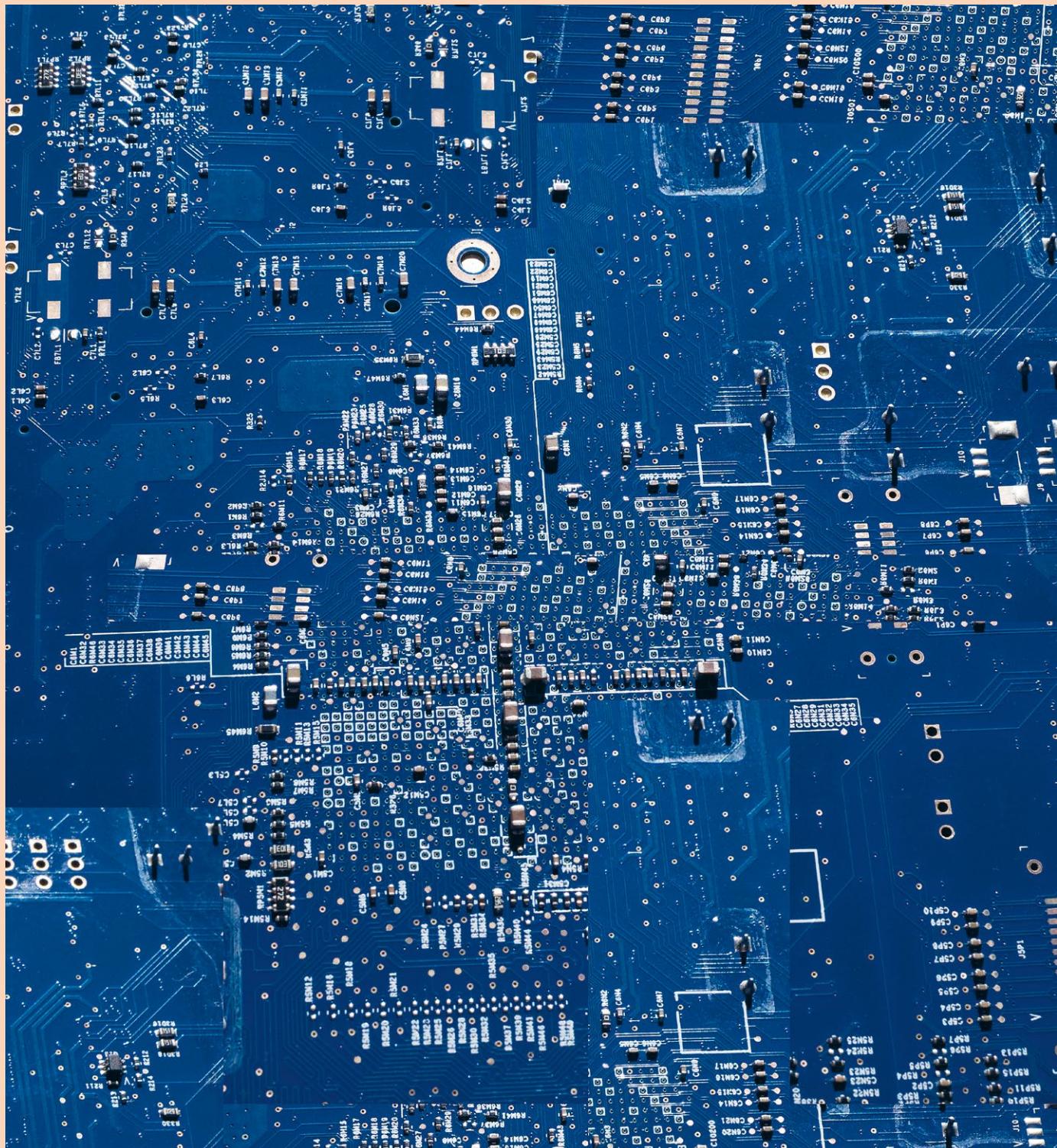


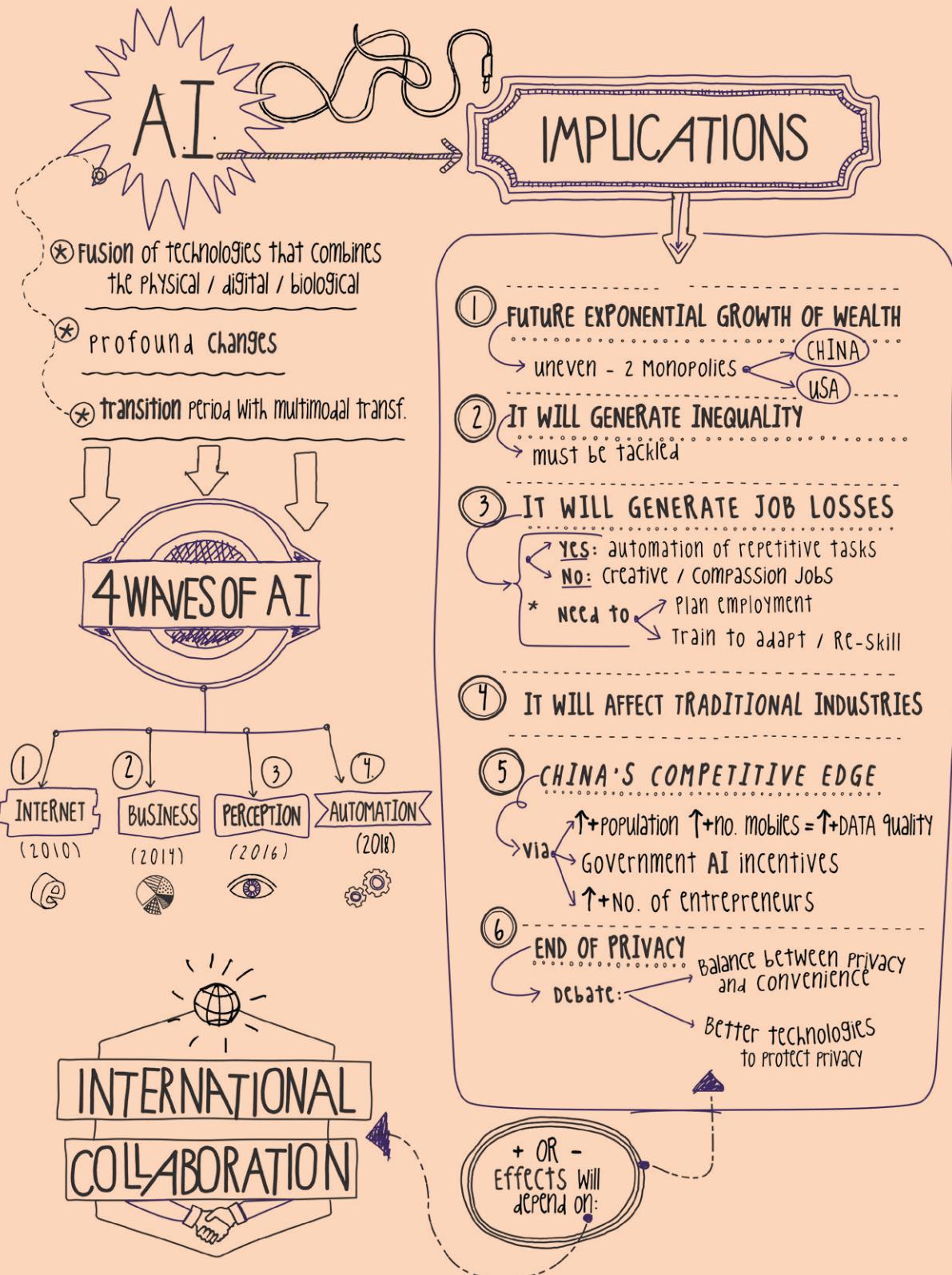
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Artificial Intelligence and the Future of Work: A Chinese Perspective

Kai-Fu Lee

As with most technological breakthroughs, the hype when it comes to artificial intelligence (AI) has far preceded its widespread application in the real world. This article explores key challenges that need to be overcome over the next decade, at a global level, in order to ensure that AI's potential can be successfully deployed to enhance our working lives and productivity gains. It also places the responsibility for AI advancement firmly in the court of "traditional" industries—radical impact will not come from the technology sector alone, rather from the innovative, timely, and systematic adoption of AI by established companies. While focused on AI's global impact, the article also provides a Chinese perspective on challenges and opportunities of its adoption at scale.

Introduction: The Age of AI

Klaus Schwab, founder and executive chairman of the World Economic Forum and author of *The Fourth Industrial Revolution*, characterized the era we currently live in as defined by "a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres."¹ No previous technological revolution drew upon so many different advancements all at once, and most certainly not at a comparable speed.

The velocity of innovation caused by this multimodal transformation has prompted a heated debate about the future of humanity, asking us to examine the limits of our own capacity to understand and make use of the technological breakthroughs previously never thought possible: can our understanding keep up with the changes at hand? How do we adjust? Will machines eventually rule our lives? What does it mean to be human in the age of the machines?

Our cognitive functions have not kept up with technological advancements. Human relationship with intelligent machines is still perhaps best epitomized by Arthur C. Clarke's and Stanley Kubrick's HAL 9000—something to admire and fear in equal measure—prompting us to defend, while at the same time question, the supremacy of human intelligence. What do we do with the machines whose limits we may not be able to imagine?

If the rate of technological change continues at this pace, it follows that humans will soon be flanked by automatons and robots, automating every aspect of our lives.

Well, maybe someday.

In reality, the science trails considerably behind the futuristic visions of a society where artificial intelligence (AI) reigns supreme. In fact, if I were to make a prediction today, based on the scientific progress at hand, I would say with confidence that true machine intelligence at human level is a very distant prospect, if ever reachable.

Advancements in AI have so far been limited to single-domain tasks. As of today, AI can more efficiently process vast quantities of information about something very specific, such as playing a game, health-care diagnostics, or speech recognition. But it cannot think laterally to apply learnings to a different domain. It cannot form an opinion about what it is doing. And it most



certainly does not have any feelings about what it is doing.

But, whether we realize truly intelligent machines (often referred to as Artificial General Intelligence or AGI) or not, AI is already transforming how we live and work, finding its way into most domains of human activity. While technologists and pundits debate humans' future relationship with machines, what is not debated nearly enough is the imminent impact of various AI-powered technologies. How do we cope with job loss? How do we ensure our education systems can keep up? What about social services?

Our understanding of ourselves and our role in society is already, if slowly, being challenged. If humans will no longer be required to perform an array of jobs, and if what we have learned at school may soon no longer apply—how do we adjust our course and our expectations of our working lives? Such questions should be front-of-mind for governments, their economic advisers, education ministers, school principals and deans, and business leaders, as well as parents everywhere.

And So It Begins

We are already at the epicenter of synchronous disruption brought upon by AI across all industries. I use a “Four Waves of AI” framework to elaborate AI’s impact on the business scenario—they do not come one after the other, but rather simultaneously, transforming the way we live (fig. 1).

The first wave of AI innovation, Internet AI, began around 2010, completely transforming our use of the Internet with the breakthrough brought by the invention of deep learning. Search, online advertising, social media, e-commerce—advancements in these online activities that are now part and parcel of our everyday lives—have all been predicated on advancements in AI.

In 2014, businesses, particularly those where data is readily available, started to embrace AI, creating the foundations for the advancement of industries such as AI fintech, remote education, digitization of public services, and supply chain management. I would call this second, largely software-driven, wave of innovation—Business AI.

Perception AI began to make inroads in 2016, enhancing machines’ ability to

capture human senses, analyze, and make decisions based on such data. Computer vision technology has become mainstream: machines now recognize human faces, traffic patterns, or even merchandise we select from stores. Speech recognition technology can now analyze and synthesize languages, enabling simultaneous translations and machine-generated news reporting. We will see fast development of AI in software and hardware during this wave.

Most recently, in 2018, autonomous systems saw their first applications across industries, allowing us to imagine the not-so-distant future where autonomous vehicles dominate the roads, and possibly even airways. Automation AI is already transforming traditional heavy-weight players in transportation, logistics, and manufacturing, to name a few.

In what seems like the blink of an eye, we have found ourselves in possession of a multifaceted technology whose application is as pervasive as that of electricity. In fact, it may not be an exaggeration to say that we already may not know what it means to have lived without AI.

What is more, the transformation through AI has only just begun. Leaders across industries have begun to consider AI’s application for their own businesses *en masse*. According to Deloitte’s “State of AI in the Enterprise” 2019 report,² 57% of business leaders believe that AI will have a transformative impact on their own company in the next three years. While fewer, 38%, believe AI will power the same transformation across their industries, the trajectory is clear: AI is permeating most domains of human endeavor. What will separate the winners from the losers is their ability to grasp the magnitude of change and adapt in time.

The fundamental truth of our time is as follows: AI is the greatest frontier facing humanity to date and we must act now to get it right.

How Prepared Are We for AI?

AI’s potential to change the way we live and work is so vast that its current uses are a mere scratch on the surface of what is yet to come. Every aspect of our lives will be affected, and every corner of the world we live in will be implicated in the change.

But, will it affect everyone in the same way?

Research shows that AI will enable the creation of unprecedented wealth: PricewaterhouseCoopers (PwC) estimates that the wide adoption of AI will add about \$15.7 trillion to worldwide GDP by 2030³—barely a decade from now. This growth will continue its exponential trajectory toward the year 2050.

There is tremendous business value to be gained through the adoption of AI, but wealth creation will not be even. As I indicate in my book—*AI Superpowers: China, Silicon Valley, and the New World Order*—gains from early AI innovation are akin to winner-takes-all scenario, with two economic giants—the United States and China—already leading the way, being the homes to all of the world’s corporate AI giants. In the PwC predictions I mentioned above, the most significant growth is expected to come from China, not least due to its vast population, which accounts for almost a fifth of all the world’s people.

Inequality between countries must be tackled through international diplomacy channels, with the US and China lending their resources and know-how to avoid exacerbating global inequality. But even more pertinently, inequality within countries—stemming from job displacement, skills gap, education inequality, and lack of access—must be made a national priority for governments and businesses across the world.

While it may take fifteen or more years for AI-powered technologies to have an impact across industries, we must act quickly to put in place the infrastructure needed to avoid massive disruption and lessen human hardship that will inevitably come in the form of vast job losses and the uneven distribution of wealth.

AI Infusion

While we are enamored by great AI companies like Deepmind, the \$15.7 trillion value will not be realized through them. From today’s vantage point, AI’s biggest opportunity is infusion into traditional companies. This will be greatly enhanced by the rapid development of AI platforms, so that more and more traditional companies can implement AI, without requiring deep AI expertise.

AI’s greatest potential is in infusing existing businesses with new ways of



problem-solving, new levels of speed and accuracy, new efficiencies, and new ways of working and thinking about what is possible. AI can be used to optimize existing processes (such as saving costs by up to 80% on back-office outsourcing or customer service), to improve processes (such as using AI to reshape sales forecasts, logistics, and supply chain), or to disrupt industries (such as using AI to help medical scientists discover drugs many times faster than today).

Business leaders must embrace the long view. Few can afford resistance to change, as businesses must integrate AI as part of their strategy in order to stay relevant. Referring back to the Deloitte study, many more executives believe AI to play a role in offering a more competitive edge to their own companies than that of their industries overall. This suggests that a blind spot is emerging, as the pace of innovation coming from elsewhere may catch businesses off guard. The fact is, no one can remain complacent as AI moves to the top of the agenda across the board.

Anticipating where disruption may come from and upskilling to be ready to take on the level of technological and operational change caused by AI will become a part of the business strategy playbook across all industries.

Impact on Jobs

The impact of AI on job creation and loss is largely misunderstood. The doomsday narrative would have us believe that AI will cause such a level of disruption that it will mark the end of the workplace as we know it. All jobs will be gone, spelling economic hardship for most of us. I am personally against the dystopian view of AI destroying the values of mankind.

A different interpretation of the same scenario holds that AI will spare us the drudgery of work, allowing us, instead, to lead lives of leisure in some sort of utopian state.

The reality is somewhere in the middle. It is true that up to half of all jobs are likely to face extinction or disruption due to the introduction of AI. What may have surprised those in industries already starting to be affected is what kinds of jobs have started to disappear first.

It may seem counterintuitive, but manual jobs, such as those in most manufacturing fields, will not be significantly affected for the time to come.

Today's machines are much better at grasping quantitative reasoning than basic sensorimotor skills. It is extremely difficult to achieve a level of meaningful dexterity and precision in most robotic applications. So, it is repetition-rich white-collar jobs

that are already being more readily disrupted than the blue-collar ones.

Robotic Process Automation (RPA)

A lot of human activity today is focused on domain-specific tasks that, when injected with a lot of data, can be more efficiently performed by AI. It is estimated that up to one-fifth⁴ of all tasks performed by humans at work is spent on repetitive computer tasks that can be automated.

Robotic Process Automation (RPA), with the use of AI and machine learning to process high-volume repetitive tasks, has started to gain traction among companies whose employees spend a significant amount of time on manual tasks, such as query handling, calculations, data entry, or record maintenance. Jobs at the forefront of disruption include those in business process outsourcing: for example, tax examiners filling numbers into cells and tables every day in order to generate data comparison and analysis.

RPA can provide significant value for businesses by freeing up their employees to focus on more complex, higher-value tasks. At the same time, it means companies can now start to reduce the number of people they employ in certain single-domain job positions.

Employers will need to understand the trade-off between efficiency gains and impact on employee morale. Communicating with transparency about the changes in business needs and implementing retraining programs where possible will help both employers and employees transition more successfully.

Is Anyone Safe?

I have established that AI can be used to perform routine work more efficiently.

But AI has no creativity, no compassion, nor the ability to connect with humans and win their trust. The higher the requirement for compassion or creativity in any given job, the less likely it is for AI to replace humans in performing such tasks (fig. 2).

Some fields, such as medical diagnostics, may experience a symbiosis between people and machines. For example, doctors can rely

201

Wave 4: Autonomous AI
Smart warehouse, manufacturing, agriculture, autonomous car, robotics

2016

Wave 3: Perception AI
Security, retail, energy, AI+IOT, smart homes, smart cities

2014

Wave 2: Business AI
Banks, insurance, trading, education, public services, medical, logistics, supply chain, back office

2010

Wave 1: Internet AI
Search, ads, games, e-commerce, social, lifestyle

Fig. 1. Four waves of AI



According to Deloitte's "State of AI in the Enterprise" 2019 report, 57% of business leaders believe that AI will have a transformative impact on their own company in the next three years

on AI to more accurately diagnose a disease based on data at hand, while they can provide not just the treatment plan, but also the warmth and the trust that are key for human interaction. Research⁵ shows that human connection can have a significant impact on the quality of health outcomes. Equally, scientists can use AI tools to discover drugs with higher accuracy. But machines cannot replace the scientists' ability to hypothesize and apply learnings, and communicate to patients with knowledge and trust.

With this in mind, it is critical for governments, businesses, and education institutions to determine what types of jobs will give humans an edge over the machines and make a plan to create more of these. Likewise, understanding where humans will be most needed should have an impact on curricula everywhere: how should we go about preparing children for the future in work? What skills will they need to ensure employability throughout the course of their working lives?

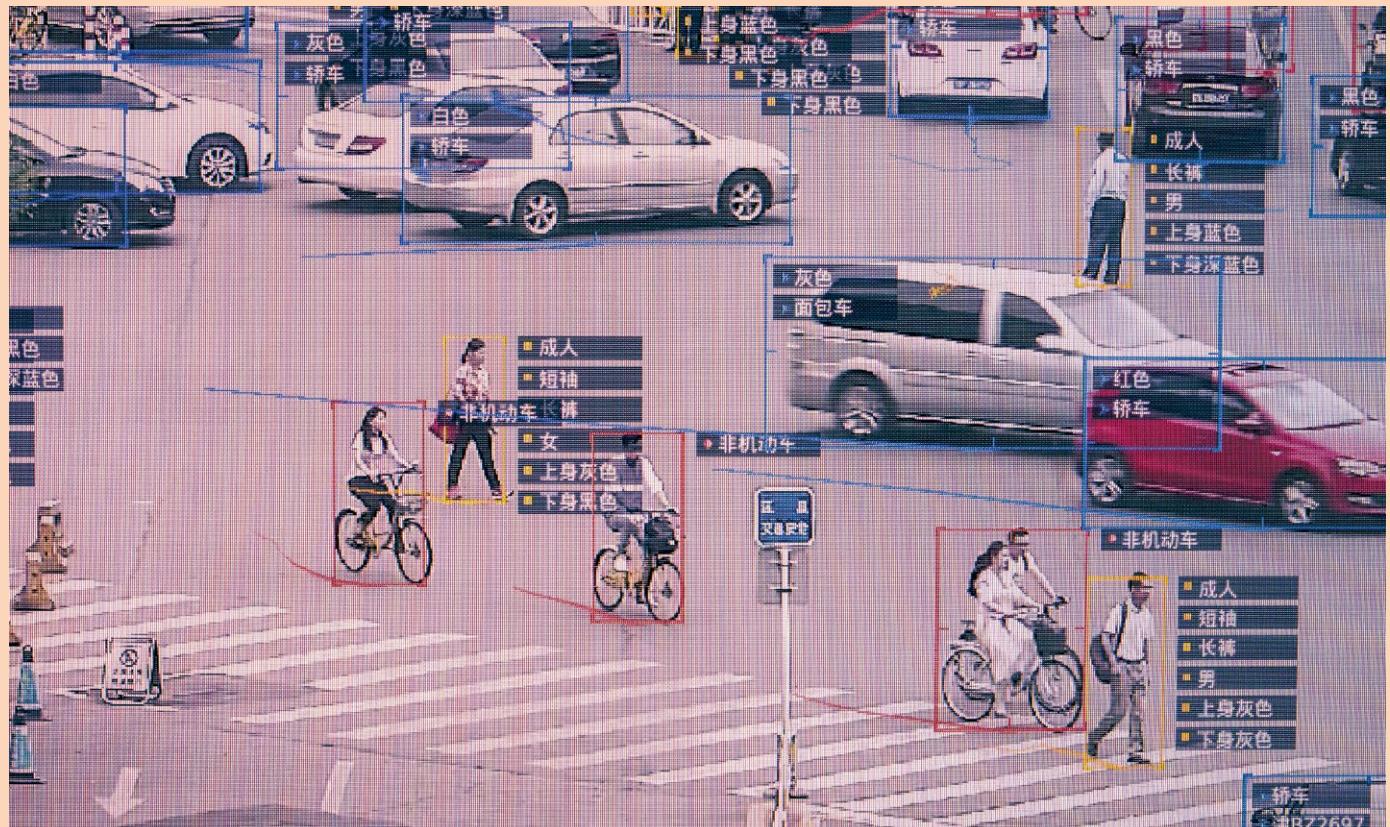
technology as part of everyday life has given China an edge when it comes to quality data crucial for the development of AI. Mobile phones are truly at the epicenter of everyday life in China—from food ordering to peer-to-peer payments to charity donation—the Chinese of all ages rely on mobile payments for most of their transactions. The vast amount of data generated in such a way allows merchants and services platforms to adopt a targeted approach to customer acquisition—causing, in turn, massive disruption of traditional industries.

AI is already omnipresent in China—from mobile payments as already mentioned, to AI-enriched mobile applications, face-recognition authentication, autonomous retail stores, AI personalized news aggregation, to customized product recommendations. The use of AI also plays a growing role in connecting rural school children with so-called "super teachers," who can now be connected to classrooms across the country, offering an immersive, interactive experience for the students and making quality education more accessible even in China's remote mountain villages, given the sheer size and resource disparity between cities and regions.

A screen shows the SenseVideo pedestrian and vehicle recognition system developed by SenseTime Group Ltd at the company's showroom in Beijing

China's AI Competitive Edge

The sheer size of China's population, nearly 1.4 billion, and its embrace of mobile



In short, mobile-first consumer demands are fueling AI innovation and digitization of the Chinese economy fast and at scale. Adding to this is the Chinese relentlessly dedicated entrepreneurial culture, significant venture capital funding, and government incentives for the development of AI.

While its size and abundance of data due to mobile technology maturity certainly represent China's fundamental advantage, its rise as an AI superpower has been predicated on painstaking promotion of entrepreneurship and infrastructure development. Readily available funding for AI has attracted a huge number of AI technical talents, providing a crucial advantage in the form of a qualified workforce.

All of these combined have enabled Chinese AI companies to cover competitive ground fast and catch up with, and even surpass, the pace of innovation coming out of Silicon Valley.

AI's Impact on China's Labor Market

Various studies of AI's likely impact on the Chinese labor market illustrate the difficulty in predicting AI outcomes on the workforce with any degree of certainty.

PwC offers an optimistic view of AI's impact on jobs in China, estimating that, on balance, the adoption of AI will lead to a 12%, or 93 million, increase in jobs, an income increase of 38%, and a possible GDP increase of 1.4% per year on top of current rates.⁶

While some 200 million jobs are expected to be lost to automation, there is an expectation that 300 million jobs will be created. However, both job loss and creation are not expected to be spread evenly across all sectors or synchronized in time.

McKinsey and Co.,⁷ in turn, ranks China among countries most likely to be affected by automation, with 51% of work activities potentially being affected by automation.

The higher the requirement for compassion or creativity in any given job, the less likely it is for AI to replace humans in performing such tasks

While its size and abundance of data due to mobile technology maturity certainly represent China's fundamental advantage, its rise as an AI superpower has been predicated on painstaking promotion of entrepreneurship and infrastructure development

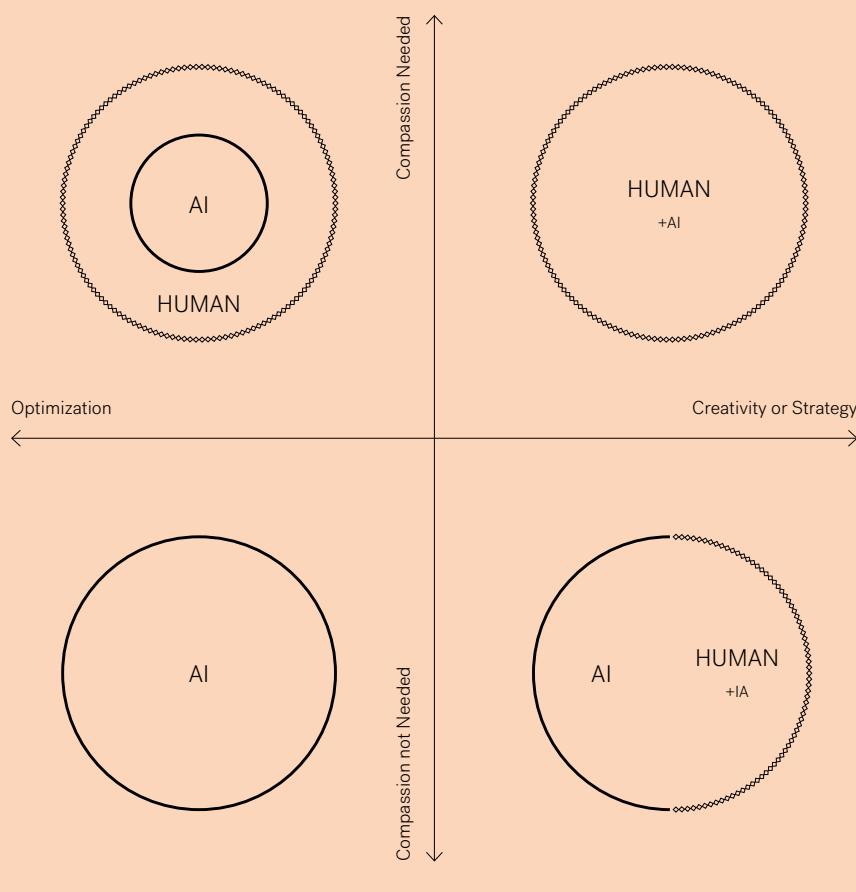


Fig. 2. AI's impact on jobs

~~~~~ Human — AI

On balance, China's economy faces the same challenges as the rest of the world when it comes to AI. While its advantage when it comes to pace of innovation delivered by its AI companies is indisputable, for all countries it is the preparedness for jobs disruption, on the national level, that will be necessary to ensure successful mitigation of imminent job losses.

While having the privilege of talking to leading policy-makers around the world, it is obvious to me that most countries are keenly aware of and deeply concerned about the collective societal impact on the workforce brought by the coming AI revolution. It is also an area where I would advocate for higher international collaboration to share best practices on policy enhancement, social programs, public-private partnerships, and innovations in the public service sector to ensure successful transition to AI across our society.

### Conclusion on Jobs

The age of AI, just like the earlier technology revolutions, is expected to lead to significant job creation. But, we do not know for sure what these jobs will look like, nor when they may start to appear.

When the Internet first came into being, no one could have predicted the arrival of Uber and the impact on traditional taxi companies. Or the disruption of the hospitality industry brought upon it by Airbnb. Equally, we cannot predict what innovative ideas are yet to be enabled by AI.

AI will also transform entire business models within existing companies. It is hard to imagine that, once upon a time, Microsoft had an Internet division. Nowadays, of course, the Internet is integrated into every aspect of its business.

The key challenge in dealing with the transition period already underway is the massive job disruption that will precede job creation. Unfortunately, those affected by the former may not be the benefactors of the latter. AI is unlikely to create new routine jobs that would require humans to do them. Thus, retraining will be required to prepare the displaced routine workers for non-routine jobs at a massive scale to mitigate the effects on job losses.

At the moment, very little is being done across the world to account for pending job displacement.

One of the seminal challenges of our time is finding a way to prepare new generations to not only enter the workforce, but also thrive throughout their working lives. This despite the pace of technological innovation and constantly moving goalposts when it comes to demand for skills and specialized knowledge.

Improving education has never been an easy task. Redesigning it entirely to shift the center of gravity away from knowledge transfer and toward self-awareness and self-discovery is a monumental task, yet a necessary one. We must prepare our children for an entirely new relationship between humans and machines.

Training and retraining must be a priority for business and governments, but this alone will not be enough to address the fundamental shift in what will be required to be able to ride the wave of disruption in the job market. As technology continues to disrupt existing processes and ways of working, field-specific expertise will matter less than transferable skills, adaptability, critical thinking, compassion, and self-awareness. These are the skills that will allow young people to navigate the changing world of work. What may constitute a career today may be gone tomorrow, so the ability to reskill and adapt will be more important than any domain-specific knowledge.

We must attempt to answer questions such as: what constitutes lasting knowledge and what value should we assign to it? What is the role of education in the world where ability to adapt and change ensures our survival more than holding onto what we know?

Ensuring a competitive edge in the global race to lead in AI innovation requires concerted government action: reforming education, job creation, incentivizing entrepreneurship, building the necessary infrastructure to enable innovation to thrive, enabling trustworthy data collection, and training AI application engineers should all be seen as priorities.

### The End of Privacy?

It is often said that AI has put an end to privacy as we know it. With millions of digital records that we all leave behind constantly, and technologies that can differentiate our unique features, the danger of misuse is evident.



A customer uses his smartphone to scan a QR code for payment at a pork stall inside the Dancun Market in Nanning, Guangxi province





Every day, a vast quantity of personal data is being collected and stored to drive new AI technologies. On the one hand, these technologies, run by algorithms that improve themselves through consuming more and more quality data, have the potential to make our lives better and more convenient. On the other, we must ensure that personal information does not fall prey to the dangers of misuse.

In response, policy-makers across the world have sought to regulate the transfer of data, hoping to create a more transparent and trustworthy relationship between consumers and companies. Enter Europe's General Data Protection Regulation (GDPR) and California's Consumer Privacy Act, which both stipulate that companies must obtain consumers' consent before collecting their data.

I do believe that these regulations play a role in protecting individual privacy; however, it is both a limiting and a limited way to deal with the issues at hand.

Privacy is not binary. Any privacy regulation must proactively balance consider-

ations of data protection with that of user convenience and value they get in return. This trade-off is largely subjective; it differs among individuals and across countries.

How do we balance the need for scientific progress and the value (convenience, security, social good) brought about by new technologies with the need to better protect personal privacy? Policies alone will tilt the spectrum to the latter, at the expense of the former. So, while regulations are needed, we must also consider technology solutions.

We should question the hypothesis that convenience and privacy are mutually exclusive. We should investigate technologies that protect privacy yet allow the data to be used to improve AI. For example, homomorphic encryption is a method of irreversibly encrypting data to enhance privacy protection. Federated learning, a technology that allows learning to take place in trusted environments, is currently being tested in a number of places.

Consider this scenario: a thousand hospitals are interested in using the power of

New data protection regulations play a role in protecting individual privacy, but it is both a limiting and a limited way to deal with the problem

A visitor at the Onassis Cultural Center in Athens looks at the multimedia project *Data Flux*, in which Japanese artist Ryoji Ikeda challenges the limits of human perception and digital technology



their collective data to train AI-powered diagnostic tools. Due to patient data privacy rules that restrict the use of data within a single health-care institution, patient information cannot be aggregated in one central place—making it impossible to train AI with sufficient data. With federated learning, AI training takes place at each of the hospitals, “federating” the resulting learnings, while “raw data” never leaves the hospital premises. These technologies are not yet perfected, but further research and testing must be encouraged.

### AI as a Force for Good

AI’s impact is akin to a tidal change morphing the very axis of our lives. I fundamentally believe that AI can act as a force for good across the world. Equally, I am not oblivious to the potential for its misuse.

We have a great responsibility to ensure that AI can live up to its potential—whether it be job creation, medical advancement, transformation of industry processes, access to better education, or making our everyday lives easier through countless conveniences—both big and small.

I hope that we can harness the collective concerns and enthusiasm for AI to start addressing the key questions about its impact on our world. I hope that we can tackle security concerns in a way that is sensitive to regional and cultural differences, while mindful of humanity’s future. That, as entrepreneurs, we can start shifting our business mindset from short-term profit to long-term viability by understanding AI’s transformative value and its impact on worker training and retraining. That governments can start to scrutinize education to ensure our children are equipped for the changes to come. That we can focus job creation on areas where us people, with our empathy, compassion, and creativity, will remain irreplaceable.

Regardless of global competition for technological dominance, we need concerted action across the nations to ensure that AI can live up to its potential. How we go about engaging with each other on this topic today will decide the nature of the human relationship with AI.



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## Notes

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