACH YEAR the 193 member states of the United Nations General Assembly vote on dozens of resolutions, earnestly setting the world to rights. In December, for example, they voted in favour of reducing space threats, eradicating rural poverty and combating dust storms, among other things. The votes count for little. The assembly's resolutions are not legally binding. Its budgetary powers are small. And it has as many military divisions as the pope.

But for scholars of international relations, these votes have long provided a handy, quantitative measure of the geopolitical alignments between countries. More recently, economists have also turned to them. Owing to the trade war between America and China, Russia's invasion of Ukraine, the conflict in Gaza and recent blockades in the Red Sea, geopolitics has become impossible for dismal scientists to ignore. Although their models of trade and investment typically give pride of place to the economic size of countries and the geographic distance between them, they are now considering "geopolitical distance" as well.

The latest such study was published last month by the McKinsey Global Institute, a think-tank attached to the consultancy of the same name. By analysing countries' votes on 201 of the higher-profile resolutions between 2005 and 2022, McKinsey was able to plot countries' geopolitical stances on a scale from zero to ten. America stands at one end of the spectrum, labelled zero. At the other end is Iran at ten. In between are countries like Britain at 0.3, Brazil at 5 and China at 9.6.

The authors use this measure to provide a new perspective on each

country's trade. As well as measuring the average geographical distance that a country's trade must travel, they also calculate the geopolitical distance it must traverse. In a hypothetical world in which half of Iran's trade was with America and half with Brazil, its trade would cover a geopolitical distance of 7.5.

Their results are illuminating. European countries trade mostly with one another. As a consequence, their trade for the most part flows to their friends and neighbours. Things are rather less comfortable for Australia, however. It must trade with countries that are both geopolitically and geographically remote.

America is somewhere in between. Thanks in part to its continental size, it has few prosperous neighbours. Less than 5% of global GDP is generated by countries within 5,000km of America, as McKinsey points out. Its trade travels almost 7,200km on average, compared with 6,600km for China's trade and a global average of less than 5,200km. Yet in the diplomatic realm, the world is not so far away. The geopolitical distance America's trade must cover is only a little above the global average. It is far shorter than the diplomatic distances bridged by China. Indeed, China's trade covers a greater geopolitical gap than that of any of the other 150 countries in McKinsey's data, bar Nicaragua, which resents America, but is doomed to do business with it.

The study finds some early evidence of "friendshoring". Since 2017, America has managed to shorten the geopolitical distance covered by its trade by 10%, on McKinsey's scale. It has, for example, sharply curtailed imports from China, although some of the goods it now buys from other countries, such as Vietnam, are full of Chinese parts and components. China has also reduced the geopolitical distance of its trade by 4%, although that has required it to trade with countries farther afield geographically.

Yet the report identifies several limits to this trend. Much of the trade countries carry out with ideological rivals is trade of necessity: alternative suppliers are not easy to find. McKinsey looks at what it calls "concentrated" products, where three or fewer countries account for the lion's share of global exports. This kind of product accounts for a disproportionate share of the trade that spans long geopolitical distances. Australia, for example, dominates exports of iron ore to China. Likewise China dominates exports of batteries made from neodymium, a "rare-earth" metal.

The attempt to reduce geopolitical dangers may also increase other supply-chain risks. Friendshoring will give countries a narrower range of trading partners, obliging them to put their eggs in fewer baskets. McKinsey calculates that if tariffs and other barriers cut the geopolitical distance of global trade by about a quarter, the concentration of imports would increase by 13% on average.

For countries in the middle of the geopolitical spectrum, friendshoring has little appeal. They cannot afford to limit their trade to other fence-sitters, because their combined economic clout is still too small. Countries that score between 2.5 and 7.5 on McKinsey's scale—a list that includes rising economies such as Brazil, India and Mexico—account for just one-fifth of global trade. To avoid falling between two stools, they must seek to trade across the geopolitical spectrum, just as they do now.

Friendshoring has limits for China as well. There are simply not enough big economies in its geopolitical orbit to compensate for reduced trade with unfriendly Western trading partners. For China, then, friendshoring is more about replacing rivals and antagonists with more neutral parties among the non-aligned world, such as in Central Asia and the Middle East.

In studying how trade might contort itself along geopolitical lines, the McKinsey study assumes that the lines themselves remain fixed. But as the report freely admits, that might not be the case. The invasion of Ukraine and the conflict between Israel and Gaza is already causing new divisions and allegiances. It is conceivable that non-aligned countries might move closer to China politically, as China embraces them economically. Certainly, by spurning Chinese trade and investment, the West would give China added incentive to ingratiate itself with the rest of the world. After all, there are two ways to shorten the geopolitical distance of trade: trade more with friends or make more friends to trade with. ■

友岸外包的虚假承诺

美国、中国和欧洲似乎在减少与地缘对手的贸易

每年，联合国大会的193个成员国都会对数十项决议投票，热切地要让世界走在正确的方向上。例如在去年12月，它们投票支持减少太空威胁、根除农村贫困和对抗沙尘暴等议题。但这些投票作用不大。联大的决议不具有法律约束力，它的预算权力很小，手里的军事力量也就与教皇相当。

但对于国际关系学者来说，这些投票长期以来提供了衡量国家间地缘关系的一项便捷的定量指标。更近些时候，经济学家们也开始关注这些投票。由于美中贸易战、俄罗斯入侵乌克兰、加沙冲突以及近期红海航路被封锁，地缘态势已经成为经济学家无法忽视的问题。尽管他们的贸易和投资模型通常把国家的经济规模和彼此间的地理距离放在首位，他们现在也在考虑"地缘距离"的因素了。

最新一项此类研究在1月由咨询公司麦肯锡旗下智库麦肯锡全球研究院发布。通过分析各国在2005年至2022年间对201项有较高关注度的决议的投票情况，麦肯锡得以在一个从零到十的刻度表上标记出国家的地缘立场。美国位于刻度的一端，标记为零。另一端是伊朗，标记为十。中间则有譬如英国（0.3）、巴西（5）和中国（9.6）等国。

研究人员使用这个刻度表为各国的贸易提供了一个新视角。除了测量一个国家的贸易必须经过的平均地理距离外，他们还计算了它必须跨越的地缘距离。假想一下，如果伊朗一半的贸易是与美国进行，另一半是与巴西，那么它的贸易将跨越7.5的地缘距离。

他们的研究结果很有启发性。欧洲国家主要是在彼此之间贸易，因此它们的贸易大多流向友好邻国。然而，对于澳大利亚来说情况就不太舒适了，它必须与地缘和地理距离都遥远的国家做贸易。

美国则介于两者之间。一定程度上由于其国土占据整个大洲的很大部分，美国并没有太多富裕的邻国。麦肯锡指出，美国周围5000公里范围内的国家只产出了全球GDP的5%不到。它的平均贸易距离接近7200公里。相比之下，中国的平均贸易距离为6600公里，而全球平均水平不到5200公里。然而在外交领域，世界离美国就没那么遥远了。美国贸易必须跨越的地缘距离仅略高于全球平均。这比中国所跨越的外交距离要短得多。实际上，中国的贸易要跨越的地缘距离超过了麦肯锡数据中的其他150个国家，除了尼加拉瓜（该国怨憎美国，但又注定要与之做生意）。

研究发现了"友岸外包"的一些早期迹象。自2017年以来，美国已经在麦肯锡的刻度表上将其贸易的地缘距离缩短了10%。例如，它大幅减少了从中国的进口，尽管它现在从越南等其他国家购买的一些商品中充斥着中国生产的零部件。中国也将其贸易的地缘距离缩短了4%，尽管这需要它与地理上更遥远的国家进行贸易。

然而，报告指出这个趋势的几方面有限性。与意识形态对手进行的贸易大部分都是必要的贸易——因为难以找到替代的供应商。麦肯锡研究了它称之为"集中型"的产品，即被三个或更少的国家占据了全球出口额大头的产品。在长地缘距离的贸易中，这类产品占据了尤其高的比例。例如，澳大利亚主导了对中国出口铁矿石。同样，中国主导了用钕这种"稀土"金属制造的电池的出口。

尝试减少地缘风险也可能增加其他供应链风险。友岸外包将使各国的贸易伙伴范围变窄，迫使他们把鸡蛋放在更少的篮子里。麦肯锡计算，如果关税和其他壁垒将全球贸易的地缘距离减少约四分之一，那么进口的集中度将平均增加13%。

对于处于地缘光谱中间地带的国家来说，友岸外包的吸引力不大。它们不能仅仅和其他居间观望的国家做贸易，因为大家加总的经济实力仍然太小。在麦肯锡的刻度表上处于2.5到7.5之间的国家——包括巴西、印度和墨西哥等崛起中的经济体——只占全球贸易的五分之一。为免落个两头不着，它们必须寻求跨越地缘光谱做贸易，就像它们现在所做的那样。

友岸外包对于中国来说也有局限。在它的地缘轨道上，没有足够多的大型经济体来弥补与不友好的西方贸易伙伴减少的贸易。因此中国的友岸外包更多是用更中立的不结盟国家，如中亚和中东，来替换对手和敌对者。

打盟友牌

在研究贸易如何沿着地缘路线扭曲自身时，麦肯锡的研究假设这些路线本身是不变的。但正如报告坦率承认的，实际情况可能并非如此。俄罗斯入侵乌克兰和以色列与加沙的冲突已经导致了新的分裂和联盟。可以想象，随着中国在经济上拥抱不结盟国家，这些国家可能在政治上向中国靠拢。当然，西方抛弃中国的贸易和投资会给中国更多动力去取悦世界其他国家。毕竟，缩短贸易的地缘距离的方式有两种：与朋友做更多贸易，或者结交更多朋友做贸易。■

Apple's Vision Pro headset ushers in a new era of personal technology

Tech firms are racing to build the gadget that supplants the smartphone

APPLE FANS have eagerly awaited February 2nd to get their hands on the tech giant's latest gadget, a new augmented-reality headset called the Vision Pro. Some early reviewers complained that it caused headaches and had a two-hour battery life. Many potential buyers will be put off by the price tag of $3,499. Still, perhaps 200,000 have been pre-ordered, about 40% of what Apple had reportedly expected to sell this year. Tim Cook, Apple's boss, has described trying the Vision Pro as an "aha moment". "You only have a few of those in your lifetime," he added.

Aha or not, the Vision Pro is part of a trend. In September techies got excited about a new pair of smart glasses made by Meta, Facebook's parent company, and Ray-Ban, an eyewear brand. The spectacles are controlled by voice and can play music, send texts and film everything you see. Two months later Humane, a startup founded by former Apple executives, launched the Pin, a brooch with which users interact by talking and gesticulating. In January the r1, a voice-controlled gizmo half the size of a smartphone, enthralled attendees at the Consumer Electronics Show in Las Vegas. Its maker, a startup called Rabbit, has sold nearly 100,000.

What all these devices have in common is that they mostly do away with screens, keyboards and mice. Thanks to "generative" artificial intelligence (AI), computers are getting good at listening to, reading and watching stuff—and understanding it. That means hardware can be controlled by voice, gesture or image rather than touch. AI is thus enabling new "form factors"—tech-speak for gadgets in new shapes and sizes, just as the iPhone looked different from older handsets.

Silicon Valley's elite are cheering on the potential shift. They believe AI could create a new market for consumer hardware, replacing the smartphone as everyone's essential device. Sam Altman, boss of OpenAI, the startup behind ChatGPT, is reportedly in talks to start a firm with Jony Ive, former head of design at Apple, to make a gadget purpose-built for AI. Satya Nadella, chief executive of Microsoft, an AI-ambitious tech titan, recently said that "once you have a new interface...new hardware is also possible."

One reason for all the excitement about new gadgets is that the old ones are looking unexciting. Last year 1.2bn smartphones were sold worldwide, down by 3% from the previous year and the lowest level for a decade, according to IDC, a research firm. PCs did even worse, declining by 15% in 2023 to 242m units. Cash-strapped consumers are opting for cheaper alternatives, such as second-hand devices, or holding on to their current ones for longer.

The hope is that they may be persuaded to fork out for all-new gadgets because they offer something that old ones do not. AI could, for instance, make using devices more seamless and more personal. Users can tell or gesture to the r1 to hail a ride, order food or play music without the need to toggle between apps. It also learns from users' previous actions. Until now people had to adapt to software, says Vinod Khosla, a veteran venture capitalist and early backer of Rabbit. In the r1, "the AI adapts to you."

New gadgets are also less finicky to develop and manufacture. Lior Susan of Eclipse, a venture-capital (VC) firm, says that ten years ago building a high-tech widget required hundreds of staff. Today he can do the same thing with about ten. Every step of the manufacturing process has become easier. Initial versions can be mocked up in design software. Rather than buying an industrial machine to make parts for a prototype, they can be ordered from 3D-printing firms like Shapeways. Sensors, batteries and chips can be

bought off the shelf. Contract manufacturers, such as Foxconn, no longer insist on working only for big clients like Apple. Some offer dedicated services for hardware startups.

The resulting crop of new AI-powered devices falls into two broad categories. The first is headsets for augmented or virtual reality (VR). So far they have been most popular among gaming enthusiasts. Sales of VR headsets hit around 10m units in 2020 following the release of Meta's Quest 2, estimates George Jijiashvili of Omdia, a research firm. He thinks that the Vision Pro will breathe new life into the industry by making VR appealing to non-gamers (see chart). Promotional videos depict people using the Vision Pro to watch films, work or talk to friends.

The second category consists of subtler gizmos. Some 540m "wearables" worth $68bn were shipped last year, according to IDC. Many already incorporate AI in one way or another. They include earphones (which account for 63% of the units sold), smartwatches (another 30%), wristbands such as the Whoop, a fitness tracker, and smart glasses, like Meta's Ray-Bans (which together make up most of the remainder). Humane's Pin and AI pendants made by two startups, MyTab AI and Rewind AI, are the latest additions to this group.

All these devices are nifty. Whether they are nifty enough to dislodge the smartphone and become the next big platform is another matter. For that to happen, consumers must take to them. This requires the things, first, to look good—which some failed early efforts, such as the dorky Google Glass specs, did not. The r1 owes its sleek retro feel to Rabbit's collaboration with Teenage Engineering, a Swedish design firm. Before its launch, the Pin appeared on a Paris catwalk at an event held by Coperni, a French fashion house. Meta's glasses are a hit in part because Ray-Ban knows what makes shades stylish.

Second, the new gadgets have to be useful in ways the old ones are not. Many hardware-makers are adding AI to existing devices. On January 31st Samsung started selling an AI smartphone that can do neat tricks such as summarising text-message threads. Microsoft's next generation of laptops and tablets will reportedly include specialist AI chips and a new keyboard button to summon "Copilot", its AI chatbot. Smart speakers, such as Amazon's Alexa and Google's Nest, and earphones, such as Apple's AirPods, are getting revamped with AI features. These including chatbots and, with AirPods, the ability to let through necessary sounds and turn down volume when the wearer is speaking.

To break through, the AI hardware will have to make life either much easier (for instance by booking a whole trip, flight, car and hotel included, with a single command) or much more marvellous (inspiring Mr Cook's "aha moment").

Users will also expect them to perform more than a couple of functions. That means lots of apps. Meta's latest VR headset, the Quest 3, offers 500 or so. The Vision Pro already boasts around 350 purpose-built apps, and can run the iPhone versions of most of the roughly 2m available in the App Store. Humane's Pin, which doubles as a phone, claims to be doing away with apps, instead offering a range of "AI-powered services" from providers such as OpenAI and Google. Rabbit's r1 piggybacks on smartphones' existing app universe, at least for the time being.

Third, although manufacturing things has got easier, managing supply chains remains the hardest part of running a hardware business, notes Shaun Maguire of Sequoia, another VC firm. Suppliers may take phone calls from smaller firms but some are still reluctant to give good prices to unproven newcomers with small orders.

None of the available AI devices overcomes all three challenges. Those that

look pretty, like the r1, the Pin or Meta's Ray-Bans, seem to be peripherals more akin to AirPods than the iPhone. Independently useful ones like the Vision Pro or the Quest are dorkier than Google Glass, and much clunkier. In addition, developing apps for Apple's headset is expensive, which is putting off developers, including some video-game studios, Netflix, Spotify and YouTube (which also happen to compete with Apple's own video and music-streaming services). Production problems afflict just about everyone. Jesse Lyu, founder of Rabbit, says that it took his product becoming an overnight sensation for him to gain a bit more bargaining power over his suppliers. Even Apple, the master of supply chains, reportedly had to scale back initial plans to ship 1m Vision Pros this year because of the complex manufacturing involved.

If some gadget-makers clear all three hurdles, they may stumble on another: keeping up with the breathtaking pace of AI advances. Apple took seven years to develop the Vision Pro, aeons in AI time. Even the next generation of Rabbit's device, which Mr Khosla says will be ready as soon as this summer, may be outmoded by the time it gets into users' hands. One of today's AI gadgets may one day dethrone the smartphone. More likely, the winning form factor has yet to take shape. ■

苹果的Vision Pro头显开启个人科技产品新时代

科技公司竞相制造取代智能手机的小设备【深度】

科技巨头苹果公司于2月2日推出最新产品——一款名为Vision Pro的新型增强现实头显。粉丝们翘首以待，跃跃欲试。一些先期评测者抱怨这款头显会引发头痛，而且电池续航时间只有两小时。许多有意向的买家也会因其3499美元的标价而却步。不过Vision Pro可能已经预售出20万台，约占传言中苹果预期年销量的40%。苹果老板库克形容试用Vision Pro是个让人惊艳的时刻。"这样的感觉一生中也就只有几次。"

不管是否如此惊艳，Vision Pro的确是潮流的一部分。去年9月，Facebook母公司Meta联合眼镜品牌雷朋推出了一副全新智能眼镜，让科技迷兴奋不已。这款眼镜由语音控制，可以播放音乐，发送信息，还可以将你目光所及都摄录下来。两个月后，由苹果公司前高管创办的公司Humane推出一款名为Pin的AI胸针，用户可以通过语音和手势与之互动。今年1月，在拉斯维加斯举行的国际消费电子展上，一款只有智能手机一半大小的声控电子设备r1让参会客商为之着迷。它的开发者、创业公司Rabbit已经卖出了近十万台设备。

这些设备的共同点是大多都摒弃了屏幕、键盘和鼠标。得益于"生成式"AI，计算设备越发擅长聆听、阅读和观看素材——并理解它们。这意味着硬件可以通过语音、手势或图像而非触摸来控制。AI就此促成新的"形式要素"（意指全新形态和尺寸的小型电子设备的行话）出现，正如iPhone看起来如此不同于它之前的手机一样。

硅谷精英们正为这可能发生的变革而欢呼。他们认为AI可以创造全新的消费硬件市场，取代智能手机成为又一个人人必备的电子产品。据称，ChatGPT背后的创业公司OpenAI的老板山姆·阿尔特曼（Sam Altman）正与曾任苹果设计主管的乔尼·艾维（Jony Ive）商谈成立新公司，打造一款专门运用AI的小设备。科技巨头微软想在AI领域大展拳脚，CEO纳德拉

最近表示："只要有了新接口……新硬件也就可能出现。"

人们如此热切期待新设备的原因之一是旧设备的市场已经显得乏味无趣。研究公司IDC的数据显示，去年全球共售出12亿台智能手机，比前一年下降了3%，是十年来的最低水平。个人电脑的情况更糟糕，2023年的销量下降了15%，至2.42亿台。手头拮据的消费者转向购买二手设备等更便宜的替代品，或者继续使用老设备。

业界希望，一旦全新的设备能提供旧设备所不具有的东西，消费者可能就会被说服而出手。比如说，AI能令使用设备的体验更方便流畅和个性化。用户可以用语音或手势示意r1打车、点餐或播放音乐，而无需在不同的应用之间切换。它还会从用户以往的操作中学习。资深风投家、Rabbit的早期投资者维诺德·科斯拉（Vinod Khosla）说，在此之前，人必须去适应软件，有了r1，那就是"AI来适应你"。

新产品的开发和制造也变得不那么繁杂棘手。风投公司Eclipse的利奥·苏珊（Lior Susan）表示，十年前制造一台高科技产品需要数百名员工，如今，同样的工作十个人左右就能完成。制造过程的每一步都已变得更容易。最初版本可以在设计软件里模拟成型。也不必购买工业机器来制造原型机的各个部件，而只要从Shapeways这样的3D打印公司订购即可。传感器、电池和芯片都可以买现成的。富士康等代工厂不再坚持只为苹果等大客户服务，有的会向硬件创业公司提供专属服务。

由此而来的新型AI设备可分为两大类。第一类是增强现实或虚拟现实（VR）头显。目前来看，最追捧这类产品的是游戏玩家。据研究公司Omdia的乔治·吉加什维利（George Jijiashvili）估计，在Meta推出Quest 2之后，VR头显的销量在2020年达到约1000万台。他认为Vision Pro能使非游戏玩家也被VR吸引，从而为该行业注入新的生机（见图表）。Vision Pro的宣传视频展现了人们使用该设备看电影、工作及与朋友聊天的场景。

第二类是相对不起眼的小设备。据IDC统计，去年"可穿戴设备"的出货量

约为5.4亿台，价值680亿美元。许多这些产品已经多多少少带有AI功能。按销量计算，其中63%为耳机，30%为智能手表，其余大部分为手环（如健身追踪器Whoop）和智能眼镜（如Meta与雷朋合作的那款智能墨镜）。Humane的Pin胸针和两家创业公司MyTab AI和Rewind AI打造的AI吊坠是该类设备的最新成员。

所有这些设备都很精巧，但是否足以取代智能手机成为下一个大平台则是另一回事了。这要有消费者买账才行。首先新设备要好看，而早期一些失败产品就没做到这一点，比如造型不够自然好看的谷歌眼镜。r1的时尚复古感归功于Rabbit与瑞典设计公司Teenage Engineering的合作。在发布之前，r1曾在法国时尚品牌哥白尼（Coperni）的一场巴黎时装秀上亮相。Meta的眼镜之所以大受欢迎，部分原因是雷朋深谙墨镜长啥样才时髦优雅。

其次，新设备必须能旧设备所不能。许多硬件制造商正在为现有设备添加AI功能。1月31日，三星开始销售一款AI智能手机，附带总结短信线程等巧妙功能。据称，微软的下一代笔记本和平板电脑将包含专门的AI芯片并新增一个用于召唤AI聊天机器人"Copilot"的按钮。亚马逊Alexa和谷歌Nest等智能音箱以及苹果AirPods等耳机都在用AI功能翻新，比如添加聊天机器人。AirPods会在佩戴者说话时让必要的音频进入并降低音量。

要取得突破，AI硬件必须能大大提升生活的便利度（例如只需一个命令就能完成整个旅程的预订，包括机票、用车、酒店等）或者精彩程度（引发库克所谓的"惊艳时刻"）。

用户还会期望它们实现更多功能。这意味着要有大量的应用。Meta最新的VR头显 Quest 3提供约500个应用。Vision Pro已有约350个专用应用，还可以运行App Store中约200万个应用中大部分的iPhone版本。Humane声称其兼具手机功能的Pin胸针摆脱了应用，而是提供一系列由OpenAI和谷歌等供应商提供的"AI驱动的服务"。Rabbit的r1则依赖于智能手机的现有应用体系，至少目前仍然如此。

第三，虽然制造电子设备变容易了，但管理供应链仍是硬件企业的经营中最艰难的部分，另一家风投公司红杉资本（Sequoia）的肖恩·马奎尔（Shaun Maguire）指出。供应商也许会接听小公司的询问电话，但有些还是不愿意给订单量小而且实力不明的新公司提供优惠价格。

现有AI设备还没有哪个克服了所有三个挑战。r1、Pin或Meta的雷朋墨镜这些外型好看的设备似乎属于和AirPods更接近的外设，而不是iPhone这样的独立产品。而Vision Pro或Quest这些独立使用的产品的外型比谷歌眼镜更突兀，而且笨重得多。此外，为苹果头显开发应用的成本很高，让开发者望而却步，包括一些电子游戏公司、奈飞、Spotify和YouTube（它们也恰好与苹果自己的视频和音乐流服务存在竞争关系）。几乎每家公司都在生产环节备受困扰。Rabbit的创始人吕聘称，产品一夜爆火后他在供应商面前的议价能力才有一点提升。据报道，因为制造工艺复杂，即便是供应链之王的苹果也不得不缩减最初要在今年出货100万台Vision Pro的计划。

假如有设备制造商扫除了这全部三个障碍，它们可能又会遇到另一个难题：跟上AI惊人的发展速度。苹果花了七年才开发出Vision Pro，这以"AI时间"衡量可说极为漫长。就连科斯拉说今年夏天便可推出的Rabbit新一代设备，等送到用户手上可能也已经过时了。今天的某个AI小设备也许有一天能取代智能手机。但更有可能的是，最终能脱颖而出的形式要素目前尚未成型。■

Can MSCI drag private markets out of the shadows?

Meet the Nicaraguan revolutionary behind the world's favourite index supplier

HENRY FERNANDEZ was once a counter-revolutionary. The man who over three decades has built MSCI, a provider of stockmarket indices, into a standard bearer of financial globalisation, started his career as a Nicaraguan diplomat in the government of Anastasio Somoza, a right-wing dictator. While some of his friends flocked to the left-wing Sandinistas ahead of the revolution that toppled Somoza in 1979, he took a look at socialism in eastern Europe and decided it was doomed to fail. Instead, he embraced free-market capitalism and moved to Wall Street.

There he encountered a different revolutionary movement that he has championed ever since: the forward march of capital markets. Starting in the Reagan era, he has played a role in several of the upheavals that have swept the world of finance, from securitisation in the 1980s and the growth of emerging-market investing in the 1990s, to the rise of index tracking and exchange-traded funds (ETFs) this century. He retains an idealistic streak. While many former advocates of environmental, social and governance investing have shied away from the climate-related fad of the past half-decade, he remains a true ESG believer.

He is now betting that MSCI's indices can penetrate the opaque world of private finance—the $12trn-plus of assets held in private equity, credit, venture capital, real estate and infrastructure. These are some of the hottest segments of the capital markets. But they are restricted to institutions and well-heeled investors. In these secretive markets asset managers are loth to encourage more transparency and liquidity lest their fees suffer as a result. Yet technology may be moving in Mr Fernandez's favour.

MSCI, which was spun off by Morgan Stanley, an investment bank, in 2007 and has a market capitalisation of $45bn, has two main lines of business. The first is benchmarking. It has more than 280,000 equity indices around the world that tell investors what is going on in the public markets, and provide a measuring stick against which to judge fund managers' performance. If a fund puts all its money into small-cap Japanese stocks, for instance, and MSCI's medium- and large-cap Japanese equity indices do better, it underperforms. Almost $15trn of assets are benchmarked in such a way globally.

The second line of business is enabling investment managers to sell low-cost portfolios, such as ETFs, based on its indices. Almost $1.5trn of ETF assets are linked to MSCI's indices, a nearly five-fold increase in a decade. BlackRock, the world's largest asset manager, is the biggest client. Its boss, Larry Fink, and Mr Fernandez have been kindred spirits for decades.

MSCI's first foray into the private realm is via benchmark indices. Since 2021 it has spent almost $2bn buying two data-gathering firms that create indices for private assets, from real estate and infrastructure to private debt. As Mr Fernandez explains, such indices enable a property investor to decide the relative merits of putting money into, for example, offices (which crashed during the pandemic) versus data centres (which soared). Gathering such information is tricky because many of the transactions are not publicly disclosed. MSCI creates indices by sourcing data from investors in private funds, who in turn receive records of those funds' quarterly performance, including valuations of the underlying assets, from the asset managers. Its most recent acquisition, for instance, gives it data from about 13,000 private funds, representing $15trn in cumulative investments.

Could these benchmarks eventually form the basis for indices used by ETFs to bring private markets to the masses? It seems hard to imagine. Private

assets do not trade with anything like the frequency of listed assets. They also lack the liquidity necessary for passive funds whose investors may want to redeem their money at short notice.

And yet Mr Fernandez believes that some parts of this opaque hinterland, such as private loans, are more liquid than others. "My bet is that over time there will be the development of a secondary market for private credit," he says. To explain why, he goes back to his days as a young trader at Morgan Stanley during the "Liar's Poker" era of the 1980s. The market for mortgage loans was fledgling and illiquid until the thrifts that made home loans came under pressure to sell them. Wall Street firms like Salomon Brothers and First Boston (where Mr Fink headed the mortgage desk) scooped them up, turned them into mortgage-backed securities and sold them to investors, creating a highly liquid secondary market. Similarly, banks that underwrite loans today face regulatory pressure to limit the size of their balance-sheets, so they sell some of the loans to firms with private-credit arms, such as Apollo and Blackstone. Mr Fernandez thinks that, as with the mortgage market, this trade could lead to a secondary market that would, eventually, have enough liquidity for index funds.

A big breakthrough will require advances in technology. For that, Mr Fernandez has his eye on his veteran comrade-in-arms, Mr Fink. This month BlackRock launched its first bitcoin ETF, and Mr Fink, who seldom keeps his cards close to his chest, hinted that this may be the start of a prolonged foray into the cryptoverse that could eventually encompass private assets. "If we could ETF a bitcoin, imagine what we could do with all financial instruments," he told Bloomberg TV. "Everything is going to be ETFed."

ETFs or WTF?

Mr Fernandez notes that Mr Fink has become an advocate of "tokenisation"—the idea that financial assets and their owners can be

registered on a blockchain-like ledger, which could make it easier to trade property and other private assets. It is an idea in its infancy. Some people think it is barmy. The MSCI boss confesses that for the time being he himself does not fully understand it. But in contrast to the Sandinistas, who have betrayed everything they once fought for, his revolutionary zeal remains as strong as ever. ■

MSCI能否照亮私人市场？

来会一会全球最受欢迎的指数供应商背后的尼加拉瓜革命家

亨利·费尔南德斯（Henry Fernandez）曾经是个反革命。在历经30多年把股票市场指数供应商MSCI打造成金融全球化的标杆之前，他最早是在尼加拉瓜的右翼独裁者阿纳斯塔西奥·索摩查（Anastasio Somoza）的政府里担任外交官。1979年推翻索摩查的革命爆发前夕，他的一些朋友转投左翼的桑地诺解放阵线，而他研究了一番东欧社会主义后认为这种制度注定失败。于是他转投自由市场资本主义的怀抱，搬去了华尔街。

在那里，他遇上了另一场革命运动并化身其领军人物至今：资本市场的进军。从里根时代开始，在席卷金融界的多次变局中他都发挥了作用，包括上世纪80年代的证券化和90年代投资新兴市场的热潮，以至本世纪指数跟踪和交易所交易基金（ETF）的兴起。他至今仍保留着理想主义的特质。许多当年支持环境、社会和治理（ESG）投资的人都回避了过去五年里关注气候的风潮，而他依然是ESG的忠实信徒。

现在，他正押注MSCI指数能穿透私人金融这个不透明的世界——总资产超过12万亿美元的私募股权、信贷、风险投资、房地产和基础设施。这些是资本市场里其中一些最热门的领域，但只有机构和富裕投资者可以参与。在这些神秘市场中，资产管理公司不愿鼓励提高透明度和流动性，以免影响它们收取费用。但技术的发展可能有利于费尔南德斯。

MSCI在2007年从投资银行摩根士丹利剥离出来，如今市值450亿美元，有两大业务线。第一是制定基准。MSCI在全球拥有超过28万个股票指数，向投资者传递公开市场的动态信息，也为判断基金管理公司的业绩提供衡量标准。举例来说，如果一只基金把所有资金投入小盘日本股票，而MSCI的中盘和大盘日本股票指数表现更好，那么这只基金就是业绩欠佳。全球有近15万亿美元的资产就是这样做基准比较的。

第二条业务线是让投资管理公司可以销售基于其指数的低成本投资组合，如ETF。与MSCI指数挂钩的ETF资产如今接近15万亿美元，十年间增至原来的近五倍。全球最大的资产管理公司贝莱德（BlackRock）是MSCI最大的客户。贝莱德的老板拉里·芬克（Larry Fink）和费尔南德斯在过去几十年里可谓志趣相投。

MSCI最开始是尝试通过基准指数打入私人金融领域。自2021年以来，MSCI已斥资近20亿美元收购了两家编制房地产、基建以及私人债务等私人资产指数的数据收集公司。费尔南德斯解释说，这些指数有助房地产投资者判断把资金投入不同领域的相对优势，比如是写字楼（疫情期间崩盘）还是数据中心（疫情期间飙升）。收集此类信息有其难度，因为许多交易都没有公开披露信息。MSCI会从私人基金投资者那里获取数据来编制指数，而这些投资者则是从资产管理公司那里获得那些基金的季度业绩记录，包括相关资产的估值。举个例子，MSCI通过最近一次收购获得了约13,000只私募基金的数据，它们的投资额总计达15万亿美元。

这些基准最终能否构成ETF采用的指数的基础，进而把私人市场推向大众？这似乎很难想象。私人资产的交易频率远不及上市资产，也缺乏被动型基金（其投资者可能想在短时间内赎回资金）所需的流动性。

然而，费尔南德斯认为，这块隐秘腹地的某些部分相较于其他有更高的流动性，比如私人贷款。"我敢打赌，以后会发展出一个私人信贷的二级市场。"他说。在解释原因时，他提到1980年代自己年轻时在摩根士丹利做交易员的日子，那正是《老千骗局》（Liar's Poker）中所讲述的时代。当时抵押贷款市场刚刚起步，流动性很差，直到后来提供住房贷款的储蓄银行在压力之下要出售这些贷款。所罗门兄弟（Salomon Brothers）和第一波士顿银行（First Boston，芬克曾管理该银行的抵押贷款部门）等华尔街金融机构吸收了这些贷款，将其转化为抵押担保证券再出售给投资者，从而打造了一个流动性极高的二级市场。同样，现在发放贷款的银行受到监管压力，需要限制资产负债表的规模，于是把部分贷款出售给阿波罗全球管理公司（Apollo）和黑石（Blackstone）等拥有私人信贷部门的公司。费尔南德斯认为，与抵押贷款市场一样，这种交易可能催生最终能为指数

基金提供足够流动性的二级市场。

要取得重大突破将有赖于技术上的进步。在这方面，费尔南德斯很关注老战友芬克的动向。1月，贝莱德推出了自家第一只比特币ETF，一向口快的芬克暗示这可能是进军加密领域的长途跋涉的开始，最终可能涵盖私人资产。"如果我们能把比特币ETF化，想想我们可以对所有金融工具做什么？"他在彭博TV的采访中表示。"一切都可以被ETF化"。

ETF还是WTF？

费尔南德斯指出，芬克已经成了"代币化"的倡导者，即主张金融资产及其所有者可以登记在类似区块链的分类账上，这可能会让房地产和其他私人资产的交易变得更容易。这个想法仍处于起步阶段。有人觉得这是在发癫。费尔南德斯承认目前他自己也没有完全把它想明白。但有别于桑地诺主义者最后背弃了自己曾为之奋斗的信念，费尔南德斯的革命热情坚定如故。■

Against the odds, Notre Dame cathedral will reopen this year

The rebuilding of the famous monument prompted a debate about how much should change

ON AN ICY January morning, perched at a dizzying height of nearly 100 metres above the ground, specialist roofers are covering the rebuilt oak spire of Notre Dame cathedral with layers of lead sheeting. Working on platforms reached by a perilous flight of narrow steps that cling to the soaring spire, they are putting the final touches on a 1,000-piece, solid-oak structure that will soon restore the cathedral's familiar silhouette.

Designed in 1859 by Eugène Viollet-le-Duc, an architect, and felled by the devastating fire of 2019, the new flèche remains hidden behind dense scaffolding. But five years after the world watched aghast as the gothic cathedral roof was devoured by flames, the project to rebuild Notre Dame is, astonishingly, on schedule. The cathedral doors are due to reopen in December. (Visitors for the Olympics, which Paris will host starting in late July, must wait to glimpse inside.)

The rebuilding of Notre Dame is one of the most complex and ambitious reconstruction projects that France has ever undertaken on a historic monument. Fire engulfed the entire wooden latticework that made up the medieval roof, before melting its lead casing and toppling the spire. The cathedral's nave, choir and transepts were mostly untouched by flames, thanks to the craftsmanship of the 12th- and 13th-century stonemasons. So were the 8,000-tube great organ and stained-glass windows.

However, molten lead and charred oak beams crashed through the roof, spreading embers and lead particles. Religious artefacts, paintings and sculptures had to be rescued and cleaned; the organ and 39 stained-glass

windows were dismantled and washed. It took two years to stabilise the cathedral's stone structure.

When a grave-looking President Emmanuel Macron stood outside Notre Dame on the night of the fire, he described it as "the epicentre of our lives". The cathedral would be rebuilt, he vowed, within five years. That promise may have sounded "a bit mad", concedes Philippe Jost, who runs the public body in charge of the reconstruction project. But, he adds, it gave everyone a clear objective.

That the project is on track is also partly due to the commanding style of General Jean-Louis Georgelin, who ran it like a military operation until his death last August. A light management team, freed from bureaucratic excess has helped, too. Gifts from rich French industrialists—the Arnault, Bettencourt and Pinault families—as well as 340,000 smaller individual donations from around the world amounted to €846m ($921m). Unlike the usual French grands projects, this one is costing the public purse almost nothing.

Today the cramped site on the Île de la Cité, an island in the River Seine, is a veritable construction village, complete with a canteen, shower block, offices and sculpture-restoration workshop. Last summer the first eight triangular oak trusses, crafted for the new transept roof, arrived by river. Passers-by watched in awe as, one by one, each seven-tonne truss was hoisted by crane from a barge and lowered into place.

The craftsmen working on the project are specialist artisans, drawn from dozens of small firms from around France. Rather than contract the rebuilding to one company, over 140 separate tenders were put out, in order to support traditional craftsmanship. The demands were unusually high: a decision was taken to restore the cathedral to its former splendour while remaining faithful both to its original designs and the construction

techniques of the time.

For the roof above the medieval nave and choir, 1,200 oak logs were individually selected from forestry plantations in France and hewn by hand into square timber beams. Craftsmen used hand-forged axes, based on late 12th- and early 13th-century models. On the curved apse roof, finished on January 12th, wooden dowel pegs hold the trusses together without a single industrial metal piece. "The idea was to work with tools that are as close as possible to those used in the Middle Ages in order to give the wood the aspect of the time," says Valentin Pontarollo, a carpenter from Ateliers Perrault, a firm in western France. One of the joys this brought was that there was often "no machinery noise, just the sound of the axe", he says.

Inside the on-site restoration workshop, sculptors and stonemasons are also working by hand, with chisels and brushes. On the floor stand some of the near-finished new stone chimeras, the grotesque and menacing beasts installed in the 19th century that look down from the cathedral façade and towers. More than a dozen gargoyles, 80 fleurons, 70 small chimeras and more than 750 crockets (decorative stone hooks) are being entirely rebuilt, as are three cathedral gables. At 96 metres above ground level, a new gilt-covered copper rooster tops the needle of the spire, hoisted into place by a crane in December. It replaces the one that miraculously survived the fire, falling to the ground beneath one of the flying buttresses. (The original is on display at a museum.)

Inevitably some modernists decry the project's conservatism. After the fire, various architects lobbied for an audacious contemporary flourish: a plate-glass spire or roof planted with vegetation. Notre Dame, after all, is an architectural hybrid, the product of different centuries, ransacked during the wars of religion and looted during the revolution. Viollet-le-Duc's spire was added only in the 19th century, not long after Victor Hugo's novel, "The Hunchback of Notre Dame", revived respect for what was then an unloved

gothic masterpiece.

Today a public debate pits those who contest the authenticity of reconstruction against those who argue that authenticity is guaranteed by respect for the original, with its irregularities as well as its durability. "This is not a monument like any other, and deserves not being distorted," says Mr Jost: "We are restoring a cathedral that is 860 years old so that it can last for at least another 860 years."

Notre Dame's overseers are trying to strike a balance. The pristine, newly cleaned cathedral may take some visitors by surprise. Inside the nave, where much of the scaffolding has come down, the freshly blond stone of the pillars and vaults, as it would have appeared in medieval times, is breathtaking—and a startling contrast to their previous darkened, partly pitted form.

But the cathedral has not rejected modernity altogether. The Archbishop of Paris has chosen two contemporary French designers for the furniture. Guillaume Bardet is making the liturgical furnishings, including the altar, with dark bronze, and Ionna Vautrin the new 1,500 solid-oak congregation seats, which will have slatted backs to suggest openness and light.

The rebuilding of Notre Dame is both a test and a showcase for France: of its ability to meet an ambitious deadline, to satisfy the demanding global gaze of both secularists and spiritualists and to flaunt French craftsmanship. Finishing in time is a matter of "French pride", says Mr Jost.

For the artisans, completion will be poignant. Emile-Armand Benoit, an ornamental roofer on the cathedral's highest point, says that they are working as quickly as possible so that the scaffolding can come down and the city "can once again see the spire reaching into the sky". Halfway down, the carpenters contemplate the newly finished roof. "It's a bit heartbreaking

to leave," says Mr Pontarollo, "We'll never have a project like this again." ■

克服万难，巴黎圣母院将在今年重新开放

对这座名胜古迹的修复引发了争论：该改变它多少？【深度】

一月的一个清晨，天寒地冻。距离地面近100米的高处令人眩晕，专业屋顶工正在那里给巴黎圣母院重建中的橡木尖塔铺上一块块铅板。他们需要惊险地走过一段沿高耸尖塔向上的狭窄扶梯，才能到达各自工作的平台。他们是在对一个由1000块实心橡木组成的结构做最后的修饰。这座大教堂往日的轮廓将很快重现在世人面前。

建筑师尤金·维奥莱特-勒-杜克（Eugène Viollet-le-Duc）于1859年设计的巴黎圣母院尖塔毁于2019年的那场毁灭性大火。如今新的尖塔仍然被密实的脚手架遮挡着。但是，在世人目瞪口呆地看着大火吞噬这座哥特式大教堂屋顶的五年之后，人们惊讶地发现，巴黎圣母院的修复工程竟然在按时推进着。这座大教堂定于今年12月重新开放。（7月下旬前往巴黎观看奥运会的游客还得等一等才能一睹其内部风貌。）

巴黎圣母院的修复是法国有史以来对历史遗迹所做的最复杂、最具挑战性的修复工程之一。大火吞噬了这座中世纪教堂屋顶的木质框架，继而导致外面的铅皮熔化和尖塔坍塌。不过得益于12、13世纪石匠们的精湛技艺，大教堂的中殿、唱经堂和耳堂的大部分都未受损。有8000根音管的巨型管风琴和花窗也幸免于难。

然而，熔化的铅和烧焦的橡木横梁冲破了屋顶，余烬和铅粒四下散落。宗教器物、绘画和雕塑必须抢救和清理，管风琴和39扇花窗被拆下来清洗。加固大教堂的石质结构花费了两年时间。

火灾当晚，法国总统马克龙站在巴黎圣母院外面，表情凝重地说圣母院是"我们生活的中心"。他誓言将在五年内修复它。负责修复工程的公共机构的负责人菲利普·约斯特（Philippe Jost）承认，这个承诺听上去可能"有点疯狂"。但这给了所有人一个明确的目标，他补充道。

修复工程能够按计划进行，一定程度上也要归功于让-路易·乔治林（Jean-Louis Georgelin）将军的严格领导——直到去年8月去世前，他都像指挥一项军事行动一样管理这个项目。一支没有繁冗官僚做派的精干的管理团队也很有助益。除了来自世界各地的34万笔小额个人捐款，修复工程还收到了来自阿尔诺、贝当古和皮诺家族等富有的法国实业家的捐赠；全部捐款共计8.46亿欧元（9.21亿美元）。与法国一般的大型项目不同，这项修复工程几乎没有动用公共资金。

如今，这块塞纳河中西堤岛（Île de la Cité）上的狭窄场地俨然成了个建筑基地，里面配有一个食堂、一个淋浴区、多个办公室和一个雕塑修复车间。去年夏天，为新耳堂的屋顶精心制作的第一批八个三角形橡木桁架通过水运抵达。每个桁架重达七吨，起重机将它们逐个从驳船上吊起，再缓缓放落到位。路人心怀敬畏地目睹了这一过程。

参与修复工程的工匠都是各有专长的手艺人，来自法国各地几十家小公司。为寻求传统技艺，修复工程经过140多次招标，发包给了不同的公司，而不是只与一家公司签订合同。各项要求异常之高——因为修复团队决定在恢复大教堂昔日辉煌的同时，还要忠于其初始设计和当时的建筑技艺。

为了制作中世纪中殿和唱经堂的屋顶，修复团队从法国的林场中一根一根地挑来共1200根橡木，手工砍凿成方形的木梁。工匠们使用的斧头是根据12世纪末和13世纪初的样式手工锻造的。1月12日完工的弧形拱顶上的桁架是用木榫钉固定在一起，没有使用任何工业金属件。"我们希望使用的工具尽可能和中世纪的一样，从而让木材呈现那时的样子。"来自法国西部的Ateliers Perrault公司的木匠瓦伦汀·庞塔罗洛（Valentin Pontarollo）说。这种做法带来的乐趣之一是，大多时候"没有机器噪音，只有斧头的砍凿声"，他说。

在现场的修复车间内，雕刻家和石匠也在用凿子和刷子进行手工作业。地板上放置着一些接近完工的新制的石像怪。原物于19世纪添装到大教堂的外立面和塔楼上，这些面目狰狞的怪兽威严地俯视着下方。正在进行彻底

重建的还有十几个滴水嘴兽、80个花形装饰物、70个小型石像怪和750多个花形浮雕（装饰性石钩），以及教堂的三面山墙。去年12月，起重机把一只新做的镀金铜公鸡吊装到距地面96米的塔尖上。原来的那只公鸡在大火中掉落到了一座飞扶壁下的地面上，奇迹般地幸存下来，目前在一家博物馆展出。

修复工程不可避免地被一些现代主义者斥为守旧。火灾发生后，各路建筑师都在游说，希望采用大胆的当代装饰手法，比如用平板玻璃建造的尖塔或者种有植物的屋顶。毕竟，巴黎圣母院本来就融合了各种建筑形式，它曾先后在法国宗教战争和大革命期间遭受劫掠，是不同世纪叠加的产物。19世纪，维克多·雨果的小说《巴黎圣母院》重新唤起了世人对这件在当时本不受喜爱的哥特式杰作的敬意。也正是此后不久，维奥莱特-勒-杜克才新建了它的尖塔。

如今在一场公开辩论中，两派观点截然对立：一些人质疑修旧如旧的做法，另一些人则主张唯有尊重原样才能保真，这既包括保留它风格不相一致的部分，也包括保存其中持久稳定的部分。"它有别于其他任何古迹，不应该被修改失真，"约斯特表示，"我们正在修复一座有着860年历史的大教堂，以期它再存续至少860年。"

巴黎圣母院的管理者正试图找到一种平衡。这座刚刚清理干净、焕然一新的大教堂可能会让一些游客大吃一惊。中殿内的大部分脚手架已经拆除，柱子和拱顶的明黄色的石头令人叹为观止，仿佛回到了中世纪的样子——与它们之前黑魆魆、有些地方还坑坑洼洼的样子形成了惊人的对比。

不过巴黎圣母院并没有完全拒绝现代元素。巴黎大主教选用了两位当代法国设计师来设计家具。纪尧姆·巴代（Guillaume Bardet）正在制作包括圣坛在内的礼拜用的陈设，采用了深古铜色；约娜·沃特林（Ionna Vautrin）正在制作1500个实心橡木的会众椅，这些新座椅的椅背将采用板条来暗示开放和光亮。

巴黎圣母院的修复工程对于法国而言既是考验也是展示：要能在如此紧迫

的最后期限前完成任务，经受住来自全世界的宗教或非宗教人士的严苛审视，并一展法国的精工细作。按期完工事关"法国人的自尊自豪"，约斯特表示。

对于工匠们而言，完工却是令人酸楚的。埃米尔-阿尔芒·伯努瓦（Emile-Armand Benoit）在大教堂的最高处装饰屋顶，他说自己的团队正在加紧工作，这样脚手架就可以拆掉了，巴黎"就能再次看到高耸入云的尖塔"。在教堂的半高处，木匠们抬头凝视新完工的屋顶。"离开总归有些难过的，"庞塔罗洛说，"我们碰不到这样的活了。"■

AI holds tantalising promise for the emerging world

It could help boost human capital, and ultimately growth

NEW TECHNOLOGY brings with it both the sweet hope of greater prosperity and the cruel fear of missing out. Satya Nadella, the boss of Microsoft, says he is haunted by the fact that the Industrial Revolution left behind India, his country of birth. (Indian manufacturers hardly enjoyed a level playing-field—Britain was then both their rival and their ruler.) Many technologies, such as online-education courses, have generated more hype than economic growth in the emerging world. Some people worry that generative artificial intelligence (AI), too, will disappoint the global south. The big winners so far seem to be a bunch of Western early adopters, as well as startups in San Francisco and America's "magnificent seven" tech firms, which include Microsoft and have together added an astonishing $4.6trn to their market value since ChatGPT's launch in November 2022.

Yet AI stands to transform lives in the emerging world, too. As it spreads, the technology could raise productivity and shrink gaps in human capital faster than many before it. People in developing countries need not be passive recipients of AI, but can shape it to suit their own needs. Most exciting of all, it could help income levels catch up with those in the rich world.

The promise of AI in developing countries is tantalising. As in the West, it will be a useful all-purpose tool for consumers and workers, making it easier to obtain and interpret information. Some jobs will go, but new ones will be created. Because emerging countries have fewer white-collar workers, the disruption and the gain to existing firms may be smaller than in the West. The IMF says that a fifth to a quarter of workers there are most exposed to replacement, compared with a third in rich countries.

But a potentially transformative benefit may come from better and more accessible public services. Developing economies have long been held back by a lack of educated, healthy workers. Primary-school teachers in India have twice as many pupils as their American counterparts, but are ill-equipped for the struggle. Doctors in Africa are scarce; properly trained ones are scarcer. Whole generations of children grow up badly schooled, in poor health and unable to fulfil their potential in an increasingly global labour market.

Policymakers and entrepreneurs around the world are exploring ways that AI can help. India is combining large language models with speech-recognition software to enable illiterate farmers to ask a bot how to apply for government loans. Pupils in Kenya will soon be asking a chatbot questions about their homework, and the chatbot will be tweaking and improving its lessons in response. Researchers in Brazil are testing a medical AI that helps undertrained primary-care workers treat patients. Medical data collected worldwide and fed into AIs could help improve diagnosis. If AI can make people in poorer countries healthier and better educated, it should in time also help them catch up with the rich world.

Pleasingly, these benefits could spread faster than earlier waves of technology. New technologies invented in the early 20th century took more than 50 years to reach most countries. By contrast, AI will spread through the gadget that many people across the emerging world already have, and many more soon will: the phone in their pockets. In time, chatbots will become much cheaper to provide and acquire.

Moreover, the technology can be tailored to local needs. So far there is little sign that AI is ruled by the winner-takes-all effects that benefited America's social-media and internet-search firms. That means a variety of approaches could prosper. Some developers in India are already taking Western models and fine-tuning them with local data to provide a whizzy language-

translation service, avoiding the heavy capital costs of model-building.

Another idea that is also taking off in the West is to build smaller, cheaper models of your own. A narrower set of capabilities, rather than the ability to get every bit of information under the sun, can suit specific needs just fine. A medical AI is unlikely to need to generate amusing limericks in the style of William Shakespeare, as ChatGPT does so successfully. This still requires computing power and bespoke data sets. But it could help adapt AI in more varied and useful ways.

Some countries are already harnessing AI. China's prowess is second only to America's, thanks to its tech know-how and the deep pockets of its internet giants. India's outsourcing industry could be disrupted, as some back-office tasks are taken on by generative AI. But it is home to a vibrant startup scene, as well as millions of tech developers and a government that is keen to use AI to improve its digital infrastructure. These leave it well-placed to innovate and adapt. Countries in the Gulf, such as the United Arab Emirates and Saudi Arabia, are determined to build an AI industry as they shift from oil. They already have the capital and are importing the talent.

Each country will shape the technology in its own way. Chinese chatbots have been trained to keep off the subject of Xi Jinping; India's developers are focused on lowering language barriers; the Gulf is building an Arabic large language model. Though the global south will not dislodge America's crown, it could benefit widely from all this expertise.

| *Teaching AId*

Plenty could yet go wrong, obviously. The technology is still evolving. Computing power could become too expensive; local data will need to be gathered and stored. Some practitioners may lack the ability to take advantage of the knowledge at their fingertips, or the incentive to try new things. Although countries in sub-Saharan Africa stand to gain the most

from improvements to human capital and government services, the technology will spread more slowly there than elsewhere without better connectivity, governance and regulation.

The good news is that investments to speed AI's diffusion will be richly rewarded. Much about the AI revolution is still uncertain, but there is no doubt that the technology will have many uses and that it will only get better. Emerging countries have suffered disappointments before. This time they have a wonderful opportunity—and the power to seize it. ∎

AI为新兴世界带来诱人前景

它有可能帮助提升人力资本，最终促进增长

新技术让人们心怀美好希望，期待更加繁荣，同时也让人心生恐惧，担心错失良机。出生于印度的微软首席执行官萨蒂亚·纳德拉（Satya Nadella）表示，印度没有赶上工业革命，这让他耿耿于怀。（当时印度制造商无法参与公平竞争，英国既是竞争对手也是它们的统治者。）在线教育等许多技术在新兴世界中引发的炒作大于实际推动的经济增长。一些人担心生成式AI也会让全球南方失望。迄今为止，最大的赢家似乎是一群西方的早期采用者，还有旧金山的创业公司和包括微软在内的美国科技"七雄"——在ChatGPT于2022年11月问世后，这七家公司的市值总计增加了惊人的4.6万亿美元。

但AI也势将改变新兴世界的生活。随着AI的普及，它可能会比之前的许多技术都更快地提高生产率和缩小人力资本差距。发展中国家的人们不必被动地接受AI，而可以按自己的需求塑造它。最令人兴奋的是，AI可以帮助发展中国家的收入水平赶上富裕世界。

AI给发展中国家带来的前景令人向往。与在西方一样，AI将成为帮助消费者和工人的多功能工具，让获取和解释信息更加容易。一些工作将会消失，但新的工作也会被创造出来。由于新兴国家的白领工人较少，AI带给现有企业的冲击和收益可能会小于在西方国家。国际货币基金组织（IMF）表示，这些国家有五分之一到四分之一的工人最容易被AI替代，而富裕国家的比例是三分之一。

但一个潜在的具变革性的益处可能来自公共服务的改善和更易获取。发展中经济体长期以来因为受过良好教育的健康劳动力不足而受制约。印度小学教师要带的学生人数是美国教师的两倍，但他们的能力不足以应对这一繁重任务。非洲急缺医生，受过正规培训的医生更是凤毛麟角。一代又一代孩子在成长时没有得到好的教育，健康状况不佳，无法在日益全球化的

劳动力市场中发挥潜力。

世界各地的政策制定者和企业家正在探索AI能够如何发挥作用。印度正在将大语言模型与语音识别软件结合起来，让不识字的农民能够向机器人咨询如何申请政府贷款。肯尼亚的学生将很快能够向聊天机器人提出有关作业的问题，而聊天机器人将相应调整和改进教学内容。巴西的研究人员正在测试一种医疗AI，辅助培训不足的初级医护人员治疗患者。从全球收集的医疗数据输入AI后可以帮助提高诊断水平。如果AI能让贫穷国家的人们更健康、接受更好的教育，那么假以时日也应该能帮助他们赶上富裕世界的生活水平。

可喜的是，这些好处可能会比之前的技术浪潮传播得更快。在20世纪初发明的新技术过了50多年才传播到大多数国家。相比之下，新兴世界中的许多人已经有了能够传播AI的设备，而且很快还会有更多人拥有这种设备——那就是他们兜里的手机。随着时间的推移，提供和购买聊天机器人的成本将大大降低。

此外，这项技术可以根据本地需求来定制。目前还没有迹象显示让美国社交媒体和互联网搜索公司受益的赢家通吃效应会支配AI的发展。这意味着各种不同的路径都有可能获得成功。印度的一些开发者已经开始把西方的模型拿来，用本地数据做优化，以提供先进的语言翻译服务，避免了建模的巨大资本成本。

另一个也开始在西方流行的思路是建造更小、更便宜的自有模型。只需开发小范围的功能，而无需拥有获得天底下所有信息的能力，将能足够应付特定的需求。医疗AI可能并不需要像ChatGPT那样能够生成莎士比亚风格的风趣打油诗。这仍然需要计算能力和定制数据集。但它可以帮助调整AI，满足更多样化、更有用的需求。

一些国家已经在利用AI。中国得益于其科技水平和互联网巨头的雄厚财力，在这方面的实力仅次于美国。印度的外包行业可能会受到影响，因为一些后台任务已经由生成式AI承担。但印度拥有充满活力的创业圈子、千

百万技术开发人员和一个热衷于利用AI改善数字基础设施的政府，这些都为它推进创新和调整适应提供了有利条件。阿联酋和沙特阿拉伯等海湾国家决心在摆脱对石油的依赖之时建立AI产业。它们已经拥有所需的资本并且正在引进人才。

每个国家都会以自己的方式塑造这项技术。中国的聊天机器人已经经过训练来避开最高领导人的话题，印度的开发者致力于降低语言障碍，海湾地区正在构建阿拉伯语的大语言模型。全球南方不会动摇美国的AI王冠，但可以从所有这些专门技术中广泛受益。

教学助理

显然，有很多方面可能出错。这项技术仍然在不断发展演变。算力可能变得成本过高；将需要收集和存储本地数据。一些从业者可能缺乏利用手边知识的能力，或者缺乏尝试新事物的动力。尽管撒哈拉以南非洲应该会从人力资本和政府服务的提升上获益最大，但在连通性、治理和监管没有改善的情况下，这项技术在那里的传播会比在其他地方更慢。

好消息是，加速AI传播的投资将获得丰厚的回报。AI革命的许多方面仍不确定，但毫无疑问的是，这项技术将有很多用途，而且只会越变越好。新兴国家之前历经失望。这一次它们有绝佳的机会，并有能力抓住它。■

The risks to global finance from private equity's insurance binge

Funding pensions with private assets holds promise—but needs scrutiny

A DECADE OR so ago private equity was a niche corner of finance; today it is a vast enterprise in its own right. Having grabbed business and prestige from banks, private-equity firms manage $12trn of assets globally, are worth more than $500bn on America's stockmarket and have their pick of Wall Street's top talent. Whereas America's listed banks are worth little more than they were before the pandemic, its listed private-equity firms are worth about twice as much. The biggest, Blackstone, is more valuable than either Goldman Sachs or Morgan Stanley—and has the confidence of a winner. "It's the alternatives era," proclaimed the company's ebullient Taylor Swift-themed festive video in December. "We buy assets then we make 'em better."

This is not, though, the business that has recently boomed for them. Traditional private equity—using lots of debt to buy companies, improving them, and selling or listing them—has been lifeless. High interest rates have cast doubt on the value of privately held companies and reduced investors' willingness to provide new funds. It does not seem to matter. Core private-equity activity is now just one part of the industry's terrain, which includes infrastructure, property and loans made directly to companies, all under the broad label of "private assets". Here the empire-building continues. Most recently, the industry is swallowing up life insurers.

All of the three kings of private equity—Apollo, Blackstone and KKR—have bought insurers or taken minority stakes in them in exchange for managing their assets. Smaller firms are following suit. The insurers are not portfolio investments, destined to be sold for a profit. Instead they are prized for

their vast balance-sheets, which are a new source of funding.

Judged by the fundamentals, the strategy makes sense. Insurance firms invest over long periods to fund payouts, including annuities sold to pensioners. They have traditionally bought lots of government and corporate bonds that are traded on public markets. Firms like Apollo can instead knowledgeably move their portfolios into the higher-yielding private investments in which they specialise. A higher rate of return should mean a better deal for customers. And because insurers' liabilities stretch years into the future, the finance they provide is patient. In banking, long-term loans are funded with lots of instantly accessible deposits; with private assets and insurance, the duration of the assets matches the duration of the liabilities.

Yet the strategy brings risks—and not just to the firms. Pension promises matter to society. Implicitly or explicitly, the taxpayer backstops insurance to some degree, and regulators enforce minimum capital requirements so that insurers can withstand losses. Yet judging the safety-buffers of a firm stuffed with illiquid private assets is hard, because its losses are not apparent from movements in financial markets. And in a crisis insurance policyholders may sometimes flee as they seek to get out some of their money even if that entails a financial penalty. Last year an Italian insurer suffered just such a bank-run-like meltdown.

Making things harder is the complexity of the tie-ups, which involve labyrinthine interlinkages between different bits of firms' balance-sheets. Much reinsurance activity takes place in Bermuda, an offshore hub where there is more than a whiff of regulatory arbitrage. Yet compared with the zealots who police the global banking system, insurance regulators are docile.

As private assets become more important, that must change. Regulators

should co-operate internationally to ensure that the safety-buffers are adequate. High standards of transparency and capital need to be enforced by suitably heavyweight bodies. The goal should not be to crush a new business model, but to make it safer. Financial innovation often brings new benefits even as it creates new ways to blow up the system. Regulators would be making a mistake to ignore either edge of the sword. ■

私募股权大举收购保险公司给全球金融带来风险

用私募资产为养老金融资前景良好——但需要严格审视

大约十年前，私募股权还是金融业的一个利基领域，如今它已自成一门庞大的生意。私募股权公司从银行手中抢走了业务和声誉，在全球管理着12万亿美元的资产，在美国股市的市值超过5000亿美元，并拥有华尔街最顶尖的人才。美国上市银行的市值与疫情暴发前相比仅略有增长，而美国上市私募股权公司的市值是疫情前的两倍。其中最大的黑石集团（Blackstone）的市值比高盛或摩根士丹利都要高，并且拥有赢家的自信。"这是另类投资的时代，"该公司在12月发布的一则热情洋溢的模仿泰勒·斯威夫特巡演的节日视频里宣称，"我们购买资产，然后把它们变得更好。"

然而，他们近期十分红火的业务并不是购买资产。用大量债务购买公司，再改善它们，然后将它们出售或上市的传统私募股权投资已经了无生气。高利率让人对私人公司的价值产生了怀疑，也降低了投资者提供新资金的意愿。这似乎并不要紧。核心私募股权投资活动如今只是该行业版图的一部分，其他业务还包括基础设施、房地产和直接向企业放贷，这些都被归在"私募资产"这个大标签之下。在这方面，帝国的建设仍在继续。最近，该行业正在大举收购人寿保险公司。

私募股权投资三巨头阿波罗、黑石和KKR都收购了保险公司或持有少数股权，以换取对其资产的管理。规模较小的公司也纷纷效仿。保险公司不是投资组合，注定会为了获利而被售出。它们备受青睐其实是因为有庞大的资产负债表，可以成为新的资金来源。

从基本面来看，这一战略是合理的。保险公司进行的是长期投资，为各种赔付提供资金，包括向养老金领取者出售的年金。传统上，它们大量购买在公开市场交易的政府和公司债券。而像阿波罗这样的公司则可以游刃有余地将其投资组合转移到收益更高的私人投资领域——这是它们的专长。

回报率更高，对客户来说应该也就越划得来。而且，由于保险公司的债务会延续到未来数年，它们提供的融资是有耐心的。在银行业，长期贷款的资金源自大量即时可用的存款，而在私募资产和保险业，资产的期限与债务的期限是相匹配的。

但这种策略也带来了风险，而且不仅仅是对公司而言。养老金的承诺对社会很重要。纳税人在某种程度上直接或间接地为保险提供了支持，监管机构则强制执行最低资本要求，使保险公司能够扛住损失。然而，要判断一家拥有大量低流动性私募资产的公司的安全缓冲能力如何是很难的，因为它的损失并不能从金融市场的变动中清楚地显现出来。而在危机中，投保人有时可能会闻风而逃，设法拿回一部分钱，即使这样做会造成财务损失。去年，一家意大利保险公司就发生了类似银行挤兑的爆雷事件。

这类并购的复杂性让事情更加麻烦，因为公司资产负债表的不同部分之间会生成错综复杂的相互关联。许多再保险活动都在百慕大进行，在这个离岸中心，监管套利并不少见。但与监管全球银行系统的积极分子们比起来，保险业的监管者显得低眉顺眼。

随着私募资产变得越发重要，这种情况必须改变。监管机构应开展国际合作，确保企业有足够的安全缓冲。关于透明度和资本的高标准还需要具备足够影响力的机构来执行。其目标不应是压垮一个新的商业模式，而是让它更安全。尽管金融创新会变出新花样来破坏金融体系，但往往也会带来新的益处。监管机构忽视这把双刃剑的任何一面都将是犯错。■

Common sense is not actually very common

Very few claims meet with universal agreement

IN 1776 THOMAS PAINE, a traitorous Englishman living in the American colonies, published a seditious 47-page pamphlet. Called "Common Sense", it became a best-seller. It argued that the colonies should seek independence from British rule. Later that year they did exactly that.

Appeals to common sense are a staple of politics, especially when an insurgent wishes to distinguish himself from a supposedly aloof and out-of-touch elite. But in a paper published in Proceedings of the National Academy of Sciences, Mark Whiting and Duncan Watts, a pair of computational social scientists at the University of Pennsylvania, note that the idea has seldom been rigorously studied.

The two researchers set out to fix that. They started by noting that the standard concept of common sense has a somewhat circular definition: common sense is a set of claims that sensible people agree with, and sensible people are those who possess common sense.

To get around such philosophical tangles, the researchers turned to Mechanical Turk, a website run by Amazon, a big tech firm, that allows people to post odd jobs. They recruited 2,046 human participants and asked them to rate 50 statements from a corpus of 4,407 claims that might plausibly be seen as commonsensical.

As common sense might have predicted, the researchers found that plainly worded claims concerning facts about the real world were the most likely to be rated as demonstrating common sense ("triangles have three sides", for example, which is true by definition, or "avoid close contact with people

who are ill"). The more abstract the claims, the less likely participants were to agree that they were common sense ("all human beings are created equal"; "perception is the only source of knowledge").

When they split the claims by subject, the researchers found that those concerning technology and science were the most likely to be rated as commonsensical, while matters of history and philosophy were the least likely. A respondent's age, sex, income and personal politics had little effect on what they thought counted as common sense, although psychological measures of social perceptiveness and the ability to reflect on one's opinions did.

Having investigated individual opinions, the researchers looked at how common sense works across big groups. Here, they found much less agreement than might have been expected. Only around 44% of claims in the corpus were rated as commonsensical by at least 75% of respondents. A stricter definition of common sense, in which everyone has to agree with a claim for it to count, cut that number to just 6.6%. Where exactly a sensible cut-off lies is a matter for debate. But truly "common" sense, it seems, is an elusive thing. ■

常识其实不太常见

很少有说法得到普遍认同

一七七六年，生活在美洲殖民地的叛徒英国人托马斯·潘恩（Thomas Paine）出版了一本煽动性的47页小册子。这本名为《常识》（Common Sense）的小册子成了畅销书。它主张殖民地应该摆脱英国的统治，寻求独立。那一年晚些时候，它们确实做到了。

诉诸常识是政治的一个常见工具，特别是当一名叛乱者希望将自己与那些被认为是高高在上、脱离群众的精英区分开来时。但是在《美国国家科学院院刊》（Proceedings of the National Academy of Sciences）上发表的一篇论文中，宾夕法尼亚大学的两位计算社会科学家马克·惠廷（Mark Whiting）和邓肯·沃茨（Duncan Watts）指出，常识这个概念很少被严谨地研究。

这两位研究人员着手解决这个问题。他们首先指出，常识的标准概念有几分循环定义的味道：常识是理智人群认同的一系列主张，而理智人群则是那些有常识的人。

为了解开这团哲学上的乱麻，研究人员使用了Mechanical Turk，这家网站由大型科技公司亚马逊运营，人们可以在上面发布各种零工杂活。他们招募了2046人参与研究，让他们给50个陈述评分，它们来自一个有4407个可能被视为常识的说法的语料库。

正如依据常识能预见到的那样，研究人员发现，关于现实世界事实的直白陈述最有可能被评断为常识（例如"三角形有三条边"这种顾名思义而正确的表述，或者"避免与生病的人密切接触"）。表述越抽象，参与者认为它们是常识的可能性就越小（"所有人生而平等"，"感知是知识的唯一来源"）。

在按主题划分这些表述时，研究人员发现，涉及技术和科学的陈述最有可能被评断为常识，而历史和哲学问题最不可能。受访者的年龄、性别、收入和个人政治观点对他们认为什么算作常识没什么影响，尽管由心理评估反映的社会洞察力和对自身观点的反思能力确有影响。

在研究了个人观点之后，研究人员又调查了群体对常识的认知。他们发现人群对于什么算常识的一致认同度要比大家原本可能以为的低得多。语料库中只有大约44%的表述被至少75%的受访者认为是常识。如果对常识做更严格的定义，即在每个人都同意的情况才能说一种表述是常识，那么这一数字将降至6.6%。把分界线划在哪里才合理是一个有待讨论的问题。但看起来，真正的"常"识近乎虚无缥缈。■

Does Las Vegas's Sphere reveal the future of concerts?

The venue is dazzling. But copycats are unlikely to be built soon

NESTLED BETWEEN hotels and conference centres, a short walk from the Las Vegas strip, is a giant, wide-eyed emoji. Sometimes it is an enormous, hyperrealistic eyeball, a basketball or a whorl of flames. The Sphere, a remarkable new concert venue, is 366 feet (110 metres) tall and 516 wide; an LED screen spanning almost 600,000 square feet covers the exterior.

Inside, enveloping the 17,500 seats, is another vast, ultra-high-resolution screen. This pleasuredome offers an experience unlike any other. It also raises questions about the future of live entertainment.

The high-tech arena was opened in September by U2, who remain in residence until March. The Irish band has a history of innovative concert design as well as corporate ventures, including a long partnership with Apple. Perhaps just as important, U2 is loved by middle-aged rock fans, who form the bulk of concertgoers in America and might shell out for a ticket. (Prices start at $140 and go up to $1,500.)

A celebration of "Achtung Baby", an album released in 1991, U2's show is an overwhelming phantasmagoria. The band plays on a stage shaped like a turntable while work by artists including Es Devlin and John Gerrard appears on the vaulting screen. During "Even Better Than the Real Thing", there are animations of slot machines and Elvis kitsch. For "Where the Streets Have No Name", the crowd is transported into the blinding daylight of the high desert. During "With Or Without You" the ceiling teems with images of endangered local species such as the leaf-nosed bat. "It's a show that's about the venue that it's in," says Willie Williams, U2's longtime production designer. "It's about us all going to experience the venue."

From one angle, the Sphere represents a major development in an existing trend of the arts becoming more immersive. Exhibitions that turn the paintings of Monet or Van Gogh into interactive, room-encompassing installations have proliferated in recent years, as have immersive theatre productions. Virtual-reality technology has improved significantly.

From another angle, it is part of the evolution of the modern rock concert, which since the 1960s has combined light and sound to transport fans into another dimension. At a show your correspondent attended at the Sphere in October, there were moments when the experience was transcendent. (There is a quiet room, filled with bean bags, for the over-stimulated.) Yet viewers still took their eyes off the big screen to reach for the smaller ones in their pockets. At times the band seemed like an expensive soundtrack to the bright lights.

Is this the future of the concert? In the short term, no. The sheer cost of the Sphere—$2.3bn—means that the model cannot be easily reproduced. Its ostentation is also a barrier: Sadiq Khan, the mayor of London, recently vetoed a sister Sphere in the city, calling it "bulky, unduly dominant and incongruous". Sphere Entertainment Company, the owner, hopes to build other iterations and is in "serious" talks for an arena in Abu Dhabi. But negotiations regarding Spheres in Saudi Arabia and South Korea have stalled.

Some artists and promoters are said to be wary of developing shows that cannot be taken on tour to other, standard arenas and of letting the venue outshine the music. For now, at least, what happens in Vegas is staying there.

The Sphere does mark a bullish bet on the future of live music, however. The biggest acts have long had to make do with sports stadiums with dodgy acoustics, but this is a capacious, purpose-built venue. There seems to be

plenty of demand for lavish productions by the biggest hitmakers: witness the billions of dollars in revenue made by Beyoncé's "Renaissance" and Taylor Swift's "Eras" tours.

According to Luminate, an analytics firm, in 2023 consumers spent 91% more on live music events than the year before and attended 32% more concerts. Goldman Sachs predicts the market for live music will grow by 5% this year to reach nearly $40bn annually by 2030.

This growth is not just driven by pent-up demand from the pandemic. Youngsters, who prefer to spend their money on experiences than on items, consider concerts good value, even when they are pricey. "People still want to have that experience of liveness," says Steve Waksman, a concert historian, regardless of whether, as at the Sphere, it is "mediated" through screens. To some, the Sphere may be more bewildering than beautiful, but one thing is clear: the future of concerts is as rosy as Bono's trademark glasses. ■

拉斯维加斯的Sphere揭幕了演唱会的未来吗？

这个场馆令人眼花缭乱。但复刻品不太可能很快建造出来

距离拉斯维加斯大道步行不远，林立的酒店和会议中心之间有一个巨大的、瞪着大眼睛的表情符号。有时它会变成一个巨大而逼真的眼球、一颗篮球或一团火焰。这是一个名为Sphere的新奇演唱会场馆，高366英尺（110米），宽516英尺；外表覆盖着近60万平方英尺的LED屏幕。

场馆内有17,500个座位，顶棚又是一个超高分辨率的巨大屏幕。这个富丽堂皇的欢乐王国提供了一种绝无仅有的体验，也提出了关于现场娱乐未来发展的问题。

这个高科技场馆的首演是U2在去年9月举办的演唱会，他们在那里的驻场演出将一直持续到今年3月。这支爱尔兰乐队向来热衷创新演唱会设计及企业创投，包括与苹果的长期合作。也许同样重要的是，U2受到中年摇滚乐迷的喜爱，而这些人构成了美国演唱会观众的主体，可能为价格不菲的门票掏腰包。（票价140美元起，最高达1500美元。）

U2此次演唱会是对1991年发布的专辑《Achtung Baby》的纪念演绎，整个演出被打造成一个壮丽幻境。乐队在一个形似唱机转盘的舞台上表演，而艾斯·德芙琳（Es Devlin）和约翰·杰拉德（John Gerrard）等艺术家的作品出现在头顶的屏幕上。在演唱《Even Better Than the Real Thing》时，屏幕上是老虎机动画和猫王俗艳风格的影像。到《Where the Streets Have No Name》时，观众被带入到高地沙漠的耀眼日光中。等到《With Or Without You》，顶棚屏幕上则满是叶鼻蝠等濒危本地物种的图像。"这场演出也是为了展现它的演出场馆，"U2的长期制作设计师威利·威廉姆斯（Willie Williams）说，"要的就是让大家都能体验这个场馆。"

从一个角度来看，在艺术变得更加沉浸式的现行趋势中，Sphere代表了一个重大发展。近些年来，将莫奈或梵高的画作变成环绕整个房间的交互式

装置的展览层出不穷。沉浸式戏剧制作也是如此。虚拟现实技术已经有了长足进步。

从另一个角度来看，它是现代摇滚演唱会演变的一部分。自1960年代起，摇滚演唱会就结合了灯光和音效来将粉丝带入另一个维度。去年10月笔者观看了在Sphere举行的一场演出，在某些时刻会有超然的体验。（那里有一个安静的房间，里面放满了豆袋沙发，专供太过兴奋的人回复平静。）不过，观众们仍然会把目光从大屏幕上移开，伸手去摸口袋里的小屏幕。有时候，乐队似乎就是绚丽灯光的昂贵配乐。

这是演唱会的未来吗？从短期来看，不是。Sphere那23亿美元的巨额造价让这种模式不易被复制。它的张扬也是一个障碍：伦敦市长萨迪克·汗（Sadiq Khan）最近否决了该市的一个Sphere姊妹项目，称它"笨重、过分突出且不协调"。Sphere的所有方Sphere娱乐公司（Sphere Entertainment Company）希望建造其他迭代版本，目前正就在阿布扎比建造一个场馆展开"严肃"谈判。但关于在沙特阿拉伯和韩国建造Sphere的谈判已经搁浅。

据称有些艺术家和推广公司对于制作无法在其他标准场馆巡演的表演持谨慎态度，也担心场馆会抢走音乐的风头。至少目前来看，发生在拉斯维加斯的还是会留在拉斯维加斯。

然而，Sphere确实对现场音乐的未来发展做出了大胆押注。长期以来，最大型的音乐活动只能将就着在音响效果不佳的体育场馆中举办，但Sphere是一个专为这类表演打造的大容量场馆。对于顶流音乐人的豪华制作似乎需求很大，碧昂丝的Renaissance巡演和泰勒·斯威夫特的Eras巡演创造出的数十亿美元收入就是例证。

据分析公司Luminate统计，2023年消费者在现场音乐活动上的支出比前一年增加了91%，观看演唱会的次数增加了32%。高盛预测，现场音乐市场今年将增长5%，到2030年将达成近400亿美元的年收入。

这一增长不仅仅是因为因疫情而受抑制的需求得到了释放。年轻人更愿意把钱花在体验而不是实物上，即使演唱会票价昂贵，他们也认为这物有所

值。"人们仍然渴望那种现场体验"，研究演唱会历史的史蒂夫·沃克斯曼（Steve Waksman）表示，无论是否像在Sphere那样通过屏幕来"传递"。对一些人来说，Sphere打造的可能更多是迷乱而非美感，但有一点是明确的：演唱会的未来就像U2主唱博诺（Bono）那标志性的粉紫色墨镜一般瑰丽。■

Why BlackRock is betting billions on infrastructure

Demand for investment is soaring thanks to decarbonisation, digitisation and deglobalisation

THE GLOBAL economy is on the cusp of an "infrastructure revolution", if Larry Fink is to be believed. The boss of BlackRock, the world's largest asset manager, made the modest prediction shortly after announcing on January 12th that his firm would acquire Global Infrastructure Partners (GIP) for $12.5bn. That company, led by Adebayo Ogunlesi, an old pal of Mr Fink's from their banking days, is the world's third-largest infrastructure investor, behind Australia's Macquarie and Canada's Brookfield. Its assets range from Gatwick Airport in London to the Port of Melbourne. Mr Ogunlesi and his fellow partners will collectively become BlackRock's second-largest shareholder.

Mr Fink is not the only one excited about the industry. On January 16th General Atlantic, a private-equity (PE) firm, confirmed reports that it would buy Actis, an infrastructure investor focused on emerging markets. In September CVC, another PE firm, announced it was buying DIF, a Dutch infrastructure investor. Over the past decade assets under management in infrastructure funds have increased almost five-fold, to $1.3trn, according to Preqin, a data provider. Pension funds and sovereign-wealth managers have been lured in by the industry's returns, which are both handsome and relatively stable. More than half of such backers surveyed by Preqin intend to increase the share of their portfolios allocated to infrastructure. Some of the larger among them now invest directly in these dull assets. Why, then, all the excitement?

The infrastructure-investment business took shape in the 1990s and 2000s. Western governments with growing debts began seeking out private

investors to acquire—and help rejuvenate—ageing infrastructure from airports and railways to water pipes. Later, a growing assortment of companies from energy suppliers to telecoms operators also turned to infrastructure investors to offload assets such as pipelines and cell towers, observes Sam Pollock, boss of Brookfield's infrastructure business.

Now demand for infrastructure investment is soaring thanks to three megatrends, explains Mr Pollock. The first is decarbonisation. For the world to meet its climate goals, some $8trn will need to be invested over the remainder of this decade in renewable energy such as solar and wind, as well as batteries to store it and transmission lines to transport it. Hefty investments will also be needed in hydrogen facilities, to produce carbon-free fuel for planes and ships, and in carbon removal. The second megatrend is digitisation. Software may well be eating the world, as a venture capitalist once predicted, but it is relying on an awful lot of physical assets to do it, from fibre-optic cables and 5G networks to data centres. Third, deglobalisation. Efforts to shift supply chains away from China are spurring demand for capital-hungry factories and new transport infrastructure to move goods over land and sea. In Europe concerns about energy security following Russia's invasion of Ukraine have also provoked a rush to build liquefied-natural-gas terminals to bring in the fuel from less belligerent places.

All that demand for investment is arriving at a time when government and corporate balance-sheets are under strain. America's $26trn (98% of GDP) pile of federal-government debt is expected to continue expanding over the coming decade. Many governments in Europe also have weighty debt burdens. Higher interest rates are making those liabilities more expensive to service. They are also making life awkward for companies which have gorged on cheap debt to juice shareholder returns. The need to deleverage will limit their ability to make big investments in the years ahead. Infrastructure investors are ready and willing to fill the gap. In 2022 Intel, a

big chipmaker, turned to Brookfield to fund 49% of a new $30bn chip factory in America.

So far most infrastructure investors have concentrated on rich countries, where governments are more dependable and currencies more stable. More than four-fifths of assets under management in the industry are allocated to Western markets, according to data from Preqin. At the same time, the need for new infrastructure is most pronounced in the global south, where both populations and economies are growing faster. "Emerging-market investment is a big opportunity for us," says Raj Rao, one of GIP's co-founders. Leigh Harrison, who leads infrastructure investing at Macquarie, notes that his firm is increasing the share of its funds it allocates to such markets.

The industry, then, looks set to become increasingly important to the global economy. Yet it is not without its detractors. In Britain Macquarie has been criticised for its stewardship of Thames Water, which manages the water supply of London and its surrounds. During its ownership of the utility from 2006 to 2017, Macquarie tripled the company's debts, to £11bn ($14bn), helping to deliver a hefty return for itself and fellow shareholders. Since then the utility, weighed down by those debts, has struggled to afford necessary investments in fixing leaky pipes and reducing the sewage it pumps into rivers. Mr Harrison counters that £1bn a year was invested in the company during Macquarie's tenure as its owner, more than in any previous period. Still, he concedes that "markets were very different" when it bought the business, and that his firm no longer loads its assets with debt to the same extent.

From spreadsheets to hard hats

In a world of pricier debt, the way infrastructure investors make money is shifting from financial engineering to cleverer management of assets. Mr Harrison notes that Macquarie is bulking up the number of industry

experts in its team. "Where we really add value is when we bring greater operational rigour to an asset," says Mr Rao of GIP. He offers the example of Gatwick, where GIP has focused on speeding up security screening, leaving travellers with more time to relax—and indulge in some pre-flight shopping. For the infrastructure firms, merely shopping around for assets is increasingly an indulgence, too. ■

为什么贝莱德在基建上押注上百亿美元

脱碳、数字化和去全球化导致对投资的需求飙升

如果拉里·芬克（Larry Fink）的话可信的话，那么全球经济正处于一场"基础设施革命"的前沿。这位全球最大资产管理公司贝莱德（BlackRock）的老板在1月12日宣布将以125亿美元收购全球基础设施投资公司（Global Infrastructure Partners，简称GIP），之后不久做出了这个温和的预测。由芬克在银行工作时的老朋友阿德巴约·奥贡莱西（Adebayo Ogunlesi）领导的GIP是全球第三大基建投资公司，仅次于澳大利亚的麦格理（Macquarie）和加拿大的布鲁克菲尔德（Brookfield）。从伦敦盖特威克机场（Gatwick Airport）到墨尔本港（Port of Melbourne），它的资产遍布全球。奥贡莱西和他的几个合伙人将共同成为贝莱德的第二大股东。

芬克并不是唯一一个对基建投资兴致浓厚的人。1月16日，私募股权公司General Atlantic证实了有关它将收购新兴市场基建投资公司Actis的报道。去年9月，另一家私募股权公司CVC宣布将收购荷兰基建投资公司DIF。据数据供应商Preqin称，过去十年里，基建基金管理的资产增长了近四倍，达到1.3万亿美元。养老基金和主权财富管理公司被这个行业既丰厚又相对稳定的回报所吸引。根据Preqin的调查，超过一半的此类投资机构计划增加其投资组合中分配给基建的份额。其中一些较大的机构已经在直接投资这些一点也不光鲜亮丽的资产。那么，对基建的兴趣为什么如此浓厚呢？

基建投资业务在上世纪90年代和2000年代初具规模。当时西方政府的负债不断增长，它们开始寻求私人投资者收购并帮助翻新从机场和铁路到水管等老化的基础设施。后来，从能源供应商到电信运营商等越来越多的公司也开始找基建投资公司出手管道和手机信号塔等资产，布鲁克菲尔德的基建业务负责人萨姆·波洛克（Sam Pollock）说。

如今有三个超大趋势导致了基建投资需求的飙升，波洛克解释说。首先是脱碳。为了实现全球气候目标，到2030年前需要向可再生能源（如太阳能

和风能）、储能电池和输电线路投资约8万亿美元。飞机和船用无碳燃料的氢能生产设施以及碳移除也需要巨额投资。第二个大趋势是数字化。正如一位风投家曾经预测的那样，软件可能确实在吞噬世界，但这需要通过光纤电缆、5G网络和数据中心等大量有形资产来实现。第三个趋势是去全球化。将供应链移出中国的努力推动了对工厂和新的陆海运输基础设施的需求，这些都需要大量资本。俄罗斯入侵乌克兰后，欧洲对能源安全的担忧也引发了快速建设液化天然气终端的热潮，以从不易燃起战火的地区进口燃料。

所有这些投资需求都发生在政府和企业的资产负债表承压之时。美国联邦政府的债务达到26万亿美元（相当于GDP的98%），预计未来十年将继续增长。欧洲许多政府的债务负担也非常沉重。利率上升让偿债成本变得更高。那些在过去大举借入低息贷款来提高股东回报的公司日子也不好过了。去杠杆化的需要将使这些公司在未来几年内难以大规模投资。基建投资公司能够并且也愿意填补这一缺口。2022年，芯片巨头英特尔向布鲁克菲尔德公司寻求融资，为自己将在美国投资300亿美元新建的芯片工厂提供49%的资金。

迄今为止，大多数基建投资公司都聚焦于政府更可靠、货币更稳定的富裕国家。根据Preqin的数据，基建投资行业管理的资产超过五分之四都配置在西方市场。与此同时，对新基础设施的需求在人口和经济增速都更快的全球南方地区最为凸显。GIP的联合创始人之一拉吉·拉奥（Raj Rao）表示："投资新兴市场对我们来说是一个巨大的机会。"麦格理的基建投资主管利·哈里森（Leigh Harrison）指出，他的公司正在增加对这些市场的资金配比。

因此，看起来这个行业对全球经济的影响必将与日俱增。但对该行业也不乏指摘之声。在英国，麦格理对负责伦敦及周边地区供水的泰晤士水务公司（Thames Water）的管理饱受批评。在2006年至2017年间，在麦格理的管理下，该公司的债务增加了两倍，达到110亿英镑（140亿美元），为麦格理和其他股东带来了可观的回报。此后，由于债务负担沉重，这家水务公司难以拿出必要的投资修复漏损的管道和减少向河流排放污水。哈里森

反驳说，麦格理在其管理期内每年向该公司投资1o亿英镑，投资力度比以往任何时期都大。不过他也承认，在麦格理收购该公司时"市场情况大不相同"，而且如今麦格理也不再让旗下资产有那么高的负债。

| 从电子表格到安全帽

在债务成本更高的大环境下，基建投资公司赚钱的方式正在从金融工程转向更巧妙的资产管理。哈里森指出，麦格理正在团队中加入更多的行业专家。"我们真正增加价值的地方是提升资产运营的严谨度。"GIP的拉奥表示。他以盖特威克机场为例，GIP着重加快安检速度，让旅客能有更多时间放松——也能在登机前纵情购物。而对于基建投资公司来说，只记着四下拣选划算的资产也日益是一种奢侈放纵了。■

AI-generated content is raising the value of trust

Who did the posting will soon matter more than what was posted

IT IS NOW possible to generate fake but realistic content with little more than the click of a mouse. This can be fun: a TikTok account on which—among other things—an artificial Tom Cruise wearing a purple robe sings "Tiny Dancer" to (the real) Paris Hilton holding a toy dog has attracted 5.1m followers. It is also a profound change in societies that have long regarded images, video and audio as close to ironclad proof that something is real. Phone scammers now need just ten seconds of audio to mimic the voices of loved ones in distress; rogue AI-generated Tom Hankses and Taylor Swifts endorse dodgy products online, and fake videos of politicians are proliferating.

The fundamental problem is an old one. From the printing press to the internet, new technologies have often made it easier to spread untruths or impersonate the trustworthy. Typically, humans have used shortcuts to sniff out foul play: one too many spelling mistakes suggests an email might be a phishing attack, for example. Most recently, AI-generated images of people have often been betrayed by their strangely rendered hands; fake video and audio can sometimes be out of sync. Implausible content now immediately raises suspicion among those who know what AI is capable of doing.

The trouble is that the fakes are rapidly getting harder to spot. AI is improving all the time, as computing power and training data become more abundant. Could AI-powered fake-detection software, built into web browsers, identify computer-generated content? Sadly not. The arms race between generation and detection favours the forger. Eventually AI models will probably be able to produce pixel-perfect counterfeits—digital clones

of what a genuine recording of an event would have looked like, had it happened. Even the best detection system would have no crack to find and no ledge to grasp. Models run by regulated companies can be forced to include a watermark, but that would not affect scammers wielding open-source models, which fraudsters can tweak and run at home on their laptops.

Dystopian possibilities abound. It will be difficult, for example, to avoid a world in which any photograph of a person can be made pornographic by someone using an open-source model in their basement, then used for blackmail—a tactic the FBI has already warned about. Perhaps anyone will be able to produce a video of a president or prime minister announcing a nuclear first strike, momentarily setting the world on edge. Fraudsters impersonating relatives will prosper.

Yet societies will also adapt to the fakers. People will learn that images, audio or video of something do not prove that it happened, any more than a drawing of it does (the era of open-source intelligence, in which information can be reliably crowdsourced, may be short-lived). Online content will no longer verify itself, so who posted something will become as important as what was posted. Assuming trustworthy sources can continue to identify themselves securely—via URLs, email addresses and social-media platforms—reputation and provenance will become more important than ever.

It may sound strange, but this was true for most of history. The era of trusted, mass-produced content was the exception. The fact that people may soon struggle to spot the invisible hand of AI does not mean the marketplace of ideas is doomed. In time, the fakes that thrive will mostly be the funny ones. ■

人工智能生成的内容正在提升信誉的价值

很快，谁发布了内容将比发布了什么内容更重要

现在只需轻点鼠标，就能生成虚假但逼真的内容。可能会是好玩的东西，比如一个TikTok账号下五花八门的视频中，有一则是人工合成的汤姆·克鲁斯穿着紫色长袍，对着抱着一只小狗狗的（真人）帕丽斯·希尔顿唱《小小舞者》（Tiny Dancer），该账号已经吸引了510万粉丝关注。这也是一个深刻的社会变化：在此之前，人们长久以来都认为图像、视频和音频几乎等同于某物真实存在的铁证。现在，搞电话诈骗的人只需要十秒钟的音频就能假扮某人的亲人求救，人工智能（AI）生成的汤姆·汉克斯和泰勒·斯威夫特在网上为可疑产品代言，有政客露脸的虚假视频也是层出不穷。

根本的问题其实是个老问题。从印刷术到互联网，新技术往往使传播不实信息或冒充可信者变得更加容易。通常情况下，人类会抓住某些破绽来识别猫腻，比如，如果拼写错误太多，就表明某封电子邮件可能是网络钓鱼攻击。至于最近，AI生成的人物图像往往会因为奇怪的手部细节被识破，伪造的视频和音频有时则会出现音画不同步的问题。现在，有悖于常理的内容马上就会引起那些清楚AI本领的人的怀疑。

麻烦在于，识别虚假的速度越发难以跟上造假的速度。随着计算能力和训练数据日益充裕，AI在不断进步。网页浏览器中内置的虚假内容检测AI软件能否识别计算机生成的内容？可惜不能。生成与检测之间的军备竞赛更有利于伪造者。最终，AI模型很可能能够生成像素级还原的赝品——假如它所呈现的事情真会发生，被记录下来的话也就会是这副样子。即便最好的检测系统也可能找不出破绽，无从下手。可以强制受监管的公司在运营的模型里加入水印，但这并不会影响使用开源模型的骗子们，他们在家里的笔记本电脑上就能调整和运行这些模型。

可能出现的反乌托邦场景俯拾皆是。一个很难避免的例子就是有人可能会

在自家地下室使用开源模型，将任何人物的照片制作成色情内容，然后用于敲诈——美国联邦调查局已经对此发出警告。也许任何人都能制作出某位总统或总理宣布发起先发制人核打击的视频，让世界瞬间进入紧张状态。冒充受害者亲属的诈骗者也会兴风作浪。

然而，社会也将适应造假者的存在。人们将认识到，图像、音频或视频并不能证明某件事情发生过，就像一幅图画不能证明某事发生过一样（可以将信息收集任务可靠地众包出去的开源情报时代可能不会长久了）。在线内容将不再能自证真实性，因此是谁发布了内容将变得和发布了什么内容一样重要。假如值得信赖的信息来源能够继续通过URL、电子邮件地址和社交媒体平台安全可靠地证明自己的身份，声誉和内容出处就将变得前所未有地重要。

这听起来可能很奇怪，但这在历史上的大部分时期都成立。批量生产可信内容的时代才是个例外。人们可能很快就会难以找出AI这只看不见的手，但这并不意味着思想市场从此就要完蛋了。随着时间的流逝，能好好存活下来的虚假内容将主要是搞笑好玩的那种。■

How to cut through the cacophony over DEI

Outrage on right and left obscures both the costs of DEI and the benefits of diversity

WHAT, IF ANYTHING, should firms do to improve the diversity of their workforce? After the murder of George Floyd in 2020, many bosses felt compelled to act. Partly out of fear of being called out for prejudice, corporate America rushed to embrace diversity, equity and inclusion (DEI) schemes. By 2022 three-quarters of the S&P 500 had a chief diversity officer; more than two-fifths of listed firms set targets to increase the racial diversity of their workforce. Now many think the pendulum has swung too far.

The resignation of Claudine Gay, a black woman, as president of Harvard University has ignited a broader debate about merit and identity. Bill Ackman and Elon Musk, two billionaires, have excoriated DEI for itself being discriminatory. After the Supreme Court's landmark decision to end affirmative action in university admissions last summer, many activists and politicians increasingly have corporate DEI schemes in their sights.

As America's culture wars rage on, bosses are being caught in the middle. Progressives argue that DEI enables companies to do their bit to tackle America's entrenched inequalities. Conservatives see it as an attack on meritocracy. One side ignores the costs of many DEI schemes, the other ignores the real benefits of diversity. How should businesses cut through the noise?

The critics are right that the thinking on DEI is muddy, and that many DEI initiatives are ineffective, even harmful. In 2015 McKinsey, a consultancy, identified a positive correlation between the gender and ethnic diversity of the workforce and firms' profitability. Although academics have since

criticised its methodology, the findings were breathlessly cited by bosses and corporate advisers, and the link was treated as causal and cast-iron. For example, from 2023 Nasdaq required firms listed on its stock exchange to have at least one board member who was not a straight white man—or explain why they do not. It was left to Jesse Fried, a professor at Harvard Law School, to point out that Nasdaq was ignoring scholarship which finds that board diversity can have a negative impact on performance.

Diversity schemes often fail. Sometimes this betrays bad faith: firms with a discrepancy between their words and actions are often accused of "diversity washing". Some schemes are well-meant but ineffective. Research by Frank Dobbin and Alexandra Kalev showed that diversity training programmes fail to reduce bias. In the worst instances, DEI initiatives backfire. Targets can be seen as quotas, which undermine the principle of fair competition and cast a shadow over minorities who do well under them. Other research shows that adding equal-employment statements to job advertisements can put minority candidates off applying. No wonder support for votes on social issues at annual general meetings is draining away.

The case for diversity does not need dressing up in pseudoscience. The simple reason for businesses and their shareholders to care about recruiting people from a broad range of backgrounds is that they want the most able people. Mr Musk and Mr Ackman are both successful businessmen: they too want to assemble the best possible teams.

Opus DEI

Diversity should be a spur to looking far and wide for talent, no matter someone's gender, race or sexual orientation. A firm convinced that it is overlooking the best candidates from a particular demographic cohort, for example, could choose to lengthen its shortlists to include more from that group. That will not mechanically create workforces that mirror the

population, but it can maximise talent and diversity of thought. Quotas, by contrast, have the perverse effect of narrowing the search by excluding talent. As with so many areas touched by the culture wars, the row over DEI has become muddle-headed. The clear, simple argument for diversity is being drowned out. ■

如何冲破"多元共融"的喧嚣争论

右翼和左翼的愤怒掩盖了DEI的代价和多元化的好处

如果真有办法的话，公司应该做些什么来提升员工队伍的多元化呢？2020年乔治·弗洛伊德（George Floyd）遇害后，许多老板感到不得不采取行动。部分出于担心被指责存在偏见，美国企业界急于拥抱"多元、公平和包容"（DEI）体系。到2022年，标准普尔500指数中四分之三的公司都设有首席多元化官，超过五分之二的上市公司设定了提升员工种族多元化的目标。现在许多人认为企业在这条路上走得太远了。

黑人女性克劳丁·盖伊（Claudine Gay）辞去哈佛大学校长一职，引发了一场关于才能和身份的更广泛辩论。比尔·阿克曼（Bill Ackman）和马斯克这两位亿万富翁曾批判DEI本身具有歧视性。去年夏天，美国最高法院做出了具有里程碑意义的裁定，终止了大学招生中的平权法案。此后，越来越多的活动人士和政界人士开始关注企业的DEI制度。

随着美国的文化战愈演愈烈，老板们被夹在了中间。进步派认为，DEI让企业能够为解决美国根深蒂固的不平等问题尽自己的一份力。保守派认为，这是对优绩主义的攻击。一方忽视了许多DEI制度的代价，另一方忽视了多元化的真正好处。企业应该如何在各种声音中理清头绪？

批评DEI的人没有说错，关于DEI的思考是混乱的，许多DEI举措是无效甚至是有害的。2015年，咨询公司麦肯锡发现，员工的性别和种族多元化与公司盈利能力之间存在正相关关系。尽管学者们之后对它的研究方法提出了批评，但老板和企业顾问们急不可待地引用这项研究结果，把这种关联性视作因果关系且确凿无疑。例如，从2023年起，纳斯达克要求在其证券交易所上市的公司至少得有一名董事会成员不是异性恋白人男性，如果没有，就要做出解释。哈佛大学法学院教授杰西·弗里德（Jesse Fried）指出，纳斯达克忽略了发现董事会多元化会对业绩产生负面影响的学术研究。

多元化计划经常失败。有时这暴露了公司不诚信：言行不一的公司常被指斥搞"虚假多元化"。有些计划意图是好的，但效果不佳。弗兰克·多宾（Frank Dobbin）和亚历山德拉·卡列夫（Alexandra Kalev）的研究表明，多元化培训计划未能减少偏见。最糟糕的情况是DEI方案适得其反。目标会被视为配额，这破坏了公平竞争的原则，并给在这样的计划中表现良好的少数群体蒙上了阴影。其他研究表明，在招聘广告中加入平等就业声明可能会让少数群体求职者放弃申请。难怪在年度股东大会上对社会问题投票的支持正在减少。

想要多元化不需要用伪科学来粉饰。企业及其股东重视从广泛背景中招聘人才的一个简单原因是，他们想要最有能力的人。马斯克和阿克曼都是成功的商人，他们也想组建最好的团队。

DEI事业

多元化应该激励人们将眼光放宽放远去寻求人才，无论他们的性别、种族和性取向如何。例如，如果一家公司确信自己忽视了某个人口群体中的最佳候选人，它可以选择加长候选名单，将更多来自该群体的人包括进来。这样不会机械地打造出完全对应人口构成的员工队伍，但可以最大限度地寻找人才并实现想法的多样性。相比之下，配额制产生了将人才排除在外、缩小搜索范围的反效果。和许多受文化战波及的领域一样，关于DEI的争执已经变成一团乱麻。支持多元化的清晰、简单的理由正在被淹没。∎

Donald Trump is winning. Business, beware

What a second term would mean for American business and the economy

WHEN DONALD TRUMP slunk out of the White House in 2021, executives at large American companies sighed with relief. Now that he has won Iowa's caucuses by a margin of 30 points, they are digesting the reality that this time next year Mr Trump could be behind the Resolute desk once again. The Economist has spent the past few weeks talking to these titans. Some are deeply alarmed by the prospect of Trump 2. But others quietly welcome the chaos trade.

People who run large organisations have to be optimistic. They must find opportunities when others are panicking. CEOs had an uneasy relationship with President Trump, many distancing themselves from his most outrageous pronouncements and tut-tutting about protectionism, even as they enjoyed his more conventional policies. Republicans in Congress may have talked about being the pro-worker party, but in practice they cut business taxes. It was hard for corporate America to be miserable amid a soaring stockmarket.

If Mr Trump is indeed elected again, those running big firms plan to keep their heads down ("don't be Bud Light" is a frequent refrain, after the beer brand fell victim to the culture wars). They would avoid being dragged onto Mr Trump's business councils, dodge presidential photo-ops and get on with making money. True, if Mr Trump did a deal with Russia that ended the war and sold out Ukraine, that would be bad for Western civilisation. But it would reduce energy bills.

What's more, Trump enthusiasts in the C-suite have plenty of grumbles about Joe Biden. Mention Lina Khan, who oversees the Federal Trade

Commission (the antitrust police), or Gary Gensler, who leads the Securities and Exchange Commission (the Wall Street police), and they inhale sharply. Mr Biden wants to raise taxes on companies. His administration also wants to go ahead with the Basel III "Endgame" regulations, which oblige big banks to hold perhaps 20% more capital on their balance-sheets, sedating animal spirits and damaging profitability.

Yet this bullish case for Mr Trump's economic management is complacent. It fails to recognise how Trumponomics—a mix of deficit-funded tax cuts and tariffs—would work differently today. And it ignores the ways in which Mr Trump's most chaotic tendencies could threaten America, including its companies.

In his first term the economy did better than many economists (including ours) expected. That was in part because Trumponomics turned out to be more moderate than the campaign had promised. The economy was also running further below capacity than thought, making it possible to cut taxes without stoking inflation. Strong overall growth and low inflation masked the damage done by Mr Trump's protectionism.

There is no evidence that Mr Trump has updated his approach: he is still a tax-cuts-and-debt guy. But the economic conditions have changed. For the past two years the Federal Reserve has been trying to bring down inflation. Though it has nearly succeeded, the labour market remains tight. Today 2.8m more 25- to 54-year-olds are in work than would be if the employment rates of January 2017 had persisted. Then there were 1.3 unemployed workers for every job opening; today there are only 0.7. As a result the economy is more prone to overheating.

The budget is in worse shape, too. In 2016 the annual deficit was 3.2% of GDP and debt was 76% of GDP. The forecasts for 2024 are 5.8% and 100%, respectively. Should Mr Trump once again pursue tax cuts, the Fed will have

to hike up interest rates to offset the stimulus, making it costlier for businesses to raise capital and for the government to service its growing debt pile.

These are the conditions under which Latin American populists bully their central banks to keep rates low, a practice Mr Trump dabbled in last time. The Fed is supposed to be independent, but Mr Trump will have a chance to nominate a stooge as chair in May 2026 and a pliant Senate could indulge him. The risk of more inflation would surge, perhaps exacerbated by more tariffs, which would also slow growth.

On top of that big macroeconomic risk are many others. Firms would not relish further trade restrictions, but some members of Mr Trump's circle have floated a 60% tariff on imports from China. Lots of companies like the federal government's support for renewable energy (which Mr Trump calls the Green New Scam). He has promised the biggest deportation scheme in American history to reduce the number of illegal immigrants in the country. As well as causing misery, this would be a shock to that tight labour market.

As ever, saying what Mr Trump would actually do is very hard: he has few fixed beliefs, is a chaotic boss and can reverse position several times a day. In a town hall in Iowa he said he would be too busy in his second term to seek retribution against his political enemies. That was a few hours after his own campaign sent out an email with the subject line: "I am your retribution!" He could recognise Taiwan's independence, prompting a meltdown in Beijing and a blockade of the island. Or he could walk away from Taiwan in exchange for China buying more stuff from America. Businesses often say that what they fear most is uncertainty. With Mr Trump that is guaranteed.

This unpredictability could make a second Trump term very much worse

than the first. His administration would lack establishment types like Gary Cohn, once of Goldman Sachs, to shuffle the president's in-tray and hide the madder ideas from him. More moments like January 6th are possible, as is a full-on revenge presidency. The idea that in this scenario business leaders could keep a low profile and focus on EBITDA is fanciful. Employees, customers and the press would demand to know where bosses stood and what they proposed to do. The administration might in turn take exception to every whiff of criticism.

In the long run, the idea that corporate profits can be insulated from societal upheaval is a fantasy. If Mr Trump is broadly corrupting of American politics, and businesses are seen to profit from his rule, that poses a big risk to them in the future. In Latin America, when big businesses have become associated with autocrats the result was usually that capitalism was discredited and the appeal of socialism rose. That seems unthinkable in America. But so, until recently, did a second Trump term. ■

特朗普传捷报，商界要当心

他重回白宫将如何影响美国商业和经济

特朗普在2021年离开白宫时，美国大企业的高管们都松了一口气。现在，眼看特朗普在艾奥瓦州共和党党团初选中以30个百分点的优势击败对手，他们正在消化一个现实：明年此时，特朗普有可能重新坐到白宫的坚毅桌后。过去几周，本刊采访了这些大佬们。有人对特朗普可能的回归深感不安，但也有人暗暗期待商界乱世的来临。

做大企业的老板是必须保持乐观的。他们要在别人惊慌失措时找到机会。特朗普在任时，企业老板们和这位总统的关系尴尬，他们很享受他那些更偏保守的政策，但同时许多人会跟他的出格言论保持距离，对他的保护主义做派发出啧啧不满声。共和党人在国会里也许声称自己是为工人谋求利益，但在行动上却是给商界减税。在强劲牛市之下，美国商界那时想过苦日子都难。

假如特朗普真的再次当选，那些美国大企业的高管打算低调行事（百威的淡啤酒品牌昕蓝成了文化战的牺牲品后，大家都在念叨着"别成了百威昕蓝"）。他们不要被拉进特朗普的商业顾问团，不要和总统合影，而是继续埋头赚钱。诚然，假如特朗普与俄罗斯达成协议，结束俄乌战争，出卖乌克兰，对西方文明来说是件坏事。但这会降低能源价格。

而且，这些企业高管中的特朗普支持者对拜登有诸多不满。一提到反垄断机构美国联邦贸易委员会的主席丽娜·可汗（Lina Khan）或者金融监管机构美国证券交易委员会的主席加里·盖斯勒（Gary Gensler），他们都会倒吸一口冷气。拜登想对公司加税。拜登政府还计划推进实施《巴塞尔协议III》"终局"规则，要求大银行在资产负债表上多持有大约20%的资本，抑制动物精神，破坏盈利能力。

然而，如此看好特朗普的经济管理就想得太美了。这没能意识到特朗普经

济学（以赤字支持的减税和加征关税）到如今可能会有不一样的效果，还忽视了特朗普反复无常的行事风格可能如何威胁到美国，包括美国的企业。

在特朗普的第一个任期内，美国经济的表现优于许多经济学家（包括本刊）的预期。部分原因是特朗普经济学的实际执行力度比竞选时的承诺更温和。经济离满负荷运行的距离也大于预期，这使得政府可以在不刺激通胀的情况下减税。强劲的总体增长和低通胀掩盖了特朗普保护主义带来的伤害。

没有证据表明特朗普已经更新了策略：他还是主张减税和举债。但经济形势已然改变。过去两年来，美联储一直在努力降低通胀。尽管这一努力接近成功，但劳动力市场依然紧张。如果2017年1月时的就业率持续到现在，25岁至54岁的就业人口会比现实情况少280万。那时的职位空缺与失业者比率为1：1.3，而现在仅为1：0.7。所以现在经济更容易过热。

财政预算状况也比之前糟糕。2016年，美国的年度赤字和债务占GDP的比例分别为3.2%和76%，而对2024年的预测为5.8%和100%。如果特朗普再次推行减税政策，美联储将不得不加息以抵消这种刺激，这将使企业融资成本上升，债台高筑的政府偿债成本也会增加。

拉美的民粹主义者就是在这种情况下迫使本国央行维持低息的，特朗普在上个任期内也已经试过了。美联储本应是独立的，但特朗普将有机会在2026年5月提名一个亲信担任美联储主席，一个温顺的参议院可能对他的做派听之任之。通胀加剧的风险可能会猛增（也许是由于关税加码火上浇油），这也会拖慢经济增长。

除了这一重大宏观经济风险外，还有许多其他风险。企业不愿看到进一步的贸易限制，但特朗普圈子里的一些人已提出对从中国进口的商品征收60%的关税。很多公司希望联邦政府支持可再生能源（特朗普称之为"绿色新骗局"）。他承诺推行美国史上最大规模的驱逐计划以减少国内非法移民的数量，这不但会造成不幸，还会对美国紧张的劳动力市场造成冲

击。

与以往一样，要预测特朗普实际会怎么做非常之难：他没什么确定的信念，是个言行混乱的老板，一天之内就可能多次改变立场。在艾奥瓦州一个市政厅内，他说自己在第二个任期会忙得不可开交，没空去报复政敌。而就在几小时前，他自己的竞选团队还发出了一封邮件，主题是"我是你的报应！"他可能承认台湾独立，触怒北京并导致台湾被封锁。他也可能放弃台湾，换取中国大陆从美国进口更多商品。商界人士常常说他们最害怕的是不确定性。假如特朗普上台，肯定会带来不确定性。

这种不可预测性可能会让特朗普第二个任期的情况比第一个任期糟糕得多。他的政府将缺少像曾在高盛任职的加里·科恩（Gary Cohn）这样的建制派来梳理总统案头的公务，挡下一些他的疯癫想法。1月6日骚乱事件这样的时刻一再出现是可能的，在任期内全面复仇也是有可能的。在这样的境况下还认为企业领导者还可以保持低调、专注赚钱，那真是异想天开了。员工、客户和媒体都将会要求了解企业老板在选举中的立场和提出的商业方案。特朗普政府继而可能就嗅到的任何一丝批评气味做出强烈反应。

长远来看，认为企业利润可以不受社会动荡的影响无异于白日做梦。假如特朗普全面腐蚀美国政治，且人们认为企业从他的统治中谋利，它们的未来就会面临巨大风险。在拉丁美洲，当大企业与威权主义者搭上关系，结果通常是资本主义信誉扫地，社会主义吸引力上升。这在美国似乎是难以想象的。但要知道，"特朗普重回白宫"在不久前也是那么难以想象。■

Hollywood studios are finding new ways to bring stories to life

Watch "Stranger Things" on stage, eat at a Batman-themed restaurant—or take your chances at "Squid Game"

THE LATEST episode in Netflix's "Stranger Things" saga was released on December 14th, featuring levitating bodies, shrieking monsters and an exploding rat. The reviews were stellar. Yet unlike the previous season of the science-fiction show, which clocked nearly 1bn hours of viewing in its first month, the most recent instalment has so far been seen by only a few thousand people. That is because Netflix's new show is not being streamed down fibre-optic cables to television screens, but performed live on a stage in London's West End.

"Stranger Things: The First Shadow" (pictured), the streamer's first stab at theatre, is playing at the Phoenix, with hopes of an international run. It is not the only example of Tinseltown invading theatreland. A few streets away at the Theatre Royal, Disney offers a live version of "Frozen", while nearby at the Adelphi there is a musical tribute to "Back to the Future". In 2025 a live production of "Paddington" will join the London line-up. Meanwhile on Broadway, Amazon is getting ready to launch a musical of "Transparent", a drama that first ran on its Prime Video service.

Hollywood's turn on the stage is part of a broader shift by the movie business towards live experiences. As attendance at the cinema declines, studios are finding new ways to excite—and monetise—their fans outside their homes. From restaurants and art exhibitions to escape rooms and assault courses, film-makers are concocting novel ways to soak up demand. "There's this insatiable appetite from those mega-fans," says Marian Lee, Netflix's chief marketing officer. "They want more. They'll eat up anything you serve them."

It is a new take on an old playbook. In the 1950s Walt Disney drew a diagram of the mutually reinforcing pillars of his business: movies promoted television spin-offs, which fed demand for theme parks, which sold merchandise, which promoted movies, and so on. Other studios such as Universal copied the blueprint, creating parks and toys from the characters made popular by films.

Today these ventures are more than sidelines. The entertainment industry's turbulent digital transition has left Hollywood more reliant than ever on rollercoasters and plastic lightsabres. In the last financial year Disney's "experiences" division, which includes five theme parks and a fleet of cruise ships, contributed $9bn in operating profit, as its streaming business lost $2.5bn. At the same time the creative engine at the centre of Walt Disney's diagram—the cinema—is sputtering. Worldwide box-office takings for 2023 will be 20% below their pre-pandemic level; even before covid the average American was going to the movies three and a half times a year, down from five in 2000. As the silver screen fades, studios are losing their most powerful way of exciting audiences.

So they are turning to new tactics. Some are doubling down on their parks. Warner Bros, a relative latecomer to the business, opened the world's largest indoor theme park in Abu Dhabi in 2018. Disney announced in September that it would double its investment in its parks and cruises over the next decade, promising "Frozen" lands among other attractions. Universal is building a resort in Texas and in December said it had bought land for a possible park in Britain.

Studios are also devising new kinds of entertainment. Warner opened "Visions of Magic", a Harry Potter "interactive art experience", in Cologne in December and plans a similar show based on its DC Comics series in late 2024. Universal promises an interactive "horror experience" in Las Vegas, based on its catalogue of scary movies, beginning with "Frankenstein"

(1931).

Moviemakers are experimenting with food and drink, too. Warner's eateries range from Park Row, a Batman-themed restaurant in London with a ten-course tasting menu priced at £195 ($246), to Central Perk, a "Friends" café that opened in Boston in November, serving coffee and Joey's meatball sandwiches.

"You're trying to take the pulse of what folks are interested in," says Peter Van Roden of Warner's themed-entertainment division, who monitors merchandise sales, online clicks and box-office receipts to see which titles are good candidates for turning into such experiences. Social media, which encourage sharing and "FOMO" (fear of missing out), have made it easier for short-term "pop-up" experiences to succeed, he adds.

Netflix, the studio that is most sceptical of the cinema, has been among the most innovative at devising alternatives. Before it began organising live events, devotees of popular shows would come to premieres in home-made costumes, says Ms Lee. "We had all these breadcrumbs that were indicating to us that fans wanted a deeper way to get together…and then have something in-person to engage with," she says. Netflix tested various formats, starting with a "Stranger Things" drive-through show during the pandemic, and has since held events including "Money Heist" escape rooms and "Bridgerton" balls.

The latest is a "Squid Game" experience in Los Angeles, where participants play six games based on the show, bossed around by suitably strict guards (there is no prize money, but no risk of execution either). The Economist's contestant came second, in part because he consumed fewer pre-game Korean cocktails from the adjoining bar than some of his rivals.

Unlike Disney, whose parks are priced with an eye on the bottom line,

Netflix sees its events as ads for its shows. The brief is: "What can you give [fans] in between seasons, to really further that excitement that they have around these characters?" says Ms Lee. Prices reflect this: the cost of the 70-minute live "Squid Game" experience starts at $39, while tickets for the "Stranger Things" play are available from £20, cheap by West End standards. (Green-and-white tracksuits and cuddly demogorgons cost extra.) The streaming company does not report revenues for its events or merchandise, but on a recent earnings call described them as "small things".

Can the new in-person experiences make audiences fall in love with characters and stories as the cinema long has? Mr Van Roden, who declares himself a cinema fan, rejects the idea that they are substitutes. But their essential, shared characteristic is that they are communal. "Even if you're not consciously connecting with the people in the room with you, it's this common, human sort of electric connection, that you're sharing it together," he says.

At the "Squid Game" assault course, the cocktail-fuelled contestants have been having such a riotous time together that Netflix has considered adding more soundproofing to the set. The growing number of live attractions from Hollywood means that audiences have more reasons than ever to get off the sofa and have fun with other people—even if the ultimate aim is to persuade them to spend yet more time in front of the television. ■

好莱坞制片厂找到演故事的新方法

观看舞台上的《怪奇物语》，在蝙蝠侠主题餐厅用餐，或者在"鱿鱼游戏"中搏一把

奈飞（Netflix）于去年12月14日推出了长剧集《怪奇物语》（Stranger Things）的最新一集，里面有悬在半空的人、尖叫的怪物和一只爆炸的老鼠。观众好评如潮。然而，不像该科幻剧的上一季在第一个月就有接近10亿小时的观看时长，这最新一集迄今为止只有几千人看过。这是因为奈飞的这集新剧不是通过光纤传输到电视屏幕上，而是在伦敦西区的一个舞台上现场表演。

《怪奇物语：第一道暗影》（Stranger Things: The First Shadow，如图）是奈飞首次涉足剧院，目前正在凤凰剧院（Phoenix）上演，并希望能开展国际巡演。这并不是好莱坞入侵戏剧界的唯一例子。在几条街之外的皇家剧院（Theatre Royal），迪士尼推出了《冰雪奇缘》剧场版，而附近的阿德尔菲剧院（Adelphi）正在上演致敬《回到未来》（Back to the Future）的音乐剧。2025年，剧场版的《帕丁顿熊》将登上伦敦的演出剧目名单。与此同时，在百老汇，亚马逊正准备推出音乐剧版的《透明家庭》（Transparent），这部剧集是在亚马逊的Prime Video上首播的。

好莱坞作品登上舞台反映了电影业向现场体验转变的大趋势。随着电影院上座率下降，制片公司正在找出新办法来吸引影视剧迷们走出家门和掏腰包。从餐馆和艺术展览，到密室逃脱和障碍训练场，电影制作者正在编造全新的戏法来满足观众需求。"超级粉丝的胃口永远填不饱，"奈飞的首席营销官玛丽安·李（Marian Lee）表示，"他们总要更多。你拿出什么，他们都会消化掉。"

这实是新瓶装旧酒。上世纪50年代，华特·迪士尼绘制了一张商业版图，让他的几大业务支柱相互支撑加固：电影促进电视衍生节目的开发，为主题公园带来需求，后者又销售周边商品，进而为电影增加热度，如此循环。环球影业等其他制片公司也如法炮制，用电影中的热门角色创造了主

题公园和玩具。

如今，这些不再只是副线业务。娱乐行业的数字化转型激烈动荡，让好莱坞变得比以往任何时候都更加依赖过山车和塑料光剑。在过去一个财年中，迪士尼的"体验"事业部管理的五个主题公园和游轮船队为公司带来了90亿美元的营业利润，而其流媒体业务则亏损了25亿美元。与此同时，处于华特·迪士尼的战略版图核心位置的创意引擎——电影——正在熄火。2023年全球票房收入较疫情前下降了20%；而在疫情前，美国人的年均观影次数已经从2000年的5次下降到了3.5次。随着银幕逐渐暗淡，制片公司正在失去激发观众兴趣的最有力武器。

制片公司因此正转向新策略。一些公司正加倍押注主题公园。华纳兄弟进入该领域相对较晚，于2018年在阿布扎比（Abu Dhabi）揭幕了全球最大的室内主题公园。迪士尼在去年9月宣布，未来十年在主题公园和游轮建设上的投资将翻番，承诺推出"冰雪奇缘"等主题园区。环球影业正在得克萨斯州兴建度假区，并于去年12月表示已在英国购买土地，以后可能会用来建一座主题公园。

制片公司也在设计新的娱乐形式。华纳兄弟去年12月在科隆推出了名为"魔法幻境"（Visions of Magic）的哈利·波特"互动艺术体验馆"，并计划在2024年底推出一个基于DC漫画系列的类似的互动体验馆。环球影业表示，将利用其恐怖片库在拉斯维加斯打造互动"恐怖体验"，第一个项目将是"科学怪人"（1931年）。

电影制片商也在试水餐饮业。华纳兄弟的餐馆有不同主题，搭配不同菜式。在伦敦的蝙蝠侠主题餐厅Park Row提供包含十道菜的品鉴套餐，售价195英镑（246美元）。去年11月在波士顿开业的"老友记"咖啡馆Central Perk提供咖啡和乔伊最爱的肉丸三明治。

"我们在试着摸清人们对什么感兴趣。"华纳兄弟主题娱乐部门的彼得·范罗登（Peter Van Roden）说，他通过监测周边商品销售、在线点击和票房收入来确定哪些作品适合转化为这类体验。他补充说，社交媒体鼓励分

享，也触发"FOMO"（错失恐惧）心理，让短期的"快闪"体验更容易取得成功。

最不看好院线的制片公司奈飞在设计创新替代方案方面走在前列。玛丽安·李表示，在奈飞还没开始组织现场活动时，热门剧集的粉丝就会穿着自制服装参加首映式。她说："有很多迹象显露出粉丝希望以更深入的方式相聚……并能参与一些面对面的互动。"奈飞做了多种尝试，先是在疫情期间让剧迷们驾车勇闯"怪奇物语"小镇，后来又组织了"纸钞屋"（Money Heist）密室逃生和"布里奇顿家族"舞会等主题活动。

奈飞最新的沉浸式体验是在洛杉矶的"鱿鱼游戏"，在严厉程度适当（赢了没奖金，但输了也不会被处决）的守卫的指挥下，参与者根据剧情玩六场游戏。笔者获得了第二名，未能夺冠的部分原因是赛前在比赛场地旁的酒吧里喝的韩国鸡尾酒没有对手多。

迪士尼乐园的定价着眼盈利，奈飞不同，它将体验活动视作给自己的节目打广告。任务简介就是："在剧歇期间，拿出什么东西延续角色（给粉丝）带来的兴奋感？"玛丽安·李说。价格就体现了这一点。70分钟的体验版"鱿鱼游戏"门票起售价39美元，剧版《怪奇物语》的门票最低20英镑，按伦敦西区的标准来说很便宜。（绿白配色的运动服和可爱的魔王公仔需要另外付费）。奈飞没有公布其主题活动或周边商品的收入，但在最近的财报电话会议上将其描述为"小意思"。

这些新的沉浸式体验能否像电影院长久以来所做的那样，让角色和故事赢得观众的喜爱？自称是影迷的范罗登否认它们是替代品。不过它们的基本共同特点是它们都是群体活动。他说："即使你没有在有意识地与同处一室的其他人交流沟通，大家也都在一起经历着一种共同的心灵触电般的感应。"

在"鱿鱼游戏"的障碍训练场，鸡尾酒上头的参赛者在一起玩得很疯，奈飞甚至开始考虑增加隔音设施。好莱坞推出的现场体验越来越多，给了观众更多从沙发上爬起来、与其他人一起玩乐的理由，即使这些活动的最终目

的是让他们在电视机前坐更久。■

Marvel seems to be losing its powers

The world's mightiest movie franchise looks increasingly fragile

IN "THE AVENGERS" (2012) Nick Fury (Samuel L. Jackson), a spy, described heroes as "an old-fashioned notion". Certainly the film's characters, including Captain America and Iron Man, were not novel, first appearing in comic books published in the mid-20th century. But if the idea was old, the excitement around superheroes had been renewed. "The Avengers" became the first Marvel movie to make more than $1bn at the global box office.

When Fury's words were used in the trailer for "The Marvels" (2023, pictured), however, they took on a different tone. Heroes may seem antiquated, he argued, but "the world can still use them". If it was an attempt to convince the viewer, it did not work. Released in November, "The Marvels", the 33rd instalment in the Marvel Cinematic Universe (MCU), made around $200m at the box office. It became the poorest-performing MCU film to date, and will probably lose money.

Nor was "The Marvels" a one-off disappointment. "Ant-Man and the Wasp: Quantumania" also underperformed. According to CinemaScore, an audience-rating benchmark, of the past eight MCU films, five have scored B+ or worse (see chart). Fans complain of dull characters, sloppy writing and amateurish special effects.

Marvel productions on the small screen have not fared much better. Recent MCU television series on Disney+, including "Secret Invasion", about Fury's character, have been poorly reviewed and, estimates suggest, little watched. It does not bode well for the shows due to be released in the coming months.

The decline is surprising: for a long time, the Marvel brand seemed invincible. Disney bought the comic-book company in 2009 and it became a prized asset. The 23 movies released between 2008 and 2019 grossed almost $23bn in total, making Marvel the largest film franchise in history.

Marvel kept standards high even as it increased production. The company released 2.75 films, on average, in 2016-19, up from 1.2 in 2008-13. Of those 23 movies, only one ranked lower than A- on CinemaScore. Three films received an A+, awarded to fewer than 100 of over 4,000 films measured since 1979. "Black Panther" (2018) even became the first comic-book adaptation to be nominated for Best Picture at the Oscars.

Marvel pioneered an innovative "cinematic universe" model, in which plotlines and characters were shared across films. As Marvel's universe grew, its competitors tried, and failed, to emulate its success. DC Comics—which owns Batman, Superman and Wonder Woman—set up, and recently scrapped, its "Extended Universe". Warner Bros has turned the Harry Potter franchise into a "Wizarding World". Universal twice tried to launch a "Dark Universe" of monsters such as Dracula and the Mummy, but both attempts failed after a single release. Efforts to build out Robin Hood and his merry men (Lionsgate), Power Rangers (also Lionsgate) and King Arthur and his round table (Warner Bros) all faltered.

By the early 2020s the MCU seemed set for further dominance. In 2019 Disney acquired 20th Century Fox, which held the rights to characters including the X-Men and the Fantastic Four. The launch of Disney+ that year made it easier for fans to keep up with the ever-expanding MCU and enabled the franchise to tell new stories in a serialised format. But instead of developing its position in pop culture, Marvel has struggled creatively and financially.

Disney insiders suggest several causes for the slump. One is to do with

personnel. Several trusted writers and directors have moved on. Many of the actors playing the most popular superheroes left the MCU after "Avengers: Endgame" in 2019, and Chadwick Boseman, the star of "Black Panther", died in 2020. Last month Disney fired Jonathan Majors after he was found guilty of assaulting and harassing his then-girlfriend. The actor played the villain at the heart of the "Multiverse Saga", the story which would connect the films released between 2021 and 2027.

Another reason is to do with geopolitics. The first 23 films were all released in China, the world's largest theatrical market, but between 2020 and 2022, none was. (China did not give a clear reason why, but it was probably building up its domestic film industry.) Though this de facto ban is now over, cinematic universes are hard to understand when audiences have missed several entries. Making matters worse, Disney+ is not available in China, so fans cannot watch the TV entries.

Yet part of the problem is of Marvel's own making. Since 2021 the MCU has released an average of 3.3 films and 3.7 television series every year—a rate that seems to strain audiences, internal creative teams and special-effects departments. For prospective viewers hoping to watch a new title, 33 films and 11 seasons of television is simply too much homework. The focus on the "multiverse", which draws on films predating the existing cinematic universe, aggravates this issue.

Audiences may yet tire of superheroes much as they tired of Westerns in the late 1960s. But for now, the genre goes on. The third "Guardians of the Galaxy" film grossed $846m, making it the fourth-highest-grossing film of 2023, and received an A rating on CinemaScore. "Spider-Man: Across the Spiderverse", an animated film by Sony, was also among the most popular films last year.

Bob Iger, Disney's CEO, who initiated Marvel's expansion, has said the

franchise can return to its former glory by slowing the pace of production. "I've always felt that quantity can be actually a negative when it comes to quality. And I think that's exactly what happened. We lost some focus." He, and Marvel's many fans, will be holding out for the heroes. ■

漫威似乎英雄失势

世界最强大系列电影看起来日渐式微

在2012年上映的《复仇者联盟》中，塞缪尔·杰克逊（Samuel L. Jackson）饰演的特工尼克·弗瑞（Nick Fury）说，英雄是个"已经过时的概念"。毫无疑问，电影中的美国队长、钢铁侠等角色都并非新创，它们最早出现在上世纪中期出版的漫画书中。如果说英雄的概念老旧了，人们对超级英雄的热情却被重新点燃了。《复仇者联盟》成为第一部全球票房破十亿美元的漫威电影。

然而，当弗瑞的这句话用在2023年上映的《惊奇队长2》（如图）的预告片中时，话风不一样了。他说，英雄可能看上去过气了，但"世界仍然可以用用他们"。如果这话想拿来说服观众，那并没有起到效果。去年11月上映的《惊奇队长2》是漫威电影宇宙（MCU）的第33部电影，票房约为两亿美元。它也因此成为MCU有史以来票房最差的影片，而且可能还会赔钱。

《惊奇队长2》并非唯一令人失望的影片。《蚁人与黄蜂女：量子狂潮》也表现不佳。根据权威观众评分网站CinemaScore的数据，在最近上映的八部MCU电影中，有五部获得了B+或更低的评分（见图表）。粉丝们抱怨它们角色乏味、剧本潦草、特效拙劣。

漫威在小屏幕上推出的制作也乏善可陈。最近在Disney+上播出的MCU剧集，包括以弗瑞为主角的《秘密入侵》（Secret Invasion），评价都很差，而且估计收视率极低。这对计划在未来几个月上映的剧集来说不是个好兆头。

这样的衰落令人惊讶——因为在很长一段时间里，漫威品牌似乎战无不胜。2009年，这家漫画公司被迪士尼收购，成为其旗下的宝贵资产。2008年至2019年间，漫威出品了23部电影，票房总收入近230亿美元，打

造出了历史上规模最大的系列电影。

漫威在增加产量的同时保持了高水准。2016至2019年间，漫威平均每年出品2.75部电影，而2008年至2013年为1.2部。在2008年至2019年上映的23部电影中，只有一部在CinemaScore上的评分低于A-；三部电影获得了A+——在1979年以来被打分的全部4000多部电影中，获得A+的还不到100部。2018年上映的《黑豹》甚至成为第一部获得奥斯卡最佳影片提名的漫画改编电影。

漫威开创了一种"电影宇宙"的新模式，让旗下电影拥有共同的情节主线和角色。随着漫威宇宙的壮大，竞争对手们也试图仿效它的成功之道，但都以失败告终。拥有蝙蝠侠、超人和神奇女侠的DC漫画建立了"扩展宇宙"（Extended Universe），但在不久前放弃了。华纳兄弟将《哈利·波特》系列电影变成了"魔法世界"（Wizarding World）。环球影业曾两次尝试将吸血鬼德古拉和木乃伊等怪物集结在一起，推出"黑暗宇宙"（Dark Universe），但都在上映了一部电影后就难以为继。此外，狮门影业着力打造的"罗宾汉和他的快乐伙伴们"（Robin Hood and his merry men）和"超凡战队"（Power Rangers），还有华纳兄弟的"亚瑟王和他的圆桌骑士"（King Arthur and his round table），最终都归于沉寂。

一直到2020年代初，MCU似乎都势将进一步占据主导地位。2019年，迪士尼收购了拥有《X战警》和《神奇四侠》等电影角色版权的二十世纪福克斯。同年，Disney+推出，这让粉丝们更容易跟上不断扩容的MCU宇宙，也让漫威系列电影可以用剧集的形式讲述新故事。但漫威并没有巩固自己在流行文化中的地位，反而在创意和财务上陷入了困境。

针对漫威的日渐式微，迪士尼内部人士提出了几点原因。一个是人事问题。好几位值得信赖的编剧和导演相继出走。2019年《复仇者联盟4：终局之战》上映之后，许多最受欢迎的超级英雄的扮演者离开了MCU。2020年，《黑豹》的主演查德威克·博斯曼（Chadwick Boseman）去世。去年12月，迪士尼解雇了在《多元宇宙传奇》（Multiverse Saga）中饰演反派的乔纳森·梅杰斯（Jonathan Majors），原因是他因殴打和骚扰

当时的女友而被定罪。《多元宇宙传奇》在故事情节上将把2021年至2027年之间上映的多部电影串联在一起，而梅杰斯的反派是其中的核心角色。

另一个原因与地缘纷争有关。MCU最早的23部电影都在中国这个全球最大的电影市场上映，但在2020年至2022年间一部也没有。（对此中国没有给出明确解释，但可能是因为它在打造本国的电影产业。）虽然这种事实上的禁令现在已经被解除，但如果观众错过了其中几部，就很难理得清整个电影宇宙的剧情了。更糟糕的是，由于Disney+在中国无法使用，粉丝们看不到MCU的电视剧集。

但也有些问题是漫威自己造成的。自2021年以来，MCU平均每年出品3.3部电影和3.7部电视剧——这样的速度似乎让观众、内部创意团队和特效部门都难以招架。对于想要观看一部新剧的观众来说，要先了解过33部电影和11季电视剧实在是太多功课了。目前重点打造的"多元宇宙"还涉及现有电影宇宙之前的电影，更加剧了这一问题。

观众可能最终会对超级英雄失去兴趣，就像他们在上世纪60年代末对西部片产生审美疲劳一样。但就目前而言，这个影视类型还会继续下去。《银河护卫队3》的总票房为8.46亿美元，是2023年票房第四高的电影，并且在CinemaScore上获得了A的评分。索尼出品的动画电影《蜘蛛侠：纵横宇宙》也是去年最受欢迎的电影之一。

开创了漫威扩张之路的迪士尼CEO鲍勃·伊格尔（Bob Iger）已表示过，通过放慢制作速度，漫威系列电影可以重回昔日的辉煌。"我一直觉得，要说质量的话，多产实际上可能是个负面因素。我想事实正是这样。我们有些偏离重点了。"他，将和众多漫威粉丝一道，坚持等待英雄回归。■

AI can transform education for the better

Meet the companies trying to make it happen

AS PUPILS AND students return to classrooms and lecture halls for the new year, it is striking to reflect on how little education has changed in recent decades. Laptops and interactive whiteboards hardly constitute disruption. Many parents bewildered by how their children shop or socialise would be unruffled by how they are taught. The sector remains a digital laggard: American schools and universities spend around 2% and 5% of their budgets, respectively, on technology, compared with 8% for the average American company. Techies have long coveted a bigger share of the $6trn the world spends each year on education.

When the pandemic forced schools and universities to shut down, the moment for a digital offensive seemed nigh. Students flocked to online learning platforms to plug gaps left by stilted Zoom classes. The market value of Chegg, a provider of online tutoring, jumped from $5bn at the start of 2020 to $12bn a year later. Byju's, an Indian peer, soared to a private valuation of $22bn in March 2022 as it snapped up other providers across the world. Global venture-capital investment in education-related startups jumped from $7bn in 2019 to $20bn in 2021, according to Crunchbase, a data provider.

Then, once covid was brought to heel, classes resumed much as before. By the end of 2022 Chegg's market value had slumped back to $3bn. Early last year investment firms including BlackRock and Prosus started marking down the value of their stakes in Byju's as its losses mounted. "In hindsight we grew a bit too big a bit too fast," admits Divya Gokulnath, the company's co-founder.

If the pandemic couldn't overcome the education sector's resistance to digital disruption, can artificial intelligence? ChatGPT-like generative AI, which can converse cleverly on a wide variety of subjects, certainly looks the part. So much so that educationalists began to panic that students would use it to cheat on essays and homework. In January 2023 New York City banned ChatGPT from public schools. Increasingly, however, it is generating excitement as a means to provide personalised tutoring to students and speed up tedious tasks such as marking. By May New York had let the bot back into classrooms.

Learners, for their part, are embracing the technology. Two-fifths of undergraduates surveyed last year by Chegg reported using an AI chatbot to help them with their studies, with half of those using it daily. Indeed, the technology's popularity has raised awkward questions for companies like Chegg, whose share price plunged last May after Dan Rosensweig, its chief executive, told investors it was losing customers to ChatGPT. Yet there are good reasons to believe that education specialists who harness AI will eventually prevail over generalists such as OpenAI, the maker of ChatGPT, and other tech firms eyeing the education business.

For one, AI chatbots have a bad habit of spouting nonsense, an unhelpful trait in an educational context. "Students want content from trusted providers," argues Kate Edwards, chief pedagogist at Pearson, a textbook publisher. The company has not allowed ChatGPT and other AIs to ingest its material, but has instead used the content to train its own models, which it is embedding into its suite of learning apps. Rivals including McGraw Hill are taking a similar approach. Chegg has likewise developed its own AI bot that it has trained on its ample dataset of questions and answers.

What is more, as Chegg's Mr Rosensweig argues, teaching is not merely about giving students an answer, but about presenting it in a way that helps

them learn. Understanding pedagogy thus gives education specialists an edge. Pearson has designed its AI tools to engage students by breaking complex topics down, testing their understanding and providing quick feedback, says Ms Edwards. Byju's is incorporating "forgetting curves" for students into the design of its AI tutoring tools, refreshing their memories at personalised intervals. Chatbots must also be tailored to different age groups, to avoid either bamboozling or infantilising students.

Specialists that have already forged relationships with risk-averse educational institutions will have the added advantage of being able to embed AI into otherwise familiar products. Anthology, a maker of education software, has incorporated generative-AI features into its Blackboard Learn program to help teachers speedily create course outlines, rubrics and tests. Established suppliers are also better placed to instruct teachers on how to make use of AI's capabilities.

AI for effort

Bringing AI to education will not be easy. Although teachers have endured a covid-induced crash course in education technology, many are still behind the learning curve. Less than a fifth of British educators surveyed by Pearson last year reported receiving training on digital learning tools. Tight budgets at many institutions will make selling new technology an uphill battle. AI sceptics will have to be won over, and new AI-powered tools may be needed to catch AI-powered cheating. Thorny questions will inevitably arise as to what all this means for the jobs of teachers: their attention may need to shift towards motivating students and instructing them on how to best work with AI tools. "We owe the industry answers on how to harness this technology," declares Bruce Dahlgren, boss of Anthology.

If those answers can be provided, it is not just companies like Mr Dahlgren's that stand to benefit. An influential paper from 1984 by Benjamin Bloom, an educational psychologist, found that one-to-one

tutoring both improved the average academic performance of students and reduced the variance between them. AI could at last make individual tutors viable for the many. With the learning of students, especially those from poorer households, set back by the upheaval of the pandemic, such a development would certainly deserve top marks. ■

人工智能可以让教育变得更好

看看正为此努力的一众公司

随着大中小学生在新的一年回到教室和讲堂，回看近几十年来的教育，其变化之小令人震惊。笔记本电脑和交互式白板基本算不上颠覆。许多父母对孩子的购物或社交方式大惑不解，但对他们的受教育方式却处之泰然。教育部门的数字化仍然落后：美国中小学和大学在技术上的支出分别约占预算的2%和5%，而美国公司的平均支出为8%。长期以来，科技公司一直觊觎着全球每年6万亿美元的教育支出，希望从中获得更大份额。

当新冠疫情迫使中小学和大学停课时，发起数字化攻势的时机似乎来到了眼前。学生纷纷涌向在线学习平台，以填补在Zoom上单调拘谨地上网课所留下的空白。在线辅导供应商Chegg的市值从2020年初的50亿美元跃升至一年后的120亿美元。它的印度同行Byju's在全球各地并购其他供应商，到2022年3月时私人市场估值已飙升至220亿美元。根据数据供应商Crunchbase统计，全球教育类创业公司拿到的风险投资从2019年的70亿美元激增至2021年的200亿美元。

然后，待疫情得到控制之后，课堂又基本恢复如初。到2022年底，Chegg的市值已暴跌至30亿美元。去年年初，随着Byju's亏损加剧，包括贝莱德（BlackRock）和Prosus在内的投资公司开始减记所持Byju's股份的价值。Byju's的联合创始人迪维亚·戈库尔纳特（Divya Gokulnath）承认："回过头看看，我们扩张得有点太大、太快了。"

如果疫情没能战胜教育部门对数字化颠覆的抵制，那么AI可以吗？ChatGPT这样的生成式AI可以就各种各样的主题机灵地对话，显然很有胜任的气势。它如此聪明，以至于教育工作者开始恐慌，担心学生会在写论文和做作业时用它作弊。2023年1月，纽约市禁止在公立学校使用ChatGPT。然而，作为一种为学生提供个性化辅导和加快批作业试卷等繁琐工作的手段，它引发的热情日益高涨。到5月，纽约又允许这个聊天机

器人重返课堂。

至于学生，他们正在积极采用这项技术。在去年Chegg对本科生的调查中，五分之二的受访者表示自己用AI聊天机器人辅助学习，其中半数的人每天都用。事实上，AI技术的普及让Chegg等公司陷入尴尬境地。去年5月，Chegg首席执行官丹·罗森斯威格（Dan Rosensweig）向投资者表示，ChatGPT正导致客户流失，公司股价应声暴跌。然而，有充分的理由相信，那些能够善用AI的专业教育公司最终仍将战胜ChatGPT的创造者OpenAI这样的通用型公司，以及其他对教育业务虎视眈眈的科技公司。

首先，AI聊天机器人有胡言乱语的坏习惯，这在教学中可不是个有益的特性。教科书出版商培生（Pearson）的首席教育学家凯特·爱德华兹（Kate Edwards）认为："学生想从值得信赖的供应商那里获得内容。"该公司不允许ChatGPT和其他AI摄取自己的教材，而是用这些内容来训练自己的模型，并将它嵌入到自己的学习应用套件中。包括麦格劳希尔（McGraw Hill）在内的竞争对手也在采取类似的做法。Chegg同样开发了自己的AI机器人，并用自有的海量题库数据集训练它。

此外，正如Chegg的罗森斯威格所言，教学不仅仅是给学生一个答案，而是要以一种有助于他们学习的方式将答案呈现出来。因此，对教育学的理解使专业教育公司更具优势。爱德华兹表示，培生设计的AI工具会分解复杂的主题、测试学生的理解程度并快速提供反馈，以促进他们投入学习。Byju's在设计AI辅导工具时考虑了学生的"遗忘曲线"，按个性化的间隔来加深记忆。聊天机器人还必须针对不同年龄段的学生量身定制，以避免让他们感到内容过于难懂或过于幼稚。

教育机构往往厌恶风险，因此已经与其建立关系的专业公司将获得额外优势，能够将AI嵌入到对方已经用惯了的产品之中。教育软件开发商Anthology在其Blackboard Learn程序中加入了生成式AI功能，帮助教师快速创建课程大纲、评分标准和测试题目。老牌供应商也更容易指导教师如何利用AI的各种能力。

将AI引入教育并非易事。尽管教师在疫情期间不得已上了一回教育科技速成班，但许多人还跟不上进度。去年在培生对英国教育工作者的调研中，只有不到五分之一的人表示接受过数字化学习工具的培训。许多机构预算紧张，向它们推销新技术将是一场苦战。必须说服那些对AI持怀疑态度的人，而且还需要新的AI工具来检测利用AI做弊的行为。至于这一切对教师的工作意味着什么，棘手的问题将不可避免：他们可能要将注意力转为激励学生，以及指导他们如何最好地利用AI工具。Anthology的老板布鲁斯·达尔格伦（Bruce Dahlgren）宣称："我们应该就如何利用这项技术为业界提供答案。"

如果能够提供这些答案，受益的就不仅仅是达尔格伦的公司了。教育心理学家本杰明·布鲁姆（Benjamin Bloom）在1984年发表的一篇颇具影响力的论文发现，一对一的辅导既提高了学生的平均学习成绩，又减少了他们之间的成绩差异。AI最终可以让大多数人都负担得起私人教师了。鉴于学生们的学业因疫情干扰而退步——特别是贫困家庭的学生——这样的进展无疑该打个高分。■

Does Europe at last have an answer to Silicon Valley?

ASML, a mighty Dutch tech firm, is at the heart of a critical supply chain

TEN TIMES a second an object shaped like a thick pizza box and holding a silicon wafer takes off three times faster than a manned rocket. For a few milliseconds it moves at a constant speed before being halted abruptly with astonishing precision—within a single atom of its target. This is not a high-energy physics experiment. It is the latest lithography machine dreamed up by ASML, a manufacturer of chipmaking tools, to project nanoscopic chip patterns onto silicon wafers. On January 5th Intel, an American semiconductor giant, became the first proud owner of this technical marvel's initial components for assembly at its factory in Oregon.

Like the outwardly unassuming machine, its Dutch maker is full of surprises. The company's market value has quadrupled in the past five years, to €260bn ($285bn), making it Europe's most valuable technology firm (see chart 1). Between 2012 and 2022 its sales and net profit both rose roughly four-fold, to €21bn and €6bn, respectively. In late 2023 ASML's operating margin exceeded 34%, staggering for a hardware business and more than that of Apple, the world's biggest maker of consumer electronics (see chart 2).

Such stellar performance, which is set to shine brightly again when ASML reports quarterly results on January 24th, is now routine. The firm holds a monopoly on a key link in the world's most critical supply chain: without its kit it is next to impossible to make cutting-edge chips that go into smartphones and data centres where artificial intelligence (AI) is trained. With global semiconductor sales forecast to double to $1.3trn by 2032, every big country and every big chipmaker wants ASML's gear. The company has become so important in the Sino-American techno-tussle that, as it

recently emerged, America's government pressed ASML to cancel planned deliveries of even its older machines to China.

Yet ASML's spectacular success is also underpinned by two other, less obvious factors. The company has created a network of suppliers and technology partners that may be the closest thing Europe has to Silicon Valley. And its business model ingeniously combines hardware with software and data. These unsung elements of ASML's success challenge the notion that the old continent is incapable of developing a successful digital platform.

ASML's complex machines perform a simple task. They project chip blueprints onto photosensitive silicon wafers. In 1986, when its first model was delivered, individual transistors measured micrometres and its kit was almost like a glorified photocopier, explains Marc Hijink, a Dutch journalist and author of "Focus—How ASML Conquered the Chip World", a new book. Today, with transistors shrunk by a factor of a thousand, ASML lithography gear is possibly the most sophisticated equipment ever sold commercially.

ASML and its partners pulled off this incredible shrinking trick with engineering that has a science-fiction ring to it. The process starts with powerful lasers incinerating droplets of molten tin, each no thicker than a fifth of a human hair and travelling at more than 250kph. This produces extremely short-wavelength light (extreme ultraviolet, or EUV, in the jargon) which is then reflected by a set of mirrors so smooth that the biggest imperfection is no bigger than the distance grass can grow in a millisecond. To make all this worth a chipmaker's while—the latest model costs more than $300m—and expose enough chips, the object that holds the wafer, called a "table", has to accelerate faster than a rocket and come to a stop at exactly the right spot.

To get an idea of what it takes to build such a device, pay a visit to a

nondescript factory in Neukölln, a neighbourhood of Berlin. This is where ASML makes, among other things, "mirror blocks", the main part of a wafer table. These are sturdy pieces of a special ceramic material, a square 8cm thick and measuring about 50cm on each side. Some get polished, measured, repolished, remeasured and so on, for nearly a year—until they are exactly the right shape, including allowances for the fact that they will sag by a few nanometres once installed.

The factory is emblematic of the company's unusual network of suppliers. Although its owner, Berliner Glas, was acquired by ASML in 2020, it lives halfway between being an independent company and a unit of the Dutch parent. Something similar is true of the 800 or so mostly European firms that help put together ASML's machines. ASML owns stakes in only a few of them. Yet their interdependence makes them act like a single organisation.

ASML outsources over 90% of what it costs to build one of its marvels and directly employs less than half the estimated 100,000 people the feat requires. This is partly because of its history. When it was spun out of Philips, a Dutch electronics giant, in 1984, ASML seemed stillborn. Its idea to build a "silicon stepper", the original name of the chip-copying machine, was promising. But it had not much else going for it, in particular no production lines. It instead relied on specialist suppliers, many of them also former Philips units, such as VDL, a contract manufacturer.

The outsourcing is also a function of technology. The different parts of a lithography machine are so cutting-edge that doing it all could overwhelm one firm. "You have to decide where you add the most value and let others do the rest," says a former ASML insider. Semiconductor economics, too, favours not doing everything yourself. The industry is prone to booms and busts, because demand moves up and down more quickly than chipmakers can install capacity. Prices rise and fall as shortages turn to gluts. Manufacturers of chipmaking gear are exposed to the same cycle. That

makes owning all the assets risky; better to shift some risk to suppliers, who can limit it by catering to customers working to different business cycles.

The required hyper-specialisation prevents the risk-reducing double sourcing that is prevalent in many other industries. In the case of ASML, technical demands are so high and production volumes so low (it shipped 317 machines in 2022) that it would be uneconomical to manage several suppliers for a single part even if they could be found. For such crucial components as lasers and mirrors, which are made by Trumpf and Zeiss, two German firms, respectively, it is impossible. Wayne Allan, who is in charge of sourcing on ASML's board, talks of "co-dependency".

The upshot is that ASML mostly limits itself to being the system's architect. It decides who does what, defines the interfaces between the main parts of its machines ("modules") and carries out research and development. This set-up makes it easier to test the pieces and transport the machines (shipping the latest model to Intel involved 250 crates and 13 containers). It also gives suppliers more freedom, including to experiment with novel technologies.

It all works because ASML has cultivated a culture of trust and transparency while preserving elements of competition. Suppliers are not squeezed to the last penny. Quite the opposite: "We need them to stay healthy," says Mr Allan. Information flows freely throughout the network, particularly between ASML, Trumpf and Zeiss. Engineering teams from different firms work together. Patents are shared, as are some financial data and, sometimes, profits. "At meetings you can't tell who is from which firm," reports a former Zeiss executive.

At the same time, many suppliers compete with each other indirectly, for instance providing similar parts for different generations of ASML's

machines. If a supplier runs into trouble, ASML dispatches a rapid intervention force, sometimes even if such help is not welcome. As a last resort, ASML can buy a supplier, as it did with Berliner Glas.

It is this loosely coupled structure that allowed ASML to outcompete more vertically integrated rivals, reckons Willy Shih of Harvard Business School. Nikon and Canon, two Japanese firms which once led the market for lithography machines, never managed to commercialise EUV kit. (Canon is trying to stage a return with "nanoimprint" lithography, which physically stamps chip designs onto wafers.)

ASML is now entrenching this dominance by complementing its hardware with software and data. When real rockets take off, their trajectory is wobbly and needs to be smoothed out by a guidance computer, which collects data to predict and adapt their course. A wafer table in a lithography machine is similarly likely to miss the mark at first. The same is true of the rest of the device. It is only with the help of lots of data and machine learning, a type of AI, that they can be fine-tuned—and made more accurate. This is rapidly turning ASML into an AI platform.

Once Intel gets all the modules for its new machine, it will take about two weeks to put the thing together. Adapting it to its new location will take a few months. Bits may have moved in transport, gravity may be slightly different in Oregon from the Netherlands and other kit nearby may create interference. Tests will collect data and trigger adjustments. "We have thousands of knobs we can turn to put it into a perfect state," says Jos Benschop, who is in charge of technology at ASML.

ASML also uses the data from one machine to turn the knobs of others. Of the roughly 5,500 devices it has sold since its founding 39 years ago, 95% are still in operation and many send data home to headquarters. That will make its products even better, leading to more chipmaking, which

generates even more data—and so on, in a "flywheel" more typically associated with digital services such as internet search. Even if Canon, Nikon or a Chinese competitor finally managed to build EUV machines as powerful as ASML's, it would not be able to catch up with the Dutch firm, argues Pierre Ferragu of New Street Research, a firm of analysts. "It's mathematically impossible, as long as ASML keeps collecting data from all the installed base."

If rivals cannot topple ASML, can anything? Maybe physics. Even with the best AI, you can't shrink transistors for ever (certainly not in a commercially viable way). If technical requirements become too otherworldly the supplier network may unravel. Or maybe economics. Chipmakers may recoil at ASML's data hunger, which extends to other linked devices in their factories. Some are pushing back against its digital expansion, insiders say.

Then there is geopolitics. ASML's share price dipped after news broke about the cancelled deliveries to China. The worry is less over lower sales; ASML cannot build its machines fast enough anyway. Of greater concern is the risk that strict export controls could in time push China to build its own chipmaking-gear industry. That could one day threaten ASML's position at the centre of the sector. For the time being, though, the company's network and its network effects remain indomitable. Who said Europe couldn't do tech? ■

...

面对硅谷，欧洲终于有了拿得出手的东西？

强大的荷兰科技公司阿斯麦是一条关键供应链的核心【深度】

每秒十次，一个形似厚披萨盒、装载着一个硅片的物体以比载人火箭快三倍的速度起飞。它以恒定速度移动几毫秒后，便以惊人的精确度——精确到目标中的某一个原子——突然停止。这不是高能物理实验，而是由芯片制造设备生产商阿斯麦（ASML）设计的最新型光刻机，用于将纳米级芯片图案投射到硅片上。1月5日，美国半导体巨头英特尔骄傲地拿到了这项技术奇迹的初始组件，将在其位于俄勒冈的工厂进行组装。

就像这台外观不起眼的机器一样，它的荷兰制造商充满了惊喜。过去五年，这家公司的市值翻了两番，达到2600亿欧元（2850亿美元），成为欧洲最有价值的科技公司（见图表1）。在2012年至2022年间，其销售额和净利润均大约增长了四倍，分别达到210亿欧元和60亿欧元。2023年底，阿斯麦的营业利润率超过了34%，这对于硬件业务而言堪称惊人，而且超过了世界上最大的消费电子产品制造商苹果（见图表2）。

这样的亮眼表现如今已成为常态，到1月24日阿斯麦公布季度业绩时还会再次大放异彩。该公司在世界上最关键的供应链中占据了垄断地位：没有它的设备，几乎不可能制造出用于智能手机和培训人工智能（AI）的数据中心的尖端芯片。预计到2032年全球半导体销售额会翻倍至1.3万亿美元，因此每个大国和每个大型芯片制造商都想要阿斯麦的设备。这家公司在中美科技角力中变得非常关键，近日有消息称美国政府向它施压，要求它取消向中国交货的计划，哪怕是型号较旧的设备。

但阿斯麦的惊人成功还得益于另外两个不那么显见的因素。该公司建立了一个供应商和技术合作伙伴网络，它可能是欧洲所具有的最接近硅谷的东西。此外，其商业模式巧妙地将硬件与软件和数据结合在一起。阿斯麦这些鲜为人知的成功要素挑战了认为旧大陆无法开发出成功的数字平台的看法。

阿斯麦的复杂机器执行的是一个简单的任务。它们将芯片设计图投射到感光硅片上。荷兰记者、新书《聚焦——阿斯麦如何征服芯片世界》（Focus—How ASML Conquered the Chip World）的作者马克·希因克（Marc Hijink）解释说，当它的第一款机型在1986年交付时，单个晶体管的尺寸是微米级的，其设备几乎就是个名字很唬人的复印机。而今天，随着晶体管缩小了一千倍，阿斯麦的光刻机可能是有史以来最精密的商用设备。

阿斯麦及其合作伙伴利用颇具科幻色彩的工程技术完成了这一令人难以置信的微缩戏法。这个过程从高能激光燃烧熔融锡滴开始，每个锡滴的直径不超过人头发丝的五分之一，以超过250公里的时速移动。这产生了极短波长的光（行话叫极紫外光，缩写为EUV），这些光会被一组非常光滑的镜子反射——光滑到最大瑕疵不及草在一毫秒内生长的长度。为了使这一切值得芯片制造商的投资——最新型号的成本超过3亿美元——并能曝光足够的芯片，承载硅片的"台"必须比火箭加速得更快，并且精准地停在正确的位置。

要了解打造这样一台设备要费多大劲，不妨参观一下柏林新科尔恩区（Neukölln）一家不起眼的工厂。这里是阿斯麦制造硅片台的主要部分——"反射镜"等部件的地方。这些反射镜是由特殊陶瓷材料制成的坚固扁方块，厚度为8厘米，方块的每边长约50厘米。其中一些经过打磨、测量，再打磨、再测量，如此持续近一年时间——直到它们达到完全正确的形状，包括要考虑到安装后会下凹几纳米的情况。

这家工厂体现了阿斯麦不同寻常的供应商网络。尽管工厂所有者Berliner Glas在2020年被阿斯麦收购，但它的性质介于一家独立公司和荷兰母公司的一个部门之间。在大约800家帮助阿斯麦生产组件的公司中，情况都差不多如此，其中大部分是欧洲公司。阿斯麦只持有其中少数公司的股份。然而，它们彼此间的相互依赖却让它们像一个单一组织那样运作。

阿斯麦将其神奇产品超过90%的制造过程外包了出去。如果是独立完成这样的奇迹估计需要10万人，而阿斯麦的直接雇员还不到这个数字的一半。

这一定程度上是因为它的历史。1984年，当它从荷兰电子巨头飞利浦分拆出来时似乎已经夭折。它打造"硅步进机"（光刻机的最初名称）的想法很有前景。但除此之外，它几乎没有其他资源，特别是没有生产线。它转而依赖专业供应商，其中许多也是出自飞利浦，例如合同制造商VDL。

外包也是出于技术上的需要。光刻机的各个部件都是尖端产品，全部自行制造可能会压垮一家公司。"你必须决定在哪里增加最多价值，并让其他人做其余部分。"一位前阿斯麦内部人士说。半导体经济学也不赞成自己做所有事情。由于需求的上下波动比芯片制造商增加产能更快，这个行业容易出现繁荣和萧条。价格随着短缺和过剩的交替而涨跌。芯片制造设备的制造商也面临同样的周期。这使得拥有所有资产变得风险重重；更好的做法是将一些风险转移给供应商，他们可以通过服务具有不同商业周期的客户来限制风险。

由此所需的超级专业化导致在许多其他行业通行的、能降低风险的双重采购并不可行。在阿斯麦的案例中，技术要求如此之高，产量如此之低（2022年仅出货317台机器），即使能为某个部件找到多家供应商，管理这几个供应商也是不经济的。对于关键组件，比如分别由德国的通快（Trumpf）和蔡司（Zeiss）制造的激光器和反射镜，这纯粹就是不可能的。阿斯麦董事会里负责采购的韦恩·艾伦（Wayne Allan）谈到了"相互依赖"。

结果是阿斯麦基本上只让自己充当系统的架构师。它决定谁做什么，定义机器主要部分（"模块"）之间的接口，并进行研发。这种安排使得测试零件和运输机器变得更加容易（将最新型号的设备运送到英特尔用了250个板条箱和13个集装箱）。它还给予供应商更多自由，包括尝试全新技术。

这一切之所以行得通，是因为阿斯麦培养了一种信任和透明的文化，同时保留了竞争元素。供应商不会被压榨到只剩最后一分钱。恰恰相反，"我们需要它们保持健康。"艾伦说。信息在整个网络中自由流动，尤其是在阿斯麦、通快和蔡司之间。不同公司的工程团队共同工作。他们共享专利，也共享一些财务数据，有时还共享利润。"在会议上，你都分辨不出

谁是哪家公司的。"一位前蔡司高管说。

与此同时，许多供应商之间也有间接的竞争，例如为阿斯麦不同代的设备提供类似的部件。如果供应商遇到困难，阿斯麦会组织力量快速介入，哪怕有时候这种帮助并不受欢迎。万不得已时，阿斯麦可以收购供应商，就像它收购Berliner Glas那样。

正是这种松散耦合的结构使阿斯麦能够击败更垂直一体化的竞争对手，哈佛商学院的史兆威（Willy Shih）认为。曾经在光刻机市场领先的两家日本公司尼康和佳能从未能成功商业化生产EUV设备。（佳能正试图通过"纳米压印"光刻技术杀回来，这种技术把芯片设计实体压印到硅片上。）

阿斯麦现在正通过用软件和数据补充硬件来巩固自己的优势。在真正的火箭起飞时，它们的轨迹是摇摆的，需要通过导航计算机来平滑，该计算机收集数据以预测并调整火箭航向。光刻机中的硅片台一开始也可能会错过正确位置。设备的其他部分也是如此。只有在大量数据和机器学习这种人工智能的帮助下，它们才能进行微调并变得更加精确。这正在迅速将阿斯麦转变为一个AI平台。

一旦英特尔拿到其新机器的所有模块，将需要大约两周时间把它们组装起来。之后再基于新地点花几个月调试。零部件在运输过程中可能会移动，俄勒冈州的重力可能与荷兰略有不同，附近的其他设备可能会造成干扰。工作人员将通过测试收集数据做出调整。"我们有成千上万个旋钮，我们可以转动它们来让设备达到完美状态。"阿斯麦负责技术的乔斯·本斯霍普（Jos Benschop）说。

阿斯麦还用源自一台机器的数据来转动其他机器的旋钮。在其成立39年来售出的大约5500台设备中，有95%仍在运行，许多设备把数据发送回总部。这将优化其产品，从而制造出更多的芯片，继而产生更多的数据——如此循环，这是在数字服务（如互联网搜索）中更为典型的"飞轮"效应。即使佳能、尼康或中国竞争对手最终能制造出与阿斯麦一样强大的EUV光刻机，它们也无法赶上这家荷兰公司，New Street Research的分析师皮埃

尔·费拉古（Pierre Ferragu）认为。"这在数学上是不可能的，只要阿斯麦继续从所有已安装设备收集数据。"

如果竞争对手无法击败阿斯麦，那还有什么可以击败它吗？也许是物理学。即便拥有最好的AI，你也不能永远缩小晶体管（要在商业上可行是必然做不到的）。如果技术要求变得太过于超现实，供应商网络可能会解体。或者也许是经济学。芯片制造商可能会厌烦阿斯麦对数据的渴望，这种渴望扩展到了它们工厂中的其他关联设备。知情人士表示，有人在反对它的数字扩张。

然后还有地缘问题。在取消向中国交付设备的消息传出后，阿斯麦的股价下跌。人们担心的主要还不是销售额下降，因为无论如何阿斯麦也无法足够快地制造设备。更大的担忧是严格的出口管制可能最终促使中国建立自己的芯片制造设备产业。这有朝一日可能威胁到阿斯麦在该行业的核心地位。然而，就目前而言，该公司的网络及其网络效应仍然不可撼动。谁说欧洲玩不转科技的？■

When your colleagues are also your rivals

How managers should balance competition and co-operation

THE MODERN company exalts both competition and co-operation. Competition is the defining feature of markets; inside organisations, too, employees compete for limited resources. Sometimes that contest is obvious, as when performance is openly ranked or there is a race for a specific job. Sometimes it is left unspoken: there is only so much money to go round and only so many promotion opportunities on offer. Either way, competition is always there.

Yet the reason firms exist is to co-ordinate the activities of many actors in pursuit of common goals. Departments and teams are expected to work together. Collaborative behaviour is usually celebrated. Companies dole out awards for the most helpful co-workers, not the Macbeth prize for the colleague most likely to murder you in your sleep.

Rivalry and teamwork can go together nicely. A paper published in 2022 by Eric VanEpps of the University of Utah, Einav Hart of George Mason University and Maurice Schweitzer of the University of Pennsylvania looked at the best way to handle an old conundrum. To make a good impression on the higher-ups, you need to highlight your own achievements. But bragging about how great you are is not a recipe for being liked. A strategy of taking the credit for some things and doling out praise to colleagues for others resolved this problem.

It is not easy for managers to strike the right balance between encouraging contests and collaboration. (You just need to hear the word "co-opetition" to know how ugly things can get.) Competition can spur more effort but it can also have unintended consequences.

A recent study by Eddy Cardinaels of Tilburg University and Christoph Feichter of the Vienna University of Economics and Business asked supervisors to use a forced performance-ranking system to assess workers' creativity. Forced rankings require managers to assign employees to given places on a scale: if there are ten workers, say, then one must come top and one must come tenth. This approach just stressed everyone out—a bit like bellowing "relax" in someone's face. People tried harder but they also became less creative.

In a literature review published in 2020 Gavin Kilduff of the Stern School of Business at New York University, Blythe Rosikiewicz of West Chester University and Christopher To of Rutgers University concluded that competition is more likely to backfire when people feel threatened: for example, when the costs of losing are high or when people are competing against others known to be better at the task in question. But even when the stakes are low, explicit competition can backfire.

In an experiment conducted by Jeffrey Carpenter of Middlebury College and his co-authors in 2007, participants were asked to stuff envelopes. When people were paid a bonus for stuffing the most envelopes, they worked harder than if they got a flat per-envelope fee. But when they were also given a chance to sabotage their peers to get ahead, the (correct) expectation that they themselves would be sabotaged made people work less hard than if they had got piece-rate pay.

Such behaviour arises because many people—and many of them men, since women tend to be less taken by the prospect of all-out competition—like winning for its own sake. This organic aspect to competition also shows up in rivalries between individuals. Workers tend naturally to benchmark themselves against their peers in the race for status and seniority; they don't need an excuse.

These specific rivalries can be especially motivating. A paper from 2018 by Adam Galinsky and Brian Pike of Columbia Business School and Mr Kilduff found that teams in a range of American sports performed better the year after an intense rival did well in tournaments. In another study, Lisa Ordóñez of the University of Arizona and Messrs Kilduff, Schweitzer and To analysed American-football games and found that teams were more likely to take risky on-field decisions against fierce rivals. Particular opponents encourage greater risk-taking than generic competition, at least if you are a very large man in tights.

All of which argues for a restrained approach to encouraging competition. Balance individual incentives with group ones. If you are going to rate performance, make sure the measures are clear, objective and fair. Think about when risk-taking is more desirable (sales, say) and less desirable (clinical trials). By their nature organisations crackle with competitiveness. Adding a bit of fuel to the fire can be fine. Spraying petrol everywhere is unnecessary. ■

当你的同事也是你的竞争对手

管理者应该如何平衡竞争与合作

现代公司既推崇竞争也推崇合作。竞争是市场的本质特征；在企业内部，员工也在争夺有限的资源。有时候，竞争是显而易见的，比如公开对业绩进行排名，或者角逐某个职位。有时候竞争又是心照不宣的：可供分配的钱只有这么多，摆在那里的晋升机会也只有这么多。无论显性还是隐性，竞争一直都在。

但是，公司之所以存在就是为了协调众多参与者的行动以追求共同的目标。部门和团队都是要通力合作的。协作行为通常会得到赞美。公司会给最乐于协作的员工颁奖，而不会向最有可能趁你睡着时向你捅刀子的同事颁发"麦克白奖"。

同事竞争和团队合作可以并行不悖。犹他大学（University of Utah）的埃里克·万尼普斯（Eric VanEpps）、乔治梅森大学（George Mason University）的埃纳夫·哈特（Einav Hart）以及宾夕法尼亚大学（University of Pennsylvania）的莫里斯·施魏策尔（Maurice Schweitzer）在2022年发表了一篇论文，探讨了一个老大难问题的最佳解决之道。为了给上司们留下好印象，你需要突显自己的成就。但自吹自擂并不能让别人喜欢你。解决办法是可以把一些成绩归功于自己，同时不吝把同事赞美一番。

对于管理者来说，在鼓励竞争和合作之间取得适当的平衡并非易事。（你只需要听到"竞合"这个怪词，就知道事情会变得多麻烦。）竞争可以激励人们更加努力，但也可能带来意想不到的后果。

荷兰的蒂尔堡大学（Tilburg University）的埃迪·卡迪纳尔斯（Eddy Cardinaels）和维也纳经济大学（Vienna University of Economics and Business）的克里斯托夫·费希特（Christoph Feichter）近期的一项研究

让主管使用强制绩效排名法来评估员工的创造力。强制排名要求管理者按照一定比例给每位员工排位：比如，如果有十名员工，那么必须有一人排在第一名，有一人排在第十名。这种方法只会让每个人都压力爆棚——有点像冲着某人大吼"放松"。人们是比以前更努力了，但同时创造力也下降了。

在2020年发表的一篇文献综述中，纽约大学斯特恩商学院（Stern School of Business）的加文·基尔达夫（Gavin Kilduff）、西切斯特大学（West Chester University）的布莱思·罗西凯维奇（Blythe Rosikiewicz）以及罗格斯大学（Rutgers University）的陶家页（Christopher To）得出结论，当人们感到威胁时，竞争更可能产生适得其反的后果：例如，当失败的代价很高，或者明知竞争对手比自己更擅长这项任务时。但即使风险不高，赤裸裸的竞争也可能带来反效果。

2007年，美国明德学院（Middlebury College）的杰弗里·卡彭特（Jeffrey Carpenter）及其合著者做了一个实验，让参与者往信封里装东西。当装完的信封数量最多的人能获得一笔额外的奖金时，人们工作起来会比每装一个信封得到一笔固定报酬时更努力。但是，如果他们还有机会给同事使绊子而让自己领先时，他们会想到自己也会被别人使绊子（也确实如此），这让他们的工作积极性比拿计件工资时更低。

许多人之所以有这样的行为，纯粹是好胜心使然——这其中很多是男性，因为女性往往不太喜欢你死我活的竞争。这种竞争的本能也表现在特定个体之间的对峙中。在对地位和资历的角逐中，员工往往会自然而然就拿同事当作对照标准；他们不需要理由。

这样的具体的对手有可能格外激励人。哥伦比亚大学商学院（Columbia Business School）的亚当·加林斯基（Adam Galinsky）、布莱恩·派克（Brian Pike）和基尔达夫在2018年发表的一篇论文中发现，在美国一系列不同的体育锦标赛中，参赛队伍在自己的劲敌取得好成绩后在下一年的赛事中表现更出色。在另一项研究中，亚利桑那大学（University of Arizona）的丽莎·奥多涅斯（Lisa Ordóñez）和基尔达夫、施魏策尔以及

陶家页分析橄榄球比赛后发现，球队在面对凶猛的对手时更有可能在赛场上做出冒险的决定。而当遭遇某个特定的对手时，会比泛泛的竞争激发出更多的冒险行为——至少对于穿着紧身衣裤的大块头们来说是如此。

所有这些都表明，鼓励竞争要适度。要平衡个人动机和团队目标。如果要对员工表现做评估，要确保评价标准清晰、客观和公平。要考虑什么时候比较值得冒险（比如销售）、什么时候不值得（比如临床试验）。企业的根本性质决定了它燃烧着竞争之火。往火里加点燃料可能还行，到处浇汽油就没必要了。■

Saudi Arabia wants to be the Saudi Arabia of minerals

The kingdom plans to be digging up plenty more than oil

IN WA'AD AL-SHAMAL, 1,200km north of Riyadh, the Saudi capital, phosphate is extracted and bathed in chemicals to turn it into an acid. From there it is shipped 1,500km east by rail to the port of Ras Al-Khair. The stuff is then made into fertiliser or its precursor, ammonia, and sails west to Brazil, south to Africa and east to India and Bangladesh, where it ends up with farmers who, according to Ma'aden, the state mining firm which runs the project, grow 10% of the world's food. The venture is vast. Its sales and domestic investment are equivalent to about 2% of the kingdom's non-oil GDP. Another similar one will soon start shipping the equivalent of another 1%.

Phosphate is not the only mineral resource Saudi Arabia is eyeing to fuel its post-oil future. On January 10th the government revised its estimate of the value of its buried mineral wealth from $1.3trn to $2.5trn. This includes deposits of gold, copper and zinc. By the standards of Saudi oil riches, worth perhaps $20trn at today's prices, that looks modest. By any other measure, it is gargantuan.

Muhammad bin Salman, the kingdom's crown prince and de facto ruler, wants the country to become as indispensable for minerals, including those needed for the energy transition, as it is today for black gold. He intends to achieve this without embracing the resource nationalism that has gripped other countries, from America to Chile and China. Intrigued, mining bosses and ministers from around 80 countries had assembled in Riyadh as we published this, for the country's Future Minerals Forum. As if to prove its commitment to openness, the kingdom has signed agreements both with Russia and with America's Export-Import Bank. It expects deals

worth $20bn to be sealed at the event.

Part of the strategy looks abroad. Saudi Arabia has set up Manara Minerals, a venture backed by Ma'aden and the Saudi sovereign wealth fund. Manara will invest up to $15bn in stakes in foreign mines. Last year it paid close to $3bn for a 10% stake in the base metals business of Vale, a Brazilian mining giant. The Saudis are "putting their money where their mouth is," says Eduardo Bartolomeo, Vale's boss.

The bigger bet, as the phosphate complex in Wa'ad Al-Shamal shows, is domestic. Saudi Arabia is pitching itself as an investment destination (the campaign includes ads in such unlikely places as the London Underground). In the past few years it has formed a new ministry for industry and mineral resources, waived duties on imported machinery and raw materials, reduced licence fees and royalties, offered state support for salaries and subsidised rents. It has also replaced an arcane mining law with one more like the investor-friendly codes in Australia, Botswana and Canada. Licences that took years to secure are now handed out in two months.

The result has been a sharp rise in active licences—to around 2,300, a fifth more than two years ago. About 700 of these are for exploration. Some are going to foreigners. Medium-sized or specialist outsiders such as Barrick Gold and Eurasian Resources Group have received licences to explore or have partnerships with Ma'aden. "I would rather have 50% of something than 100% of nothing," says Robert Wilt, Ma'aden's chief executive.

"To draw big players in, Saudi Arabia will need big discoveries," says Mark Bristow, boss of Barrick Gold. To that end it is investing over $180m in incentives for exploration. The Saudi Industrial Development Fund, a government vehicle, offers to finance up to three-quarters of project costs. The kingdom is also bankrolling a $200m effort to map its geology and

create a database of resources, on top of $500m it spent on an earlier survey. Ma'aden is doing more prospecting, too, Mr Wilt says.

The government is also training a cadre of geoscientists and engineers. Such professionals are in short supply not just in Saudi Arabia but everywhere. No amount of money can get you all the people you need today, says John Bradford of the Colorado School of Mines. To ensure Saudi Arabia can get them tomorrow, it has teamed up with American think-tanks in mining research and is working with Mr Bradford's institution to create training programmes. In November Ma'aden endowed a new undergraduate degree in mining science and engineering at King Fahd University of Petroleum and Minerals.

The princely plan may misfire. Abroad, it could run into the sort of resource nationalism it itself eschews. Partners in Africa, bruised by decades of outsiders shipping off resources without boosting development, insist that this time benefits trickle down to their economies. A partnership with Saudi Arabia must be "not just extracting the ore and taking it away", says Henry Dele Alake, Nigeria's solid-minerals minister. It would require investments in Nigerian processing and factories.

At home, Prince Muhammad's short timelines are, sceptical executives note, at odds with those typical of prospecting, mine development and mining education, all of which take years. Unlike phosphate deposits, metal ores from deeper underground are harder to extract quickly. A harsh summer shuts down work for safety reasons, halting projects for three or four months a year. Little has been done to realise Saudi Arabia's potential in power-hungry processing and refining, where it could excel thanks to plentiful energy.

Last, turning the Saudi vision into reality requires a radical shift among the world's miners. In an unpredictable world, many prefer to shovel profits to

shareholders rather than into risky new projects. To change this, the prince will need all his powers of persuasion. ■

另一种沙特黄金

沙特希望成为矿业大国

这个王国计划大量开采的不止石油

在沙特首都利雅得以北1200公里处的瓦阿德·沙马尔（Wa'ad Al Shamal），人们将磷酸盐提取出来，浸泡在化学品中，使它变成一种酸。再沿铁路向东行驶1500公里，运送到达拉斯海尔港（Ras Al-Khair）。然后再把这种酸制成肥料或其前体——氨，接着扬帆向西驶向巴西，向南驶向非洲，向东驶向印度和孟加拉国，最后到达农民手中。据负责该项目的国有矿业公司沙特阿拉伯矿业公司（Ma'aden）称，这些农民种植了世界上10%的食物。这个项目规模庞大。其销售额和国内投资约相当于沙特非石油GDP的2%。另一个类似的项目不久也将开始交付另外的1%。

磷酸盐并不是沙特阿拉伯希望能为其后石油未来提供燃料的唯一矿物资源。1月10日，沙特政府将其未开发矿藏的估价从1.3万亿美元修订为2.5万亿美元。其中包括黄金、铜和锌矿。按照沙特石油财富（以今天的价格计算约为20万亿美元）的标准，这看起来并不高。但以任何其他标准衡量，这都是一笔巨大的财富。

沙特王储、实际统治者穆罕默德·本·萨勒曼希望，今后世界要获取矿物（包括能源转型所需的那些矿物）将离不开沙特，就像今天说到"黑色黄金"就绕不开沙特一样。他意图在追寻这一目标时不像从美国到智利再到中国的其他国家那样诉诸资源民族主义。这吸引了来自80个国家的矿业老板和部长们在本文发表之际齐聚利雅得，参加该国的未来矿产论坛（FMF）。似乎是为了证明自己对开放的承诺，沙特与俄罗斯和美国的进出口银行都签署了协议。它预计此次论坛将敲定价值200亿美元的交易。

其战略一定程度上着眼于国外。沙特成立了马纳拉矿业公司（Manara Minerals），该项目受到沙特阿拉伯矿业公司和沙特主权财富基金支持。马纳拉将投资最多150亿美元参股外国矿山。去年，它以近30亿美元购入巴西矿业巨头淡水河谷（Vale）基本金属业务10%的股份。淡水河谷的老

板爱德华多·巴托洛梅奥（Eduardo Bartolomeo）说，沙特人"正拿出真金白银证明自己的态度"。

正如瓦阿德·沙马尔的磷酸盐产业综合体所显示的，更大的赌注还是放在国内。沙特阿拉伯正以投资目的地的名号来推销自己，其宣传活动包括在伦敦地铁等偏门的地方投放广告。在过去几年中，沙特成立了新的工业和矿产资源部，免除了进口机械和原材料的关税，降低了许可证费用和特许权使用费，并提供政府工资资助和租金补贴。它还用一部更接近澳大利亚、博茨瓦纳和加拿大那样的投资者友好型法规取代了一部晦涩的采矿法。过去需要数年才能获得的许可证现在只需两个月。

结果就是有效许可证数量急剧上升，达到约2300个，比两年前增加了五分之一。其中约700个是勘探许可证。一些许可证由外国人获得。巴里克黄金公司（Barrick Gold）和欧亚资源集团（Eurasian Resources Group）等中型或专业的外来公司或是获得了勘探许可证，或是与沙特阿拉伯矿业公司建立了合作伙伴关系。沙特阿拉伯矿业公司首席执行官罗伯特·威尔特（Robert Wilt）说："能得到一半比一点也得不到要好。"

"要吸引大玩家进入，沙特阿拉伯需要有重大的发现。"巴里克黄金公司的老板马克·布里斯托（Mark Bristow）说。为此，沙特正投资超过1.8亿美元激励勘探工作。政府投资工具沙特工业发展基金（Saudi Industrial Development Fund）提供多达四分之三的项目成本融资。此外，沙特还出资2亿美元绘制地质图并建立资源数据库，此前已在一项勘测工作中花费了5亿美元。威尔特说，沙特阿拉伯矿业公司也在进行更多的勘探工作。

沙特政府还在培训一批地质学家和工程师。不仅在沙特，这类专业人员在任何地方都十分紧缺。科罗拉多矿业学院（Colorado School of Mines）的约翰·布拉德福德（John Bradford）说，砸再多的钱也得不到今天就需要的所有人才。为了确保明天能得到这些人才，沙特已与美国矿业研究方面的智库合作，并与布拉德福德的学院合作制定培训计划。11月，沙特阿拉伯矿业公司在法赫德国王石油矿业大学（KFUPM）资助了一个新的采矿科学和工程本科专业。

沙特王储的宏伟计划可能不会奏效。在国外，它可能会撞上自己所回避的那种资源民族主义。数十年来，外来者将资源运出非洲，却没有促进非洲的发展，严重挫伤了非洲合作伙伴的信心。这一回，它们坚持要求合作要惠及本国经济。尼日利亚固体矿产部长亨利·德勒·阿拉克（Henry Dele Alake）说，沙特来合作"绝不能只是把矿石开采出来后运走"。它将要求对尼日利亚的加工业和工厂进行投资。

而在国内，持怀疑态度的高管指出，穆罕默德王储给出的时间表很紧迫，不符合勘探、矿山开发和矿业教育培训通常的时间表，这些工作全都需要耗时数年。与磷酸盐矿藏不同，地下深处的金属矿石更难快速开采。出于安全考虑，酷热的夏季会停工，导致项目一年中会中断三四个月。沙特在实现自身在加工和精炼上的潜力方面鲜有作为，这些工作耗能很高，能源丰富的沙特原本可以大显身手。

最后，将沙特的愿景变为现实还需要全球矿业公司做出重大转变。在这个变幻莫测的世界里，它们中的许多更愿意把利润分给股东，而不是投入到有风险的新项目中。要改变这一点，沙特王储可得使出浑身解数来说服人了。■

An influx of Chinese cars is terrifying the West

But it should keep its markets open to cheap, clean vehicles

IS CHINA ABOUT to unleash another wave of deindustrialisation on the rich world? About 1m American manufacturing workers lost their jobs to Chinese competition in 1997-2011, as the country integrated into the global trading system and began shipping cheap goods overseas. This "China shock" has since been blamed for everything from rising deaths among working-class Americans to the election of Donald Trump. The rejection of liberal attitudes to trade also explains why politicians embrace industrial policy today. Now China's carmakers are enjoying an astonishing rise. That stokes fears of another ruinous shock. In fact, the successes of Chinese cars should be celebrated, not feared.

Just five years ago China shipped only a quarter as many cars as Japan, then the world's biggest exporter. Earlier this month the Chinese industry claimed to have exported over 5m cars in 2023, exceeding the Japanese total. China's biggest carmaker, BYD, sold 0.5m electric vehicles (EVs) in the fourth quarter, leaving Tesla in the dust. Chinese EVs are so snazzy, whizzy and—most important—cheap that the constraint on their export today is the scarcity of vessels for shipping them. As the world decarbonises, demand will rise further. By 2030 China could double its share of the global market, to a third, ending the dominance of the West's national champions, especially in Europe.

This time it will be even easier for politicians to pin the blame for any Western job losses on Chinese foul play. A frosty geopolitical climate will feed the sentiment that subsidised production unfairly puts Western workers on the scrapheap. And there have certainly been subsidies. Since the launch of its "Made in China" agenda in 2014, China has brazenly

disregarded global trading rules, showering handouts on its carmakers. It is hard to be precise about the value of the underpriced loans, equity injections, purchase subsidies and government contracts Chinese firms enjoy. But by one estimate, total public spending on the industry was in the region of a third of EV sales at the end of the 2010s. These subsidies come on top of the ransacking of technology from joint ventures with Western carmakers and Western and South Korean battery-makers.

The temptation will therefore be for rich-world policymakers to shield their carmakers from the onslaught of state-backed competition. In October the European Commission opened an investigation into Chinese cars. President Joe Biden is said to be considering increasing tariffs on them, even though America's carmakers, protected by a 27.5% levy and handouts from the Inflation Reduction Act, currently face little Chinese competition. Yet locking out Chinese cars would be a mistake. The potential gains to the West from a ready supply of cheap, green vehicles are simply enormous—and dwarf the cost of disruption and the dangers it brings.

One reason is that the market for cars is going to be upended, regardless of trade with China. In 2022, 16-18% of new cars sold around the world were electric; in 2035 the EU will ban the sale of new cars with internal-combustion engines. Though firms are retaining their workers as they switch to making EVs, the process is less labour-intensive. Much as the first China shock was responsible for less than a fifth of total manufacturing job losses occurring at the time—many of which were attributable to welcome technological advances—so too there is a danger of confusing disruption caused by the shift to EVs with that caused by Chinese production of them.

Next consider the gains from letting trade flow. Vehicles are among people's biggest purchases, accounting for about 7% of American consumption. Cheaper cars mean more money to spend on other things, at a time when real wages have been squeezed by inflation. And Chinese cars are not only

cheap; they are better-quality, particularly with respect to the smart features in EVs that are made possible by internet connectivity. Nor does the existence of a carmaking industry determine a country's economic growth. Denmark has among the world's highest living standards without a carmaker to speak of. Even as cars roll off Chinese assembly lines, the economy is spluttering—in part because it has been so distorted by subsidies and state control.

Last, consider the benefits to the environment. Politicians around the world are realising just what a tall order it is to ask consumers to go green, as a backlash against costly emissions-reductions policies builds. EVs, too, are currently more expensive than gas-guzzling cars (even if their running costs are lower). Embracing Chinese cars with lower prices could therefore ease the transition to net-zero emissions. The cheapest EV sold in China by BYD costs around $12,000, compared with $39,000 for the cheapest Tesla in America.

What about the risks? The threat to industry from cheap imports is usually overblown. The lesson from the rise of Japanese and South Korean carmakers in the 1980s is that competition spurs local firms to shift up a gear, while the entrants eventually move production closer to consumers. Already, BYD is opening a factory in Hungary and many Chinese carmakers are scouting for sites in North America. Meanwhile the likes of Ford and Volkswagen are racing to catch Chinese firms. Last year Toyota said a breakthrough in its "solid state" technology would let it slash the weight and cost of its batteries.

Another worry is national security. Depending entirely on China for batteries, whose importance to electrified economies will go far beyond cars, would be risky. It is also possible that EVs, which are filled with chips, sensors and cameras could be used for surveillance. (China has banned even locally made Teslas from some government properties.) But so long as

presidents and spooks can travel in vehicles made in the West or by its allies, there is little reason to fear consumers sporting Chinese wheels; they can adjudicate personal-privacy concerns themselves and locally made cars will be easier to inspect.

Policymakers should therefore curb their protectionist instincts and worry only in the unlikely event that Western carmakers implode altogether. A hefty market share for Chinese carmakers that invigorates wider competition, however, is not to be feared. If China wants to spend taxpayers' money subsidising global consumers and speeding up the energy transition, the best response is to welcome it. ■

中国汽车大量涌入令西方恐惧

但西方市场应对廉价的绿色车辆保持开放

中国是否即将在富裕国家掀起另一波去工业化浪潮？在1997年至2011年间，随着中国融入全球贸易体系并开始向海外输送廉价商品，约有100万美国制造业工人因来自中国的竞争而失业。此后，从美国工人阶级死亡人数上升到特朗普当选，一切都被归咎于"中国冲击"。对自由贸易观的排斥拒绝也导致政客们如今纷纷采取产业政策。目前，中国的汽车制造商正在惊人崛起中。这引发了人们对另一场毁灭性冲击的担忧。事实上，中国汽车的成功值得庆祝，而不是忧惧。

仅在五年前，中国的汽车出口量还只有当时全球最大汽车出口国日本的四分之一。本月稍早时，中国汽车业称2023年中国总共出口了超过500万辆汽车，超过了日本。中国最大的汽车制造商比亚迪在第四季度售出50万辆电动汽车，让特斯拉望尘莫及。中国的电动汽车造型时尚、技术先进，而且最重要的是价格低廉，目前制约其出口的仅仅是运输船只不足。随着全球走向脱碳，需求将进一步上升。到2030年，中国在全球市场的份额可能会增加一倍，达到三分之一，从而结束西方各国龙头车企的主导地位，尤其是在欧洲。

这一次，政客将更容易把西方的一切就业流失归咎于中国的不正当竞争。冰冷的地缘氛围将强化人们的观感，认为受补贴的生产不公平地夺走了西方工人的生计。而补贴当然是真实存在的。自2014年开始实施"中国制造"计划以来，中国一直公然无视全球贸易规则，大肆补贴本国汽车制造商。它们所享受的低息贷款、股本注入、购车补贴和政府合同的价值难以确切计算。但据一项估计，到2010年代末，对汽车行业的公共支出约占电动汽车销售额的三分之一。除了补贴，中国还在与西方汽车制造商以及西方和韩国的电池制造商的合资企业中掠夺技术。

因此，富裕国家的政策制定者将会很想要保护自己的汽车制造商，让它们

免受由政府资助的竞争的猛攻。去年10月，欧盟委员会启动了对中国汽车的调查。据说美国总统拜登正在考虑对中国汽车增加关税，尽管在27.5%的汽车进口关税和《通胀削减法案》补助的保护下，美国汽车制造商目前几乎没有遭遇中国的竞争。然而，排斥中国汽车将是一个错误。西方可以通过廉价且环保的车辆的稳定供应获得巨大的潜在利益，远超过它带来的破坏和危险。

一个原因是，无论与中国的贸易往来如何，汽车市场都即将被颠覆。2022年，在全球销售的新车中，电动汽车占16%至18%。2035年欧盟将全面禁止销售内燃机汽车。尽管企业在转向电动汽车生产时会保留工人，但制造电动汽车所需的劳动力将减少。第一次中国冲击造成的制造业岗位流失实际上不到流失总数的五分之一，当时许多流失是因为值得欢迎的技术进步而造成的。这一次，转向电动汽车引起的冲击与中国生产电动汽车引起的冲击同样有可能被混为一谈。

接下来想想保持贸易畅通带来的好处。汽车是人们购买的最大件商品之一，约占美国总消费的7%。在实际工资受到通胀挤压的时候，汽车更便宜就意味着人们可以把更多的钱用在别处。而且中国车不仅仅是便宜，它们的质量更好，特别是在电动汽车中通过互联网连接实现的智能功能方面。再则，一国的经济增长也不取决于是否有汽车制造业。没什么汽车制造可言的丹麦是全球生活水平最高的国家之一。大批新车从中国的生产线上下来之际，其经济增长萎靡不振，部分原因就是补贴和政府控制导致了严重扭曲。

最后看看环境效益。随着对成本高昂的减排政策的抵制越来越强烈，世界各地的政客都意识到要让消费者转向绿色生活是一项多么艰巨的任务。目前，电动车的价格也高于燃油车（尽管使用成本更低）。接受价格更低的中国汽车可能有助于向净零排放的过渡。比亚迪在中国销售的最便宜的电动汽车约为1.2万美元，而在美国最便宜的特斯拉也要3.9万美元。

那有哪些风险呢？廉价进口商品对产业的威胁往往会被夸大。从上世纪80年代日本和韩国汽车制造商的崛起中我们可以得出一个经验，就是竞争能

够促使本地企业快速自我提升，而新进入者最终都将生产转移到更贴近消费者的地方。比亚迪已经开始在匈牙利建厂，许多中国汽车制造商正在北美选址准备设厂。与此同时，福特和大众等公司正在奋起追赶中国企业。去年，丰田表示其"固态"技术的突破将大幅降低其电池的重量和成本。

另一个担忧是国家安全。在电气化的经济中，电池的重要性远远超出汽车，在电池上完全依赖中国会有风险。电动汽车里有大量芯片、传感器和摄像头，也可能被用于监视。（中国甚至已经禁止在本土制造的特斯拉汽车进入一些政府机构所在地。）但只要国家首脑和情报人员可以乘坐西方或其盟友制造的车辆出行，就没什么理由担心消费者开中国车。消费者可以自行判断个人隐私问题，并且本地生产的汽车也更容易检查。

因此，政策制定者应该抑制自己的保护主义本能。他们只在一种情况下需要担心，而它不太可能发生，那就是西方汽车制造商全面崩溃。中国车商占据重大市场份额而激发更广泛竞争的情形不需要忧惧。如果中国想用自己纳税人的钱补贴全球消费者和加速能源转型，最好的回应就是欢迎它。■

Nostalgia for China's boom years drives a TV hit

A drama series presents 1990s capitalists as heroes, not villains

CHINA CENTRAL TELEVISION, the flagship network of the country's propaganda machine, has a new hit on its hands. "Blossoms Shanghai", a big-budget melodrama in 30 parts, has enjoyed huge audiences since its first episode aired on December 27th. The show's success—boosted by approving coverage in official and commercial media outlets—is at once unexpected and revealing. It is a surprise because its heroes are swashbuckling capitalists in the Shanghai of the early 1990s. A hard-living bunch, they cut deals, swap stock tips and scheme against rivals over an endless succession of boozy late-night banquets, filmed in demonic shades of black, gold and red. It is all a far cry from the prim, flag-waving dramas that have become the norm on state TV during Xi Jinping's rule. Typically, such series depict crime-fighting police officers, Communist Party officials toiling to serve the masses, brave Chinese soldiers or other model citizens.

Enthusiasm for the drama, the first TV series to be directed by Wong Kar-wai, a pillar of Hong Kong's film industry, sheds light on the Chinese public's mood. Much praise for the show has a distinctly backward-looking feel to it. Online, fans share their memories of boom years when ordinary Chinese could transform their fates with a lot of luck, good connections and hard work.

At the same time, the show's endorsement by government media is revealing about the hopes and fears of the country's rulers. This official embrace is rather tactical and forward-looking. Boosterish coverage of the drama is in line with a broader campaign by party leaders to cheer up Chinese consumers, whose post-pandemic caution is one reason why the economy is in a funk. Party newspapers credit the drama with sparking a

measurable surge in Shanghai hotel and restaurant bookings. Arguably, a show whose stars are heroic entrepreneurs also aligns with current official efforts to reassure China's private sector. Business types have been battered by heavy-handed regulation in recent years and left feeling generally unloved.

The hero is A Bao, a former factory worker shown making and almost losing a fortune on the stockmarket and in domestic and foreign trade. He is guided by an old man whose counsel runs from business strategy to the right cut for a three-piece suit. ("It has to be British-woven, pure wool," the sage sternly instructs a local tailor, summoned to make A Bao a new wardrobe.) The drama, adapted from a novel by Jin Yucheng, portrays capitalism as something between a test of nerves, a cruel game and a form of madness, capable of inducing a frenzy in consumers and investors alike. Characters cheat one another and commit suicide when ruined. Yet time and again the survivors are drawn to feast together at the same few restaurants, to plot and show off and drink. In contrast with the real 1990s, official corruption is nowhere to be seen. Indeed, the only important character with a public-sector job (at Shanghai's agency for foreign trade) is a paragon of honesty who uses her savings to repay businessmen for gifts they offer her.

To learn more about the show's success, Chaguan caught a fast train to Shanghai and headed to Huanghe Road, a street of restaurants and Art Deco mansions from the 1930s where much of the drama is set. He found a throng of fans taking photographs and filming themselves for social media, over the shrill, electronic whistles of police officers controlling crowds and directing traffic.

Chinese public opinion is rarely monolithic, and responses to the drama divided along lines of home town, age and social class. Locals are happy that the whole series was filmed in Shanghai dialect, with a second version

dubbed into Mandarin for nationwide release. Several Shanghainese pensioners shared strong views about the drama's realism, or lack of it. Back in the 1990s a lot of business was done over dinner, agreed an old man who worked in Shanghai's finance sector. But overall the series is a "fantasy", he scowled. "Those who went into the stockmarket and business were the rare bold ones. Most people worked in factories."

Three older women taking pictures had dressed for a fine dinner, though it was noon. They recalled neon signs that lit up Huanghe Road in those boom years. "Many businessmen gathered here, with their huge mobile phones," remembered one of the women. The trio were not among them. They were assigned jobs in a state-owned textile factory and stayed there until retirement. Modern life offers more choices but more pressure, they declared. In their telling, the series brings the Shanghai of their youth back to life. "But what use is nostalgia?" asked the same woman.

| *Nostalgia as a veiled form of complaint*

The sharpest opinions came from middle-aged fans, some of whom carried small dogs or trailed bored-looking husbands. The early years of China's "reform and opening" era were a time of hope, filled with new experiences, said a 50-year-old woman. She sighed: "We were lucky that we were born in a good age." In her view, life is very different now, and more stressful. Asked why, she replied that it is "hard to talk openly" about this. "There are so many reasons, political factors, among many others."

Young fans sounded more wistful than cross. For two female students, a lesson of the series is that there were more opportunities to move up in the world in the 1990s than now. A 25-year-old man had travelled from Hangzhou, an hour away by train, to take pictures of Huanghe Road. The series may inspire some viewers to start businesses, he enthused. Alas, capitalism is all about timing, he went on. Some may feel they have missed their moment.

Still, China's entrepreneurs should not become cocky about being cast as on-screen heroes. "Blossoms Shanghai" may be a runaway success, but at moments in early January the most-watched show on state TV was a documentary series about officials corrupted by business interests. Back when China first embraced market reforms, party leaders declared: "To get rich is glorious." In the Xi era, the lure of money remains distinctly dangerous. ■

对中国经济繁荣年代的怀旧推动一部电视剧爆火

这部剧把1990年代的资本家塑造成英雄而非反派

中国宣传机器的头牌电视网中央电视台最近播出了一部大火的新剧。自12月27日开播第一集以来，30集的大制作情节剧《繁花》吸引了大批观众收看。该剧的成功——受到官方和商业媒体正面评价的推动——既出人意料，也耐人寻味。说出人意料是因为该剧的主角是1990年代初上海一些大胆冒险的传奇资本家。在黑、金、红色交织的暗黑影调中，一群恣意人生的人在无休止的深夜酒局上谈生意、交换股票内幕消息、算计对手。这一切都与习近平执政后国家电视台上常见的那些正经八百、民族情绪高涨的电视剧大相径庭。通常，这些剧集描画的都是打击犯罪的警察、为人民鞠躬尽瘁的共产党官员、勇敢的中国军人或其他模范公民。

观众对该剧（它是香港电影界中流砥柱王家卫执导的首部电视剧）的追捧反映了中国民众的心境。对该剧的赞誉大多带有明显的怀旧色彩。剧迷们在网上分享他们对那个繁荣年代的回忆，那时普通人可以凭借好运、人脉和奋斗改变自己的命运。

与此同时，官方媒体对该剧的认可透露出上层的期盼和忧虑。这种官方的肯定在某种程度上是策略性和前瞻性的。对该剧的积极报道配合了党的领导人提振消费者信心的宏观举措，中国民众在疫情后不敢消费，是如今经济低迷的原因之一。据各家党报报道，在该剧带动下，上海的酒店和餐馆的预订量显著增加。可以说，这部以英雄企业家为主角的电视剧也配合了当前官方为安抚中国私营部门所做的努力。近年来，商界人士受到监管的重拳打压，感到在社会上不受待见。

剧中主人公阿宝原本是工厂工人，后来通过炒股和从事国内外贸易发家致富，最后又几乎倾家荡产。他得到一位长者在方方面面的指点，从商场上的策略到三件套西装的正确剪裁等。("一定要英纺、纯羊毛的。"这位智者严格叮嘱被召来给阿宝做新衣服的一位本地裁缝）。这部改编自金宇澄的

小说的电视剧把资本主义描绘成某种介于胆量的考验、残酷的博弈和某种癫狂之间的东西，能在消费者和投资者中引发狂热。剧中人物尔虞我诈，在生意失败后自杀。然而，那些熬过来的人却一次又一次回到同样那几家餐厅吃饭、密谋、炫耀、喝酒。与真实的1990年代不同，剧中看不到腐败的官员。实际上，唯一一个公营部门的重要角色（在上海外贸局工作）堪称正直的典范，商人给她送礼物，她会拿自己的积蓄来付钱。

为更多了解该剧爆火的情况，笔者乘坐高铁来到上海，直奔遍布餐馆和上世纪30年代装饰艺术风格洋房的黄河路，该剧大部分剧情都在这里展开。在控管人群和指挥交通的警察那尖锐的电子警哨声中，笔者看到一大群剧迷在那里拍摄照片和视频，准备发到社交媒体上。

中国的公众舆论很少能众口一词，人们对该剧的反应也因家乡、年龄和社会阶层的不同而各异。让上海人开心的是《繁花》全部用沪语拍摄，另有一个普通话配音的版本在全国播放。几位上海退休老人对该剧的写实或不够写实有着强烈的看法。在上世纪90年代，很多生意的确是在饭桌上谈成的，一位曾在上海金融界工作的老人对此表示赞同。但总的来说，这部电视剧是一种"幻想"，他皱着眉说。"那些炒股经商的是极少数胆子大的人。大多数人都是在工厂工作。"

虽是中午时分，有三位在那里打卡拍照的老阿姨却是一身要赴晚宴的打扮。她们回忆起那个繁荣年代黄河路上闪烁的霓虹灯。"当年有许多生意人聚在这里，手里拿着大哥大。"其中一人回忆说。三位阿姨并不在其中。她们被分配到一家国有纺织厂工作，直到退休。她们表示，现代生活提供了更多选择，但也带来了更多压力。在她们看来，《繁花》重现了她们年轻时上海的模样。"但怀旧有什么用呢？"还是那位阿姨问道。

怀旧是一种隐晦的抱怨

表达最尖锐看法的是中年剧迷，他们当中有人抱着小狗，有人拽着神情无聊的丈夫。一位50岁的女士说，中国"改革开放"初期是个充满希望和新体验的时代。她叹道："我们出生在一个好时代，那会儿是幸运的。"在她看来，现在的生活已经大不一样，压力也更大。当被问及原因时，她回答说

"很难公开谈论"这个问题。"原因太多了，比如政治因素。"

年轻剧迷表达的更多是怅然，而非怨怒。两名女学生表示，《繁花》带来的启示是，与现在相比，1990年代有更多出人头地的机会。一名25岁男子从杭州坐一小时火车来到黄河路打卡拍照。他兴奋地说，这部剧可能会激励一些观众创业。可惜啊，资本主义讲究的是时机，他接着说道。有些人可能会觉得自己已经错过时机了。

尽管如此，中国的企业家们也别因为在荧屏上被塑造成英雄而自鸣得意。《繁花》可能一炮而红，但在1月初时，央视收视率最高的节目是一部讲述官员被商业利益腐蚀的系列专题片。在中国开展市场改革之初，党的领导人宣称"致富光荣"。而在习时代，金钱的诱惑显然还是洪水猛兽。■

Robert Solow was an intellectual giant

His criticisms were energetic and witty, which could make them harder to take

ENSCONCED IN A lorry, hidden from the enemy by the brow of a hill, the young Robert Solow decoded the radio signals of Nazi platoons across Italy. "We were very, very good at it," he said. The trick was to get close to the enemy but not too close: near enough to pick up their transmissions, but not so near as to risk capture.

The codes were not fancy—it was "combat stuff". But if they could be broken quickly, they might reveal an ammunition delivery that could be thwarted. The radiomen were not fancy either. Most were high-school graduates. Even Solow, who would go on to earn a Nobel prize in economics, the Presidential medal of freedom and a Portuguese knighthood, before his death on December 21st 2023, was "middle-middle-class". He was educated at Brooklyn state schools. He preferred softball to books, and was destined for Brooklyn College until a teacher spotted his potential, broadened his reading, and encouraged him to apply to Harvard University, which he joined two years early and rejoined after the war.

Solow's years as a soldier only strengthened his egalitarian streak. He declined to become an officer, so he would not have to boss anyone around. When the Massachusetts Institute of Technology (MIT) offered him a job in 1949, he asked what the lowest paid professor earned, and accepted the same. When he served in President Kennedy's Council of Economic Advisers, the Swiss embassy wanted to know his protocol rank. His answer was that he was a full professor at MIT and the government had no rank as high. Informed in the predawn hours in October 1987 that he had won the Nobel prize, his first instinct was to go back to sleep.

What he craved was more precious than prizes: the esprit de corps that comes from membership of a small, highly motivated band of colleagues. "If you're in a group that is doing good work, it'll have a high morale. And if it has high morale, it'll do good work," he once said. As an economist, he liked formal models and mathematics. But nothing too fancy. Over-refinement reminded him of the man who knew how to "spell banana" but did not "know when to stop". His strategy was to break big questions—about growth, resources, unemployment—into littler ones, in the hope that small answers would aggregate into larger ones.

The MIT culture he embodied disdained hierarchy, cherished collegial lunches and made time for students, many of whom became illustrious friends. Four of Solow's students later received their own sleep-disturbing calls from Sweden. Economics, Solow maintained, was a "handicraft" industry, often driven by the "extraordinarily powerful research apparatus" of one professor and one undergraduate assistant.

Something he liked about academia was that ideas, no matter how prestigious their source, could be scrutinised by anyone. His own criticisms were energetic and witty, which could make them harder to take. He found the "freshwater" school of macroeconomics, identified with the University of Chicago, preposterous, especially in its early incarnations, which assumed a "representative agent" could stand in for the many actors in an economy. To get into a technical discussion with freshwater types was like discussing cavalry tactics with someone claiming to be Napoleon, he said. The claim is absurd, however well they know their stuff.

The work that made his name began as criticism of the growth theories of the 1930s and 1940s. In these, investment added both to national spending and the economy's productive capacity. There was no guarantee these additions to demand and supply would stay in line with each other. Moreover, excessive spending, by boosting demand, would inspire firms to

invest even more, whereas inadequate investment would induce firms to spend still less. The economy was for ever poised on a "knife-edge" between deepening unemployment or intensifying labour shortages.

This precariousness was hard to square with the relatively stable progress of advanced economies like America, where even the Great Depression eventually ended. Solow showed that the knife-edge disappeared if economies could vary the capital-intensity of production. Strong investment would not then be destabilising. It would merely result in higher capital per worker.

High investment would not, however, result in faster growth over the long run. At some point, capital would run into diminishing returns, leaving growth to be dictated by other factors. Solow calculated that capital accumulation could explain less than 13% of the growth in income per person in America from 1909 to 1949. The remainder was attributable to other forces, which he loosely labelled "technical change". This vast unexplained portion of growth became known as the "Solow residual".

Tough paternal love

Although his work created reams of subsequent research, the father of growth theory was not impressed by many of his progeny. He was sceptical of statistical exercises that dissected growth rates across countries at every stage of development. Nor had he intended to imply that technological progress, which he did not model, fell entirely outside economics. A lot of innovation was "dumb luck". And much of it emerged on the factory floor, "invented" by unheralded foremen. But some was the result of profit-driven investment in research. Later attempts to create formal theories of technological progress nevertheless asked more questions than they answered, he argued.

Part of the problem was that innovation is often peculiar and particular,

whereas growth theorists strive for generality and abstraction. Solow, who had himself observed the research labs at General Motors and collaborated with the McKinsey Global Institute on industry-level studies of productivity, thought model-builders could learn from case studies and business histories. The aim was to "extract a few workable hypotheses" without getting lost in the detail. To understand how the economy works, to decode its secrets, you need to get up close, but not too close. ■

罗伯特·索洛，一位思想巨人

他的批判活力十足、机智风趣，这可能让它们更难被接受

年轻的罗伯特·索洛（Robert Solow）躲在一辆卡车里，利用山丘的掩护避开敌人视线，抓紧破译意大利各地纳粹部队的无线电信号。"我们特别擅长干这个。"他说。诀窍是要与敌军若即若离：近到足以接收到他们的信号，但又不能太近，以免被捉住。

这些无线电密码并不复杂——就是些"作战信息"。但如果能迅速将之破解，就可能发现某个弹药运送行动而挫败它。无线电破译员也没什么神秘的，大多数是高中毕业生。即便是索洛——他后来获得诺贝尔经济学奖、总统自由勋章和葡萄牙爵位，于2023年12月21日去世——也只是一个"普通中产阶级"。他在美国布鲁克林的公立学校接受教育。比起读书，他更喜欢垒球，本来打算报读布鲁克林学院（Brooklyn College），直到一位老师发现了他的潜力，拓宽了他的阅读面，并鼓励他报读哈佛大学。他提前两年入读哈佛，战后又重返校园。

在他的从军岁月里，索洛的平等主义倾向进一步强化。他拒绝担任军官，这样他就不必对任何人发号施令。当麻省理工学院1949年聘任他时，他询问了收入最低的教授的薪资水平，并接受了同样的待遇。当他在肯尼迪总统的经济顾问委员会（Council of Economic Advisers）任职时，瑞士大使馆想了解他的礼宾级别。他答说自己是麻省理工的正教授，政府里没有比这更高的级别了。1987年10月的一个黎明时分，他得知自己获得了诺贝尔奖，第一反应是继续睡觉。

他渴求的东西比奖项更珍贵：一小群干劲十足的同事凝聚起的团队精神。他曾说过："如果你所在的团队工作出色，士气就会高昂。如果士气高昂，工作就会出色。"作为一名经济学家，他喜欢正式的模型和数学。但他不喜欢过于繁复精致的东西。过度精细在他眼里就好像知道如何"拼写banana"却不知道"在哪里停下"。他的策略是将大问题——增长、资源、失

业——分解成若干较小问题，希望小的答案能汇聚成更大的解答。

他身上展现的麻省理工文化对等级制度不屑一顾，珍惜同事共进午餐的时光，乐意为学生抽出时间，其中许多学生日后成为了赫赫有名的友人。索洛的四名学生后来也在深夜被来自瑞典的电话吵醒。索洛认为，经济学是一种"手工艺"产业，常常由一名教授和一名本科生助理组成的"极强大研究器具"驱动。

他喜欢学术圈的一点是，无论提出观点的人地位多么显赫，任何人都可以对观点加以审视。他自己做出的批判活力十足、机智风趣，这可能让它们更难被接受。他认为以芝加哥大学为代表的宏观经济学"淡水"学派是荒谬的，尤其是其早期版本，它假定一个"代表性主体"可以代替经济中的众多参与者。他说，与淡水学派的人做学术讨论就像和某个声称自己是拿破仑的人讨论骑兵战术。无论他们多么懂行，这种自诩都是荒诞的。

他的成名始于对上世纪三四十年代经济增长理论的批判。这些理论认为，投资既增加了国民支出，也提高了经济的生产能力，但谁也不能保证这些需求和供应的增加能够保持相互匹配。此外，刺激需求导致的过度支出将激励企业进一步加大投资，而投资不足则会导致企业进一步削减支出。经济始终悬在失业恶化和劳动力短缺加剧之间的"刀口"上。

这种岌岌可危与美国等发达经济体相对平稳的发展态势并不相符合，因为即使是大萧条最终也还是结束了。索洛表明，如果经济体能够改变生产的资本密集度，刀口就会消失。这时，强劲投资就不会带来不稳定性，而只会导致工人的人均资本量增加。

然而，从长期来看，高投资并不会带来更快的增长。到了一定程度，资本将陷入收益递减，此时经济增长将受到其他因素的支配。根据索洛的计算，从1909年到1949年，美国人均收入的增长只有不到13%能用资本积累解释。其余部分归因于其他因素，他笼统地称之为"技术变革"。增长中这一无法解释的庞大部分后来被称为"索洛残差"。

尽管他的成果引发了大量的后续研究，但这位增长理论之父对众多后辈的表现不甚满意。他对剖析各国在不同发展阶段的增长率的统计学方法持怀疑态度。虽然他没有对技术进步建模，但他也无意暗示技术进步完全跌出了经济学范畴。很多创新"纯属好运"。其中大部分都是名不见经传的工头在工厂车间里"发明"的。但也有一些是源于利润驱动的对研发的投资。他认为，后来人们试图建立关于技术进步的正式理论，相比解答问题，反而提出了更多问题。

这在一定程度上是因为创新往往是特殊且具体的，而增长理论家追求普遍性和抽象性。索洛亲身观察过通用汽车的研究实验室，并与麦肯锡全球研究院合作开展行业层面的生产率研究。他认为，建模者可以从案例研究和商业史中学习。其目标是"提取几个可行的假设"，但不迷失在细枝末节之中。要了解经济的运作规律，破译其秘密，关键是若即若离：要近距离观察，但又不能太近。■

Welcome to the era of AI nationalism

Sovereigns the world over are racing to control their technological destinies

THE HOTTEST technology of 2023 had a busy last few weeks of the year. On November 28th Abu Dhabi launched a new state-backed artificial-intelligence company, AI71, that will commercialise its leading "large language model" (LLM), Falcon. On December 11th Mistral, a seven-month-old French AI startup, announced a blockbuster $400m funding round, which insiders say will value the firm at over $2bn. Four days later Krutrim, a new Indian startup, unveiled India's first multilingual LLM, barely a week after Sarvam, a five-month-old one, raised $41m to build similar Indian-language models.

Ever since OpenAI, an American firm, launched ChatGPT, its humanlike conversationalist, in November 2022, just about every month has brought a flurry of similar news. Against that backdrop, the four latest announcements might look unexceptional. Look closer, though, and they hint at something more profound. The three companies are, in their own distinct ways, vying to become AI national champions. "We want AI71 to compete globally with the likes of OpenAI," says Faisal al-Bannai of Abu Dhabi's Advanced Technology Research Council, the state agency behind the Emirati startup. "Bravo to Mistral, that's French genius," crowed Emmanuel Macron, the president of France, recently. ChatGPT and other English-first LLMs "cannot capture our culture, language and ethos", declared Krutrim's founder, Bhavish Aggarwal. Sarvam started with Indian languages because, in the words of its co-founder, Vivek Raghavan, "We're building an Indian company."

AI is already at the heart of the intensifying technological contest between America and China. In the past year their governments have pledged

$40bn-50bn apiece for AI investments. Other countries do not want to be left behind—or stuck with a critical technology that is under foreign control. In 2023 another six particularly AI-ambitious governments around the world—Britain, France, Germany, India, Saudi Arabia and the United Arab Emirates (UAE)—promised to bankroll AI to the collective tune of around $40bn (see chart). Most of this will go towards purchases of graphics-processing units (GPUs, the type of chips used to train AI models) and factories to make such chips, as well as, to a lesser extent, support for AI firms. The nature and degree of state involvement varies from one wannabe AI superpower to another. It is early days, but the contours of new AI-industrial complexes are emerging.

Start with America, whose tech firms give everyone else AI envy. Its vibrant private sector is innovating furiously without direct support from Uncle Sam. Instead, the federal government is spending around $50bn over five years to increase domestic chipmaking capacity. The idea is to reduce America's reliance on Taiwanese semiconductor manufacturers such as TSMC, the world's biggest and most sophisticated such company. Supplies from Taiwan could, fear security hawks in Washington, be imperilled if China decided to invade the island, which it considers part of its territory.

Another way America intends to stay ahead of the pack is by nobbling rivals. President Joe Biden's administration has enacted brutal export controls that ban the sale of cutting-edge AI technology, including chips and chipmaking equipment, to adversaries such as China and Russia. It has also barred Americans from sharing their AI expertise with those countries.

It is now coercing those on the geopolitical fence to fall in line. In October the American government started requiring companies in third countries, including Saudi Arabia and the UAE, to secure a licence in order to buy AI chips from Nvidia, an American firm that sells most of them. The rules have a "presumption of approval". That means the government will

"probably allow" sales to such firms, says Gregory Allen, who used to work on AI policy at the Department of Defence—as long, that is, as they do not have close ties to China. On December 6th Xiao Peng, who runs a state-backed AI startup in Abu Dhabi called G42, announced that the company would be cutting ties with Chinese hardware suppliers such as Huawei, a Chinese electronics company.

China's AI strategy is in large part a response to American techno-containment. According to data from JW Insights, a research firm, between 2021 and 2022 the Chinese state spent nearly $300bn to recreate the chip supply chain (for AI and other semiconductors) at home, where it would be immune from Western sanctions. A lot of that money is probably wasted. But it almost certainly helped Huawei and SMIC, China's biggest chipmaker, to design and manufacture a surprisingly sophisticated GPU last year.

The central and local authorities also channel capital into AI firms through state-backed "guidance funds", nearly 2,000 of which around the country invest in all manner of technologies deemed to be strategically important. The Communist Party is guiding private money, too, towards its technological priorities. Often it does so by cracking down on certain sectors—most recently, in December, video-gaming—while dropping heavy hints about which industries investors should be looking at instead. The government is also promoting data exchanges, where businesses can trade commercial data on everything from sales to production, allowing small firms with AI ambitions to compete where previously only large data-rich firms could. There are already 50 such exchanges in China.

Elements of this state-led approach are being emulated in other parts of the world, notably in the Gulf's petrostates. Being autocracies, Saudi Arabia and the UAE can move faster than democratic governments, which must heed voters' concerns about AI's impact on things like privacy and jobs. Being wealthy, they can afford both the GPUs (on which the two countries have

together so far splurged several hundred million dollars) and the energy needed to run the power-hungry chips.

They can also plough money into developing human capital. Their richly endowed universities are quickly climbing up global rankings. The AI programme at King Abdullah University of Science and Technology in Saudi Arabia and the Mohamed bin Zayed University of Artificial Intelligence (MBZUAI) in Abu Dhabi, the world's first AI-focused school, have poached star professors from illustrious institutions such as the University of California, Berkeley, and Carnegie Mellon University in Pittsburgh. Many of their students and researchers come from China. And plenty stick around. Nearly all of MBZUAI's graduates, who number a couple of hundred, stay in the region to work at local firms and labs, says its provost, Timothy Baldwin (himself lured to the Middle East from the University of Melbourne).

The Gulf approach is producing results. The capabilities of the Falcon model, first built by a team of 20 or so engineers, rival those of Llama 2, the most widely used "open-source" model, devised by Meta, an American tech giant. AI71 plans to improve its open-source models using national datasets from fields including health, education and, some day, perhaps oil. "In the last 50 years, oil drove the country...now data is the new oil," says Mr al-Bannai.

The alignment problem

A third group of governments is combining elements of America's approach with those of the Chinese and Emiratis. The EU has its version of America's incentives for domestic chipmaking. So do some member states: Germany is footing a third of the €30bn ($33bn) bill for a new chip factory to be built there by Intel, an American chipmaker. Outside the bloc, Britain has promised to funnel £1bn ($1.3bn) over five years to AI and supercomputing (albeit without going into detail about how exactly the money will be spent). India's government is promoting manufacturing,

including of semiconductors, with generous "production-linked incentives", encouraging big cloud-computing providers to build more Indian data centres, where AI models are trained, and thinking about buying $1.2bn-worth of GPUs.

Like China and the Gulf but unlike America, where federal and state governments are reluctant to part with public data, India and some European countries are keen on making such data available to firms. France's government "has been very supportive" in that regard, says Arthur Mensch, Mistral's boss. Britain's is considering allowing firms to tap rich data belonging to the National Health Service. India's government has enormous amounts of data from its array of digital public services, known as the "India Stack". Insiders expect it eventually to integrate Indian AI models into those digital services.

In contrast to China, which regulates consumer-facing AI with a heavy hand, at least for the time being Britain, France, Germany and India favour light-touch rules for AI or, in India's case, none at all. The French and German governments have soured on the EU's AI Act, the final details of which are being hotly debated in Brussels—no doubt because it could constrain Mistral and Aleph Alpha, Germany's most successful model-builder, which raised €460m in November.

It is natural for countries to want some control over what may prove to be a transformational technology. Especially in sensitive and highly regulated sectors such as defence, banking or health care, many governments would rather not rely on imported AI. Yet each flavour of AI nationalism also carries risk.

America's beggar-thy-neighbour approach is likely to upset not just its adversaries but also some allies. China's heavy regulation may offset some of the potential gains from its heavy spending. Building models for local

languages, as Krutrim and Sarvam in India plan to do, may prove futile if foreign models continue to improve their multilingual capabilities. The Gulf's bet on open-source models may misfire if other governments limit their use, as Mr Biden has hinted at in a recent executive order and the EU could do through its AI Act, out of fear that open LLMs could be put to malign uses by mischief-makers. Saudi and Emirati institutions may struggle to hold on to talent; a developer who worked on Falcon admits it greatly benefited from a partnership with a French team of engineers who have since been poached by Hugging Face, a high-flying Silicon Valley AI startup. As one sceptical investor notes, it is not yet clear how vast or useful public Emirati data actually is.

As Nathan Benaich of Air Street Capital, a venture-capital firm, sums it up, most efforts to create national models "are probably a waste of money". Mr Benaich's warning is unlikely to dissuade AI-curious governments, mindful of the rewards should they succeed, from meddling. Mr Macron will not be the only leader to greet it with a Gallic shrug. ■

欢迎来到人工智能民族主义的时代

世界各地的主权国家正竞相控制它们的科技运数【深度】

二〇二三年最热门的技术在年末的几周里热闹非凡。11月28日，阿布扎比推出了一家由政府支持的新人工智能公司AI71，致力于把阿联酋领先的"大语言模型"（LLM）Falcon商业化。12月11日，成立七个月的法国AI创业公司Mistral宣布了一轮4亿美元的大手笔融资，知情人士称这将使该公司估值超过20亿美元。四天后，印度新兴创业公司Krutrim发布了印度首个多语言LLM，而不过一周前，创立五个月的Sarvam才刚融资了4100万美元构建类似的印地语语言模型。

自从美国公司OpenAI在2022年11月推出了对话能力接近人类的ChatGPT以来，几乎每个月都会冒出一连串类似的新闻。在这一背景下，最近的这四个公告看似并无特别之处。但仔细观察，就会发现它们透露出某种更深层的动态。这三家公司正在以各自不同的方式竞逐AI国家冠军之位。AI71背后的政府机构、阿布扎比的先进技术研究委员会（Advanced Technology Research Council）的费萨尔·班奈（Faisal al-Bannai）表示："我们希望AI71能在全球范围里与OpenAI这样的公司竞争。"法国总统马克龙最近喜不自胜地夸赞："为Mistral喝彩，它是法国人天分的体现。"Krutrim的创始人巴维什·阿加瓦尔（Bhavish Aggarwal）宣称，ChatGPT和其他以英语为先的LLM"无法捕捉我们的文化、语言和精神"。Sarvam的联合创始人维韦克·拉加万（Vivek Raghavan）表示"我们是在建立一家印度公司"，因此Sarvam从印地语开始。

AI已经是美国和中国日益激烈的科技竞争的核心。在过去一年中，两国政府都承诺了四五百亿美元的AI投资。其他国家不想落后或受制于一项由他国掌控的关键技术。2023年，世界上另外六个在AI上格外有抱负的政府——英国、法国、德国、印度、沙特阿拉伯和阿联酋——承诺将总共投入约400亿美元用于支持AI（见图表）。其中大部分资金将用于购买图形处理单元（GPU，用于训练AI模型的芯片）和制造此类芯片的工厂，还有较

少部分用来支持AI公司。意欲成为AI超级大国的国家在政府参与的性质和程度上各不相同。现在一切还只是个开始，但新的AI产业联合体的轮廓正在浮现。

先来看美国，它的科技公司拥有令各方羡慕的AI实力。其充满活力的私营部门正在疯狂创新，而无需山姆大叔的直接支持。美国政府转而致力提升国内的芯片制造能力，正为此在五年内投入约500亿美元。其想法是减少美国对台湾半导体制造商（如全球最大、最先进的台积电）的依赖。华盛顿的安全鹰派担心，如果中国大陆决定对台动武（中国大陆认为台湾是中国领土的一部分），那么来自台湾的供应可能会受到威胁。

美国试图保持领先的另一个方式是阻挠竞争对手。拜登政府已实施严厉的出口管制，禁止向中国和俄罗斯等对手销售尖端AI技术，包括芯片和芯片制造设备。它还禁止美国人与这些国家分享他们的AI专业知识。

现在，美国正在迫使那些在地缘上不肯选边的国家站到它这一边。去年10月，美国政府规定，包括沙特阿拉伯和阿联酋在内的第三国公司须获得许可才能从销售了全球大部分AI芯片的美国公司英伟达购货。这些规则有一个"批准假定"。也就是说，美国政府"可能会允许"向这些公司销售，曾在国防部负责AI政策的格雷戈里·艾伦（Gregory Allen）说——只要它们与中国没有密切联系。12月6日，掌管由政府支持的阿布扎比AI创业公司G42的肖鹏宣布，公司将切断与电信公司华为等中国硬件供应商的联系。

中国的AI战略在很大程度上是对美国技术遏制的回应。根据研究公司集微咨询的数据，2021年至2022年间，中国政府花费了近3000亿美元在国内重建芯片供应链（包括AI和其他半导体），以求对西方制裁免疫。其中很多钱可能被浪费掉了。但它几乎肯定帮助华为和中国最大的芯片制造商中芯国际在去年设计和制造了一款先进程度出人意料的GPU。

中央和地方政府还通过政府"引导基金"将资本导向AI公司，全国有近2000个此类基金投资于各种被认为具有重要战略意义的技术。共产党也在引导私人资金投向它要优先发展的技术。为实现这一目标，它通常会打击某些

行业——最近一次是在12月整顿电子游戏业——同时重点提示投资者应该转而关注哪些行业。中国政府还在推动建立数据交易所，企业可以在这里交易从销售到生产的各类商业数据，使怀抱AI雄心的小公司能够在过去唯数据充足的大公司才能立足的领域里竞争。中国已有50个此类交易所。

这种政府主导的模式中的一些要素正被世界其他地区仿效，尤其是海湾的石油国家。沙特和阿联酋这样的威权国家可以比民主政府行动更快，后者必须听取选民对AI影响隐私和就业等方面的担忧。而由于国家富有，它们既买得起GPU（这两个国家到目前为止已经为此花费了几亿美元），也能负担运行这些高耗能芯片所需的能源。

它们还能投资发展人力资本。它们的大学资金充裕，全球排名正在迅速攀升。沙特的阿卜杜拉国王科技大学（King Abdullah University of Science and Technology）的AI项目，以及阿布扎比的穆罕默德·本·扎耶德人工智能大学（MBZUAI，世界上第一所专注于AI的大学）已经从加州大学伯克利分校和匹兹堡的卡内基梅隆大学等声名赫赫的院校挖走了明星教授。它们的许多学生和研究人员来自中国，而且其中很多人留了下来。MBZUAI的毕业生大约有几百人，几乎全部留在了中东地区，在当地的公司和实验室工作，MBZUAI的教务长蒂莫西·鲍德温（Timothy Baldwin）说。他本人也是从墨尔本大学被吸引到中东的。

海湾国家的模式正在取得成果。最初由大约有20名工程师的团队构建的Falcon模型的性能可媲美美国科技巨头Meta设计的最广泛使用的"开源"模型Llama 2。AI71计划利用健康、教育等领域的国家数据集改进其开源模型，有朝一日或许还会包括石油领域。"过去50年里，石油驱动了这个国家……现在数据是新的石油。"班奈说。

对齐问题

第三类政府正在把美国模式与中国和阿联酋的模式中的要素结合起来。欧盟有类似美国的国内芯片制造激励措施。它的一些成员国也有这类措施：德国承担了美国芯片制造商英特尔将在该国建造的新芯片工厂300亿欧元（330亿美元）造价的三分之一。在欧盟之外，英国承诺在五年内向AI和

超级计算领域投入1o亿英镑（13亿美元），尽管没有详细说明这笔钱会怎么用。印度政府正在推动包括半导体制造在内的制造业，它提供慷慨的"生产挂钩激励"，鼓励大型云计算提供商在印度建设更多可用于训练AI模型的数据中心，并考虑购买总价值12亿美元的GPU。

印度和一些欧洲国家热衷于向企业提供公共数据，这与中国和海湾国家相似，而与美国不同（联邦和州政府不愿分享这类数据）。法国政府在这方面"非常支持"，Mistral的老板亚瑟·门什（Arthur Mensch）说。英国正在考虑允许企业获取国家医疗服务体系（NHS）中的丰富数据。印度政府拥有大量来自各类数字公共服务（被称为"印度堆栈"）的数据，知情人士预计它最终将把印度的AI模型整合到这些数字服务中。

中国对面向消费者的AI实行严格管制，而英国、法国、德国和印度则倾向于宽松监管AI——至少在目前是如此，印度更是完全不加管束。法国和德国政府对欧盟的《人工智能法案》（AI Act）感到不满。谈判代表们正就该法案的最终细节在布鲁塞尔激烈辩论——毫无疑问，这是因为它可能会限制Mistral和德国最成功的模型开发公司Aleph Alpha（它在去年11月融资4.6亿欧元）。

各国想要对一项可能具有变革性的技术有所控制是自然的事。尤其是在国防、银行或医疗等敏感且受高度监管的领域，许多政府不愿意依赖进口AI。然而，各色AI民族主义也会带来风险。

美国以邻为壑的政策不仅可能激怒对手，也很可能惹恼一些盟友。中国的严格监管可能会抵消其大量支出带来的潜在收益。在印度，Krutrim和Sarvam计划为本地语言构建模型，但如果外国模型继续提高其多语言能力，这些努力就可能是无用功。如果其他政府担心开放式LLM可能被图谋不轨者恶意使用而限制对开源模型的使用，海湾国家对这类模型的押注可能会落空。拜登在最近的行政命令中已暗示会限制使用开源模型，欧盟也可能通过其《人工智能法案》这样做。沙特和阿联酋的机构可能难以留住人才；一位参与Falcon项目的开发人员承认，该项目从与一个法国工程师团队的合作中受益匪浅，这些工程师后来被高歌猛进的硅谷AI创业公司

Hugging Face挖走。正如一位持怀疑态度的投资者所指出的，阿联酋公共数据实际上有多丰富和有用还是个未知数。

正如风险投资公司Air Street Capital的内森·贝奈奇（Nathan Benaich）所总结的那样，大多数创建国家模型的努力"可能是浪费钱"。贝奈奇的提醒不太可能说服那些对AI兴致盎然的政府不插手，它们一心想着如果成功将能获得的回报。马克龙不会是唯一以耸耸肩来回应的领导人。■

Can Sino-Arabian business ties replace Sino-American ones?

The Middle Kingdom gets cosy with the Middle East

WHEN CHINESE and Middle Eastern moneymen meet, it is usually behind closed doors. Last month they mingled openly in the lobby of the Hong Kong Stock Exchange, at the "FII Priority" summit, an event organised by the Public Investment Fund (PIF), a $780bn vehicle for Saudi sovereign wealth. It was the first meeting of its kind in east Asia. It will not be the last. The PIF announced it was planning to set up an office in China. Mubadala and the Investment Corporation of Dubai, two Emirati sovereign wealth funds, the Qatar Investment Authority and Kuwait Investment Authority are all said to be preparing to deploy more capital in the world's second-biggest economy. They think they can to do this without angering the increasingly China-wary West. "We are friendly people, we are friends with everyone," Jerry Todd, an executive at the PIF, told the conference in Hong Kong.

China's investment firms and the companies they back need friends right now. As Sino-American geopolitics sour, American investments in China have collapsed. Chinese tech firms got $1.2bn from American venture capitalists in 2022, down from $14bn in 2018. Mergers and acquisitions (M&A) by American firms in China fell below $9bn in 2023, down from $20bn five years earlier. Meanwhile M&A deals by Gulf entities have ballooned—from next to nothing in 2019 to nearly $9bn in 2023, according to data from LSEG, a financial-information firm (see chart).

Last month NIO, a Chinese Tesla wannabe, said it had received $2.2bn from CYVN Holdings, a firm controlled by Abu Dhabi's government that had previously put more than $1bn into the electric-car maker. The NEOM Investment Fund, part of a pharaonic Saudi project to build a futuristic city

in the desert, has backed Pony.AI, a part-Chinese developer of self-driving tech. Earlier in the year Saudi Aramco, the kingdom's oil colossus, invested $3.6bn in a Chinese petrochemical refinery called Rongsheng, and entered into a joint venture with the PIF and Baosteel, one of China's largest steelmakers, to produce high-quality metal plates in Saudi Arabia. Chinese VC firms are tight-lipped in public about their limited partners but privately confirm that in the past two years interest from Middle Eastern ones has jumped.

Tech talent, of which the Gulf is short but China has aplenty, is flowing in the other direction. The Shenzhen campus of the Chinese University of Hong Kong and the Shenzhen Research Institute of Big Data are helping Saudi Arabia's King Abdullah University of Science and Technology (KAUST) build an artificial-intelligence model to power an Arabic-language chatbot called AceGPT. Around one in five of KAUST's students and one in three of its postdoctoral researchers are Chinese.

The budding Sino-Arabic relationship will not replace the wilting Sino-American one. Dubai and Riyadh cannot match the depth of Silicon Valley's expertise and New York's capital markets. The Gulf wealth funds mostly cut cheques for a few hundred million dollars, whereas Americans also back early-stage startups in need of a few million. And for the Gulf, America remains a vital partner. In December an Emirati AI startup called G42, whose backers include Mubadala and Silver Lake, an American investor, said it would sever ties with Chinese firms rather than lose access to American technology. "We cannot work with both sides," its chief executive, Xiao Peng, told the Financial Times. So much for being friends with everyone. ■

中阿经贸关系能否取代中美经贸关系？

中国与中东关系拉近

中国和中东的金融家会面时一般都是闭门会议。上月，在港交所的大会堂里，他们在"未来投资倡议优先事项"峰会（FII Priority summit）上举行了公开会谈。组织此次活动的公共投资基金（PIF）是手握7800亿美元的沙特主权财富基金。这是东亚地区首次举行此类会议。但不会是最后一次。PIF宣布计划在中国设立办事处。据称，阿联酋两家主权财富基金穆巴达拉（Mubadala）和迪拜投资公司（Investment Corporation of Dubai）、卡塔尔投资局（Qatar Investment Authority）以及科威特投资局（Kuwait Investment Authority）都准备在这个全球第二大经济体部署更多资本。它们认为可以在不激怒日益警惕中国的西方世界的情况下做到这一点。"我们与人为善，我们和所有人都是朋友。"PIF高管杰里·托德（Jerry Todd）在香港的会议上表示。

中国的投资公司以及它们所支持的公司现在需要朋友。随着中美地缘关系恶化，美国在中国的投资已经崩溃。2022年，中国科技公司从美国风险投资机构那里仅获得12亿美元，低于2018年的140亿美元。2023年，美国公司在中国的并购交易还不到90亿美元，低于五年前的200亿美元。与此同时，根据金融信息公司伦敦交易所集团（LSEG）的数据，由海湾实体达成的并购交易激增——从2019年的几乎为零飙升到2023年的近90亿美元（见图表）。

上个月，想要成为中国版特斯拉的电动汽车制造商蔚来表示从CYVN Holdings获得22亿美元，此前它已经从这家由阿布扎比政府控制的公司获得超过10亿美元投资。NEOM投资基金（NEOM Investment Fund）是沙特一个在沙漠中建造未来城市的宏大项目的一部分，该基金投资了有中国背景的自动驾驶技术开发商小马智行。2023年更早时，沙特石油巨头沙特阿美（Saudi Aramco）向中国炼油企业荣盛石化投资36亿美元，并与PIF和中国最大钢铁企业之一宝钢成立了一家合资企业，在沙特生产高质量的金

属板材。中国的风投公司在公开场合对其有限合伙人的信息守口如瓶，但私下证实过去两年里来自中东的风投兴趣大增。

中国盛产海湾缺乏的技术人才，这些人才正涌向海湾。香港中文大学深圳校区和深圳大数据研究院正在帮助沙特阿拉伯的阿卜杜拉国王科技大学（KAUST）搭建一个人工智能模型，来驱动一个名叫AceGPT的阿拉伯语聊天机器人。KAUST大约五分之一的学生和三分之一的博士后研究人员是中国人。

萌芽中的中阿关系不会取代日渐枯萎的中美关系。迪拜和利雅得没有硅谷那么丰富的专业知识，也没有纽约那样深厚的资本市场。海湾的财富基金开出的大多是数亿美元的支票，但美国人还支持需要数百万美元的早期创业公司。而对海湾来说，美国仍然是一个至关重要的伙伴。上月，一家名为G42的阿联酋人工智能创业公司表示，宁愿切断与中国公司的联系，也不愿失去获得美国技术的机会。G42的投资者包括穆巴达拉和美国投资公司银湖（Silver Lake）。该公司首席执行官肖鹏向《金融时报》表示，"我们不能跟两边都合作。"所谓的和所有人做朋友看来也就这样了。∎

Meet ACWA Power, Saudi Arabia's unlikely solar star

The utility has green ambitions beyond its desert home

SITTING ATOP a fifth of the world's oil reserves, Saudi Arabia doesn't spring to mind when you think about renewables. Muhammad bin Salman, its crown prince and de facto ruler, would like this to change. He wants half of Saudi electricity to come from wind and solar farms by 2030. Two-thirds of that capacity, or around 40 gigawatts (GW) will, if Prince Muhammad gets his wish (as he tends to do), be courtesy of one firm: ACWA Power.

For most of its 19-year existence the utility was a relatively anonymous family-run affair. No longer. Since it went public in Riyadh in 2021 its market value has swelled nearly four-fold. It is now worth $50bn. The Public Investment Fund (PIF), the steward of Saudi sovereign wealth, owns a 44% stake. ACWA has 24GW of green projects at home and abroad either already running or at an advanced stage, up from 0.3GW in 2014. Add its other capacity under construction and the total is 54GW. Its original business of desalinating water went from 1m cubic metres a day in 2006 to 7.6m cubic metres in December. Its newish boss, Marco Arcelli, a seasoned Italian energy executive, expects assets it has a stake in to triple between now and 2030, to $250bn. Its projects will, he hopes, help create a broader domestic green-energy supply chain. "We are a big enabler," he says.

ACWA has thrived as many other renewables operators around the world have struggled. Whereas those rivals are seeing the cost of projects soar as a result of rising interest rates, ACWA has received non-interest-bearing loans from the PIF, in addition to debt secured against individual projects and loans from banks to tide it over while it raises more equity capital and brings in partners. Access to easy money has allowed ACWA to expand capacity, while lowering costs for customers. This has helped make the

levelised cost of Saudi solar energy, which takes into account both construction and operation of a power plant, among the lowest in the world.

Nevertheless, ACWA's returns on domestic projects are low by global standards. Mr Arcelli is thus keen to take advantage of juicier ones on offer abroad. He is investing nearby (in Bahrain, Egypt, Jordan, Oman, Turkey and the United Arab Emirates) and farther afield (Azerbaijan, Morocco, South Africa and Uzbekistan). Two-fifths of ACWA's overall capacity is to be found outside Saudi Arabia. It is also eyeing China, a highly competitive market but one where ACWA could, thinks Mr Arcelli, gain both scale and technology partners in the form of Chinese manufacturers of wind turbines and solar panels.

ACWA has its work cut out. To meet Prince Muhammad's domestic goals for it, the company must add 6-7GW of capacity—equivalent to three or four big projects—every year for the rest of the decade. It currently has just 14GW at various stages of development. Managing fast expansion will require a laser focus on costs (those of its nascent hydrogen venture has already risen by 70% from initial estimates, to $8bn). It will also require more debt. In September ACWA was already sitting on $7bn of it, equivalent to seven times its earnings before interest, taxes, depreciation and amortisation. Such a ratio would be considered a red flag at most firms.

ACWA may yet rise to the challenge. It can count on the PIF's deep pockets. And it is a fast learner; its domestic 1.5GW Sudair solar project may be fully up and running in just over two years, reckons Oliver Connor of Citigroup, a bank, brisk by industry standards. Mr Arcelli wants things to go faster still. Given that the prince is watching, that is no surprise. ■

认识下ACWA Power，沙特冷门的太阳能明星

这家公用事业公司的绿色雄心冲出了沙漠家园

说到可再生能源，你通常不会想到坐拥全球五分之一石油储量的沙特阿拉伯。沙特的实际统治者、王储穆罕默德·本·萨勒曼想要改变你的想法。他希望到2030年，沙特一半的电力都来自风能和太阳能。如果这位王储得偿所愿（通常都能），那么其中三分之二也就是大约40GW的发电能力都将由一家公司提供：沙特国际电力和水务公司（ACWA Power）。

在成立的19年间，这家公用事业公司大多数时候都只是个不大起眼的家族企业。现在不一样了。自2021年在利雅得上市以来，ACWA的市值已经增长了近三倍，目前为500亿美元。管理着沙特主权财富的公共投资基金（PIF）持有44%的股份。ACWA在国内外已运营的或处于收尾阶段的绿色项目的总装机容量达24GW，而2014年仅为0.3GW。如果加上其他在建项目，总装机容量达到54GW。ACWA以海水淡化业务起家，其淡化水产量从2006年的每天100万立方米增加到去年12月的每天760万立方米。ACWA上任不久的意大利老板马尔科·阿尔切利（Marco Arcelli）有丰富的能源业管理经验，他预计从现在到2030年ACWA参与投资的项目资产将增长两倍，达到2500亿美元。他希望这些项目能够帮助建立一个更广泛的国内绿色能源供应链。"我们是大型赋能者。"他表示。

ACWA蓬勃扩张之时，世界各地的许多其他可再生能源运营商却在艰难求生。上升的利率让这些竞争对手的项目成本飙升，而ACWA除了以单个项目为抵押来借债和从银行贷款，还从PIF获得了无息贷款以度过难关；同时它还筹集更多股权资本、引入合作伙伴。能轻易获得资金让ACWA得以扩大发电能力，同时降低客户的成本。这使得沙特太阳能发电的平准化成本（将发电厂的建设和运营成本都考虑在内）在全球处于最低水平。

然而按照全球标准来看，ACWA国内项目的回报率处于低水平。因此阿尔切利迫切想利用在国外可以拿到的利润更高的项目。他投资的项目有近有

远，近的有巴林、埃及、约旦、阿曼、土耳其和阿联酋，远的有阿塞拜疆、摩洛哥、南非和乌兹别克斯坦。ACWA总装机量有五分之二位于沙特以外。它还瞄准了中国，尽管这是个竞争激烈的市场，但阿尔切利认为ACWA可以形成业务规模，还能找到中国的风力涡轮机和太阳能电池板制造商做自己的技术合作伙伴。

ACWA面临巨大挑战。为了实现穆罕默德王储为它设立的国内目标，它必须在2030年前每年新增6至7GW的装机量，也就是要有三到四个大型项目。而目前它在国内处于各种开发阶段的项目加在一起也只有14GW。管理快速扩张需要高度聚焦成本（其新兴的氢能业务的成本已经比最初估计高出70%，达到80亿美元）。此外也需要借更多债。去年9月，ACWA的债务就已经达到70亿美元，相当于其税息折旧及摊销前利润的七倍。这样的比率在大多数公司都会被视为危险信号。

但ACWA仍可能临危不乱。它可以倚赖PIF的雄厚财力。而且它学得很快；花旗银行的奥利弗·康纳（Oliver Connor）认为，ACWA的体量1.5GW的国内太阳能项目Sudair可能会在两年多一点的时间内就全面建成并投入运营，这以行业标准来看已经很高效。但阿尔切利希望项目进展得更快些。这也难怪，毕竟穆罕默德王储在背后盯着呢。■

Why is Brazil a hotspot for financial crime?

Its success as a fintech hub is mostly to blame

BRAZILLIANS HAVE long been early adopters of fintech. In 2017 EY, an accounting firm, found that two-fifths of Brazilians regularly used online banking, one of the highest rates worldwide. In 2020 44% of customers had a digital-only account, compared with less than 20% in the United States and Canada, according to a survey by Accenture, a consulting firm. That year the central bank released Pix, an instant-payments platform. It has been wildly successful. Today it has 3bn transactions a month. That is five times more than transactions by debit and credit cards combined.

This bonanza has attracted cyber-criminals. Their main weapon has been the "banking trojan", a programme that steals users' account information. According to Kaspersky Lab, a cyber-security firm, Brazil is the top country for attacks by banking trojans, with 1.8m attempted infections from June 2022 to July 2023 (the latest data available). Globally eight of the 13 most popular types of trojans are made in Brazil.

Cyber-criminals initially focused on trojans as they require little skill to use. However, as banks developed better defences, criminals were forced to branch out into more complex and lucrative attacks. Brazil's underworld has developed the most advanced "point of sale" malware, which scammers use to filch bank details from card readers, according to Kaspersky Lab. Known as Prilex, this application can block contactless payments by stopping the short-range connection between a credit card and the payment terminal. The terminal reads: "Error. Please Insert." When a customer inserts her card and PIN, the malware uses the credentials to authorise a fraudulent transaction. During Rio's carnival in 2016, a hacker used a basic version of this software to remotely take over 1,000 ATMs.

Another example is ransomware, which gangs use to scramble computers and demand money to restore them. In October last year Brazil's lawmakers met to discuss the increasing use of artificial intelligence in cyber-crime, too.

The financial losses are big. According to Andre Fleury of Accenture, Brazil is in the top five countries for the cost of cyber-crime. He estimates the figure is around $20bn per year. That is the equivalent of 0.9% of GDP. There is some hope, though. In 2022 a hefty data-protection law came into effect, forcing companies to defend consumers' data. In 2023 Brazil's banks spent $9bn on cyber-security, nearly double the amount in 2019, according to the Brazilian Federation of Banks. The bigger problem is naive customers who fall for scams, says Eduardo Mônaco of ClearSale, a Brazilian fraud-management company. Until they fully know the risks, there will be plenty more phish in the sea. ∎

巴西为什么是金融犯罪的高发地？

成功跻身金融科技中心是主要原因

在采用金融科技方面，巴西人早就走在了前面。2017年，安永会计师事务所发现，五分之二的巴西人经常使用网上银行，这一比例在全球属于第一梯队。根据咨询公司埃森哲的一项调查，2020年，巴西44%的消费者拥有一个纯数字账户，而在美国和加拿大这一比例不到20%。同年，巴西央行推出了即时支付平台Pix并大获成功。如今，每月通过Pix进行的交易达30亿笔，是借记卡和信用卡交易总和的五倍。

这一富矿带吸引了众多网络犯罪分子。他们主要利用"银行木马"程序来窃取用户的账户信息。根据网络安全公司卡巴斯基实验室（Kaspersky Lab）的数据，巴西是遭受银行木马攻击最多的国家——从2022年6月到2023年7月（可获得的最新数据），未遂的银行木马攻击有180万次之多。全球最流行的13种银行木马中有八种是在巴西编写的。

网络犯罪分子最初主要利用木马，是因为使用它们不需要什么技能。但随着银行加强了防御，犯罪分子不得不转而采取更为复杂、也更能获利的攻击手段。卡巴斯基实验室称，巴西黑社会开发出了最先进的针对POS机的恶意软件，骗子利用该软件从读卡器窃取银行账户的详细信息。这款名为Prilex的应用程序可以通过中断信用卡与支付终端之间的短程连接来阻止非接触式支付。支付终端会显示："错误。请插卡。"当顾客插入银行卡并输入密码时，这个恶意软件就会使用认证信息授权欺诈性交易。在2016年里约狂欢节期间，一名黑客使用该软件的基础版远程控制了1000多台自动取款机。

另一种方式是勒索软件，犯罪团伙用它来扰乱电脑，然后索要赎金以换取电脑恢复。去年10月，巴西的立法者也开会讨论了不断增长的利用人工智能实施网络犯罪的问题。

这带来了巨大的经济损失。埃森哲的安德烈·弗勒里（Andre Fleury）表示，巴西是为网络犯罪付出最高代价的五个国家之一。他估计巴西每年遭受的损失约为200亿美元，相当于其GDP的0.9%。不过情况有望获得改善。2022年，一部严格的数据保护法生效，强制要求企业保护消费者的数据。巴西银行业联合会（Brazilian Federation of Banks）表示，巴西的银行在2023年为网络安全花费90亿美元，几乎是2019年的两倍。巴西一家防欺诈公司ClearSale的爱德华多·莫纳戈（Eduardo Mônaco）表示，更大的问题是消费者太轻信，容易上当受骗。在他们完全了解风险之前，网络海洋中还会有很多诱饵等着鱼儿上钩。■

Can India, Indonesia and Saudi Arabia be the next great economies?

Meet the countries making bold—and risky—bets on growth

POLITICIANS AND policymakers all over the world share a preoccupation: how to make their countries richer. The trouble is that the route to prosperity looks ever more daunting. The global economy is changing, as new, green technologies emerge and trading relationships fragment. In countries that are already rich the state, after decades of free-market rhetoric, is back in a big way. Governments are spending hundreds of billions on handouts for industries they deem to be strategically important.

In the face of this, many developing countries' ideas for growth are staggeringly ambitious. India and Indonesia hope to become high-income countries within 25 years. Muhammad bin Salman, Saudi Arabia's crown prince, wants to diversify and develop its economy just as rapidly. Refreshingly, such plans are more outward-looking than many development strategies of old. But they contain pitfalls, too.

In many ways, the developing world is choosing to bank on globalisation. Indonesia wants a bigger role in green supply chains. It seeks to do everything from mining and refining nickel, even to building the electric vehicles that run on it. It then wants to export the finished products to the rest of the world. Countries in the Gulf want to become attractive homes for global business, and are opening up to flows of people, cargo and cash. Narendra Modi envisions India as a high-tech manufacturer for the world, churning out microchips and smartphones.

That is a welcome shift. Less than 50 years ago India hoped to grow by closing itself off from the global economy. It turned out to be an approach that failed miserably. Some still suggest that India's domestic demand

could carry its growth.

But serving foreign markets plays a vital role in development. It keeps firms honest, by forcing them to compete in markets that their governments do not control. It lets them reach the largest possible scale. And foreign customers can teach firms how to serve them better. In East Asia export performance was also a useful yardstick for policymakers, because it revealed which industries deserved their continued backing.

Nonetheless, today's development strategies also hold dangers. In many countries governments are running the risk of warping the economy in the name of nurturing it. Saudi Arabia's onslaught of industrial policy, mainly disbursed as handouts from the Public Investment Fund, exceeds the spending even of America's Inflation Reduction Act. In order to help exporters grow, India is seeking to fence off its high-tech manufacturers behind tariffs and subsidies. Indonesia's all-in bet on nickel leaves it perilously exposed, should other battery chemistries prevail.

The rich world's new-found zeal for protectionism may make it tempting for poorer countries to follow suit. Yet floods of cash and shelter from foreign competition make it impossible to know whether a government's development gambles are paying off. A bet on one technology could go wrong if others emerge.

Parts of the developing world have paid dearly to learn these lessons before. For most of the 1960s Africa's policymakers had the same ideas as East Asia's, and the continent grew as fast, until picking the wrong champions left it languishing between 1975 and 1985. It is the poorest region in the world today.

Picking winners is also harder than it was 60 years ago. Then the choice was over which form of manufacturing to promote. Cheap, abundant

workforces gave poor countries an edge. Manufacturing was the only sector in which poor countries got better faster than rich countries.

Today, however, factories have become more capital-intensive. Though manufacturing still offers a way to boost a country's productivity, it is less certain to become a poor country's comparative advantage. That makes it even harder for policymakers to spot a good industry for them to place their bets. Rather than gambling with the public's money, they would be better off keeping it off the table.

There are, after all, plenty of other worthwhile things to spend it on. The state has a vital role in providing public goods by investing in infrastructure to stitch regions together, or education to boost workers' skills. That might still favour some industries over others. But if economies stay open, then they will at least experience the disciplines and benefits of trade.

Vision 2050

The stakes are high. The developing world is home to over 6bn people and some of the most fragile democracies. Getting growth wrong would keep such places poorer for longer. That would be not just a human tragedy, but also a potential source of political instability. To avert it, the developing world needs to be bold—and resist the urge to build walls around itself. ■

印度、印尼和沙特能否成为下一批大经济体？

来看看这些押下大胆而冒险的赌注追求增长的国家

全世界的政客和政策制定者都操心同一件事：如何让自己的国家更加富裕。问题是，通往繁荣的道路看起来越发艰巨了。随着绿色新技术的出现和贸易关系四分五裂，全球经济正在发生变化。在那些已经富裕起来的国家，自由市场的口号喊了几十年后，政府干预又大举回归。各国政府正在斥资数千亿美元补贴它们认为具有重要战略意义的产业。

面对这样的情形，许多发展中国家关于增长的想法展现出了惊人的雄心。印度和印度尼西亚希望在25年内成为高收入国家。沙特阿拉伯王储穆罕默德·本·萨勒曼（Muhammad bin Salman）希望以同样快的速度实现经济多元化和经济发展。这些计划比以往的许多发展战略更加开放外向，令人耳目一新。但它们也存在隐患。

在许多方面，发展中国家选择指望全球化。印尼希望在绿色供应链中发挥更大作用。它希望把触角伸到方方面面，要开采和提炼镍，甚至还要制造使用镍的电动汽车。接着它还想把制成品出口到世界其他地方。海湾国家希望成为对全球商业有吸引力的家园，正在向人员、货物和现金的流动开放。而在莫迪的展望中，印度将成为世界的高科技制造商，大量生产微芯片和智能手机。

这是一个值得欢迎的转变。将近50年前，印度希望通过将自己隔绝在全球经济之外来实现增长。事实证明，这种做法一败涂地。如今仍有一些人认为印度的内需可以支撑其经济增长。

但服务外国市场在发展中起到至关重要的作用。企业将不得不在其政府无法控制的市场上参与竞争，也就不得不诚信经营。服务外国市场还能让企业达到尽可能大的规模。外国客户可以教会企业如何更好地为他们服务。在东亚，出口业绩对政策制定者来说也是个有用的衡量标准，可以揭示哪

些行业值得他们继续支持。

然而，如今的发展战略也存在危险。在许多国家，政府面临着以培育经济为名扭曲经济的风险。沙特推出了一连串产业政策，主要通过公共投资基金（PIF）拨款，其支出甚至超过了美国的《通胀削减法案》。为了帮助出口商发展壮大，印度正试图筑起关税和补贴的高墙来保护本国的高科技制造商。倘若最终是其他电池化学材料大行其道，印尼对镍的全盘押注就将使它落入岌岌可危的境地。

看到富裕国家新萌生的保护主义热情，较贫穷国家可能也会想要效仿。然而，大量的现金补贴和免受外国竞争的庇护让人无法判断政府在发展上的押注是否在收获回报。如果其他技术崭露头角，对某一种技术的押注可能就会打水漂。

部分发展中国家此前付出了惨痛的代价得到这些教训。在20世纪60年代的大部分时间里，非洲政策制定者的想法与东亚政策制定者相同，非洲大陆的发展速度也同亚洲差不多，直到因为选择了错误的扶持对象而在1975年至1985年间裹足不前。非洲如今是世界上最贫穷的地区。

挑选国家冠军的难度也比60年前更大。当时只需要选择促进哪种形式的制造。 廉价、充足的劳动力给贫穷国家带来了优势。制造业是穷国唯一比富国进步更快的部门。

然而今天，工厂已变得更加资本密集。尽管制造业仍然是提高一国生产率的途径之一，但它能否成为贫穷国家的比较优势却不再那么确定无疑。这就让政策制定者更难找到一个好的行业来押宝。相比拿民众的钱去赌，他们不如谨慎行事。

毕竟，还有其他很多地方值得花钱。国家在提供公共产品方面发挥着至关重要的作用，它可以投资基础设施，将各个地区连接起来，还可以投资教育，提高劳动者的技能。这可能仍然会导致对不同的行业厚此薄彼。但如果经济体保持开放，那么它们至少会体验到贸易带来的纪律约束和好处。

这一切事关重大。发展中世界有6o多亿人口和一些最脆弱的民主国家。如果没有把增长这件事做对，这些地方就会久久无法摆脱更贫困的处境。这不仅会是一种人道悲剧，也可能成为政治不稳定的源头。为了避免这种情况的发生，发展中世界需要大胆行动，还要克制在自身周围筑起围墙的冲动。■

Is America's raging bull market exhausted, or taking a breath?

Investors have a slight hangover

IF YOU HAD an overindulgent Christmas, you may have begun the new year in a more austere frame of mind. Recent goings-on in the markets may therefore seem familiar. As 2023 drew to a close the American stockmarket was on a ripping run. It ended the year with nine consecutive weeks of gains, the longest winning streak since 2004. The S&P 500 index of leading American stocks was a whisker away from its all-time high, set on January 3rd 2022, when investors thought that interest-rate rises would be small and slow. Now punters are suddenly in a more sober mood, with stocks falling by 1.4% in the first two trading days of the new year. Such modest fluctuations are hardly unusual. Nonetheless, they raise the question of whether the blistering bull market is over, or has further to go.

For the first ten months of 2023, the market rally was largely concentrated in seven tech stocks, led by Nvidia, a maker of the computer chips that are used to process artificial-intelligence (AI) algorithms. Since then, however, it broadened and gained pace. Firms that mirror the wider economy, such as retailers and banks, soared—JPMorgan Chase is up by a quarter since late October. The S&P 500 rose by 14% in the final two months of 2023, and towers 31% above its most recent trough, well above the 20% that is often used to define a bull market.

The explanation for the run was a happy mix of strong economic growth, an orderly reduction of inflation and, crucially, an enormous shift in interest-rate expectations over the past two months. America's economy expanded at an impressive annualised pace of 4.9% in the third quarter; real-time estimates suggest it grew at a still-robust 2.5% in the last three months of the year. In the past three months "core" consumer prices have

risen at an average annualised pace of just 2.2%, only a smidgen above the Federal Reserve's inflation target.

That led to a big shift in investors' expectations for interest rates. In October they thought one-year rates in a year's time would be close to 5%. Thanks to lower inflation data and a doveish set of forecasts from the Fed, that has fallen to 3.5%. Bond investors see the central bank cutting rates as soon as March—and continuing in almost every meeting in 2024. This tantalising prospect of immaculate disinflation, robust growth and the promise of easier monetary policy has underpinned the rally.

Can the bull market be sustained? Asset prices still have room to rise. Although markets are close to the heights they reached after the protracted mania of 2021, that does not mean that things are as excessive now as they were then. In real terms, stock prices remain lower; valuations are therefore not quite as elevated. Participation by retail investors, which reached a giddy peak of 24% of daily trading volumes in early 2021, was steady at around 18% in 2023.

Moreover, although tech led the charge in both 2021 and 2023, investors this time have been discerning. They have lifted up Nvidia and Microsoft but Alphabet, Amazon and Tesla are all trading below their peak valuations. It is not just Americans excited about AI who are buoying stocks: in dollar terms European and Japanese equity indices are also within touching distance of their level two years ago.

| Rude awakening

Yet everything hangs on whether investors' ideal economic scenario comes to pass. The expectation that it will helped lift stocks close to a record high last year. But risks to the outlook abound, and may have given investors pause in the cold light of January. Inflation in America may not be fully vanquished, not least with the economy still in rude health and the fiscal

deficit unusually wide. Strife in the Middle East could cause another commodity-price shock; the one-time easing of the supply-chain disruptions of the pandemic may be keeping inflation low only temporarily.

A downturn may merely be delayed, not dodged. Rises in interest rates may not yet have fully fed through to borrowers. Indeed, history suggests that recessions are hard to spot in real time, and tend to catch out central banks. If a recession does not arrive, it is still possible that the Fed will not move with as much alacrity as investors hope. To see what will happen in the markets in 2024, watch the real economy. ■

美国的红火牛市是精疲力竭了，还是暂时喘口气？

投资者略感宿醉

如果你在圣诞节肆意狂欢了一番，可能就会以更加冷静节制的心态进入新年。你对近期市场上的动态可能也就不会觉得陌生。2023年接近尾声时，美国股市一路狂飙，最终以连涨九周走完了2023年，创下自2004年以来的最长连涨纪录。主要股指标普500距离2022年1月3日（当时投资者预测加息将会是"小步慢跑"）的历史最高点仅一步之遥。现在，投资者突然变得更冷静了：股市在新年的头两个交易日下跌了1.4%。这种小幅波动并不稀奇，但还是引发了一个疑问：这轮大牛市是走到头了，还是能再往前一步？

在2023年的头十个月，美股上涨主要集中在七支科技股上，由制造处理人工智能（AI）算法的计算机芯片的英伟达领跑。之后上涨范围扩大，涨速也加快。零售商和银行等反映更广泛经济的公司股价飙升，摩根大通的股价自10月底以来上升了四分之一。标普500指数在2023年最后两个月上涨了14%，比最近期的低点高出31%，明显高于通常用来定义牛市的20%。

对这轮牛市的解释是几方面因素恰好叠加：经济增长强劲、通胀有序回落，最关键的是过去两个月里利率预期的巨大转变。美国经济第三季度的年化增长达到可观的4.9%；实时估算显示，2023年最后一季度的增长仍相当稳健，达到2.5%。过去三个月里，"核心"消费价格的平均年化增长只有2.2%，仅略高于美联储的通胀目标。

这让投资者对利率的预期有了巨大转变。10月时，他们认为一年后的一年期利率将接近5%。随着通胀数据下降及美联储发布一系列鸽派预测，这个预期数字已降至3.5%。债券投资者认为美联储最快会在3月降息，而且在2024年几乎每次议息会议上都会继续降息。"完美去通胀"、增长强劲，以及货币政策有望放宽的诱人前景支撑了市场上涨。

牛市能否持续？资产价格仍有上升的空间。尽管市场已接近2021年持续大热后达到的高点，但这并不意味着现在就和当年一样过热。按实际价值计算，股票价格仍然低于当时，所以估值也没当时那么高。散户投资者的交易在2021年初达到令人眩晕的高峰，占日交易量的24%，2023年则稳定保持在18%左右。

此外，虽然在2021年和2023年领涨的都是科技股，但这次投资者是挑剔的。他们推高了英伟达和微软的股价，而Alphabet、亚马逊和特斯拉的股价则均低于各自的最高点。不仅是兴奋于AI发展前景的美国人在提振股市：以美元计算，欧洲和日本的股指也回升至接近两年前的水平。

猛然觉醒

然而，一切取决于投资者理想中的经济情景能否实现。认为能够实现的预期推动股市在去年创下历史高点。但这样的展望面临各种风险，可能会让投资者在经历新年的冷静思考后暂时停手。美国的通胀也许不会完全受控，尤其是在经济依然强劲而且财政赤字异常庞大的情况下。中东的冲突可能引发另一轮大宗商品价格冲击；新冠疫情过后，供应链中断的缓解是一次性的，这也许只能暂时压低通胀。

经济衰退可能只是延后了，最终仍难以躲开。加息的影响可能尚未完全传导至借款人。事实上，历史表明，经济衰退很难被及时发现，而往往会把央行打个措手不及。假如衰退不来，美联储仍有可能不像投资者希望的那般欣然快速行动。想知道2024年的市场走势，请关注实体经济。■

How to put boosters under India's economy

With the right policies, growth could be astonishing

LAND IN ANY Indian city, such as Bangalore or Hyderabad, and you will be struck by its heady optimism. India's economy may be in the early stage of a historic boom. Recently released figures show that economic growth roared to an annualised pace of 7.6% in the third quarter of 2023. In the past few weeks four international forecasters have raised their growth projections for the year, from an average of 5.9% to one of 6.5%. The National Stock Exchange of India is now neck-and-neck with Hong Kong's stock exchange for the title of the world's seventh-largest bourse.

Pause for breath, though, and India's performance looks a little less impressive. GDP growth has been slightly slower under Narendra Modi, India's prime minister, who was elected in 2014, than in the decade before. Labour-force participation is a paltry 40-50%, and only 10-24% for women. Subsidies are distorting the economy. A semiconductor plant in Gujarat will create 5,000 jobs directly and 15,000 indirectly. But a state handout covered 70% of its $2.7bn cost. Assuming rather generously that the factory would not have been built without government support, each job cost $100,000—nearly 40 times India's average income per person.

Grappling with the tension between India's enormous potential and an often messy reality is the task of a new book by Raghuram Rajan, a former governor of the Reserve Bank of India, and Rohit Lamba of Pennsylvania State University. The pair sketch out a vision that amounts to an entirely new model of development for India—one that they argue is better suited to its strengths than its current model. Three lessons stand out from their work.

The first is that India should stop fetishising manufacturing—an obsession born of East Asia's growth miracle. In the 1960s India's income per person was on a par with that of China and South Korea. By 1990 South Korea had taken off, while India remained level with China. Today China is three times richer and South Korea is seven times richer, adjusted for purchasing power. The growth of India's rivals was driven by low-skilled manufacturing, which received plenty of state support. Globalisation created a vast market, leading to previously unheard of double-digit growth rates. Once workers and companies got good at the easy stuff, they began to tackle more complex tasks with their newfound skills. Why shouldn't India follow its rivals' example?

As Messrs Rajan and Lamba explain, the problem is that East Asia has made manufacturing so competitive there is little profit left to be captured. Moreover, automation has reduced the number of available jobs—and manufacturing is no longer where value is to be found. Apple is worth $3trn because it designs, brands and distributes its products. By comparison, Foxconn, which actually makes Apple's iPhones, is worth a mere $50bn.

The second lesson concerns the export of services, which some in India's government think is a fresh way to tap into global demand. Modern technology, especially the internet, has made services far more tradable. Remote work has accelerated this trend. Meanwhile, governments around the world are desperate to shore up domestic industries. Partly as a result, global trade in goods has declined over the past decade. Yet trade in services has continued to grow. It is hard to argue against seeking a slice of the cushiest part of the global value chain, especially when the line between services and manufacturing is blurring. Some 40% of the value-added in a Chevrolet Volt, for instance, comes from its software.

In places, India is finding success. Its famed IT service sector has moved from mostly providing back-office work to more complex front-office fare.

According to one estimate, 20% of the global chip-design workforce can already be found in the country. But profound reforms will be required if India is to succeed more broadly. Spending on education as a share of GDP is 3-4%—middling relative to others of similar income. The bigger problem is that India appears to get little bang for its buck. By the latter half of high school, around half of students have dropped out. Bosses report that many of those who graduate are still not ready for work. Getting a new business off the ground is such a nightmare that many startups incorporate in Singapore. Labour laws make workers difficult to sack once they have been employed for more than a year, which incentivises the use of intermittent contracts. France and Italy have global brands, point out Messrs Rajan and Lamba. India does not. It is these sorts of problems that help explain why.

The last big item on the authors' wishlist is liberalism—of both the economic and political varieties. Politicians should start, they write, by jettisoning protectionism. From 1991, when India opened up to global markets, to 2014, when Mr Modi took power, average tariff levels fell from 125% to 13%. They have since risen to 18%, raising the cost of intermediate inputs for producers. India has refused to join regional free-trade agreements, which inhibits the ability of its exporters to reach customers abroad. And Mr Modi's authoritarian tendencies make it difficult for business leaders to criticise the government when a change of tack is required.

| *Hear the roar*

Messrs Rajan and Lamba paint a lovely picture of what could be. A better governed, more open India would be wonderful. But whether their ambitions are politically feasible is another question. For example, better public services probably mean devolving power from the central and state governments to localities. And who wants to give up power? Certainly not Mr Modi; probably not his rivals. Moreover, a country can endure quite a lot

of illiberalism before growth starts to falter. Until recently, China was humming along just fine. The Asian tigers only became more politically free when they were rich. India's economy is already growing at north of 6% a year with a policy mix that is far from the perfect.

In a strange way, though, this ought to provide Indian reformers with encouragement. Even if only half of what would be ideal is feasible, India's boom may only just be getting started. ■

如何给印度经济加助推器

政策若得当，增长可能是惊人的

踏上印度任何一座城市，比如班加罗尔或海德拉巴，都会感受到那里洋溢的乐观情绪。印度经济可能正处于一段历史性繁荣的开端。近期公布的数据显示，在2023年第三季度，印度经济年化增长率飙升至7.6%。过去几周，四家国际预测机构上调了对2023年印度经济增长的预测，从平均5.9%调至6.5%。印度国家证券交易所（National Stock Exchange of India）现在与香港证券交易所旗鼓相当，竞逐世界第七大证券交易所的头衔。

但停下来缓口气，就会觉得印度的表现看起来没那么惊人了。在2014年当选印度总理的莫迪治下，印度的GDP增速略低于之前十年。劳动力参与率仅在40%至50%之间，女性更是只有10%至24%。政府补贴正在扭曲经济。古吉拉特邦的一家半导体工厂将直接创造5000个工作岗位，间接创造1.5万个。但政府补贴覆盖了其27亿美元成本的70%。做个豪气的假设，如果该工厂的建设没有政府支持，每个岗位的成本就会高达10万美元，几乎是印度人均收入的40倍。

印度前央行行长拉古拉姆·拉詹（Raghuram Rajan）和宾夕法尼亚州立大学的罗希特·兰巴（Rohit Lamba）合撰的新书探讨了印度的巨大潜力与往往混乱的现实之间的矛盾。二人为印度的发展勾画愿景，搭建出一个全新模式，他们认为比当前的模式更利于印度发挥自身优势。他们的研究结果凸显了三条经验教训。

首先，印度应停止痴迷制造业，这种迷恋源于当年东亚的增长奇迹。上世纪60年代，印度的人均收入与中国和韩国相当。到1990年，韩国经济腾飞，印度仍与中国持平。而现在，按购买力调整后，中国的人均收入是印度的三倍，韩国更是印度的七倍。印度这些竞争对手的增长是由政府大力支持的低技能制造业推动的。全球化创造了巨大的市场，带来了前所未有的两位数增长率。一旦工人和企业掌握了简单的技能，就会开始利用这些

新学到的技能处理更复杂的任务。那么印度为何不该效仿竞争对手？

正如拉詹和兰巴所解释的，问题是东亚已经让制造业竞争激烈到几乎无利可图的地步。此外，自动化减少了制造业所能提供的工作岗位，而且制造本身也不再是价值所在。苹果市值三万亿美元是因为它设计、打造品牌并销售产品。相比之下，实际制造苹果iPhone手机的富士康价值仅为500亿美元。

第二条经验是关于服务出口的。印度有些政府官员认为服务出口是接入全球需求的新途径。现代技术，特别是互联网技术，大大提高了服务的可交易性。远程工作加速了这一趋势。与此同时，世界各国政府都急于扶持本国产业，这在一定程度上导致全球货物贸易在过去十年出现下降。但服务贸易却持续增长。印度想从全球价值链中最轻松的环节分一杯羹，这没什么可反驳的，尤其是如今服务业与制造业之间的界限越来越模糊。举个例子，雪佛兰Volt汽车约40%的附加值来自其软件。

在某些领域，印度正在获得成功。它著名的信息技术服务业已从主要提供后台服务转向更为复杂的前台服务。据估计，印度的芯片设计人员已占到全球的20%。但要在更广泛的领域取得成功，印度还需要深刻的改革。在印度，教育支出占GDP的比例为3%至4%，与收入相近的其他国家相比处于中等水平。更大的问题是，印度的教育投入似乎成效不大。在中学的后半段约有半数学生辍学。而雇主则表示，那些完成了学业的毕业生有许多仍不能胜任工作。在印度要创办一家公司简直就是一场噩梦，许多创业公司宁愿在新加坡注册成立。现行劳动法让雇主很难解雇受雇一年以上的员工，这就促使他们采用断断续续的短期合同。拉詹和兰巴指出，法国和意大利拥有全球品牌，印度却没有。上述这些问题可能是部分原因所在。

拉詹和兰巴的愿望清单上的最后一个大项是自由主义——既包括经济上的，也包括政治上的。他们写道，政客们应从摒弃保护主义开始做起。从1991年印度向全球市场开放到2014年莫迪上台执政时，印度的平均关税水平从125%降至13%。而自此之后又上升到18%，提高了生产商的中间投入成本。印度拒绝加入区域自由贸易协定，抑制了印度出口商争取国外客户

的能力。在需要改变政策方针的时候，莫迪的威权倾向也让商界领袖难以批评政府。

拉詹和兰巴描绘了一幅可能出现的美好图景。一个治理改善、更加开放的印度将是很美好的。但他们的宏伟构想在政治上是否可行就是另一个问题了。例如，改善公共服务可能意味着要把权力从中央和邦政府下放到地方。谁愿意放弃权力呢？莫迪肯定不会，他的政治对手可能也不会。而且，一个国家有可能经受相当久的不自由，一时并不会出现经济增长减速。直到不久前，中国经济一直发展得不赖。亚洲小龙们是在富起来之后政治上才变得更自由的。在政策组合远非完美的情况下，印度的经济年增长率已超过6%。

不过，这应该能以一种奇怪的方式鼓舞印度的改革者。即使理想图景只有一半有望实现，印度的繁荣也可能才刚刚开始。■

Big tech and geopolitics are reshaping the internet's plumbing

Data cables are turning into economic and strategic assets

WHEN THE navies of Britain, Estonia and Finland held a joint exercise in the Baltic Sea earlier last month, their goal was not to hone warfighting skills. Instead, the forces were training to protect undersea gas and data pipelines from sabotage. The drills followed events in October when submarine cables in the region were damaged. Sauli Niinisto, the Finnish president, wondered whether the Chinese ship blamed for the mischief dragged its anchor on the ocean bed "intentionally or as a result of extremely poor seamanship".

Submarine cables used to be seen as the internet's dull plumbing. Now giants of the data economy, such as Amazon, Google, Meta and Microsoft, are asserting more control over the flow of data, even as tensions between China and America risk splintering the world's digital infrastructure. The result is to turn undersea cables into prized economic and strategic assets.

Subsea data pipes carry almost 99% of intercontinental internet traffic. TeleGeography, a research firm, reckons there are 550 active or planned submarine cables that currently span over 1.4m kilometres. Each cable, which is typically a bundle of between 12 and 16 fibre-optic threads and as wide as a garden hose, lines the seabed at an average depth of 3,600 metres. Close to half have been added in the past decade. Newer ones are capable of transferring 250 terabits of data every second, the equivalent of 1.3m cat videos. Data may be stored in the cloud, but it flows under the ocean.

Since 2019 demand for international internet bandwidth has tripled to more than 3,800 terabits per second, estimates TeleGeography. The boom in data-hungry artificial intelligence may strengthen this trend. Synergy

Research Group, a data firm, predicts an almost three-fold increase in big cloud providers' data-centre capacity over the next six years. To connect these data centres to the internet, between 2020 and 2025 the data-cable industry will install 440,000km of new subsea lines.

One big shift has come from big tech. Until the early 2000s subsea cables were mainly used for transporting voice traffic across the world. Telecom operators like BT and Orange (formerly France Telecom) controlled most of the capacity. By 2010 the rise in data traffic led internet and cloud-computing giants—Amazon, Google, Meta and Microsoft—to start leasing capacity on these lines.

As their data needs surged, the tech firms began investing in their own pipes. In 2012 the four companies used around a tenth of international bandwidth; nowadays they claim almost three-quarters. Big tech's deep pockets ensure that projects are completed. According to Submarine Telecoms Forum, an industry body, only about half of all announced cable systems actually get built—unless they are backed by tech firms, in which case they almost always do.

Big-tech-backed cables account for almost a fifth of the $12bn in planned investments in new systems over the next four years. Amazon and Microsoft part-own one and four networks, respectively. Meta owns one cable system outright and is an investor in another 14. Google is the most aggressive—the search giant directly owns 12 of its 26 cables. Last year it completed Firmina, a $360m project that stretches more than 14,000km from the east coast of North America via Brazil to Argentina.

Dedicated cables allow the tech giants to avoid competing with others for third-party bandwidth, and to react quickly to changes in user demand and to any problems (if a cable on a route is damaged, data can be redirected to another one of the firms' lines). Alan Mauldin from TeleGeography points

out that being owner-operators also gives the tech giants the luxury of designing routes that meet their specific needs. Most telecom carriers rely on public "landing stations"—which connect the cables in the sea to customers' data centres on land. By owning their cables, the companies can plug these more directly into their own data centres, speeding up traffic.

Their bandwidth and speed is further enhanced thanks to clever technology, which ownership makes easier to deploy. In 2019 Google introduced an innovation ("space division multiplexing") that increased the number of fibre threads in a cable from 16 to 24. Last year it went further, doubling the number of "cores"—clusters of fibre threads—in its new TPU cable system that links Taiwan, the Philippines and America, increasing capacity while lowering the operating cost per bit.

All this is transforming the business of data cables. Having begun as large buyers of bandwidth from telecom companies, big tech is now leasing capacity on some of its cables to telecom operators. Legacy telecom firms are happy with this arrangement, since they face constant pressure from consumers for more capacity but, unlike big tech, they are desperately short of capital. As for the specialist companies which supply the equipment and lay the cables, these are go-go years.

Like many other global industries, the data-cable business is also being entangled in the tech contest between America and China—a second big shift. Take the Pacific Light Cable Network (PLCN). The 13,000km data pipeline was announced in 2016, with the backing of Google and Meta. It aimed to link the west coast of America with Hong Kong. By 2020 it had reached the Philippines and Taiwan. But in 2022 America's government denied approval for the final leg to Hong Kong, worried that this would give Chinese authorities easy access to Americans' data. Hundreds of kilometres of cable that would link Hong Kong to the network are languishing unused on the ocean floor.

America is stymieing China in another way. Laying cables at depth is a complicated job. Only a handful of contractors have the required chops. Three—Alcatel Submarine Networks from France, NEC from Japan and SubCom from America—receive more than 80% of the spending on cable construction. HMN Tech, a Chinese challenger spun out of Huawei, China's telecoms-gear champion, claims 9% of new annual construction spending. But amid Sino-Western tensions, new cables that have links to America, which is to say most of them, avoid HMN Tech as a supplier. Telecoms executives say they are discouraged from using HMN. In 2022 a lucrative contract for SEA-ME-WE 6, a 19,000km line owned by a group of telecoms operators including India's Bharti Airtel and Singapore's SingTel, and linking South-East Asia to Europe, was awarded to SubCom, even though HMN's bid was reportedly lower.

China is responding by charting its own course. PEACE, a 21,500km undersea cable linking Kenya to France via Pakistan, was built entirely by Chinese firms as part of China's "digital silk road", a scheme to increase its global influence. Reuters reported that this year three Chinese carriers—China Telecom, China Unicom and China Mobile Limited—are investing $500m in a cable network that connects China and France via Singapore, Pakistan and Egypt. The project, to be built by HMN Tech, will compete directly with SEA-ME-WE 6.

Despite the growing Sino-American rivalry, from 2019 to 2023 bandwidth between the two has grown by 20% a year. American and Chinese mobile operators, which also rely on cables, continue to increase network connectivity in each other's territory. The necessary licences are, however, getting harder to secure.

In March America's Federal Communications Commission issued a proposal that would require licensees to provide more information about who owns them. It also acknowledged concerns that the presence in

America of physical infrastructure of China Telecom is "highly relevant to the national-security and law-enforcement risks". All this is making the route taken by bits and bytes more circuitous than before, and thus costlier. If transpacific tensions continue to mount, those routes may one day vanish altogether. ∎

科技巨头和地缘纷争正在重塑互联网的管道

数据电缆正在变成经济和战略资产

英国、爱沙尼亚和芬兰的海军于2023年12月上旬在波罗的海进行了联合演习，他们的目标并不是磨练战斗技能，而是操练如何保护水下天然气和数据管道免遭破坏。在此次演习开展前的10月，该地区的海底电缆被损坏。芬兰总统绍利·尼尼斯托在纳闷，被指为肇事者的中国船只究竟是"故意还是因为极差劲的航行技术"在海底拖曳了船锚。

海底电缆曾被视为互联网的平凡无奇的管道。如今，正当中美紧张关系可能令全球数字基础设施分崩离析之时，亚马逊、谷歌、Meta和微软等数据经济巨头在宣示对数据流的更大控制权。其结果是，海底电缆变成了备受重视的经济和战略资产。

海底数据管道承载了几乎99%的洲际互联网流量。研究公司TeleGeography估计，目前有550条在用或计划建造的海底电缆，总长超过140万公里。每根电缆通常包裹着12到16根光纤线，粗细如同花园浇水软管，沿海底铺设，平均深度约为3600米。近一半的电缆是在过去十年里铺设的。较新的电缆能够每秒传输250太比特的数据，相当于130万段猫咪视频。数据可能被存储在云端，但它是在海底流动的。

据TeleGeography估计，自2019年以来，对国际互联网带宽的需求增长了两倍，达到每秒3800太比特以上。数据需求巨大的人工智能的腾飞可能加强这一趋势。数据公司Synergy Research Group预测，在未来六年内，大型云服务提供商的数据中心容量将增加近三倍。为了将这些数据中心连接到互联网，从2020年到2025年，数据电缆行业将新铺设44万公里的海底电缆。

一个大转变源自科技巨头。直到本世纪初，海底电缆还主要用于在全球范围内传输语音流量。像英国电信（BT）和Orange（原法国电信）这样的电

信运营商控制了大部分容量。到2010年，由于数据流量的增加，互联网和云计算巨头亚马逊、谷歌、Meta和微软开始租用这些线路上的容量。

随着它们的数据需求激增，科技公司开始投资自己的电缆。2012年，这四家公司使用了大约十分之一的国际带宽；如今它们几乎占用了三分之二。科技巨头的雄厚资金确保了项目能够完成。据行业组织海底电信论坛（Submarine Telecoms Forum）统计，所有公布投建的电缆系统中只有约一半左右最后会实际完成——除非是由科技公司支持的，那么几乎总能完成。

在未来四年总共120亿美元的新电缆投资计划中，科技巨头支持的项目占到近五分之一。亚马逊部分拥有一个电缆网，微软部分拥有四个。Meta完全拥有一个电缆系统，还是另外14个电缆系统的投资者。谷歌是最积极的——这家搜索巨头直接拥有其26条电缆中的12条。去年，谷歌完成了费尔米纳（Firmina）项目，耗资3.6亿美元，全长超过1.4万公里，从北美东海岸经巴西抵达阿根廷。

专用电缆使科技巨头能够避免与其他公司争夺第三方带宽，并迅速应对用户需求的变化和任何问题（如果某个线路上的电缆损坏，数据可以转移到这些公司的另一条电缆上）。TeleGeography的艾伦·莫尔丁（Alan Mauldin）指出，拥有并运营电缆也使科技巨头得以根据自己的需求设计线路。大多数电信运营商要依赖公共"登陆站"——它们将海底电缆连接到陆地上的客户数据中心。拥有属于自己的电缆，这些公司就可以将电缆更直接地连接到自己的数据中心，加速数据传输。

自己拥有电缆也方便了部署先进技术，进一步提升带宽和速度。2019年，谷歌推出了一项创新（"空间分集复用"），将电缆中的光纤线数量从16根增加到24根。2023年，谷歌更进一步，在其连接台湾、菲律宾和美国的新TPU电缆系统中将"核心"也就是光纤簇的数量翻了一番，增加容量的同时降低了单位流量的运营成本。

所有这些都在改变数据电缆生意。科技巨头最初是从电信公司大量购买带

宽，现在正将自家一些电缆的容量出租给电信运营商。传统电信公司乐于接受这种安排，因为它们持续面临着消费者要求更多带宽的压力，但与大科技公司不同，它们极度缺乏资金。至于那些专门提供相关设备和铺设电缆的公司，它们迎来了生意兴隆的好年景。

与许多其他全球性产业一样，数据电缆业务也被卷入了中美科技战——这是第二个大转变。太平洋光缆网络（Pacific Light Cable Network，PLCN）就是一个例子。这条长1.3万公里的数据管道项目于2016年宣布，得到谷歌和Meta的支持。它想要连接美国西海岸和香港。到2020年，它已经铺设到了菲律宾和台湾。但是2022年，美国政府拒绝批准最后一段通往香港的线路，担心这将让中国当局轻松获取美国人的数据。原本将把香港连接到该网络的数百公里电缆就此被弃用，闲置在海底。

美国也在以另一种方式阻挠中国。在深海铺设电缆是一项复杂的工作。只有少数几个承包商具备所需的技术。全球海底电缆建设支出的超过80%支付给了三家公司——法国的阿尔卡特海底网络（Alcatel Submarine Networks）、日本的NEC和美国的SubCom。中国电信设备巨头华为旗下的中国挑战者华海通信声称在新年度建设支出中拿到9%。但在中西方关系紧张的背景下，与美国有关的新电缆——也就是说大多数电缆——都在绕开华海通信这个供应商。电信业高管表示，他们被劝阻使用华海通信。2022年，连接东南亚与欧洲的SEA-ME-WE 6这个大项目的合同被授予了SubCom，尽管报道称华海通信在投标中的报价更低。SEA-ME-WE 6电缆长1.9万公里，由印度的Bharti Airtel和新加坡电信（SingTel）等一群电信运营商拥有。

中国的回应是绘制自己的电缆航道。PEACE是一条长2.15万公里的海底电缆，连接肯尼亚与法国，中间经过巴基斯坦。它完全由中国公司建设，是中国提升其全球影响力的"数字丝绸之路"的一部分。路透社报道，今年三家中国运营商——中国电信、中国联通和中国移动——正在投资5亿美元建设一条通过新加坡、巴基斯坦和埃及连接中国和法国的电缆网络。该项目将由华海通信建设，会直接与SEA-ME-WE 6竞争。

尽管中美之间的竞争日益激烈，但从2019年到2023年，两国之间的带宽每年增长20%。美国和中国的移动运营商也依赖电缆，都在继续增加在对方区域内的网络连接。然而，获取必要牌照的难度在加大。

2023年3月，美国联邦通信委员会（FCC）提出了一项提案，要求牌照持有人提供更多其所有者的信息。它还承认担忧中国电信在美国境内建设的实体基础设施"与国家安全和执法风险高度相关"。所有这些都使比特和字节的传输路径变得比以往更加迂回，因此成本更高。如果太平洋两岸的紧张局势继续升级，这些路径某天可能会完全消失。■

Why economists love "Robinson Crusoe"

The classic yarn of a shipwrecked sailor reveals a lot about scarcity

AFTER SPENDING 28 years, two months and 19 days marooned on an island, Robinson Crusoe does not lose his nose for adventure or his "native propensity to rambling". He crosses the Pyrenees, stalked by "hellish wolves", witnesses the "pomp and poverty" of China and battles Tartars on the Russian steppe.

The character's strangest adventure, however, is none of these. It is surely his centuries-long ramble through the literature of economics. Crusoe has appeared in Karl Marx's "Das Kapital", John Maynard Keynes's "General Theory" and Milton Friedman's Chicago lectures on "Price Theory". He has an entry in the New Palgrave Dictionary of Economics. And he often washes up in economics textbooks.

Crusoe's economic appeal is unsurprising. The sailor spends a few pages escaping pirates and shooting cannibals. But his real battle is against scarcity, which he defeats through careful deployment of the resources at his disposal, including his own labour.

After being shipwrecked, Crusoe makes his island prison habitable, even hospitable. Salvaging what he can from the wreck, he fortifies a cave (his "castle"), erects a tent ("my country house"), plants crops, tames goats (and a parrot) and fills his improvised shelves with pigeon, turtle and other foodstuffs.

Scarcity also stalked Daniel Defoe, the novelist who created Crusoe in 1719. Over a chequered career he traded in bricks, wines, pickles, tobacco and the glands of civet cats. He dabbled in horse-trading. Literally. He defaulted on

his debts. Twice. "No man has tasted differing fortunes more," he wrote. "And thirteen times I have been rich and poor."

He wrote allegories that turned dry economic variables into colourful characters like "Count Tariff", an English nobleman dressed in domestically manufactured cloth, and "Lady Credit" ("if she be once Disoblig'd; no Entreaties will bring her back again). His publication "The Compleat English Tradesman" has been described as the first business textbook.

But it is his island fable that has most resonated, as Michael White of Monash University has documented. Economists are eager to find behavioural laws that apply anywhere. Crusoe's isolation thus provides a useful thought experiment. Principles that hold true on his island must be elemental, not socially incidental.

William Forster Lloyd, for example, was keen to show that economics had something to say about value even in the absence of markets and exchange. In a publication in 1834, he pointed out that Crusoe prizes his goods more dearly as they become more scarce ("my ink beginning to fail me", Crusoe says, "I contented myself to use it more sparingly"). He took that as evidence for the principle of diminishing marginal utility: a second bottle of ink is worth less than the first.

Most economists have turned to the tale not to corroborate a theory but merely to illustrate it. Textbook authors, for example, want to introduce the principles of supply and demand in the simplest possible case, and nothing is simpler than a one-person "Robinson Crusoe" economy.

Such an economy features in a textbook by Hal Varian, chief economist at Google. Crusoe must decide how to divide his day between gathering coconuts and working "on his tan". In keeping with diminishing marginal utility, each extra coconut or hour of sunbathing is worth less than the last.

Each hour of work also yields fewer coconuts than the last. Under these assumptions, Crusoe should stop working at the point when an extra coconut is worth no more to him than the additional leisure he must sacrifice to gather it.

A one-person economy has several things going for it. There is no waste. If an extra coconut is not wanted, it will not be collected—supply implies its own demand. There is no unemployment. If Crusoe wants the extra coconut more than the leisure, he will employ himself to gather it. Such an economy, Keynes pointed out, cannot suffer the kind of slump that cursed the 1930s—when people fail to spend enough of their income on the goods the economy could produce.

Textbooks present Crusoe's one-man economy as a kind of benchmark, against which more sophisticated economies can be judged. Can its harmony be replicated, even when decision-making is divided up and dispersed—even when consumers and producers do not share the same mind?

The answer is yes, through the magic of flexible prices and wages. In his own more elaborate version of the parable, Daniel McFadden, a Nobel prize-winning economist who was also Mr Varian's thesis adviser, introduces a second character ("Friday"). In this version, Crusoe gathers yams not coconuts. Friday acts as a manager, hiring Crusoe's labour, paying him in yams, and giving him leftover yams as a "dividend".

Mr McFadden shows that there is an hourly wage that will reconcile the demand and supply of labour, and also, miraculously, the demand and supply of yams. But things can go wrong if wages get misaligned or expectations sink too low. If the wage gets stuck at too high a level, for example, Crusoe might find himself unable to work as long as he wants. The yams he could collect in an extra hour may be worth more to him than

the leisure he would lose. But if the wage he must receive is higher still, Friday will deny him the extra employment. The island would suffer a recession, combining unmet needs (for yams) with unused resources (Crusoe's spare labour).

If Friday worries that he will not be able to sell as many yams as he can produce, he may limit his demand for labour. That will curb his customer's purchasing power, thereby seeming to bear out his pessimistic sales forecast. Crusoe will lack work, because Friday lacks sales. And Friday will lack sales, because Crusoe lacks work.

An obvious objection to these parables is their cartoonishness. The concept of a Crusoe economy has become "another cuss-word to people who crave realism and are contemptuous of theory" noted Frank Knight, a Chicago economist, in 1960. But simplification can often aid understanding. Mr McFadden's parable, for example, illustrates that recessions are not necessary or salutary, but absurd and inefficient.

| *Never too late to be wise*

For Crusoe-lovers, however, what is most striking about these exercises is not their distance from reality, but their distance from Defoe's original tale. Neither coconuts nor yams appear in the book. And far from working on his tan, Crusoe took a "world of pains" to hide from the sun, making a "clumsy, ugly, goat's-skin umbrella" to ward off its rays. His island is not in the South Seas, as Mr McFadden maintains, but near Trinidad. And Friday and Crusoe do not bargain over labour or anything else. After Crusoe saves him from the cannibals who have carried him to the island by canoe, Friday in effect indentures himself to the sailor. One of the first English words he is taught is "Master".

Obliviousness to Defoe's tale does not invalidate the textbook parables. Little of importance hangs on whether Crusoe gathers coconuts, yams or

grapes, in the South Seas or anywhere else. But the neglect is nonetheless a missed opportunity. There is a lot of economic incident and insight in the original story. Economists might enjoy rediscovering it.

They could start not with coconut-gathering but with bread-making. "Few people have thought much upon...the strange multitude of little things necessary in the providing, producing, curing, dressing, making, and finishing [of] this one article of bread," Crusoe says, as he struggles to make some for himself. In trying to start from near-scratch, Crusoe discovers that even the simplest product is a minor miracle of economic choreography. His thoughts resemble the classic essay, "I, Pencil", written by Leonard Read in 1958, which details the "genealogy" of the humble pencil, with its wood from Oregon, graphite from Sri Lanka and rubber from Indonesia, all collected, transported and refined by machines that have their own even more complex genealogy.

After bread-making, economists could turn to Crusoe's pottery. It takes him about two months to make a pair of jars—"two large, earthen ugly things"—in which to store his grain. Preserving resources is no easy matter: pests threaten his crops and decay unravels his clothes. In his 1916 book "The Natural Economic Order", Silvio Gesell imagines how grateful Crusoe would be to lend his spare provisions to another islander, like Friday, in return for similar provisions a few years hence. He would accept the deal even if Friday pays no interest, because merely keeping wealth intact represents a victory against the relentless forces of decay. It is a useful thought experiment for anyone who resents today's financial system, which for all its flaws, allows people to preserve their wealth in convenient savings accounts, not misshapen jars.

The Crusoe in the textbooks is a rational man, always equating marginal this with marginal that. He is the stock character of economics 101. The Crusoe in Defoe's story is more mercurial and conflicted. As such, he lends

himself to more recent, psychologically informed theories of decision-making. He could become an icon of "behavioural economics".

The want of thankfulness for what we have

At one point, Crusoe uses his scarce ink to take stock of his predicament, drawing up a kind of balance-sheet of comforts and miseries, credits and debits. He is a lone castaway (a debit), but he is alive (a credit). The island is uninhabited, but it is not barren. He has no defences, but the island has no obvious predators. No companion survived the wreck, but provisions could be salvaged from it.

Daniel Kahneman, a psychologist who won the Nobel prize in economics, and Amos Tversky have shown that when assessing their lives, people often evaluate not their level of well-being, but their gains or losses from some "neutral" reference point.

The choice of reference point is not always obvious. On each line of his balance sheet, Crusoe entertains alternatives. His shipwrecked isolation represents a grievous loss from where he was. But it counts as a gain from an alternative scenario—not hard to imagine—in which he drowned or washed up on a more perilous shore. Mr Kahneman and Tversky point out that in dreaming up these alternative scenarios, people follow certain rules. They reimagine the chain of events leading up to their predicament, removing any strange or surprising twists of fate.

After Crusoe abandons the wrecked ship, it drifts closer to shore, allowing him to return to it and strip it bare. That, Crusoe recognises, was unlikely (100,000 to one, he says). It is therefore easy for him to imagine an alternative reference point in which he rescued nothing from the wreck. That helps him psychologically.

Behavioural economists stress that more choice is not always better. People

may be unable to resist choices they know will hurt them in the long run. Choice also invites regret. It obliges us to compare our fate with the alternative we could have chosen. Forced to stay on his island, Crusoe can be happy. But if he were to choose his isolation, he would be haunted by the alternative life he could have chosen elsewhere.

Indeed, Crusoe later concludes that he can be happier within the tight compass of his island than he would be in the outside world, where he had once lived a "wicked, cursed, abominable life". He also immediately admits to himself that if offered the chance to escape, he would nonetheless take it.

As these examples show, economists might profit from greater familiarity with the Crusoe story. And the trade could be two-way. Defoe scholarship could and has benefited from a closer acquaintance with economics. There are several corners of Defoe's works that require some economic knowledge to appreciate.

When Crusoe embarks on his ill-fated voyage to Guinea to buy slaves, he leaves behind a growing tobacco plantation in Brazil that would soon be worth "three or four thousand pounds". It is hard for a reader today to make sense of such a figure. Drawing on the work of economic historians, David Spielman, formerly of Penn State University, calculates that the income on such a sum would have put Crusoe in the top 5% of English families at the time. With so much wealth in prospect, Crusoe has no reason to take risks. His voyage was as "preposterous" as he himself admits.

Economists might also resolve some other mysteries. After his return from the island, Crusoe reclaims his plantation and sells it. In the first six editions of the book, he receives 328,000 pieces of eight, worth about £72,000. But in later ones, a zero is deleted. That matters for the interpretation of the story. Does Crusoe finish the novel a rich man or a

very rich one?

Literary scholars pride themselves on their sensitivity to every nuance of a text. But the decimation of Crusoe's wealth has barely registered. "Despite the careful attention that the textual history of Robinson Crusoe has received, no one has even noticed a problem," Mr Spielman has pointed out. Economists may have lost sight of Robinson Crusoe's richness. But literary scholars have overlooked most of his riches. ■

为什么经济学家喜爱《鲁滨逊漂流记》

沉船水手的经典故事揭示了关于稀缺性的许多问题【深度】

在孤岛上度过了28年零2个月又19天后，鲁滨逊·克鲁索并没有失去对冒险的嗅觉，也没有丢掉"四处游逛的天性"。他在"地狱般的狼群"的追逐下穿越了比利牛斯山脉，目睹了中国的"浮华与贫困"，在俄罗斯大草原上与鞑靼人作战。

然而，这个角色最奇特的冒险并不是这些，而无疑是他几个世纪以来在经济学文献中的漫游。鲁滨逊曾出现在卡尔·马克思的《资本论》、约翰·梅纳德·凯恩斯的《就业、利息和货币通论》和米尔顿·弗里德曼在芝加哥主讲的《价格理论》中。《新帕尔格雷夫经济学词典》中有他的条目。而且他还经常冲上经济学教科书的岸头。

鲁滨逊对于经济学的吸引力并不让人惊讶。这个水手花了几页的时间逃离海盗并射杀食人族。但真正的战斗是对抗稀缺——他通过仔细部署他所掌握的资源（包括他自己的劳动力）来战胜稀缺性。

在遭遇海难之后，鲁滨逊把他的小岛监狱改造得适合居住，甚至可说宜人。他从沉船中打捞出一些东西，加固了一个山洞（他的"城堡"），搭建了一个帐篷（"我的乡间别墅"），种植庄稼，驯养了山羊（和一只鹦鹉），在简易架子上摆满了鸽子、乌龟和其他食物。

在1719年创作了《鲁滨逊漂流记》的小说家丹尼尔·笛福也被稀缺所困。在他坎坷的职业生涯中，他做过砖块、葡萄酒、泡菜、烟草和麝猫腺体的贸易。他还搞过马匹交易。他曾债务违约。两次。"没有人比我更饱尝命运转折，"他写道，"我经历过十三次贫富起落。"

他撰写的寓言故事将枯燥的经济变量转化为丰富多彩的人物形象，如"关税伯爵"——一位身穿家纺布料的英国贵族，以及"信用夫人"（"一旦对她

失信，再多的恳求也无法使她回心转意"）。他出版的《英格兰商人全书》（The Compleat English Tradesman）被誉为第一本商业教科书。

但正如莫纳什大学的迈克尔·怀特（Michael White）所写，他的荒岛寓言最能引起共鸣。经济学家渴望找到适用于任何地方的行为规律。因此，鲁滨逊的与世隔绝提供了一个有用的思想实验。在他的岛上适用的原则必然是基本的，而不是因社会而偶然形成的。

例如，威廉·福斯特·劳埃德（William Forster Lloyd）热衷于证明，即使在没有市场和交换的情况下，经济学也能对价值做出解释。他在1834发表的一篇著作中指出，随着商品变得越来越稀缺，鲁滨逊越来越珍视它们（"我的墨水开始不好用了，"鲁滨逊说，"我满足于更加节约地使用它"）。他将此作为边际效用递减原理的证据：第二瓶墨水的价值低于第一瓶。

大多数经济学家引用这个故事并不是为了证实某个理论，而只是为了阐释。例如，教科书的作者们希望在一个尽可能简单的案例中介绍供求原理，而最简单的莫过于一个人的"鲁滨逊·克鲁索"经济了。

谷歌首席经济学家哈尔·瓦里安（Hal Varian）在一本教科书中描述了这样的经济。鲁滨逊必须决定如何将一天的时间在采摘椰子和"晒黑皮肤"上做分配。根据边际效用递减原理，每多收一个椰子或多晒一小时太阳，其价值都会低于上一个椰子或上一小时日光浴。每工作一小时产出的椰子也比上一小时少。根据这些假设，鲁滨逊应该在一个额外椰子的价值已经比不上他为采这只椰子而必须牺牲的额外闲暇时停止工作。

单人经济有几个好处。没有浪费。如果额外的椰子不被需要，它就不会被采摘——供应量就意味着经济本身的需求量。没有失业。如果鲁滨逊想要额外的椰子而不是闲暇，他就会亲自去采摘。凯恩斯指出，这样的经济不会遭受20世纪30年代那样的衰退——当时人们没能将足够的收入用于购买经济所能生产的商品。

教科书将鲁滨逊的单人经济视为一种基准，我们可以用它来评判更复杂的

经济。即使决策被分割和分散——即使消费者和生产者的想法不同，这种和谐能否被复制？

答案是肯定的，这要利用弹性价格和工资的魔力。获得诺贝尔奖的经济学家，也是瓦里安的论文导师的丹尼尔·麦克法登（Daniel McFadden）为这个寓言写了一个更详细的版本。他引入了第二个角色（"星期五"）。在这个版本中，鲁滨逊采集的是山芋而不是椰子。"星期五"充当经理，雇用鲁滨逊的劳动力，用山芋支付报酬，并将剩余的山芋作为"红利"分给他。

麦克法登证明了，存在这样一个时薪水平，它可以协调劳动力的供求关系，还能奇迹般地协调山芋的供求关系。但是，如果工资偏离这个水平或期望值过低就会出问题。举例来说，如果工资停留在过高的水平，鲁滨逊可能会发现自己并不能想工作多久就工作多久。他多工作一小时所能收获的山芋可能对他来说比失去的闲暇更有价值。但是，如果他必须得到的工资比这个价值还要高，"星期五"就会拒绝让他额外工作。这样一来，岛上的需求（山芋）得不到满足，资源（鲁滨逊的剩余劳动力）得不到利用，经济就会出现衰退。

如果"星期五"担心自己生产的山芋卖不出去，他可能会限制对劳动力的需求。这将抑制他的客户的购买力，从而似乎证实了他悲观的销售预测。鲁滨逊缺乏工作，因为"星期五"销售不足。"星期五"销售不足，因为鲁滨逊缺乏工作。

对这些寓言的一个明显反对意见是它们太卡通了。芝加哥经济学家弗兰克·奈特（Frank Knight）在1960年指出，"克鲁索经济"的概念已成为"又一个咒骂那些渴望现实主义且蔑视理论的人的字眼"。但简化往往有助于理解。例如，麦克法登的寓言说明，经济衰退并非必要或有益，而是荒谬和低效的。

明智永远不嫌太晚

然而，对于鲁滨逊爱好者来说，这些思想实验最惹眼的地方不是它们与现实的距离，而是它们与笛福原著故事的差异。书中既没有椰子，也没有山

芋。鲁滨逊不仅不求晒黑皮肤，反而"费尽千辛万苦"躲避太阳，制作了一把"笨拙、丑陋的山羊皮伞"来遮挡阳光。他的岛并不像麦克法登所说的那样在南海，而是在特立尼达附近。"星期五"和鲁滨逊并没有就劳动力或任何其他问题讨价还价。食人族用独木舟把"星期五"带到了岛上，鲁滨逊把他解救出来，之后"星期五"实际上成了鲁滨逊的奴仆。他学到的头几个英语单词里就有"主人"。

对笛福原著的忽视并不意味着教科书上的寓言就失效了。鲁滨逊是在南海还是其他地方采集椰子、山芋或葡萄并不重要。但这种忽视仍然是错失了机会。原著中有很多经济事件和见解。重新发现它可能会让经济学家欣喜。

他们可以不从采集椰子开始，而是从制作面包开始。"很少有人考虑过……在提供、生产、腌制、调味、制作和完成这一个面包时所必需的奇怪的一大堆小事。"鲁滨逊在费劲给自己制作一些面包时说道。在尝试几乎是从头开始的过程中，鲁滨逊发现，即使是最简单的产品也是经济编排的一个小小奇迹。他的想法类似于伦纳德·里德（Leonard Read）在1958年写的经典文章《我，铅笔》（"I, Pencil"），其中详细介绍了不起眼的铅笔的"谱系"：其木材来自俄勒冈州，石墨来自斯里兰卡，橡胶来自印度尼西亚，所有这些都由拥有还更复杂谱系的机器进行采集、运输和精制。

在看完了面包制作之后，经济学家可以看看鲁滨逊的陶器。 他花了大约两个月的时间制作了一对罐子——"两个又大又丑的土制东西"——来储存谷物。保护资源绝非易事：害虫威胁着他的庄稼，他的衣服开始腐烂毁坏。西尔维奥·格塞尔（Silvio Gesell）在1916年出版的《自然经济秩序》一书中想象到，如果鲁滨逊能将自己的备用物资借给另一个岛民（比如"星期五"）以换取几年后类似的物资，他会多么感恩。即使"星期五"不支付利息，他也会接受这笔交易，因为仅仅保持财富完好无损就代表着对无情的自然摧毁力量的胜利。对于那些憎恨当今金融体系的人来说，这是一个有用的思想实验：尽管金融体系存在种种缺陷，但它让人们得以将财富保存在方便的储蓄账户而不是畸形的罐子里。

教科书中的鲁滨逊是一个理性人，总是在平衡边际这个和边际那个。他是经济学101的典型人物。笛福故事中的鲁滨逊更加善变和矛盾，让他更适用于阐释更新近的、受心理学启示的决策理论。他可能成为"行为经济学"的偶像。

对我们所拥有的事物缺乏感恩之心

有一次，鲁滨逊用他稀缺的笔墨来评估自己的困境，绘制了一份舒适与痛苦的资产负债表，有贷项有借项。他是一个孤独的漂流者（借项），但他还活着（贷项）。该岛无人居住，但并不荒芜。他没有防御措施，但岛上没有明显的掠食者。没有同伴在沉船中幸存，但可以从船上打捞出给养。

获得诺贝尔经济学奖的心理学家丹尼尔·卡尼曼（Daniel Kahneman）和阿莫斯·特沃斯基（Amos Tversky）指出，在评估自己的生活时，人们通常不是评估自己的幸福水平，而是从一些"中立"参考点出发来评估自己的得失。

参考点的选择并不总是显而易见的。在资产负债表的每一行上，鲁滨逊都考虑了其他选择。他遭遇海难，与世隔绝，这代表着他相对于之前身处之地是遭受了严重损失。但这相对于另一种情景来说则是收益——不难想象，他也可能被淹死或被冲到更危险的海岸上。卡尼曼和特沃斯基指出，在想象另外这些场景时，人们会遵循某些规则。他们重新想象导致他们陷入困境的一系列事件，消除任何奇怪或令人惊讶的命运转折。

鲁滨逊抛弃了失事的船后，船漂到了离岸更近的地方，这让他可以回到船上，把能拿的东西扒了个精光。鲁滨逊意识到这是极为难得的好运气（他说是十万分之一的几率）。这就使他很容易想象出另一个参照点：他从沉船上什么也没拿回来。这对他的心理很有帮助。

行为经济学家强调，选择并非越多越好。人们可能无法抵抗明知从长远来看会伤害自己的选择。选择的存在也会让人心生遗憾。它迫使我们把自己的命运与我们本可以选择的其他方案比来比去。当鲁滨逊被迫留在岛上，他可能会很快乐。但如果他是自己选择了与世隔绝，那他本可以选择的另

一种生活就会让他难以释怀。

事实上，鲁滨逊后来得出结论，他在自己小岛的狭小范围内比在外面的世界更快乐，因为他曾经在外面的世界过着"邪恶、受诅咒的、可憎的生活"。但他也立即向自己承认，如果有机会逃离，他还是会抓住的。

正如这些例子所显示的，经济学家可能会从更了解鲁滨逊的故事中获益。这种受益可以是双向的。对笛福的研究也可以（而且已经）受益于对经济学的更深入了解。笛福作品中有几个角落需要一定的经济学知识才能鉴赏。

当鲁滨逊踏上前往几内亚购买奴隶的命运多舛的航程时，他在巴西留下了一个正在生长的烟草种植园，很快就会价值"三四千英镑"。今天的读者很难理解这样一个数字意味着什么。曾任教于宾夕法尼亚州立大学的戴维·斯皮尔曼（David Spielman）根据经济史学家的研究，计算出这样一笔收入将使鲁滨逊跻身当时英国家庭收入的前5%。面对如此丰厚的财富，鲁滨逊没有理由冒险。他的航行就像他自己承认的那样是"荒谬的"。

经济学家还可能解开其他一些谜团。从岛上回来后，鲁滨逊收回了他的种植园并将其出售。在该书的前六版中，他收到了328,000个西班牙银洋，价值约72,000英镑。但在后来的版本中，一个零被删掉了。这对于故事的解释很重要。小说结尾时，鲁滨逊是个有钱人，还是个超级有钱的人？

文学学者为自己对文本每一处细微差别的敏感而自豪。但鲁滨逊的财富十去其九却无人在意。斯皮尔曼指出："尽管《鲁滨逊漂流记》的文本历史受到了仔细的关注，但没有人注意到有这么个问题。"经济学家可能忽视了鲁滨逊其人的丰富性。但文学学者却忽视了他的大部分财富。■

AI is stalking the last lions of Hollywood

The first actors to lose their jobs to artificial intelligence are four-legged

PADDING AROUND his spacious ranch in the hills outside Los Angeles, Luke has the swagger of an actor who has made it in Hollywood. After six successful years in the movies he lives in an open-plan home with mountain views, a large swimming pool and staff who bring him steak or smoothies when required. A driver is on hand to take him into the city when he gets a call to shoot an ad or make a paid appearance at an event, for which he commands a fee equal to a week's pay for a lowlier actor. Luke turns heads like few other artists. His agent's only complaint is that, given half a chance, he might try to eat his co-stars.

As a 500lb African lion, Luke (pictured) has to deal with challenges not experienced by other actors. But lately, he and his human colleagues have found common cause. America's screenwriters and actors spent half of 2023 on overlapping strikes. One of the reasons for their bust-up with the studios was the use of artificial intelligence (AI) in film and television production. Writers worry that AI will soon be churning out scripts, while actors fear that, as the technology improves the quality of computer-generated imagery (CGI), they may be replaced by digital stand-ins.

For most human actors that is still a hypothetical worry. But for four-legged screen stars it is already a reality. Work for animal actors is drying up as computer graphics offer an easier—and, some argue, more humane—way to portray creatures on screen. As AI makes those special effects still more realistic and easier to produce, the replacement of real animals with digital ones is accelerating, in television and advertising as well as in high-end movies. As demand for animal actors declines, their owners and trainers are leaving the business. Luke and his colleague, Maasai, who lies snoozing

in a nearby enclosure, are the last two working lions in Hollywood.

Ever since a lion appeared on the title card of Goldwyn Studios, later part of MGM, animals have been an essential part of the Tinseltown talent pool. The star who saved Warner Bros from bankruptcy in the 1920s was Rin Tin Tin, a German shepherd who was in more than 20 pictures and was so bankable that producers dubbed him "the mortgage lifter". From the 1950s an annual Oscars-style awards ceremony, first compered by an actor called Ronald Reagan, gave out gongs to stars such as Flipper the dolphin. In 1993 Entertainment Weekly ranked "the most powerful non-humans in entertainment", including Moose, a dog-actor in "Frasier" (whose human co-stars were smeared with liver pâté to encourage him to nuzzle them).

Animals with the right skills can still find fame. Steve Martin, Luke the lion's owner and trainer, has been in the business for more than 50 years, supplying everything from the deer in the "The Deer Hunter" to a pair of skunks named Alice and Cooper. One of the first big roles he landed for Luke was in "A Royal Romance", a TV movie about Prince Harry and Meghan Markle. Luke played a wild lion in Botswana who, the film implied, may have been Princess Diana reincarnated. Another of Mr Martin's lions, the late Major, had his paw prints set in Hollywood's Walk of Fame, during an appearance alongside a nervous Sylvester Stallone to mark MGM's 90th anniversary.

In an enclosure next to Luke and Maasai is Tag, an 11-year-old bear who lumbers over to greet Mr Martin with a lick. For a role in "Action Point", a film released by Paramount Pictures in 2018, the 1,000lb bear was trained to drink from a beer can. "He never dented one, even," says Mr Martin, proudly. Earlier this year Tag had to maul a dummy inside a sleeping bag, for an independent movie called "Night of the Grizzly" (Tag is a Kodiak, but he can play a grizzly). Training for that scene took two weeks, and a lot of

biscuits. Like any good film star, Tag has become somewhat fussy about his diet, shunning the raw salmon that a bear might eat in the wild in favour of cooked chicken from Walmart.

Such successful animal-acting careers are increasingly rare. Mr Martin once kept 100 or so animals at his 60-acre ranch, looked after by 15 trainers. Now his staff is down to a core of three, and most of the enclosures on the ranch are empty. Other businesses have closed or radically reduced their stock. Trainers are fewer, too. Moorpark College, on the edge of Los Angeles, has supplied animal wranglers to Hollywood through its Exotic Animal Training Management course since 1974. Gary Mui, a faculty instructor, estimates that when he graduated from the programme in 1995, about 70% of his classmates went into the entertainment industry. These days only about 10% of graduates do.

One reason for the industry's contraction is a growing public sensitivity to animal welfare, a hot topic in Hollywood since animals were first put in front of the camera. Early moviemakers treated animals as disposable props; Westerns used tripwires to make horses fall as if they had been shot. Public outcry greeted a cowboy film, "Jesse James", in 1939 in which a horse was deliberately driven off a cliff into a lake, where it drowned. The following year the American Humane Society, a charity, began providing its now-famous certification that "No animals were harmed" in the making of productions that passed its on-set inspections.

Animals' treatment in Hollywood has vastly improved since the days of "Jesse James". But abuse has not disappeared, and the risk of scandal makes studios nervous. HBO cancelled its racing drama, "Luck", after three horses died on set (poor ratings may have been another factor; one critic quipped that the animals may have died of boredom). "Gladiator 2", currently in production, has faced protests for using macaque monkeys and horses. These days many trainers are reluctant to talk about their work; one, who

says that animal-rights activists once called a police SWAT team to his home, insists (amid deafening squawking) that for security reasons he can no longer disclose whether he keeps animals on the premises.

Truly plausible digital stand-ins are now an alternative to real animals for wary studios. For many years, computer-generated creatures were convincing only in limited circumstances. "Jurassic Park" wowed audiences with its special effects in 1993, but used animatronic dinosaurs more than CGI ones. For years after that, computer models struggled to create realistic hair, which animals tend to have a lot of. Furry CGI creatures looked weirdly smooth—"like Gummi Bears", recalls Mr Mui. Then, in 1998, came Disney's "Mighty Joe Young", whose star is a giant ape created from animatronics and CGI. Mr Mui watched it in dismay. "I said, 'Oh, our days are numbered now'," he recalls. For the first time, the hair looked good.

As the effects have got better, directors have relied on them more often. Disney has produced a series of live-action remakes of classic animal-based animations, including "The Jungle Book" (2016) and "Dumbo" (2019), in which it has cast real actors in the human roles but created the leading animals on a screen. In its blockbuster remake of "The Lion King" (2019) every creature, from warthog to wildebeest, was computer-generated. Disney is not alone. The star of Universal's comedy-horror hit in February, "Cocaine Bear", was a CGI creation. Tag never even got to audition. "They used to call us for stuff like that," says Mr Martin. "Those guys really pushed us out of business."

So far the "exotics" have lost the most work. Chimps have not acted in a big American movie since Paramount's "The Wolf of Wall Street" in 2013. The last elephants are thought to have lumbered out of Hollywood around the same time. Studios are increasingly unwilling to work with big cats, says Mr Martin. "For wild animals, it's basically finished," he concludes.

Trainers of smaller stars are wondering how much further the digital trend will go. An hour or so from Luke the lion's ranch is Studio Animal Services, with an obstacle course in its front yard and multiple dog chews and fly swatters inside. Karin McElhatton, who has trained animals in Hollywood since the 1970s, is the company's owner—though Rumor, a white Pekin duck, appears to believe that he is its real proprietor, as he waddles in from a swim and preens in front of a fan, filling the room with a cloud of feathers and down.

"The business is getting more and more narrow in terms of the animals they want to use," says Ms McElhatton. She once flew a team of five squirrels, raised from babies, to Hungary for a Kinder chocolate ad, which required them to carry a coin to a vending machine. These days such jobs are nearly always computer-generated, she explains.

Ms McElhatton's 35 cats and 25 dogs still find work. Albert, a serene brown tabby on a pink lead, spends most of his time modelling for pet food commercials, though he also scored a recent role in a horror film pretending to devour a corpse. Tank, a German shepherd, is in demand as a sniffer dog on shows like "NCIS" and "911" (his trainer, David Meyers, has a Screen Actors Guild card so that he can play the accompanying police officer). Two golden retrievers, Parker and Porter, are often cast as family pets. Two years ago they went to Mexico for a comedy movie called "El Roomie"; they were flown first-class and got their own trailer.

Domestic animals have been somewhat protected against digital competition. Audiences are more familiar with the real thing and thus quicker to spot a fake dog than a fake bear. Animal-rights protesters seem somewhat less bothered by their involvement, too. Yet even man's best friend is now losing work to digital doppelgangers. "The Call of the Wild", a Disney movie released in 2020, called in computer animators to create

Buck, the St Bernard-Scotch shepherd who co-stars alongside Harrison Ford. Audiences didn't much like the digital dog; for now, directors still prefer to cast the real thing. Nonetheless, "it was extremely disconcerting for us," says Ms McElhatton, who was relieved when the movie fizzled at the box office.

Could CGI replace the two-legged animals at the top of the acting food chain? Near Seattle, an unusual team of animal trainers has seen signs that it might. The trainers recently taught a lion cub to climb onto its father's head, before rolling off his back and onto the ground. Yet the lions in question do not live in a cage, but on a hard drive, and their training is not done with biscuits, but with biomechanical elastic-body solvers and quasi-static integrators.

The digital lion-tamers work for Unity, which creates virtual environments and characters for video games and has dabbled in movies (including 2022's sequel to "Avatar"). Creating believable animals is still easier than creating realistic humans, says Allan Poore, who moved to Unity after working as an animator at Disney's Pixar. "We stare at faces and people all day…so we're going to notice."

Eyes are hard to get right, and skin can look waxy without elaborate light-diffusion techniques. But creating digital humans is getting easier. The addition of AI to the animator's toolkit has sped things up, meaning that "rigging" a digital model of a human face (think the wires on a puppet) might take an hour or two, down from a month. "We've been on this journey a long time, and I think we're getting closer and closer," Mr Poore says. "I've seen some stuff [where] it's hard to tell the difference. And you'll see more of that."

Actors are already being "de-aged" for roles which might once have gone to young lookalikes. In "Indiana Jones and the Dial of Destiny", released in

June, the octogenarian Mr Ford was rejuvenated by half a century by animators who used AI to mine footage of the actor in his "Raiders of the Lost Ark" days. Robert DeNiro underwent a similar transformation in Netflix's "The Irishman" (2019), as did Samuel L. Jackson in Disney's "Captain Marvel", released in the same year. Background actors, or extras, fret that they may soon not be needed at all.

What kind of work awaits human stars then? The animals offer a preview of the coming attractions. Some still give performances that are later digitally enhanced. Disney's live-action remake of "Lady and the Tramp" (2019) mixes footage of real dogs with CGI shots, including animating their mouths to simulate talking (an effect that trainers used to achieve by feeding the dog something chewy before the cameras rolled). Real dogs acted in Warner Bros' "Birds of Prey" (2020), only to be morphed into a hyena in post-production. American Humane explains that a herd of 100 CGI horses is likely to be modelled on ten real ones.

Others have moved away from feature films to focus on more humdrum work. Social-media influencers, prizing high-impact, low-budget stunts, have become regular employers of exotic animals. Tag the bear has gamely "wrestled" with Logan Paul, a YouTuber, and taken on humans in a hot-dog eating contest organised by Barstool Sports, a blokeish entertainment site. Live events are also fairly safe from AI interlopers. Tag was hired in 2021 to appear at campaign rallies alongside John Cox, a California Republican who called himself "the beast". Even this kind of work is becoming scarce, however, amid animal-welfare concerns. Mr Martin is being sued by an animal-rights group over Tag's appearance at the rallies.

| *Circle of life*

Many of Hollywood's last animal-handlers are now near retirement. "When this generation of trainers kicks the bucket, I don't know that you're going to have hardly anything in America," says Ms McElhatton.

Animal-rights advocates are delighted. PETA, a lobby group, advocates more use of CGI creatures, arguing that "creative people can tell compelling, emotional stories using special effects and without exploiting any real animals." "I understand some of the motivations of animal-rights people. And they need to understand that we have more in common with them than we don't," says Mr Mui sadly. "I want what's best for animals, but I don't have an issue with animals working with people as long as it's done correctly," he says. But now, "it's all fading away."

At Luke's ranch, a for-sale sign has gone up at the end of the long driveway. Mr Martin, 76, is planning to move to Oregon with his remaining animals. He believes that their absence from the screen will ultimately harm the cause of animal welfare, by removing the audience's connection to real, living creatures. "These guys are ambassadors for the ones in the wild," he says. Soon, Luke and Maasai will head north with him in their air-conditioned trailer. And then the only lions left in Hollywood will be digital. ■

人工智能盯上了好莱坞最后几头狮子

因AI失业的第一批演员是四条腿的家伙们【深度】

卢克（Luke）在洛杉矶郊外山上宽敞的牧场里转悠，一副好莱坞大腕的趾高气昂的派头。经过六年成功的电影生涯后，他住在一户开放式山景寓所，配有一个大游泳池，工作人员会在有需要时送上牛排或冰沙。当他接到拍摄广告或出席有偿活动的电话时，会有司机把他送进城，他收取的报酬相当于普通演员一周的工资。卢克所到之处，吸睛水平难有匹敌。他的经纪人唯一的抱怨是，一有机会，他可能就试图把他的合作演员吃了。

身为一头重达500磅的非洲狮，卢克（如图）必须应对其他演员没有经历过的挑战。但最近，他和他的人类同事们开始共进退。2023年的一半时间里，美国的编剧和演员的罢工此起彼伏。他们与制片厂争执的原因之一是人工智能（AI）在影视制作中的应用。编剧们担心AI很快就会开始大量创作剧本，演员们则害怕随着技术让计算机生成图像（CGI）的质量越来越好，他们可能会被数字替身取代。

这对于大多数人类演员来说仍然只是个假设性的担忧，但对于四条腿的银幕明星来说已经成为现实。动物演员的工作正趋枯竭，因为计算机图形技术为在银幕上塑造动物形象提供了更简便（而且一些人认为更为人性化）的方法。随着AI使这些特效更加逼真和易于制作，在电视、广告和高端电影中，数字动物正在加速取代真实的动物。对动物演员的需求减少后，它们的主人和驯兽师正纷纷离开这个行当。卢克和他躺在附近围栏里打盹的同事马赛（Maasai）是好莱坞最后两头还在工作的狮子。

渲染腥牙血爪

自一只狮子出现在戈德温影业（Goldwyn Studios，后来成为米高梅的一部分）的商标上起，动物就成为了好莱坞演艺人才库中不可或缺的一部分。20世纪20年代，拯救华纳兄弟免于破产的明星是任丁丁（Rin Tin Tin），他是一只德国牧羊犬，曾出演过20多部影片，票房非常出色，制

片人戏称它为"能还贷的角儿"。从1950年代起，一年一度的形同奥斯卡的颁奖礼会向海豚飞宝（Flipper）等明星颁奖，一位名叫罗纳德·里根的演员主持了第一届典礼。1993年，《娱乐周刊》发布"娱乐圈最具影响力的非人类"排行榜，上榜的包括《欢乐一家亲》（Frasier）中的狗子演员穆斯（Moose，与他合作的人类演员身上涂满了肝酱，以吸引他用鼻子蹭他们）。

拥有适当技能的动物仍有机会名声大噪。狮子卢克的主人兼驯兽师史蒂夫·马丁（Steve Martin）从事这一行已有50多年，供应过的动物林林总总，从《猎鹿人》（The Deer Hunter）中的鹿，到一对名为爱丽丝（Alice）和库珀（Cooper）的臭鼬等。他最早为卢克争取到的重要角色之一是在一部关于哈里王子和梅根·马克尔的电视电影《皇家情缘》（A Royal Romance）中。卢克在片中饰演了博茨瓦纳的一头野生狮子，影片暗示这头狮子可能是戴安娜王妃转世。马丁的另一头狮子，已故的"少校"（Major），在米高梅公司90周年庆典上与神色紧张的史泰龙一同亮相，爪印被刻在了好莱坞的星光大道上。

在卢克和马赛旁边的围栏里，11岁大的泰格（Tag）笨拙地移步过来，舔了舔马丁向他问好。为了在派拉蒙影业于2018年上映的电影《行动时刻》（Action Point）中扮演一个角色，这只重达1000磅的熊接受了从啤酒罐里喝水的训练。"他甚至没有弄瘪过一个罐头。"马丁自豪地说。今年早些时候，泰格不得不在一部名为《灰熊之夜》（Night of the Grizzly，泰格是棕熊，但它可以扮灰熊）的独立电影里袭击睡袋里的一个假人。这场戏的训练花费了两周时间和大量饼干。和其他优秀的电影明星一样，泰格变得对饮食有些挑剔，他不碰熊在野外可能会吃的生鲑鱼，而选择沃尔玛超市里的熟鸡肉。

如此成功的动物表演生涯日益罕见。马丁曾经在他占地60英亩的牧场里饲养了100多只动物，配有15名驯兽师。现在，他的员工只剩下核心三人团，牧场里的大部分围栏都空了。其他企业也纷纷关闭或大幅削减饲养的动物数量。驯兽师也越来越少。位于洛杉矶周边的莫尔帕克学院（Moorpark College）自1974年以来通过其"奇珍动物训练管理"课程为好

莱坞提供驯兽师。该学院教师加里·穆伊（Gary Mui）估计，当他1995年从该课程毕业时，约有70%的同学进入了娱乐业。如今，只有一成左右的毕业生进入该行业。

行业萎缩的原因之一是公众对动物福利日益敏感。自动物首次出现在镜头前以来，动物福利一直都是好莱坞的热门话题。早期的电影制作人将动物视为一次性道具；西部片使用绊索让马匹摔倒，制造出中弹倒地的效果。1939年，牛仔电影《杰西·詹姆斯》（Jesse James）故意将一匹马赶下悬崖，掉进湖里淹死，引发了公众强烈不满。次年，慈善机构美国人道协会（American Humane Society）开始提供到今天大家都已很熟悉的"没有动物受到伤害"认证，证明影片的制作过程通过了其现场检查。

自《杰西·詹姆斯》时代以来，好莱坞对待动物的方式有了很大改善。但虐待动物的现象并未消失，引发丑闻的风险也让制片厂感到紧张。在三匹马死在片场后，HBO中途砍掉了其赛马题材剧集《幸运》（Luck）（收视率不佳可能是另一个因素；一位剧评人打趣说它们可能是被无聊的剧情闷死的）。目前正在制作中的《角斗士2》因使用猕猴和马而遭到抗议。如今许多驯兽师都不大愿意提起自己的工作。一位驯兽师说，动物权利活动人士曾经叫了一支特警队到他家。他（在一片震耳欲聋的动物叫声中）坚持说，出于安全考虑，他不能再透露他是否在这里饲养了动物。

对于谨慎的制片厂而言，真正可信的数字替身如今已成为真实动物的一种替代选项。多年来，电脑制作的动物只有在某些情况下看着令人信服。1993年，《侏罗纪公园》的特效令观众叹为观止，但它使用的更多是仿真恐龙而不是CGI恐龙。在那之后的多年里，计算机模型一直难以制作出逼真的毛发，而动物往往有很多毛。穆伊回忆说，CGI制作出来的毛茸动物看起来很奇怪，滑溜溜的"就像小熊软糖"。1998年，迪士尼的《无敌大猩猩》（Mighty Joe Young）上映，该片的主角是一只用动画和CGI制作的巨猿。穆伊看得垂头丧气。"当时我说，'哦，这下我们的日子可不多了'。"他回忆道。这是动物的毛发头一回看起来对劲了。

随着效果越做越好，导演们也越来越依赖它们。迪士尼已经制作了一系列

经典动物动画的真人翻拍版，包括《奇幻森林》（The Jungle Book，2016年）和《小飞象》（Dumbo，2019年），其中人类角色由真人演员出演，动物主角则是在显示屏上制作出来的。在翻拍大片《狮子王》（The Lion King，2019年）中，从疣猪到角马的每一种动物都是电脑制作的。这样做的不只是迪士尼。环球影业去年2月推出的卖座喜剧恐怖片《可卡因熊》（Cocaine Bear）的主角就是由CGI制作的。泰格甚至连试镜的机会都没有。"过去有这种角色他们会给我们打电话，"马丁说，"那些家伙真把我们逼得没事干了。"

到目前为止，"奇珍品种"丢掉的工作最多。自2013年派拉蒙出品的《华尔街之狼》（The Wolf of Wall Street）之后，黑猩猩就再没出演过美国大片。据称最后一批大象也是在同一时期沉重出走好莱坞的。马丁说，制片厂越来越不愿意与大型猫科动物合作。"对于野生动物来说，基本上已经玩完了。"他总结道。

人类最佳化身

小型动物明星的驯兽员们想知道数字化趋势会走多远。距狮子卢克的牧场约一小时车程的制片厂动物服务公司（Studio Animal Services）的前院设有障碍训练场，里头有多种狗咬胶和苍蝇拍。公司所有者卡琳·麦克尔哈顿（Karin McElhatton） 自20世纪70年代以来一直在好莱坞训练动物。不过，白色的北京鸭"流言"（Rumor）似乎相信自己才是这里真正的主人，他游完泳摇摇摆摆地进屋，在一台风扇前搔首弄姿，扬起一阵羽毛和绒毛。

"娱乐业想要使用的动物品类越来越窄。"麦克尔哈顿说。她曾经带着五只从小养大的松鼠飞往匈牙利拍摄一支健达巧克力广告，广告要求它们把一枚硬币拿到自动售货机上。如今这类工作几乎都是由计算机完成了，她解释说。

麦克尔哈顿的35只猫和25只狗仍然有活干。阿尔伯特（Albert）是一只安详的棕色虎斑猫，套着粉红色的牵绳，大部分时间都在为宠物食品广告做模特，不过最近还参演了一部恐怖电影，假装吞食一具尸体。坦克

（Tank）是一只德国牧羊犬，在《海军罪案调查处》（NCIS）和《911》等节目中扮演嗅探犬（他的训练师大卫·迈耶斯［David Meyers］拥有美国演员工会会员证，因此可以扮演随行警官）。两只金毛猎犬帕克（Parker）和波特（Porter）常扮演家庭宠物。两年前，他们去墨西哥参演喜剧电影《室友》（El Roomie），坐头等舱，还有自己的移动化妆拖车。

家畜在某种程度上免受数字竞争的影响。观众对家畜的真身更熟悉，因此假狗比假熊更容易看出来。动物权利抗议者对它们的参与也更宽容些。但即使是人类最好的朋友现在也在被数字分身取代。2020年上映的迪士尼电影《野性的呼唤》（The Call of the Wild）请电脑动画师制作了与哈里森·福特共同出演的圣伯纳-苏格兰牧羊犬巴克（Buck）。观众们不大喜欢这只数码狗。目前而言，导演们仍然更倾向于用动物真身。不过，"我们那次可是紧张死了，"麦克尔哈顿说。直到这部片子票房惨淡，她才松了一口气。

CGI能否取代处于表演食物链顶端的两足动物？在西雅图附近，一支不同寻常的驯兽师团队已经看到了这种可能性的迹象。最近，驯兽师教一只幼狮爬到它的父亲头上，然后从父亲的背上滚到地上。不过，这些狮子并不生活在笼子里，而是生活在硬盘上，它们的训练也不是用饼干完成的，而是用生物力学弹性体解算器和准静态积分器。

这些数字驯狮者为Unity工作，该公司为视频游戏创建虚拟环境和角色，还涉足电影（包括2022年的《阿凡达》续集）。在迪士尼的皮克斯担任动画师后加入Unity的艾伦·普尔（Allan Poore）表示，创造可信的动物仍然比创造逼真的人类更容易。"毕竟我们整天都盯着面孔和人看……我们会看出来的。"

眼睛就很难做好，而如果没有精致复杂的光漫射技术，皮肤看起来会像是蜡像。但创造数字人类正变得越来越容易。在AI加入动画师的工具包后，进展已经提速，"操纵"一个人脸数字模型（想想提线木偶）现在可能只需要一两个小时，而以前要一个月。"我们已经在这条路上走了很久，我认

为离目标越来越近了，"普尔说，"我已经见过一些真假难辨的东西。而你会看到更多这种东西。"

老演员们已经在被"减龄"，去扮演那些本来可能得找长得像他们的年轻人来演的角色。在6月上映的《夺宝奇兵：命运之盘》（Indiana Jones and the Dial of Destiny）中，动画师利用AI挖掘哈里森·福特在《夺宝奇兵》第一部时期的镜头，让已经八旬高龄的福特变回三十多岁。罗伯特·德尼罗在奈飞的《爱尔兰人》（The Irishman，2019年）中实现了类似的容颜转变，塞缪尔·杰克逊在同年上映的迪士尼的《惊奇队长》（Captain Marvel）中也是如此。背景演员（群演）担心自己可能很快就完全不被需要了。

那么，什么样的工作等待着人类明星呢？这些动物预告了即将到来的精彩节目。它们有些仍在表演，但后来经过了数字增强。迪士尼的真人版《小姐与流浪汉》（Lady and the Tramp，2019）将真狗的镜头与CGI镜头混剪，包括让狗的嘴巴模拟出讲话的效果（过去，训练师会在镜头启动前给狗喂一些有嚼劲的东西来达到这种效果）。真狗出演了华纳兄弟的《猛禽小队》（Birds of Prey，2020年），但在后期制作中变成了鬣狗。美国人道协会解释说，一群100匹的CGI马很可能是以10匹真马为原型制作出来的。

其他动物已经从参演电影长片转向更日常平淡的工作。社交媒体博主们推崇高冲击力、低预算的特技表演，已经成为了奇珍动物的常见雇主。棕熊泰格曾与YouTube博主洛根·保罗（Logan Paul）英勇"搏斗"，在男性体育娱乐网站Barstool Sports组织的吃热狗比赛中挑战人类。现场活动也不会受到AI的威胁。泰格在2021年受聘与自称"野兽"的加州共和党人约翰·考克斯（John Cox）一起出席竞选集会。但由于对动物福利的担忧，连这样的工作也变得稀缺。马丁因泰格参加了这次集会被动物权利组织告上了法庭。

生生不息

好莱坞最后一批驯兽师中的许多人如今已近退休。麦克尔哈顿说："等这

一代驯兽师去世了，我不知道美国还会有什么动物演员。"

动物权益倡导者很高兴。游说团体PETA主张更多使用CGI制作的动物，认为"文艺创作者可以利用特效来讲述引人入胜的情感故事，而无需利用任何动物真身"。"我理解动物权益人士的某些动机。但他们要明白，我们和他们的共识要比分歧多。"穆伊伤感地说。"我希望为动物谋福利，但我并不反对动物与人合作，只要方式正确。"但现在，"一切都快没了。"

在卢克的牧场，长长的车道尽头竖起了一块写着待售的牌子。76岁的马丁计划带着他剩下的动物搬去俄勒冈州。他认为，它们从银幕上消失最终会损害动物福利事业，因为观众与真实动物的连结断了。"这些家伙是野生动物的形象大使。"他说。很快，卢克和马赛将乘坐带空调的拖车和他一起北上。然后，好莱坞就只剩下数字狮子了。■

Delivery robots will transform Christmas

Santa's hi-tech little helpers

A SHOP ASSISTANT leaves a Co-op convenience store in Milton Keynes and opens the lid of a white box, about the size of a small suitcase, with a red flag on top and six wheels. After the assistant drops a bag of shopping inside and scans a bar code, the box trundles off. Travelling at a brisk walking pace along the footpath, it pauses at a road junction until two cars have passed before crossing safely. Neither pedestrians nor car drivers give it a second glance. Delivery robots like this have become part of the scenery since they started work in this town, some 80km north-west of London, in 2018.

"That's when you know a new technology is successful," says Ed Lovelock. "People don't notice it any more." Mr Lovelock is product manager for Starship Technologies, a Californian firm that has so far delivered more than 5m shopping orders and restaurant meals in Europe and America using its autonomous Starships.

In some places such deliveries arrive by air. "It soon becomes a normal part of your life," says Keller Rinaudo Cliffton, the boss of Zipline, a drone-delivery firm also based in California. Zipline began using drones to deliver blood and medical products in Rwanda in 2016. It is expanding into groceries and meals and now operates in other parts of Africa as well as America and Japan. In 2024 Zipline will begin deliveries to hospitals and clinics in the north of England for Britain's National Health Service.

Where's my bot?

Like many new technologies, delivery bots have gone through something of a hype cycle. A decade ago many predicted they would soon be everywhere.

Amazon, for one, announced with great fanfare ambitious plans for its Prime Air drone-delivery service in 2013, but progress was slow and not much happened. That is changing, and even Amazon's drones finally look like they are about to take off.

A number of things have brought this about. Companies like Starship and Zipline began modestly in areas where regulators were more comfortable with robotic deliveries. Milton Keynes, for instance, is a new town with wide paths and cycleways for bots to drive along, and with few low-flying aircraft to worry about in the sky above Rwanda, drones can operate safely.

Having steadily gained solid operating experience, officialdom is becoming more relaxed about such services. What that means is, particularly at this time of year, instead of fleets of delivery vans with drivers hauling seasonal gifts and shopping to people's front doors, an increasing number of goods are arriving by robot.

Starship has gone on to launch services in ten British towns, including older places with narrower streets like Manchester, Leeds and Cambridge. It also makes deliveries on more than 50 university campuses in America. Nor is it alone. Serve Robotics, which is backed by Uber, a ride-sharing platform, began using "sidewalk robots" for restaurant deliveries in Los Angeles in 2022 and aims to deploy some 2,000 in other American cities.

Customers typically use an app to order, with the firms adding a small delivery fee. Depending on distance, this starts at 99 pence ($1.20) in Milton Keynes. Around 100 Starships, each able to carry up to 10kg, serve a number of stores. They navigate along pre-mapped routes using satellite positioning. Sensors, including a dozen cameras and radar, create a "bubble of awareness" around the robot. On arrival, customers use their phone to unlock the robot's storage compartment and collect their shopping.

It helps that Starships have been made cutesy. Customers in Milton Keynes can choose a song, like "Happy Birthday" for the bot to play on arrival. Some are also decorated for festive occasions, such as "pumpkinbots" during Halloween or "reindeerbots" at Christmas. As a result, adds Mr Lovelock, residents are protective of them and few are tampered with. The bots emit a high-pitched screech if anyone tries to steal them or their contents.

The growing acceptance of delivery bots is helping the idea spread. A trial scheme using sidewalk robots in Helsinki, the Finnish capital, is due to be expanded in the spring of 2024. In November the South Korean government warned people "not to be surprised" by more of them appearing in the capital, Seoul, where the 7-Eleven convenience chain has been testing four-wheel models produced by Neubility, a startup backed by Samsung.

Much the same is happening with drones, although they are not yet dressing up and singing songs. America's Federal Aviation Administration recently allowed some firms, including Zipline, to fly "beyond-visual-line-of-sight" (BVLOS). In America and many other countries drones are not allowed to be flown out of sight of their operators unless ground observers monitor them in case other aircraft are in the vicinity. This restricted how far drones could fly and drove up costs.

Advances in technology helped win these new freedoms. For BVLOS flights, new miniaturised sensing devices can be built into drones to detect and avoid other aircraft. Zipline's system uses specially developed microphones which can pick up the sound of an approaching aircraft and determine its position, allowing the drone to take evasive action if necessary.

Drone highways

In Britain a 165-mile (265km) superhighway for drones, connecting southern England with the Midlands, will start operating in 2024. It will

rely on a series of ground stations along the route to communicate with the drones to keep them apart and avoid any other aircraft.

The ability to fly BVLOS allows Zipline to offer similar services to its African operations. For these, the company uses a fixed-wing drone capable of a round trip of some 200km. Carrying up to 1.8kg, it is launched with a giant catapult and drops its delivery using a parachute.

The company is starting to work with a number of medical centres in America. In a recent deal with the Cleveland Clinic, it will deliver medicines directly to people's homes in locations throughout Ohio. For this Zipline will use a new type of hovering drone, able to make round trips of some 30km carrying up to 3.6kg. Instead of a parachute, this drone uses a load-carrying device called a "droid". After being lowered on a cable, the droid employs a small fan motor to manoeuvre, allowing it to set packages down in precise locations, such as the front steps of a home. This drone-plus-droid system will also be used to deliver groceries and meals.

Both sidewalk robots and drones still require some level of human supervision. Usually this involves people in a control centre monitoring them and intervening if necessary. For Starships, these interventions tend only to come when a bot stops and seeks confirmation that a manoeuvre it intends to undertake, like crossing a tricky road junction, is safe. Zipline's drones can be called back to base in the event of a problem, or ordered to stop flying immediately and deploy a parachute to land in an emergency. Such events, however, are "extraordinarily rare", says Mr Rinaudo Cliffton.

As for Amazon, it began a limited drone-delivery service in two small areas of California and Texas in 2022. It has since developed a new drone, called the MK30, which it plans to put into service in America, Britain and Italy by the end of 2024. These will operate out of the company's delivery centres and also use a sense-and-avoid system for BVLOS flights. It is quieter than

the firm's existing model, can carry packages up to 2.2kg and will be able to fly in unsettled weather, including light rain.

Amazon is talking about delivering millions of packages by drone every year by the end of the decade. If the giant of online retailing can finally crack the technology, then automated delivery could spread almost everywhere. If not, there are already enough firms demonstrating that, at least in some areas, delivery bots using wheels, wings or rotors are coming your way. ■

送货机器人带来别样圣诞节

圣诞老人的高科技小助手

一名店员从米尔顿凯恩斯（Milton Keynes）的一家Co-op便利店走出来，打开一个白色箱子的盖子。这个箱子的大小和一个小行李箱差不多，上面插着一面小红旗，底下装着六个轮子。店员把一袋商品放进箱子、扫描完条形码，箱子就缓缓滑走了。它以比路人散步略快的速度沿着人行道滑行，在一个路口停下来，等两辆车经过后，才安全穿过路口。无论是过往行人还是司机都不会多看它一眼。自2018年以来，这样的送货机器人就开始穿梭在这个位于伦敦西北向约80公里处的小镇，成为镇上的一道风景。

"当人们对它熟视无睹的时候，"埃德·洛夫洛克（Ed Lovelock）表示，"你就知道一项新技术取得了成功。"洛夫洛克是加州公司Starship Technologies的产品经理。截至目前，该公司已经使用其自主移动机器人Starship为欧美的商店和餐馆完成了500多万单外送服务。

在有些地方，这些配送是从空中送达的。"它很快就会成为你日常生活的一部分。"同样位于加州的无人机送货公司Zipline的老板凯勒·里纳乌多·克利夫顿（Keller Rinaudo Cliffton）表示。2016年，Zipline开始在卢旺达使用无人机运送血液和医疗用品。它正在向食品杂货和餐饮领域扩张，现在除了在美国和日本，它也在非洲其他地区开展业务。2024年，Zipline将为英国国家医疗服务体系（NHS）提供服务，开始向英格兰北部的医院和诊所送货。

我的机器人在哪里？

和许多新技术一样，送货机器人也经历了某种程度上的技术成熟度曲线。十年前，许多人预测它们很快就会无处不在。例如，亚马逊在2013年大张旗鼓地宣布了其雄心勃勃的Prime Air无人机送货服务，但该计划后来进展缓慢，并未取得多少成就。现在情况正在改变，亚马逊的无人机似乎也终于要一飞冲天了。

一些因素促成了这些改变。Starship和Zipline等公司起步都较为谨慎，选择了监管机构对机器人送货较为包容的地区。例如，米尔顿凯恩斯是新城镇，这里有宽阔步道和自行车道可供机器人行驶；在卢旺达的上空几乎没有低空飞行的飞机可担心，无人机因而可以安全飞行。

在这类公司稳步积累了扎实的运营经验后，官员们开始放宽对它们的服务的限制。这意味着越来越多的货物正由机器人送达，而不是由货车司机把节日礼物和其他商品送到居民家门口，尤其是在每年的圣诞季。

Starship后续在英国的十个城镇推出了服务，包括曼彻斯特、利兹和剑桥等一些街道狭窄的较古老城镇。它还在美国50多所大学的校园里送货。Starship并非个例。2022年，由拼车平台优步（Uber）支持的Serve Robotics公司开始在洛杉矶使用"人行道送货机器人"为餐馆送外卖，并计划在美国其他城市部署约2000台。

顾客一般会通过应用下单，送货公司会加收少许送货费。在米尔顿凯恩斯，送货费根据距离远近而定，起步价为99便士（1.20美元）。米尔顿凯恩斯大约有100台Starship，每台最多可携带十公斤物品，为好几家商店送货。它们利用卫星定位沿着预先规划好的路线行进。包括十二个摄像头和雷达在内的传感器在机器人周围形成一个"感知气泡"。到达目的地后，顾客用手机解锁机器人的储物箱，取走自己购买的物品。

Starship萌萌的外型设计也是一个加分项。米尔顿凯恩斯的顾客可以选择一首歌曲（比如《生日快乐》），让机器人在到达时播放。逢年过节时，一些机器人还会被装饰成不同造型，比如万圣节的"南瓜机器人"或圣诞节的"驯鹿机器人"。因此，洛夫洛克补充道，居民很护着它们，很少有机器人被蓄意破坏。如果有人试图偷走它们或者它们运送的物品，这些机器人会发出刺耳的尖叫声。

人们对送货机器人不断提高的接受度有助于让这个创意传播开来。2024年春季，芬兰首都赫尔辛基将扩大一项使用人行道机器人的试验计划的范围。在韩国首都首尔，7-11连锁便利店已经在测试由三星支持的创业公司

Neubility生产的四轮电动送货机器人。对于首尔街头出现的越来越多的送货机器人，韩国政府在去年11月提醒民众"无需惊讶"。

送货无人机的情况大致相同，尽管它们还没有被装扮起来或是被安排唱歌。美国联邦航空管理局（FAA）不久前允许包括Zipline在内的一些公司进行"超视距"飞行。根据美国和许多其他国家的规定，无人机不准飞出操控员的视线，除非地面观察员能够监视它们，以防它们碰到附近的其他飞行器。这一规定限制了无人机的飞行距离，推高了成本。

技术上的进步帮助无人机争取到了新的自由度。执行超视距飞行的无人机可以内置新的微型传感设备以探测和避开其他飞行器。Zipline的系统使用了专门研发的麦克风，可以捕捉到其他飞行器靠近时发出的声音并确定其位置，从而让无人机在必要时采取规避行动。

无人机高速通道

在英国，一条连接英格兰南部和中部地区的165英里（265公里）长的无人机高速通道将于2024年开始运营。它将依靠沿途的一系列地面站与无人机建立通信，让无人机相互保持距离，同时避开其他所有飞行器。

因为具备了超视距飞行的能力，Zipline能够为其在非洲的业务提供类似的服务。Zipline使用的是一架单次能够往返飞行约200公里的固定翼无人机。它最大载重1.8公斤，通过一个巨大的弹射器起飞，并使用降落伞投放物品。

Zipline开始与美国的一些医疗中心合作。根据不久前与克利夫兰诊所（Cleveland Clinic）达成的协议，Zipline将把药品直接送到俄亥俄州各地的居民家中。为此，Zipline将使用一种新型悬停式无人机，单次能够往返飞行约30公里，最大载重3.6公斤。这款无人机使用的是一种叫作"机器人"的载货装置，而不是降落伞。"机器人"被缆绳放下后，会启动一个小型风扇马达来让自己移动，从而将包裹精准放在指定位置，比如房门口的台阶上。这种"无人机+机器人"的系统也将被用来运送食品杂货和餐食。

无论是人行道机器人还是无人机，都还需要一定程度的人类监督。通常是

由控制中心里的人员监控，并在必要时干预。对于Starship来说，一般只有当机器人停下来并试图确认自己打算采取的行动（比如穿过一个复杂的十字路口）是否安全时，才会进行干预。Zipline的无人机在遇到问题时可以被召回基地，或者在紧急情况下按指令立即停止飞行并使用降落伞着陆。不过，这种情况"极为罕见"，里纳乌多·克利夫顿表示。

至于亚马逊，它于2022年在加州和得克萨斯州的两小块区域开始了有限的无人机送货服务。此后，亚马逊开发了一种名为MK30的新型无人机，计划在2024年底前在美国、英国和意大利投入使用。这些无人机将从亚马逊的配送中心起飞，并且同样使用了"感知回避"系统来执行超视距飞行。它的噪音比亚马逊的现有机型小，最多可携带2.2公斤的包裹，并能在小雨等不稳定的天气条件下飞行。

亚马逊正在谈论在2030年前实现每年用无人机运送数百万个包裹。如果这家在线零售巨头最终能够攻克这项技术，那么自动化配送可能会遍布几乎世界各地。就算做不到这一点，也已经有足够多的公司证明，至少在某些地方，使用轮子、机翼或螺旋桨的各种送货机器人正在向我们走来。■

China's quest to become a robot superpower

As its population shrinks, China hopes machines can pick up the slack

CHINA'S FIRST attempt at building a humanoid robot did not hit the mark. The machine produced in 2000 by a team at the National University of Defence Technology looked like a walking toaster. It had googly eyes and cannon-like protuberances near its crotch. Called Xianxingzhe, or Forerunner, it was mocked in neighbouring Japan, which at the time boasted far sleeker robots. Japanese netizens described it as China's secret weapon—designed to make its enemies die of laughter.

China has stuck with it, though. In November the government published a plan calling for the mass production of humanoids by 2025. The country's love of robots goes beyond those that can walk and talk. Last year half of all the industrial robots installed worldwide were fitted in China, according to the International Federation of Robotics, an industry body. It is now the fifth most automated country in the world when measured by robots per worker. Motivated by pride and pressing demographic challenges, China is on a mission to become a robot superpower.

Many of the country's newly installed robots are mechanical arms that can be programmed to weld, drill or assemble components on a production line. But last year China also produced over 6m "service robots", which help humans with tasks apart from industrial automation. Such machines scoot around warehouses, moving boxes. Others clean hotels. At a restaurant in the southern city of Guangzhou meals are cooked and served by robots.

Some of this may seem gimmicky, but to the Communist Party led by Xi Jinping robots are serious business. Officials believe China fell behind and was humiliated by Western powers in the 19th century in part because it did

not embrace technological revolutions happening elsewhere. Now China aims to stay ahead of the game. Whereas officials once used steel production as a gauge of economic advancement, today they look at the number of robots installed, says Dan Wang of Hang Seng Bank.

China's impressive economic growth in recent decades was a result of three main factors: a soaring urban workforce, a big increase in the capital stock and rising productivity. Today, though, less new infrastructure is needed. And the working-age population, those between 15 and 64, is shrinking. It is projected to drop by over 20% by 2050. Earlier this year the government released a list of 100 occupations for which there is a shortage of labour. Manufacturing-related positions accounted for 41 of them. A surfeit of young and cheap workers once did these jobs; now wages are higher and workers less abundant.

As a result, Mr Xi has made boosting China's productivity a priority. The government sees robots playing a big part in this effort. For years it has pushed industry to go from being labour-intensive to robot-intensive. Provinces have spent billions of dollars helping manufacturers upgrade in this way. China's experience during the pandemic reinforced this mindset. Endless lockdowns caused factories to close and Western firms to reconsider their supply chains. When all of the controls were lifted in 2022, a wave of covid-19 again disrupted businesses as workers fell ill. With robots, health is not a concern.

Many of the challenges faced by factories apply to agriculture, too. The average Chinese farmer is in his or her 50s. Few young people want to take their place in the fields. Countries that face similar predicaments often import either their food or cheap labour. But China is paranoid about food security and uninterested in immigration. Robots could be the answer. Some aspects of agriculture, such as milking cows, can be automated fairly easily. Others are trickier, but appear possible on a small scale. The south-

western city of Chengdu has developed an unmanned vegetable farm which could, in theory, produce ten harvests a year.

In time, robots might replace ageing workers. They might also play a role in caring for them. China has far too few professionals looking after its 8.1m care-home residents. A plan from the National Health Commission, published in 2021, called for developing smart elderly care. Some of it is aspirational, such as providing frail people with electronic exoskeletons to aid their movements. But simpler robots could be used to help old folk bathe or stand up. China's tech giants are looking into the challenge. In 2022 iFlytek, a big artificial-intelligence firm, said it wanted to send robots into the homes of seniors to offer companionship and health management. Residents of a care home in Shanghai are kept happy by a robot that zips around singing revolutionary songs from their youth, according to local media.

What would make the government happy is if China's robotics industry became more self-sufficient. Local firms still rely on foreign companies for parts and know-how. China is fearful of being shut out of Western markets, for good reason. America has blocked Chinese firms from buying advanced semiconductors and the equipment used to make them (robots require chips, but usually not the most advanced kind). So the government has been trying to stimulate robotics research. In August the city of Beijing announced a 10bn-yuan ($1.4bn) fund for robot development.

Such efforts are having some effect. Last year 36% of the industrial robots China installed were made at home, up from 25% in 2013. Shenzhen Inovance Technology, a big Chinese firm, builds robots that are used to make LED lights and mobile phones. It may be able to source all of the components it needs from Chinese companies within five years, says Zhu Xingming, its chairman.

For most Chinese robotics firms, though, self-sufficiency is still some way off. That is part of the reason why the government is pushing the development of humanoids. These may not be very practical or affordable in the near term. But officials hope the process of manufacturing them will create a domestic supply chain.

One thing the government does not have to worry about is much pushback against its plans. Surveys suggest most Chinese people think robots will create more jobs than they destroy. China, it seems, is a land of techno-optimists. It helps, of course, that independent labour unions are banned. ■

中国追求成为机器人超级大国

面对人口萎缩，中国希望机器人能填补空缺

中国打造人形机器人的第一次尝试并不理想。2000年，国防科技大学的一个团队开发了一台机器，看起来就像是会走路的烤面包机。它有圆溜溜的眼睛，胯部附近有炮筒一样的突起。这台名为"先行者"的机器人被当时机器人技术远远领先的邻国日本大加嘲笑。日本网民说它是中国的秘密武器——能让敌人笑死。

但中国坚持了下来。2023年11月，中国政府公布了一项计划，提出要在2025年实现大规模生产人形机器人。中国对机器人的热爱远不限于那些会走路说话的。据行业机构国际机器人联合会（International Federation of Robotics）的数据，2022年中国的工业机器人装机量占到了全球的50%。按平均每名工人配备的机器人数量计算，中国目前是全球自动化程度第五高的国家。受荣誉感的驱动，加上紧迫的人口挑战，中国正在努力成为机器人超级大国。

中国新安装的机器人有许多是经设置程序后可在生产线上焊接、钻孔或组装部件的机械臂。不过2022年中国还制造了600多万台"服务机器人"，辅助人类完成工业自动化以外的任务。这些机器人在仓库内穿行，搬运货箱。还有一些在酒店里打扫卫生。在南方城市广州的一家餐厅里，烹饪和传菜都由机器人完成。

这里面有些可能看起来只是营销噱头，但对习近平领导的共产党来说，机器人是件很严肃的事情。官员们认为，中国在19世纪落后于西方列强并遭受它们欺辱，一定程度上是因为没有接纳发生在其他地方的技术革命。现在，中国要力求在技术上保持领先。在过去，官员们用钢铁产量来衡量经济发展水平，如今他们看重的是机器人装机量，恒生银行的王丹指出。

中国近几十年来令人瞩目的经济增长归功于三大因素：城市劳动力激增，

资本存量大幅增加，以及生产率不断提升。但到了今天，对新基础设施的需求减少了。而15至64岁的劳动年龄人口日渐萎缩，预计到2050年将减少超过20%。2023年初，政府公布了一份清单，列出了"最缺工"的100个职业，其中与制造业相关的就有41个。曾经有大量年轻的廉价劳动力从事这些职业，而现在工资更高了，工人却不再充足。

因此，习已经把提高中国的生产率列为要务。政府认为机器人能在这方面发挥重要作用。多年来，政府一直在推动工业从劳动密集型向机器人密集型转型。多省投入数十亿美元计的资金帮助制造企业做这种升级。新冠疫情期间的经历更是强化了这一思路。无休止的封控导致工厂关闭，让西方企业重新考虑供应链部署。2022年所有管制解除后，一波疫情让员工纷纷病倒，再度打断了公司运作。有了机器人，就不会受制于员工的身体状态了。

工厂面临的许多挑战也是农业面对的难题。中国农民的平均年龄是50多岁。很少有年轻人愿意接手务农。陷于类似困境的国家通常会进口粮食或者引进廉价劳动力。但中国执着于保障粮食安全，也无意引进劳工。机器人可能是个出路。农业的某些工作要实现自动化并不难，比如挤奶，其他工作的自动化虽然比较棘手，但似乎也可以小规模实现。西南部城市成都开发了一个无人蔬菜农场，理论上一年可以收获十茬蔬菜。

假以时日，机器人也许能取代日渐年迈的人力，还可能在照顾他们方面发挥作用。中国入住养老院的老人达810万，而照护他们的专业人员远远还不够。国家卫健委于2021年发布的一项计划呼吁发展智慧养老服务。其中一些设想雄心勃勃，比如为体弱者提供电子外骨骼帮助其行动，但同时也可使用更简单的机器人帮助老人洗澡或站立。中国的科技巨头正迎向这一挑战。2022年，大型人工智能公司科大讯飞表示，希望把机器人送入老人家中，提供陪伴和健康管理服务。据上海媒体报道，在当地一家养老院，一台机器人会一边转悠一边唱老人们年轻时传唱的革命歌曲，把他们逗得很开心。

会让政府开心的是中国的机器人产业能变得更自给自足。本地企业仍依赖

外国公司提供零部件和专门技术。中国有充分理由担心被西方市场拒之门外。美国已禁止中国企业购买先进半导体和用于制造这些半导体的设备（机器人需要芯片，但通常不是最先进的芯片）。因此，中国政府一直努力推动机器人研究。8月，北京市宣布成立一项100亿元的基金用于机器人研发。

这些努力正初见成效。2022年中国安装的工业机器人中有36%是国产的，高于2013年的25%。大型企业深圳汇川技术制造的机器人用于生产LED灯和手机。公司董事长朱兴明表示，他们可能在五年内就能从中国企业采购到所需的全部零部件。

不过对于大多数的中国机器人公司而言，要达到自给自足仍有一段距离。这也是中国政府大力发展人形机器人的原因之一。短期内，这些机器人可能不太实用，价格也太高。但官员们希望在开发这些机器人的过程中能形成一条国内供应链。

政府不必担心其计划会遭到很多反对。调查显示，大多数中国人认为机器人创造的就业机会将多于它们会破坏掉的。由此看来，中国是一个技术乐观主义者的国度。当然了，这也得益于这里禁止成立独立工会。■

A short history of tractors in English

What the tractor and the horse tell you about generative AI

IT WAS THE ChatGPT of its day. "Come and see the tractors", entreated an article in the Prairie Farmer in 1915, advertising a trade show in Illinois showing off the new tech. "It will mark a new epoch in farming—the farmer's liberation from sole dependence on the weary horse." "Tractors are more economical than horses," insisted an agricultural expert in a government report around the same time, "not only making farm work cheaper but easier." The tech clearly impressed people, but it also scared them. One American observer, watching a tractor in England, said it "walked over the earth like some huge animal, puffing and snorting". Tractors promised a revolution in American agriculture, an industry which in 1900 employed about a third of workers and produced about 15% of GDP.

Today many people expect another revolution, linked to developments in generative artificial intelligence (AI). Like then, the general public today view the technology with a mixture of awe and fear. Goldman Sachs, a bank, reckons generative AI could raise annual global GDP by 7% over ten years. Some economists now talk about "explosive growth". Others say that before long, jobs will be eliminated in their millions. Yet the economic history of the tractor casts doubt over these predictions. Over the sweep of history the tractor has indeed had an immense impact on people's lives. But it conquered the world with a whimper, not a bang.

Historians disagree about who invented the tractor. Some say it was Richard Trevithick, a British engineer, in 1812. Others credit John Froelich, working in South Dakota in the early 1890s. Still more point out that the word "tractor" was little used until the start of the 20th century; and that only then did people start seriously talking about the average farmer buying

one. At the time horses and mules pulled around an impressive array of farm implements, from ploughs to reapers.

The horses faced up to a bigger, more powerful beast. You can put yourself in the shoes of an early 20th-century horse by visiting Gene Jones's tractor museum in Millbrook, a small city in rural Alabama, which contains dozens of machines, including Farmalls and Fords, from the 20th century. The tractors are beautiful—and not just because Mr Jones has lovingly restored them, painting them in a variety of rich auburn-reds. They are also intimidating. Some weigh thousands of pounds. Others have cranks to start the engine which can break your arm if you don't know what you're doing.

With hindsight, it is clear that the tractor had profound impacts. It meant that a given quantity of farmland could feed more people. Tractor-owning farmers no longer needed to pasture horses, each of which required about three acres of cropland for feed each year. More intensive farming also had downsides. Some researchers have argued that tractors helped bring about the Dust Bowl of the 1930s. Their powerful ploughing techniques damaged the topsoil that had once prevented wind erosion.

The economic impact eventually became clear, too. The greater efficiency afforded by tractors allowed farmers to expand their operations, as they could manage more land with the same number of workers. Farms began to grow in size, with smaller family farms giving way to larger, mechanised operations. According to one estimate, by 1960 the average American farm was 58 acres (equivalent to the land occupied by ten big Walmarts today) larger than it would have been without tractors. The tractor also reduced the number of workers needed to produce food by about 2m, or 25% of farm employment in 1960. All these improvements added up. In a paper published in 2012 Richard Steckel and William White, two economists, argue that by the mid-1950s farm mechanisation had raised American GDP by about 8%.

And yet for much of the first half of the 20th century, tractor-induced changes did not feel very profound. This is because the tractor diffused across the American economy slower than one of Mr Jones's old Fords trying to cross a waterlogged field. In 1920, despite rave reviews in the Prairie Farmer, just 4% of American farms had a tractor (see chart). Even by 1940 only 23% had them. In the 1910s opportunistic businessmen had piled into the tractor-making business, hoping to make a quick buck (just as every second tech firm in Silicon Valley now describes itself as "AI-first"). Many had no customers and were forced to close.

The horse endured for a surprisingly long time. For much of the 1930s the total productive capacity of equine animals—quite literally, horsepower—across American farms still exceeded that of tractors. In 1945 a quarter of farms reported both draft animals and tractors. The slow diffusion of the tractor produced slow productivity gains. The data are spotty, but in the first half of the 20th century annual productivity growth in agriculture probably never exceeded 3%. That 8% GDP effect is real, but it made itself felt only over decades. Explosive growth? Hardly.

The tractor's plodding progress is one of the big puzzles of economic history. If they were so good, why did farmers not buy them more quickly? They were not Luddites who resisted new technologies on principle. True, anti-tractor lobby groups, such as the Horse Association of America, warned that buying one would land the farmer in unmanageable debt. But in the 1910s and 1920s many tractorless farmers did own cars, suggesting that they were willing to try new tech. In 1917 Power Farming, a journal, published letters from 15 farmers who used tractors. They were probably solicited, but these letters urged others to follow suit.

Three reasons explain why the triumph of the tractor took so long. First, early versions of the technology were less useful than people had originally believed, and needed to be improved. Second, adoption required changes

in labour markets, which took time. And third, farms needed to transform themselves.

Take capabilities first. The early tractors of the 1900s were behemoths. They were useful for ploughing, and a few other things, but not for cultivating fields of growing crops. Many early models had metal wheels, not tyres, so they got stuck in the mud. They were also costly. Between 1910 and 1940, however, the machines became both more versatile and smaller, making them suited to a wider range of tasks.

In 1927 John Deere released a power lift for its models. This meant that a farmer could pull a lever to raise an implement (such as a plough), rather than doing it manually. Rubber tyres came along in about 1933. For a long time the general-purpose tractor could not mechanise corn and cotton harvests, one reason why the area in which Mr Jones lives was one of the slowest to adopt tractors. But by the 1920s America had the corn-picker, followed by the mechanical cotton-picker after the second world war. By the end of the fighting, tractor prices had also fallen from their level in 1910, after adjusting for inflation, by about half.

Wages were the second factor. Horse technology was labour-intensive: horses require feeding, cleaning and medical care, even when they are not working. In the early 1930s, during the Depression, average real wages in agriculture fell. So for many farmers it became easier to hire someone to manage a horse—you could always fire them—than it was to splurge on a tractor. But by the second world war, labour shortages mounted, leading real wages to rise quickly. Suddenly, machines seemed like a better deal.

The third factor was corporate restructuring. Tractors worked best on big farms, where the farmer could spread out the expense of a huge upfront investment. As a result, enlarging the size of their holdings and buying a tractor were two sides of the same coin. In a survey in Illinois in 1916, for

instance, farmers who used tractors profitably also talked about increasing their acreage. But growing a farm takes time. A farmer looking to expand had to gather the necessary capital, and then negotiate the purchase with the owners.

The history of the tractor hints at how quickly generative AI may take over. At present most AI models still have metal wheels, not rubber tyres: they are insufficiently fast, powerful or reliable to be used in commercial settings. Over the past two years real wages have hardly grown as inflation has jumped, limiting companies' incentives to find alternatives to labour. And companies have not yet embraced the full-scale reorganisation of their businesses, and in-house data, necessary to make the most of AI models. No matter how good a new technology may be, society needs a long, long time to adjust. ■

英语拖拉机简史

从拖拉机和马的对峙看生成式人工智能来袭

它就是当年的ChatGPT。"来看看拖拉机吧！"1915年，《草原农场主》（Prairie Farmer）杂志上的一篇文章恳请道，它在为伊利诺伊州展示这项新技术的展销会做广告。"这将标志着农业的新纪元，让农场主从只能依靠疲倦的马匹中解放。""拖拉机比马更经济，"一位农业专家在大约同一时间发布的一份政府报告中坚称，"它不仅让农业劳作的成本更低，也让农活更轻松。"这项技术显然让人们惊叹不已，但也让他们害怕。一位美国观察家在英国观摩拖拉机作业时说，它"喷着响鼻，像一头巨兽般在大地上横行"。拖拉机预示着美国农业的一场革命，该行业在1900年雇用了约三分之一的劳动力，创造了约15%的GDP。

如今，许多人预期另一场革命到来，这次是与生成式AI的发展相关。和当年一样，今天的公众对这项技术又敬又怕。高盛认为，生成式AI可能在十年内将全球年GDP提高7%。一些经济学家正大谈"爆炸性增长"。其他人则表示，用不了多久，千百万工作岗位将被淘汰。然而拖拉机的经济史让人对这些预测心生怀疑。纵观历史长河，拖拉机确实对人们的生活产生了巨大的影响。但它是悄无声息地征服了世界，而非轰轰烈烈地席卷而来。

历史学家对于谁发明了拖拉机存在分歧。有人说是英国工程师理查德·特里维希克（Richard Trevithick）在1812年发明的。另一些人认为是1890年代初在南达科他州工作的约翰·弗罗利希（John Froelich）。还有更多人指出，在20世纪初之前很少能看到"拖拉机"这个词。要等到进入20世纪后人们才开始认真讨论普通农场主购买拖拉机的事宜。那会儿，从犁到收割机等各种令人眼花缭乱的农具都是由马和骡子来拉动的。

马儿们遭遇了一种更高大威猛的巨兽。参观一下吉恩·琼斯（Gene Jones）位于阿拉巴马州乡村小城米尔布鲁克（Millbrook）的拖拉机博物馆，你就能体会到20世纪早期马儿们的感受了。这家博物馆内收藏了数十

台拖拉机，其中包括20世纪的Farmall系列和福特（Ford）拖拉机。它们都很漂亮，这一部分要归功于琼斯对它们的精心修复，还给它们刷上了深浅各异的赤褐色。它们也很吓人，有些重达数千磅，还有一些需要用摇动曲柄来启动发动机——要是你不知道怎么操作，可能会弄折了自己的胳膊。

事后看来，拖拉机显然产生了深远的影响。有了它，同样面积的农田就可以养活更多的人。有了拖拉机，农场主不再需要牧马，而饲养每匹马每年需要大约三英亩的耕地来种植草料。更集约化的农业也有其弊端。一些研究人员认为，拖拉机的应用是20世纪30年代沙尘碗（Dust Bowl）灾害事件发生的原因之一。它们强大的犁耕技术破坏了以往防止风蚀的表层土壤。

拖拉机的经济影响最终也变得清晰起来。拖拉机效率更高，让农场主能够用相同数量的雇工管理更多的土地，从而可以扩大经营。农场规模开始扩大，较小的家庭农场被规模更大的机械化农场取代。据一项估计，到1960年，美国农场的平均面积要比假如没有拖拉机的情况下大58英亩（相当于今天十家大型沃尔玛的占地）。拖拉机还让生产食物所需的工人减少了约200万，相当于1960年农场就业人数的25%。所有这些进步累积起来产生了巨大影响。在2012年发表的一篇论文中，经济学家理查德·斯特克尔（Richard Steckel）和威廉·怀特（William White）认为，到20世纪50年代中期，农业机械化让美国GDP提高了约8%。

然而，在20世纪上半叶的大部分时间里，拖拉机引发的变化并没有让人感觉非常深刻。这是因为拖拉机在美国经济中的普及速度比琼斯的老旧福特拖拉机穿越积水田地的速度还要慢。1920年，尽管《草原农场主》大加好评，仍只有4%的美国农场有拖拉机（见图表）。即使到了1940年也只有23%的农场有。在1910年代，投机商人纷纷涌入拖拉机制造业，希望能赚笔快钱（就像在如今的硅谷，每两家科技公司就有一家自称"以AI为先"）。许多厂家无人光顾，只能关门收场。

马儿坚持的时间之久出人意料。在20世纪30年代的大部分时间里，美国农

场上马类役畜的总生产力（可谓真正的"马力"）仍然大于拖拉机。1945年，四分之一的农场同时拥有役畜和拖拉机。拖拉机普及缓慢，导致生产率的提高同样缓慢。虽然缺乏完整数据，但可以知道在20世纪上半叶，农业生产力的年增长率可能从未高过3%。推动GDP提高8%的作用确实有，但要历经好几十年才感受得到。至于说推动爆发式增长？几乎没有。

拖拉机缓慢的普及速度是经济史上的一大谜题。如果拖拉机这么好，为什么农场主不赶紧买呢？他们并不是从原则上抵制新技术的卢德派。确实，美国马协会（Horse Association of America）等反拖拉机游说团体曾警告说，购买一辆拖拉机将使农场主陷入难以负担的债务。但在1910年代和1920年代，许多没有拖拉机的农场主却拥有汽车，表明他们是愿意尝试新技术的。1917年，《机械农业》（Power Farming）期刊发表了15位使用拖拉机的农场主的来信。虽说这些来信可能是应邀写的，但起到了敦促他人效仿的作用。

三个原因解释了为什么拖拉机的胜利花了这么长时间。首先，早期的拖拉机并没有人们最初以为的那么有用，它需要改进。其次，采用拖拉机需要改变劳动力市场，而这需要时间。第三，农场本身也需要改造。

先说说拖拉机的性能。1900年代的早期拖拉机都是些庞然大物。它们可用于开垦荒地和其他一些作业，但不适用于耕作已种植作物的田地。许多早期的机型都使用金属轮子，而不是轮胎，所以会陷在泥里。而且它们价格高昂。然而在1910年至1940年间，拖拉机变得功能更多样，体积也更小，能适用于更广泛的任务。

1927年，约翰·迪尔（John Deere）为其拖拉机设计了一个动力升降装置。这样农场主就可以拉动操作杆来拉起农具（例如犁），而无需手动操作。橡胶轮胎在1933年前后出现在拖拉机上。在很长一段时间里，通用拖拉机无法实现玉米和棉花收割的机械化，这便是琼斯居住的地区是采用拖拉机最慢的地区之一的一个原因。但到了20年代，美国有了玉米采摘机，第二次世界大战后又出现了机械采棉机。到战争结束时，拖拉机经通胀调整后的价格也比1910年的水平下降了约一半。

工资是第二个因素。用马从事农业生产要耗费很多劳动——马需要喂养、清洁和医护，即便是在它们不工作时。1930年代初经济大萧条期间，农业平均实际工资下降。因此，对于许多农场主来说，雇人管理马匹比花大钱买拖拉机更容易，雇工还可以随时解雇。但到了第二次世界大战时，劳动力变得日渐短缺，导致实际工资迅速上涨。突然间，用机器似乎更划算了。

第三个因素是农场重组。拖拉机在大型农场中效果最好，因为农场主可以摊薄巨额前期投资。因此，扩大农场规模和购买拖拉机变成了事情的一体两面。例如，在1916年伊利诺伊州的一项调查中，使用拖拉机获利的农场主也谈到了要增加农场面积。但扩大农场需要时间。想要扩大规模的农场主必须筹集所需的资金，接着还要与土地所有者协商购买事宜。

拖拉机的历史透露出生成式AI可能会以怎样的速度占据主导。目前，大多数AI模型采用的仍旧是"金属轮子"，而不是"橡胶轮胎"，它们的速度、动力或可靠性都还不足以应用于商业环境中。过去两年，随着通胀飙升，实际工资几乎没有增长，限制了企业寻找劳动力替代选择的积极性。而且企业尚未开启全面重组业务和内部数据，而这是充分利用AI模型所必需的。无论一项新技术可能有多么好，社会都需要很长很长的时间来调整适应。 ■

Is the age of Milton Friedman over?

Some may say so. But we are still living in it

Milton Friedman. By Jennifer Burns. Farrar, Straus and Giroux; 592 pages; $35

IT IS VOGUISH to declare the ideas of Milton Friedman dead, whether you think they deserve damnation or eulogy. In America, prominent Democrats spit out his name contemptuously. The most influential American economist of the 20th century is routinely disparaged as a heartless fetishist of Ayn Randian capitalism, who evangelised corporate greed at home and authoritarianism abroad. Friedman is a special bugbear of President Joe Biden. While running for office in 2020, he declared that "Milton Friedman isn't running the show anymore."

Meanwhile, the current, populist standard-bearers of American conservatism—the political movement with which Friedman was identified throughout his life—agree, having turned their backs on fiscal discipline and open markets.

It might be tempting to buy into the thesis that Friedman's ideas are passé and even to wish them good riddance. But that would be a mistake. Few thinkers are as important (and as grotesquely caricatured) as Friedman. His critiques of Keynesianism, his advocacy of the importance of central banks, his emphasis on the primacy of the monetary supply in explaining inflation and his prioritisation of real interest rates over nominal ones were once unorthodox. They are now mainstream.

A recent biography by Jennifer Burns, a professor at Stanford University, dispels fallacies. Because of Friedman's long life (he was born in 1912 and

died in 2006) and prolific career involving the modern era's most important economic debates, Ms Burns's book functions as an intellectual guide to the entire 20th century, benefiting from nearly a decade of archival research.

The Friedman who emerges here is one of astonishing economic brilliance, establishing monetary policy as a field worthy of serious study. It is a portrait of a surprisingly heterodox economist, who was perhaps the last great political economist and thought deeply about the connection between political and economic freedom.

Friedman is best known for revolutionary ideas on the importance of money to the macroeconomy, which is now seen as blindingly obvious but once was not. With Anna Schwartz—his greatest intellectual partner other than his wife, Rose Director Friedman—he wrote "A Monetary History of the United States" (1963), which computed aggregate monetary supply to argue that the Federal Reserve had contributed to the Great Depression.

Ben Bernanke, the man who would lead the Fed through the global financial crisis of 2007-09, gave cheeky tribute to this argument in a speech at a gathering celebrating Friedman's 90th birthday: "Regarding the Great Depression, you're right, we did it. We're very sorry. But thanks to you, we won't do it again."

By the 1980s Friedman was catapulted to global renown, claiming a Nobel prize, a column in Newsweek and even a popular TV series. He was a perpetual gadfly at the Fed. Were he alive today, he would probably jab at Jerome Powell for thinking that dramatic growth in the monetary supply would not manifest in higher inflation. (During his life, he sported a vanity licence plate with the formula of his quantity theory of money, MV=PY; the equals sign was drawn with the help of black tape, which resulted in several traffic tickets.)

He became a bogeyman of the left for a six-day trip to Chile to advise Augusto Pinochet, its dictator, though Ms Burns argues that while he "failed to the appreciate the optics", that "in truth, he played almost no role in policy design". Other trips, to China and to countries east of the Iron Curtain, did not provoke so much conspiracism, outrage or damage to his reputation.

Although Ms Burns admires Friedman, her book is not a hagiography. She argues that his concept of freedom, the nominal core of his political philosophy, could be "woefully thin". Friedman was vocally opposed to the Civil Rights Act of 1964, which outlawed racial discrimination, and "never revisited his position on civil rights", she writes with disappointment.

Much as the three Abrahamic religions lay claim to one saviour, conservatives, libertarians and classical liberals all claim Friedman. But he defies easy categorisation. Unlike some libertarians, Friedman accepted the legitimacy of the state (though he fought against it and advocated eliminating some government departments). Unlike many conservatives, he deemed redistribution acceptable to alleviate poverty. Indeed, Friedman envisioned the school-voucher and health-care programmes still in effect in America, as well as the tax policies that top up working class wages—perhaps the country's most important anti-poverty programme.

Despite consulting for Barry Goldwater, Ronald Reagan and Margaret Thatcher, Friedman considered himself a classical liberal. "Those of us who believe in liberalism...have a new faith to offer; it behoves us to make it clear to one and all what the faith is", he wrote in 1951. He was critical of overly doctrinaire, laissez-faire philosophy that "assigned almost no role to the state other than the maintenance of order and the enforcement of contracts".

Ms Burns insists on dubbing Friedman "the last conservative" because "the

synthesis Friedman represented—based in free-market economics, individual liberty and global co-operation—has cracked apart" in politics. Friedman may no longer be running the show, but he is still one of economics' most influential acts. ■

经济史

弗里德曼的时代终结了吗？

也许有人这么认为。但我们仍生活在他的时代【《弗里德曼传》书评】

《弗里德曼传》，詹妮弗·伯恩斯著。Farrar, Straus and Giroux出版社，592页；35英镑。

无论你认为对米尔顿·弗里德曼（Milton Friedman）的思想是应该诅咒还是讴歌，宣称弗里德曼思想已死都很时髦。在美国，民主党要员提起他的名字时都语带轻蔑。这位20世纪最具影响力的美国经济学家经常被贬斥为安·兰德式资本主义的冷血信徒，在国内宣扬企业贪婪，在国外宣扬威权主义。弗里德曼是美国总统拜登的心头之患。在2020年竞选总统时，他宣称"米尔顿·弗里德曼已经不再是主角了"。

与此同时，美国保守主义（弗里德曼终其一生被视为这一政治运动的一员）当前的民粹主义旗手们也持相同的观点，他们已经背弃了财政纪律和开放市场。

也许人们会很容易听信弗里德曼的思想已经过时的观点，甚至庆幸终于从中解脱了。但这会是个错误。很少有思想家像弗里德曼一样重要（也很少像他那样被如此荒诞地歪曲丑化）。他批判凯恩斯主义、倡导央行的重要性、强调货币供应在解释通胀中的首要作用，以及优先考虑实际利率而非名义利率，这些观点一度都是非正统的。现在，它们已经成了主流。

斯坦福大学教授詹妮弗·伯恩斯（Jennifer Burns）最近出版的一本传记驳斥了种种谬误。由于弗里德曼的长寿（生于1912年，卒于2006年），以及学术生涯成果丰硕且参与了现代最重要的经济辩论，伯恩斯花了近十年研究档案文献写就的这本书可以充当整个20世纪的知识指南。

书中呈现的弗里德曼具有惊人的经济学才华，是他将货币政策确立为一个值得认真研究的领域。这本书描绘了一位有惊人非正统思想的经济学家，

也许是最后一位伟大的政治经济学家，对政治自由和经济自由之间的关联有深刻的思考。

弗里德曼最为人熟知的是关于货币对宏观经济的重要性的开创性思想，这一点在当今显而易见，但在当时却不然。他和除了妻子罗斯·戴瑞克特·弗里德曼（Rose Director Friedman）之外最重要的智力伙伴安娜·施瓦茨（Anna Schwartz）共同撰写了《美国货币史》（A Monetary History of the United States，1963年出版），通过计算货币供应总量来证明美联储对大萧条负有责任。

在庆祝弗里德曼90岁生日的聚会上，后来领导美联储渡过2007至2009年全球金融危机的本·伯南克（Ben Bernanke）在发言时顽皮地致敬了他的观点："说到大萧条，你说得对，是我们干的。我们非常抱歉。但多亏了你，下次不会再犯了。"

到了1980年代，弗里德曼在全球名声鹊起，获得了诺贝尔奖，为《新闻周刊》撰写专栏，甚至还制作了一部热门电视系列片。他永远都在给美联储挑刺。如果他今天仍然在世，恐怕也会抨击鲍威尔认为大幅增加货币供应不会导致通胀上升的想法。（他一生都骄傲地挂着一张自选车牌，车牌号就是他的货币数量论公式MV=PY，等号是用黑胶带贴出来的，还因此吃了几张交通罚单。）

他曾访问智利六天，为独裁者奥古斯托·皮诺切特（Augusto Pinochet）出谋划策，因而被左派视为妖魔。不过伯恩斯认为，尽管他"没有意识到这么做给外界的观感"，但"事实上，他在政策设计中几乎没有发挥任何作用"。他的其他出访，例如前往中国和铁幕以东的其他国家，并没有引起如此多的阴谋论、愤怒或对他声誉的贬损。

虽然伯恩斯钦佩弗里德曼，但她的书并不是一本歌功颂德之作。她认为，作为他政治哲学名义上的核心，弗里德曼的自由观可能"薄弱得可怜"。他曾公开反对1964年禁止种族歧视的《民权法案》，而且"从未重新审视过自己在民权问题上的立场"，她失望地写道。

正如三大亚伯拉罕宗教都宣称救世主在自己这边一样，保守主义者、自由意志主义者和古典自由主义者都将弗里德曼归入自己的阵营。但要给他归类并不容易。与一些自由意志主义者不同，弗里德曼接受国家的合法性（尽管他也与国家抗争并主张取消一些政府部门）。与许多保守主义者不同，他认为可以接受通过再分配来减轻贫困。事实上，弗里德曼设想的教育券和医疗保健计划仍然在美国实施，还有补贴工人阶级工资的税收政策——这也许是美国最重要的脱贫措施。

尽管曾为巴里·戈德华特（Barry Goldwater）、里根和撒切尔做过顾问，弗里德曼仍将自己视为一名古典自由主义者。他在1951年写道："我们这些信奉自由主义的人……有一种新的信仰要奉上；我们有责任向每个人阐明这种信仰是什么。"他批评过于教条的自由放任主义哲学，认为它"除了维持秩序和执行契约之外，几乎没有赋予国家任何作用"。

伯恩斯坚持将弗里德曼称为"最后的保守派"，因为"弗里德曼所代表的以自由市场经济、个人自由和全球合作为基础的综合理念在政治上已经分崩离析"。弗里德曼也许不再是主角，但他仍然是经济学舞台上最有影响力的角色之一。■

Economists had a dreadful 2023

Mistaken recession calls were just part of it

SPARE A THOUGHT for economists. Last Christmas they were an unusually pessimistic lot: the growth they expected in America over the next calendar year was the fourth-lowest in 55 years of fourth-quarter surveys. Many expected recession; The Economist added to the prognostications of doom and gloom. This year economists must swap figgy pudding for humble pie, because America has probably grown by an above-trend 3%—about the same as in boomy 2005. Adding to the impression of befuddlement, most analysts were caught out on December 13th by a doveish turn by the Federal Reserve, which sent them scrambling to rewrite their outlooks for the new year.

It is not just forecasters who have had a bad year. Economists who deal in sober empirical work have also had their conclusions challenged. Consider research on inequality. Perhaps the most famous economic studies of the past 20 years have been those by Thomas Piketty and his co-authors, who have found a rising gap between rich and poor. But in November a paper finding that after taxes and transfers American incomes are barely less equal than in the 1960s was accepted for publication by one of the discipline's top journals. Now Mr Piketty's faction is on the defensive, accusing its critics of "inequality denial".

Economists have long agreed that America would be richer if it allowed more homes to be built around popular cities. There is lots of evidence to that effect. But the best-known estimate of the costs of restricting construction has been called into question. Chang-Tai Hsieh of the University of Chicago and Enrico Moretti of the University of California, Berkeley, found that easing building rules in New York, San Francisco and

San Jose would have boosted American GDP in 2009 by 3.7%. Now Brian Greaney of the University of Washington claims that after correcting for mistakes the true estimated effect is just 0.02%. If builders disagreed as wildly about roof measurements, the house would collapse.

Think social mobility in America is lower than it was in the freewheeling 19th century, when young men could go West? Think again, according to research by Zachary Ward of Baylor University. He has updated estimates of intergenerational mobility between 1850 and 1940 to account for the fact that past studies tended to look only at white people, as well as correcting other measurement errors. It now looks as if there is more equality of opportunity today than in the past (albeit only because the past was worse than was thought).

A rise in suicides, overdoses and liver disease has reduced life expectancy for white Americans. Angus Deaton and Anne Case of Princeton University popularised the idea that these are "deaths of despair", rooted in grimmer life prospects for those without college degrees. But economists have been losing faith in the idea that overdoses, which are probably the biggest killer of Americans aged 18-49, have much to do with changes in the labour market. New research has instead blamed the carnage on simple proximity to smuggled fentanyl, a powerful opioid.

Other findings are also looking shaky. The long decline in the prestige of the once-faddish field of behavioural economics, which studies irrationality, continued in 2023. In June Harvard Business School said it believed, after an investigation, that some of the results in four papers co-written by Francesca Gino, a behavioural scientist and PhD economist, were "invalid", owing to "alterations of the data". (Ms Gino, who has written a book about why it pays to break rules, is suing for defamation the university and the bloggers who exposed the alleged fiddling.)

What lessons should be drawn from economists' tumultuous year? One is that for all their intellectual discipline they are still human. Replicating existing studies and checking them for errors is crucial work.

Another lesson is that disdain for economic theory in favour of the supposed realism of empirical studies may have gone too far. After the global financial crisis of 2007-09, commentators heaped opprobrium on theorists' common assumption that people make rational predictions about the world; gibes about an unrealistic, utility-maximising Homo economicus helped raise the status of behavioural economics. Yet rational-expectations models allow for the possibility that inflation can fall rapidly without a recession—exactly the scenario that caught out forecasters in 2023.

A last lesson is that economists should cheer up. The research that has been called into question this year inspired much pessimism about the state of modern capitalism. But a dodged recession, flatter inequality trends and less despair would all be good news. Perhaps the dismal science should be a little less so. ■

经济学家经历了一个糟糕的2023年

对衰退的错误预测只是糟心事之一

体谅下经济学家的处境吧。2022年圣诞节时，这个群体异常悲观：他们对2023年美国增长的预计是55年来第四季度调查中的第四低。许多人预期会出现衰退；本刊也奉上了一些惨淡预测。到了2023年的圣诞节，经济学家们只能把圣诞布丁换成一盘尴尬的苦果，因为2023年美国的增长可能达到了3%，高于长期平均水平，大约与2005年的繁荣时期相当。再加上大多数分析师在12月13日被美联储的鸽派转向打了个措手不及，纷纷匆忙地改写自己对新一年的展望，更让人觉得这群人已经茫然无措。

不仅仅是做预测的人经历了糟糕的一年。从事严谨实证工作的经济学家们的结论也受到了挑战。看看关于不平等的研究。过去20年里最著名的经济学研究或许是由托马斯·皮凯蒂及其合著者所做的研究，他们发现富人与穷人之间的差距在扩大。但去年11月，一篇论文发现，经过税收和转移支付之后，美国的收入差距几乎与1960年代相当，该论文被一家顶级经济学期刊接受待发表。现在皮凯蒂一派摆出防御姿态，指责其批评者"否认不平等"。

经济学家长期以来一致认为，如果美国允许在热门城市的周围建造更多住房，美国会更加富裕。有很多证据支持这一点。但关于限制建筑的代价的最知名估计受到了质疑。芝加哥大学的谢长泰和加州大学伯克利分校的恩里科·莫雷蒂（Enrico Moretti）曾认为，放宽纽约、旧金山和圣何塞的建筑限制将会使2009年的美国GDP增长3.7%。现在，华盛顿大学的布赖恩·格里尼（Brian Greaney）声称，在纠正错误后，真实的影响估计仅为0.02%。如果建筑商们在屋顶测量上有这么大的分歧，那房子就得塌了。

你觉得美国的社会流动性低于自由奔放的19世纪（那时年轻人可以到西部去）？那你得再想想了——贝勒大学（Baylor University）的扎卡里·沃德（Zachary Ward）指出。他的研究更新了对1850年到1940年间代际流动性

的估计，考虑了过去的研究往往只关注白人这一问题，同时纠正了其他测量错误。现在看起来，如今的机会平等性要好于过去（尽管这只是因为过去比人们原本以为的更糟糕）。

自杀、药物过量和肝病的增加降低了美国白人的预期寿命。普林斯顿大学的安格斯·迪顿（Angus Deaton）和安妮·凯斯（Anne Case）在过去普及了一种观点：这些都属于"绝望之死"，其根源在于那些没有大学学位的人面对更加晦暗的生活前景。但经济学家开始不大相信药物过量——可能是18至49岁美国人的第一大杀手——与劳动力市场的变化有很大关系。新的研究将这类大量死亡归咎于仅仅是很容易到手的走私芬太尼，一种强效阿片类药物。

其他发现如今看起来也不大站得住脚了。研究非理性行为的行为经济学曾经风靡一时，之后声望持续下降，在2023年延续了这种趋势。哈佛商学院在6月表示，经调查认为，在行为科学家、经济学博士弗朗西斯卡·吉诺（Francesca Gino）与他人共同撰写的四篇论文中，部分结果由于"篡改数据"而"无效"。（曾著书解释为何违反规则有好处的吉诺正在控告哈佛以及曝光她涉嫌造假的博文作者诽谤。）

从经济学家动荡纷乱的一年里，应该吸取什么教训？有一点是，尽管经济学家富有智识自律，但他们终究是人。重复已有研究并检查其中的错误是至关重要的工作。

另一个教训是，蔑视经济理论、偏爱实证研究所谓的求真务实可能走过了头。在2007至2009年的全球金融危机之后，评论员对理论家认为人们会对世界做出理性预测的普遍假设大加指责；对不现实的、追求效用最大化的"理性经济人"的嘲弄帮助提升了行为经济学的地位。然而在理性预期模型中，通胀是有可能迅速下降却不引发衰退的——正是这种情景在2023年打了预测者的脸。

最后一个教训是经济学家应该振作起来。过去这一年受到质疑的这些研究激发了对现代资本主义状态的许多悲观情绪。而躲过了衰退、不平等趋势

走平，以及人们没那么绝望都应该是好消息。也许这门郁闷的科学应该变得稍微不那么郁闷些了。■

Where does the modern state come from?

Economists attempt to answer a profound political question

IT IS PART metaphor, part myth and part history. Thomas Hobbes thought life there was nasty, brutish and short. John Locke disagreed, proclaiming that it was where people first learnt how to own things. Jean-Jacques Rousseau described it as the place where people were born free, before they became ensnared in chains. Robert Nozick thought that people were so desperate to escape it, there was an inevitable result: the creation of a state.

Ideas about the "state of nature"—how people lived before politics organised itself into governments—have held the attention of philosophers for centuries. Discovering whether it played out as imagined was nigh-on impossible. And yet thinking about what people would do without a government helped answer profound questions. What are the limits of political power? Is the modern state something that citizens would freely choose?

Now, after all this theorising, three economists think they have some empirical answers. According to Robert Allen of New York University, Abu Dhabi, Leander Heldring of Northwestern University and Mattia Bertazzini of the University of Nottingham, the key to understanding the emergence of modern politics is not a metaphor, but the constantly shifting courses of ancient rivers in Iraq. The first states, they argue in a paper published in the American Economic Review, were glued together not as shelters from violence, as Hobbes believed, but by economics.

The banks of the Tigris and the Euphrates, Iraq's two longest rivers, are home to some of the world's oldest settlements. Mesopotamia, which 5,000 years ago refined the first known system of writing, earned the area the

reputation of "the cradle of civilisation". The paths of these rivers shift, as floods and droughts cause their beds to flood. When a shift came, some ancient farmers were left without water for their crops.

Mr Allen and his co-authors investigate whether the timing of changes to a river's course had anything to do with when the number and size of settlements grew. They do so by looking at the effect of the first recorded shift in 2,850BC. This presented farmers with something close to the choice imagined by philosophers when theorising about the state of nature. Those left behind by the river could revert to nomadism. Or they could band together to build irrigation systems to ferry water from distant rivers.

A philosophical question is therefore transformed into something akin to a laboratory experiment, only one set thousands of years ago and extending hundreds of miles across. Moreover, the results of the experiment are clear. A 5km-by-5km square in the basin left behind by a river was 14% more likely to have a settlement, marked by a public building such as a temple or marketplace, 150 years after the shift than in the 50 years before it. Each square was 12% more likely to have a built canal, a form of artificial irrigation that made farming far from rivers possible. Five new cities were created, and only three abandoned. Esnunna, one city along a new tributary of the river, became much bigger.

This, Mr Allen and his co-authors say, is evidence that that the fist states were formed by farmers co-operating for economic reasons. A canal network would have been too large a cost for any to bear alone. But by spreading the cost, the construction was worth it for each. Such decisions were momentous. They represent some of the earliest examples of governments providing infrastructure in return for taxes, and thus the genesis of the earliest states.

The authors then divide centuries of thinking on the origins of states into

two camps. The first, which they say ranges from Daron Acemoglu, an influential economist at the Massachusetts Institute of Technology, to Karl Marx, supposes that states ultimately emerge from a process of social bargaining. The rich and high-status seize power for personal gain, and periodically dole out services, such as a road, school or police force, in order to keep populations on board. But if this had been the case in Mesopotamia then it would have been in the areas that a river shifted towards that settlements would have formed. After all, they developed richer and more fertile farmland, yielding a bigger tax take.

That Mesopotamian farmers seem to have chosen to band together as the river shifted away lends support to the second camp. Philosophers in this group, who include Locke and Rousseau, contend that governments emerged when people chose to co-ordinate themselves, swapping their freedom to do whatever they wanted for a state that mediates disputes and provides a degree of safety. Mr Allen and his co-authors analyse only Mesopotamian Iraq, but they argue that their results ought to apply more generally to other fledgling states. Governments, in other words, are chosen rather than foisted upon their citizens.

Meandering path

This is quite the landgrab by economists, seizing terrain that is more commonly occupied by political theorists. The study is not flawless. Perhaps an unknown conquest explains the spread of settlements in the period under consideration. Maybe the authors are wrong and the pattern does not hold elsewhere. There were already six cities and many more settlements in the Mesopotamian Valley before its rivers really began to move, and some had existed for a thousand years. The authors insist that they are only interested in how new governments form, but there is a chance they have in fact captured older ones spreading.

The paper is nevertheless bold and valuable. Philosophers have sought for

centuries to explain why states emerge. Too little time has been spent considering whether economic factors might have been at play. Although transforming the state of nature into a specific time and place means losing some of its complexity, doing so opens the door to the sort of experiment that could only have been imagined by earlier philosophers. If Hobbes or Locke could have studied something approximating the state of nature about which they were theorising, they surely would have tried. ■

现代国家从何而来？

经济学家试图回答一个深奥的政治问题

那种状态一部分是隐喻，一部分是神话，一部分是历史。托马斯·霍布斯认为那种状态下的生活恶劣、野蛮而又短暂。约翰·洛克不认同，他宣称正是在那种状态中人们第一次学会了拥有财产。让-雅克·卢梭称那种状态下的人们生而自由，直至被锁链束缚。罗伯特·诺齐克认为，人们如此迫切地想要逃离那种状态，而导致了不可避免的结果：国家被创造了出来。

几个世纪来，有关"自然状态"（state of nature）——也就是政治活动组织成政府之前人们的生活状态——究竟是怎么回事一直吸引了哲学家的关注。要想查明其状貌是否如人们想象的那样几乎是不可能的。然而，思考"假如没有政府，人们的生活会是什么样"有助于回答一些深刻的问题。政治权力的局限性在哪里？现代国家是公民会自愿选择的东西吗？

如今，三位经济学家经过如此种种理论分析，认为他们得出了一些实证答案。纽约大学阿布扎比分校的罗伯特·艾伦（Robert Allen）、西北大学的利安德·赫尔德林（Leander Heldring）和诺丁汉大学的马蒂亚·贝尔塔齐尼（Mattia Bertazzini）认为，理解现代政治何以出现的关键不是什么隐喻，而是伊拉克古代河流不断变化的河道。他们在《美国经济评论》（American Economic Review）上发表的一篇论文中提出，最早的国家并不是像霍布斯认为的那样是作为躲避暴力的庇护所而被组织起来，发挥粘合作用的其实是经济因素。

在伊拉克最长的两条河流底格里斯河和幼发拉底河的沿岸，世界上一些最古老的定居点曾分布于此。美索不达米亚于5000年前完善了第一个已知的文字体系，为该地区赢得了"文明的摇篮"的美誉。由于洪水和干旱导致河床被淹没，这些河流的路径发生了变化。一旦河流改道，一些古代农民就无法灌溉庄稼了。

艾伦和他的合著者调查了河道变迁的时间与定居点数量和规模发生增长的时间是否存在关联。他们的方法是研究有记录的第一次河流变道的影响，这次改道发生在公元前2850年。当时农民面临的选择与哲学家对自然状态进行理论分析时所想象的差不多。那些被改道的河流抛在身后的人们可以回归游牧生活。或者他们可以联合起来修建灌溉系统，从遥远的河流取水。

一个哲学问题就这样转化成了类似于实验室实验的东西，只不过实验时间是在数千年前，实验范围绵延数百英里。而且，实验的结果十分清晰。将河道变迁后留下的盆地划分为一个个5公里乘以5公里的方格，每个方格在河流改道150年后比改道前50年出现定居点（以拥有一个公共建筑为标志，如寺庙或市场）的可能性要高14%。每个方格修建运河的可能性也会高12%，这种人工灌溉形式使得在远离河流的地方发展农业成为可能。五个新城市被创建，只有三个被废弃。位于该河一条新支流沿岸的城市埃什努纳（Esnunna）规模大大扩张了。

艾伦及其合著者说，这证明最初的国家是由农民出于经济原因展开合作而形成的。运河网络的成本太高，任何人都无法独自承担。但分摊了成本后，这项建设对每个人来说都是划算的。这样的决定意义重大。它们代表了政府在征税后提供基础设施的一些最早的例子，也就代表着最早那批国家的起源。

作者随后将关于国家起源的几个世纪的思考分为两个阵营。他们说，从麻省理工学院颇具影响力的经济学家达龙·阿西莫格鲁（Daron Acemoglu）到卡尔·马克思都属于第一个阵营，这一派认为国家说到底是在社会层面的讨价还价过程中产生的。富人和地位高的人为了个人利益而夺取权力，并不时提供道路、学校或警力等服务，以换取民众的合作。但如果美索不达米亚是属于这种情况，那也应该发生在改道河流最新流经的地方所形成的定居点才对。毕竟，它们开垦出了更肥沃的农田，也就创造出了更多的税收。

当河流改道流走时，美索不达米亚的农民似乎选择了团结起来，这为第二

个阵营提供了支持。这一派的哲学家包括洛克和卢梭，他们认为，当人们选择互相协调、放弃为所欲为的自由而选择建立起一种能调解争端并提供一定程度安全保障的国家形态时，政府便出现了。艾伦和他的合著者只分析了伊拉克美索不达米亚，但他们认为他们的研究结果应该能更普遍地适用于其他新生国家。换句话说，政府是人们自发选择的，而不是强加给公民的。

河道蜿蜒

这着实是经济学家在抢地盘了，他们抢占了更常由政治理论家占据的领地。这项研究并非毫无瑕疵。也许某次未知的征服可以解释在研究所覆盖的时期内定居点的扩展。也许作者是错的，这种模式在其他地方并不成立。在其境内的河流真正开始改道之前，美索不达米亚的大河流域就已经有六座城市和多得多的定居点，有些已经存在了一千年。作者们坚称，他们只对新政府如何形成感兴趣，但他们实际上有可能捕捉到了那些更早形成的政府的扩展情况。

尽管如此，这篇论文还是大胆且有价值的。哲学家们花了几百年的时间解释国家为何出现。而花在考虑经济因素是否可能发挥了作用上的时间仍少之又少。尽管将自然状态具体化为一个特定的时间和地点会损失一些复杂性，但这样的操作为开展对早年的哲学家而言只能想想而已的那种实验打开了方便之门。如果霍布斯或洛克当初有办法研究一下跟自己推断的自然状态近似的东西，他们肯定乐于一试。■

How to entice Japanese couples to have babies

A few cities are bucking the country's low birth rate

KISHIKI NORIYO pulls up outside a house in Akashi, a city in western Japan, in a truck emblazoned with a heart logo and the slogan: "Diaper delivery: we also deliver kindness." She steps out with two bags of nappies. Higuchi Miki, a young mother, appears at the front door with a baby on her hip. Ms Kishiki is on the front line of a ten-year push by Akashi to encourage its residents to have children. It includes delivering free baby food as well as nappies, free medical care and school lunches. The effort seems to be paying off. Akashi's population has increased for ten years in a row, to more than 300,000.

This makes the town exceptional. Japan's birth rate dipped below the replacement level of 2.1 children per woman in the mid-1970s and has been steadily declining ever since. In 2022 the total number of births dropped below 800,000 for the first time since records began in 1899. Of Japan's 1,800 municipalities, only around 200 have a rising population. According to Kishida Fumio, the prime minister, this has put the country on "the brink".

Even in Akashi, which is an easy commute from the cities of Osaka and Kobe, most of the growth is from migration, not births. The town's birth rate is 1.65. Yet given that the national figure is 1.3, this represents success of a sort. Schools are closing across Japan for want of pupils; Akashi is short of school places.

Many of the obstacles to young Japanese forming families, from high education costs to inflexible family laws, can only be tackled with national policies. But Akashi shows how local communities can make a difference.

That starts with improving access to nurseries and day care. Smaller projects such as Ms Kishiki's, which assist parents of young children, also help.

The population of Nagareyama, a commuter town outside Tokyo, is also booming. Over the past decade it has grown by 24%, to 211,000. The opening of an express-train service to Tokyo in 2005 largely explains that. But Nagareyama's commitment to child care—the "utmost priority" of its local government—has also attracted young families. In 2007 the town launched a bus service that picks up children at train stations and takes them to day-care centres. Nagareyama has increased its number of nurseries from 17 to more than 100 in the past 15 years. "Our aim was to create an environment in which parents can continue to work while raising children," says Izaki Yoshiharu, the town's mayor.

Lack of child care is endemic across Japan. The central government has made some improvements in this regard, reducing the number of children waiting for a nursery place by 90%. It has also introduced tax and other economic incentives to encourage people to reproduce. But, as scattered examples like Akashi and Nagareyama suggest, making a real difference requires a more fundamental shift.

Kato Hisakazu of Meiji University reckons Japan "needs to foster a culture that is generous to children". Efforts to build more child-care facilities are often blocked by locals who worry about increased noise. When Soup Stock, a popular restaurant chain, started offering free food for babies last April, it encountered a fierce online backlash from people who objected to the prospect of sitting next to crying infants.

Tanaka Yumi, a mother of two in Nagareyama, says young Japanese parents are used to receiving a "cold look" from their unsympathetic neighbours. But the abundance of young families in the town and the supportive

policies of its local administration provide reassurance, she says. "I have many friends in Nagareyama who decided to have a second or a third."

Akashi's pro-child efforts are intended to drive the same cultural change. Morioka Kazumi of the town's child-care department says the nappy deliveries are more about "alleviating loneliness" than the goods themselves. Ms Higuchi, the young mother, appreciates that. "It's nice when someone checks on me," she says. "It makes me feel I'm on the right track." ■

如何说服日本夫妇生孩子

有几个城市正在对抗这个国家的低出生率

岸城乃理世（Kishiki Noriyo，音译）把车停在日本西部的明石市的一栋房子前，这是一辆绘有爱心标志的卡车，上面还印着一句口号："送纸尿裤，也送温暖。"她走下车，拿着两袋纸尿裤。年轻的母亲樋口三希（Higuchi Miki，音译）到门口迎接，怀里抱着个宝宝。明石市十年来一直鼓励当地居民生孩子，岸城就在这项工作的第一线忙碌。该市的政策包括免费提供婴儿食品、纸尿裤、医疗保健和学校午餐。努力似乎得到了回报，明石的人口已经连续增长了十年，如今达到三十多万。

这让这个小城与众不同。日本的出生率在20世纪70年代中期降至人口更替水平（每位妇女生育2.1个孩子）以下，之后一直持续下降。2022年，出生人口自1899年有记录以来首次降至80万以下。在日本的1800个自治市中，只有200个左右的人口在增长。日本首相岸田文雄表示，这已经让日本站在了"悬崖边上"。

即便在明石市（从这里到大阪和神户的通勤都很方便），人口增长也主要来自移民，而不是本地出生。这里的生育率为1.65。不过考虑到全国的平均值是1.3，这仍代表着某种程度上的成功。因为生源不足，日本各地都有学校在关闭；明石市则是入学名额短缺。

从高昂的教育成本到僵化的家庭法，组建家庭的日本年轻人面临诸多障碍，其中许多只能通过国家政策来解决。但明石展示了地方社区能如何发挥作用。首先要做的就是提供更方便的托儿所和日托服务。类似岸城所从事的那种协助幼儿父母的小项目也能帮上忙。

在东京外围的通勤城镇流山市，人口也在迅速增长。过去的十年中，这里的人口增长了24%，达到了21.1万。这很大程度上要归功于2005年通往东京的特快列车开通。但流山对儿童保育的承诺——当地政府的"重中之重"

一一也吸引了年轻家庭。2007年，流山启动了一项公共汽车服务，从火车站接上孩子并将他们送往日托中心。在过去的15年里，流山市托儿所的数量已经从17个增加到了100多个。市长井崎义治表示："我们的目标是创造一种环境，让父母在抚养孩子的同时能够继续工作。"

儿童保育匮乏的问题在日本普遍存在。中央政府在这方面取得了一些进步，将等待入托的儿童人数减少了90%。政府还出台了税收优惠和其他经济激励措施，鼓励人们生育。但正如明石和流山等零星例子所示，要想真正改变现状，需要一种更加根本性的转变。

明治大学的加藤久和认为，日本"要培养一种对儿童更包容的文化"。建造更多儿童保育设施的行动常常遭到本地居民的阻挠，担心会产生噪音。去年4月，当知名餐饮连锁店Soup Stock开始为婴儿提供免费食品时，遭到了一些网友的强烈反对，他们不想以后吃饭时旁边有婴儿哭闹。

居住在流山的田中佑美（Tanaka Yumi，音译）是两个孩子的母亲，她说日本的年轻父母习惯了邻居嫌幼儿太吵的"冷眼"，但流山有很多年轻家庭，加上有本地政府的支持政策，让他们感到安心。"我在流山有好多朋友都决定生第二胎或第三胎。"

明石对育儿的支持意在推动同样的文化转变。该市儿童保育部门的森冈和美（Morioka Kazumi，音译）表示，送纸尿裤更多是为了"减轻孤独感"，而不是为了纸尿裤本身。年轻的母亲樋口很感激这一点。"有人来看我真好，"她说，"这让我觉得自己走在正确的路上。"■

Which economy did best in 2023?

Another unlikely triumph

ALMOST EVERYONE expected a global recession in 2023, as central bankers raised interest rates to cool inflation. The consensus was wrong. Global GDP has probably grown by 3%. Job markets have held up. Inflation is on the way down. Stockmarkets have risen by 20%.

But this aggregate performance conceals wide variation. The Economist has compiled data on five indicators—inflation, "inflation breadth", GDP, jobs and stockmarket performance—for 35 mostly rich countries. We have ranked them according to how well they have done on these measures, creating an overall score. The table shows the rankings, and some surprising results.

Top of the charts, for the second year running, is Greece—a remarkable result for an economy that was until recently a byword for mismanagement. Aside from South Korea, many of the other standout performers are in the Americas. The United States comes third. Canada and Chile are not far behind. Meanwhile, lots of the sluggards are in northern Europe, including Britain, Germany, Sweden and, bringing up the rear, Finland.

Tackling rising prices was the big challenge in 2023. Our first measure looks at "core" inflation, which excludes volatile components, such as energy and food, and is a good indicator of underlying inflationary pressure. Japan and South Korea have kept a lid on prices. In Switzerland core prices rose by just 1.3% year on year. Elsewhere in Europe, though, many countries still face serious pressure. In Hungary core inflation is running at 11% year on year. Finland, which is heavily dependent on Russian energy supplies, is also

struggling.

In most countries inflation is becoming less entrenched—as measured by "inflation breadth", a measure that calculates the share of items in the consumer-price basket where prices are rising by more than 2% year on year. Central bankers in places including Chile and South Korea increased interest rates aggressively in 2022, sooner than many of their peers across the rich world, and now appear to be reaping the benefits. In South Korea inflation breadth has fallen from 73% to 60%. Central bankers in America and Canada, where inflation breadth has dropped even more sharply, can take some credit, too.

However, in other places, the battle against inflation is not even close to being won. Take Australia. Inflation there remains firmly entrenched, with the price of close to 90% of the items in the average person's shopping basket rising by more than 2% year on year. Worse, inflation breadth is not coming down either. France and Germany are also in trouble. And so is Spain, where inflation seems to be becoming more entrenched over time.

Our next two measures—growth in employment and GDP—hint at the extent to which the 35 economies are delivering for ordinary folk. Nowhere fared spectacularly well. Across the world productivity growth is weak, limiting potential increases in GDP. Already tight labour markets at the start of 2023 meant there was little room for improvement when it came to jobs.

Only a few countries, though, actually saw their GDP decline. Ireland was the worst performer, with a drop of 4.1% (take that with a pinch of salt: there are big problems with the measurement of Irish GDP). Estonia, another country whacked by the fallout of Russia's invasion of Ukraine, did badly. Britain and Germany also underperformed. Germany is struggling with the consequences of the energy-price shock and rising competition from imported Chinese cars. Britain is still dealing with the aftermath of

Brexit—most economists expect the country to suffer from weak economic growth in the coming years.

America, by contrast, did well on both GDP and employment. It has benefited from record-high energy production as well as a generous fiscal stimulus implemented in 2020 and 2021. The world's largest economy may have pulled along other countries. Canada's employment has risen smartly. Israel, which counts America as its largest trading partner, comes fourth in the overall ranking, although its war with Hamas, which began in October, makes the outlook for 2024 deeply uncertain.

You might think that the American stockmarket, stuffed with firms poised to benefit from the revolution in artificial intelligence, would have done well. In fact, adjusted for inflation it is a middling performer. The Australian stockmarket, filled with commodities firms managing a comedown from high prices in 2022, underperformed. The Finnish stockmarket had a poor year, with the share price of Nokia, a national champion, continuing its long, slow decline. Japan's firms, by contrast, are experiencing something of a renaissance. For that, thank reforms to corporate governance, which finally seem to be bearing fruit. The country's stockmarket was one of the best performers in 2023, rising in real terms by nearly 20%.

But for glorious equity returns, look thousands of miles west—to Greece. There the real value of the stockmarket has increased by more than 40%. Investors have looked afresh at Greek companies as the government implements a series of pro-market reforms. Although the country is still a lot poorer than it was before its almighty bust in the early 2010s, the IMF, once Greece's nemesis, praised "the digital transformation of the economy" and "increasing market competition" in a recent statement. While underperforming Finns can console themselves this Christmas by drowning their sorrows alone in their underwear (or getting päntsdrunk, as

it is known locally), the rest of the world should raise a glass of ouzo to this most unlikely of champions. ◼

哪个经济体在2023年表现最好？

又一次意想不到的凯旋

由于各国央行加息以抑制通货膨胀，几乎所有人都预计2023年会出现全球经济衰退。这个共识是错误的。全球GDP可能增长了3%。就业市场保持坚挺。通胀正在下降。股市上涨了20%。

但这一整体表现掩盖了个体间的很大差异。《经济学人》根据五个指标——通胀、"通胀广度"、GDP、就业和股市表现——给35个以富裕经济体为主的国家编制了数据。我们根据它们在这些指标上的表现给它们排名，创建了一个综合得分。下表显示了排名，以及一些出人意料的结果。

希腊在这个排行榜上连续第二年蝉联榜首——这对于一个前些年还是管理不善的代名词的经济体来说是一个引人瞩目的成绩。除了韩国，其他排名前列的经济体大都位于美洲。美国排名第三。加拿大和智利与它相差不远。与此同时，许多表现疲软的国家位于北欧，包括英国、德国、瑞典，还有垫底的芬兰。

控制物价上涨是2023年的大挑战。我们关注的第一个指标是"核心"通胀，它不包括能源和食品等价格波动较大的项目，能很好地显示根本性的通胀压力。日本和韩国成功控制了物价。在瑞士，核心价格同比仅上涨了1.3%。然而在欧洲其他地方，许多国家仍然面临严重的通胀压力。在匈牙利，与一年前相比，核心通胀达到11%。严重依赖俄罗斯能源的芬兰也在艰难应对。

以"通胀广度"来衡量，在大多数国家，通胀正在变得不那么顽固。该指标计算了消费价格篮子中价格同比上涨超过2%的商品所占的份额。智利和韩国等国央行在2022年积极加息，动作比许多富裕国家的央行更快，现在似乎正在收获成果。在韩国，通胀广度从73%降至60%。美国和加拿大的央行官员成绩也不错，这两国的通胀广度降幅还要更大。

然而在其他一些地方，对抗通胀的战斗还远未接近胜利。比如澳大利亚。那里的通胀仍然顽固，普通人的购物篮中近90%的商品价格同比上涨超过2%。更糟糕的是，通胀广度也没能缩减下来。法国和德国也陷入了困境。西班牙也是如此，该国的通胀似乎变得越来越顽固。

接下来的两个指标是就业和GDP增长，它们显示了这35个经济体为普通人带来多少好处。没有哪个地方表现得特别出色。全球范围内生产率增长疲弱，制约了GDP的潜在增长。劳动力市场在2023年初就已经很紧张，意味着就业方面的提升空间很小。

不过只有少数几个国家实际上出现了GDP下降。爱尔兰表现最差，下降了4.1%（对此要持保留态度：爱尔兰GDP的测量存在很大问题）。另一个受俄罗斯入侵乌克兰影响的国家爱沙尼亚表现也很差。英国和德国同样表现不佳。德国正受困于能源价格冲击和中国进口汽车造成的竞争加剧。英国仍在应付脱欧的后果——大多数经济学家预计未来几年该国经济增长疲弱。

相比之下，美国在GDP和就业方面都表现良好。它受益于创纪录的能源产量以及2020年和2021年实施的慷慨财政刺激。这个世界上最大的经济体可能也拉动了其他国家的增长。加拿大的就业率大幅上升。以美国为最大贸易伙伴的以色列在总排名中位列第四，尽管该国与哈马斯于10月开始的战争让它在2024年的前景存在很大的不确定性。

你可能认为美国股市应该表现不错，因为它里头满是准备从人工智能革命中大赚一笔的公司。事实上，经过通胀调整后，它的表现只能算是中等水平。澳大利亚股市表现不佳，其中很多大宗商品公司正在应对2022年高价以后的跌落。芬兰股市度过了惨淡的一年，龙头企业诺基亚的股价延续了长期缓慢下滑的走势。相比之下，日本的公司可以说正在经历一场复兴。这要感谢企业治理方面的改革，它似乎终于开始见效。该国的股市是2023年表现最佳的股市之一，实际涨幅接近20%。

但说到亮眼的股本回报，还要看向西数千英里的希腊。在那里，股市的实

际价值增长超过40%。政府实施了一系列亲市场的改革，令投资者重新审视了希腊企业。尽管该国相比2010年代初经济大崩溃之前仍要穷得多，但希腊曾经的"报应女神"国际货币基金组织（IMF）最近在一份声明中赞扬了"该经济体的数字化转型"和"市场竞争加大"。当表现不佳的芬兰人在圣诞节时穿着内衣独自借酒消愁的时候（按当地的说法，就是päntsdrunk[穿着内裤喝个大醉]），世界其他地方应该向希腊这个最意想不到的冠军敬上一杯茴香酒。■

Will TikTok's GoTo gambit save its Indonesian business?

How the video app is navigating around a digital shakedown

THE MORE the world's youngsters love TikTok's viral videos, the more their elected elders hate the app. They decry it for supposedly corroding young minds and, worse, for its links to China, home to its parent company, ByteDance. Many in America want to ban it. India already has. In October Indonesia, another big and promising market, shut down TikTok's fledgling but lucrative sideline of selling goods via its videos, by requiring social-media firms to obtain an e-commerce licence—with no guarantee of success.

Such obstacles have forced TikTok to act strategically, for instance by moving its global headquarters to Singapore and hiring a Singaporean chief executive, which has put distance between it and its Chinese parent. In another canny move, on December 11th it announced that it was paying $840m for a 75% stake in Tokopedia, the e-commerce arm of GoTo, an Indonesian tech conglomerate. It has also pledged to invest $1.5bn in the tie-up.

The deal is something of a shotgun marriage, but it benefits both sides. GoTo, which has struggled to turn a profit in recent years, will no longer need to subsidise its loss-making retail arm. TikTok, for its part, will be allowed to restart its e-commerce operations. Sales on TikTok's app will be fulfilled by Tokopedia's logistics network (though, like all e-merchants in Indonesia, it must now charge minimum prices for products made abroad).

TikTok and Tokopedia separately account for 10% and 28%, respectively, of Indonesia's fast-growing e-commerce market, according to Momentum Works, a data firm. Together, they are a powerhouse, matching the market

share of Shopee, hitherto the country's biggest online emporium (owned by Sea Group, a Singaporean technology conglomerate).

Most important, an intimate link with a domestic champion makes TikTok look less like a foreign interloper. If the firm can make its new partnership work in the world's fourth-most-populous country, it could use this as a model for expansion and consolidation in other countries where it is greeted with wariness, such as Malaysia and the Philippines.

It will be an uphill struggle, and not just because of challenges particular to TikTok. All over the world, the advocates of international openness in digital commerce are losing the battle for hearts and minds. Last year Sea halted its expansion to India in the face of regulatory pressure, after its popular mobile game, "Free Fire", was banned. Stringent new European rules on cloud computing, including requirements to store local users' data locally, are aimed squarely at the American tech giants.

Last month America, itself in an increasingly isolationist mood, dropped earlier demands to liberalise trade in digital goods and services as part of the Indo-Pacific Economic Framework, the already flimsy pact which President Joe Biden's administration has been negotiating with 13 Asian allies. To thrive amid rising protectionism—digital and otherwise—TikTok and its rivals will need to show plenty of delicate diplomatic footwork. ■

TikTok联姻GoTo能否拯救其印尼业务？

这个视频应用如何应对数字业监管震荡

全球年轻人越爱看TikTok上的爆红视频，他们国家掌权的长辈们就越憎恶这个应用。他们谴责它可能侵蚀年轻人的思想，更严重的是，还谴责它与中国的关联，因为其母公司字节跳动来自中国。美国的许多政客想把它禁掉。印度已经这样做了。去年10月，另一个潜力大市场印尼规定社交媒体公司须获得许可（并不保证能成功获批）方可开启电子商务交易，从而叫停了TikTok新生但利润丰厚的视频带货业务。

这些障碍迫使TikTok采取战略行动，例如将其全球总部迁至新加坡，并聘请了一位新加坡籍的首席执行官，从而与中国母公司拉开距离。它还使出了另一个精明的招数，于12月11日宣布将支付8.4亿美元收购印尼科技企业集团GoTo旗下电商平台Tokopedia75%的股份。它还承诺将在这次合作中投资15亿美元。

这笔交易有点像是一场无奈的联姻，但对双方都有利。近年来一直难以盈利的GoTo将不再需要贴补亏损的零售业务。而TikTok将获准重新启动其电商业务。TikTok平台上的销售将由Tokopedia的物流网络履行（尽管与印尼的所有电商一样，它现在必须对国外制造的产品限定最低价格）。

根据数据公司Momentum Works的统计，在印尼快速增长的电商市场上，TikTok和Tokopedia分别占到10%和28%的份额。合在一起，它们是一支强大的力量，市场份额堪比目前印尼最大的在线商城虾皮购物（由新加坡科技企业集团冬海集团所有）。

最重要的是，与本土领军企业建立亲密联系使TikTok看起来不那么像是一个擅闯的外来者。如果该公司能够在全球人口第四多的国家中让这一新伙伴关系顺利推进，它就能以此为模板，在其他目前对它怀有戒心的国家扩张和巩固地位，比如马来西亚和菲律宾。

这将是一场艰苦的进军，不仅仅是因为TikTok特有的挑战。在全球各地，支持数字商务国际开放的人们都在输掉人心之战。去年，在其热门手机游戏"Free Fire"被禁后，冬海在监管压力之下暂停了向印度的扩张。欧洲对云计算出台了严厉的新规定，包括要求在本地存储本地用户数据，就是在直接针对美国的科技巨头。

美国自身的孤立主义氛围也日益浓厚。11月，它放弃了之前要求在《印太经济框架》（Indo-Pacific Economic Framework）中实现数字商品和服务贸易自由化的要求，拜登政府一直在与13个亚洲盟国谈判的这个协议本就已经脆弱不稳。想要在不断高涨的保护主义浪潮（无论是数字经济还是其他方面）中蓬勃发展，TikTok及其竞争对手将需要走出很多高难度的外交步伐。■

How to master the art of delegation

You can entrust decisions to subordinates without regretting it

DELEGATING WELL is the six-pack of management: widely desired and harder to achieve the older you get. In theory, handing appropriate decisions off to people lower down the corporate ladder means greater satisfaction all round. Bosses get more time to concentrate on the issues that really deserve their attention. Middle managers and workers enjoy a greater sense of autonomy. And the organisation benefits from faster decision-making on the part of people who are better informed about the matter at hand. In practice, however, delegation is a minefield.

Some bosses do not even try to delegate. They may mistrust people below them or crave control. Their career success may simply have persuaded them of their own genius. But there are kinder explanations, too. Startup founders are conditioned to do everything, at least until firms get to a certain size. Plenty of managers shoulder more work than they should in order to protect their teams from overload.

Other managers do delegate but they do so for the wrong reasons. Studies suggest that people are likely to hand off decisions when choices are hard, when the consequences affect others and when they want to avoid being blamed for a bad outcome. In a paper from 2016 by Mary Steffel of Northeastern University and her co-authors, volunteers were told that they had to book hotel rooms at a conference, either for their own use or for their boss, and asked them if they would like to reserve the rooms themselves or delegate the task to an office manager. When they were choosing for the boss and the hotels were ropey, people were more likely to pass the job to the hapless office manager.

A new study, by Victor Maas and Bei Shi of Amsterdam Business School, reaffirms this bleak picture of human motivation. It found that people were more likely to hand work off to subordinates when the performance targets for that particular task were demanding; they were much happier to keep hold of tasks with targets that were easier to attain. If a habitual micromanager unexpectedly asks you to take the lead on something, in other words, run for the hills.

The great mass of managers fall into a greyer area. They may be full of good intentions to leave decisions to others but still find it hard to do so. What if you put trust in your team members but then discover you violently dislike the choices they make? What if you want to hand over some decisions but you know that your own bosses will hold you personally responsible for them? These problems can easily result in "faux-tonomy"—a lip-service version of delegation in which managers do not actually leave their teams to get on with things or underlings use their freedom solely to guess what the boss would like.

One way to navigate such problems is to use an explicit decision-making framework that tries to make it clear who is on the hook for what. These frameworks are not perfect. Project managers often use something called the RACI model. Its first two letters sort those who are "responsible" from those who are "accountable", a distinction which normal people may find "confusing" and "incomprehensible". Other, clearer frameworks are available. They have punchy names like DACI, DARE and DICE: you might be choosing a cloud-computing vendor but you get to feel a little like you are in the special forces.

As well as working out who does what, it helps to have a way to parse what kinds of decision can be delegated and what not. Before Jeff Bezos started hanging out in spacesuits and doing laughable photoshoots in Vogue, he liked to articulate his management philosophy in annual letters to

Amazon's shareholders. In 2015 he made a useful distinction between type-1 decisions ("one-way doors") that are important and irreversible, and type-2 decisions ("two-way doors") that can be reversed if they do not pan out. Type-1 decisions warrant slow, deliberative processes; type-2 decisions should be taken quickly by smaller groups. Having a theory of decisions improves choices on what to delegate and reduces the chance of regrets.

Delegating well requires a lot of judgment, too. Delegation is not all-or-nothing. A detached boss can be as demotivating as a micromanager; you have to stay informed on decisions and, on occasion, override them. But checking in at the right cadence, and letting people proceed with decisions that you would not have made yourself, demands self-restraint and discipline. Just like those abs.■

如何掌握授权的艺术

你可以放心地让下属去做决策而不后悔

良好的授权就像保持六块腹肌：人人渴求，但随着年龄增长愈发难实现。理论上，将适当的决策交给下属能让公司里的各方皆大欢喜。老板们有更多时间专注于真正值得关注的问题。中层管理人员和员工享受更大的自主权。让那些对手头的事务进展更清楚的人更快地做出决策，整个组织都能从中受益。然而在实践中，授权是个雷区。

有些老板连试都不试一下。他们可能不信任下属，或者渴望掌控一切。他们在事业上的成功可能就是会让他们相信自己是天才。但也有更客气的解释。创业公司创始人习惯于亲力亲为，至少在公司达到一定规模之前是这样。为了不让团队不堪重负，许多管理者承担了额外的工作。

另一些管理者确实在授权，但出发点是错误的。研究表明，当难以抉择、后果影响他人，以及想避免为糟糕的结果担责时，人们更有可能把决策甩手给他人。东北大学（Northeastern University）的玛丽·斯特费尔（Mary Steffel）及其合著者在2016年发表了一篇论文。这项研究中的志愿者被告知他们必须为一次会议预订酒店房间，有的是为自己订，有的是为他们的老板订，然后问他们是想自己预订房间还是将这件事交给办公室经理。结果发现，当他们是要为老板选房间并且酒店条件糟糕时，他们更有可能把它推给倒霉的办公室经理去干。

阿姆斯特丹商学院（Amsterdam Business School）的维克多·马斯（Victor Maas）和石贝所做的一项新研究再次证实了人类动机的这种阴暗面。该研究发现，当某项任务的绩效目标挑战较大时，人们更有可能把工作交给下属；而对于目标较易达成的任务，留给自己的意愿就高多了。换句话说，如果一个惯于微观管理的上司突然要求你去负责某件事情，那么最好赶紧躲开。

大多数管理者处于灰色地带。他们可能满怀好意地想授权别人做决定，但仍觉得这做起来很难。如果你信任团队成员，让他们去做决定，但后来发现自己极不喜欢他们的选择，那该怎么办？如果你想授权下属做一些决策，但又知道你自己的上司会把它们算在你的头上，那又该怎么办？这些问题很容易导致"假自主"——一种表面上的授权，即管理者实际上并没有让团队自己决定事情，或者下属拥有的自由仅够用来猜老板喜欢什么。

应对这些问题的一种方法是使用一个清楚明白的决策框架，尽量明确谁对什么事情负责。这些框架并不完美。项目管理者经常使用称为RACI模型的东西。它的前两个字母将"负责"的人与"负有责任"的人区分开来，这可能会让一般人感到"困惑"和"难以理解"。还有其他更清晰的框架。它们有响亮的名字，如DACI、DARE和DICE：你可能正在选择云计算供应商，但会感觉自己有点像在特种部队里。

除了弄清谁做什么之外，有一套区分哪些决策可以授权、哪些不可以的方法也会有帮助。在贝索斯开始穿上太空服、为《Vogue》杂志拍摄好笑的照片之前，他喜欢在每年给亚马逊股东的信中表达自己的管理理念。在2015年，他对重要且不可逆转的第一类决策（"单向门"）和可以在不奏效时撤销的第二类决策（"双向门"）做了有用的区分。第一类决策要审慎，可以做得慢一些；第二类决策应由较小的团队迅速做出。有了一套决策理论，可以在授权时做出更好的选择，减少后悔的机会。

良好的授权还需要做很多的判断。授权并非撒手不管。和微观管理者一样，冷漠的老板也可能会让人感到泄气；你必须保持对决策的了解，并在必要时出手干预。但是，以正确的节奏了解状况，并允许人们做出你自己不会做出的决策，这需要自我克制和纪律。就像保持腹肌那样。■

Is China understating its own export success?

The $230bn puzzle at the heart of the country's trade figures

CHINA'S CURRENT-ACCOUNT surplus was once one of the most controversial statistics in economics. The figure, which peaked at almost 10% of GDP in 2007, measures the gap between China's earning and its spending, driven largely by its trade surplus and the income it receives from its foreign assets. For much of the past two decades, China's surpluses have left it open to the charge of mercantilism—of stealing jobs by unfairly boosting its exports. Some trading partners now worry about a similar shock if the country's output of electric vehicles grows too quickly.

But China's current-account surplus is now modest: $312bn or 1.5% of GDP over the past year, according to the country's State Administration of Foreign Exchange (SAFE). That is below the 3% threshold that America's Treasury deems excessive.

Is the figure reliable? Some, such as Brad Setser of the Council on Foreign Relations and Matthew Klein, a financial commentator, believe that the official numbers are dramatically understated. China's true surplus, Mr Klein reckons, is now "about as large as it has ever been, relative to the size of the world economy". They offer two arguments. First, China may be understating income from its foreign assets. Second, it may be understating exports.

According to SAFE, the income China earns on its stock of foreign assets plunged from mid-2021 to mid-2022. This seems odd given rising global interest rates. Mr Setser's alternative estimate, based on assumptions about China's assets, would add about $200bn to the surplus.

China's goods surplus also appears smaller in SAFE's figures than it does in China's own customs data. The gap was $230bn over the past year. "That is real money, even for China," says Mr Setser.

China might take some comfort from a bigger surplus. But it has an unsettling implication. What is happening to the additional dollars China is earning? Since they are not showing up on the books of China's central bank or its state-owned banks, they must be offset by a hidden capital outflow. Such outflows typically end up in a residual category of the ledger. Mr Setser believes this residual should be about 2% of GDP, not the official figure of near zero.

SAFE has a different explanation. It attributes the export gap largely to China's free-trade zones and similar enclaves. These lie inside China's territory but outside its official tariff border (see diagram). Goods leaving these enclaves for the rest of the world are counted as exports by customs but not by SAFE. Adam Wolfe of Absolute Strategy Research points out that these zones account for a growing share of China's exports. That may explain why the gap has emerged only in the past two years.

Mr Setser is unconvinced. If China's free-trade zones have enjoyed a dramatic export boom, it should produce ripples elsewhere. Wages earned by workers, for example, should appear as increased remittances. In fact, they have risen only a little. And as Mr Wolfe points out, even if the official current-account surplus is correctly calculated, it may be of little comfort to China's trading partners. After all, if the country's domestic demand remains weak, goods made in its free-trade zones may flood foreign markets. The rest of the world will count them, and experience them, as Chinese imports, even if SAFE does not count them as Chinese exports. ■

中国是否低报了它的出口成就？

中国贸易数据的核心是一个2300亿美元的谜团

中国的经常账户盈余曾经是经济学中最具争议的统计数据之一。这个数字衡量中国的收入和支出之间的差距，它在2007年达到峰值，几乎占到GDP的10%，这主要是受到中国的贸易顺差和从海外资产中获得的收入推动。在过去二十年的大部分时间里，中国的盈余让它被指责为重商主义——即通过不公平地促进出口来窃取就业机会。一些贸易伙伴现在担心，如果中国的电动汽车产量增长过快，可能会出现类似的冲击。

但是中国的经常项目盈余现在并不算高：按照国家外汇管理局的数据，去年中国的经常项目盈余为3120亿美元，占GDP的1.5%。这低于美国财政部认为过高的3%的门槛。

这个数字可信吗？有些人，比如美国外交关系协会（Council on Foreign Relations）的布拉德·塞瑟（Brad Setser）和金融评论员马修·克莱因（Matthew Klein），认为官方数据是大大低报了。克莱因认为，中国目前的真实盈余"相对于世界经济规模而言和过去任何时候都差不多大"。他们提出了两个论据。首先，中国可能算少了其海外资产的收入。其次，它对出口的统计可能打了折扣。

根据外汇局的数据，从2021年中到2022年中，中国从它的外国资产存量中获得的收入大幅下降。考虑到全球利率不断上升，这似乎有些奇怪。塞瑟根据对中国资产的假定做了另一种估算，按照他的算法，盈余要再多出约2000亿美元。

外汇局数据里中国的商品贸易顺差也小于中国海关的数据。过去一年这两个数字的差异达到2300亿美元。"即便对中国来说，这也是一大笔钱。"塞瑟表示。

盈余实则更大可能会让中国得到一些安慰。但这透露出的隐情让人不安。中国多赚的那些美元去了哪里？既然它们没有出现在中国央行或国有银行的账簿上，那么必定是被一种隐性的资本外流抵消了。这样的流出通常最终会入在分类账的一个剩余类别里。塞瑟认为这个剩余部分应该在GDP的2%左右，而不是官方数据中的接近于零。

外汇局对此有不同的解释。它把出口额上的差异主要归因于中国的自由贸易区和类似自贸区的飞地。这些区域位于中国境内，但在官方征收关税的边界之外（见图）。从这些飞地运往世界其他地方的货物在海关被算作出口，但在外汇局不算出口。Absolute Strategy Research的亚当·沃尔夫（Adam Wolfe）指出，这些自贸区在中国出口中所占的份额越来越大。这或许可以解释为什么数字差异只在过去两年才出现。

这没能让塞瑟全然信服。如果中国的自贸区出口非常繁荣，那应该会在其他地方产生连锁反应。例如，工人挣的工资应该表现为汇款增加。但实际上汇款只增长了一点点。而正如沃尔夫指出的那样，即使官方经常项目盈余的计算是正确的，可能也无法给中国的贸易伙伴带来多少安慰。毕竟，如果中国国内的需求持续疲软，其自贸区生产的商品可能会涌向国外市场。即使中国外汇局不把它们算作中国的出口，世界其他国家还是会把它们算作从中国的进口，并体验到它们的存在。■

China's cities compete for kids

Enlightened self-interest nudges rich places to woo rural families

AS A RULE, China's central planners do not say much about love. But look closely at recent plans from some reform-minded provinces—notably schemes that try to address a shrinking population—and appeals to hearts as well as minds leap from the page.

Take, for instance, a five-year plan to help rural migrants settle down in the cities of Zhejiang, a prosperous coastal province, and ideally to bring their young children with them. At first sight, Zhejiang's proposal, issued in July and covering 2023 to 2027, is dry stuff. One section explains how, in every city except the provincial capital, Hangzhou, recently arrived families can access places at city-funded schools and other public services. They qualify without buying a home or securing a local hukou (household registration). The hukou system has been used to regulate internal migration since Maoist times, when the Communist Party feared hungry peasants might crowd into cities. On the ground in Zhejiang the human import of these changes is well understood.

Chaguan travelled to Yiwu, a city of 1.9m in Zhejiang that is a trading hub for small commodities, supplying the world with pencils and parasols, shoelaces and shopping trolleys. He heard locals and migrants weigh the likely impact of relaxed residency rules on Yiwu's economy, on school waiting lists and on housing prices. Strikingly often, the same people then stopped talking about statistics and spoke of how the reforms make them feel.

Though Zhejiang stands out for reforming zeal, cities across China are being encouraged to hand out hukou papers more easily. Some are opening

public services to migrants who prefer to remain registered in their rural birthplaces. Both economics and demographics are driving change. Fertility rates are dropping fast and China's population declined in 2022 for the first time since the early 1960s. Natives of some of China's biggest and richest cities are proving indifferent to offers of baby-bonuses and other government incentives. Far-sighted provinces and cities are now focusing on a stock of young people who have already been born: China's 67m "left-behind children". That is the term for youngsters being raised by relatives or in boarding schools in villages, county towns or minor provincial cities, while one or both parents works as a migrant away from home.

Even some of China's biggest cities are anxious about maintaining their populations, says Lu Ming, an economist at Shanghai Jiaotong University and a prominent advocate of hukou reform. What is more, China is generating fewer of the factory jobs that can be filled by migrants straight from the countryside, and creating more service-sector jobs that require an understanding of city folk and their ways, notes Professor Lu. By way of example he cites jobs in nursing or housekeeping or as decorators, adding that workers raised and educated in cities are best placed to fill such vacancies. Cities have been offering hukous to university graduates and other skilled workers for years. Now, the contest is on for blue-collar families, the professor suggests.

Not every city has the means to compete. Yiwu, a wealthy place, has spent heavily on wooing young families this year. To help outsiders, the city closed 28 private schools that catered to migrant children, some of which charged as much as 20,000 yuan ($2,811) a year. Others offered classes in shabby industrial premises. The city converted 24 into publicly funded schools, bringing 25,000 migrant children into the state sector. It built new primary schools, too, with one campus costing 224m yuan.

Migrant parents have mixed reactions. Yiwu's wide avenues are lined with

commercial complexes devoted to specific industries. Outside a centre for stationery merchants, your columnist found three men from the same rural corner of Hunan province. They eke out a living selling adhesive price labels from plastic crates balanced on electric scooters. One used to pay over 6,000 yuan a year to send his child to a local private school. The same school is now public and costs him a tenth of that. Yiwu "wants to hang on to more outsiders", suggests that lucky father. A younger colleague will not be moving his 13-year-old daughter from Hunan to the city, however. "Of course, she'd prefer to live with her parents," he admits. But he and his wife both work in Yiwu, often till midnight or later. "We don't have time to take care of the child here," says the label-seller, smoking as he waits for customers.

Inside the mall, a mother of one from elsewhere in Zhejiang sells children's diaries and pens to buyers from around the world. The reforms leave her both grateful and sceptical. Migrants who rent homes and pay social-security contributions can now access city schools, even without a full hukou, she agrees. But they rarely land spots at Yiwu's best schools. Homeowners and longstanding hukou-holders have a higher priority than newcomers who rent, she explains. In a nearby shop, a mother of two who moved to Yiwu years ago reports that she paid a hefty premium to live near a good school. She ventures that it would be "very unfair" on homebuyers if the newcomers could access the best schools.

| *A benign contest for growth*

Some migrants prefer a life in two places. Some keep a rural hukou to maintain their rights to village land. A woman from southern China may send her daughter back to her home province to take university-entrance exams in ten years' time. Back home, the competition is less "ferocious" than in wealthy Zhejiang, she says.

In a playground near a new primary school, a retired migrant worker from

Hunan talks proudly of her grown children and the four grandchildren that she now helps to raise, each of whom has a hukou from Yiwu. A generation ago, her own children lived in her home village and she saw them twice a year. She supposes that her children missed her, she says, with a strained laugh. "But I don't know and I would not ask." China remains full of such sad tales. Self-interest now prompts cities and provinces to help more families stay together. Easing heartache will be one of their rewards. ■

中国城市的抢娃大作战

开明的自利促使富裕地区想办法吸引农村家庭

中国的中央规划者一般很少谈"爱"。但仔细阅读一些具改革意识的省份近期出台的规划，尤其是那些试图应对人口减少的方案，会明显感受到字里行间不仅试图晓之以理，更试着动之以情。

以浙江省为例，这个富裕的沿海省份制定了一项为期五年的计划，旨在协助农业转移人口在该省各市安家落户，且最好他们年幼的子女也随迁。这份提案于7月发布，覆盖2023年至2027年，初看起来似乎索然无味。其中一个章节说明了除省会杭州以外，其他所有城市的新迁入家庭如何能获得公办学校入学名额和享受其他公共服务，而无需购房或获得当地户口。户籍制度自毛泽东时代起便被用来管理国家内部人口迁移，当时共产党担心饥饿的农民可能涌入城市。在浙江，民众对于目前这些变革在人口上的用意领会得非常清楚。

笔者走访了义乌。浙江这座190万人口的城市是一个小商品贸易中心，向全世界供应铅笔、遮阳伞、鞋带和购物车。笔者在那里听到本地人和外来工琢磨居住规定放宽会怎样影响义乌的经济、入学排队和房价。几无例外的是，本来说着数据的他们往往聊着聊着就开始述说起自己对这些改革的感受来。

尽管浙江的改革热情尤为突出，但全国各地的城市都受到敦促来放宽落户限制。一些城市正向更愿意保留农村出生地户籍的务工者开放公共服务。经济和人口结构变化都在推动变化。生育率迅速下降，2022年，中国人口自20世纪60年代初以来首次减少。一些中国最大、最富裕城市的居民对于生育奖励等政府激励措施反应冷淡。一些目光长远的省份和城市现在将关注的焦点放在了一个已经出生的年轻群体上，那就是中国6700万"留守儿童"。这些孩子的父母两人或之一远离家乡在外务工，孩子被留在乡村、县城或小城市里，由亲属抚养或上寄宿学校。

即便是中国最大的一些城市也在为保持人口规模而忧虑，上海交通大学经济学家、户口制度改革的知名倡导者陆铭表示。此外，他指出，中国可由直接从农村迁移而来的民工填补的工厂岗位在减少，而需要从业者懂得城里人及其生活方式的服务业岗位在增多。陆铭教授列举了护理、家政、装修这样的城市工作，并表示在城市长大和受教育的工人更适合填补这些职位空缺。多年来，城市一直向大学毕业生和其他技术工人提供户口。陆铭表示，如今争夺的焦点正转向蓝领家庭。

并非每个城市都有财力参与竞争。富裕的义乌今年投入了大量资金吸引年轻家庭。为帮助外来人口，该市关闭了28所专门面向农民工子女的民办学校，其中一些学费高达2万元一年。其他一些学校在破旧的工业场地授课。该市将其中的24所转为公办学校，将2.5万名农民工子女纳入公立教育体系。此外，义乌还新建小学，其中一个校园耗资2.24亿元。

农民工父母对此反应不一。义乌宽阔的大道两旁，聚集特定行业的商业综合体一字排开。在一个文具商场外，笔者发现了三名来自湖南省同一个村落的男子。他们以卖不干胶价签为生，"柜台"就是放在电瓶车上的塑料箱。其中一人过去每年花6000多元送孩子上义乌的民办学校。这所学校现在成了公办的，费用只有过去的十分之一。义乌"想留住更多外地人"，这位幸运的父亲表示。不过，旁边比他年轻的搭档却不准备将13岁的女儿从湖南接过来。"她当然更愿意和父母在一起。"他承认。但他和妻子两人都在义乌工作，经常会忙到半夜或更晚。"我们在这里没时间照顾孩子。"这位卖标签的父亲说着，一边抽烟一边等待顾客上前。

在商场里面，一名妇女向来自世界各地的买家销售儿童日记本和笔。她来自浙江其他地方，有一个孩子。对眼下这些改革，她既感激又怀疑。她承认，即使没有完整的户口，租房子并缴纳社保的农民工如今也能让孩子入读城市里的学校。但他们很少能够进义乌最好的学校。有房者和有常住户口的人比租房的新迁人口有优先权，她解释说。在旁边一个店铺里，一位迁居义乌多年的两个孩子的母亲称，她下了血本在一所好学校附近安了家。她提出，如果新来的人能进最好的学校，那对买了房的人就"非常不公平"。

一些外来务工者更倾向两地来回的生活。有些人保留农村户口以保持在农村的土地权益。一名来自中国南方的妇女可能会在十年后把女儿送回家乡省份参加高考。她说，在老家，竞争不像在富庶的浙江那么"激烈"。

在一所新建小学附近的操场上，一名来自湖南的退休农民工自豪地谈起她的成年子女和她现在帮忙带的四个孙辈，每个孩子都有义乌户口。二三十年前，她自己的孩子住在农村老家，她每年见他们两次。那会儿孩子们应该是想念自己的吧，她说，勉强地笑了一声。"但我不确定，也不会去问。"中国仍然有很多这样的悲伤故事。出于自身利益考虑，如今各省市正帮助更多的家庭团聚。减轻这样的内心伤痛将是它们收获的回报之一。
■

Jensen Huang says Moore's law is dead. Not quite yet

3D components and exotic new materials can keep it going for a while longer

TWO YEARS shy of its 60th birthday, Moore's law has become a bit like Schrödinger's hypothetical cat—at once dead and alive. In 1965 Gordon Moore, one of the co-founders of Intel, observed that the number of transistors—a type of electronic component—that could be crammed onto a microchip was doubling every 12 months, a figure he later revised to every two years.

That observation became an aspiration that set the pace for the entire computing industry. Chips produced in 1971 could fit 200 transistors into one square millimetre. Today's most advanced chips cram 130m into the same space, and each operates tens of thousands of times more quickly to boot. If cars had improved at the same rate, modern ones would have top speeds in the tens of millions of miles per hour.

Moore knew full well that the process could not go on for ever. Each doubling is more difficult, and more expensive, than the last. In September 2022 Jensen Huang, the boss of Nvidia, a chipmaker, became the latest observer to call time, declaring that Moore's law was "dead". But not everyone agrees. Days later, Intel's chief Pat Gelsinger reported that Moore's maxim was, in fact, "alive and well".

Delegates to the International Electron Devices Meeting (IEDM), a chip-industry shindig held every year in San Francisco, were mostly on Mr Gelsinger's side. Researchers showed off several ideas dedicated to keeping Moore's law going, from exploiting the third dimension to sandwiching chips together and even moving beyond silicon, the material from which microchips have been made for the past half-century.

A transistor is to electricity what a tap is to water. Current flows from a transistor's source to its drain via a gate. When a voltage is applied to the gate, the current is on: a binary 1. With no voltage on the gate, the current stops: a binary 0. It is from these 1s and 0s that every computer program, from climate models and ChatGPT to Tinder and Grand Theft Auto, is built.

Small is beautiful

For decades transistors were built as mostly flat structures, with the gate sitting atop a channel of silicon linking the source and drain. Making them smaller brought welcome side benefits. Smaller transistors could switch on and off more quickly, and required less power to do so, a phenomenon known as Dennard scaling.

By the mid-2000s, though, Dennard scaling was dead. As the distance between a transistor's source and drain shrinks, quantum effects cause the gate to begin to lose control of the channel, and electrons move through even when the transistor is meant to be off. That leakage wastes power and causes excess heat that cannot be easily disposed of. Faced with this "power wall", chip speeds stalled even as transistor counts kept rising (see chart).

In 2012 Intel began to build chips in three dimensions. It turned the flat conducting channel into a fin standing proud of the surface. That allowed the gate to wrap around the channel on three sides, helping it reassert control (see diagram). These transistors, called "finFETs", leak less current, switch a third faster and consume about half as much power as the previous generation. But there is a limit to making these fins thinner and taller, and chipmakers are now approaching it.

The next step is to turn the fins side on such that the gate surrounds them completely, giving it maximum control. Samsung, a South Korean electronics giant, is already using such transistors, called "nanosheets", in its newest products. Intel and TSMC, a Taiwanese chip foundry, are

expected to follow soon. By stacking multiple sheets and reducing their length, transistor sizes can drop by a further 30%.

Szuya Liao, a researcher at TSMC, compares going 3D to urban densification—replacing sprawling suburbs with packed skyscrapers. And it is not just transistors that are getting taller. Chips group transistors into logic gates, which carry out elementary logical operations. The simplest is the inverter, or "NOT" gate, which spits out a 0 when fed a 1 and vice versa. Logic gates are made by combining two different types of transistor, called n-type and p-type, which are produced by "doping" silicon with other chemicals to modify its electrical properties. An inverter requires one of each, usually placed side by side.

At IEDM Ms Liao and her colleagues showed off an inverter called a CFET built from transistors that are stacked on top of each other instead. That reduces the inverter's footprint drastically, to roughly that of an individual transistor. TSMC says that going 3D frees up room to add insulating layers, which means the transistors inside the inverter leak less current, which wastes less energy and produces less heat.

The ultimate development in 3D chip-making is to stack entire chips atop one another. One big limitation to a modern processor's performance is how fast it can receive data to crunch from memory chips elsewhere in the computer. Shuttling data around a machine uses a lot of energy, and can take tens of nanoseconds, or billionths of a second—a long time for a computer.

Julien Ryckaert, a researcher at Imec, a chip-research organisation in Belgium, explained how 3D stacking can help. Sandwiching memory chips between data-crunching ones drastically reduces both the time and energy necessary to get data to where it needs to be. In 2022 AMD, an American firm whose products are built by TSMC, introduced its "X3D" products,

which use 3D technology to stick a big blob of memory directly on top of a processor.

As with cities, though, density also means congestion. A microchip is a complicated electrical circuit that is built on a circular silicon wafer, starting from the bottom up. (Intel likens it to making a pizza.) First the transistors are made. These are topped with layers of metal wires that transport both electrical power and signals. Modern chips may have more than 15 layers of such wires.

As chips get denser, routing those power and data lines gets harder. Roundabout routes waste energy, and power lines can interfere with data ones. 3D logic gates, which pack yet more transistors into a given area, make things worse.

To untangle this mess, chipmakers are moving power lines below the transistors, an approach called "backside power delivery". Transistors and data lines are built as before. Then the wafer is flipped and thick power lines are added to the bottom. Putting the power wires along the underside of the chip means fundamental changes to the way expensive chip factories operate. But shortening the length of the power lines means less wasted energy and cooler-running chips. It also frees up nearly a fifth of the area above the transistors, giving designers more room to squeeze in extra data lines. The end result is faster, more power efficient devices without tinkering with transistor sizes. Intel plans to use backside power in its chips from next year, though combining it with 3D transistors in full production is still a while away.

Even making use of an extra dimension has its limits. Once a transistor's gate length approaches ten nanometres the channel it governs needs to be thinner than about four nanometres. At these tiny sizes—mere tens of atoms across—current leakage becomes much worse. Electrons slow down

because silicon's surface roughness hinders their movement, reducing the transistor's ability to switch on and off properly.

Some researchers are therefore investigating the idea of abandoning silicon, the material upon which the computer age has been built, for a new class of materials called transition metal dichalcogenides (TMDs). These can be made in sheets just three atoms thick. Many have electrical properties that mean they leak less current from even the tiniest of transistors.

Three TMDs in particular look promising: molybdenum disulphide, tungsten disulphide and tungsten diselenide. But while the industry has six decades of experience with silicon, TMDs are much less well understood. Engineers have already found that their ultra-thin profile makes it difficult to connect transistors made from them with a chip's metal layers. Consistent production is also tricky, particularly at the scales needed for reliable mass production. And the materials' chemical properties mean it is harder to dope them to produce n-type and p-type transistors.

The atomic age

Those problems are probably not insurmountable. (Silicon suffered from doping problems of its own in the industry's early days.) At the IEDM, Intel was showing off an inverter built out of TMDs. But Eric Pop, an electrical engineer at Stanford University, thinks it will be a long while before they replace silicon in commercial products. For most applications, he says, silicon remains "good enough."

At some point, the day will arrive when no amount of clever technology can shrink transistors still further (it is hard to see, for instance, how one could be built with less than an atom's worth of stuff). As Moore himself warned in 2003, "no exponential is for ever." But, he told the assembled engineers,

"your job is delaying for ever". Chipmakers have done an admirable job of that in the two decades since he spoke. And they have at least sketched out a path for the next two decades, too. ■

黄仁勋说摩尔定律已死。其实还没有

3D元件和奇异新型材料可给它续会儿命

摩尔定律还差两年就要满6o岁了，如今它已经变得有点像薛定谔的猫——既死又活。1965年，英特尔公司的联合创始人之一戈登·摩尔（Gordon Moore）提出，一块微芯片上可容纳的晶体管（一种电子元件）的数量每一年就会翻一番，后来他又将翻番的时间从一年改为两年。

摩尔的言论成了一种追求，为整个计算机行业设定了前进步调。1971年生产的芯片可以在一平方毫米中塞入2oo个晶体管。如今最先进的芯片可以在同样的面积上塞入1.3亿个晶体管，而且每个晶体管的运行速度也比当初快几万倍。如果汽车也以同样的速度进步，那么现如今汽车的最高时速可达到数千万英里。

摩尔很清楚这一进程不可能永远持续下去。每一次翻番都比上一次更困难、成本也更高。2o22年9月，芯片制造商英伟达的老板黄仁勋成为最新一个唱衰摩尔定律的人，他宣称摩尔定律"已死"。但并非所有人都赞同他的观点。几天后，英特尔的CEO帕特·基辛格（Pat Gelsinger）表示，摩尔定律其实还"活得好好的"。

参与国际电子器件大会（IEDM）的代表大多站在基辛格一边。这一芯片行业的盛会每年在旧金山举行。研究人员在会上展示了若干让摩尔定律持续下去的创意，比如利用3D结构或把多个芯片堆叠起来，甚至不再使用硅这种过去半个世纪里用来制造微芯片的材料。

晶体管之于电流就像水龙头之于自来水一样。电流通过栅极从晶体管的源极流向漏极。当电压施加到栅极上时，电流接通——我们用二进制中的1来表示。当栅极上没有电压时，电流断开——用二进制中的o来表示。从气候模型、ChatGPT到手机交友应用Tinder、《侠盗猎车手》游戏，所有的计算机程序都由这些1和o构成。

几十年来，晶体管大多是平面结构，栅极位于连接源极和漏极的硅沟道上。制造更小的晶体管也带来了一些可喜的附带好处：晶体管越小，开关速度就越快，并且功耗也越低。这种现象被称为登纳德缩放定律。

然而到2000年代中期，登纳德缩放定律已经失效。随着晶体管源极和漏极之间距离的缩短，出现了量子效应，导致栅极开始无法控制沟道，并且即使晶体管处于关闭状态，电子也会隧穿。如此造成的漏电不仅浪费电能，还会产生难以散去的过多热量。因为这堵"功耗墙"，虽然芯片上的晶体管数量在持续增多，芯片速度却停滞不前（见图表）。

2012年，英特尔开始制造3D芯片。它把原来平面的电流通道变成了凸起于表面上的"鳍"。如此一来，栅极从三面包裹通道，帮助它增强了控制力（见图）。这些鳍式场效应晶体管（FinFET）漏电减少，开关速度提升三分之一，且功耗只有上一代晶体管的一半左右。但是这些鳍不可能无限变薄或变高，芯片制造商如今正在接近其极限。

下一步是翻转鳍，使栅极完全包裹住沟道，从而最大限度地控制沟道。韩国电子巨头三星已经在其最新产品中使用了这种叫作"纳米片"的晶体管。预计英特尔和芯片代工厂台积电也将很快跟进。通过把多个纳米片堆叠起来并缩短其长度，晶体管的尺寸可以进一步缩小30%。

台积电的研究人员廖思雅把芯片3D化比作提高城市密度——用密集的摩天大楼取代四处延伸的郊区。这不仅指晶体管在不断变高。芯片将晶体管分组组成逻辑门，这些逻辑门执行基本的逻辑运算。最简单的逻辑门是反相器，又称"非门"——如果输入为1，则其输出为0；反之亦然。逻辑门是由N型和P型两种不同类型的晶体管组成，这两种晶体管都是通过在硅中"掺杂"其他化学物质来改变其导电性能而制成的。一个反相器需要N型和P型晶体管各一个，通常并排放置。

在今年的IEDM上，廖思雅及其同事展示了一种名为互补场效应晶体管（CFET）的反相器，由晶体管相互堆叠而成。这大幅减少了反相器占用

的空间，差不多只需要一个晶体管的空间。台积电表示，芯片3D化可为增加绝缘层腾出空间，这样就可以减少反相器内部晶体管的漏电，从而降低能耗、减少发热。

研发3D芯片制造的终极目标是将整块芯片一个个堆叠起来，形成一个整体。现代处理器要从计算机其他位置的存储芯片接收所要处理的数据，接收速度是限制其性能的一大因素。计算机内部的数据传输需要消耗大量能量，并且可能需要几十纳秒（一纳秒等于十亿分之一秒）——这对计算机来说是很长的时间。

比利时微电子研究中心（Imec）的研究人员朱利安·瑞卡特（Julien Ryckaert）解释了3D堆叠技术如何可以帮助解决这个问题。将存储芯片夹在数据处理芯片之间，大大减少了将数据传输到指定位置所需的时间和能量。2022年，美国公司AMD（台积电为其代工）推出了它的"X3D"处理器，使用3D技术将一大片内存直接连接到处理器上面。

然而和城市一样，密集也意味着拥堵。微芯片是以圆形硅片为基片、自下而上构建起来的复杂电路。（英特尔将它比作做披萨。）首先要制造晶体管。它们的上端有多层用来传输电力和信号的金属线。现代芯片可能有15层以上这样的金属线。

随着芯片上的元件越来越密集，这些电源和数据线的布线变得越来越困难。线路迂回会浪费能量，而且电源线会对数据线造成干扰。3D的逻辑门因为在一定区域内塞入了更多的晶体管，布线就变得更难了。

为了解开这团"乱麻"，芯片制造商正在将电源线移至晶体管下方，这种技术被称为"背面供电"。晶体管和数据线的构建方式和以前一样。然后将晶圆片翻转过来，并在底部加上较粗的电源线。把电源线排布在芯片底部将从根本上改变造价高昂的芯片工厂的运作方式。但缩短电源线的长度意味着减少能耗，也能降低芯片运行时的温度。该技术还在晶体管上方腾出了近五分之一的面积，给设计人员留出了更多空间来塞进额外的数据线。该技术最终会制造出速度更快、能效更高的芯片，而不需要调整晶体管的尺

寸。英特尔计划从明年开始在其芯片中使用背面供电，不过把它与全面投产的3D晶体管结合起来还需要时日。

而即便是利用3D技术也有其上限。一旦晶体管的栅极长度接近10纳米，它所控制的沟道就需窄至大约在4纳米以下。如此微小的尺寸只够几十个原子通过，漏电因而会更加严重。由于硅片表面的粗糙度阻碍了电子的运动，电子的速度会变慢，也就会影响晶体管的正常开关。

因此，一些研究人员正在研究是否可以弃用硅这种让计算机时代得以建立的基础材料，转而使用一类名为过渡金属二硫属化物（TMD）的新材料。TMD可以制成只有三个原子厚的薄片。许多TMD具有良好的导电性能，即便制成最小的晶体管也能减少漏电。

三种尤其被看好的TMD材料分别是：二硫化钼、二硫化钨和二硒化钨。但是芯片制造行业与硅材料打了60年交道，对TMD的了解却要少得多。工程师们已经发现，由于TMD是一种超薄材料，用它们制造的晶体管很难与芯片的金属层连接起来。TMD也很难持续生产，尤其是要达到可靠的批量生产所需规模的话。而且TMD的化学特性决定了很难往它们掺杂别的物质来制造N型和P型晶体管。

原子时代

这些问题或许并非解决不了。（在行业发展初期，硅也曾遇到过掺杂上的问题。）在今年的IEDM上，英特尔展示了一款用TMD制造的反相器。但斯坦福大学的电气工程师埃里克·波普（Eric Pop）认为，要在商业产品中用TMD取代硅还需要相当长一段时间。他表示，在大多数应用场景下，硅仍然"足够好"。

总有一天，再巧妙的技术也无法进一步缩小晶体管的体积（例如，很难想象如何用不到一个原子大小的材料来制造晶体管）。正如摩尔本人在2003年警告的那样："没有什么指数级增长能够永远持续。"但是，他又对当时与会的工程师们说："你们的工作就是永远延后那一天的倒来。"自他讲这番话以来的二十年里，芯片制造商在延后上取得了令人钦佩的成绩。而且

他们至少也已蚀刻出了未来20年的发展线路。■

Could newborn neurons reverse Alzheimer's?

Some scientists think so. Others doubt the cells even exist

ONE OF THE first signs of Alzheimer's disease is confusion. Most people can park their car in a different space every morning and find it again in the evening. Those with Alzheimer's find this type of problem much harder. Memories of things they do often, like eating or taking medication, become tangled in their minds.

The ability to distinguish between similar memories depends on a tiny strip of brain tissue called the dentate gyrus. Studies in mice have shown that the dentate gyrus is one of the few bits of the brain to generate new neurons even in adulthood. Those new neurons are thought to help keep similar memories distinct.

Whether something similar happens in humans is less clear. But a clutch of new results described recently at the Society for Neuroscience's conference in Washington, DC, suggest that it might. And if it does, then encouraging the process might offer a new treatment for Alzheimer's disease.

Until the 1960s scientists thought adult brains did not produce new neurons. Then evidence began to emerge of young neurons in the brains of adult rats and mice,—specifically in the olfactory bulb, which processes smell, and the dentate gyrus. These new neurons had developed from neural progenitor cells, a type of undifferentiated neuron akin to a stem cell, in a process scientists call neurogenesis.

And there seems to be a link, at least in mice, between these new neurons and Alzheimer's disease. Mice genetically engineered to have Alzheimer's-like symptoms also have fewer young neurons in their brains. Two studies

published in 2021 and 2022 showed that encouraging neurogenesis could improve memory in such animals. And a paper published in April this year found that boosting neurogenesis also caused other cells known as microglia to begin cleaning up tangles of protein, called amyloid-beta plaques, that are characteristic of Alzheimer's disease.

So far so promising—if you are a mouse. But studying neurogenesis in humans is tricky. MRI scanners cannot watch the growth of individual neurons. Scientists must take samples of brain tissue from cadavers and either stain them with chemicals that bind only to young neurons, or measure the genes that have been expressed within brain cells to look for the hallmarks of youth.

Dozens of such papers have been published. But for every one that has found evidence of neurogenesis, another has failed to do so. The pro-neurogenesis camp thinks the null results are down to poor-quality brain tissue or crude preservation techniques. The antis argue that either humans do not grow these neurons in the dentate gyrus, or if they do, there are too few of them to be useful.

The research presented in Washington strengthens the case for human neurogenesis. Maura Boldrini of Columbia University, María Llorens-Martín of the University of Madrid, Orly Lazarov at the University of Illinois at Chicago and Hongjun Song of the University of Pennsylvania presented evidence of young neurons in the dentate gyruses of humans—though most of their findings have not yet been peer reviewed.

Three of these researchers also studied the brains of healthy older people or people with Alzheimer's disease. Their results suggested that the production of the supposed new neurons slows with age, and falls precipitously in Alzheimer's disease. Previous studies by two of the groups also found that Alzheimer's patients with more of these neurons had better

memories.

But while the new research strengthens the case for human neurogenesis, it is not yet definitive. One group of researchers from Yale University questioned whether the staining technique used in one of the studies was accidentally tagging other brain cells such as astrocytes. They are also concerned that the studies tend to find very few progenitor cells. "Where are all the mothers of these baby neurons?" asked Jon Arellano, one of the sceptics.

There are other wrinkles. Dr Song found a different set of genes expressed in the supposedly young human neurons from those seen in neurons from other animals. And the few young neurons that both Dr Song and Dr Lazarov found in the brains of Alzheimer's patients looked very different from the same neurons in healthy brains. If the new cells are somehow defective, increasing their number may not help.

But although not all the scientists at the conference were convinced, some drug-makers appear to be. In April, Biomed Industries, a pharmaceutical firm based in California, said that results from an early clinical trial suggested that a new drug that the firm claims increases neurogenesis in mice improved memory in people with moderate Alzheimer's. If subsequent trials prove to be equally encouraging, that could be further evidence that the neurogenesis theory of Alzheimer's may indeed have something to it. ■

新生神经元能逆转阿尔茨海默症吗？

有科学家认为可以。也有人怀疑这种细胞根本不存在【新知】

阿尔茨海默症的初期症状之一是思维混乱。大多数人可以每天早上把车停在不同地点，晚上又能找到。而阿尔茨海默症患者却很难做到。一些日常活动的记忆，比如吃饭或服药，会在他们的大脑中乱作一团。

区分相似记忆的能力取决于一小块称为齿状回的脑组织。对小鼠的研究表明，齿状回是大脑中少数几个即使在成年期也会生长出新神经元的部位之一。据信这些新神经元有助于区分相似的记忆。

在人身上是否也是如此还不太清楚。但近日神经科学学会（Society for Neuroscience）在华盛顿举行的会议上公布的一系列新研究结果表明，这是有可能的。如果确实如此，那么促进这一生长过程可能会为阿尔茨海默症带来新的治疗方法。

在1960年代以前，科学家一直认为成人大脑不会产生新的神经元。后来有证据表明，成年大鼠和小鼠的大脑中会出现年轻的神经元，特别是在处理气味的嗅球以及齿状回中。这些新神经元是由神经祖细胞（一种类似于干细胞的未分化神经元）发育而来，科学家将这一过程称为神经发生。

至少在小鼠身上，这些新神经元和阿尔茨海默症之间似乎存在关联。经过基因改造而出现类似阿尔茨海默症状的小鼠，其大脑中新生神经元的数量也较少。2021和2022年发表的两项研究表明，促进神经发生可以改善这些动物的记忆力。今年4月发表的一篇论文发现，促进神经发生还能使被称为小神经胶质的其他细胞开始清理蛋白质缠结，这些被称为β-淀粉样斑块的缠结是阿尔茨海默症的症状表现。

这一切都很有希望——如果你是老鼠的话。但要研究人类的神经发生却很棘手。核磁共振扫描仪无法观察单个神经元的生长。科学家必须从尸体上

采集脑组织样本，要么用只与新生神经元结合的化学物质给它们染色，要么测量脑细胞内表达的基因来寻找年轻神经元的印记。

此类论文已发表了数十篇。但是，每有一篇论文找到神经发生的证据，就有另一篇没有找到。支持神经发生的阵营认为，这些无效结果是由于脑组织的质量太差或保存技术粗糙造成的。反方则认为，要么人类在齿状回中没有生长出这些神经元，要么就是即使生长了，也因为数量太少而没有作用。

在华盛顿会议上发表的研究进一步支持了人类神经发生的论证。哥伦比亚大学的莫拉·博尔德里尼（Maura Boldrini）、马德里大学的玛丽亚·洛伦斯-马丁（María Llorens-Martín）、伊利诺伊大学芝加哥分校的奥利·拉扎罗夫（Orly Lazarov）和宾夕法尼亚大学的宋红军展示了人类齿状回中存在新生神经元的证据——尽管他们的大部分发现尚未经过同行评议。

其中三位研究人员还研究了健康老年人或阿尔茨海默症患者的大脑。他们的研究结果表明，随着年龄的增长，这些所认为的新生神经元的生成速度会减慢，而在阿尔茨海默症患者身上更是急剧下降。其中两个团队之前的研究还发现，拥有更多这些神经元的阿尔茨海默患者的记忆力更好些。

但是，虽然新研究为人类神经发生提供了更多证据，却仍不足以下定论。耶鲁大学的研究团队质疑其中一项研究中使用的染色技术是否意外地标记了其他脑细胞，例如星形胶质细胞。他们也很关注这些研究往往只能发现极少量祖细胞的问题。"这些幼年神经元的所有母细胞在哪里呢？"怀疑者之一乔恩·阿雷利亚诺（Jon Arellano）问道。

还有其他疑惑。宋红军发现，在这些所认为的人类新生神经元中表达的基因与其他动物的神经元不同。此外，宋红军和拉扎罗夫都发现，阿尔茨海默症患者大脑中的少数新生神经元与健康大脑中的同类神经元看起来也有很大差异。如果这些新细胞存在某种缺陷，那么增加其数量可能也没什么好处。

但是，尽管不是所有与会的科学家都被说服了，一些制药商似乎已经信心

十足。今年4月，加州制药公司Biomed Industries表示，它声称能促进小鼠神经发生的一种新药在一项早期临床试验中改善了中度阿尔茨海默氏症患者的记忆力。如果后续的试验结果同样令人鼓舞，那将进一步证明，阿尔茨海默氏症的神经发生理论可能确有其价值。■

The Extremely Large Telescope will transform astronomy

It will be the world's biggest optical telescope by far—and a powerful time machine

IT IS THE colours of a sunset that inspire Joseph Anderson, an astronomer at the European Southern Observatory (ESO) in the high Atacama desert, in northern Chile. "They start off very blue and turquoise. And gradually, as it gets more purple, then we're getting closer to observing the universe." Once night falls the sky is dominated by the star-spangled curve of the Milky Way. If there were any extra left to give, more than two kilometres above sea level, your correspondent's breath would have been taken away.

The Atacama is home to more than a dozen different astronomical observatories, and for good reason. It is far from the light pollution of civilisation. The air is thin and dry, which improves what astronomers call the "seeing". And the desert averages 325 cloudless nights each year. Dr Anderson is standing on top of a mountain called Cerro Paranal, showing off the Very Large Telescope (VLT). The VLT is made up of four individual telescopes, each individually one of the largest in the world, alongside another four much smaller ones. It is Earth's most productive astronomical facility, yielding more than one scientific paper each day. In 2004 it took the first picture of an extrasolar planet—one that orbits a star other than the Sun—and was the first instrument to track individual stars whipping around the enormous black hole at the centre of the Milky Way.

But it may not hold that title for much longer. An hour's drive from the VLT, atop Cerro Armazones, a 3,046-metre peak, sits the half-finished bulk of the ELT, or Extremely Large Telescope. (ESO is a fan of quotidian names.) Like so many big projects, the ELT is behind schedule. But when it is finished—in 2028, on current plans, at a cost of €1.5bn ($1.6bn)—it will be, by far, the biggest optical telescope in the known universe. The result, says Robert de

Rosa, an astronomer at ESO, will be "a step change in what we can do in terms of observational astronomy".

Optical telescopes use a series of mirrors to capture light from space and redirect it to their various instruments. A bigger mirror can collect more light, which means it can both see dimmer things and resolve them in finer detail than a smaller one. The ELT's main mirror will have a diameter of 39.3 metres, more than four times that of the VLT's big telescopes (8.2 metres) and over three times that of the present record-holder, the 10.4-metre Gran Telescopio Canarias (GTC), in the Canary Islands. Since a telescope's power depends on the area of its mirror, looking only at the diameter understates the difference. The GTC has a collecting area of around 75 square metres. The ELT will boast 978 square metres, a little smaller than four tennis courts (see diagram 1).

That size will be a boon for many branches of astronomy. The ELT will shed light on everything from the role of black holes in shaping the large-scale structure of the universe to how dark matter and dark energy affect the rate at which it is expanding, and even whether the supposed constants of physics really are constant over vast intergalactic distances.

It should also provide a big boost to the study of planets outside the solar system. These days, the existence of most exoplanets is inferred from the effects they have on the light from their parent stars. Taking pictures of them—so-called direct imaging—is rare. Of the roughly 5,500 known exoplanets, scientists have pictures of only around 1% of them.

| *Time and relative dimension in space*

The ELT's enormous mirror will allow astronomers to separate the faint light of a planet from the overwhelming glare of its star from dozens of light-years away. The result should be a direct-imaging bonanza. And direct imaging will also help reveal the chemical composition of exoplanet

atmospheres, and whether any show signs of potential alien life.

And because telescopes are also time machines, the ELT will allow scientists more insight into what happened shortly after the universe began. Since the speed of light is finite, astronomers see distant objects not as they are today, but as they were when the light that arrives in their instruments first set out. Astronomers are keen to use the ELT to investigate how stars and galaxies formed when the universe was young. Early results from the James Webb Space Telescope, launched in 2021, have already turned up an array of stars and galaxies that seem too old to fit easily into existing theories of universal evolution. The ELT could help resolve that mystery.

Assuming, that is, that everything works. When your correspondent visited, the 80-metre-tall steel dome that will shelter the telescope was still being built. Each segment takes around 20 minutes to lift and slot into place; a further six hours are needed to tighten each of the 200 bolts. Work must finish before night, lest gusts of wind blow a panel loose. Once finished, the entire 5,500-tonne dome will be able to rotate so that the telescope can follow the stars as they move across the sky.

One of the few downsides of doing astronomy in Chile is that the country is prone to earthquakes. The telescope will therefore float atop a thin layer of oil. The oil, in turn, will sit atop hundreds of rubber shock absorbers, with the whole lot built on a 3-metre concrete foundation. That will isolate the dome both from earthquakes and any vibrations from the offices and laboratories next door.

The most impressive parts are the mirrors, of which the ELT will have five. Astronomical mirrors are precise, delicate things. Even the comparatively small mirrors of the big VLT telescopes are so heavy that, if not supported properly, they would shatter under their own weight. Engineers must lift

them with a special harness with 15 hooks when they need cleaning.

The ELT's main mirror is so big that it cannot be made as a single piece. Instead Schott, a German optics firm, will make 798 separate pieces that will act as a single mirror. Each is a slightly curved, 1.5-metre-wide hexagonal slice of high-tech glass ceramic that undergoes almost no thermal expansion. The segments are cast in Germany, polished in France, and then mated with supports produced in the Netherlands before being transported to Chile.

Each is checked to ensure it has survived the trip unscathed. Ricardo Parra, an ELT engineer, likens the process to ringing a bell. Vibrations are induced in the glass, and measurements made by accelerometers in strategic locations. The segments are finished by coating them with several further layers of chemicals, including a 100-nanometre layer of silver that provides the reflectivity. (A nanometre is a billionth of a metre.) That silver is protected from tarnishing by a layer of hard silicon nitride glass. Even so, the ESO thinks each segment will need re-coating every two years.

Getting all 798 segments to work together presents another set of difficulties. To produce a usable image each segment must be held in a precise position, with an accuracy of just tens of nanometres. Each is backed by a system of sensors and motors that can subtly deform the surface of the glass in order to correct for warping due to everything from small temperature variations to the changing angle of gravity as the mirror moves and tilts.

The primary mirror is just the first stop (see diagram 2). Light hitting it will be redirected towards a secondary and tertiary mirror, which are designed to correct various subtle optical defects. At around 4 metres across, each could be an impressive telescope main mirror in its own right.

The job of the fourth mirror is to counteract the vagaries of Earth's atmosphere. The reason stars appear to twinkle when seen from the ground is that the atmosphere is constantly churning. Frédéric Gonté, an instrumentation engineer at ESO, compares the effect to peering into water. "Try to see the ground of the swimming pool, you can see it is moving," he says. "The atmosphere is doing that to us."

Space telescopes avoid this problem by flying above the atmosphere. Ground-based ones can rely instead on a technology called adaptive optics. This involves deforming the surface of a mirror to cancel out the distortions imposed by the air. The technology is not unique to the ELT. Many modern telescopes sport it, including one of the VLT's big telescopes (it is being added to the other three). But the ELT's sheer size makes it more susceptible to atmospheric distortion than smaller telescopes. More than 5,000 actuators behind the ELT's fourth mirror will make tiny, rippling adjustments to its shape a thousand times each second. Without the adjustments, the ELT's images would be hopelessly blurred.

Working out exactly how the mirror must be deformed, millisecond by millisecond, requires the presence in the sky of something whose shape is known in advance. Comparing what the telescope actually sees with what it should see reveals the state of the atmosphere at that particular moment, allowing the system to counteract it. Often the object in question is a bright star near the object being studied. If no convenient star is available, though, astronomers can create an artificial one. "Laser guide stars" are made by firing four bright orange laser beams upwards so that they converge in a single point around 90 kilometres up, above the atmosphere's thickest layers. Because the system knows exactly what the ersatz star should look like, it can make whatever mirror-twisting adjustments are needed.

You might think that once the ELT is up and running, all other telescopes will be rendered obsolete. That is not really true, for even a machine such as

the ELT cannot do everything. The twin Keck telescopes in Hawaii, for example, once the world's largest, have mirrors that are a comparatively puny ten metres across. But they have the advantage of sitting on a substantially taller mountain, where the seeing is even better than it is in Chile. And the fact that there are two of them means they can serve twice as many astronomers at once.

The VLT, and other multi-mirror telescopes, can also use a technique called interferometry, a clever way of combining signals such that resolving power depends not on the size of individual mirrors, but on the distance between them. For the VLT that is more than 100 metres. On the other hand, that resolving power comes at the cost of a narrower field of view. The ELT is not competing with telescopes like the VLT, says Dr Gonté. "It's completing."

Ain't no replacement for displacement

But when it comes to detecting the dimmest and most distant objects, there is no substitute for sheer light-gathering size. On that front the ELT looks like being the final word for the foreseeable future. A planned successor, the "Overwhelmingly Large Telescope", would have sported a 100-metre mirror. But it was shelved in the 2000s on grounds of complexity and cost. The Giant Magellan Telescope is currently being built several hundred kilometres south of the ELT on land owned by the Carnegie Institution for Science, an American non-profit, and is due to see its first light some time in the 2030s. It will combine seven big mirrors into one giant one with an effective diameter of 25.4 metres. Even so, it will have only around a third the light-gathering capacity of the ELT.

A consortium of scientists from America, Canada, India and Japan, meanwhile, has been trying to build a mega-telescope on Hawaii. The Thirty Meter Telescope would, as its name suggests, be a giant—though still smaller than the ELT. But it is unclear when, or even if, it will be finished.

Construction has been halted by arguments about Mauna Kea, the mountain on which it is to be built, which is seen as sacred by some. For the next several decades, it seems, anyone wanting access to the biggest telescope money can buy will have to make their way to northern Chile. ∎

极大望远镜将让天文学改观

它将是世界上遥遥领先的第一大光学望远镜，也是一台强大的时间机器【深度】

智利北部高海拔的阿塔卡马沙漠（Atacama）上日落降临，天空中变幻的色彩引领着欧洲南方天文台（European Southern Observatory，以下简称ESO）驻智利天文学家约瑟夫·安德森（Joseph Anderson）。"晚霞一开始是蓝绿交映，渐渐变得越来越紫，这时我们差不多可以开始观察宇宙了。"夜幕降临后，璀璨的银河横贯中天。海拔2000多米的此时此刻令笔者叹为观止。

在阿塔卡马沙漠有十多个不同的天文观测站，这是有充分理由的。这里远离人类文明的光污染。空气稀薄而干燥，可以提高天文学家所说的"视宁度"。阿塔卡马沙漠平均每年有325个夜晚晴空万里。安德森站在帕拉纳尔山（Cerro Paranal）山顶，向记者展示着"甚大望远镜"（Very Large Telescope，以下简称VLT）。VLT由四个独立的望远镜组成，每一个都是世界上最大的望远镜之一，旁边还有另外四个小得多的望远镜。VLT是地球上产出成果最多的天文设施，每天产出一篇以上的科学论文。2004年，它拍下了第一张太阳系外行星的照片（即一颗围绕太阳以外的恒星运行的行星），并且首次观测到围绕银河系中心巨大黑洞旋转的恒星。

但VLT可能没法保持世界最大望远镜的头衔太久了。在距离VLT一个小时车程、海拔3046米的阿玛索内斯山（Cerro Armazones）的山顶上，屹立着尚未完工的极大望远镜（Extremely Large Telescope，以下简称ELT）。（ESO喜欢毫无新意的名字。）和太多大型项目一样，ELT的施工进度已经延误。但等建成后（按目前的计划将于2028年竣工，造价15亿欧元[16亿美元]），它将成为已知宇宙中遥遥领先的第一大光学望远镜。ESO的天文学家罗伯特·德·罗莎（Robert de Rosa）表示，这将使"观测天文学的能力向前迈进一大步"。

光学望远镜通过一组镜片收集来自太空的光，并将其投射到各种仪器上。

口径更大的镜面可以收集更多的光，意味着相比口径较小的镜面，它可以看到更暗的物体，成像也更清晰。ELT的主镜口径将达到39.3米，是VLT那几个大型望远镜（8.2米）的四倍多，也是加那利群岛（Canary Islands）上加那利大型望远镜（Gran Telescopio Canarias，以下简称GTC）的三倍多，口径10.4米的GTC是目前世界上最大的望远镜。由于望远镜的探测能力取决于其镜面面积，因此只看口径会低估它们之间的能力差异。GTC的镜面集光面积约为75平方米，而ELT将达到978平方米，略小于四个网球场的面积之和（见图1）。

这么大的面积对于天文学的许多分支来说都是福音。从黑洞在塑造宇宙大尺度结构中的作用，到暗物质和暗能量如何影响宇宙膨胀的速度，乃至我们所认为的物理常数放在广阔的星系际距离中是否真的是恒定的，ELT将帮助解答各种谜题。

它还将大大推动对太阳系外行星的研究。如今，大多数系外行星的存在都是根据它们对其母星发出的光的影响来推断的，很少能拍到它们本身的照片（所谓直接成像）。在大约5500颗已知系外行星中，科学家只有其中约1%的行星的照片。

| 时间和空间的相对维度

ELT的巨大镜面将使天文学家能够将数十光年之外的行星的微弱光芒与其恒星的强烈眩光区分开。这样就应该可以对系外行星大量直接成像。直接成像还将有助于揭示系外行星大气的化学成分，以及是否有任何行星存在外星生命的迹象。

由于望远镜也是时间机器，ELT将能让科学家更深入了解宇宙刚形成后不久的情况。由于光速是有限的，天文学家看到的遥远物体并不是当天的样子，而是望远镜收集到的光线从这些星体发出时的样子。天文学家热切期盼着利用ELT来研究在宇宙年轻时恒星和星系是如何形成的。2021年发射的詹姆斯·韦伯太空望远镜（James Webb Space Telescope）的初期结果已经发现了一系列恒星和星系，它们都似乎非常古老，不太符合现有的宇宙演化理论。ELT可以帮助天文学家解开这个谜团。

这一切的前提是ELT能按计划竣工。在笔者采访时，用于保护望远镜的80米高钢制圆顶仍在建造中。每一块钢板需要约20分钟才能吊起并安装到位，还需要6小时一个个拧紧200个螺栓。每天的工作必须在夜晚之前完成，以免阵风将钢板吹松。完工后，这个5500吨重的圆顶将能够整体旋转，让望远镜得以追踪在天空中移动的恒星。

在智利建设天文台的少数缺点之一是该国容易发生地震。因此，望远镜将浮在一层薄薄的油膜之上，油膜之下放置了数百个橡胶减震器，再往下是3米高的混凝土基座。这将使圆顶免受地震以及隔壁办公区和实验室产生的任何振动的影响。

ELT最令人印象深刻的部分是五个反射镜。天文镜片精密易碎。即使是VLT的那些大型望远镜中相对较小的子镜也很重，如果支撑不当，就会在自重作用下破碎。需要清洁时，工程师必须用带有15个挂钩的特殊安全带将它们吊起。

ELT的主镜太大，无法做成一整张镜面。德国光学公司肖特（Schott）将制造798个独立子镜组成一面主镜。每面子镜都是对角线1.5米的六角形，有一点曲度，用几乎不会热膨胀的高科技玻璃陶瓷制成。这些子镜的镜坯在德国制作，在法国抛光，与荷兰生产的支架组装好后运往智利。

每一面子镜都会经过检查，以确保在运输途中完好无损。ELT的工程师里卡多·帕拉（Ricardo Parra）将这个过程比作敲钟。在玻璃中引起振动，用放置在关键位置的加速度计测量振动幅度。每一面子镜都会再涂上几层化学物质，其中包括提供反射能力的100纳米厚的银。（一纳米为十亿分之一米。）最后再加一层坚硬的氮化硅玻璃以防止银失去光泽。即便如此，ESO认为每面子镜每两年就需要重新做涂层。

要让全部798面子镜协同工作还带来了另一类困难。为了生成可用的图像，每面子镜所在的位置必须十分精确，精度公差仅为数十纳米。每面子镜都由一套传感器和电机支持，它们可以让玻璃表面微微变形，以纠正从微小的温度变化到主镜移动和倾斜时重力角度变化等各种原因造成的翘

曲。

主镜只是光线到达的第一站（见图2）。照射到主镜上的光线将被折射到第二块和第三块副镜上，它们的作用是纠正各种细微的光学缺陷。每块副镜的口径约4米，本身就可以充当一个较大型望远镜的主镜。

第四块副镜的作用是抵消地球大气层的干扰。之所以从地面上会看到星星在闪烁就是大气湍流的影响。ESO的仪表工程师弗雷德里克·冈特（Frédéric Gonté）将这种效果比作向水中凝望。"试着看看游泳池的池底，你会看到它在动。"他说，"大气层就给我们造成了这种幻象。"

空间望远镜通过在大气层上方飞行来避免这个问题。地面望远镜则可以依靠一种称为自适应光学的技术，即通过让镜面变形以抵消大气造成的扭曲。该技术并非ELT独有。许多现代望远镜都有自适应光学系统，比如VLT的一个独立大型望远镜（其他三个望远镜也正在配备该系统）。但ELT非常庞大，比小型望远镜更容易受到大气湍流造成扭曲的影响。ELT的第四块副镜后面有5000多个促动器，每秒都会对其形状进行一千次联动式微调。如果不做这种调整，ELT的成像将会极其模糊。

要精确计算出每一毫秒间镜面要如何调整，需要天空中有某个形状预先已知的物体。将望远镜实际看到的这个物体的成像与应该看到的成像比较，就可以揭示这一时刻的大气状态，让系统能够抵消它的光学扭曲。通常，这样的物体是正在观测的物体附近一颗明亮的恒星。不过，如果附近没有恒星方便使用，天文学家可以创造一颗人造恒星。向天空发射四束明亮的橙色激光束，让它们在距离地面约90公里处汇聚到一个点上，就形成了"激光导星"，这个高度已经高过了大气层最稠密的部分。因为系统确切地知道这颗人造星应该是什么样子，所以它可以随时根据需要调整镜面的曲率。

你可能会认为，一旦ELT投入使用，所有其他望远镜就都过时了。但事实并非全然如此，因为即使是像ELT这样的仪器也无法完成所有任务。例如，夏威夷的那两台凯克望远镜（Keck）曾经是世界上最大的望远镜，其

镜面口径相对较小，只有十米。但它们的优势是所在的山峰要高得多，那里的视宁度甚至比智利还要好。而且有两台望远镜，就可以同时为两倍之多的天文学家提供服务。

VLT和其他多镜面望远镜还可以使用"干涉测量法"，这是一种组合信号的巧妙方法，让分辨率不取决于单个子镜的大小，而是取决于它们之间的距离。对于VLT而言，这就让它的组合等效口径超过了100米。另一方面，高分辨率是以视野变窄为代价的。冈特表示，ELT并不与VLT等望远镜竞争，"而是它们的补充。"

| 无可替代

但说到观测最暗和最远的物体，巨大尺寸的聚光镜面是无可替代的。在这方面，ELT在可预见的未来似乎将无与伦比。计划中的下一个更大的"绝大望远镜"（Overwhelmingly Large Telescope）口径将达到100米。但由于复杂度和成本原因，它的建造计划在2000年代搁置。在ELT以南数百公里处，巨型麦哲伦望远镜（Giant Magellan Telescope）目前正在美国非营利组织卡内基科学研究所（Carnegie Institution for Science）拥有的土地上建造，预计将在2030年代的某个时候收集到第一束光。它将把七面大尺寸子镜组合成一面有效口径为25.4米的巨大主镜。即便如此，它的聚光能力也只有ELT的三分之一左右。

与此同时，一个成员来自美国、加拿大、印度和日本的科学家联盟直力图在夏威夷建造一台巨型望远镜，取名三十米望远镜（Thirty Meter Telescope，以下简称TMT）。听名字就知道它的尺寸很大，但仍然比ELT小。不过目前还不清楚它何时能建成，甚至是否能建成。由于TMT选址在被一些人视为圣山的莫纳克亚山（Mauna Kea），相关争议已导致该项目暂停。看来在接下来的几十年里，想要使用花钱就能建成的最大的望远镜，就只能前往智利北部了。■

How a Canadian company became the world's best acquirer of tech firms

Meet Constellation Software, tech's Berkshire Hathaway

FOR OLDER startups these are tough times. The weak recent stockmarket debuts of Arm, a British chipmaker, Instacart, a grocery-delivery group, and Klaviyo, a software firm, have dampened enthusiasm for initial public offerings. Venture capital (VC) has dried up. Data from PitchBook, a research firm, show that late-stage startups need almost three times as much money as is available to them. Many are putting themselves up for sale. Acquisitions of private firms valued at $100m or more are at their highest since September 2022.

One happy buyer is Constellation Software. The Canadian firm's targets must have sales of at least $5m and show consistent revenue and profit growth. A strong management team, preferably founder-led, is a plus. Though it has splurged on larger deals, the median value of firms it acquires is around $3m. According to Royal Bank of Canada (RBC), since 2005 Constellation has spent $8.7bn on more than 860 firms (see chart 1). In that time its revenue has grown by about 25% a year on average. This year it could exceed $8bn. The company's market value is up by a big-tech-like 250% in the past five years, to $50bn, outperforming the tech-heavy NASDAQ index (see chart 2). It is now Canada's second-largest tech firm after Shopify, an e-commerce platform.

Whether by fluke or design, Constellation's dealmaking success is based on principles that look strikingly similar to those of the world's heavyweight acquirer, Berkshire Hathaway. Like Warren Buffett, Berkshire's boss, and his right-hand man, Charlie Munger (who died on November 28th), the founder and president of Constellation, Mark Leonard, seeks out

businesses with a lasting competitive edge. In Constellation's universe, such a "moat" is enjoyed by software firms that specialise in building digital wares for unsexy industries from car dealerships and builders to spas. Tech giants shun these relatively piddling markets and smaller rivals lack the requisite know-how. The result is rich profits for the incumbents.

After a deal is done Constellation, much like Berkshire, runs the business with benevolent neglect. It does not integrate newly acquired companies or parachute in fresh managers. It is content to leave day-to-day operations to the existing leadership. It does not desperately try to squeeze out inefficiencies by centralising common business functions. Constellation believes that splitting a business weakens its bond with customers, notes Paul Treiber of RBC. Cash from the subsidiaries flows to the parent company, which uses it to buy new businesses. These in turn generate more cash, and so on.

To manage over 800 firms, Constellation is structured as a holding company with six large operating groups. Businesses in similar markets are grouped together. In 2021 Constellation floated Topicus, an operating entity that generated 14% of the firm's total revenue and is now valued at $5.8bn. When any of the other five big operating units get large enough, they, too, may be listed. As with Topicus, Constellation would retain control of the board.

Like Berkshire but in contrast to private-equity or VC funds, Constellation has no exit clock ticking. It can thus be patient with investment decisions. Mr Leonard's annual letters to investors echo Mr Buffett's in describing the company as a "good perpetual owner". This marathon mentality shapes employee pay. Bonuses are tied to returns on invested capital rather than just revenue growth. Executives must invest three-quarters of their bonus in company stock, which they cannot sell for four years. This aligns management's incentives with those of shareholders.

Constellation's success reveals an important truth about mergers and acquisitions that would also be familiar to Mr Buffett: serial acquirers tend to outdo occasional dealmakers. Tobias Lundberg of McKinsey, a consultancy, calculates that regular buyers on average generate about two percentage points more in excess total returns to shareholders annually compared with irregular ones.

Mr Lundberg puts this edge down to practice. As with exercise, the more buying a company does, the better it gets. A few firms like Tyler Technologies from Texas and Roper Technologies from Florida are trying to emulate Constellation's workout regime of picking up niche software makers. None has so far come close to matching the Canadian company's muscle. ■

一家加拿大公司如何成为全球最佳科技公司收购者

来认识下星座软件，科技界的伯克希尔·哈撒韦

对于老牌创业公司来说，这是个艰难的时期。英国芯片制造商安谋（Arm）、杂货配送公司Instacart和软件公司Klaviyo近期挂牌上市的表现不佳，打击了市场对IPO的热情。风险投资（VC）资金已经枯竭。研究公司PitchBook的数据显示，处于后期阶段的创业公司所需资金几乎是可获得资金的三倍。许多公司正在寻求出售。被以1亿美元或更高的价格收购的私人公司数量达到了自2022年9月以来的最高峰。

其中一个心满意足的买家是"星座软件"（Constellation Software）。要成为这家加拿大公司的收购目标，销售额至少要达到500万美元，收入和利润也须显示持续增长。强大的管理团队（最好由创始人领导）是个加分项。尽管该公司在较大规模的交易上花费不菲，但所收购公司的中位数价值约为300万美元。根据加拿大皇家银行（RBC）的数据，自2005年以来，星座软件已斥资87亿美元收购了860多家公司（见图表1）。在此期间，其收入年均增长约25%。今年的收入可能超过80亿美元。在过去五年中，该公司市值以堪比大科技公司的势头猛增250%，达到500亿美元，超过了科技股主导的纳斯达克指数（见图表2）。它现在是加拿大第二大科技公司，仅次于电子商务平台Shopify。

不管是因为运气还是有意为之，星座软件的成功交易所遵循的一些原则看起来与全球重量级收购者伯克希尔·哈撒韦惊人地相似。与伯克希尔的老板沃伦·巴菲特和他的得力助手查理·芒格（于11月28日去世）一样，星座软件的创始人兼总裁马克·莱昂纳德（Mark Leonard）寻觅的也是具有持久竞争优势的企业。星座软件"宇宙"中的软件公司就拥有这样的"护城河"，这些公司专门为汽车经销商、建筑商和水疗中心等不那么光鲜的行业构建数字产品。科技巨头看不上这些相对较小的市场，而较小的竞争对手又缺乏所需的专业知识。结果就是这些既有公司获得了丰厚的利润。

一项交易达成后，星座软件也如伯克希尔一样，以"善意的忽略"来经营业务。它不会整合新收购的公司，也不会空降新的经理人。它放心地让现有领导层负责日常运营，也不会集中共同业务职能以竭力铲除低效。加拿大皇家银行的保罗·特雷伯（Paul Treiber）指出，星座软件认为拆分业务会削弱与客户的联系。子公司的现金流向母公司，母公司再用这些现金收购新企业，而新企业又会产生更多的现金，如此循环。

为了管理800多家公司，星座软件采用了一个控股公司下设六个大型运营集团的结构。在相似的市场里经营的业务被组合在一起。星座软件旗下的Topicus于2021年上市，该经营实体占公司总收入14%，目前估值为58亿美元。其余五大运营单位变得足够壮大时，可能也会上市。和对Topicus一样，星座软件将保留对董事会的控制权。

与伯克希尔类似、但与私募股权基金或风投基金不同的是，星座软件没有既定的退出时间。因此，它可以在投资决策上不急不躁。莱昂纳德在每年的致投资者信中将自己的公司描述为一个"优秀的长期持有者"，与巴菲特的说法如出一辙。这种从长计议的心态也体现在员工薪酬上。奖金不仅仅要看营收增长，还与投资资本回报挂钩。高管必须将四分之三的奖金投资于公司股票，四年内不得出售。这就使管理层的激励机制与股东的利益相一致了。

星座软件的成功揭示了一个关于并购的重要真理，巴菲特对此也不会陌生：连续收购者往往胜过偶尔的交易者。咨询公司麦肯锡的托比亚斯·隆德伯格（Tobias Lundberg）估算，与不常收购的公司相比，经常收购的公司平均每年为股东带来的超额总回报要高出约两个百分点。

隆德伯格将这种优势归结为熟能生巧。正如体育锻炼一样，一家公司收购的次数越多，就越得心应手。来自得克萨斯州的泰勒科技（Tyler Technologies）和来自佛罗里达州的儒博科技（Roper Technologies）等少数公司试图效仿星座软件的"健身"方案，收购利基软件制造商。然而，迄今没有一家公司的块头能与这家加拿大公司相媲美。■

How to succeed—and fail—as a foreign business in India

Why some companies are staying put while others up sticks

THE RECENT history of foreign business in India is littered with failures. Even as the country has tried to lure global businesses keen to diversify into a fast-growing emerging market and, amid rising geopolitical tensions, away from China, many multinational companies are throwing in the towel. Notable departures over the past couple of years include Abu Dhabi Commercial Bank; Ford, an American carmaker; Holcim, a Swiss cement giant; and Metro, a German retailer. Disney is negotiating the sale of all or part of its streaming business. On November 24th Berkshire Hathaway, a $780bn American investment Goliath, offloaded its 2.5% stake in Paytm, an Indian payments processor.

These are only the latest companies to call it quits. Inbound foreign direct investment has been flat since 2018. Although nearly 11,000 foreign firms entered India between 2014 and 2021, a government report found that 2,783 had left or closed in that period—a dispiritingly high number for a supposedly fast-charging economy.

Some were probably put off by practical challenges, such as clogged roads, unbreathable air and patchy telecoms networks. Some no doubt balked at the legal obstacles to hiring workers, buying land or paying the right taxes. Some may simply have felt unwelcome; local bureaucrats and business leaders often see foreigners as a direct threat to domestic interests. Crucially, many fared less well than home-grown rivals. According to BCG, a consultancy, their gross operating margins average 12%, against 15% for Indian firms. When confronted by India's reality, as opposed to its potential, plenty of excited foreign chief executives quickly find themselves "disabused", sighs a consulting boss.

Plenty, but not all. Dove soap, Knorr stock cubes and other consumer staples made by Hindustan Unilever, the Indian arm of a British giant, can be bought in 9m shops across the country. India's top car-seller is Maruti Suzuki, a joint venture with a Japanese firm, followed by Hyundai of South Korea. Honda of Japan may soon dethrone Hero, an Indian rival, as the bigger maker of two-wheelers. Indians snap up Samsung phones and use WhatsApp, part of Meta's social-media empire, to talk private and, increasingly, commercial business. They make half of all their digital payments via PhonePe, which is owned by Walmart, an American retailer.

Far from quitting, some foreign companies are doubling down on their Indian bets. Which businesses persevere—and why—helps understand what it takes to succeed in India as a foreign enterprise.

One group of corporate outsiders that can thrive in India are those whose business is aligned with the priorities of the Indian state, such as boosting export-oriented manufacturing. Apple has become the poster child of this approach, by moving some iPhone-making to contract manufacturers setting up shop in India. Vestas of Denmark and Senvion of Germany are producing wind turbines for sale abroad. Tesla is reportedly negotiating lower import tariffs on its electric cars in exchange for setting up an electric-car factory.

An indirect way to shore up India's economic ambitions is to help build the roads, ports and other infrastructure needed to get products from the factories to faraway markets. An investment manager at a big financial firm lists the Indian subsidiaries of engineering companies as good wagers on Indian growth. Over the past ten years ABB's Indian affiliate has generated annual total stockmarket returns of 21%, two and a half times those of its Swedish-Swiss parent. America's Honeywell averaged 11% globally but 28% for its Indian arm.

Another successful group are foreigners who make an effort to indigenise their Indian business. Some team up with well-connected locals. Google and Meta have invested billions of dollars in partnerships with Reliance Industries, India's biggest conglomerate, whose Jio telecoms unit brought mobile internet to 440m Indians. In August BlackRock, the world's biggest asset manager, returned to India in a joint venture with Reliance. Its earlier foray involving a smaller partner was discontinued in 2018. If this time works out, BlackRock will have succeeded where those trying to go it alone, such as Fidelity, had failed. SAIC Motor, a Chinese car firm, is reportedly looking to sell a large stake in MG Auto, a local subsidiary facing a pernickety tax exam, to JSW, India's steel champion.

Outsiders have other ways to make their business more Indian. Rather than run its Indian bank from its home in Singapore, DBS set up a local affiliate complete with an Indian board accountable to Indian regulators. Walmart strengthened its Indian presence by acquiring a controlling stake in Flipkart, a local e-commerce platform, in 2018. In July the American retailer increased its interest by buying the stakes held by two American tech-investment firms, Tiger Global and Accel.

One last important group is staying put—firms that are already big in India. Often, says the India head of a sovereign wealth fund, they flourish not by creating new markets but by replacing informal provision of existing goods and services. Many, similarly to ABB and Honeywell, earn better returns from their Indian subsidiaries, notes Nikhil Ojha of Bain (see chart). Some, like Hindustan Unilever or Maruti Suzuki, have been in the country for decades. Many Indians would consider them homegrown.

Some are not so well liked, at least at first. Since it entered India ten years ago, Amazon has faced limits on local acquisitions, restrictions on selling own-label products, rules on inventory size and accusations that it threatened millions of kirana corner shops. Rather than give in, the e-

emporium has stood firm. In June its boss, Andy Jassy, said it would invest an extra $6.5bn in India by 2030, bringing its total spending in the country to $26bn. It is expanding its e-commerce distribution network and building cloud-computing data centres. In November it launched FanCode, a channel on its Prime Video streaming service dedicated to sports including cricket, the national pastime.

This resolute approach appears to be paying off. Resistance to Amazon's Indian growth seems to be easing among government officials, who may have concluded that its logistical expertise is what India needs to connect its factories to the world. Billions of dollars in promised investments can't have hurt, either. ■

外企如何在印度成功——或失败

为什么有些公司扎下根来，有些在撤离

回顾不算久远的历史，外国企业在印度失败的案例比比皆是。一些寻求多元化的全球企业渴望进入快速增长的新兴市场，随着地缘紧张局势不断加剧，还希望撤离中国。就在印度想方设法吸引这些企业的同时，许多跨国公司正纷纷离开这里。过去几年，退出印度的知名外企有阿布扎比商业银行（Abu Dhabi Commercial Bank）、美国汽车制造商福特、瑞士水泥巨头豪瑞（Holcim），以及德国零售商麦德龙等。目前迪士尼正在就出售它在印度的全部或部分流媒体业务进行谈判。11月24日，市值7800亿美元的美国投资巨头伯克希尔·哈撒韦（Berkshire Hathaway）清仓了所持印度数字支付公司Paytm全部2.5%的股份。

这些还只是最近退出的公司。自2018年以来，印度的外国直接投资一直无甚起色。尽管2014年至2021年间有近1.1万家外企进入印度，但一份政府报告发现，同期撤离或关闭的外企多达2783家——对于一个被认为正在高速发展的经济体来说，这个数字高得令人沮丧。

有些公司对印度望而却步可能是因为一些客观存在的困难，比如道路堵塞、空气糟糕以及电信网络覆盖不全等。但毫无疑问，有些公司踟蹰不前则是因为在雇用员工、购买土地或合理纳税方面遇到的法律障碍。有些可能就是感觉自己不受待见，因为地方官员和商界领袖常常视外国公司为对本土企业的直接威胁。关键是，许多外国公司发展得不如印度本土对手。根据波士顿咨询公司的数据，外国公司的平均毛营业利润率为12%，而印度公司为15%。当面对与印度透出的潜力反着来的现实，许多原本怀着兴奋之情的外企CEO"幡然醒悟"，一位咨询公司的老板叹道。

这样的公司有很多，但不是全部。英国巨头联合利华的子公司印度斯坦联合利华（Hindustan Unilever）生产的多芬香皂、家乐浓汤宝和其他日常消费品在印度各地900万家商店都有售。印度最大的汽车销售商马鲁蒂铃

木（Maruti Suzuki）是一家与日本合资的公司，第二大汽车销售商则是韩国的现代。日本的本田可能很快就会超过印度对手Hero，成为更大的摩托车制造商。印度人抢购三星手机，使用社交媒体帝国Meta旗下的WhatsApp聊私事，并越来越多地将它用于商务洽谈。他们一半的数字支付都是通过美国零售商沃尔玛拥有的PhonePe完成的。

一些外国公司非但没有退出，反而加倍在印度下注。哪些企业锲而不舍？又是出于什么原因？弄清这两个问题有助于了解外企在印度的成功要素。

首先，能在印度蓬勃发展的一类外国公司是那些自身业务与印度政府的发展重点相一致的企业，比如能够促进出口导向型制造业发展的企业。苹果便是一个典型，它将部分iPhone的制造转移到了在印度开设的代工厂。丹麦的维斯塔斯（Vestas）和德国的Senvion的印度工厂正在生产销往国外的风力涡轮机。据说特斯拉正以在印度建厂作为交换条件，就降低其电动汽车的进口关税与印度谈判。

外国企业帮助修建公路、港口和其他基础设施，从而将产品从工厂运往遥远的市场，也会间接助力印度成就其经济雄心。鉴于印度的经济增长，一家大型金融公司的投资经理把工程企业的印度子公司列为优质投资对象。在过去的十年里，ABB印度分公司的年股市投资总回报率达到21%，是其瑞典和瑞士合资母公司的2.5倍。美国公司霍尼韦尔的全球平均收益率为11%，而其印度子公司为28%。

还有一类外国公司之所以成功，是因为它们努力让自己在印度的业务本土化。一些公司与人脉甚广的本土企业合作。谷歌和Meta已投资数十亿美元，与印度最大的企业集团信实工业（Reliance Industries）建立合作关系，信实旗下电信公司Jio为4.4亿印度人提供移动互联网服务。今年8月，全球最大的资产管理公司贝莱德（BlackRock）重返印度，与信实成立了一家合资企业。贝莱德之前曾与一家较小的印度公司合作并于2018年终止了合作关系。如果此次合作进展顺利，贝莱德将在富达（Fidelity）等公司曾试图凭一己之力拿下却败下阵来的领域取得成功。据报道，中国汽车公司上汽集团正打算将其面临严苛税务审查的印度子公司MG Auto的大量

股份出售给印度钢铁龙头企业JSW。

外国公司还有其他办法让自己的业务更加印度化。星展银行没有将其印度分行的领导权放在新加坡本部，而是在印度设立了一家分支机构，建立印度董事会对印度的监管机构负责。2018年，沃尔玛通过收购印度本土电商平台Flipkart的控股权，巩固了在印度的根基。今年7月，沃尔玛又加大押注，收购了两家美国科技投资公司老虎环球（Tiger Global）和Accel所持有的Flipkart的股份。

最后一个重要的群体在印度稳扎稳打，它们就是那些已经在印度发展壮大的公司。一家主权财富基金的印度负责人表示，这些公司能够做大做强，往往不是因为开创了新市场，而是取代了既有的非正规商品和服务供应。其中许多与ABB和霍尼韦尔一样，其印度子公司的收益率高于母公司，贝恩的尼基尔·欧嘉（Nikhil Ojha）指出（见图表）。有些公司，比如印度斯坦联合利华以及马鲁蒂铃木等，已经在印度经营了几十年。许多印度人都愿意视它们为本土公司。

也有一些外国公司不大受待见，至少一开始是这样。亚马逊自十年前进入印度以来，一直面临各种障碍，比如限制其并购本土企业、销售自有品牌产品，规定其库存规模，以及指控其对街头巷尾数以百万的小卖部生存构成威胁等等。不过这家电子商务巨头没有退却，而是选择了坚守。今年6月，亚马逊CEO安迪·贾西（Andy Jassy）表示，在2030年前，亚马逊将在印度追加65亿美元的投资，使其在印度的总投资达到260亿美元。它正在扩大其电子商务配送网络，并建立多个云计算数据中心。11月，亚马逊在其流媒体服务Prime Video上推出了FanCode频道，专门播放有印度"国球"之称的板球等体育节目。

这种坚持不懈的做法看上去奏效了。印度政府官员似乎正在放松对亚马逊在印度扩张的抵制。他们可能得出了结论，认为亚马逊在物流上的专长正好契合了印度将其工厂与世界连接起来的需要。况且，亚马逊承诺的数十亿美元投资也不会有什么坏处。■

How not to motivate your employees

Douglas McGregor's prescient writing on management and motivation

HERE ARE some handy rules of thumb. Anyone who calls themselves a thought leader is to be avoided. A man who does not wear socks cannot be trusted. And a company that holds an employee-appreciation day does not appreciate its employees.

It is not just that the message sent by acknowledging staff for one out of 260-odd working days is a bit of a giveaway (there isn't a love-your-spouse day or a national don't-be-a-total-bastard week for the same reason). It is also that the ideas are usually so tragically unappreciative. You have worked hard all year so you get a slice of cold pizza or a rock stamped with the words "You rock"?

This approach reveals more about the beliefs of the relevant bosses than it does anything about what actually motivates people at work. In a book published in 1960, called "The Human Side of Enterprise", Douglas McGregor, a professor at MIT Sloan School of Management, divided managers' assumptions about workers into two categories. He called them theory X and theory Y.

McGregor, who died in 1964, was a product of his time. The vignettes in the book feature men with names like Tom and Harry. But his ideas remain useful.

Theory X managers believe that people have a natural aversion to work; their job is to try and get the slackers to put in some effort. That requires the exercise of authority and control. It relies heavily on the idea of giving and withholding rewards to motivate people. Perks and pizza fit into this

picture but pay is critical to theory X; work is the price to be paid for wages.

Theory Y, the one McGregor himself subscribed to, is based on a much more optimistic view of humans. It assumes that people want to work hard and that managers do not need to be directive if employees are committed to the goals of the company. It holds that pay can be demoralising if it is too low or unfair, but that once people earn enough to take care of their basic needs, other sources of motivation matter more. In this, McGregor was a follower of Abraham Maslow, a psychologist whose hierarchy of needs moves from having enough to eat and feeling safe up to higher-order concepts like belonging, self-esteem and purpose.

Theory X is not dead. It lives on in low-wage industries where workers must follow rules to the letter and in high-wage ones where pay motivates people long after they can feed themselves. It surfaces in the fears of managers that working from home is a golden excuse for people to do nothing. It shows up in the behaviour of employees who phone in and bosses who bully and berate.

Nevertheless, theory Y is in the ascendant. You cannot move for research showing that if people think what they do matters, they work harder. A meta-analysis of such research, conducted by Cassondra Batz-Barbarich of Lake Forest College and Louis Tay of Purdue University, found that doing meaningful work is strongly correlated with levels of employee engagement, job satisfaction and commitment. Trust is increasingly seen as an important ingredient of successful firms; a recent report by the Institute for Corporate Productivity found that high-performing organisations were more likely to be marked by high levels of trust.

Firms of all kinds are asking themselves Y. Companies in prosaic industries are trying to concoct purpose statements that give people a reason to come into work that goes beyond paying the rent. The appeal of autonomy and

responsibility permeates the management philosophy not just of creative firms like Netflix but also of lean manufacturers that encourage employees to solve problems on their own initiative. Some retailers have raised wages in the theory Y belief that reducing workers' financial insecurity will improve employee retention and organisational performance.

McGregor himself wrote that the purpose of his book was not to get people to choose sides but to get managers to make their assumptions explicit. On this score he is less successful. It is still possible to run financially viable firms in accordance with theory X. It is impossible to admit it. ■

如何不激励你的员工

道格拉斯·麦格雷戈关于管理和激励的著作很有先见之明

这里有一些简单易用的经验法则。对任何自称思想领袖的人都敬而远之。不穿袜子的人不可信。还有，设置员工赞赏日的公司并不真的赞赏自己的员工。

一年有26o多个工作日，只拿出其中一天予以员工认可，这传递出的信息本就有点不对劲（同样的道理，世界上可没有"爱配偶日"，也没有全国性的"别做彻头彻尾的王八蛋周"）。更何况，那些用来表达赏识的点子往往漫不经心到了悲催的地步。你一年到头辛勤工作，就是为了一片凉掉的披萨或者一块印着"你'石'在棒"几个大字的石头？

这种方法更多地揭示了那些老板们想当然的见解，而非真正激励员工努力工作的因素。麻省理工学院斯隆管理学院（MIT Sloan School of Management）教授道格拉斯·麦格雷戈（Douglas McGregor）在196o年出版的《企业的人性面》（The Human Side of Enterprise）一书中，将管理者对员工的臆断分为两类，分别称之为X理论和Y理论。

1964年去世的麦格雷戈是他那个时代的产物。书中小花絮的出场角色都叫汤姆和哈利这样的名字。但他的理念至今仍然有用。

X理论管理者认为人生来就厌恶工作，他们的任务就是设法让懒鬼们付出些努力。这就需要行使权威和控制。X理论严重依赖给予或不给予奖励来激励人们。福利和披萨属于这种情况，但在X理论中最关键的还是薪酬：工作就是获得工资的代价。

麦格雷戈本人赞同的Y理论是基于一种对人类乐观得多的看法。它假设人们愿意努力工作，而如果员工致力于实现公司目标，就无需管理者发号施令。该理论认为，如果薪酬过低或不公平，就可能会打击士气，但一旦人

们的收入足以满足他们的基本需求，其他动力来源就更为重要了。在这一点上，麦格雷戈是亚伯拉罕·马斯洛（Abraham Maslow）的追随者，在这位心理学家提出的需求层次中，底层是能吃饱饭和有安全感，再往上便是更高层次的概念，如归属感、自尊和使命感。

X理论并没有消亡。它依旧存活在工人必须严格遵守规章制度的低薪行业，以及薪水在早就能满足温饱之后仍在激励人们的高薪行业。每当管理者担心居家办公成了人们摸鱼的万能借口，或是员工敷衍了事、老板霸凌责骂员工时，都是X理论在浮现真容。

然而，Y理论日益占得上风。数不胜数的研究表明，如果人们认为自己的工作很重要，他们就会更加努力地工作。森林湖学院（Lake Forest College）的卡桑德拉·巴茨-巴尔巴里奇（Cassondra Batz-Barbarich）和普渡大学的路易斯·泰伊（Louis Tay）对这类研究的综合分析发现，做有意义的工作与员工敬业度、工作满意度和忠诚度密切相关。信任越来越被视为企业成功的重要因素。企业生产率研究所（Institute for Corporate Productivity）最近的一份报告发现，高绩效的组织更有可能拥有高水平的信任度。

各行各业的公司都在自问如何让Y理论为己所用。一些平淡乏味的行业里的公司煞有介事地编写使命声明，想给人们一个除了赚房租之外的去上班的理由。自主性和责任心的感召力不仅渗透到像奈飞（Netflix）这样的创意公司的管理哲学中，在鼓励员工主动解决问题的精益制造商那里也是如此。一些零售商提高了工资，因为Y理论促使他们相信减少员工的财务不安全感会提高员工留任率和组织绩效。

麦格雷戈本人写道，他写这本书的目的不是让人们选边站，而是要让管理者坦率阐明自己对员工的假定。就这一点来说，他不太成功。遵照X理论把公司经营得财务状况良好仍然是可能的，但要承认这一点是绝无可能的。■

How to manage teams in a world designed for individuals

If collaboration matters so much, why don't firms do more to promote it?

THERE IS NO "i" in team. But there is one in "autopilot". Despite the growing importance of teamwork in organisations, the processes used to manage employees have carried on much as before. Bosses may wax lyrical about collaboration, but the way they reward, review and recruit has not caught up.

People in organisations have always worked in concert with others. But the emphasis on teams is growing, for a variety of reasons. Technology has made the sharing of ideas and information easier, while hybrid working has made it more vital. (There's a reason it's not called Microsoft Silos.) The software industry has spread the gospel of teams—agile, scrums, OKRs and all the rest of it—into all kinds of places.

Teams, it turns out, are better at solving complex problems, according to a recent paper by Abdullah Almaatouq of the MIT Sloan School of Management. Research also suggests that people have a greater attachment to their work group than to their organisation; you're less likely to go for lunch with a logo.

Knowledge is also accumulating as to what makes teams tick. Project Aristotle, a famous bit of research by Google into the characteristics of its best-performing teams, identified "psychological safety"—comfort to speak one's mind—as the most important ingredient, alongside things like dependability, role clarity and meaningful work. Different teams excel at different things. Analysis by Lingfei Wu of the University of Chicago and his co-authors found a correlation between team size and types of scientific research: larger teams develop existing ideas and smaller ones

disrupt the field with new ones.

But a greater emphasis on, and understanding of, teams does not generally translate into matching management practices. Recruitment processes focus on the achievements of the individual rather than the collectives they have been in. Performance management is still largely a one-player sport. Reviews are usually based on individual targets, as are bonuses. Metrics are often confined to concrete outputs rather than softer team-based measures, such as how trusted people are. It doesn't help that many bosses have little idea what their teams really do. Soroco, a software firm, and academics at Harvard Business School and the Wharton School of the University of Pennsylvania asked managers to describe the processes that they thought took up most of their teams' time. On average they did not know or could not recall 60% of what their team members did, making them more like high-functioning goldfish than bosses.

There are good reasons for much of this. People move jobs and get promoted one by one, not as battalions. Rewarding people on the basis of team performance can lead to unfairness: free-riders might get too much recognition or hard workers might be penalised for someone else not pulling their weight. It's difficult to quantify team contributions. When teams are made up of people from different departments—or form for limited periods—managers find it harder to know what their direct reports are up to.

But these problems are not insurmountable. When hiring people, it is possible to assess traits that make for good group members: scoring well on a test that asks participants to determine what people are feeling from a snapshot of their eyes is correlated with being a good team player, for example. Peer reviews can give a good sense of how people are seen within teams.

The worry that team-based bonuses may encourage free-riding also seems to be overblown. A recent study by Anders Frederiksen of Aarhus University and his co-authors looked at the impact of introducing group-based incentives at a manufacturing firm, and found it sparked a big leap in performance. That jump was not just because the scheme incentivised existing workers to be more efficient, but also because it attracted more productive new hires.

Employees are individuals; managers should never forget that. But if teams are where a lot of the magic happens, bosses should have better ways to get the most out of them. Working out what they do all day might be a good place to start. ■

如何在为个体设计的系统中管理团队

如果合作如此重要，为什么企业不采取更多措施促进合作呢？

"Team"（团队）一词中没有"i"（我）这个字母，但在"autopilot"（自动惯性模式）中却有。尽管团队合作在组织中日益重要，但管理员工的流程基本还是老一套。谈到合作，老板们可能口若悬河，但在奖励、考评和招聘上却没有相应的行动。

处于组织中的人从来都在与其他人协同工作。但对团队的强调越来越多，这有多方面原因。技术让想法和信息共享变得更加容易，而混合工作则让这种共享变得更加重要。（微软的会议软件叫Teams而不是Silos["孤岛"]是有原因的。）软件行业已经将敏捷、敏捷开发框架scrum、OKR（目标与关键成果法）以及其他种种团队合作的信条散播到各个角落。

麻省理工学院斯隆管理学院（MIT Sloan School of Management）的阿卜杜拉·阿尔马图克（Abdullah Almaatouq）最近发表的一篇论文表明，事实证明，团队更擅长解决复杂的问题。还有研究表明，人们对所在的工作团队比对整个企业组织更有感情——你总不大可能和公司标识去吃午餐。

关于是哪些因素让团队有效运作的了解也在不断积累。谷歌著名的亚里士多德项目（Project Aristotle）研究了公司表现最佳的团队的特征，认为"心理安全"（能否放心说出自己的想法）是其中最重要的因素，此外还有团队成员可靠、角色明确和工作有意义等。不同的团队擅长不同的任务。芝加哥大学的吴令飞及其合著者的分析发现，团队规模和科研的类型之间存在相关性。较大的团队发展某一领域内的现有想法，较小的团队用新想法颠覆某个领域。

然而，对团队的重视加强和理解加深通常不会转化为相应的管理实践。招聘流程主要看的是个人已取得的成就，而不是他们过去所在的集体如何。绩效管理在很大程度上仍然只看个人表现。评价通常基于个人目标，奖金

也是如此。衡量标准通常仅基于实际产出，而不是更软性的基于团队的衡量标准，例如人们的受信赖度如何。更糟糕的是，许多老板根本不知道他们的团队到底在做什么。软件公司Soroco以及哈佛商学院和宾夕法尼亚大学沃顿商学院的学者请主管们说出哪些流程最占用手下团队的时间。平均而言，他们不知道或记不起团队成员60%的工作内容是什么，这让他们更像是高功能忘事佬，而不是老板。

这其中大部分情况都是有充分理由的。调动和升迁都是个人行为而非团队行动。根据团队绩效奖励员工可能会导致不公平："白嫖怪"可能会得到过度的奖励，努力工作的人可能会因为其他人没有尽职尽责而承担后果。量化团队贡献很难。当团队的成员来自不同部门，或者团队只是临时组建时，管理者就更难知道他们的直接下属在做什么。

但这些问题并非无法克服。在招聘时是有可能评估候选人是否具有成为优秀团队成员的特质的。例如，有一项测试要求参与者根据对眼睛的快照来判断人的情绪，能在这个测试中取得良好成绩的就可能是优秀的团队合作者。同事评议可以很好地反映个体在团队中的形象。

至于说根据团队表现来发放奖金可能会导致有人坐享其成，这种担忧似乎也被夸大了。奥胡斯大学（Aarhus University）的安德斯·弗雷德里克森（Anders Frederiksen）和合著者最近调查了在一家制造企业引入基于团队的激励措施的影响，发现这种措施引发了绩效的巨大飞跃。出现这种飞跃不仅是因为这样的措施激励了现有员工提高效率，还因为吸引来了生产率更高的新员工。

员工们都是一个一个的人，管理者永远不应该忘记这一点。但如果团队能促成众多奇迹发生，老板就应想出更好的方法来充分利用团队。弄清楚团队一整天在忙什么可能是一个不错的起点。■

Why Monday is the most misunderstood day

What's wrong with the start of the workweek?

WHEN THE Boomtown Rats, an Irish band, released "I Don't Like Mondays" in 1979, the song became an instant hit. The inspiration behind it was the Cleveland Elementary School shooting in San Diego that year. The 16-year-old perpetrator listed "not liking Mondays" as her main reason for firing 36 shots, killing two adults and injuring eight children and a police officer. This is not, though, why the song resonated with millions of people around the world; most of them are in all likelihood unaware of its tragic origins. What many do recognise all too well is the difficulty of summoning the energy to get out of bed on Monday mornings in order to face the week ahead.

Many bosses argue that starting off the week in person in the office creates good energy. Plenty of employees beg to differ. A paper published in 2021 by the Journal of Applied Psychology, found that people tend to be more ill-mannered on Mondays, and grow more courteous as the week unfolds.

A paper from 2015 by Yun Tae Hwang and Amy Kang published in the Medical Journal of Australia goes so far as to diagnose a new condition, Mondayitis. The authors define it as "a systemic illness with a non-specific constellation of symptoms including fatigue, lethargy or asthenia, dysthymia, irritability, light-headedness, photophobia, dry mouth, myalgia and headache in the absence of another focal or systemic illness".

These symptoms typically appear on the first working day after a period off work, which could be a weekend or a longer holiday. They can lead sufferers to call in sick, decide to work from home or, if they do show up in the office, come across as detached and unavailable. So much for good

energy.

Mondayitis appears to be contagious, infecting other days of the week. Some Americans now complain of "Sunday scaries", when pre-Monday dread sets in as the weekend draws to a close. Both conditions can be aggravated by a weekend hangover, a looming deadline or painful memories (double science in secondary school first thing in the morning?). They are likely to be particularly acute among the nearly half of American workers who, according to a poll from 2022 conducted by UKG, an HR-software company, hate their jobs.

Still, the sudden shift from non-work to work affects everyone, not just those who despise what they do for a living. The covid-19 pandemic has led many people to re-evaluate their work-life balance. A barrister in London who spends weekends working on cases likes to ease into the formal workweek with an elegant breakfast at The Delaunay and lunch in Inner Temple Hall. A broader movement is promoting the idea of a four-day workweek, one permutation of which would make Monday part of the weekend (though this may lead to an epidemic of Tuesdayitis instead). Less ambitiously, and more realistically, a social-media campaign for "bare-minimum Mondays" argues for a gentle start to the week.

All this reflects a deep human instinct towards self-indulgence and procrastination; there is a reason why "Thank God it's Monday" does not feature on many bumper stickers or T-shirts. Still, on that first day of the week employees do not have to be mired in apathy, weariness and desire that things were otherwise. As Robert Frost counselled in his poem, "A Servant to Servants", "the best way out is always through."

The preceding 60 hours or so were probably spent with people who have nothing to do with your job. You may have prepared—or merely enjoyed—a more elaborate meal than an al desko sandwich. You may have gone for a

walk in the park or simply lounged in bed. Either way, you almost certainly cleared your head. Unless you capped the weekend off by going on a bender, this means that the following morning could be your most productive time of the week.

For one banker, Monday is the day to cross items off their to-do list. Your columnist, a guest Bartleby, feels crisp and invigorated on Monday mornings (which is when the editorial meetings take place at The Economist, planning and discussing the coming week's issue). The first shower, coffee and commute after the weekend do not have to feel like a hike with a rucksack full of stones. They can instead be imbued with a renewed sense of purpose and, as such, act as a tonic. It is on Friday afternoons when Bartleby feels depleted and cannot wait to go home—until Monday morning, when revived and spirited, she is ready to do it all over again. ■

为什么星期一受误解最深

工作周的第一天有什么不好？

爱尔兰乐队"新城之鼠"（Boomtown Rats）在1979年推出了单曲《我不喜欢星期一》（I Don 't Like Mondays），这首歌迅速爆红。歌曲的灵感来自当年发生在美国加州圣地亚哥市的克利夫兰小学（Cleveland Elementary School）的枪击事件。16岁的罪犯称，"不喜欢星期一"是她连开36枪，导致两名成年人死亡、八名儿童和一名警察受伤的主要原因。当然，全世界千百万人对这首歌深有感触并不是因为枪击案，他们大部分人十有八九都不知道这首歌源自一场悲剧。但很多人对于在星期一清早鼓起勇气起床去开始一周工作的艰难都太清楚不过了。

不少老板认为，员工到办公室开启新的一周会带来正能量。很多员工不这么看。2021年在《应用心理学杂志》（Journal of Applied Psychology）上发表的一篇论文发现，人们在周一往往更粗鲁无礼，但随着一周往后推移，他们会越来越彬彬有礼。

黄润泰（Yun Tae Hwang，音译）和艾米·姜（Amy Kang，音译）2015年在《澳大利亚医学杂志》（Medical Journal of Australia）上发表的一篇论文甚至诊断出一种新型疾病——星期一综合征。作者将其定义为"在没有其他局灶性或全身性疾病的情况下出现的一种具有非特异性症状的全身性疾病，症状包括疲劳、嗜睡或无力、精神不振、易怒、头晕、畏光、口干、肌痛和头痛"。

这些症状通常出现在结束一段休息后的第一个工作日，这段休息可能是周末或更长的假期。患者可能因此请病假、决定居家工作，或是即便人在办公室，也是一副爱理不理、生人勿近的样子。正能量什么的就算了吧。

星期一综合征似乎还会传染，蔓延到一周中的其他日子。如今有些美国人抱怨起了"星期天恐惧"，当周末接近尾声时，即将面临周一的恐惧就来

了。周末宿醉、某个最后期限将近或是痛苦的回忆（中学时周一早上要连上两节科学课？）都会让这两种病情加重。人力资源软件公司UKG从2022年开始的一项民意调查显示在美国有近一半的劳动者讨厌自己的工作，这些人的星期一综合征和星期天恐惧症很可能尤其严重。

不过，从非工作状态突然切换到工作状态会影响到每个人，不仅是那些讨厌自己手头活计的人。新冠疫情让很多人重新评估自己工作与生活的平衡。伦敦一位周末也要处理案子的大律师喜欢在德罗涅饭店（The Delaunay）享用一顿优雅的早餐，然后在内殿律师学院大堂（Inner Temple Hall）享用午餐，让自己轻松缓和地进入正式的工作周。越来越多人在推动每周四天工作制，其中一种安排是把星期一算成周末（不过这可能又会导致"星期二综合征"蔓延开来)。在社交媒体上发起的"最低强度星期一"（bare-minimum Mondays）的运动没这么激进，而是更加现实，主张温和地开启新的一周。

所有这些都反映了人类自我放纵和拖延的深层本能；难怪保险杠车贴或T恤上永远不可能写着"感谢上帝，今天周一"。尽管如此，在一周的第一天，员工们也无需陷入冷漠和倦怠之中不可自拔，或是幻想着能有另一种现实。正如罗伯特·弗罗斯特（Robert Frost）在他的诗《仆人们的仆人》（A Servant to Servants）中提出的忠告："最好的出路永远都是走下去。"

之前的60个来小时你可能是和跟工作无关的人一起度过的。也许你精心准备了——或仅仅是享用了——一顿美食，怎么样也比坐在办公桌前啃三明治强。也许你去了公园散步，或者就是懒洋洋地躺在床上。不管怎样，你几乎一定是头脑清明，神清气爽了。所以接下来的周一上午应该是你一周效率最高的时候，除非你周末净忙着花天酒地了。

对银行家来说，星期一是从待办事项清单上划掉条目的日子。作为本专栏的特邀撰稿人，笔者在星期一早上也是精力充沛（《经济学人》编辑部会在这时开会，计划和讨论这一周的选题）。不必非得把周末过后的第一次起床淋浴、第一杯咖啡和第一趟通勤搞得像是背着一大包石头在徒步一

样。相反，它们可以被注入一种重燃的使命感而帮助你振奋精神。每到星期五下午，笔者就会感到精疲力竭，迫不及待地想回家，直到星期一早上，她才恢复过来，精神抖擞，准备好投入新一周的工作。■

Covid-19 was a disaster for the world's schoolchildren

The costs of wasting brainpower are huge

EVERY THREE years for the past two decades analysts at the OECD, a club of mostly rich countries, have asked pupils in dozens of places to take tests in reading, maths and science, the better to compare the quality of their schools. No one was expecting the latest round of exams, sat a year late in 2022 after years of pandemic-induced disruption, to bring good news. But the results, released on December 5th, are still a blow. An average teenager in the rich world is found to have fallen about six months behind in reading and nine months behind in maths, compared with peers who sat similar tests in 2018. In several rich countries 15-year-olds are performing at levels that back then would have been expected of learners a full year younger.

These findings are all the gloomier because of the discouraging trends that preceded them. Years of international testing suggest that, when the pandemic struck, typical teenagers in the rich world were no more numerate than those schooled some 20 years earlier. In reading and science, average scores have been drifting down for a decade, according to the OECD's yardstick, even though spending has been going up. So there are good reasons to think that grades in the latest exams (often known as the PISA tests) might have slipped even without the turmoil of covid-19.

The sombre school report should rally governments to accomplish two tasks. The first is to renew pandemic "catch-up" programmes, for which energy and funding is beginning to flag even though the job is far from complete. Data released in July by a big test-provider suggest that in the most recent academic year many pupils in America made no faster progress than was normal before the pandemic. This month's PISA results suggest

that America's scores may have fallen back a bit less than in lots of other places—but that means nothing to the millions of youngsters who are nonetheless approaching the end of their school days with yawning gaps in their skills.

A priority of any revamped catch-up schemes should be to bring down absenteeism. In both America and Britain 20-30% of pupils miss at least one lesson in ten, and often many more. This is roughly double the rate before the pandemic. As for pupils who are regularly coming to class, schools could be offering them more lessons than usual. Providing more learning time—in holidays, at weekends and after school—is perhaps the simplest way of getting youngsters back up to speed. But in many places extra hours have been given only a minimal role in catch-up plans; they are expensive because teachers would have to be paid more, or more teachers hired. And the children are not keen.

Governments' second task is to turn around the disheartening long-term trends. International tests offer clues about what works and what does not. Cutting class sizes is often a waste of money; having high-quality teachers matters more. Education budgets could be better focused. Across rich countries, disadvantaged pupils put up with less qualified staff and make do with fewer books. Changing much of this means taking on powerful lobbies, including teachers' unions and wealthy parents. In theory the crisis offers a big opportunity to make such reforms.

All the more reason to regret that politicians are focusing their energies elsewhere. Britain's government has painted its pupils' performance in the PISA tests as a triumph (like America it has drifted up the league tables, but only because its scores collapsed a smidgeon less than the average). The Labour Party, which will probably come to power next year, plans to get tougher on private schools by making them pay tax; they cost the government nothing and get excellent results, but taxing them will

probably force some parents to increase the burden on the public sector. In America, meanwhile, the past few years have seen much energy wasted on fiery but mostly fruitless battles about the teaching of history, gender and race. Neverending disruptions during the pandemic were bad for learning. Schoolchildren must not be let down once again. ■

新冠肺炎是全球学童的灾难

智力浪费代价巨大

在过去二十年里，主要由发达国家组成的经合组织（OECD）的分析师每三年就对几十个地方的学生开展阅读、数学和科学测试，以便更好地比较他们学校的教学质量。由于过去几年里疫情造成的干扰，最新一轮测试在推迟一年后于2022年举行。没人指望它会带来惊喜，但12月5日公布的结果仍是当头一棒。与2018年参加类似测试的同龄人相比，发达国家青少年的阅读能力平均落后了约六个月，数学落后九个月。在几个发达国家，15岁青少年的成绩只达到以前比他们整整小一岁的学生的水平。

在此之前的趋势本就不乐观，这次的结果因而愈发令人气馁。纵观多年的国际测试结果可以发现，疫情来袭时，发达国家一般青少年的算数能力还比不上20来年前的学生。尽管支出一直在增加，但根据经合组织的衡量标准，阅读和科学的平均分数十年来却持续下滑。因此有充分理由认为，即使没有新冠疫情的扰乱，这一次的测试（通常称为PISA测试）成绩也可能会下降。

这份黯淡的成绩单应该促使政府行动起来完成两项任务。首先是继续疫情"追赶"计划，尽管这项工作远未完成，但投入的精力和资金都已开始减退。一家大型考试机构7月发布的数据显示，在最近一个学年里，美国许多学生的进步速度未超过疫情前的正常水平。本月的PISA结果显示，美国分数下滑的程度比其他许多地方略低，但这对数百万青少年来说毫无意义，因为他们仍将带着巨大的技能缺口结束学业。

无论怎样重振追赶计划，降低缺勤率都应该是首要任务。在美国和英国，20%至30%的学生至少缺课十分之一，常常还远多于此。这大约是疫情前的两倍。对于那些正常上课的学生，学校可以给他们提供比平时更多的课程。延长学习时间——在假期、周末和课后——也许是让孩子们赶上进度的最简单方法。但在许多地方，额外加课在追赶计划中扮演的角色非常有

限，因为这得向教师支付更多薪资或者雇用更多教师，成本高昂。再者孩子们也不愿意。

政府的第二项任务是扭转令人沮丧的长期趋势。从国际测试中可以看出哪些做法有效、哪些无效。减少班级人数往往是浪费金钱；拥有高素质的教师更加重要。教育预算可以做到更加有的放矢。在发达国家，弱势群体的学生只能忍受更差的师资和更少的书籍。要真正改变这种状况，就必须与包括教师工会和富裕家长在内的强大游说集团抗争。从理论上讲，这场危机是进行此类改革的大好机会。

更让人感到遗憾的是政客把精力都放在了别处。英国政府将其学生的PISA测试表现形容为一场胜利（与美国一样，英国的排名有所上升，但只不过是因为其分数下滑的幅度略小于平均水平而已）。明年可能上台执政的工党计划对私立学校采取更强硬的立场，要求它们缴税；私立学校不需要政府花钱，而且教学成果优异，但对其征税可能会迫使部分家长转向公立学校而增加公共负担。与此同时，过去几年美国将大量精力浪费在关于历史、性别和种族的教学的激烈但基本无果的争论上。疫情期间无休止的干扰影响了学习。学童们不能再一次被辜负。■

Generative AI generates tricky choices for managers

Transformational technologies can be very trying

THE REMARKABLE capabilities of generative artificial intelligence (AI) are clear the moment you try it. But remarkableness is also a problem for managers. Working out what to do with a new technology is harder when it can affect so many activities; when its adoption depends not just on the abilities of machines but also on pesky humans; and when it has some surprising flaws.

Study after study rams home the potential of large language models (LLMs), which power AIs like ChatGPT, to improve all manner of things. LLMs can save time, by generating meeting summaries, analysing data or drafting press releases. They can sharpen up customer service. They cannot put up IKEA bookshelves—but nor can humans.

AI can even boost innovation. Karan Girotra of Cornell University and his co-authors compared the idea-generating abilities of the latest version of ChatGPT with those of students at an elite university. A lone human can come up with about five ideas in 15 minutes; arm the human with the AI and the number goes up to 200. Crucially, the quality of these ideas is better, at least judged by purchase-intent surveys for new product concepts. Such possibilities can paralyse bosses; when you can do everything, it's easy to do nothing.

LLMs' ease of use also has pluses and minuses. On the plus side, more applications for generative AI can be found if more people are trying it. Familiarity with LLMs will make people better at using them. Reid Hoffman, a serial AI investor, has a simple bit of advice: start playing with it. If you asked ChatGPT to write a haiku a year ago and have not touched it

since, you have more to do.

Familiarity may also counter the human instinct to be wary of automation. A paper by Siliang Tong of Nanyang Technological University and his co-authors that was published in 2021, before generative AI was all the rage, captured this suspicion neatly. It showed that AI-generated feedback improved employee performance more than feedback from human managers. However, disclosing that the feedback came from a machine had the opposite effect: it undermined trust, stoked fears of job insecurity and hurt performance. Exposure to LLMs could soothe concerns.

Or not. Complicating things are flaws in the technology. The Cambridge Dictionary has named "hallucinate" as its word of the year, in tribute to the tendency of LLMs to spew out false information. The models are evolving rapidly and ought to get better on this score, at least. But some problems are baked in, according to a new paper by R. Thomas McCoy of Princeton University and his co-authors.

Because off-the-shelf models are trained on internet data to predict the next word in an answer on a probabilistic basis, they can be tripped up by surprising things. Get GPT-4, the LLM behind ChatGPT, to multiply a number by 9/5 and add 32, and it does well; ask it to multiply the same number by 7/5 and add 31, and it does considerably less well. The difference is explained by the fact that the first calculation is how you convert Celsius to Fahrenheit, and therefore common on the internet; the second is rare and so does not feature much in the training data. Such pitfalls will exist in proprietary models, too.

On top of all this is a practical problem: it is hard for firms to keep track of employees' use of AI. Confidential data might be uploaded and potentially leak out in a subsequent conversation. Earlier this year Samsung, an electronics giant, clamped down on usage of ChatGPT by employees after

engineers reportedly shared source code with the chatbot.

This combination of superpowers, simplicity and stumbles is a messy one for bosses to navigate. But it points to a few rules of thumb. Be targeted. Some consultants like to talk about the "lighthouse approach"—picking a contained project that has signalling value to the rest of the organisation. Rather than banning the use of LLMs, have guidelines on what information can be put into them. Be on top of how the tech works: this is not like driving a car and not caring what is under the hood. Above all, use it yourself. Generative AI may feel magical. But it is hard work to get right. ■

生成式人工智能给管理者出了难题

变革性技术可能很难应付

生成式人工智能（AI）的非凡能力，你一试就明白。但对于管理者来说，能力非凡也是个问题。当一项新技术可以影响众多活动，而且采用该技术并不仅仅取决于机器的能力，也取决于麻烦的人类，况且该技术还有些出人意料的缺陷时，要弄清楚该如何应对它的难度就更大了。

一项又一项的研究充分表明，ChatGPT等AI背后的大语言模型（LLM）具有改善各种事务的潜力。LLM能够生成会议纪要、分析数据或起草新闻稿，从而节省时间。它们能够提升客户服务。它们不能组装宜家的书架——但人类也一样不行。

AI甚至可以促进创新。康奈尔大学的卡兰·吉罗特拉（Karan Girotra）及合著者比较了最新版ChatGPT和一所名牌大学的学生的创意能力。一个人单枪匹马可以在15分钟内想出大约五个创意，配备上一个AI后可以想出200个。关键是这些创意的质量还要更高，至少从新产品概念的购买意向调查来看是这样。这样巨大的可能性反而可能让老板们手足无措：如果你什么都能做，最后很容易什么都没做。

LLM的易用性也是有利有弊。有利的一面是，越多人尝试使用生成式AI，就越能发现它的更多用处。越熟悉LLM，就越懂得如何善用它们。投资了一系列AI项目的里德·霍夫曼（Reid Hoffman）给出了一条简单的建议：先用起来。如果你一年前让ChatGPT写了一首俳句，之后就再没碰过它，那么就该多用用了。

熟悉感也可能对抗人类对自动化的本能的警惕。南洋理工大学的佟思亮及合著者于2021年生成式AI尚未风行之时发表的一篇论文精准地捕获了这种疑惧。该研究表明，AI生成的反馈比人类管理者的反馈更能提高员工的绩效。然而，披露这些反馈来自机器却会产生相反的效果：它破坏了信任，

引发了饭碗不保的恐惧，损害了绩效。多接触LLM有可能缓解这些担忧。

但也未必。这项技术的缺陷让事情变得更复杂。剑桥词典将"hallucinate"（幻觉）选为年度热词，它描述的就是LLM胡说八道的倾向。这些模型目前迅速演进，在这方面应该至少会有所改进。但普林斯顿大学的托马斯·麦考伊（R. Thomas McCoy）及合著者新发表的论文显示，有些问题是根深蒂固的。

现有的模型是用互联网数据训练的，在作答时是根据概率来预测下一个单词，因此可能会被意想不到的问题难倒。ChatGPT背后的LLM是GPT-4，让它把一个数乘以1.8再加上32，它算得很准；让它把同样这个数字乘以1.4再加上31，表现就差多了。造成这种差异的原因是，第一种计算是将摄氏度换算为华氏度的方法，因此在互联网上很常见；第二种计算比较罕见，因此在训练数据中很少出现。闭源模型也会存在这样的缺陷。

除此之外，还有一个现实问题：公司很难跟踪员工使用AI的情况。机密数据可能会被上传，并可能在随后的对话中泄露出去。今年早些时候，电子巨头三星禁止员工使用ChatGPT，因为据称有三星工程师向这个聊天机器人分享了源代码。

能力超凡、使用简单、可能出错，这样的混乱组合让老板难以驾驭。但这也指向了一些经验法则。要有针对性。一些咨询顾问爱谈论"灯塔方法"——选择一个对组织其他部分有指导意义的受控项目。与其禁用LLM，不如制定指引，明确哪些信息可以输入LLM。要了解这项技术的工作原理：它不像开车，不用关心引擎盖下面是什么。最重要的是，要亲自去使用它。生成式AI可能让人感觉神奇，要把它用好却得下苦功夫。■

A Google AI has discovered 2.2m materials unknown to science

Zillions of possible crystals exist. AI can help catalogue them

CRYSTALS CAN do all sorts of things, some more useful than others. They can separate the gullible from their money in New Age healing shops. But they can also serve as the light-harvesting layer in a solar panel, catalyse industrial reactions to make things like ammonia and nitric acid, and form the silicon used in microchips. That diversity arises from the fact that "crystal" refers to a huge family of compounds, united only by having an atomic structure made of repeating units—the 3D equivalent of tessellating tiles.

Just how huge is highlighted by a paper published in Nature by Google DeepMind, an artificial-intelligence company. Scientists know of about 48,000 different crystals, each with a different chemical recipe. DeepMind has created a machine-learning tool called GNoME (Graph Networks for Materials Exploration) that can use existing libraries of chemical structures to predict new ones. It came up with 2.2m crystal structures, each new to science.

To check the machine's predictions, DeepMind collaborated on a second paper, also published in Nature, with researchers at the University of California, Berkeley. They chose 58 of the predicted compounds and were able to synthesise 41 of them in a little over two weeks. The team at DeepMind say more than 700 other crystals have been produced by other groups since they began preparing their paper.

To help any other laboratories keen to investigate the computer's bounty, the firm has made public a subset of what they think should be the 381,000 most stable structures. Among them are many thousands of crystals with

structures potentially amenable to superconductivity, in which electrical currents flow with zero resistance, and several hundred potential conductors of lithium ions that could find a use in batteries. In both cases DeepMind's work has increased the total number of candidate materials known to researchers tens of times over.

Aron Walsh, a materials scientist at Imperial College London who was not involved in the research, says DeepMind's work is impressive. But "this is the start of the exploration rather than the end," he says, noting that the machine has only scratched the surface of what might be possible. In a recent paper of his own he tried to calculate how many stable crystals incorporating four chemical elements (so-called quaternaries) might be potentially manufacturable. He wound up with a conservative estimate of 32trn. For its part, GNoME looked only at crystals that form under relatively low temperatures and pressures. And crystals are only one subset of a universe of materials that includes everything from amorphous solids such as glass through to gases, gels and liquids.

Whether any of DeepMind's 2.2m new crystals will be useful remains to be seen. Even if they do not, the techniques used to make the predictions could be valuable. Besides suggesting new crystals, AI may also shed light on as-yet-unknown rules that govern how they form.

Ekin Dogus Cubuk at DeepMind highlights one such finding. Previously, he says, crystals made from six elements, called senaries, were thought to be vanishingly rare. But DeepMind's AI found around 3,200 in its sample of 381,000 stable compounds. A better understanding of how crystals form, and what sorts are possible, might also save scientists curious to test how the 2.2m new materials behave from the tedious task of synthesising each one of them by hand. ■

谷歌的人工智能发现了220万种科学界未知的材料

有无数种可能的晶体存在。AI可以帮忙罗列和编目

晶体有各种各样的用途，其中一些比另一些用处更大。摆在新时代疗愈店里的那些能让轻信的人乖乖掏出钞票。但它们也可以用作太阳能电池板的光收集层，催化工业反应以制造氨和硝酸等物质，还可以制成用于微芯片的硅。用途如此多样是因为"晶体"指的是一个庞大的化合物家族，它们仅有的共同点是原子结构都由重复的单元组成——相当于三维的瓷砖拼接。

这个家族的成员数量之庞大，在谷歌的人工智能公司DeepMind于《自然》上发表的一篇论文中可见一斑。科学家们已知的晶体大约有48,000种，每种的化学成分都不相同。DeepMind开发了一个名为材料探索图谱网络（Graph Networks for Materials Exploration，以下简称GNoME）的机器学习工具，可以运用现有的化学结构库预测新的化学结构。它预测出了220万个晶体结构，每一个在科学上都是全新的。

为了验证这个机器的预测，DeepMind与加州大学伯克利分校的研究人员合作，在《自然》上发表了第二篇论文。他们从所预测出的化合物中选择了58种，并在两周多一点的时间内就成功合成了其中41种。DeepMind的团队表示，自他们开始准备论文以来，其他研究团队已经制造出700多种其他晶体。

为了辅助其他任何有兴趣的实验室探究这一机器学习的丰硕成果，DeepMind公开了38.1万个他们认为最稳定的结构。其中包括成千上万种可能具有超导结构的晶体，电流在其中能以零电阻流动，还有数百种可能用于电池的锂离子导体。在这两个方向上，DeepMind的工作均让研究人员已知的候选材料总数增加了数十倍。

没有参与这项研究的伦敦帝国理工学院的材料科学家阿隆·沃尔什（Aron Walsh）表示，DeepMind的研究令人惊叹。但他说"这只是探索的开始，

而不是终点"，指出这台机器只是触及了所有可能性的皮毛。在他自己最近的一篇论文中，他尝试算出有多少种含有四种化学元素（所谓的四元化合物）的稳定晶体可能被制造出来。他最后得出的保守估计是32万亿种。但GNoME只观察在相对较低的温度和压力下形成的晶体。而晶体只是物质宇宙的一个子集，这个宇宙包括无定形固体（如玻璃）、气体、凝胶和液体等各种形态。

DeepMind的220万个新晶体中有没有哪个会有实际用途还有待观察。即使没有，这种用于预测的方法也可能有重要价值。除了提示新的晶体之外，AI还可能揭示有关晶体形成的尚未破解的规则。

DeepMind的伊金·多乌什·楚布克（Ekin Dogus Cubuk）特别指出了这方面的一个发现。他说，以前人们认为由六种元素组成的六元化合物的晶体非常罕见。但DeepMind的AI在这38.1万种稳定化合物的样本中就发现了大约3200种。如果能更好地了解晶体是如何形成的，以及可能形成什么类型的晶体，那些想对这220万种新材料的性能一探究竟的科学家们也许就不用费力逐一合成它们了。■

In a first, COP28 targets the root cause of climate change

Now to turn diplomacy into action

AS ACTIVISTS AND diplomats first assembled in Dubai for COP28, the UN's climate summit, a fortnight ago, the chances of significant progress seemed slim. War had returned to the Middle East and the geopolitical order was fragmenting. The choice of the summit's host country—the United Arab Emirates, one of the world's leading petrostates—and its chairman, Sultan al-Jaber, the head of its national oil company, threatened to turn the event into a giant exercise in greenwashing.

Instead, COP28 defied the pessimists. For the first time the world has agreed to move away from the coal, oil and natural gas that are the principal causes of global warming. The 198 parties to the UN Framework Convention on Climate Change agreed on a text that called for a transition away from fossil fuels "in energy systems, in a just, orderly and equitable manner".

Some will be disappointed at the compromises made. The Europeans had hoped to agree to "phase out" fossil fuels entirely, to which fossil-fuel producers refused to sign up. Small island countries say their voices were not heard. The deal states that only "unabated" coal power will be phased down, leaving the option of the dirtiest fuel continuing to be burnt as long as its emissions are captured at source. Nonetheless, the document is an important, and realistic, step forward.

The call to phase out fossil fuels was both politically naive and economically unfeasible. COP operates by consensus, meaning that the big petrostates had a veto on any deal. Moreover, fossil fuels are likely to remain part of the energy mix for decades to come. Even optimistic forecasts suggest a substantial role for oil and gas, balanced by

technologies that remove their greenhouse-gas emissions, in scenarios for the world to achieve net zero by 2050. Although clean energy has made vast strides, it is unlikely to displace fossil fuels fully by then.

Climate diplomacy also proved to be more potent than the pessimists had expected. Mr al-Jaber proved keener to ensure a negotiating success for his country than to distort the process to favour its economic interests. An early pledge from 50 oil companies, including Mr al-Jaber's firm, to reduce their emissions of methane, a potent greenhouse gas, suggests that there were some benefits to an oilman running the show.

An agreement between America and China ahead of the summit helped lay the groundwork. It meant that the two largest polluters and geopolitical rivals together pressed for restoring some language on fossil fuels into the deal, which helped steer recalcitrant petrostates towards agreement. Even the choice of the venue for next year's summit—Baku—was a symbol of harmony. Armenia lent its support for Azerbaijan's bid as the two warring neighbours inch towards peace.

Yet a global agreement is only one small step. A far bigger and harder one will be to translate words on a page into action in the real world. The deal sends a signal to oil companies, especially in rich countries, that they may find it harder to do business, for example because of legal challenges to exploration licences. But reducing reliance on fossil fuels will ultimately depend on making them uncompetitive. A combination of carbon prices and well-targeted subsidies for clean technologies can do so in the rich world.

Poorer countries will need help. The summit largely sidestepped this thorny issue. Developing countries with fossil-fuel reserves argued that it was unfair to expect them to forgo one of their few revenue streams without being given aid to do so. According to the Energy Transition

Commission, a think-tank, getting rid of coal power early will require the rich world to make available around $25bn-50bn a year in grants and other concessional finance to poor countries over the rest of this decade, to retire coal assets early.

This provides the backdrop for a fierce battle. Projects in poor countries are much costlier than those in rich ones, because the private sector demands a premium to compensate for the associated risk. But rich countries will try to limit their financial obligations to the developing world. Bridging the gap, far more than diplomatic backslapping in Dubai, will determine whether the beginning of the end for the fossil-fuel era has come. ■

COP28瞄准气候变化的根本成因，这是第一次

现在，把外交转化为行动吧

两周前，气候活动人士和外交官们最初齐聚迪拜参加联合国气候大会COP28时，取得显著进展的机会似乎显得很渺茫。中东再次爆发战争，地缘秩序分崩离析。峰会主办国阿联酋是全球的主要产油国之一，峰会主席苏丹·贾比尔（Sultan al-Jaber）是该国国家石油公司的负责人，这使得此次会议有可能演变成一场大型漂绿行动。

然而，COP28打破了悲观者的预期。世界各国首次同意摆脱煤炭、石油和天然气这些导致全球变暖的主要成因。联合国气候变化框架公约的198个缔约方达成了一项协议，其中呼吁"以公正、有序、公平的方式减少能源系统"对化石燃料的依赖。

一些人会对这当中所做的妥协感到失望。欧洲人本希望达成"逐步淘汰"化石燃料的协议，但化石燃料生产国拒绝签署。小岛国表示它们的声音未被听到。协议规定只是将逐步淘汰"未经消减技术处理"的煤电，这意味着这种最脏的燃料仍可能继续燃烧，只要其排放在源头被捕获即可。尽管如此，这份文件仍是迈出了重要而务实的一步。

逐步淘汰化石燃料的呼吁在政治上很天真，在经济上也不可行。COP通过达成共识来运作，这意味着大型产油国对任何协议都有否决权。而且，化石燃料在未来几十年内很可能仍是能源组合的一部分。即使乐观的预测也显示，在实现2050年全球净零排放的情境中，在经减排技术处理后，石油和天然气仍将发挥实质性作用。尽管清洁能源取得了巨大的进展，但到那时它仍不太可能完全取代化石燃料。

气候外交也比悲观者的预期更有成效。事实证明，贾比尔更愿意为他的国家争取一次谈判成功，而不是为其经济利益而扭曲谈判。包括贾比尔的公司在内，有50家石油公司在之前承诺减少排放强效温室气体甲烷，这表明

由一位石油专业人士主持会议确实带来了一些好处。

在此次峰会前，中美两国达成的协议帮助奠定了基础。这意味着全球最大的两个污染国和地缘竞争对手共同推动了在协议中重新加入一些关于化石燃料的内容，帮助引导了顽固的产油国同意协议。甚至明年峰会的举办地巴库（Baku）也是和谐的象征。亚美尼亚支持阿塞拜疆申办峰会，这两个交战邻国正逐渐走向和平。

然而，达成一项全球协议只是迈出了一小步。远为重大和艰巨的一步将是把纸面上的言辞转化为现实世界里的行动。该协议向石油公司发出信号，特别是富裕国家的石油公司，预示它们可能会发现经营变得更加困难，例如获得勘探许可要面对法律挑战。但要减少对化石燃料的依赖，最终就得要让它们失去竞争力。在富裕国家，同步实施碳定价和对清洁技术的精准补贴可以实现这一点。

贫穷国家将需要帮助。峰会在很大程度上回避了这个棘手的问题。拥有化石燃料储量的发展中国家认为，不给予援助就期望它们在收入来源本就不多的情况下放弃其中一项是不公平的。据智库能源转型委员会（Energy Transition Commission）称，如果要尽早淘汰煤电，富裕国家就要在2030年前每年向贫穷国家提供250亿至500亿美元左右的拨款和其他优惠融资，以让煤炭资产提前退役。

这为一场激烈的斗争提供了背景。贫穷国家的项目成本要远高于富裕国家，因为私营部门会要求溢价来弥补相关风险。但富裕国家将力求限制它们对发展中国家的财务责任。弥合这道鸿沟将决定是否能够开启化石燃料时代的终篇，远重要过在迪拜外交场面上的握手寒暄。■

Why Chinese companies are flocking to Mexico

The country offers a back door to the United States

CHINESE INVESTMENTS have been pouring into Mexico lately. Last month alone brought two notable ones. The government of Nuevo León, a northern state bordering the United States, announced that China's Lingong Machinery Group, which makes diggers and other construction equipment, would build a factory that it estimates will generate $5bn dollars in investment. The same day Trina Solar, a solar-panel manufacturer, said it would invest up to $1bn in the state. Both companies and their corporate compatriots can now find a home away from home at Hofusan, a Chinese-Mexican industrial park in Nuevo León.

Chinese companies' heightened interest in Mexico dates to 2018 when Donald Trump, America's president at the time, launched a trade war that included raising tariffs on imports from China. His successor, Joe Biden, has kept the tariffs in place. Mr Biden's own America-first policies, such as the Inflation Reduction Act, are encouraging companies to consider "nearshoring" in North America, in large part to thwart China. The pandemic and the snarl-ups in supply chains it caused also pushed manufacturers to move closer to the American market. And setting up in Mexico has begun to look cheaper, as wages and other costs in China rise.

Mexico has tried to lure Chinese money before. The Mexico-China Chamber of Commerce and Technology organised events in 2008 to encourage the flow of capital but they were unsuccessful, says the chamber's César Fragoz; back then China had no need to use Mexico as a way into America, which had yet to turn its back on Chinese companies. "The irony is that the first to react positively to an explicit policy against China are Chinese firms," says Enrique Dussel Peters of the Centre for Chinese-Mexican Studies at UNAM,

a university in Mexico City.

China gets a back door into America because Mexico is part of a free-trade agreement with the United States and Canada. Depending on what components they use, Chinese companies based in Mexico cannot enjoy all the benefits of the trading bloc, whose rules dictate what percentage of a product must originate in North America. But, Mr Dussel Peters notes, the average American tariff on imports from Mexico in 2021 was 0.2%, far lower than on those from China.

Accurate statistics are hard to come by but, according to some estimates, Chinese foreign direct investment in Mexico increased from a total of $500m in 2000-04 to $2.5bn in 2022 alone. That is below a peak of nearly $6bn in 2016, but more than twice the figure in 2018—and rising (see chart). The nature of these investments differs from how China spends its money in the rest of Latin America. In countries such as Brazil and Chile most Chinese investments are in raw materials or infrastructure, often courtesy of Chinese state-backed companies. In Mexico, Chinese investment is in services and manufacturing, including of electronics, cars and home appliances.

In the 1990s and 2000s Mexican exports to America lost out to Chinese competition. Now Chinese investments are helping Mexico's exporters. In September Mexico overtook China for the first time since the early 2000s to become the leading exporter of goods to the United States. Net trade with China generated 6.8m jobs in Latin America between 1995 and 2021, compared with 6.7m for the region's exchange with the United States. Chinese investors are also less particular about environmental and human rights. And they have learned to deal with the challenges of working in Mexico, such as insecurity and poor infrastructure.

A growing Chinese presence in Mexico could backfire if it raises tensions

with the United States. Most Chinese manufacturing and assembly in Mexico seems to be aimed at exports, observes Mr Dussel Peters—especially to America. This is alarming some lawmakers across the border. In a recent letter to Katherine Tai, the US Trade Representative, four members of Congress warned of Chinese carmakers in Mexico trying to take "advantage of preferential access to the US market through our free-trade agreements and circumvent any [China-specific] tariffs". If China is too successful in skirting tariffs it may find its back door as well as the front entrance slammed shut. ■

中国企业为何涌向墨西哥

该国为通往美国开了个后门

近来中国投资大量涌入墨西哥。仅10月就有两起值得注意的事件。在墨西哥北部与美国接壤的新莱昂州（Nuevo León），州政府宣布，生产挖掘机和其他建筑设备的中国临工重机将在该州建设一座工厂，预计将带来50亿美元的投资。同一天，太阳能电池板制造商天合光能表示将在该州投资多达10亿美元。现在，这两家公司及其他中国企业都可以在新莱昂州的中墨合作的华富山工业园（Hofusan）安家落户。

中国企业对墨西哥兴趣大增可以追溯到2018年，当时的美国总统特朗普发起了贸易战，措施包括提高对中国进口产品的关税。他的继任者拜登维持了加征的关税。拜登自己提出的《通胀削减法案》等美国优先政策正在鼓励美国企业考虑在北美展开"近岸外包"，很大程度上是为了挫败中国。疫情及其造成的供应链混乱也促使制造商向美国市场靠拢。随着中国的工资和其他成本不断上涨，在墨西哥设点开始显得更便宜了。

墨西哥以前尝试过吸引中国资金。墨西哥中国商业科技商会（Mexico-China Chamber of Commerce and Technology）的塞萨尔·弗拉格兹（César Fragoz）表示，该商会在2008年组织了一些活动鼓励中国资本流入，但没有收到成效。当时美国还没有背对中国企业，中国不需要通过墨西哥进入美国。墨西哥城的墨西哥国立自治大学中墨研究中心（Centre for Chinese-Mexican Studies at UNAM）的恩里克·杜塞尔·彼得斯（Enrique Dussel Peters）表示："吊诡的是，最先对明确针对中国的政策做出积极反应的是中国的企业。"

中国能在墨西哥找到进入美国的后门是因为墨西哥与美国和加拿大签有自由贸易协定。位于墨西哥的中国公司无法享受该自贸区的所有好处，具体要看它们所使用零部件的来源而定，因为根据北美自由贸易区的规定，产品的零部件必须有一定比例来自北美。但杜塞尔·彼得斯指出，2021年美

国从墨西哥进口产品的平均关税为0.2%，远低于从中国进口产品的关税。

虽然很难获得准确的统计数据，但据一些估计，中国对墨西哥的外国直接投资从2000年至2004年间的总计5亿美元上升至2022年的25亿美元。尽管这一数字低于2016年近60亿美元的峰值，但却是2018年的两倍多，而且还在不断上升（见图表）。这些投资的性质不同于中国在拉丁美洲其他地区的投资。在巴西和智利等国，中国的大部分投资都集中在原材料或基础设施方面，通常是靠中国国有企业的支持。在墨西哥，中国的投资则集中在服务业和制造业，包括电子、汽车和家用电器。

在1990年代和2000年代，墨西哥对美国的出口不敌中国。现在，中国的投资正在帮助墨西哥的出口商。9月，墨西哥自2000年代初以来首次超越中国，成为对美第一大商品出口国。1995年至2021年间，与中国的净贸易为拉丁美洲创造了680万个就业岗位，而该地区与美国的贸易创造了670万个就业岗位。中国投资者对环境和人权也没那么多讲究。他们还学会了应对在墨西哥经营的各种挑战，例如不安全和基础设施薄弱等。

如果中国在墨西哥势力日增加剧了它与美国的紧张关系，结果就可能适得其反。杜塞尔·彼得斯表示，大多数中国在墨西哥的制造和组装似乎都是为了出口，尤其是出口到美国。这令一些美国的立法者感到不安。在最近致美国贸易代表戴琪的一封信中，四名国会议员警告说，在墨西哥的中国汽车制造商试图"通过我们的自由贸易协定获得进入美国市场的优惠待遇，并规避所有（针对中国的）关税"。如果中国在规避关税上做得过于成功，可能会发现这扇后门也会和前门一样砰然关闭。■

How economists have underestimated Chinese consumption

The surprising relevance of state-subsidised spicy cucumber

"CONSUMPTION IS THE sole end and purpose of all production," Adam Smith pointed out. But his "perfectly self-evident" maxim has never held much sway in China. Earlier this year the country's statisticians revealed that household consumption accounted for only 37% of China's GDP in 2022, its lowest level since 2014.

Although removing covid-19 controls should have helped lift that figure a bit, tweaks to Chinese data could lift it rather more. China's headline statistics may understate household income and consumption. Look closer, and both appear higher than reported—and both have risen faster.

For almost two decades, Chinese policymakers have sought to "rebalance" the economy from exports and investment towards spending on more immediate gratifications. "We will work to restore and expand consumption...and increase personal income through multiple channels," the finance ministry declared in this year's budget, for example. Yet progress has been slow. In recent years, the IMF has graded China's efforts on a colour-coded "rebalancing scorecard". The latest card, published in February, was mostly red.

Advocates of rebalancing typically identify two problems. First, Chinese households save a lot of their income; second, their income is too small a slice of the national cake. The second problem features prominently in the arguments of Michael Pettis, an influential professor at Peking University. In the West, he has noted, household income typically represents 70-80% of GDP. In China, by contrast, it is only 55%. Rebalancing, he has argued, will necessarily involve shifting wealth and therefore power to ordinary

people.

Indeed, some observers now wonder whether Xi Jinping, China's leader, has soured on the goal altogether. For him, the end and purpose of Chinese production is not limited to consumption—it also includes ambitions such as making China a resilient power, less dependent on "chokehold" technologies that are dominated by the West. As a young man, he was "repulsed by the all-encompassing commercialisation of Chinese society", according to the leaked account of a professor who knew him in the 1970s and 1980s.

But although Mr Xi is no fervent champion of rebalancing, his scorecard may be better than commonly thought. Economists have long believed that China's figures understate household earning and spending. Surveys probably fail to capture the unreported "grey" income of the wealthy. And the national accounts probably still underestimate the implicit "rent" that homeowners pay themselves when they live in property they own.

Less well known are the struggles of China's statisticians to account for goods and services that governments provide to individuals at little or no cost. These transfers include education and health care, not least reimbursements for medicines. They also encompass cultural amenities and subsidised food. Zhu Hongshen of the University of Virginia has highlighted community canteens, often housed in state-owned buildings but operated by private contractors, which provide tasty dishes, such as oyster mushroom or spicy cucumber, at heavily discounted prices.

According to international standards, these goodies should appear in the official statistics as "social transfers in kind" (sometimes abbreviated to STIK). They can then be added to household income and consumption to provide a fuller "adjusted" picture. "In principle, social transfers should be included in a complete definition of income," argued an international team

of experts known as the Canberra Group in 2001, although they recognised it is not straightforward to do in practice.

China in particular has struggled. In the past, it has not reported them cleanly or separately, shovelling them into other parts of the national accounts, including government consumption. If these transfers are ignored, then the disposable income of China's households was only 62% of national income in 2020 (and as low as 56% in 2010). This seems strikingly low, as Mr Pettis has argued. But that is partly because of everything it leaves out. If social transfers in kind are also stripped out of the disposable income of other countries, their numbers look more like China's. The figure for the euro area would be less than 64% in 2020 (see chart 1). By this measure, a dozen European countries had a smaller income share than China.

Fortunately, China's statisticians can now do better. In the past few years, they have begun publishing figures for social transfers in kind in their annual statistical yearbooks, Mr Zhu has pointed out. These amounted to 6.8trn yuan ($1trn, or almost 7% of national income) in 2020, larger, as a share of GDP, than America's. That has enabled China's National Bureau of Statistics to publish an "adjusted" figure for disposable income that makes international comparisons with OECD countries easier.

Adding these social transfers in kind raises China's share of household income to 69% of national income, placing it near the bottom of the pack, but not at the very bottom. Moreover, since they have grown faster than the economy over the past decade, they make Mr Xi's rebalancing record more promising. Household consumption, including these transfers, increased from 39% of GDP in 2010 to 45% in 2019 before the pandemic struck (see chart 2).

Such revisions do make government consumption look weaker. And

China's social transfers in kind, as a share of national income, are still not high compared with the OECD average. There is thus scope to raise them. If Mr Xi objects to the commercialisation of Chinese society, the state could instead provide more of the things that he thinks his citizens should be consuming. That would be a way for Mr Xi to rebalance towards consumption without reconciling himself to consumerism. ■

经济学家如何低估了中国的消费

政府补贴的炝黄瓜大有乾坤

"消费是所有生产的唯一归宿和目的。"亚当·斯密指出。但他这句"完全不证自明"的格言在中国却从未产生过太大影响。今年早些时候，中国的统计学家透露，2022年中国的居民消费仅占GDP的37%，为2014年以来的最低水平。

尽管取消新冠疫情控制措施应该稍微提高了这一比例，对中国的数据做些微调却可能大幅提高它。中国公布的核心统计数据可能少算了居民收入和消费。仔细观察，会发现这两项都高于公布数据，而且增速也都更快。

近20年来，中国的政策制定者一直寻求经济"再平衡"——从出口和投资转向更注重即时满足的消费。例如，财政部在今年的预算草案中宣布"要促进恢复和扩大消费……多渠道增加居民收入。"但进展缓慢。近年来，国际货币基金组织用不同颜色标记的"再平衡计分卡"对中国的成果进行评分。今年2月最新发布的计分卡大部分显示为红色。

经济再平衡的支持者通常会指出两个问题。其一是中国居民将很大一部分收入存了起来；其二是他们的收入只占了国民收入大蛋糕中太小的一块。在颇有影响力的北京大学教授迈克尔·佩蒂斯（Michael Pettis）的论述中，第二个问题成为重要的论据。他指出，在西方，居民收入通常占GDP的70%至80%。而在中国，这一比例仅为55%。他认为，经济再平衡必然涉及将财富、继而将权力转移到老百姓手里。

事实上，一些观察人士如今猜测中国领导人习近平是否已经对这一目标彻底失去了兴趣。对他来说，中国生产的归宿和目的并不局限于消费——还包括一些雄心壮志，比如让中国成为韧性强的大国、减少对西方主导的"卡脖子"技术的依赖。根据一份揭秘文件，一位在上世纪七、八十年代就认识习的教授回忆，他年轻时就"反感中国社会铺天盖地的商业化"。

但是，尽管习不是经济再平衡的热切支持者，他的再平衡记分卡得分可能比一般认为的要好。经济学家长期以来都认为，中国的数据少算了居民收入和支出。各项调查可能没有捕捉到富人未申报的"灰色"收入。此外，国民经济账户可能还低估了居住在自有房产中的房主支付给自己的隐性"租金"。

不那么广为人知的是，中国统计人员在核算时很难将政府向个人提供的低成本或免费的商品和服务纳入其中。这些转移支付包括教育和医疗保健支出，尤其是药品报销。它们还包括文化便利设施和受补贴的食品等。弗吉尼亚大学的朱洪申特别提到了社区食堂——它们通常设在公家建筑内，但由私人承包商经营，以非常优惠的价格提供平菇、炝黄瓜等美味菜肴。

按照国际标准，这些福利应该以"实物社会转移"（有时缩写为STIK）的形式出现在官方统计数据中。然后再将它们计入居民收入和消费，就能得到一幅更为全面的"调整后"图景。"原则上，完整的收入定义应该包括社会转移支付。"一个名为堪培拉小组（Canberra Group）的国际专家团队在2001年提出，尽管他们也承认在实际操作中要做到这一点并不容易。

而中国在这方面尤其吃力。过去，中国没有清晰或单独地公布这些数据，而是将它们纳入政府消费等国民经济账户的其他部分。如果忽略这些转移支付，那么2020年中国居民的可支配收入仅占国民收入的62%（2010年则低至56%）。正如佩蒂斯所认为的那样，这一比例看起来低得惊人。但这一定程度上是由它遗漏的各种因素造成的。如果从其他国家的可支配收入中同样剔除实物社会转移，它们的比例看起来和中国也差不多。比如欧元区2020年的这一比例就会低于64%（见图表1）。按照这一标准，欧洲有十来个国家的居民可支配收入占国民收入的比例低于中国。

所幸如今中国的统计人员可以做得比以前更好了。朱洪申指出，过去几年，他们已经开始在每年的统计年鉴中公布实物社会转移的数据。这部分在2020年达到6.8万亿元人民币（接近国民收入的7%），占GDP的比重超过了美国。这让中国国家统计局能够公布一个"调整后"可支配收入数据，更易于与经合组织成员国进行国际间比较。

如果加上这些实物社会转移，中国居民收入占国民收入的比例将提高到69%，尽管这一数字落后于大部分经合组织成员国，但还不至于垫底。此外，在过去十年里它们的增速快于经济增速，这让习的经济再平衡得分显现出更乐观的前景。把这些实物社会转移包括在内，居民消费占GDP的比例从2010年的39%上升到2019年新冠疫情暴发前的45%（见图表2）。

这样的修正确实让政府消费看起来更疲软了。而中国的实物社会转移占国民收入的比例相比经合组织的平均水平仍然不高。因此还有提升的空间。如果习反对中国社会的商业化，政府可以转而提供更多他认为国民应该消费的东西。这将是习实现朝向消费的再平衡却不向消费主义妥协的一个办法。■

Elon Musk's X is especially vulnerable to an ad boycott

The perils of telling advertisers to clear off

FOR SOMEONE who despises the advertising industry, Elon Musk has a way with viral slogans. At a New York Times event on November 29th the world's richest man was asked how he felt about firms pulling ads from X, the social network he bought last year when it was known as Twitter. "If somebody's going to try to blackmail me," he replied, "go fuck yourself." The "GFY" approach, as he dubbed it, may come naturally to billionaires. But it is bold for a company that last year made 90% or so of its revenue from ads. Those that have pulled ads from X include Apple and Disney, whose presence Mr Musk previously cited as evidence that X was a safe space for brands.

Advertisers are worried about unsavoury content on the platform. Since Mr Musk fired 80% of X's staff, including many moderators, more bile seems to be leaking through the filters. Last month Media Matters for America, a watchdog, reported that ads for brands such as IBM had appeared alongside posts praising Adolf Hitler (X disputes this and is suing Media Matters).

Social networks are freer than mainstream media to tell advertisers to get lost. Whereas a typical TV network in America gets most of its ad revenue from fewer than 100 big clients, social networks can have millions of small ones. A year ago the largest, Facebook, was getting 45% of its domestic sales from its 100 biggest advertisers, reckons Sensor Tower, a research firm; a boycott against it in 2020 by more than 600 firms, including giants like Unilever and Starbucks, had little effect on sales. But X lacks Facebook's sophisticated ad-targeting apparatus, and relies on campaigns by big brands. In October 2022, when Mr Musk bought Twitter, its 100 top clients accounted for 70% of American ad sales.

Half of them have since left X, Sensor Tower says. On December 1st Walmart said it had gone, owing to its ads' poor results on X. The impact has been severe. In September Mr Musk said that X's American ad business was down by 60%. Advertisers in other regions may be less bothered by the culture wars that Mr Musk is fighting. But X is unusually reliant on America. Whereas Meta, Facebook's parent company, makes most of its money abroad, 56% of Twitter's revenue came from America before Mr Musk bought it. Even before GFY, Insider Intelligence, another research firm, expected X's worldwide ad sales to fall by more than half this year (see chart).

Mr Musk's fans insist being rude to air-kissing admen and "woke" brands delights X's everyman users. X still has nearly five times as many as Threads, a newish rival from Meta. Yet Sensor Tower reports that the X app is being downloaded less often than a year ago, and estimates that it has lost 15% of monthly users.

Some observers put this down to a purge of bots and fake users. Still, X must monetise the users it has in new ways to make up for the declining ad dollars. One idea is X Premium, which offers extra features and fewer ads for between $3 and $16 a month. So far there seem to be few takers: Sensor Tower estimates that X has sold $60m-worth of subscriptions in the past year, equivalent to 1% of pre-Musk annual ad sales. Mr Musk has talked of turning X into an "everything app", handling payments, calls and more. But even optimists concede this would take years.

Until then, the aim is to replace the departing big advertisers with an army of little ones. X is said to be working on its ad technology for smaller firms, eyeing a Facebook-like long tail of clients. There is no time to lose. Further drops in ad sales could necessitate a bail-out from investors, or from Mr Musk himself. X's employees have their work cut out to attract advertisers faster than their boss repels them. ■

马斯克的X公司尤其易受广告商抵制的冲击

让广告主滚蛋的风险

马斯克看不上广告业，对病毒式口号的运用倒是自有一套。在11月29日《纽约时报》举办的一次活动上，有人问这位全球首富对各家公司从他去年收购的社交网络X（当时还叫推特）撤下广告作何感想。"如果有人想以此要挟我，"他回答道，"去他妈的吧。"他口中这种"去他妈"的态度对于亿万富翁来说可能是再自然不过的。但对于一家去年90%左右的收入来自广告的公司而言，就很大胆了。从X上撤下广告的公司包括苹果和迪士尼，而马斯克先前曾以它们的存在为依据，说明X对品牌来说是个安全的空间。

广告主对该平台上的不良内容感到担忧。自从马斯克解雇了X 80%的员工后（其中包括许多审查员），似乎有更多的恶意言论逃过了筛查。上个月，监督组织美国媒体事务（Media Matters for America）报告称，IBM等品牌的广告出现在赞美希特勒的帖子旁边（X对报告所述提出异议并将该组织告上法庭）。

相比主流媒体，社交网络更能随意地叫广告主滚蛋。美国一个普通电视网络的大部分广告收入来自不到100个大客户，而社交网络则可能有数百万个小客户。据研究公司Sensor Tower估计，一年前，最大的社交网络Facebook有45%的国内销售来自其最大的100家广告客户；2020年，包括联合利华和星巴克等巨头在内的600多家公司对它发起抵制，对广告销售几乎没有影响。但是X缺乏Facebook那种先进的广告定向系统，并且依赖大品牌的推广活动。2022年10月马斯克收购推特时，其100个最大客户占到美国广告收入的70%。

据Sensor Tower称，自那以后其中一半的客户已经离开了X。12月1日，沃尔玛表示已经离开，原因是在X上投放的广告效果不佳。影响已经很严重。9月，马斯克表示X在美国的广告业务下降了60%。其他地区的广告主

可能不那么在意马斯克开打的文化战。但X异常依赖美国市场。Facebook的母公司Meta的大部分收入来自海外，而在被马斯克收购之前，推特的56%的收入来自美国。即便在"去他妈"事件之前，另一家研究公司Insider Intelligence也预计今年X的全球广告收入将减少一半以上（见图表）。

马斯克的拥趸坚持认为，冒犯惺惺作态的广告人和倒向"觉醒文化"的品牌让X的普通人用户群体拍手称快。相比于Meta推出的新竞争对手Threads，X仍然拥有近五倍的用户。然而Sensor Tower的报告显示X应用的下载量较一年前有所减少，并估计它失去了15%的月活跃用户。

一些观察人士将这归因于对僵尸虚假账号的清理。即便如此，X必须以新的方式利用现有用户创造收入，以此弥补广告收入的下降。其中一个想法是推出X Premium，每月付费3到16美元可以得到额外功能和刷到更少的广告。到目前为止，似乎没有太多人愿意接受这种模式：Sensor Tower估计，X在过去一年内售出了6000万美元的订阅服务，相当于马斯克收购之前年广告收入的1%。马斯克曾谈到将X打造成一个"全能应用"，能处理支付、通话等等。但即使是乐观派也承认这还得等上好几年。

在那之前，目标是用一大批小广告主取代离开的大广告主。据说X正在为小型企业开发广告技术，像Facebook那样瞄准长尾客户。时间紧迫。如果广告销售进一步下滑，可能就需要投资者或马斯克本人出手援助。X的员工们得拼劲全力，赶在被他们的老板赶走之前吸引来广告主。■

Will China leave behind its economic woes in 2024?

Xi Jinping must decide whether to set an ambitious growth target

AFTER THE global financial crisis of 2007-09, economists quickly understood that the world economy would never be the same again. Although it would get past the disaster, it would recover to a "new normal", rather than the pre-crisis status quo. A few years later the phrase was also adopted by China's leaders. They used it to describe the country's shift away from breakneck growth, cheap labour and monstrous trade surpluses. These changes represented a necessary evolution in China's economy, they argued, which should be accepted, not resisted too strenuously.

After China's long campaign against covid-19 and its disappointing reopening this year, the sentiment is popping up again. China's growth prospects seem "structurally" weaker—one reason why Moody's, a rating agency, said this week that it might have to cut the country's credit rating in the medium term. Several economists have declared a new normal in China's unruly property market. Some commentators hope for a new equilibrium in China's relations with America following the recent meeting between the two countries' leaders. In September Cai Fang of the Chinese Academy of Social Sciences identified a "new" new normal, brought about by a mixture of China's shrinking population, greying consumers and picky employers.

Calibrating the new normal is a matter of some urgency. China's leaders will soon gather in Beijing for the Communist Party's Central Economic Work Conference. Their deliberations will help set a growth target for 2024, which will be announced in March. Most forecasters expect China's economy to grow by less than 5%. Moody's forecasts 4%. Officials must thus decide how strenuously to resist this slowdown.

If they think it represents a new equilibrium, they may accept it and lower their growth target accordingly. If they think China has room to grow faster, they may stick with the 5% target they set for 2023. Meeting such a goal will be more difficult in 2024 than it was this year, because the economy will not benefit from another reopening boost. However, an ambitious target could also serve a purpose, underlining the government's commitment to growth, and reassuring investors that more fiscal help is on its way if required.

It is impossible to think about how the economy will grow without first considering how China's property slump will end. Although most economists agree that the market "cannot return to its past glory", as Liu Yuanchun of the Shanghai University of Finance and Economics has put it, there is less agreement on how inglorious its future must be. In the past, sales were buoyed by speculative demand for flats from buyers who assumed they would rise in price. In the future, the market will have to cater chiefly to fundamental demand from buyers who want a new or better home.

How much fundamental demand remains? China now enjoys a living area of 42 square metres per person, according to the census of 2020; an amount comparable to many European countries. On the face of it, this suggests that the market is already saturated. But the European figures typically count only the useable area of a property, as Rosealea Yao of Gavekal Dragonomics, a research firm, has pointed out. The Chinese number, on the other hand, refers to everything that is built, including common areas shared by several households.

Ms Yao has estimated that China might eventually reach a living space per person of about 45-50 square metres when common areas are included. The country's property sales might therefore have room to grow from their depressed levels of 2023, even if they never return to the glories of earlier

years. Ms Yao believes that sales needed to fall by about 25% from their levels in 2019. Yet in recent months the drop has been closer to 40%.

Property developers could also benefit from the government's new efforts to renovate "urban villages". As China's cities have expanded, they have encompassed towns and villages that were once classified as rural—the cities move to the people not the other way around. This "in-situ urbanisation" accounted for about 55% of the 175m rural folk who became city-dwellers over the ten years from 2011 to 2020, according to Golden Credit Rating International, a Chinese rating agency. By some estimates, the government's "urban villages" project could span as many as 40m people in 35 cities over the next few years.

China's property slump has also revealed the need for a "new normal" in the country's fiscal arrangements. The downturn has hurt land sales, cutting off a vital source of revenue for local governments. That has made it more difficult for them to sustain the debts of the enterprises they own and the "financing vehicles" they sponsor. These contingent liabilities are "crystallising", as Moody's puts it.

The central government would like to prevent an outright default on any of the publicly traded bonds issued by local-government financing vehicles. But it is also keen to avoid a broader bail-out, which would encourage reckless lending to such vehicles in the future. Although any assistance that the central government grudgingly provides will weaken the public finances, a refusal to help could prove fiscally expensive, too, if defaults undermine confidence in the state-owned financial system. For now, the relationship between China's central government, its local governments and local-government financing vehicles remains a work in progress.

Whatever happens, property seems destined to shrink in the medium term. What will take its place? Officials have begun to talk about the "new three",

a trio of industries including electric cars, lithium-ion batteries and renewable energy, especially wind and solar power. But despite their dynamism, such industries are relatively small, accounting for 3.5% of China's GDP, according to Maggie Wei of Goldman Sachs, a bank. In contrast, property still accounts for almost 23% of GDP, once its connections to upstream suppliers, consumer demand and local-government finances are taken into account. Even if the "new three" together were to expand by 20% a year, they cannot add as much to growth in the next few years as the property downturn will subtract from it (see chart 1).

| *Under the hammer*

The new three as a group are also not as labour-intensive as property, which generates a useful mixture of blue-collar jobs (builders) and white-collar careers (estate agents and bankers). A period of transition from one set of industries to another can make jobs and career paths less predictable. Mr Cai worries that this labour-market uncertainty will inhibit spending by Chinese consumers, who will anyway become more conservative as they age.

During erratic pandemic lockdowns, consumer confidence collapsed and household saving jumped (see chart 2). Many commentators believe that the experience has left lasting scars. Consumers still say they are gloomy in surveys. Yet they seem less stingy in the shops. Their spending is now growing faster than their incomes. They have, for example, snapped up Huawei's new Mate 60 smartphone, with its surprisingly fast Chinese chips.

One question, then, is whether China's new normal will feature a permanently higher saving rate. Some economists fear that further declines in house prices will inhibit consumption by damaging people's wealth. On the other hand, if people no longer feel obliged to save for ever-more

expensive flats, then they might spend more on consumer items. Hui Shan of Goldman Sachs argues that retail sales, excluding cars and "moving-in items", such as furniture, are, if anything, negatively correlated with house prices. When homes become cheaper, retail sales grow a little faster. She believes the saving rate will continue to edge down, albeit gradually.

What do these shifts add up to for the economy as a whole? The consensus forecast for Chinese growth next year is of about 4.5%. China's policymakers might accept this as the new normal for the economy, just as they accepted the slowdown after 2012. But should they?

According to economic textbooks, policymakers can tell when an economy is surpassing its speed limit when it starts to overheat. The traditional sign of overheating is inflation. By that measure, China can grow faster than its present pace. Consumer prices fell in the year to October. And the GDP deflator, a broad measure of prices, is forecast to decline this year (see chart 3), raising the spectre of deflation.

Another potential sign of overheating is excessive lending. The Bank for International Settlements, a club of central bankers, calculates a country's "credit gap", which compares the stock of credit to companies and households with its trend. From 2012 to 2018 and again in mid-2020, China's credit gap surpassed the safe threshold of 10% of GDP. Yet the gap has since disappeared. China's problem now is not excessive credit supply to companies and households. It is weak loan demand.

Therefore neither test suggests that China's economy is growing too fast. And growing too slowly poses its own dangers. If China's policymakers do not do more to lift demand, they might fail to dispel deflation, which will erode the profitability of companies, increase the burden of debt and entrench the gloominess of consumers. After the global financial crisis, many economies "muddled along with subpar growth", as Christine

Lagarde, then head of the IMF, put it. They resigned themselves to a "new normal", only to instead lapse into a "new mediocre". China could find itself making the same mistake. ■

中国能在2024年摆脱经济困境吗？

习必须决定是否设定一个高增长目标【深度】

在2007年至2009年的全球金融危机过后，经济学家们很快就意识到，世界经济将再无法回到过去。尽管它会渡过难关，但只会恢复到一种"新常态"，而非危机前的状态。几年后，中国领导人也采用了这个词，用它描述中国从飞速增长、廉价劳动力和巨额贸易顺差的状态的转变。他们认为，这些变化代表了中国经济的必然演进过程，应该接受它而非竭力抵抗。

经历了长时间的新冠疫情管控后，中国今年重启经济，但表现令人失望，让这种论调再度浮现。中国的增长前景似乎呈现"结构性"疲软，这也是评级机构穆迪近期表示可能不得不下调中国中期信用评级的原因之一。多位经济学家宣称中国难以管控的房地产市场步入了新常态。一些评论人士希望，在中美两国领导人近期会晤后，两国关系能找到一个新的平衡。9月，中国社会科学院的蔡昉指出，中国人口减少、消费人群老龄化、雇主变得挑剔，这些因素的混合带来了一种"新"新常态。

因应新常态做调整成了当务之急。中国领导人很快将在北京召开中共中央经济工作会议。他们的商议将帮助制定2024年的经济增长目标，该目标将于明年3月公布。多数人预测中国经济增长将低于5%。穆迪的预测为4%。因此，官员们必须决定要花多大的力气抵抗这种经济减速。

如果他们认定这是一种新的平衡，也许就会接受现状并相应调低增长目标。假如他们认为中国经济仍有加快增长的空间，则可能沿用对2023年设定的5%的目标。要在2024年实现这样的目标将比在今年更困难，因为经济不会再一次因重启受到提振。不过把目标定高一点也可能有用处，能突显政府求增长的决心，并使投资者相信在必要时政府会提供更多财政支援。

要思考中国经济的增长前景，就不能不先讨论中国的房地产业将如何走出低迷。尽管大多数经济学家都认同上海财经大学校长刘元春所说的中国房地产市场"不能重返过去的辉煌"，但至于未来会多黯淡，看法就没那么一致了。过去，预期房价会上涨的购房者的投机性需求推高了销售。而未来，市场将只能主要满足购买首套房或者改善型住房的基本需求。

这样的基本需求还有多少？2020年的人口普查显示，中国当前人均居住面积为42平方米，与许多欧洲国家相当。表面上看，这表明市场已经饱和。但正如研究公司龙洲经讯（Gavekal Dragonomics）的咬丽蔷所指出的，欧洲的数字通常只计算房屋使用面积。但中国的数字是建筑面积，包括了多户分摊的公共区域面积。

据咬丽蔷估计，中国含公摊面积的人均居住面积最终可能达到45至50平方米左右。因此，中国的房地产销售即使永远无法重返过去的辉煌，却可能仍有机会在2023年的低迷水平上实现增长。她认为销售额会跌至比2019年低约25%。但最近几个月的降幅已接近40%。

房地产开发商也可以从政府新启动的"城中村"改造中获益。随着中国城市的扩张，以往被归为农村的乡镇和村庄已被城市包围——是城市走向人们，而不是反过来。据中国评级机构东方金诚的数据，在2011年到2020年的十年间，1.75亿农村人口变为城镇居民，其中约55%属于这样的"就地城镇化"。一些估计显示，未来几年，中国政府的"城中村"改造项目将覆盖35个城市的4000万人口。

中国房地产的低迷也揭示出中国财政措施需要进入一个"新常态"。经济放缓影响卖地，切断了地方政府一个至关重要的收入来源。这使它们更难承受下属企业和它们发起的地方"融资平台"的债务压力。正如穆迪指出，这些或有负债正在"明晰化"。

中央政府想阻止由地方政府融资平台发行的任何公开交易的债券发生直接违约。但它也很希望避免更广泛的救助，因为这会助长日后对这些融资平台轻率放贷。尽管中央政府勉为其难地提供的任何援助都会削弱公共财

政，但如果违约会削弱对国有金融体系的信心，拒施援手也可能带来昂贵的财政代价。目前看来，中央政府、地方政府和地方政府融资平台之间的关系仍在梳理中。

无论如何，房地产部门在中期似乎注定要萎缩。哪些行业能接替它？官员们已经开始谈论"新三样"——电动汽车、锂电池和可再生能源（尤其是风能和太阳能）这三大产业。但高盛的魏美琪指出，尽管势头喜人，但这些产业的规模相对较小，仅占中国GDP的3.5%。相比之下，算上与之关联的上游供应商、消费需求和地方政府财政，房地产仍占到GDP的近23%。即使"新三样"一起以每年20%的速度扩张，在未来几年对经济的拉动也无法弥补房地产衰退对经济的拖累（见图表1）。

待价而沽

整体而言，"新三样"的劳动密集程度也不如房地产，后者带来了既包含蓝领工作（建筑工人）又创造白领岗位（房地产经纪和银行员工）的有益组合。从一组行业转到另一组行业的过渡期会使工作和职业发展变得不那么明朗。蔡昉担心，劳动力市场的这种不确定性将抑制中国消费者的支出，他们本来也将随着年龄增长变得更为保守。

在反复无常的疫情封控期，消费者信心崩溃，居民储蓄猛增（见图表2）。许多评论人士认为，这一经历留下了持久的创伤。消费者在接受调查时仍在表达沮丧悲观的情绪。但是他们在商店里购物时似乎又没那么"手紧"。目前居民消费增速高于收入增速。一个例证是他们争相抢购华为搭载了速度出人意料的国产芯片的新款智能手机Mate 60。

那么一个问题是，中国新常态的一个特点会不会是储蓄率长期走高。有经济学家担心房价进一步下跌会令人们财富受损，进而抑制消费。而另一方面，如果人们发觉不必再为购买越来越贵的房子而存钱，他们在消费品上的花销就可能提高。高盛的闪辉认为，如果说零售（不包括汽车，以及家具等"家装用品"）与房价真有什么关联，那也是负相关。房价下降，零售增长会略为加快。她认为储蓄率将继续下降，尽管是逐步下降。

所有这些变化对整体经济有何影响？人们普遍预测明年中国的经济增速在4.5%左右。中国的政策制定者可能接受它为经济的新常态，就像他们接受了2012年后经济放缓的现实一样。但这次他们应该接受吗？

按经济学教科书的说法，在经济刚开始过热时，政策制定者就能判断出经济是否超过速度限制。经济过热的传统标志是通货膨胀。以此标准衡量，中国经济的增速还可以比目前水平更快一些。在截至10月的一年里，消费价格下降。预计GDP平减指数这一衡量物价的宽泛指标今年也将下降（见图表3），引发通缩之忧。

经济过热的另一个潜在迹象是过度放贷。央行组织国际清算银行（BIS）计算一个国家的"信贷缺口"，即比较企业和居民的信贷存量与其长期趋势的偏离度。从2012年到2018年，以及在2020年中期，中国的信贷缺口超过了占GDP10%的安全阈值。但之后这个"缺口"就消失了。中国现在的问题不是企业和居民信贷供应过多，而是贷款需求疲软。

因此，这两个检验指标都没有显示目前中国经济增长过快。而增长过慢会有它自己的问题。假如中国的政策制定者不采取更多措施提振需求，通缩可能将无法避免，进而削弱企业的盈利能力，加重债务负担，加深消费者的悲观情绪。正如国际货币基金组织（IMF）前总裁克里斯蒂娜·拉加德（Christine Lagarde）所说，全球金融危机爆发后，许多经济体"在低于应有水平的增长中混日子"。它们甘愿接受"新常态"，结果却堕入了"新平庸"。中国也可能发现自己在犯同样的错误。■

How to save China's economy

Lessons from the last stimulus for the next one

EARLIER THIS year a Chinese publisher released a translation of "In Defence of Public Debt", a book by Barry Eichengreen of the University of California, Berkeley, and several others. Reaching deep into history, the book seeks to restore balance to the debate on government borrowing by emphasising its neglected benefits. Mr Eichengreen argues that indebted countries can get into trouble when they turn to fiscal restraint too soon, neglect growth or succumb to deflation, which only makes debt harder to service. The arrival of the translated edition was timely. Many economists believe the Chinese government's fiscal caution this year has contributed to disappointing growth and the danger of falling prices.

Thankfully, China's government has now begun to loosen the purse strings. It has taken the rare step of revising its budget-deficit target from 3% of GDP to 3.8%. It has allowed provinces to issue "refinancing bonds", which will help them repay some of the more expensive debt owed by affiliated infrastructure firms known as local-government financing vehicles. Financial regulators have urged banks to meet the "reasonable" financing needs of the less rickety property developers, without discriminating against private ones. Officials also talk more often about "three major projects": affordable housing; leisure facilities that can also help China cope with disasters and emergencies; and efforts to renovate "urban villages", or formerly rural enclaves.

But these steps by themselves will not be enough. Houze Song of MacroPolo, a think-tank, worries that the "stimulus is not big enough to reflate the economy". The government seems to fear an excessive response more than it fears an inadequate one. Many in China view public debt as

suspect despite the arguments in its favour. Even defenders of public borrowing are careful not to appear too strident. The Chinese edition of Mr Eichengreen's book is not called "In Defence of Public Debt". It carries the more anodyne title "Global Public Debt: Experience, Crisis, Response".

What explains the government's fiscal reticence? It may be ideology. But it may also be recent history. Fifteen years ago this month, China's government announced a fiscal stimulus worth about 4trn yuan (or $590bn) in response to the global financial crisis. Financial regulators also gave their blessing to local governments to sidestep restrictions on their borrowing by setting up financing vehicles that could issue bonds and borrow from banks. Local governments responded with "frenzied enthusiasm", as Christine Wong of the University of Melbourne put it. With the extra borrowing, the initial 4trn yuan ballooned into 9.5trn yuan (or 27% of 2009 GDP) spread over 27 months.

The frenzy successfully revived growth. But in the years since, stimulus has acquired a stigma in China. Chinese officials have repeatedly warned of the dangers of a similar "flood-like" response to economic slowdowns. The lending spree has been accused of privileging state-owned enterprises, crowding out manufacturing investment, and impeding spending on industrial R&D.

Drawing on confidential loan data from 19 banks, Lin William Cong, now of Cornell University, and co-authors have shown that the increased supply of credit in 2009 and 2010 favoured state-owned enterprises over private firms. And among private firms, it favoured those making less productive use of their capital. The authors guess that in a crisis, banks prefer to lend to companies that enjoy the backing of local governments, whether they be state-owned enterprises or well connected but inefficient private firms. Jianyong Fan of Fudan University and co-authors argue that spending on R&D by industrial firms was squeezed by higher capital costs in parts of the

country where local governments borrowed most heavily. These localities were often led by newly promoted party secretaries who were eager to shine.

It is easy to read these studies and conclude that the 2008 stimulus was a mistake. But the flaws of that response do not mean that it was worse than nothing. The paper by Mr Cong, for example, does not show that the increased supply of credit hurt borrowing by private firms, merely that it benefited them less than it helped state-owned firms. The study of R&D by Mr Fan and his colleagues also controls for each locality's growth rate. That means that if the stimulus boosted growth, and growth boosted R&D, this beneficial effect will be stripped out of their results.

Since the stimulus amounted to a "flood" of lending and investment, it would be surprising if private firms were parched of credit. Indeed, lending to them grew briskly in 2009 and 2010, show figures compiled by Nicholas Lardy of the Peterson Institute for International Economics, a think-tank. Investment by private manufacturers was also strong. Instead stimulus spending crowded out China's accumulation of foreign assets, including the American Treasury bonds bought by its central bank, argues Zheng Song of the Chinese University of Hong Kong, co-author of another influential paper on China's fiscal expansion.

Stimulus check

Looser financial limits on local governments nonetheless cast a "long shadow", as Mr Song's paper put it. Their financing vehicles continued to borrow long after the crisis. Some of the debts these vehicles have accumulated now look impossible for local governments to repay, adding to the gloom hanging over China's economy. Like many economists, Mr Song believes the next stimulus should adopt different fiscal machinery, providing handouts to households. Mainland China could, for example, copy the electronic consumption vouchers distributed in Hong Kong,

which are forfeited if they are not spent within a few months.

Fifteen years on, the side-effects of China's 2008 lending spree are an argument for better stimulus, not zero stimulus. Public borrowing to rescue an economy can leave a difficult financial legacy, as Mr Eichengreen's book points out. But that is different from saying that "not borrowing would have been better". ■

如何挽救中国经济

上一次刺激计划为下一次提供的经验教训

今年早些时候，中国的一家出版社出版了《In Defence of Public Debt》一书的中文译本。该书由加州大学伯克利分校的巴里·艾兴格林（Barry Eichengreen）和其他几位作者合著。它深入历史，试图通过强调政府借贷被忽视的好处来让相关辩论重回平衡。艾兴格林认为，背负高额债务的国家如果过早采取财政紧缩措施、忽视增长或接受通缩，可能就会陷入麻烦，结果只会更难偿还债务。其中文版的出版恰逢其时。许多经济学家认为，中国政府今年的财政政策过于谨慎，导致增长令人失望和通缩的危险。

幸好中国政府现在已经开始松开钱袋子。它罕有地将预算赤字目标从GDP的3%修订为3.8%，允许各省发行"再融资债券"，这将帮助它们偿还一部分由名为地方政府融资平台的附属基础设施投资公司欠下的成本更高的债务。金融监管机构敦促银行满足那些状况尚可的房地产企业的"合理"融资需求，不歧视私营开发商。官员也更经常谈论"三大工程"：保障性住房、"平急两用"设施，以及"城中村"改造。

但仅仅这些措施本身是不够的。智库MacroPolo的宋厚泽担心"刺激措施不足以重振经济"。政府似乎更担心刺激过度而非不足。尽管有支持公务债务的理据，但许多中国人仍然对它持怀疑态度。即使是为政府借债辩护的人也小心翼翼，不敢表现得过于激进。艾兴格林那本书的中文版没有按英文标题直译为《捍卫公共债务》，而变成了更温和的《全球公共债务：经验、危机与应对》。

该如何解释政府在财政上的审慎态度？原因也许出在意识形态上，但也可能是并不久远的历史所致。十五年前的11月，为应对全球金融危机，中国政府宣布了约4万亿元的财政刺激计划。金融监管机构还允许地方政府通过设立融资平台规避借贷限制，这些平台可以发行债券并从银行借款。正

如墨尔本大学的黄佩华所说，地方政府积极响应，"热情高涨"。在27个月内，加上这些额外的借贷，最初的4万亿元刺激规模膨胀到了9.5万亿（占2009年GDP的27%）。

这一轮信贷狂潮成功地恢复了经济增长。但在之后的那些年里，刺激措施在中国背上了污名。中国官员一再警告，对经济放缓采取类似的"大水漫灌"式措施存在风险。这轮放贷潮被指特别偏向国企、挤压了制造业投资，阻碍了工业研发支出。

现就职于康奈尔大学的丛林及其合著者此前根据19家银行的机密贷款数据指出，2009年和2010年增加的信贷供应更偏向国企而非私企。而在私企中，更多信贷流向了那些资本利用效率较低的企业。几位作者猜测，在危机中，银行更愿意向享有地方政府支持的企业提供贷款，无论是国企还是有人脉但效率低的私企。复旦大学的范剑勇和合著者认为，在地方政府借贷最多的地区，工业企业的研发支出因资本成本上升受到挤压。这些地方政府的领导者往往是急于出政绩的新晋党委书记。

看完这些研究很容易得出结论，认为2008年的刺激计划是一个错误。但刺激计划有缺陷并不意味着还不如不刺激。例如，丛林的论文并没有显示信贷供应的增加妨碍了私企借贷，只是表明相对于国企，私企从中受益更少。范剑勇和他的同事在对研发的研究中也控制了各地增长率的影响。这意味着，如果刺激措施促进了增长，而增长又促进了研发，那么这种有益影响会被从研究结果中剥除。

既然刺激措施达到了贷款和投资"大水漫灌"的水平，这种情况下如果私企还严重缺乏信贷就有些奇怪了。而事实上，智库彼得森国际经济研究所（Peterson Institute for International Economics）的尼古拉斯·拉迪（Nicholas Lardy）编制的数据显示，2009年和2010年向私企提供的贷款增长迅速。私营制造企业的投资也很强劲。香港中文大学的宋铮与人合著了另一篇关于中国财政扩张的有影响力的论文，他认为刺激性支出反而挤出了中国积累的外国资产，包括央行购买的美国国债数额。

尽管如此，正如宋铮的论文所言，对地方政府放松财政限制还是投下了"长长的阴影"。在危机过去很久以后，地方政府融资平台仍在继续借贷。地方政府如今看起来无法偿还这些平台积累的部分债务，加重了中国经济的阴霾。与许多经济学家一样，宋铮认为，下一次刺激措施应该采用不同的财政机制，转而向家庭发放补贴。例如，中国大陆可以复刻香港发行电子消费券的做法，如果在几个月内的期限内没有使用，电子消费券就会自动失效。

十五年过去了，中国2008年信贷热潮的副作用提供的前车之鉴是要采取更好的刺激措施，而不是不采取刺激措施。正如艾兴格林的书所指出的那样，以公共借贷拯救经济可能会遗留财政金融难题。但这并不等同于说"当初不借钱才更好"。■

Are artificial wombs the future?

It is at the intersection of art, design, biology and engineering. Good modeling is the key to success here.

人造子宫是未来趋势吗？

这项技术是艺术、设计、生物和工程的交汇点，良好的模型是成功的关键。

Travellers face another year of disruption in 2024

Demand is recovering faster than supply, which means delays and higher prices

NOBODY ENJOYS starting or ending a hard-earned holiday by wasting hours in an airport waiting for a flight. Alas, that is what many travellers will face in 2024.

People have recovered their appetite for whizzing around the world. The UN World Tourism Organisation estimates the global number of travellers will be at 95% of pre-pandemic levels in 2023, up from 63% in 2022, driven by a post-pandemic "revenge tourism" boom. Business travel is also rebounding faster than expected: the Global Business Travel Association now anticipates a return to pre-pandemic levels of business-travel spending in 2024, rather than its previous estimate of 2026.

For the airline industry, however, restoring capacity has not been straightforward. Reversing the mass lay-offs triggered by the pandemic is taking time. With demand for flights outstripping supply, prices have risen faster than inflation, padding airlines' profits. But operations are buckling under the pressure. In America, the share of flights delayed continues to rise.

Flying will not be the only pain point for travellers in 2024. Cities around the world are cracking down on short-term rentals like those accessed through Airbnb. A new law that came into effect in New York in September requires hosts to register with the city and be present during a guest's stay. Airbnb calls the law a "de facto ban". Berlin, Paris and Rome have also implemented restrictions, and others including Vienna will follow suit in 2024. Municipal governments hope these curbs will ease pressure on rents and house prices for residents. For travellers, the result is less choice and

higher prices.

China could yet throw out a wild card. The World Travel and Tourism Council, a trade group, forecasts that Chinese outbound travel-and-tourism spending will reach roughly nine-tenths of 2019 levels in 2024, up from half in 2023. But a flagging Chinese economy could derail that recovery. That would be bad for businesses counting on Chinese demand. For other tourists, however, it might mean a less crowded return to globetrotting.

THOMAS LEE-DEVLIN, Global business correspondent, The Economist ■

旅行者面临又一个混乱的年份

需求恢复快于供应，导致延误和涨价

没人喜欢以在机场苦等航班来开始或结束一个来之不易的假期。可惜，这将是许多旅行者在2024年的遭遇。

人们已经恢复了在世界各地跑来跑去的兴致。联合国世界旅游组织（UN World Tourism Organisation）估计，在疫情后"报复性旅游"热潮的推动下，2023年全球游客数量将恢复到疫情前水平的95%，高于2022年的63%。商务旅行的反弹速度也快于预期：全球商务旅行协会（Global Business Travel Association）目前预计商务旅行支出将在2024年恢复到疫情前水平，而不是之前估计的2026年。

然而，对于航空业来说，恢复运力没有那么简单。扭转疫情引发的大规模裁员仍需要时间。由于航班供不应求，机票涨价速度已快过通胀，增加了航空公司的利润。但它们的运营难以承受压力。在美国，航班延误的比例持续上升。

旅行者在2024年碰到的麻烦不只在飞行上。世界各地的城市都在打击爱彼迎（Airbnb）等短租民宿。纽约9月生效的一项新法律要求房东向市政府登记，并且在客人入住期间留在出租屋内。爱彼迎称该法律为"事实上的禁令"。柏林、巴黎和罗马也实施了限制措施，维也纳等其他城市也将在2024年效仿。市政府希望这些限制措施能够缓解其居民在房租和房价上的压力。对于旅行者来说，结果是选择更少、价格更高。

中国可能增加事态的不确定性。行业组织世界旅行和旅游理事会（World Travel and Tourism Council）预测，2024年，中国出境旅行和旅游支出将达到2019年水平的约90%，而2023年为2019年的一半。但疲软的中国经济可能会拖累这一复苏。这对于那些依赖中国需求的企业来说不是个好消息。而对于其他游客来说，这可能意味着他们重新踏上的环球之旅没那么

拥挤了。

《经济学人》全球商业记者托马斯·李-德弗林■

New medical treatments will use genetic scissors, and other clever tricks

From sickle-cell disease to glaucoma, these are the drugs to look out for

NEW MEDICINES to treat sickle-cell disease and beta thalassaemia, two genetic blood disorders, will make headlines in 2024. Most notable of these is the first CRISPR-gene-edited drug, which made its historic arrival in late 2023. Gene editing uses molecular scissors to edit DNA. It is a more precise form of modification than gene therapy, an older technology that uses a viral vector to inject a working gene into a cell. Gene editing has moved astonishingly quickly through drug pipelines—much faster than gene therapies, which have been slow and difficult to develop.

For sickle-cell disease, the gene-edited therapy, exa-cel, developed by Crispr Therapeutics and Vertex, is likely to be approved just ahead of a gene-therapy drug from Bluebird Bio, lovo-cel. In both cases, stem cells are first extracted from a patient's body. They are then either edited (exa-cel) or transfected with the viral vector (lovo-cel), and returned to the body, where they correct the genetic defect. The effects are said to last a lifetime.

But these drugs will cost more than $2m per patient. Even in America some patients will struggle to get hold of them. In poorer countries, where most patients with sickle-cell disease live, they will be impossible to obtain.

The great flexibility of the gene-editing technology, and its ability to target non-genetic diseases, means it has a particularly bright future. The coming year will see progress in efforts by Crispr Therapeutics and Caribou Biosciences to develop off-the-shelf cell products that can treat cancer and other diseases.

The workhorse of the immune system, the T-cell, can be gathered from donors and reprogrammed, via gene editing, to fight cancer without triggering an immune rejection by the patient's body. This approach means that powerful CAR-T treatments no longer have to be manufactured individually, and expensively, for each patient.

Crispr Therapeutics is developing similar technology to create replacement insulin-producing cells in the pancreas. There are also efforts to develop "in vivo" gene editing, to allow gene-editing treatments to be delivered into the body by packaging them in lipid nanoparticles.

Gene-editing technology is advancing in other ways, too. Verve Therapeutics is focusing on cardiovascular disease using a more precise approach to gene editing known as "base editing", which can change a single base in the genome without damaging the DNA molecule itself. Look for news of its early-stage work, on a treatment to lower cholesterol levels. Meanwhile another treatment, EBT-101 from Excision, which aims to use gene editing to eliminate HIV infection from the body, will complete enrolment of patients for its first phase-1 trial in 2024.

Other coming highlights in the year ahead include a hotly anticipated decision on a new antibiotic for urinary-tract infections, many of which are resistant to existing antibiotics; two "pentavalent" meningococcal vaccines that protect against a wide range of serotypes of meningitis; and an innovative "microinvasive" eye implant that continuously releases minuscule amounts of a drug for glaucoma, an eye disease. It promises to deliver far better results than eye drops, which patients often forget to apply regularly. Yet another exciting new treatment to keep an eye on, you might say, in the coming year.

NATASHA LODER, Health editor, The Economist ■

新疗法将使用基因剪刀和其他妙招

从镰状细胞病到青光眼，这些是值得留意的药物

治疗镰状细胞病和β地中海贫血这两种遗传性血液疾病的新药将在2024年登上新闻头条。其中最引人注目的是首款CRISPR基因编辑药物，它于2023年底历史性地问世了。基因编辑使用分子剪刀编辑DNA，比起使用病毒载体将治疗基因注入细胞的旧技术基因疗法，这种修饰形式更为精确。用基因编辑制造新药的进展快得惊人——相比研发缓慢又困难的基因疗法要快得多。

在镰状细胞病上，由Crispr Therapeutics和Vertex研发的基因编辑药物exa-cel很可能会比Bluebird Bio的基因疗法lovo-cel先一步获批。两种疗法都先从患者体内提取干细胞，然后编辑它们（exa-cel）或用病毒载体转染（lovo-cel），然后回输到患者体内，纠正遗传缺陷。据称疗效持续一生。

但这些药物的花费超过每名患者200万美元。即使在美国，一些患者也很难买到它们。而在大多数镰状细胞病患者居住的较贫穷国家根本无处可寻。

基因编辑技术具有巨大的灵活性，并且能以非遗传性疾病为标靶，这使得它显现出特别光明的前景。明年，Crispr Therapeutics和Caribou Biosciences将在开发可治疗癌症和其他疾病的开架细胞治疗产品方面取得进展。

免疫系统的主力军T细胞可以从捐赠者那里收集到，并通过基因编辑重编程以对抗癌症，而不会引发患者身体的免疫排斥。有了这种方法后，强大的CAR-T细胞疗法就不再需要以高昂的成本为每名患者定制实施了。

Crispr Therapeutics正在研发类似的技术来制造胰腺中生成胰岛素的胰腺

细胞的移植细胞。人们也在致力开发"体内"基因编辑，把基因编辑药物包装在脂质纳米粒中递送入体内。

基因编辑技术也在其他方面取得进展。Verve Therapeutics正在使用一种名为"碱基编辑"的更精确的基因编辑法来对抗心血管疾病，这种方法可以改变基因组中的单个碱基而不损坏DNA分子本身。用它来降低胆固醇水平的前期研究很快会有结果。与此同时，来自Excision的另一种疗法EBT-101旨在利用基因编辑消除体内的艾滋病毒感染，将于2024年完成首次1期试验的患者入组。

未来一年的其他亮点包括：一种治疗尿路感染的新抗生素将迎来备受期待的审评决定，这类感染中有许多对现有抗生素耐药；两种"五价"脑膜炎球菌疫苗，可预防多种血清型脑膜炎；还有一种创新的"微创"眼部植入物，能持续释放微量的青光眼药物。它的疗效有望远好过滴眼液，因为患者常常会忘记定期使用滴眼液——你可能会说，这是来年又一个值得我们拭目以待的新疗法。

《经济学人》医疗编辑娜塔夏·洛德■

Self-driving cars are slowly moving forward

Having kept riders waiting for years, they are finally arriving

A HIGH-PERFORMANCE sensor is not needed to detect the list of missed targets for the widespread adoption of self-driving cars. General Motors once promised autonomous vehicles (AVS) in abundance by 2019. Ford and Lyft, a ride-hailing firm, had reckoned 2021 was more plausible. For a decade, Elon Musk has loudly proclaimed that fully autonomous Teslas were a year away at most. Taking a nap behind the wheel on a tediously long drive remains a distant dream. But broad adoption of AVs will inch closer in 2024.

In the coming year robotaxis will spread beyond test zones and powerful self-driving features will become available to more motorists. The pursuit of autonomy has split into three camps: firms working on fully autonomous robotaxis; carmakers focused on various forms of driver assistance; and Tesla, which does its own thing.

Hailing robotaxis will become more commonplace. Waymo (owned by Alphabet) and Cruise (GM's AV arm), have long been testing vehicles. They have been charging for rides in San Francisco around the clock, with no need for safety drivers (though Cruise's licence was suspended in October after an accident involving a pedestrian).

In 2024 such vehicles, already operating in Austin, Los Angeles and Phoenix, as well as AVs from Amazon's Zoox, may pop up in other American cities including Atlanta, Miami and Seattle. In China, Baidu, a tech giant, and Pony.ai, also both with small operations in Beijing and other cities, have similar expansion plans—in Baidu's case to 65 cities by 2025.

Establishing a robotaxi business requires years of investment, and the prospects remain uncertain. Many carmakers think a faster route to profit is to add self-driving tech to ordinary cars. Some already have "level 2" systems that can steer, brake and change lanes. But Mercedes-Benz is leading the way with Drive Pilot, a "level 3" system that does not require constant supervision. Already available in Germany, it will become available in several American states in 2024, as a $2,500-a-year subscription option in some of the firm's fanciest models. Crucially, Mercedes assumes full legal liability when Drive Pilot is on. Other carmakers are not far behind: Ford, Stellantis and others are likely to launch similar "level 3" systems in 2024.

And that leaves Tesla. Despite much hype, its self-driving system is "level 2", requiring constant supervision and hands on the steering wheel. Mr Musk claims the next version, likely to be made available in 2024, provides a far higher level of autonomy. Perhaps it will. One way or another, the driverless journey is creeping ever closer.

SIMON WRIGHT, Industry editor, The Economist ■

自动驾驶汽车正在缓慢前行

在让乘客等待多年之后，它们终于要来了

用不着高精度传感器就可以看到自动驾驶汽车在通往普及的路上曾有多少目标没能达成。通用汽车公司曾承诺在2019年之前大量普及自动驾驶汽车。福特汽车和网约车公司Lyft则认为2021年更现实些。十年来，马斯克一直大声宣称，完全自动驾驶的特斯拉汽车最多还需要一年时间就将问世。在乏味的长途驾驶中，坐在方向盘前打个盹仍然是一个遥不可及的梦想。但在2024年，自动驾驶汽车的广泛应用将又向我们靠近一点点。

在未来的一年里，自动驾驶出租车将超越测试区，更多的驾驶者将享受到强大的自动驾驶功能。对自动驾驶的追求分为三个阵营：致力于开发完全自动驾驶出租车的公司；专注于各种形式的驾驶辅助功能的汽车制造商；以及独辟蹊径的特斯拉。

呼叫自动驾驶出租车将变得更加普遍。Waymo（Alphabet旗下公司）和Cruise（通用汽车的自动驾驶部门）早已开始测试车辆。它们在旧金山昼夜不停地收取乘车费用，不需要安全驾驶员（不过Cruise在10月份发生一起涉及行人的事故后被吊销了许可）。

2024年，已在奥斯汀、洛杉矶和凤凰城运营的此类车辆以及亚马逊Zoox公司的无人车可能会出现在亚特兰大、迈阿密和西雅图等其他美国城市。在中国，科技巨头百度和小马智行（Pony.ai）都在北京和其他城市有小规模运营，也有类似的扩张计划——百度的计划是到2025年扩张到65个城市。

建立自动驾驶出租车业务需要多年投资，前景仍不明朗。许多汽车制造商认为，为一般车辆添加自动驾驶技术是更快实现盈利的途径。一些汽车制造商已经拥有"2级"系统，可以转向、刹车和变道。但梅赛德斯-奔驰率先推出了驾驶领航（Drive Pilot），这是一种无需持续监控的"3级"系统。该系统已在德国投入使用，并将于2024年铺开到美国的几个州，为该公司最

豪华的一些车型提供每年2500美元的订户选项。最重要的是，梅赛德斯将在驾驶领航功能开启时承担全部法律责任。其他汽车制造商也不甘落后：福特、斯特兰蒂斯和其他公司也很可能在2024年推出类似的"3级"系统。

剩下的就是特斯拉了。尽管大肆炒作，但特斯拉的自动驾驶系统仍属于"2级"，需要持续的监督和手握方向盘。马斯克声称，可能在2024年推出的下一个版本的自动驾驶水平要高得多。也许会吧。无论如何，无人驾驶之旅正在悄然接近。

《经济学人》产业编辑西蒙·赖特■

EVs are poised to make China the world's biggest car exporter

Its lead in battery-making is crucial

COMBUSTION ENGINES in motor vehicles account for about 15% of carbon-dioxide emissions each year. Eliminating them requires the electrification of transport, which in turn requires batteries in unprecedented quantities. In 2024 the outlines of a new global battery-production infrastructure will come into focus in China, Europe and America—a network of factories capable of churning out batteries in sufficient amounts to store the energy required to propel the global fleet of vehicles.

The majority of battery factories, existing and planned, are in China. Many in Europe are being built by Chinese firms. Benchmark Mineral Intelligence, a firm of analysts, says that China will have 69% of global battery-production capacity by 2030, down from 78% in 2022, but still sufficient to make enough batteries for 90m cars every year. Europe and America, in contrast, are each forecast to have around 14% of global capacity by 2030, enough for 19m vehicles each.

China holds this lead in part because its government has been supporting electric-vehicle (EV) manufacturing and adoption for longer. Tax breaks for EV purchases began in the early 2010s, and by 2022 the Chinese government had poured around $30bn into supporting the market through consumer incentives alone; EV manufacturers received further support through local governments. These subsidies created competition between many new EV companies. Most have now gone bust, leaving winners such as BYD and CATL in a strong position. China's pre-existing strengths in the electronics supply chain also gave EV manufacturers a boost. By 2010 there were already more than 100m electric bikes in China, thanks to government bans of petrol-powered motorcycles in city centres.

Europe and America have only recently started to catch up. In America the Inflation Reduction Act (IRA), passed in 2022, provides tax breaks for EV buyers, but only if the car contains no parts from China or Russia. The IRA also offers battery-makers a tax credit which covers about one-third of the cost of production. All told, Benchmark calculates that American automakers will receive $140bn in subsidies over the next decade. In early 2023 the European Union proposed a similar measure, the Green Deal Industrial Plan, which opened the way for member-states to offer subsidies of their own, as well as providing some funding.

Thanks to these stimulus efforts, it now looks as though both Europe and America will have sufficient battery-production capacity to cover domestic demand for EVs by 2030. China is set to have three times more battery capacity than it needs to service its home market. As 2024 begins, China is poised to become the world's largest car exporter for the first time. And no matter how much money Europe and America spend trying to catch up, China's battery dominance will last for the foreseeable future.

HAL HODSON, Special projects writer, The Economist ■

电动汽车将使中国成为全球最大的汽车出口国

它在电池制造方面的领先地位至关重要

机动车中的内燃机每年导致了约15%的二氧化碳排放。要淘汰内燃机，就必须实现交通电气化，而这又需要数量空前的电池。2024年，一个新的全球电池生产基础设施的轮廓将在中国、欧洲和美国显现出来——这个工厂网络能够生产出足够多的电池来储存驱动全球汽车所需的能量。

大多数现有和规划的电池工厂都位于中国。欧洲的许多工厂都是由中国公司建造的。分析机构基准矿物情报（Benchmark Mineral Intelligence）称，到2030年，中国将拥有全球电池生产能力的69%，低于2022年的78%，但仍满足每年生产9000万辆汽车所需的电池。相比之下，预计到2030年，欧洲和美国的产能将各占全球产能的14%左右，分别足够装配1900万辆汽车。

中国之所以领先，部分原因是中国政府支持电动汽车制造和落地的时间更长。中国政府从2010年代初就开始实行电动汽车购置税减免，到2022年，仅通过消费者激励措施就投入了约300亿美元支持电动汽车市场；电动汽车制造商还通过地方政府获得了进一步支持。这些补贴造成了许多新兴电动汽车公司之间的竞争。现在，大多数此类公司都已倒闭，而比亚迪和宁德时代等赢家则占据了强势地位。中国原有的电子产品供应链优势也为电动汽车制造商助推了一把。由于政府禁止在市中心使用汽油动力摩托车，到2010年，中国的电动自行车保有量已超过1亿辆。

欧洲和美国最近才开始迎头赶上。在美国，2022年通过的《通货膨胀削减法案》（IRA）为电动汽车购买者提供税收减免，但前提是汽车不含来自中国或俄罗斯的零部件。IRA还为电池制造商提供税收减免，减免额约为生产成本的三分之一。根据基准矿物情报的计算，未来十年美国汽车制造商将获得1400亿美元的补贴。2023年初，欧盟提出了一项类似的措施，即《绿色交易工业计划》，为成员国自行提供补贴和部分资金开辟了道路。

得益于这些刺激措施，现在看来，到2030年，欧洲和美国的电池生产能力将足以满足国内对电动汽车的需求。中国的电池产能将是其国内市场需求的三倍。到2024年，中国就将首次成为世界上最大的汽车出口国。而无论欧洲和美国花多少钱试图赶上，在可预见的未来，中国在电池方面的主导地位都将持续下去。

《经济学人》特别项目撰稿人哈尔·霍德森■

The fight to control the headset market will intensify

They are the next big tech platform

THE MOST eagerly awaited gadget of 2024 is Apple's Vision Pro, a sleek headset that can transport users to the middle of a "Star Wars" battlefield, or simply project the world's biggest Excel spreadsheet into their office. The magic goggles combine virtual reality (VR) with "mixed reality", using front-mounted cameras to show the user a live video-feed of the outside world, onto which computer graphics can be superimposed. The device is controlled with eye movements and hand gestures. Apple calls it the most ambitious product it has ever made. At $3,499 its price is ambitious, too.

Apple will be jostling for consumers' attention with various rivals. Chief among them is Meta, formerly known as Facebook, which had a big hit with its Quest 2 headset during covid-19 lockdowns, when the metaverse was briefly more enjoyable than real life. It launched an upgraded Quest 3 late in 2023, offering mixed reality. The Quest 3 is more basic than Apple's device, but at $499 will outsell it. Fancier models will follow.

Google may re-enter the headset race. A decade ago it launched camera-toting smart specs called Google Glass, which flopped. Plans for high-tech glasses called Iris seem to have gone the same way. Its latest gambit is a partnership with Samsung, a South Korean giant, and Qualcomm, an American chipmaker. The three are working on a mixed-reality project which may produce a headset.

Smaller firms are creating their own niches. Valve, an American video-game company, makes VR headsets for gamers, as does Pico, a Chinese-owned VR firm. Pico's parent company, Bytedance, also owns TikTok, an app that has aroused suspicion in America—a situation that might make it

hard to sell a device that tracks your eyeballs.

Don't expect any headset to take the world by storm just yet. Worldwide sales of video headgear will grow by a third in 2024, but will still total only 18m units, forecasts Omdia, a market-research company. (Smartphone sales will exceed 1bn.) Apple's Vision Pro will probably sell fewer than 200,000 units, because of supply constraints on components, as well as the price tag. It "will be a hit with developers in 2024 and then consumers in 2025", predicts Dan Ives of Wedbush Securities, an investment company.

The thing to watch in 2024 is what those developers find to do with the device. Smartphones took off only after the launch of apps that turned internet-connected phones from novelties into vital everyday tools. Headsets, used mostly for gaming, still lack compelling use cases for most people. But as programmers begin to play around with the Vision Pro, that could change. In the months ahead, tech-watchers will have their eyes on Apple's new gadget—and it will have its four internal cameras looking right back at them.

TOM WAINWRIGHT, Technology and media editor, The Economist ■

头显市场争霸战将愈演愈烈

它们是下一个大技术平台

2024年最受期待的电子产品是苹果的Vision Pro。这款时尚的头显可将用户带至"星球大战"战场的中心，或将世界上最大的Excel电子表格投影到他们的办公室里。这款神奇的眼镜把虚拟现实（VR）与"混合现实"结合起来，使用前置摄像头向用户展示外部世界的实时视频，并可在其上叠加计算机图形。该设备用眼球移动和手势控制。苹果说它是该公司史上最宏伟大胆的产品——它3499美元的定价也是。

苹果将与各种竞争对手争夺消费者的注意力。首当其冲的是Meta（原Facebook），该公司在疫情封锁期间推出的Quest 2头显大受欢迎，当时元宇宙一度变得比现实生活还有趣。它于2023年末推出升级版Quest 3，提供混合现实功能。Quest 3比苹果的设备更基础，但因售价仅499美元，销量会更大。之后还会推出更高级的版本。

谷歌可能会重新加入头显竞赛。十年前，它推出了名为谷歌眼镜的带摄像头的智能眼镜，但以失败告终。名为Iris的高科技眼镜计划似乎再度折戟。它的最新招数是与韩国巨头三星和美国芯片制造商高通合作。三家公司正在开发一个混合现实项目，可能会带来一款头显。

较小的公司正在创造自己的利基市场。美国视频游戏公司Valve为游戏玩家生产VR耳机，中国的VR公司Pico也一样。Pico的母公司字节跳动还拥有TikTok，这款应用在美国引发质疑，这种局面可能会导致Pico很难销售一款追踪眼球的设备。

目前还不要期待哪款头显能够席卷全球。市场研究公司Omdia预测，在2024年，视频头戴设备的全球销量将增长三分之一，但总量将仍仅为1800万套。（智能手机销量将超过10亿部。）苹果的Vision Pro由于零部件供应限制以及价格高昂，销售量可能不会超过20万部。投资公司韦德布什证

券（Wedbush Securities）的丹·艾夫斯（Dan Ives）预测，它"将在2024年大受开发者的欢迎，然后在2025年走向消费者"。

2024年值得关注的事情是那些开发人员发现可以拿Vision Pro干什么。智能手机真正风靡世界要等到各种应用出现之后，这些应用把联网的手机从一件新奇玩意变成了不可或缺的日常工具。头显目前主要用于游戏，仍缺乏让大多数人感觉不可或缺的用例。但如果程序员开始捣弄Vision Pro了，情况可能就会有变化。未来几个月里，科技观察者将把目光投向苹果的新设备——而它的四个内置摄像头也会径直回望他们。

《经济学人》技术和媒体编辑汤姆·维恩莱特■

Semiconductors will remain central to America's tech rivalry with China

Expect America to step up global enforcement of its sanctions on chips and chipmaking gear

AS SOON AS the Huawei Mate 60 Pro handset went on sale on August 29th, technologists raced to smash it open and see how it worked. The Chinese telecoms-equipment maker had somehow succeeded in creating a new 5G smartphone—something few thought it could accomplish. Huawei had been forced to give up making such devices in 2020 after American sanctions blocked it from buying advanced semiconductors or the equipment needed to make them. Sales of Huawei smartphones, which at one stage even outsold Apple's iPhones globally, collapsed. Yet as they sifted through the innards of the Mate 60 Pro, engineers discovered a Chinese-made chip that seemed to show that American sanctions had been overcome by indigenous innovation.

This chip, the Kirin 9000S, was manufactured by SMIC, the leading Chinese chipmaker, and its appearance was a deeply symbolic moment. China's tech war with America began in earnest in 2019 when Donald Trump's administration banned the sale of high-end chips to Huawei. In 2022 President Joe Biden built on the framework of those sanctions to introduce a blanket ban on the sales of advanced semiconductors to all companies in China. Since then leaders in Beijing have retaliated by banning the sales of some chips made by Micron, an American firm, to Chinese companies, on security grounds. They also began restricting exports of gallium and germanium, two rare metals needed to make state-of-the-art chips.

Huawei's new phone, and the chip that powers it, are thus seen in China as signalling a paradigm shift. "People can see from this that American

sanctions cannot stop China's technological progress," read an editorial on September 12th in the People's Daily, a government mouthpiece. Photos on local social media showed children bowing in front of Huawei advertisements in Shenzhen. In America, the Mate 60 Pro was used as evidence both to argue that sanctions on China were failing and should be abandoned and to argue that they should be tightened. In fact, it highlights just how difficult it will be for Huawei and other Chinese firms to make new breakthroughs in 2024 and beyond.

The performance of the Mate 60 Pro is on a par with Samsung's Galaxy S20, a handset released in 2020 and powered by a chip manufactured by TSMC of Taiwan, the world's leading chipmaker. Being three years behind may not sound like a lot, but SMIC is using a previous generation of lithography machines, based on a technology called DUV, to etch its chips.

Industry observers reckon that the Kirin 9000S represents the limit of DUV technology. TSMC's superior chips are made using more advanced EUV technology. And that is off-limits to SMIC and other Chinese chipmakers because EUV machines are made only by ASML, a Dutch company, and are covered by American sanctions.

Impressive as it is, in short, the Kirin 9000S probably marks the boundary of what China can achieve without EUV technology, which it will have to develop on its own. That is likely to take many years—and TSMC will continue to race ahead in the meantime. The Mate 60 Pro is not the decisive blow in the tech war that it seemed. And other aspects of the phone's innards signal the direction the tech war will take in 2024.

The handsets were found to contain memory chips made by SK Hynix, a South Korean firm. It says it has not done business with Huawei in years. But Chinese companies have found clever workarounds to get their hands on chips via underground markets. For this reason, America is likely to step

up global enforcement of its sanctions. The Biden administration has already dragged allies such as Japan, the Netherlands and South Korea into the fight, to the displeasure of companies in those countries. In 2024 it may expand that group, perhaps in places such as the Middle East, where Chinese firms are rumoured to be buying chips.

That may hamper Chinese firms' ability to create new high-tech products, from smartphones to the specialised systems needed to train artificial-intelligence models. But it will also sap the patience that America's friends have for its tech war.

DON WEINLAND, China business and finance editor, The Economist, Shanghai ■

半导体仍将是美国与中国科技竞争的核心

预计美国将在全球范围内加大对芯片和芯片制造设备的制裁力度

华为Mate 60 Pro手机在8月29日甫一上市，技术专家们就争先恐后地把它大卸八块，看看它是如何工作的。这家中国电信设备制造商以某种方式成功打造了一款全新的5G智能手机——很少有人觉得它能做到这一点。在美国的制裁阻止了华为购买先进半导体或制造设备后，华为被迫于2020年放弃制造此类手机。华为智能手机的销量一度在全球范围内超过了苹果的iPhone手机，在这以后一蹶不振。然而，当工程师们仔细检查Mate 60 Pro的内部结构时，却发现了一个中国制造的芯片，似乎表明美国的制裁已被本土创新所克服。

这款名为麒麟9000S的芯片由中国领先的芯片制造商中芯国际制造，它的出现是一个具有深刻象征意义的时刻。中美科技战于2019年正式打响，当时特朗普政府禁止向华为出售高端芯片。2022年，总统拜登在这些制裁框架的基础上全面禁止向中国所有公司销售先进半导体。此后，北京领导人以安全为由，禁止了美国公司美光向中国公司销售它生产的部分芯片作为报复。中国还开始限制镓和锗这两种制造最先进芯片所需的稀有金属的出口。

因此，华为的新手机及其芯片在中国被视为模式转变的标志。政府喉舌《人民日报》9月12日的社论写道："人们从中看到，美国制裁无法阻止中国技术进步。"当地社交媒体上的照片显示，深圳的孩子们在华为广告前鞠躬。在美国，Mate 60 Pro既被用来证明对华制裁失败因而应该放弃制裁，也被用来论证应该加强制裁。而事实上，它凸显了华为和其他中国企业在2024年及以后取得新突破的难度。

Mate 60 Pro的性能与三星Galaxy S20相当，后者于2020年发布，采用世界领先的芯片制造商台积电生产的芯片。落后三年听起来也许并不多，但中芯国际使用的是上一代基于深紫外（DUV）技术的光刻机来蚀刻芯片。

行业观察家认为，麒麟9000S代表了DUV技术的极限。台积电的高级芯片采用的是更先进的极紫外（EUV）技术。中芯国际和其他中国芯片制造商无法采用这种技术，因为EUV机器只能由荷兰公司阿斯麦（ASML）制造，而且受美国制裁的限制。

简而言之，尽管麒麟9000S令人印象深刻，但可能也标志着中国在没有EUV技术的情况下所能达到的极限，而EUV技术必须由中国自主研发。这可能需要很多年的时间——而在此期间走在前头的台积电也不会停止脚步。Mate 60 Pro并不像先前看起来的那样是技术大战中的决定性一击。这款手机内核的其他方面预示着2024年科技大战的走向。

人们发现这些手机含有韩国公司SK海力士生产的内存芯片。海力士自称已多年未与华为开展业务。但中国公司找到了巧妙的变通办法，通过地下市场获得了芯片。因此，美国很可能在全球范围内加大制裁力度。拜登政府已经把日本、荷兰和韩国等盟国拖入了这场斗争，令这些国家的公司感到不满。2024年，美国可能会扩大制裁的适用范围，也许会扩大到中东等地，据传中国企业正在中东购买芯片。

这可能会阻碍中国企业创造新的高科技产品的能力——从智能手机到训练人工智能模型所需的专用系统。但这也会消耗美国盟友对其科技战的耐心。

《经济学人》驻上海中国商业与金融编辑唐·维兰德■

Generative AI will go mainstream in 2024

Data-savvy firms will benefit first

WHEN NEW technologies emerge they benefit different groups at different times. Generative artificial intelligence (AI) first helped software developers, who could use GitHub Copilot, a code-writing AI assistant, from 2021. The next year came other tools, such as ChatGPT and DALL-E 2, which let all manner of consumers instantly produce words and pictures.

In 2023 tech giants gained, as investors grew more excited about the prospects of generative AI. An equally weighted share-price index of Alphabet, Amazon, Apple, Meta, Microsoft and Nvidia grew by nearly 80% (see chart). Tech firms benefited because they supply either the AI models themselves, or the infrastructure that powers and delivers them.

In 2024 the big beneficiaries will be companies outside the technology sector, as they adopt AI in earnest with the aim of cutting costs and boosting productivity. There are three reasons to expect enterprise adoption to take off.

First, large companies spent much of 2023 experimenting with generative AI. Plenty of firms are using it to write the first drafts of documents, from legal contracts to marketing material. JPMorgan Chase, a bank, used the technology to analyse Federal Reserve meetings to try to glean insights for its trading desk.

As the experimental phase winds down, firms are planning to deploy generative AI on a larger scale. That could mean using it to summarise recordings of meetings or supercharging research and development. A survey by KPMG, an audit firm, found that four-fifths of firms said they

planned to increase their investment in it by over 50% by the middle of 2024.

Second, more AI products will hit the market. In late 2023 Microsoft rolled out an AI chatbot to assist users of its productivity software, such as Word and Excel. It launched the same thing for its Windows operating system. Google will follow suit, injecting AI into Google Docs and Sheets. Startups will pile in, too. In 2023 venture-capital investors poured over $36bn into generative AI, more than twice as much as in 2022.

The third reason is talent. AI gurus are still in high demand. PredictLeads, a research firm, says about two-thirds of S&P 500 firms have posted job adverts mentioning AI. For those companies, 5% of adverts now mention the technology, up from an average of 2.5% over the past three years. But the market is easing. A survey by McKinsey, a consultancy, found that in 2023 firms said it was getting easier to hire for AI-related roles.

Which firms will be the early adopters? Smaller ones will probably take the lead. That is what happened in previous waves of technology such as smartphones and the cloud. Tiddlers are usually more nimble and see technology as a way to gain an edge over bigger fish.

Among larger companies, data-centric firms, like those in health care and financial services, will be able to move fastest. That is because poor data management is a big risk for deploying AI. Managers worry about valuable data leaking out through AI tools. Firms without solid data management may have to reorganise their systems before it is feasible to deploy generative AI. Using the technology can feel like science fiction, but getting it to work safely is a much more humdrum affair.

GUY SCRIVEN, US technology editor, The Economist ■

生成式人工智能将在2024年成为主流

精通数据的企业将首先受益

当新技术出现时，它们会在不同时间使不同群体受益。生成式AI（Generative AI）首先帮到了软件开发人员——他们从2021年起就可以使用能编写代码的AI助手GitHub Copilot。第二年出现了其他工具，如ChatGPT和DALL-E 2，它们可以让各种各样的消费者即刻生成文字和图片。

2023年，随着投资者对生成式AI的前景愈感兴奋，科技巨头获益了。Alphabet、亚马逊、苹果、Meta、微软和英伟达的同等权重股价指数增长了近 80%（见图表）。科技公司会受益，是因为它们要么供应了这类AI模型本身，要么提供了驱动和支持这些模型的基础设施。

在2024年，最大的受益者将是科技行业以外的公司，它们会认真采用AI以期降低成本并提高生产率。预期企业会开始大量采用该技术的理由有三。

首先，大公司在2023年已经花了很多时间在试用生成式AI。许多公司现在用它生成从法律合同到营销材料的文本初稿。摩根大通使用该技术分析了美联储会议内容，尝试为其交易部门收集信息。

随着实验阶段逐步结束，企业正计划更大规模地部署生成式AI。这可能意味着用它来总结会议录音或加强研发。毕马威会计师事务所（KPMG）的一项调查发现，五分之四的公司表示计划到2024年中期将这方面投资增加50%以上。

其次，更多的AI产品将上市。2023年末，微软推出了一款AI聊天机器人来辅助其生产力软件（如Word和Excel）用户。它也为Windows操作系统推出了同样的产品。谷歌也将效仿，将AI嵌入谷歌文档和表格中。创业公司也将蜂拥挤入。2023年，风险资本投资者向生成式AI投入超过360亿美

元，是2022年的两倍多。

第三个原因是人才。对AI专家的需求仍然很大。研究公司PredictLeads表示，标准普尔500强公司中，约三分之二的公司发布了提及AI的招聘广告。而就这些公司而言，它们的广告目前有5%提到该技术，高于过去三年的平均2.5%。但这个吃紧的人才市场正在放松。咨询公司麦肯锡的一项调查发现，在2023年，企业表示招聘AI相关职位变得容易了些。

哪些公司将成为早期采用者？较小的公司可能会跑在前面。这就是在智能手机和计算云等之前的技术浪潮中发生的情况。小鱼小虾通常更加灵活，并将技术视为获得相对于大鱼的优势的一个途径。

在较大的公司中，那些以数据为中心的公司（如医疗和金融服务公司）将能够采取最快的行动。这是因为数据管理不善是部署AI的一大风险。企业主管们担心有价值的数据会通过AI工具泄露出去。缺乏可靠的数据管理的公司可能必须首先重组其系统，然后才能切实部署生成式AI。使用这项技术可能让人感觉身处科幻世界，但让它安全地工作却是一项乏味得多的事务。

《经济学人》美国技术编辑盖伊·斯克瑞文■

AI will transform every aspect of Hollywood storytelling

But it will also cause more friction

REUNIONS OFFER a chance to reflect on how much has changed. One will happen during the coming year in Hollywood when "Here" premieres, bringing together the actors, director and writer behind "Forrest Gump" 40 years later for a new, unrelated film. Set in a single room over decades, "Here" is very much a film of the here and now. The stars, Tom Hanks and Robin Wright, will be "de-aged" using new AI tools, rendering them more youthful in some scenes and enabling the film-makers to see the transformation in real time while shooting.

Generative AI now means images can be produced in seconds. Songs can be created in the style of singers dead or alive. More than 3,000 books on Amazon name ChatGPT as the author or co-author, lending new meaning to the term "ghostwriter".

It is still early days, but 2024 will be a preview of what is to come. Three things are worth watching. The first is how AI will be used to tell new types of stories, as storytelling becomes more personalised and interactive. Films will change and so will gaming, an industry where people can choose their own adventures more easily than moviegoers can. The amount of entertainment available will also balloon.

Like the arrival of the internet, which led to an explosion of "user-generated content" being posted to social media and YouTube, generative AI will contribute to reams of videos and other material proliferating online. Some predict that as much as 90% of online content will be AI-generated by 2025. Curation and good search tools will be vital, and there will be debates about whether, and how, to label AI-generated content.

No one is quite sure how the nature of storytelling will change, but it is sure to. David Thomson, a film historian, compares generative AI to the advent of sound. When movies were no longer silent, it altered the way plot points were rendered and how deeply viewers could connect with characters. Cristóbal Valenzuela, who runs a company called RunwayML, which offers AI-enhanced software tools to creative types, says AI is more like a "new kind of camera", offering a fresh "opportunity to reimagine what stories are like". Both are right.

The Hollywood writers' strike shone a spotlight on the question of whether AI would start producing scripts. For now, studios have agreed to concessions and will not bypass writers' rooms to employ ChatGPT instead. It will probably be a few years before a full-length blockbuster is produced entirely by AI.

Instead, the second big development to watch is how AI will be used as a time-saving tool. Generative AI will automate and simplify complex tasks like dubbing, film-editing, special effects and background design. For a glimpse of the future, watch "Everything Everywhere All at Once", which won the Academy Award for Best Picture in 2023. It featured a scene that used a "rotoscoping" tool offered by RunwayML to edit out the green-screen background and make a talking rock more believable. It compressed into hours what might have otherwise taken days of video-editing.

The third thing to watch for is more dramatic clashes between creators (otherwise known as copyright-owners) and those who run AI platforms. The coming year is likely to bring a deluge of lawsuits from authors, musicians, actors and artists about how their words, music and images have been used to train AI systems without consent or payment. Perhaps they can agree on some sort of licensing arrangement, in which AI companies start paying copyright-holders for content to train their models. But that will not happen without an intense legal brawl.

AI presents bigger questions about the future of stories and the nature of collective storytelling. For example, will generative AI simply imitate previous hits, resulting in more derivative blockbuster films and copycat interpretations of pop songs that lack depth, rather than original stories and art forms? And as entertainment becomes more personalised, will there still be stories that become part of humanity's collective consciousness and move large numbers of people, who can talk about them together?

As creators grapple with AI's rise, they will channel their anxieties about technology into their work. Look out for more "Terminator"-style clashes between man and machine. Life imitates art—and art life.

ALEXANDRA SUICH BASS, Culture editor, The Economist ■

人工智能将改变好莱坞叙事的方方面面

但也会造成更多的摩擦

重聚提供了一个机会，让人们反思发生了多大的变化。明年好莱坞的一次机会是《这里》（Here）的首映，《阿甘正传》的演员、导演和编剧在40年后将齐聚一堂，打造一部不相关的新电影。《这里》的故事发生在一个房间里，时间跨度长达数十年，基本上就是一部"此时此地"的电影。主演汤姆·汉克斯和罗宾·怀特将使用新的人工智能（AI）工具来"减龄"，使他们在某些场景中变得更加年轻，并让电影制作人能够在拍摄过程中实时看到容颜转变。

现在，生成式AI意味着可以在几秒钟内生成图像。歌曲可以按照已故或在世歌手的风格来创作。亚马逊上有超过3000本书将ChatGPT列为作者或共同作者，这为"捉刀人"或"影子写手"一词赋予了新的含义。

现在也许还为时过早，但2024年将是未来的预演。有三件事值得关注。首先是如何利用AI讲述新型故事，因为讲故事会变得更加个性化和互动化。电影会改变，游戏也会改变——在游戏里，人们比电影观众更容易选择自己的冒险经历。可提供的娱乐的数量也将激增。

就像互联网的到来导致社交媒体和YouTube上发布的"用户生成内容"激增一样，生成式AI也将促使视频和其他资料在网上激增。有人预测，到2025年，多达90%的网络内容将由AI生成。内容管理和良好的搜索工具将至关重要，而关于是否以及如何标记AI生成内容的问题也将引起争论。

没有人确切知道叙事的性质会发生怎样的变化，但它肯定会变化。电影历史学家大卫·汤姆森（David Thomson）将生成式AI比作有声电影的出现。当电影不再无声时，它改变了情节转折点的表现方式，也改变了观众与角色的共情深度。克里斯托巴尔·巴伦苏埃拉（Cristóbal Valenzuela）经营的RunwayML公司为创意人士提供AI增强软件工具。他表示AI更像是

一种"新型摄影机"，提供了全新的"重新想象故事的机会"。这两位说的都是对的。

好莱坞编剧的罢工让AI是否会开始制作剧本成为人们关注的焦点。目前，电影公司已同意做出让步，不会绕过编剧室而改用ChatGPT。要完全由AI制作一部长篇大片，可能还需要几年的时间。

真正应关注的第二个重大发展是如何将AI用作节省时间的工具。生成式AI将自动化和简化配音、剪辑、特效和背景设计等复杂任务。要想一窥未来，请看看2023年获得奥斯卡最佳影片奖的《瞬息全宇宙》吧。其中有一个场景使用了RunwayML提供的"动态遮罩"工具来剪掉绿幕背景，让一块会说话的石头更加真实可信。它将原本可能需要数天时间的视频剪辑压缩到几个小时。

第三件值得关注的事，是创作者（也称版权所有者）与AI平台运营者之间的冲突变得更激烈。未来一年，作家、音乐家、演员和艺术家很可能会提起大量诉讼，控告他们的文字、音乐和图像在未经同意或未支付报酬的情况下被用于训练AI系统。也许他们可以达成某种许可安排，让AI公司开始向版权所有者就用于训练模型的内容付费。但是，不经过激烈的法律斗争，这种情况是不会发生的。

AI也带来了关于故事的未来和集体叙事的性质的更大问题。例如，生成式AI会不会只是简单地模仿以前的热门作品，从而产生更多缺乏深度的衍生大片和山寨版流行歌曲，而不是原创故事和艺术形式？当娱乐变得更加个性化时，是否还会有故事成为人类集体意识的一部分，感动大批人，成为他们共同的谈资？

随着创作者努力应付AI的崛起，他们会把对技术的焦虑输出到他们的作品中。等着看更多的人类与机器之间发生"终结者"式冲突的故事吧。生活模仿艺术——艺术也模仿生活。

《经济学人》文化编辑亚历山德拉·苏伊奇·巴斯 ■

AI models will become smaller and faster

They will improve in plenty of other ways, too

INTEREST IN artificial intelligence (AI) reached fever pitch in 2023. In the six months after OpenAI's launch in November 2022 of ChatGPT, the internet's most famed and effective chatbot, the topic "artificial intelligence" nearly quadrupled in popularity on Google's search engine. By August 2023, one third of respondents to the latest McKinsey Global Survey said their organisations were using generative AI in at least one capacity.

How will the technology develop in 2024? There are three main dimensions on which researchers are improving AI models: size, data and applications.

Start with size. For the past few years, the accepted dogma of AI research has been that bigger means better. Although computers have got smaller even as they have become more powerful, that is not true of large language models (LLMs), the size of which is measured in billions or trillions of "parameters". According to SemiAnalysis, a research firm, GPT-4, the LLM which powers the deluxe version of ChatGPT, required more than 16,000 specialised GPU chips and took multiple weeks to train, at a cost of more than $100m. According to Nvidia, a chipmaker, inference costs—getting the trained models to respond to users' queries—now exceed training costs when deploying an LLM at any reasonable scale.

As AI models transition to being commercial commodities there is a growing focus on maintaining performance while making them smaller and faster. One way to do so is to train a smaller model using more training data. For instance, "Chinchilla", an LLM developed in 2022 by Google DeepMind, outperforms OpenAI's GPT-3, despite being a quarter of the size (it was trained on four times the data). Another approach is to reduce the

numerical precision of the parameters that a model comprises. A team at the University of Washington has shown that it is possible to squeeze a model the size of Chinchilla onto one GPU chip, without a marked dip in performance. Small models, crucially, are much less expensive to run later on. Some can even run on a laptop or smartphone.

Next, data. AI models are prediction machines that become more effective when they are trained on more data. But focus is also shifting from "how much" to "how good". This is especially relevant because it is getting harder to find more training data: an analysis in 2022 suggested that stocks of new, high-quality text might dry up in the next few years. Using the outputs of the models to train future models may lead to less capable models—so the adoption of LLMs makes the internet less valuable as a source of training data. But quantity isn't everything. Figuring out the right mix of training data is still much more of an art than a science. And models are increasingly being trained on combinations of data types, including natural language, computer code, images and even videos, which gives them new capabilities.

What new applications might emerge? There is some "overhang" when it comes to AI, meaning that it has advanced more quickly than people have been able to take advantage of it. Showing what is possible has turned into figuring out what is practical. The most consequential advances will not be in the quality of the models themselves, but in learning how to use them more effectively.

At present, there are three main ways to use models. The first, "prompt engineering", takes them as they are and feeds them specific prompts. This method involves crafting input phrases or questions to guide the model to produce desired outputs. The second is to "fine-tune" a model to improve its performance at a specific task. This involves giving a pre-existing model an extra round of training using a narrow dataset tailored to that task. For

instance, an LLM could be fine-tuned using papers from medical journals to make it better at answering health-related questions. The third approach is to embed LLMs in a larger, more powerful architecture. An LLM is like an en gine, and to make use of it for a particular application, you need to build the car around it.

One example of this is "retrieval augmented generation", a technique that combines an LLM with extra software and a database of knowledge on a particular topic to make it less likely to spit out falsehoods. When asked a question, the system first searches through its database. If it finds something relevant, it then passes the question, along with the factual information, to the LLM, requesting that the answer be generated from the information supplied. Providing sources in this way means users can be more confident of the accuracy of responses. It also allows the LLM to be personalised, like Google's NotebookLM, which lets users supply their own databases of knowledge.

Amid all the focus on AI's commercial potential, the hunt for artificial general intelligence continues. LLMs and other forms of generative AI may be a piece in the puzzle, or a step on the way, but they are probably not the final answer. As Chris Manning of Stanford University puts it: there is "no reason to believe...that this is the ultimate neural architecture, and we will never find anything better."

ABBY BERTICS, Science correspondent, The Economist ∎

AI模型将变得更小更快

它们也会在其他许多方面取得进步

在2023年，人们对人工智能（AI）的兴趣近乎白热化。在OpenAI于2022年11月推出互联网上最有名、效果最好的聊天机器人ChatGPT后的六个月里，"人工智能"话题在谷歌搜索引擎上的流行度几乎翻了两番。到2023年8月，麦肯锡最近一次全球调查的受访者中有三分之一表示，他们所在的机构在至少一种职能中使用生成式AI。

在2024年，这项技术将如何发展？研究人员正从三大维度改进AI模型：规模、数据和应用。

先看规模。过去几年里，AI研究中公认的信条是"大即好"。计算机在变得更强大的同时尺寸变小了，但大型语言模型（LLM）却不是这样，这种模型的大小以几十亿或几万亿个"参数"论。据研究公司SemiAnalysis称，ChatGPT豪华版背后的LLM GPT-4需要用到超过16,000个专用GPU芯片，花费好几周训练，成本超过1亿美元。据芯片制造商英伟达（Nvidia）称，如今，当以任何尚够用的规模部署LLM时，推理成本（让经过训练的模型响应用户查询的成本）都超过了训练成本。

随着AI模型转变为商业化日用品，人们越来越关注如何能把它们变得更小、更快而不折损性能。一种方法是用更多的训练数据来训练更小的模型。例如，谷歌DeepMind于2022年开发的LLM"龙猫"（Chinchilla）的性能优于OpenAI的GPT-3，尽管其大小仅为GPT-3的四分之一（它接受了四倍的数据训练）。另一种方法是降低模型包含的参数的数值精度。华盛顿大学的一个团队已经证明，有可能把"龙猫"大小的模型压缩到一个GPU芯片上，性能却不会明显下降。至关重要的是，小模型在日后运行时的成本要低得多。有些甚至可以在一台笔记本电脑或一部智能手机上运行。

然后是数据。AI模型这种预测机器接受的训练数据越多效果越好。但焦点

也在从"多少"转向"多好"。这一点尤其重要，因为找到更多训练数据变得越来越难：2022年的一项分析表明，新的高质量文本库存可能会在未来几年内耗尽。使用模型的输出来训练未来模型可能会生成能力较差的模型，因此LLM的普遍采用使得互联网作为训练数据源的价值降低。但数量不代表一切。找出训练数据的正确组合仍然更像一门艺术而非科学。而模型正在越来越多地接受各种类型数据的组合的训练，它们包括自然语言、计算机代码、图像，甚至视频，这赋予了它们新的能力。

可能出现哪些新应用？AI存在"能力过剩"的问题，即它的发展速度快过人们能够利用它的速度。人们的注意力已经从展示它们的可能性转向弄清楚什么是实际可行的。最重要的进步将不在于模型本身的质量，而在于学习如何更有效地利用它们。

目前，使用模型的方式主要有三种。首先是"提示工程"，也就是按它们本来的用处，向它们输入特定的提示。需要精心设计输入的短语或问题来引导模型生成所需的输出。第二种是"微调"模型以提高其在特定任务中的性能。这涉及使用针对该任务定制的狭窄数据集，对已存在的模型进行一轮额外训练。例如，可以使用医学期刊中的论文微调一个LLM，使其能更好地回答健康相关问题。第三种是将LLM嵌入到更大、更强的架构中。LLM就如同一台发动机，而要让它在特定的应用中发挥作用，就需要围绕它构建汽车。

这方面的一个例子是"检索增强生成"，这是一种将LLM与额外的软件和特定主题知识数据库相结合的方法，以降低其给出错误回答的概率。当被提问时，该系统首先搜索其数据库。如果发现了相关的内容，就将问题连同这些事实信息一起传递给LLM，要求它根据所提供的信息来生成答案。以这种方式提供信息源意味着用户可以对答案的准确性更有信心。它也让LLM可以被个性化定制，就像谷歌的NotebookLM让用户可以提供自己的知识数据库。

在人们聚焦于AI的商业潜力之际，对通用人工智能的探索也在继续。LLM和其他形式的生成式AI可能是拼图中的一块，或前进中的一步，而可能不

是最终的答案。正如斯坦福大学的克里斯·曼宁（Chris Manning）所说："没有理由相信……这就是终极的神经架构，而我们永远找不到更好的了。"

《经济学人》科学记者艾比·伯提斯■

Metrics to keep an eye on in 2024, from solar cells to superhero movies

Some are merely fun—while others are potentially world-changing

SOMETIMES THE best way to follow a trend is to plot it on a chart. Here is a selection of noteworthy metrics that are worth keeping an eye on in 2024, from solar-cell technology to superhero movies. Some are merely fun—while others are potentially world-changing.

Will the cost of launching things into orbit fall further?

The cost of launching things into space has plunged over the past decade, a direct consequence of the development of reusable rockets by SpaceX, the rocket-launch company founded by Elon Musk. Its Falcon 9 rocket has a reusable booster stage, which can send a payload on its way to orbit and then return to Earth, touching down either on land or on a drone ship. Not throwing away the booster, which costs tens of millions of dollars, but instead reusing it up to 15 times, has slashed launch costs, and SpaceX now carries more to orbit than the rest of the world combined. But launch costs could soon fall even further, if two new rockets make successful flights in 2024. The first is SpaceX's Starship, the largest rocket ever built, which is fully reusable and can carry as much as 150 tonnes into orbit, ten times more than Falcon 9. But keep an eye, too, on Neutron, a new reusable rocket from Rocket Lab, a rival startup. It aims to be competitive on a cost-per-kilogram basis with the Falcon 9, but for smaller payloads. To open up new opportunities in space, what goes up must come down—in price.

Is enthusiasm for AI chatbots in decline?

ChatGPT attracted 100m users within two months of its launch in November 2022, but user visits peaked in mid-2023 and have since levelled off. This may indicate flagging enthusiasm for chatbots in general. Or it

may just signal that users have become more discerning, and have switched to other chatbots that are better suited to particular tasks. Another possibility is that the mid-year decline is the result of school holidays: watch to see if the numbers tick up again in late 2023.

Will perovskite solar cells take off?

Most photovoltaic cells are made of silicon, and convert sunlight to electricity with an efficiency of about 23%. Perovskite cells, which use other elements in a particular crystal structure, cost more but offer higher efficiency: over 25%, and over 30% when combined in a "tandem" cell with silicon. So the extra expense can be worth it, particularly in situations where space is tight. Firms in America, Britain, South Korea and Sweden aim to start selling perovskite cells in 2024.

When will renewables overtake coal?

Renewable supplies of energy, such as solar and wind power, will soon overtake coal-fired power stations to become the world's largest single source of electricity, according to the International Energy Agency (IEA). But when? Having previously said it would be in 2025, the IEA now thinks it could happen in 2024, "as a result of the accelerated pace of renewable capacity additions" and "the plateauing of electricity generation from coal". Adoption of renewables in Europe has been accelerated by the war in Ukraine: EU countries added 41 gigawatts (GW) of solar capacity in 2022, and are expected to add more than 50GW in 2023. China added 107GW of solar capacity in 2022, roughly equivalent to all existing capacity in America, and is expected to have added two Americas' worth of solar capacity in 2023. Meanwhile, use of coal for generation rose by 1.7% in 2022, as high natural-gas prices prompted gas-to-coal switching. But use of coal in Europe and America in 2023 and 2024 is predicted to drop sharply, more than offsetting a slight increase in Asia.

Will superhero films make a comeback?

Superheroes may have met their match—at the box-office, that is. In 2023 superhero films were overshadowed by "Barbie", whose plastic heroine battled the patriarchy with frequent wardrobe changes, rather than superhuman powers, and "Oppenheimer", a biopic of an non-super (but very clever) human. Much speculation ensued about whether the appetite for endless superhero flicks from Marvel, and its imitators, had cooled. The scene is thus set for a showdown in 2024, when superhero releases include "Captain America: Brave New World", "Deadpool 3" and two Spider-Man spin-offs, "El Muerto" and "Madame Web". They face off against "Mickey 17", Bong Joon Ho's follow-up to "Parasite"; "Challengers", Luca Guadagnino's tennis drama; "It Ends with Us", based on Colleen Hoover's book; and "Gladiator 2", Ridley Scott's follow-up to his epic of 2000. Let battle commence.

Will your cup of coffee get more expensive?

Consumption of coffee is now outstripping production, according to the International Coffee Organisation. The gap could widen in 2024: extreme weather in Brazil in late 2023 may reduce harvests of arabica beans, while El Niño threatens to depress yields of robusta beans in Indonesia. Coffee producers may need to consider cultivation in new areas as the planet warms, and encourage coffee-drinkers to embrace a third species, called liberica, which is more heat-tolerant.

Will wild polio be eradicated?

2024 could be the first year without wild polio. Pakistan and Afghanistan are the last countries where the disease is endemic. Cases have dwindled (the chart shows the number of cases, not thousands or millions) and are limited to small geographical areas. Eradication programmes have a good chance of eliminating the wild virus in the coming months. The focus is shifting towards eliminating a new form of the disease, vaccine-derived

polio, which is on the rise.

| *Will robotaxis turn the corner?*

After much hype five years ago, plans for self-driving robotaxis were delayed and scaled back, as ironing out the bugs from the technology proved harder than expected. But they have since made quiet progress, with the distance between "disengagements" (mistakes requiring intervention by a safety driver) ticking up across the industry, and commercial roll-outs in more cities. More will follow in 2024. But Americans' trust in self-driving cars fell for the second year running in 2023, according to a survey by J.D. Power. People who have ridden in one, however, were more positive. The question for 2024 is: can robotaxis get better more quickly than perceptions of them get worse?

| *Will quantum computing become useful?*

A race is under way to harness the spooky, counter-intuitive laws of quantum physics to build a new kind of computer. For some tasks a quantum computer could outperform any non-quantum machine that could ever be built, blazing through calculations in cryptography, chemistry and finance. But when will a useful machine arrive?

One measure of a quantum computer's capability is its number of quantum bits, or qubits. But existing machines, which implement qubits in various different ways, all have a fatal flaw: the delicate quantum states on which they depend "decohere" after a fraction of a second.

A better measure may be so-called "quantum volume" (QV), which depends on the "width" of a computer (its number of qubits) and its "depth" (the number of operations they can perform before decohering). A computer with 14 qubits that is able to execute 14 operations is said to have a QV of 2 to the power of 14, or 16,384.

The maximum QV achieved is rising steadily, but the volume needed to perform useful operations, not just small-scale tests, remains unclear. IBM, a leader in the field, has set itself a QV target of 2 to the power of 100. Like artificial intelligence, which disappointed for decades before its sudden, spectacular success, quantum computing is likely to go from useless to ubiquitous very quickly—just as soon as researchers figure out how to turn up the volume.

Will the number of coups continue to rise?

Coups are back, and in sub-Saharan Africa in particular, after a lull in the 2010s. You can walk from the Red Sea to the Atlantic entirely within countries that have had coups in the past three years. Of 18 attempted coups since 2021, nine have succeeded. Coups tend to occur for one of two reasons: either a collapse of security, as in Niger and Mali, where generals claimed to be restoring order; or when an unpopular leader outstays his welcome, as in Gabon.

Instability in the Sahel shows no sign of abating, so further coups are possible. But where? Analysts at BMI, a research firm, reckon South Sudan is at most risk, followed by the Central African Republic, much of which is no longer under government control. SBM Intelligence, a Nigerian firm, reckons the chances are highest in the Democratic Republic of Congo. And keep an eye on Equatorial Guinea, which is ruled by Africa's longest-standing leader, Teodoro Obiang Nguema Mbasogo, now 81 years old. A succession crisis could trigger a coup.

When will China take the lead in car exports?

The switch to electric vehicles (EVs) has reshaped the car industry. In many ways, EVs have more in common with smartphones on wheels than they do with combustion-engine vehicles; they contain fewer moving parts and are mechanically much less complex. Incumbent manufacturers, which excel at building engines and gearboxes, have lost their competitive advantage.

Chinese manufacturers spotted an opening—and have charged into it.

Some time in 2024 China will overtake Germany and Japan to become the world's largest car exporter, driven by demand for EVs. Admittedly, Chinese car exports include a lot of vehicles made by Tesla, an American firm, in its Chinese factory. But Tesla, the world's biggest maker of EVs, will be overtaken by BYD, a Chinese firm, which will sell more vehicles, both within China and globally.

Compiled and written by GILEAD AMIT, RACHEL LLOYD, JONATHAN ROSENTHAL, TOM STANDAGE, PRATIBHA THAKER and CHRISTOPHER WILSON, The Economist ■

2024年值得关注的指标，从太阳能电池到超级英雄电影

有些只是好玩，而另一些则有可能改变世界

有时，跟踪趋势的最好方法是将其绘制在图表上。以下是2024年一系列值得注意的指标，从太阳能电池技术到超级英雄电影等等。有些只是好玩，而另一些则有可能改变世界。

将物体送入轨道的成本会进一步下降吗？

在过去十年中，将物体发射到太空的成本大幅下降，这是马斯克创立的火箭发射公司SpaceX开发可重复使用火箭的直接结果。它的"猎鹰9号"火箭有一个可重复使用的助推器级，它可以在进入轨道的途中将有效载荷送入轨道，然后返回地球并在陆地或无人机船上着陆。这种做法没有扔掉耗资数千万美元的助推器，而是重复使用多达15次，从而降低了发射成本。如今SpaceX送入轨道的物体比世界其他地区的总和还要多。但是，如果两枚新火箭在2024年成功发射，发射成本可能很快就会进一步下降。第一个是SpaceX的"星舰"，这是有史以来最大的火箭，它可完全重复使用，能携带多达150吨的重量进入轨道，是"猎鹰9号"的十倍。但也要关注"中子号"（Neutron），这是来自竞争对手创业公司火箭实验室（Rocket Lab）的新型可重复使用火箭。它的目标是每千克成本能与"猎鹰9号"竞争，但有效载荷较小。要在太空中开辟新的机会，必须有去有回、有起有落——说的是价格。

对人工智能聊天机器人的热情是否在减退？

ChatGPT在2022年11月推出后的两个月内吸引了1亿用户，但用户访问量在2023年年中达到顶峰，此后趋于平稳。这可能表明对聊天机器人的热情总体上正在减弱。或者它可能只是表明用户变得更加挑剔，并已转向其他更适合特定任务的聊天机器人。另一种可能性是，年中的下降是学校假期的结果：看看这些数字是否会在2023年底再次上升吧。

钙钛矿太阳能电池会起飞吗？

大多数光伏电池由硅制成，将太阳光转化为电能的效率约为23%。钙钛矿电池在特定的晶体结构中使用其他元素，成本更高，但效率更高：超过25%；当与硅结合制成"串联"电池时，效率超过30%。所以额外的成本或许是值得的，尤其是在空间紧张的情况下。美国、英国、韩国和瑞典的公司计划在2024年开始销售钙钛矿电池。

可再生能源发电何时会超过煤炭？

根据国际能源署（IEA）的数据，太阳能和风能等可再生能源将很快超越燃煤发电站，成为世界上最大的电力来源。但这会在什么时候发生呢？国际能源署此前曾说它将在2025年发生，但现在认为，"由于可再生能源新增速度加快"和"煤炭发电进入平台期"，这有可能在2024年发生。乌克兰战争加速了欧洲可再生能源的采用：欧盟国家在2022年增加了41吉瓦的太阳能装机容量，预计2023年将增加超过50吉瓦。中国在2022年增加了107吉瓦的太阳能装机容量，大致相当于美国现有的全部装机容量，预计在2023年将增加两个美国的太阳能装机容量。与此同时，2022年煤炭发电使用量增长了1.7%，原因是天然气价格高企促使天然气转煤。但预计2023年和2024年欧洲和美国的煤炭使用量将大幅下降，远远抵消亚洲的轻微增长。

超级英雄电影会卷土重来吗？

超级英雄可能遇到了对手了——说的是在票房上。2023年，超级英雄电影的风头被《芭比娃娃》和《奥本海默》盖过，前者的塑料娃娃女主角用频繁更换的服装而不是超能力与父权作斗争，后者是一部非超级（但非常聪明的）人类的传记片。业界纷纷猜测，观众对漫威及其模仿者无休止的超级英雄电影的胃口是否已经减退。2024年看来将上演一场大对决，届时上映的超级英雄电影将包括《美国队长：美丽新世界》、《死侍3》和两部蜘蛛侠衍生作品《亡灵》（El Muerto）和《蜘蛛夫人》（Madame Web）。它们面对的是奉俊昊的《寄生虫》续集《米奇17》；卢卡·瓜达尼诺（Luca Guadagnino）的网球题材正剧《挑战者》；改编自科琳·胡佛（Colleen Hoover）小说的《以我们结束》（It Ends with Us）；以及雷

德利·斯科特（Ridley Scott）2000年史诗的续集《角斗士2》。让战斗开始吧。

你的咖啡会变得更贵吗？

根据国际咖啡组织的数据，咖啡的消费量现在超过了产量。这一缺口在2024年可能会扩大：2023年底巴西的极端天气可能会减少阿拉比卡咖啡豆的收成，而厄尔尼诺现象可能会压低印度尼西亚的罗布斯塔咖啡豆的产量。随着地球变暖，咖啡生产商可能需要考虑在新的地区种植咖啡，并鼓励咖啡饮用者接受第三个更为耐热的品种"大果咖啡"（liberica）。

野生脊髓灰质炎会被根除吗？

2024年可能是没有野生脊髓灰质炎的第一年。巴基斯坦和阿富汗是最后两个流行这种病的国家。病例数有所减少（上图显示了病例数，而单位不是千或百万），并且仅限于较小的地理区域。根除计划很有可能在未来几个月内消灭野生脊灰病毒。重点正在转向消除这种疾病的一个新形式，即疫苗衍生脊髓灰质炎，其发病数正在上升。

无人驾驶出租车会有转机吗？

五年前，无人驾驶出租车的计划被炒得沸沸扬扬，但由于消除技术缺陷的难度超出预期，该计划被推迟和缩减。但自那以后，技术悄然取得了进展，发生"干预"（需要安全驾驶员做出干预的错误）的行驶里程间距普遍拉大，商业推广也打入更多城市，2024年还会有新的进展。但根据君迪（J.D. Power）的调查，美国人对无人车的信任度在2023年连续第二年下降。不过，那些已经乘坐过无人车的人群的态度更为积极。2024年的问题是：无人出租车进步的速度是否能快过人们对其看法恶化的速度？

量子计算会派上用场吗？

一场利用量子物理那诡异而反直觉的定律来制造新型计算机的竞赛正在上演。在某些任务中，量子计算机的性能可能会超过任何非量子计算机，在密码学、化学和金融领域的计算中大显身手。但是，一台实用的机器何时才能出现呢？

衡量量子计算机能力的一个指标是其量子比特（quantum bits或qubits）的数量。但是，现有的机器以各种不同的方式实现量子比特，都有一个致命的缺陷：它们所依赖的微妙的量子态会在几分之一秒后"退相干"。

更好的衡量标准可能是所谓的"量子体积"（QV），它取决于计算机的"宽度"（量子比特数）和"深度"（它们在退相干之前可以执行的操作数）。一台具有14个量子比特且能够执行14次操作的计算机的QV为2的14次方，即16,384。

已实现的最大QV值正在稳步上升，但执行有用操作（而不仅仅是小规模测试）所需的体积仍不明确。该领域的领军企业IBM已将自己的QV目标设定为2的100次方。就像人工智能在突然取得辉煌成功之前令人失望了几十年一样，量子计算很可能会很快从无用变为无处不在——只要研究人员弄清楚如何提高量子体积。

政变的数量会继续上升吗？

在经历了2010年代的平静之后，尤其是在撒哈拉以南的非洲，政变卷土重来。过去三年里发生过政变的国家可以完全从红海连接到大西洋。自2021年以来，18次尝试的政变中有9次获得成功。政变的发生往往有两个原因：一是安全局势崩溃，如尼日尔和马里，将军们声称要恢复秩序；二是不受欢迎的领导人难以为继，如加蓬。

萨赫勒地区的不稳定没有缓解的迹象，因此有可能发生更多政变。但会发生在哪里呢？研究公司BMI的分析师认为，南苏丹的风险最大，其次是中非共和国，因为该国大部分地区已不再受政府控制。尼日利亚公司SBM Intelligence认为刚果民主共和国的风险最高。还要关注赤道几内亚，它由现年81岁的特奥多罗·奥比昂·恩圭马·姆巴索戈统治，他是非洲在位时间最长的领导人。继任危机可能引发政变。

中国何时成为最大的汽车出口国？

向电动汽车（EV）的转变重塑了汽车行业。在许多方面，电动汽车更像车轮上的智能手机而不是内燃机汽车；它们包含的运动部件更少，机械复杂

程度也低得多。擅长制造发动机和变速箱的现有制造商已经失去了竞争优势。中国制造商发现了这一商机并蜂拥而入。

在电动汽车需求的推动下，中国将在2024年的某个时候超过德国和日本，成为世界上最大的汽车出口国。诚然，中国的汽车出口包括美国的特斯拉公司在其中国工厂生产的大量汽车。但全球最大的电动汽车制造商特斯拉将被中国公司比亚迪超越，后者将在中国和全球都售出更多汽车。

由《经济学人》的吉利德·阿米特、雷切尔·劳埃德、乔纳森·罗森塔尔、汤姆·斯坦迪奇、普拉蒂巴·塔克和克里斯托弗·威尔逊编写■

Demand for "green" metals will redraw the global mining map

The energy transition will mint new fortunes in surprising places

A NET-ZERO GLOBAL economy, if it materialises, will not just be carbon-neutral. It will also consume far fewer raw materials. Going from here to there, however, will require a heap of them. In the next few decades, supplying them will create new fortunes.

A planet moving towards a cleaner energy system will still need dirty fuel. And even when oil consumption peaks, countries that can produce high-quality crude at low cost will be strengthened rather than weakened, as their market share and pricing power rise in tandem. Gulf giants such as Saudi Arabia and the UAE will be obvious beneficiaries. Less on the radar is tiny Guyana, where recent discoveries—enough for it to extract 1.2m barrels a day, or 1.1% of global supply, by 2028—could allow it to produce more oil per person than any country in the world.

Appetite for natural gas, a cleaner alternative to coal in fossil-fuel-fired power plants, may last longer still. As Europe has weaned itself off Russian gas, America, Australia and Qatar, which are cranking up output of the fuel in liquefied form, will pocket the proceeds. But so may Argentina. And African countries, meanwhile, could see their share of the global gas market double by 2050.

More durable riches may be earned through exporting the billions of tonnes of metal the planet needs to build new, low-carbon infrastructure. Chile and Peru already supply much of the world's copper; their vast remaining reserves will be tapped as the roll-out of everything green, from wires to wind turbines, boosts demand for the red metal. Declining copper content of ores in ageing mines is raising costs, however, and pushing

miners to riskier frontiers. Barrick Gold, a Canadian firm, wants to invest $7bn in a copper mega-project in the volatile borderlands between Pakistan and Iran.

The Democratic Republic of Congo is already well known as the world's biggest source of cobalt, used in electric-car batteries. Less well known is the fact that cobalt is a by-product of the extraction of other minerals. In recent years that has allowed Indonesia, the largest exporter of nickel, another battery metal, to become a big and growing supplier of cobalt as well. The world's fourth-largest producer of nickel, by the way, is New Caledonia, a French territory of 300,000 people in the Pacific that holds 7% of global reserves.

When it comes to lithium, the king of battery metals, Latin America, Australia and China look like the obvious champions (Latin America alone hosts 60% of known resources). But they may face unexpected competition. In March, Iran said it had discovered what may be the world's second-largest deposit. Atlantic Lithium, an Australian firm, is developing Ghana's first lithium mine. And in September a huge deposit was found in America, on the Nevada-Oregon border. Demand for "green" metals will redraw the global mining map in ways that are hard to predict.

MATTHIEU FAVAS, Commodities editor, The Economist ■

对"绿色"金属的需求将重新绘制全球矿业版图

能源转型将在令人意想不到的地方创造新的财富

如果全球净零经济成为现实，那么它将不仅仅是碳中和的。它消耗的原材料也将大幅减少。然而，实现这一目标将需要很多原材料。在接下来的几十年里，供应它们将创造新的财富。

迈向清洁能源系统的地球仍然需要肮脏的燃料。即使石油消费达到顶峰，能够以低成本生产优质原油的国家也会增强实力而不是削弱，因为它们的市场份额和定价能力会同步上升。沙特阿拉伯和阿联酋等海湾大国将是明显的受益者。不太受关注的是小国圭亚那，该国最近的发现足以使其到2028年每天开采120万桶石油，占全球供应量的1.1%，这可能使其人均石油产量超过世界上任何国家。

天然气是化石燃料发电厂中煤炭的更清洁替代品，人们对天然气的需求可能会持续更长时间。随着欧洲逐渐摆脱对俄罗斯天然气的依赖，正在提高液化天然气产量的美国、澳大利亚和卡塔尔将把收益收入囊中。但阿根廷也可能如此。与此同时，到2050年，非洲国家在全球天然气市场的份额可能会翻一番。

地球建设新的低碳基础设施需要数十亿吨金属，出口这类金属或许可以赚取更持久的财富。智利和秘鲁已经供应了世界上大部分的铜；随着从电线到风力涡轮机等所有绿色产品的推出，对这种红色金属的需求将会提升，两国剩余的巨大储量将被利用起来。然而，老化的矿山中矿石的铜含量下降，这会提高成本，并将矿商推向风险更高的地域。加拿大公司巴里克黄金（Barrick Gold）公司希望投资70亿美元，在巴基斯坦和伊朗之间动荡的边境地区建设一个大型铜项目。

至于电动汽车电池中所用的钴，众所周知，刚果民主共和国是世界上最大的产地。不太为人所知的是，钴是提取其他矿物的副产品。近年来，这使

得印度尼西亚这个最大的镍（另一种电池金属）出口国也成为了一个不断增长的大型钴供应国。顺便说一句，世界第四大镍生产国是新喀里多尼亚，这是一个位于太平洋的法国海外领地，有30万人口，拥有全球储量的7%。

说到电池金属之王锂，拉丁美洲、澳大利亚和中国看起来是明显的领导者（仅拉丁美洲就拥有60%的已知资源）。但它们可能会面临意想不到的竞争。今年3月，伊朗表示已发现可能是世界第二大矿床。澳大利亚公司大西洋锂业（Atlantic Lithium）正在开发加纳的第一个锂矿。9月，美国在内华达州和俄勒冈州的交界处发现了巨大的矿床。对"绿色"金属的需求将以难以预测的方式重新绘制全球采矿版图。

《经济学人》大宗商品编辑马蒂尤·法瓦斯■

Global average temperatures may pass a threshold in 2024

El Niño won't help

WHEN WILL the annual global average temperature rise by more than 1.5°C above pre-industrial levels for the first time? There have been individual days when the global average temperature has exceeded that threshold, but so far no single year has, on average, been that hot overall. This may change in 2024, when the steady, century-long rise in temperatures driven by greenhouse-gas emissions syncs with a natural cyclical warming pattern for the first time in nearly a decade.

Meteorological agencies collect temperature data from across the globe and throughout the year to determine the annual average global surface temperature. That number, published each January, has been rising since early in the 20th century, but not systematically. The line zigzags (see chart). This is because global warming, driven by greenhouse gases, is happening at the same time as natural variations in the global climate system, which cause some years to be hotter or colder than others.

The largest such hot-and-cold cycle is the El Niño Southern Oscillation (ENSO), a pattern that begins in and above the waters of the equatorial Pacific and affects the weather in the tropics and beyond. ENSO alternates between three states: La Niña, neutral and El Niño. The two extremes are typically cooler (La Niña) and hotter (El Niño) than average; both bring enhanced probabilities of wild weather extremes.

From mid-2020 to early 2023, ENSO was in a La Niña pattern. As well as exacerbating some remarkable weather events, including record-breaking floods in Pakistan in 2022, this unusually long La Niña temporarily depressed global average temperatures, masking some of the warming

caused by industrial emissions. There will be no such reprieve in 2024. In June 2023, ENSO flipped into a much-anticipated El Niño state, which will add to global warming. And this El Niño is forecast to be a strong one, bringing a greater likelihood of extremes.

The last such event was in 2015-16. It brought record-breaking global temperatures in 2016, an annual record that still stands. There are two possibilities. El Niño is an end-of year phenomenon that starts in the later days of the boreal summer and peaks at Christmas and the new year (it was named after Baby Jesus by Peruvian fishermen who noticed the way its warmer Pacific temperatures chased anchovies into deeper, cooler waters). Typically, the year after an El Niño is the record-breaker. But the boreal summer of 2023 brought serious climate fevers in both the oceans and the atmosphere. Starting in July, daily temperatures rose to new heights. As a result, when all the data are in and published in January, it may turn out that 2023 was the hottest year ever. If it was not, then 2024 almost certainly will be.

So will either year's average exceed the Paris threshold? The Paris agreement talks of a rise in temperatures "above pre-industrial". Naturally, when the threshold is passed depends on what is used as the pre-industrial average (temperatures are now measured with a precision that is not available from the proxies used to estimate averages before the steam engine). So some predict it will happen in 2024, others that it could take one more El Niño cycle.

Paris signatories will, however, have a little longer before the overshoot of 1.5°C will technically have been reached. The deal refers to a vaguely defined long-term average, taken over several years. So there will be a few more ups and downs before that average exceeds the threshold. Not many, though—climate models suggest the game will be up in the 2030s.

CATHERINE BRAHIC, Environment editor, The Economist ■

全球平均气温可能在2024年突破阈值

厄尔尼诺的叠加效应

全球年平均气温何时将首次较工业化前水平上升超过1.5℃？全球平均气温曾有个别日子超过了这一阈值，但到目前为止，平均而言还没有哪一年整体如此炎热。这在2024年可能会改变，届时温室气体排放导致的持续了一个世纪的气温稳定攀升将在近十年来首次与自然周期性变暖模式同步。

气象机构收集来自全球各地的全年温度数据以确定全球年平均表面温度。这个在每年1月发布的数字自上世纪初以来不断上升，但并不是系统有序的。这条线呈锯齿状（见图表）。这是因为由温室气体驱动的全球变暖与全球气候系统的自然变化同时发生，导致某些年份比其他年份更热或更冷。

此类冷热循环中，最大的一个是厄尔尼诺南方涛动（ENSO），这一模式始于赤道太平洋水域及其上方，影响热带地区及其他地区的天气。ENSO在三种状态之间交替：拉尼娜、中性状态和厄尔尼诺。两个极端状态通常比平均水平更冷（拉尼娜）和更热（厄尔尼诺），都会增加发生极端天气的概率。

从2020年中到2023年初，ENSO处于拉尼娜状态。这次异常漫长的拉尼娜现象加剧了一些重大天气事件，包括2022年巴基斯坦破纪录的洪水，还暂时降低了全球平均气温，掩盖了工业排放造成的部分变暖现象。2024年不会有这样的缓和效应了。2023年6月，ENSO已转变为姗姗来迟的厄尔尼诺状态，这将加剧全球变暖。而预计这次厄尔尼诺将很强烈，出现极端事件的可能性会更大。

上一次厄尔尼诺是在2015到2016年间，它使得全球气温在2016年创下历史新高，这一年度纪录保持至今。现在有两种可能性。厄尔尼诺是一种在年底时出现的现象，它始于北半球夏季的后期，在圣诞节和新年达到顶峰

（最初秘鲁的渔民以婴儿耶稣为其命名，他们注意到太平洋变暖的水温驱动凤尾鱼游向更深更冷的水域）。通常情况下，在厄尔尼诺发生后的翌年气温会打破纪录。但2023年的北半球夏季给海洋和大气都带来了严重的"高烧"。从7月开始，每日气温不断攀升新高。因此，当所有数据汇整并在2014年1月份发布时，可能会揭示2023年是有史以来最热的一年。如果不是的话，那么2024年几乎肯定会是了。

那么这两年的平均气温会超过巴黎门槛吗？巴黎协议讨论的气温上升是"高于工业化前水平"。何时超过阈值自然要取决于拿什么作为工业化前的平均值（现在测量温度的精度是蒸汽机问世前用于估计平均值的指标所无法达到的）。因此，一些人预测这将在2024年发生，另一些人预测可能需要再经历一轮厄尔尼诺周期。

不过，在严格达到超过1.5度的阈值之前，留给巴黎协议签署国的时间还要略多一点。该协议所指是一个模糊定义的长期均值，跨越数年。因此，在这个平均值超过阈值之前还会有几回起伏波动。不过也不会太多——气候模型显示这将在2030年代到头。

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