The Economist

SPECIAL REPORT

AI IN BUSINESS

March 31st 2018

GrAIt expectations

EMERGING MARKETS LEAP INTO THE DIGITAL ERA: WE SEE ALPHA.

At PGIM, we identify the trends driving specific sectors of outperformance – like youthful populations adopting fintech and e-commerce faster than the developed world.

We see explosive growth in mobile phone penetration in countries such as Brazil, with 141 handsets per 100 people.[1] In India, retail e-commerce sales are expected to triple to $47 billion by 2020.[2]

And every day, our 1,100 investment professionals around the world seek out such opportunities.[3]

Professional and institutional investors can partner with PGIM to see the implications across emerging market sectors and themes.

Get our perspective at **pgim.com/EM**

Your capital is at risk and the value of investments can go down as well as up. Investments in emerging markets may by their nature have higher volatility and risk. Past performance is not indicative of future results.

PGIM

FIXED INCOME | EQUITIES | REAL ESTATE | ALTERNATIVES | PRIVATE DEBT

Alpha indicates the performance, positive or negative, of an investment when compared against an appropriate standard, typically a group of investments known as a market index. This information is not intended as investment advice and is not a recommendation about managing or investing assets. Investing is subject to investment risk, including the loss of the principal amount invested.

[1] PwC, *Emerging Markets – Driving the Payments Transformation*, July 12, 2016, www.pwc.com/gx/en/financial-services/publications/assets/pwc-emerging-markets-12-July.pdf.
[2] "eMarketer Cuts Estimates for Ecommerce in India: New Currency Rules Limit Online Buying Options," *eMarketer*, December 6, 2016. [3] Data as of 31 December 2017.

GrAIt expectations

Artificial intelligence is spreading beyond the technology sector, with big consequences for companies, workers and consumers, says Alexandra Suich Bass

LIE DETECTORS ARE not widely used in business, but Ping An, a Chinese insurance company, thinks it can spot dishonesty. The company lets customers apply for loans through its app. Prospective borrowers answer questions about their income and plans for repayment by video, which monitors around 50 tiny facial expressions to determine whether they are telling the truth. The program, enabled by artificial intelligence (AI), helps pinpoint customers who require further scrutiny.

AI will change more than borrowers' bank balances. Johnson & Johnson, a consumer-goods firm, and Accenture, a consultancy, use AI to sort through job applications and pick the best candidates. AI helps Caesars, a casino and hotel group, guess customers' likely spending and offer personalised promotions to draw them in. Bloomberg, a media and financial-information firm, uses AI to scan companies' earnings releases and automatically generate news articles. Vodafone, a mobile operator, can predict problems with its network and with users' devices before they arise. Companies in every industry use AI to monitor cyber-security threats and other risks, such as disgruntled employees.

Instead of relying on gut instinct and rough estimates, cleverer and speedier AI-powered predictions promise to make businesses much more efficient. At Leroy Merlin, a French home-improvement retailer, managers used to order new stock on Fridays, but defaulted to the same items as the week before so they could start their weekend sooner. The firm now uses algorithms to take in past sales data and other information that could affect sales, such as weather forecasts, in order to stock shelves more effectively. That has helped it reduce its inventory by 8% even as sales have risen by 2%, says Manuel Davy of Vekia, the AI startup that engineered the program.

AI and machine learning (terms that are often used interchangeably) involve computers crunching vast quantities of data to find patterns and make predictions without being explicitly programmed to do so. Larger quantities of data, more sophisticated algorithms and sheer computing power have given AI greater force and capability. The outcomes are often similar to what an army of statisticians with unlimited time and resources might have come up with, but they are achieved far more quickly, cheaply and efficiently.

One of AI's main effects will be a dramatic drop in the cost of mak- ▸▸

CONTENTS

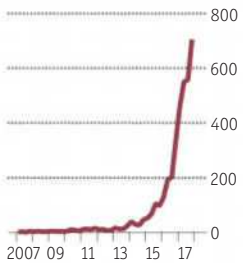
ACKNOWLEDGMENTS

In addition to those mentioned in the text, the author would like to express special thanks to Marco Annunziata, Vijay Balasubramaniyan, Katie Baynes, Marc Benioff, Jack Berkowitz, Steve Blank, Bryan Catanzaro, James Cham, Frank Chen, Pia Chatterjee, Paul Cheesbrough, Youngcho Chi, Shawn Edwards, Benedict Evans, William Fitzgerald, Anthony Goldbloom, Adam Goldstein, Jensen Huang, Isabelle Kocher, Alexander Kvamme, Alfred Lin, Lucas Mayer, Andrew Moore, Frida Polli, Shankar Raman, Emmanuel Roman, Tariq Shaukat, Peter Sims, Chiku Somaiya, Mike Volpi, Matt Wood and Shivon Zilis.

ing predictions, says Ajay Agrawal of the University of Toronto and co-author of a new book, "Prediction Machines". Just as electricity made lighting much more affordable—a given level of lighting now costs around 400 times less than it did in 1800—so AI will make forecasting more affordable, reliable and widely available.

Machine earning

Mentions of AI and machine learning on earnings calls of public companies



Source: Bloomberg

Computers have been able to read text and numbers for decades, but have only recently learned to see, hear and speak. AI is an omnibus term for a "salad bowl" of different segments and disciplines, says Fei-Fei Li, director of Stanford's AI Lab and an executive at Google's cloud-computing unit. Subsections of AI include robotics, which is changing factories and assembly lines, and computer vision, used in applications from identifying something or someone in a photo to self-driving-car technology. Computer vision is AI's "killer app", says Ms Li, because it can be used in so many settings, but AI has also become more adept at recognising speech. It underlies voice assistants on phones and home speakers and allows algorithms to listen to calls and take in the speaker's tone and content.

Techtonic shifts

Until now the main beneficiary of AI has been the technology sector. Most of today's leading tech firms, such as Google and Amazon in the West and Alibaba and Baidu in China, would not be as big and successful without AI for product recommendations, targeted advertising and forecasting demand. Amazon, for example, uses AI widely, for tasks such as guiding robots in its warehouses and optimising packing and delivery, as well as detecting counterfeit goods and powering its speaker, Alexa. Alibaba, a Chinese rival, also makes extensive use of AI, for example in logistics; and its online-payments affiliate, Ant Financial, is experimenting with facial recognition for approving transactions. Sundar Pichai, Google's boss, has said that AI will have a "more profound" impact than electricity or fire.

Bosses of non-tech companies in a broad range of industries are starting to worry that AI could scorch or even incinerate them, and have been buying up promising young tech firms to ensure they do not fall behind. In 2017 firms worldwide spent around $21.8bn on mergers and acquisitions related to AI, according to PitchBook, a data provider, about 26 times more than in 2015 (see chart, right). They are doing this partly to secure talent, which is thin on the ground. Startups without revenue are fetching prices that amount to $5m-10m per AI expert.

As AI spreads beyond the tech sector, it will fuel the rise of new firms that challenge incumbents. This is already happening in the car industry, with autonomous-vehicle startups and ride-hailing firms such as Uber. But it will also change the way other companies work, transforming traditional functions such as supply-chain management, customer service and recruitment.

The path ahead is exhilarating but perilous. Around 85% of companies think AI will offer a competitive advantage, but only one in 20 is "extensively" employing it today, according to a report by MIT's *Sloan Management Review* and the Boston Consulting Group. Large companies and industries, such as finance, that generate a lot of data, tend to be ahead and often build their own AI-enhanced systems. But many firms will choose to work with the growing array of independent AI vendors, including cloud providers, consultants and startups.

This is not just a corporate race but an international one, too, especially between America and China. Chinese firms have an early edge, not least because the government keeps a vast database of faces that can help train facial-recognition algorithms; and privacy is less of a concern than in the West.

There will be plenty of opportunities to stumble. One difficult issue for companies will be timing. Roy Bahat of Bloomberg Beta, a venture-capital firm, draws a parallel between now and the first dotcom boom of the late 1990s: "Companies are flailing to figure out what to spend money on." If they invest huge sums in AI early on, they run the risk of overcommitting themselves or paying large amounts for worthless startups, as many did in the early days of the internet. But if they wait too long, they may leave themselves open to disruption from upstarts, as well as from rivals that were quicker to harness technology.

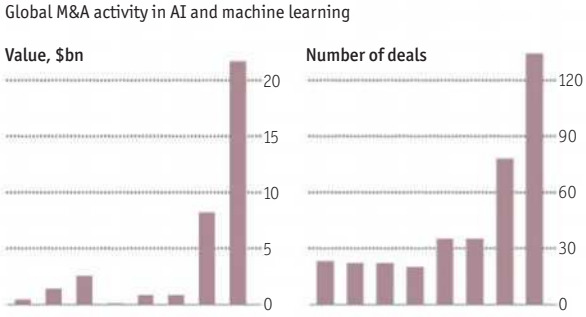
Some may have been misled by glowing media reports, believing AI to be a magic wand that can be installed as easily as a piece of Microsoft software, says Gautam Schroff of Tata Consultancy Services, an Indian firm. AI systems require thorough preparation of data, intensive monitoring of algorithms and a lot of customisation to be useful. Gurdeep Singh of Microsoft speaks of AI systems as "idiots savants"; they can easily do jobs that humans find mind-boggling, such as detecting tiny flaws in manufactured goods or quickly categorising millions of photos of faces, but have trouble with things that people find easy, such as basic reasoning. Back in 1956, when academic researchers held their first gathering to discuss AI, they were looking for a way to imbue machines with human-like "general" intelligence, including complex reasoning. But that remains a distant aspiration.

The excitement around AI has made it hard to separate hype from reality. In the last quarter of 2017 public companies across the world mentioned AI and machine learning in their earnings reports more than 700 times, seven times as often as in the same period in 2015 (see chart, above). There are so many firms peddling AI capabilities of unproven value that someone should start "an AI fake news" channel, quips Tom Siebel, a Silicon Valley veteran.

Bosses must keep several time horizons in mind. In the near future AI will reshape traditional business functions such as finance, HR and customer service, according to Michael Chui of the McKinsey Global Institute, a think-tank within a consultancy. But over time it will also disrupt whole industries, for example by powering the rise of autonomous vehicles or the discovery of entirely new drug combinations. Whereas humans may have preconceptions about which product designs or drug combinations are likely to work best, algorithms are more likely to come

Artificial sweeteners

Global M&A activity in AI and machine learning



Source: PitchBook

up with novel solutions.

In private, many bosses are more interested in the potential cost and labour savings than in the broader opportunities AI might bring, says John Hagel of Deloitte, a consultancy. That is certainly not good for workers, but nor, ultimately, is it good for business. "If you just cut costs and don't increase value for customers, you're going to be out of the game," he says. Some companies may not actually eliminate existing jobs but use technology to avoid creating new ones. And workers who keep their jobs are more likely to feel spied on by their employers. Some firms already use AI to comb through their workers' communications to ensure that they are not breaking the law. Such practices will spread, raising privacy issues.

A longer-term concern is the way AI creates a virtuous circle or "flywheel" effect, allowing companies that embrace it to operate more efficiently, generate more data, improve their services, attract more customers and offer lower prices. That sounds like a good thing, but it could also lead to more corporate concentration and monopoly power—as has already happened in the technology sector. ■

Supply chains

In algorithms we trust

AI is making companies swifter, cleverer and leaner

DELIVERING 25 PACKAGES by lorry or van might seem straightforward enough, but it is devilishly complex. The number of possible routes adds up to around 15 septillion (trillion trillion), according to Goldman Sachs, an investment bank. Integrating AI into the complex web of production and distribution—the supply chain—will have a bigger economic impact than any other application of the technology and affect a larger number of businesses, says Sudhir Jha of Infosys, a large IT company. McKinsey estimates that firms will derive between $1.3trn and $2trn a year in economic value from using AI in supply chains and manufacturing (see chart). Many firms are already using robots powered by machine learning to improve the running of their factories and warehouses. But AI will transform several other aspects of supply chains as well.

One is the unglamorous work of managing finances and paying suppliers. Just as Microsoft's Excel spreadsheets changed finance departments, AI will make routine back-office work more efficient, says Morag Watson, BP's chief digital-innovation officer. Some early adopters are starting to use AI to scan invoices and predict payments. Workday, a software firm, offers a financial-planning tool using AI to forecast which clients are going to pay late.

Another opportunity is to improve manufacturing through computer-vision systems that can inspect products on assembly lines and spot flaws. These systems are more accurate than humans, says Andrew Ng of Landing.AI, a startup that works with Foxconn, a big Taiwanese contract manufacturer, and others. Nvidia, a chipmaker, already uses computer vision to ensure that its chips are properly assembled.

Companies will also use AI to predict when their equipment might fail. This will benefit firms that operate large assets, such as airlines, oil firms, energy companies and industrial giants, where unexpected breakdowns come at a big cost. Companies can combine data on past performance with those generated by smart sensors on machinery (part of the much-hyped "internet of things") to predict when a jet engine or a wind turbine is likely to fail, so they can do maintenance before that happens. America's air force and defence department are working with C3 IOT, a startup, to scan maintenance logs and past technical problems for signs that aircraft are wearing out. Companies are also building "digital twins"—virtual representations of assets—to run simulations of how weather and other factors affect machinery.

Next year's hits

Better predictions will improve inventory management and demand forecasting, too, freeing up cash and storage space. This is especially important for retailers, which often have very thin margins, says Chen Zhang, chief technology officer of JD.com, a Chinese e-commerce firm. In 2015 the cost to companies of overstocking was around $470bn and of understocking $630bn worldwide, according to IHL Group, a research firm. Amazon now has algorithms to predict demand for hundreds of millions of products it sells, often as much as 18 months ahead. Among the most difficult items are clothes, where the company must decide which sizes and colours to stock at which warehouses, depending on nearby buyers' shapes and tastes, says Ralf Herbrich, Amazon's director of machine learning.

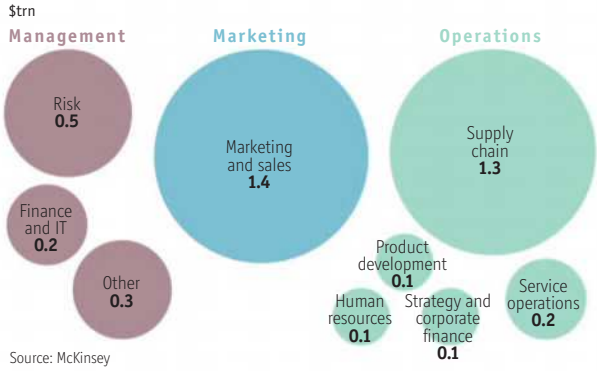
Lineage, a firm that keeps food cold for clients such as grocers and restaurants, uses AI to forecast in what order items will arrive at and leave a warehouse, so that it can put the pallets in the right position. "I put the toothbrush by my sink because I use it three times a day, and my Christmas tree in the attic for a reason," says Greg Lehmkuhl, Lineage's boss, adding that using AI for smart placement has boosted efficiency by 20%.

AI is also helping firms track the movement of their goods. Most of the businesses in global shipping, from ports and lorries to container ships, have been technological laggards, so their customers never knew when their goods might show up. This is starting to change. Systems are getting better at routing items efficiently and predicting their arrival, and companies are investing more in them. To forecast arrivals, they can put sensors on shipments or design whole systems to use data like the GPS signals put out by lorries. Packages are also being routed more efficiently, with big potential gains. Jack Levis, director of process management for United Parcel Service (UPS), a package-delivery firm, says that for every mile that its drivers in America are able to reduce their daily route, the firm saves around $50m a year.

Goldman Sachs expects AI to bring logistics costs down by

Ballooning

Potential economic-value creation from AI in the next 20 years
$trn



Source: McKinsey

at least 5%, which could generate additional profits of $25bn over the next ten years. That would make a big difference in this cut-throat and low-margin business. It may also introduce new competitors who completely rethink old processes. "When you build a new jet, you don't just put a jet engine on the Wright Brothers' plane," says Ryan Petersen of Flexport, a logistics startup. Many firms, including JD.com, are investing in AI-powered drone-delivery technology.

Now mighty Amazon is moving into the logistics business, piloting a service in Los Angeles for picking up packages from businesses and delivering them to customers, which puts it in direct competition with FedEx and UPS. The e-commerce giant has become "everyone's competitor", says Ibrahim Gokcen, chief digital officer of Maersk, a global shipping firm. "Everybody in the supply chain has a heightened awareness they have to up their game, in part because of the capabilities of Amazon," says Rich Carlson of Savi, a smart-logistics startup. Amazon's rivals may fret, but consumers will be pleased. ■

Customer service

Here to help

How AI can make businesses look more caring

"YOUR CALL IS important to us," a recorded voice tells resigned customers as they wait endlessly to speak to a human agent. AI is starting to help companies improve the quality and consistency of their service in order to persuade customers that they do in fact care about them.

Ocado, a British online grocer, receives around 10,000 e-mails from customers every day and uses AI to detect the prevailing sentiment in them. It now replies to the most urgent ones first, and is planning to route complaints to agents with expertise in the relevant field. "Like other applications of AI, it's about trying to make humans more efficient, not take them out of the process entirely," says Paul Clarke, Ocado's chief technology officer. Between 2017 and 2021 the share of customer-service interactions worldwide handled entirely by AI will rise fivefold, to 15%, and by 2019 at least 40% of such interactions will involve an element of AI, according to Gartner, a research firm.

AI will change customer service as much as the telephone did in its day. Before the phone started to spread in the early 20th century, companies handled customer inquiries by post or by visiting in person. Phones helped agents to become more productive, and AI will boost productivity even more dramatically, because it can handle large numbers of customer inquiries more quickly than humans can. This has become more important as communications channels have multiplied to take in e-mail, mobile messaging apps and social media. And consumers have got used to dealing with automated services. Surveys suggest that around 40% of American internet users would rather use digital customer services than speak to someone on the phone.

Virtual agents are on the rise. Some 30% of companies now offer standalone "bots" that can answer questions and solve problems, although their range remains narrower than that of a human. Many of these use some AI. They are trained on logs and transcripts of past customer interactions, and as they are fed more data they become better at solving more complex queries. Such bots enable businesses to deal with many more inquiries without hiring extra people. China Merchants Bank, a commercial bank, uses a bot on the popular Chinese app WeChat to handle 1.5m-2m queries every day, a workload equivalent to around 7,000 human staff. Caesars, the hotel and casino group, offers a virtual concierge, Ivy, at two of its hotels, which answers guests' queries by text, many of them automatically if the inquiry is simple to answer. This has reduced calls to the human-concierge desk by 30%.

AI will also enhance customer-service agents' knowledge, performance and speed. Some companies are experimenting with "voice-printing" technology which recognises clients' voices and alerts agents if a caller is impersonating someone else. This will be especially helpful in financial services.

One Australian bank is experimenting with a standalone smart voice-controlled speaker to listen in on agents' conversations about loans. If the agent forgets something or makes a mistake, it jumps in. Some companies are also using AI to suggest responses to customer queries which a human agent can approve or adapt before sending. Over the past year this has allowed KLM, the Dutch flag carrier, to double the number of text-based customer inquiries it handles to 120,000 a week while increasing the number of agents by only 6%, says Dmitry Aksenov of Digital Genius, a firm that helps automate customer support.

A few companies have started offering AI-enabled services that listen to calls to judge agents' performance and send them suggestions for improvement in real time. One startup, Cogito, whose customers have included insurance firms such as Humana and MetLife, focuses on recognising "compassion fatigue" in agents. It takes in details such as how fast agents are talking and what words callers are using to detect emotion and gauge whether the interaction is going well. If there is a problem, it cues agents to act more empathetically. A tool like this can help large

companies monitor their agents' performance, but the agents may also welcome the feedback. Call-centres have a turnover of 30-40% a year, partly because agents have had little help with improving their performance, says Joshua Feast, Cogito's boss.

Marty Lippert, head of technology for MetLife, reckons that in areas like customer service and human resources AI offers a return on investment of around 20%. Most companies buy AI services from outside providers, but firms with technical know-how often prefer to create their own. For example, a team at Uber, a ride-hailing firm, has built a system using AI to deal with e-mailed queries (there is no telephone option). It sends the agent ranked options for what to do next, which has cut the time it takes to resolve a complaint by around 10%.

Services that make customers' lives easier will generate more customers, who will provide more training data to make the AI systems smarter

One hope for AI is that it will free customer-service agents from routine tasks so they can sell customers other services and generate new revenue. KLM has been able to generate millions of dollars of extra sales since it started using AI because agents now have more time to help customers book upgrades and new flights, says Mr Aksenov of Digital Genius. But not all customers will appreciate more sales pitches.

AI will certainly change the way selling is done. Many firms are experimenting with developing AI-enhanced recommendation tools, like those used by Amazon and Netflix, to help salespeople with their jobs. Google, Facebook and Amazon have been using AI to target consumers with ads and special offers online for years, with great success. Similar practices could spread to other businesses. For example, when sales staff at Goldman Sachs, an investment bank, take orders for corporate bonds, they can now see instant suggestions of bonds with similar risk profiles to pitch to their clients. Caesars uses AI to work out customers' potential daily spending, choose the clients who will receive personal phone calls and in what order, and decide what specific promotions to offer them. The company's boss, Mark Frissora, says that refining marketing to a "message of one" boosts customer loyalty over time.

Don't call us

Gartner, a research firm, expects the number of phone-based customer-service agents worldwide to decline by 10% by 2019. That would increase the workload of those who are left. But companies need to be careful not to dilute their interactions with customers too much. The rise of virtual communication has left them with fewer opportunities to establish deep relationships, so customer service will become ever more important.

Clever firms will use AI not just to improve existing services but to engineer new ones. Metro Group, a German retailer, is testing the use of computer vision at the checkout: the items in a basket are recorded by cameras and the shopper is charged accordingly. Amazon uses similar technology in a convenience store in Seattle. Timo Salzsieder, chief information officer of Metro Group, reckons these new unmanned, vision-enhanced checkouts can handle 50 customers per hour, more than double the number for a manned checkout.

Some insurers, including Ping An of China, use AI to let customers file a claim after a car accident. Instead of having to phone the insurance company and fill in lots of forms, customers take photos of the damage to their car and submit them through an app for a quick quote for repairs. Building a tool like this is a technological challenge, but getting in early is a good idea. Services that make customers' lives easier will generate more customers, who will provide more training data to make the AI systems smarter. Ping An gets 15m claims a year and handles 30% of them on its app. "It takes an enormous amount of cost out of the system and puts customers in control," says Jonathan Larsen, Ping An's chief innovation officer. Such offerings also reinforce firms' direct relationship with their customers.

Conversely, voice-controlled smart speakers, as offered by Amazon, Google, Microsoft and Apple, could come between the companies and their targets. Some of these speakers host other firms' apps. For example, UPS has built a tool enabling customers to track their packages through Amazon's Alexa, which they might previously have done online or by phone. Companies worry they could be disintermediated, so that the firm that makes the speaker becomes the customer's primary relationship, says Paul Daugherty of Accenture, a consulting firm, and co-author of a new book, "Human + Machine: Reimagining Work in the Age of Artificial Intelligence". And, since voice-controlled speakers guide customers to a single answer rather than offering them multiple choices of firms to interact with, those that cannot or do not want to use these speakers may miss out on forming a relationship in the first place. Much will depend on how quickly voice speakers spread. Currently only about one in six American adults owns one, but that is already more than double the figure a year ago. And as speech recognition improves further, the appeal of speakers will grow, especially among youngsters. ■

Human resources

Hire education

AI is changing the way firms screen, hire and manage their talent

HUMAN RESOURCES (HR) is a poorly named department. It usually has few resources other than overworked staff, clunky technology and piles of employee handbooks. Hassled recruiters have to sort through reams of applications that vastly outnumber the jobs available. For example, Johnson & Johnson (J&J), a consumer-goods company, receives 1.2m applications for 25,000 positions every year. AI-enabled systems can scan applications far more quickly than humans and work out whether candidates are a good fit.

Oddly enough, they may also inject more humanity into hiring. According to Athena Karp of HiredScore, a startup that uses algorithms to screen candidates for J&J and others, only around 15-20% of applicants typically hold the right qualifications for a job, but they are rarely told why they were not hired, nor are they pointed to more suitable jobs. Technology is helping "give respect back to candidates", she says.

Nvidia, a chipmaker, also gets more résumés than it can comfortably cope with, so it spent a year building its own system to predict which candidates are worth interviewing. It has recognised patterns that recruiters might not: for example, candidates who submit especially long résumés turn out to do less well than

others, so those extra words will count against them. Hilton, a hotel chain, has shortened the average time it takes to hire a candidate from 42 days to five with the help of HireVue, a startup. It analyses videos of candidates answering questions and uses AI to judge their verbal skills, intonation and gestures. This can be especially helpful when the candidate comes from a different culture or speaks another first language, says Ellyn Shook, chief leadership and HR officer of Accenture, a consultancy with 435,000 employees that also uses HireVue.

Employers tend to hire candidates who are like themselves, which makes for undiversified workplaces. Orchestras, for example, used to be mostly male. Recruitment of female musicians went up only when they introduced "blind" auditions behind a screen. Algorithms can act as virtual screens, making hiring fairer. Pymetrics, a startup whose clients include companies such as Unilever, a consumer-goods giant, and Nielsen, a research firm, offers a set of games for candidates to play, usually at an early stage of the recruitment process, that ignore factors such as gender, race and level of education. Instead they test candidates for some 80 traits such as memory and attitude to risk. Pymetrics then uses machine learning to measure applicants against top performers and predict their suitability for a role. This can help candidates without conventional qualifications.

Another firm that is helping companies become more diverse is Textio, a startup that uses AI to improve job descriptions. For example, it has found that corporate jargon like "stakeholders" and "synergies" tend to drive away certain candidates, especially non-whites, and that women are less likely to apply for a job that is described as "managing" than "developing" a team. Tweaking job descriptions can get 25% more qualified people through the door and boost recruitment among minorities, says Kieran Snyder, Textio's boss.

Another time

Recruiters often come across candidates who have good qualifications but are not the right fit for the particular position they are trying to fill. In the past, there was no way of redirecting them to other jobs as they became available. AI will make it possible to "repurpose candidates we have attracted before", says Sjoerd Gehring, vice-president of talent acquisition for J&J. The health-care giant uses HiredScore, a startup, to grade candidates. When a vacancy opens up, the system automatically generates a shortlist of candidates that could be a good fit. This will bring big cost savings, says Mr Gehring.

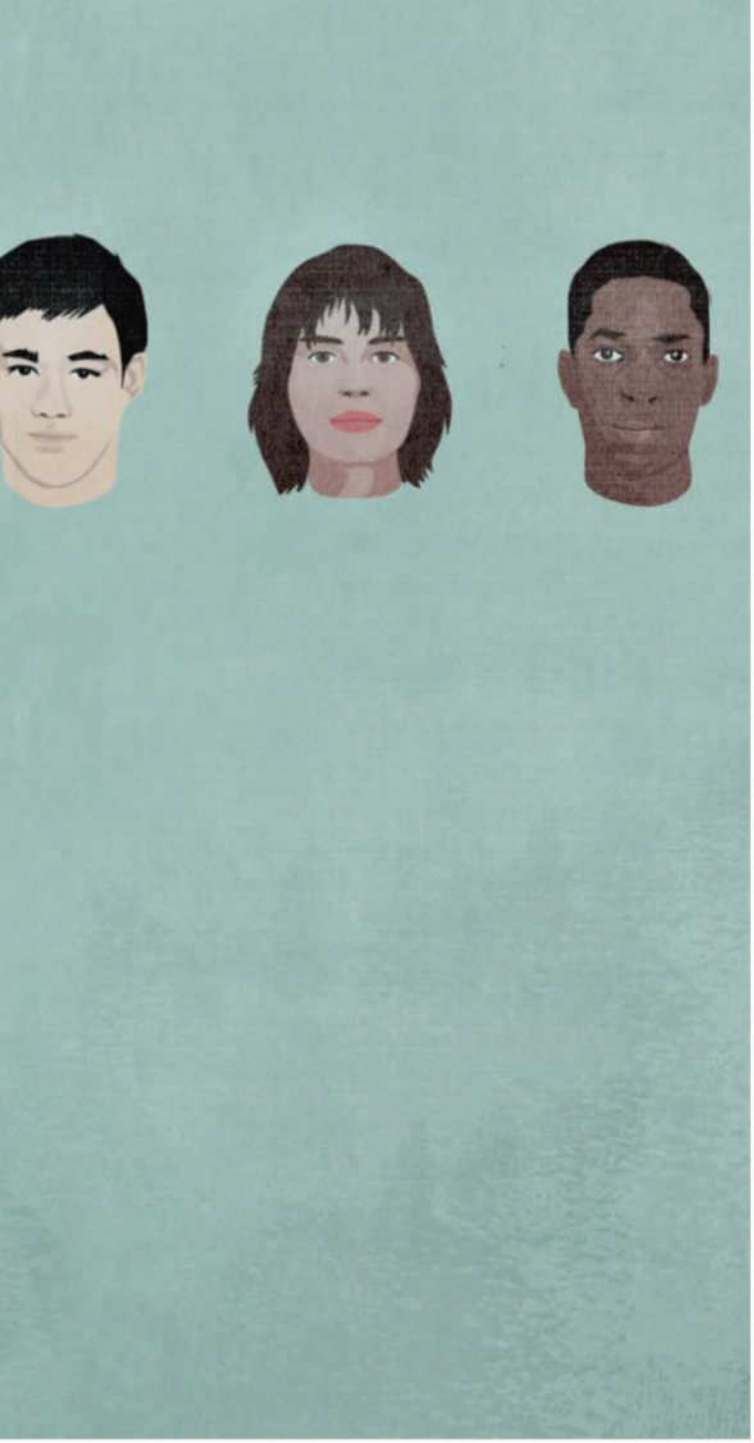
AI can also help with managing employees. HR professionals and recruiters at big firms cannot possibly know all their own talented workers across countries and departments, says Chris Louie of Nielsen. His company is using AI to improve internal mobility. Twine Labs, a startup that is working with Nielsen, suggests internal candidates for new roles, based on employee data and job requirements, taking in hundreds of variables. Around half the candidates it suggests are approved and promoted, says Joseph Quan, Twine Labs' boss. That is about the same success rate as for a human recruiter.

Another use for AI is to help employers reduce staff turnover. On average, replacing a worker takes around 20% of annual salary, sometimes much more. Workday, a software firm, has started to predict how likely employees are to leave. It looks at around 60 factors—such as pay, time between holidays taken and turnover in managers to whom the employee reports—and flags those at risk of quitting so companies can try to retain them.

Arena, a startup that works with hospitals and care-home companies, where turnover is high, considers retention even before it takes someone on. By using data from job applications and third parties to predict which applicants are likely to stay for more than a year, Arena has reduced its clients' median turnover by 38%, says Michael Rosenbaum, Arena's boss.

In future AI may also be used to determine pay. Infosys is looking into using AI to decide when to give employees a rise, based on their performance and their pay relative to that of colleagues. The technology will make pay fairer by taking biases and personality traits out of consideration, says Sudhir Jha, head of product management and strategy at Infosys. But there is a risk that workers will try to game the system.

All this points to a broader issue in AI: transparency. Companies will need to ensure that algorithms are being constantly monitored. In America, where it is illegal to discriminate against protected groups such as racial minorities, firms must be able to prove that they are hiring from these groups roughly in proportion to the population and are not introducing any bias, says Mr Rosenbaum. Startup bosses say they offer their clients transparency and regularly check their algorithms to make sure they are



free of bias. But as AI becomes more prevalent, concerns will grow that algorithms could reinforce discrimination.

Recruitment is just one example of the technological disruption that AI will bring to the workforce. The number of recruiters will come down, because AI will handle many of the mundane tasks they used to do, and face-to-face interviews will become rarer. At Unilever only shortlisted candidates are now interviewed, after several rounds of AI-enabled screening and recorded interviews through HireVue. For the remaining recruiters, though, AI will make work easier and more interesting.

It may even help some of the workers it displaces. Accenture is rolling out a custom-built tool called Job Buddy which tells employees how vulnerable their job is to automation and predicts what training they might need so they can develop the right skills for the future. Ms Shook of Accenture says that around 80% of the people who have tried it are taking the advice it offers. But they may not have much choice. ■

Future workplaces

Smile, you're on camera

AI will make workplaces more efficient, safer—and much creepier

WALK UP A set of steep stairs next to a vegan Chinese restaurant in Palo Alto in Silicon Valley, and you will see the future of work, or at least one version of it. This is the local office of Humanyze, a firm that provides "people analytics". It counts several *Fortune* 500 companies among its clients (though it will not say who they are). Its employees mill around an office full of sunlight and computers, as well as beacons that track their location and interactions. Everyone is wearing an ID badge the size of a credit card and the depth of a book of matches. It contains a microphone that picks up whether they are talking to one another; Bluetooth and infrared sensors to monitor where they are; and an accelerometer to record when they move.

"Every aspect of business is becoming more data-driven. There's no reason the people side of business shouldn't be the same," says Ben Waber, Humanyze's boss. The company's staff are treated much the same way as its clients. Data from their employees' badges are integrated with information from their e-mail and calendars to form a full picture of how they spend their time at work. Clients get to see only team-level statistics, but Humanyze's employees can look at their own data, which include metrics such as time spent with people of the same sex, activity levels and the ratio of time spent speaking versus listening.

We can see through you

Such insights can inform corporate strategy. For example, according to Mr Waber, firms might see that a management team is communicating only with a couple of departments and neglecting others; that certain parts of a building are underused, so the space should be redesigned; that teams are given the wrong incentives; or that diversity initiatives are not working.

Hitachi, a Japanese conglomerate, sells a similar product, which it has cheerily branded a "happiness meter". Employee welfare is a particular challenge in Japan, which has a special word, *karoshi*, for death by overwork. Hitachi's algorithms infer mood levels from physical movement and pinpoint business problems that might not have been noticed before, says Kazuo Yano, Hitachi's chief scientist. For example, one manufacturing client found that when young employees spent more than an hour in a meeting, whole teams developed lower morale.

Employers already have vast quantities of data about their workers. "This company knows much more about me than my family does," says Leighanne Levensaler of Workday, a software firm that predicts which employees are likely to leave, among other things. Thanks to the internet, smartphones and the cloud, employers can already check who is looking at a document, when employees are working and whether they might be stealing company files and contacts. AI will go further, raising concerns about Orwellian snooping by employers on their workers. In January Amazon was granted a pair of patents for wristbands that monitor warehouse workers' exact location and track their hand movements in real time. The technology will allow the company to gauge their employees' productivity and accuracy. JD.com, the Chinese e-commerce firm, is starting to experiment with tracking which teams and managers are the most efficient, ▸▸

and using algorithms to predict attrition among workers.

The integration of AI into the workplace will offer some benefits to workers and might even save lives. Companies with a high-risk work environment are starting to use computer vision to check whether employees are wearing appropriate safety gear, such as goggles and gloves, before giving them access to a danger area. Computer vision can also help analyse live video from cameras monitoring factory floors and work environments to detect when something is amiss. Systems like this will become as "commonplace as CCTV cameras are in shops", says Alastair Harvey of Cortexica, a firm that specialises in building them.

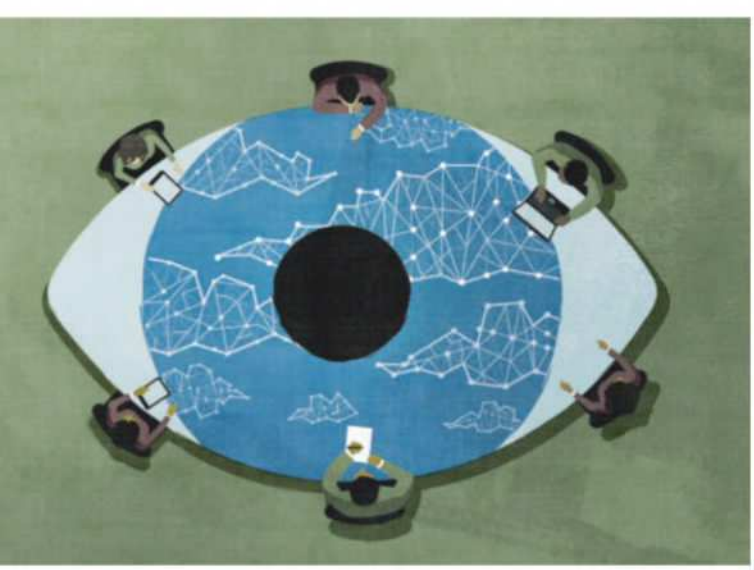
Employees will also be able to track their own movements. Microsoft, the software giant, already offers a programme called MyAnalytics which puts together data from e-mails, calendars and so on to show employees how they spend their time, how often they are in touch with key contacts and whether they multitask too much. It also aggregates the data and offers them to managers of departments so they can see how their teams are doing. "It doesn't have that 'big brother' element. It's designed to be more productive," insists Steve Clayton of Microsoft. The idea is that individuals' data are not given out to managers, though it is not clear whether workers believe that. As part of a broader investment in AI, Microsoft is also starting to use the technology to translate the monthly question-and-answer session held by the company's boss, Satya Nadella, for its workers worldwide, and analyse employees' reactions.

It does not take much imagination to see that some companies, let alone governments, could take this information-gathering too far. Veriato, an American firm, makes software that registers everything that happens on an employee's computer. It can search for signals that may indicate poor productivity and malicious activity (like stealing company records), and scans e-mails to understand how sentiment changes over time. As voice-enabled speakers become more commonplace at work, they can be used to gather ever more data.

This is of particular concern in authoritarian states. In China increasing numbers of firms, and even some cities, use cameras to identify employees for the purpose of giving them access to buildings. More troubling, the government is planning to compile a "social credit" score for all its citizens, pooling online data about them to predict their future behaviour.

All this may require a new type of agreement between employers and employees. Most employment contracts in America give employers blanket rights to monitor employees and collect data about them, but few workers are aware of that. Mr Waber of Humanyze thinks these data should have better legal protection, especially in America (Europe has stronger privacy laws).

As more companies rely on outside firms to collect and crunch employee information, privacy concerns will increase, and employees may feel violated if they do not think they have given their consent to sharing their data. Laszlo Bock, who used to run Google's human-resources department and now heads a startup focused on work, reckons that "it's going to play out in a bad way before it plays out in a good way." ■



External providers

Leave it to the experts

A thriving ecosystem has sprung up to offer AI expertise and technical help

MANY TECH FIRMS' offices boast luxurious perks such as nap pods, massages and soda fountains that offer employees a choice of exotically flavoured sparkling water. Corporate bosses like to think that finding customised AI solutions is just as easy as selecting a fizzy drink with a hint of grapefruit. They are wrong. Buying AI takes time, can feel like hard work, and the results are often imperfect.

A number of vendors are scurrying to come to would-be users' aid. The leaders are the West's biggest providers of cloud storage: Amazon, Google and Microsoft. Cloud computing is a vast market worth $300bn, and fiercely competitive. All three firms offer pre-trained models that corporate clients can use to build AI-enabled systems. For example, they all sell "vision" tools that enable customers to use computer vision to improve their existing services and build new ones. Uber, the ride-hailing firm, worked with Microsoft's toolset to design a system that scans drivers' faces to confirm their identity when they start a shift. C-Span, a television network, used Amazon's vision system to compile a database of politicians so it can quickly name them when they appear on screen.

A broad range of tools is available to help mainstream companies build anything from search and recommendation engines to speech-recognition and translation systems, customer-service bots and more. Jeff Dean, director of Google Brain, the search giant's AI-research arm, reckons there are 10m organisations in the world that "have a problem that would be amenable to a machine-learning solution. They have the data but don't have the experts on staff."

The potential corporate market for AI software, hardware and services is vast: around $58bn by 2021, compared with $12bn last year, according to IDC, a research firm. Amazon has a clear lead in the broader cloud market, with a 44% share of the total, compared with Microsoft's 7% and Google's 2.3%, but for AI tools the field remains wide open. Paul Clarke, chief technology officer of Ocado, an online grocer, says it can be good for clients to be promiscuous and use the best tools from each. He thinks it unlikely that any one of them will sweep the board.

Cloud providers try to differentiate their AI offerings in two ways: by ease of use, through a well-designed interface, and by offering better algorithms. Each of the tech giants draws on

where its "strength is today", says Joseph Sirosh of Microsoft. For example, Google offers an excellent tool which companies can use to create or redesign their own search engines, and has especially good engineering talent. Microsoft and Amazon have solid tools for voice recognition. Microsoft's interface currently has the best design, says Pedro Domingos, a professor of computer science at the University of Washington and author of "The Master Algorithm", a book about AI and business.

In future tech firms will develop more specialised hardware that will help companies crunch enormous data piles more quickly. Google has a lead in this area; it has built some remarkably powerful custom chips, called Tensor Processing Units (TPUs), and uses other customised accelerators to increase the processing speed of its data centres. The tech firms are also offering free open-source libraries to clients' machine-learning experts that can be used to design AI-enabled programs. This is "not altruistic", says Matt Turck of FirstMark Capital, a venture investor. Tech firms want to provide great tools in order to attract clients to their platforms and impress AI experts.

Microsoft has more experience than either Amazon or Google of catering to large firms' software needs, so it is well placed to serve mainstream companies in need of help with AI. But most such offerings still require a lot of customisation and technical work to make them useful, says Oren Etzioni of the Allen Institute for Artificial Intelligence, a non-profit research group.

The cloud providers are trying to fill the gap by offering consulting services. Google has opened an "Advanced Solutions Lab" that is part consulting service, part tech bootcamp. Whole teams from client companies can come to acquire machine-learning skills and build customised systems alongside Google engineers. Courses typically last from four weeks to several months. Demand has been "overwhelming", says Vats Srivatsan of Google Cloud, who is now hoping to roll this out much more widely. That is a new departure for tech firms, which in the past have been strong on technical infrastructure but light on people.

The cloud providers will increasingly compete with management consultancies, which charge fat fees for helping clients navigate technological disruption. "The Googles, Amazons and Microsofts of the world may take over from the McKinseys, Boston Consulting Groups and Bains," says Roy Bahat of Bloomberg Beta, a venture-capital firm. "Consultancies are built for two-by-two matrices. AI's matrices are a million by a million." In this race, consultancies with deep expertise in data and technology are better placed than those that focus on general strategy.

Straight from the horse's mouth

The generalists know they are vulnerable. McKinsey has been investing heavily to beef up its expertise in data, for example by buying QuantumBlack, an advanced-analytics firm, for an undisclosed sum in 2015. But many clients seek advice direct from tech firms, which are themselves pioneering users of AI. "All consultants do is listen to you and tell you back what you've already told them," says Morag Watson of BP, an oil giant.

IBM is trying to bridge the gap between the tech wizards and the conventional consultants. "People think this will go the way the digital and mobile revolutions went. I would argue the opposite. If people get their AI right, it's a great way to extend their incumbent advantage," says David Kenny, the boss of Watson, IBM's AI offering. Watson has been heavily marketed on television and enjoys strong name recognition, aided by its victory over human contestants in a game of Jeopardy in 2011. But its bespoke solutions for clients take lots of time to develop, running up hefty bills for consulting hours. "Watson is a branding concept that's being portrayed as a product," says Tom Siebel of C3 IOT, an AI startup. "You can't easily buy it, and you can't install it."

IBM also suffers from the same problem as any tech firm other than Google, Amazon and Microsoft: it finds it hard to get hold of the best talent. None of the top doctoral candidates in AI goes to work for IBM, says Mr Domingos of the University of Washington. The old saying that "nobody ever got fired for buying IBM" may no longer apply in the AI era.

Startups, too, are hoping to jump on the AI bandwagon. Many offer services like helping clean up and label data, and take on specific tasks that large tech firms are not yet offering, like helping firms recruit, scan job descriptions and improve customer service. For large companies it makes sense to outsource most of their AI work, except where it directly affects their strategic edge. For example, BP would not want to build AI tools to automate back-office or HR functions, but it would want to develop its own AI system for interpreting seismic imaging to detect oil, says Ms Watson.

If companies want to get products rolled out quickly, they have to work with multiple vendors, says Mr Lippert of MetLife. That may be good for startups, which can be nimble. But the incumbent tech firms' size, computing infrastructure, proprietary data and balance-sheets give them an unassailable advantage. "Right now everyone thinks they can win. The field will become considerably less democratic," predicts Martin Reeves of Boston Consulting Group. Having used AI to boost their own fortunes, the incumbents will move on to selling the technology to customers who may become AI-fuelled giants in their own right. ■

The future

Two-faced

AI will mainly be good for business, but mind the pitfalls

MENTION ARTIFICIAL INTELLIGENCE, and most people will think of robots. But a more fitting image may be that of Janus, the Roman god of beginnings, transitions and endings, who has two faces looking in opposite directions. On one side are the positive changes that AI will bring, enabling people to achieve more, far more quickly, by using technology to enhance their existing skills. Recruiters will be able to pinpoint the best candidates more easily, and customer-service staff will be able to handle queries faster. Jobs that never existed before could be created. And getting machines to do routine work can make professional lives more fulfilling and stimulating.

Consumers, too, will benefit from AI-enhanced services such as personalised recommendations and faster and more efficient delivery, as well as from radical changes in industries like health care and transport that could lead to new drug discoveries

and treatments and safer ways to move around.

Look the other way, though, and there are plenty of potential pitfalls. Technological change always causes disruption, but AI is likely to have a bigger impact than anything since the advent of computers, and its consequences could be far more disruptive. Being both powerful and relatively cheap, it will spread faster than computers did and touch every industry.

Sunny with a chance of thunderstorms

In the years ahead, AI will raise three big questions for bosses and governments. One is the effect on jobs. Although chief executives publicly extol the broad benefits AI will bring, their main interest lies in cutting costs. One European bank asked Infosys to find a way of reducing the staff in its operations department from 50,000 to 500. This special report has shown that AI-enhanced tools can help pare staff in departments such as customer service and human resources. The McKinsey Global Institute reckons that by 2030 up to 375m people, or 14% of the global workforce, could have their jobs automated away. Bosses will need to decide whether they are prepared to offer and pay for retraining, and whether they will give time off for it. Many companies say they are all for workers developing new skills, but not at the employer's expense.

A second important question is how to protect privacy as AI spreads. The internet has already made it possible to track people's digital behaviour in minute detail. AI will offer even better tools for businesses to monitor consumers and employees, both online and in the physical world. Consumers are sometimes happy to go along with this if it results in personalised service or tailored promotions. But AI is bound to bring privacy violations that are seen as outrageous. For example, facial-recognition technology has become so advanced that it may be able to detect someone's sexual orientation. In the wrong hands, such technology could militate against fair and equal treatment. Countries with a record of surveillance and human-rights abuses, such as China, are already using AI to monitor political activity and suppress dissent. Law-enforcement officials around the world will use AI to spot criminals, but may also snoop on ordinary citizens. New rules will be needed to ensure consensus on what degree of monitoring is reasonable.

The third question is about the effect of AI on competition in business. Today many firms are competing to provide AI-enhanced tools to companies. But a technology company that achieves a major breakthrough in artificial intelligence could race ahead of rivals, put others out of business and lessen competition. This is unlikely to happen in the near future, but if it did it would be of great concern.

More likely, in the years ahead AI might contribute to the rise of monopolies in industries outside the tech sector where there used to be dynamic markets, eventually stifling innovation and consumer choice. Big firms that adopt AI early on will get ever bigger, attracting more customers, saving costs and offering lower prices. Such firms may also reinvest any extra profits from this source, ensuring that they stay ahead of rivals. Smaller companies could find themselves left behind.

Retailing is an illustration of how AI can help large firms win market share. Amazon, which uses AI extensively, controls around 40% of online commerce in America, helping it build moats that make it harder for rivals to compete. But AI will increase concentration in other industries, too. If, say, an oil company can use AI to pump 3% more efficiently, it can set prices 3% lower than those of a rival. That could force the competitor to shut down, says Heath Terry of Goldman Sachs. He thinks that AI has "the power to reshuffle the competitive stack".

Janus, the Roman god, contained both beginnings and endings within him. That duality characterises AI, too

It is too early to tell whether the positive changes wrought by AI will outweigh the perils. But leading a company in the years ahead is sure to be more challenging than at any time in living memory. AI will require bosses to rethink how they structure departments, whether they should build strategic technologies internally or trust outside firms to deliver them, whether they can attract the technical talent they need, what they owe their employees and how they should balance their strategic interests with workers' privacy. Just as the internet felled some bosses, those who do not invest in AI early to ensure they will keep their firm's competitive edge will flounder.

Janus, the Roman god, contained both beginnings and endings within him. That duality characterises AI, too. It will put an end to traditional ways of doing things and start a new era for business and for the world at large. It will be pervasive, devastating and exhilarating all at the same time. Look ahead. ■