Navigating the AI Opportunity

AI is changing how we work — and what work we do. Leaders must learn how to navigate issues such as rapid job transformation and AI integration.
Navigating the AI Opportunity

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INTRODUCTION

Companies are looking to artificial intelligence to create business value. This collection of articles from MIT Sloan Management Review examines how early implementers are positioning themselves to reap the benefits of AI at scale — while managing the human side of using the technology.

From “Artificial Intelligence in Business Gets Real”:

- Companies are utilizing artificial intelligence to create business value, according to MIT Sloan Management Review’s 2018 Global Executive Study and Research Report.
- The report, based on a survey of 3,076 people from 29 industries and 126 countries, found that early adopters of AI are pulling ahead of their counterparts. They’re investing more, too: Some 88% of “Pioneers” said that they had invested more in AI than they had in the previous year, in contrast to just 62% of “Experimenters” and “Investigators.”
- Pioneers prioritize revenue-generating applications over cost-saving ones. Some 72% said that they expect AI to deliver mainly revenue increases in the next five years, while only 28% reported that they expected mainly cost savings.
- By deepening their commitment to AI and focusing on revenue-generating applications over cost savings, early implementers are positioning themselves to reap the benefits of AI at scale.

From “The Fundamental Flaw in AI Implementation”:

- Many executives are enthusiastic about the business potential of machine learning applications, but they often overlook the fact that they need to upgrade their employees’ skills in order to fully unlock the benefits of artificial intelligence.
- AI systems, even more than ERP systems, eliminate many nonspecialized tasks and create new tasks that require good judgment and domain expertise.
- Building an empowered, AI-savvy workforce means helping people understand how to use probabilistic output to guide actions that make a company more effective.
- Probabilistic outputs are easy when, say, an application such as Salesforce.com’s AI tool indicates that one lead has a 95% chance of converting into a sale while another has a 60% chance. The salesperson knows what to do with that information. But when an AI application tells a recruiter that a job candidate has a 50% likelihood of being a good fit, will the recruiter know what to do with that data?
From “The Jobs That Artificial Intelligence Will Create”:

- A global study by Accenture finds that the emergence of AI is leading to the creation of several new categories of human jobs — and those new jobs will require skills and training that will surprise many companies.
- The research reveals three new categories of AI-driven business and technology jobs: trainers, explainers, and sustainers. Trainers teach AI systems how they should perform; explainers bridge the gap between technologists and business leaders; and sustainers help ensure that AI systems are operating as designed and that unintended consequences are addressed with appropriate urgency.
- These three categories of jobs will involve unprecedented new responsibilities and duties and are likely to require advanced degrees and highly specialized skill sets.
- Employers across all industries will need people to fill these new roles.

From “Justifying Human Involvement in the AI Decision-Making Loop”:

- As the potential of AI-driven decision-making increases, businesses are questioning whether (and when) to remove humans from their decision-making processes.
- There are no simple answers. As AI continues to improve, the clear advantage that humans once held in the decision-making process is diminishing.
- To highlight the risk of relying on computers to make decisions, many people point to real-world events that occurred in 1983, when Stanislav Petrov, a lieutenant colonel in the Soviet Air Defense Forces, chose to second-guess a Soviet information system report that nuclear missiles were incoming from the United States. Instead of approving the retaliation that such a scenario seemed to dictate, Petrov decided that a real attack was unlikely based on several outside factors. He is credited with “quietly saving the world” by choosing not to escalate the situation.
- Most scenarios that businesses face are not as consequential as nuclear attacks. But many business decisions may still benefit from second opinions informed by human knowledge and understanding of context.

From “Could AI Be the Cure for Workplace Gender Inequality”:

- Artificial intelligence is beginning to replace many of the workplace roles that men dominate.
- Many of the jobs that will have staying power are those that rely on emotional intelligence — skills in which women typically excel.
- Gender difference is a sensitive topic. But whether you believe that men and women, on average,
have different types of brains or that gender differences are a result of cultural norms and conditioning, the real-world results are similar: Men and women, on average, excel in different dimensions and take on different roles in the workforce.

- Emotional quotient (EQ) skills are likely to become a critical job differentiator in more roles. Both people and the organizations they work in need to pay real attention to often-neglected EQ skills.

From “How to Thrive — and Survive — in a World of AI Disruption”:

- The pace of progress in AI and machine learning is accelerating beyond expectations, and there’s a backlash brewing: Rumblings about robots replacing humans in more and more roles have been heating up.
- But the challenge we face today is not a “world without work” but a world with rapidly changing work.
- Today’s AI advances are augmenting the work of human minds, not just muscles. Automation is starting to creep into occupations beyond those that require a good deal of repetitive manual labor and into fields that once seemed immune to that kind of disruption, such as law, education, and journalism.
- H&R Block’s tax preparers have begun using IBM’s Watson computer system to maximize customer deductions. Watson “knows” thousands of pages of federal tax code and will continually update changes as they occur.

From “What to Expect From Artificial Intelligence”:

- With the rise of AI, one task that is now ubiquitous and inexpensive is prediction — which can be defined as the ability to take information you have and generate information you didn’t previously have.
- Although the discussion about AI is often framed simply in terms of machines versus humans, it may be more useful to take a more nuanced view of the question and look at the challenge as a matter of understanding the level of judgment necessary to pursue actions.
- In cases where whole decisions can be clearly defined with an algorithm, computers can replace humans. This will happen more slowly in areas where judgment can’t be easily described.
- Increasingly, the manager’s role will involve determining how best to apply artificial intelligence. Managers will have to ask questions such as these: What are the opportunities for prediction? What should be predicted? How should the AI agent learn the information it needs to make better predictions over time?
Artificial Intelligence in Business Gets Real

Executive Summary

Executives in companies around the world are increasingly looking to artificial intelligence to create new sources of business value. This is especially true for leading adopters of AI — those that have invested in AI initiatives and seen impressive results. This small group of companies is doubling down on AI investments, building competencies, and working to take AI to scale. The opportunities and challenges these AI Pioneers face are the focus of the 2018 *MIT Sloan Management Review* and The Boston Consulting Group (BCG) Artificial Intelligence Global Executive Study and Research Report.

Continuing last year’s analytical approach, our latest research combines a global survey of 3,076 business executives and 36 in-depth interviews with business executives. We classified the organizations surveyed into four groups based on respondents’ responses to questions about their levels of AI adoption and AI understanding. Pioneers are enterprises that have extensive understanding of AI tools and concepts and significant levels of AI adoption; Investigators understand AI but have limited adoption; Experimenters have adopted AI but with limited understanding of it, and Passives have limited adoption and understanding of AI.
This report highlights four major patterns in the survey and interview data:

1. **Pioneers are deepening their commitments to AI.** Is AI really taking off in business? In one respect, the percentage of Pioneers among survey respondents remained essentially the same as last year, at just under one-fifth of those polled. Yet the level of commitment to AI within the Pioneer group is striking: Fully 88% of Pioneers invested more in AI than in the previous year — in contrast to just 62% of Experimenters and Investigators. Pioneers continue to push forward.

2. **Pioneers are eager to scale AI throughout their enterprise.** Typically, an organization that gained early success with AI did so because some AI-knowledgeable managers within a business unit spotted a problem that could be solved more effectively with, for example, natural language processing. Attacking such targets in isolation, they came up with impressive solutions. However, these point solutions left enterprises with no greater systemic capabilities than they had before. This year’s research highlights a growing ambition in organizations to scale AI for enterprise-level advantage. As Ibrahim Gokcen, chief digital officer at Danish shipping company Maersk, puts it, “AI at scale is the next step of digital transformation.” But how do you get beyond isolated AI point solutions? Many companies have discovered, often to their surprise, that it is easy to apply AI and get quick results. What is not so easy is building a system of AI applications along with associated data pipelines that interact and are reliable. Pioneers overwhelmingly see the need for an AI strategy: 85% agree they have an urgent need for an AI strategy, and 90% say they have a strategy in place already. Organizing AI for the entire enterprise requires a strategy.

3. **Pioneers prioritize revenue-generating applications over cost-saving ones.** Which is more important to pursue with AI applications: new revenues or cost efficiencies? In the first wave of corporate AI adoption, many companies focused on making operational processes more efficient. Easily documented cost savings are a classic way of garnering support for further investment. But the finding here is that all but the most passive organizations anticipate AI will pay off most on the revenue-generating side. More sophisticated organizations expect more in this direction, as 72% of Pioneers say AI will deliver mainly revenue increases in the next five years, while only 28% of Pioneers expect mainly cost savings. For the Investigators group, the corresponding numbers are 59% and 41%. In the near future, AI initiatives will focus on generating revenues, not cutting costs.

4. **AI is creating both fear and hope among workers.** How will AI affect individual workers? Popular societal debate evokes the specter of smart machines outperforming humans, making legions of workers redundant. Other research has found individuals are evenly divided on the question of whether AI will produce job losses or job gains overall.1 Our survey echoes the ambivalence: 47% say their workforce will be reduced because of AI in the next five years. Yet a gulf opens when we consider the respondents’ positions in their organizations. Lower-level operational and clerical workers are most concerned that layoffs are imminent, perhaps because these workers are less able to influence the course of events and thus feel particularly exposed. Chief executives are among those least convinced AI adoption will result in more overall job loss. Only 38% of surveyed CEOs expect workforce reductions due to AI. The effects of AI on the workforce won’t be uniform. Managers need to address the concerns of their employees through reskilling, change management, and communication.

In addition, we conducted a separate survey of 300 executives in China. Findings from this survey contrast pioneering Chinese companies with companies based in other regions. Chinese AI Pioneers are investing more aggressively and report a greater focus on business model transformation. However, they may be held back by unclear business cases and shortfalls of techni-
cal capabilities. Other striking differences are Chinese companies’ larger emphasis on using AI to achieve cost reductions versus revenue enhancements, and their greater expectations of job losses due to AI. Whether China’s approach is successful or not, the determination of Chinese companies serves as a wake-up call for governments and other companies across the globe.

Overall, the second annual *MIT Sloan Management Review*-BCG research report tells a story of measurable benefits from current AI initiatives, increased investments, and determined efforts to expand AI across the enterprise.

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**ABOUT THE RESEARCH**

To understand the challenges and opportunities associated with the use of artificial intelligence in business, *MIT Sloan Management Review*, in collaboration with The Boston Consulting Group, conducted its second annual survey of business executives, managers, and analysts from organizations around the world, which this year included 3,076 participants.

The survey, conducted in the spring of 2018, captured insights from individuals working in organizations of various sizes, spread across 29 industries and located in 126 countries. More than two-thirds of the respondents were based outside the United States. The sample was drawn from a number of sources, including *MIT Sloan Management Review* readers and other interested parties.

As a starting point for this report’s analysis, the total survey population was divided into four subgroups based on the relative AI maturity of respondents’ organizations, combining levels of understanding of AI tools and concepts and levels of adoption of AI applications. To indicate overall understanding, respondents rated their organization’s understanding of nine areas, ranging from familiarity with the technological state of the art to challenges of AI application development to organizational behavior implications. Based on their level of adoption and understanding, we divided survey respondents into these four groups:

- **Pioneers (18%)**: Organizations that both understand and have adopted AI. These organizations are on the leading edge of incorporating AI into both their offerings and internal processes.

- **Investigators (33%)**: Organizations that understand AI but are not deploying it beyond the pilot stage. Their investigation into what AI may offer emphasizes looking before leaping.

- **Experimenters (16%)**: Organizations that are piloting or adopting AI without deep understanding. These organizations are learning by doing.

- **Passives (34%)**: Organizations with no adoption or much understanding of AI.

“Artificial intelligence” is a term that can refer to various technologies. It is often used loosely, and it can mean different things to people in different groups. Participants in this study were made aware of the definition of artificial intelligence in the *Oxford English Dictionary*: “AI is the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.”

To gain context and a deeper understanding of survey findings, the research team interviewed 36 executives. All of the interviewees are experienced managers, representing a variety of industries and types of organizations.
Introduction

At Allianz, the Munich-based insurance giant, CEO Oliver Bäte outlined a Renewal Agenda for the company in 2015. He wanted Allianz to energetically pursue higher levels of value creation through the kind of digitalization that he saw transforming economies and economics. Gemma Garriga, global head of AI and advanced business analytics at Allianz, says that agenda lit a fire under her group’s efforts to identify new AI applications. Garriga’s team has since deployed an array of AI-based solutions, from initial customer personalization to final claims automation. She says most of these projects are delivering exciting results.

One improvement came, for example, when Allianz’s underwriting process identified fraud in online insurance applications. The problem is that when users provide information, there is a possibility that they are not being truthful with the data Allianz needs to calculate the right pricing. Car owners might exaggerate their no-claims bonus level or input a false postcode in order to reduce the cost of the insurance. This, naturally, leads to higher costs for other customers as risks aren’t calculated correctly and distributed fairly.

To address that problem, Garriga’s team developed AI models that calculate in real-time both the probability that an application is accurate — giving it a so-called Anti-Fraud Underwriting Score — as well as the potential future costs of accepting the application. The models were put into production about two years ago and promptly “increased fraud detection by around 50%.” The new system benefits both Allianz and its customers by enabling the company to better calculate risks and premiums, and more fairly distribute costs.

This example illustrates many of the key findings from the MIT Sloan Management Review-BCG 2018 Artificial Intelligence Global Executive Study and Research Report. As a leader in its information-based industry, Allianz, though not yet an AI powerhouse, is boldly building AI capabilities and determined not to lag behind more aggressive AI adopters, such as Chinese insurer Ping An Insurance (see the MIT SMR-BCG 2017 Artificial Intelligence Global Executive Study and Research Report).

We find many companies like Allianz — those experiencing positive outcomes from early AI applications — are looking to invest even more in their AI efforts. The most ambitious of those companies, the Pioneers, have resolved to take their AI advantages to scale. Pioneers not only believe AI will generate a wide range of opportunities but are creating strategies for prioritizing them and building platforms to encourage AI’s use throughout the enterprise. At the same time, Pioneers are discovering the challenges inherent in the scaling effort. They are highly attuned to the workforce implications of corporate-wide adoption of AI and the need to lead and manage organizational change. They describe their efforts with humility and call it “early days,” but they fully expect substantial business value from the implementation of AI.

Pioneers Are Deepening Their Commitments to AI

Has artificial intelligence finally reached the point where it is a practical technology for business use? One indication of commercial viability would be if early adopters were not quietly shelving their projects and backing off their investments but instead actively following up with more applications. This is precisely what the 2018 research reveals: Today’s AI Pioneers are deepening their AI commitments.

As an example, consider Chevron. In a joint interview, CIO Bill Braun and Margery Connor, Chevron fellow at the Modeling and Analytics Center of Excellence, described an impressive range of
AI applications already delivering value at the energy giant — from diagnosing machinery performance and predicting maintenance needs to strengthening cybersecurity. One particularly clever solution uses text analytics to review contracts with subcontractors, compare them with invoices and payments, and zero in on any “spend leakage.”

Connor’s group scored so many victories that, in 2017, it started sending “data science of the month” write-ups to Chevron’s senior leadership. “Just like when an executive picks up the magazine on a flight, reads something, and says, ‘Hey, what are we doing about this?’ we’re trying to cause that same reaction widely across the company,” says Braun. It gets more colleagues “connecting the dots,” not only to spot more immediate use cases but to see why they should back projects that require more patient investment. For example, “Sensorization and mobility are also going to add a lot of value to us,” Braun says, “but those are a little bit longer plays than just harnessing the power of the data that we already have.”

Survey data reveals the same finding at many other companies. Asked if they had increased their level of investment in AI in the past year, the majority of respondents said yes — but Pioneers were far more likely than others to say they had. (See Figure 1.)

More specifically, a significant majority of Pioneers reported investing more in the past year than in prior years in AI talent (81%), AI technology (86%), the data required to train AI algorithms (79%), and the processes required to train the algorithms (80%). This is not a given by any means; Pioneers might have just as easily decreased their investment relative to prior years, but their results with AI have emboldened them to go further.

However, compared with last year, the actual percentage of Pioneers did not grow. The excitement around AI notwithstanding, the distribution of our survey respondents across the four maturity groups (Pioneers, Investigators, Experimenters, and Passives) in 2018 is comparable to what it was in 2017. In the 20% that are Pioneers, only the top five percentage points of respondents indicated that they have extensively incorporated AI in processes and offerings — a result that also remains unchanged from 2017.

These Pioneers, however, may be pulling further away from their investigating, experimenting, and passive peers. For example, in terms of their organization’s understanding of AI over the past year (see Figure 2), Pioneers reported greater growth than other groups. Whereas enterprises in the Passive category reported scant gains on average, more than two-thirds of Pioneers believe their organization has added “a lot” to their AI understanding since 2017.
An organization can improve its overall understanding of artificial intelligence in many ways. Direct experience working with AI tools and techniques on actual business problems is one approach. Another is to hire new people with AI expertise. At Swiss specialty chemical provider Clariant, executive committee member Britta Fuenfstueck says the company has tripled the size of the team working on AI projects. Providing formal education and training of existing talent is another way to build organizational understanding of AI. Tassilo Festetics, vice president of global solutions at Anheuser-Busch InBev, took his entire extended team to the University of California, Berkeley, for a weeklong intensive immersion in AI. “It is important for the team to understand the basics of machine learning and AI to be able to identify game-changing opportunities for the company, be it for commercial, supply, logistics, or employee-related topics,” he says. “We consider it a long-term investment, since this is an investment into capabilities of the future that will be needed in all departments.” These approaches to building organizational understanding of AI are complementary and cross-functional.

FIGURE 3: AI SHIFTS BUSINESS MODELS
Looking ahead to the next five years, a majority of companies expect AI to spur business model change.

FIGURE 4: GREAT EXPECTATIONS FOR AI
Overall, 91% of survey respondents expect new business value from AI implementations in the coming five years. Even among Passives — which today primarily experience the benefits of AI-based products indirectly — 81% expect to derive value directly from AI within five years.

Overall, a surprising number of respondents (28%) say AI solutions have already led to business model change in their organization. In the case of Pioneers, a majority make this claim. The majority of all organizations (58%) foresee modifications of their business models due to AI within five years. This is true across all levels of AI maturity and across a variety of industries. These results suggest that organizations don’t expect AI to merely help improve current business operations; they widely expect AI adoption to change business models. What’s more, nine out of 10 respondents believe AI will create new value for their business in the next five years. (See Figure 4.)

Data can be the key to success or failure in AI. Not surprisingly, Pioneers are more mature than other respondents in their management of this fundamental
CHINA’S BIG PUSH INTO AI

In the spring of 2018, The Boston Consulting Group and *MIT Sloan Management Review* conducted a separate survey of Chinese executives in an effort to address other big questions: How are companies based in China—home of digital giants Alibaba, Tencent, and Baidu—progressing in their adoption of AI for business purposes? How does their progress compare with companies in other regions? To investigate, we translated our global survey into Chinese and surveyed 300 executives across industries in China. For the Pioneers, we then compared their responses with the non-Chinese respondents from our global survey. Three findings are especially noteworthy:

**Chinese companies are aggressively investing in AI business applications** relative to their counterparts in other parts of the world. Buoyed by the Chinese government’s recent five-year plan calling for businesses to achieve leadership in artificial intelligence, Chinese companies report greater increases in AI investment than companies in other regions. Their approach to data also appears advantageous. Because AI engines learn by ingesting training data—the more the better—companies should centralize the housing and governance of data, and Chinese Pioneers do this particularly well. For example, 78% maintain their corporate data in centralized data lakes, compared with only 37% and 43% of European and U.S. pioneers, respectively.

And 83% of Chinese AI-leading companies surveyed manage corporate data centrally, while only 39% of European Pioneers and 40% of U.S. Pioneers do so.

**Chinese companies face their own challenges** in their ambitious push into AI. For example, nearly half of Chinese Pioneers say the business case for AI is unclear or missing—a potential impediment to determining appropriate levels of investment. The barrier Chinese Pioneers report most often is a lack of talent in AI. Nearly six in 10 Pioneers in our China sample say constraints in technological talent are holding them back, far higher than in the United States and Europe. Chinese companies also report that they are focusing on using AI to cut costs and putting less emphasis on using the technology to generate new revenue streams. Finally, and perhaps as a result of the cost focus, they have more people-related concerns and changes. More than two-thirds of Chinese Pioneers (68%) say AI deployments are likely to reduce the size of their workforce. In Europe and the United States, just 32% and 50% of Pioneers, respectively, share that concern.

**China’s rapid rise in AI has been a wake-up call** for nations, industries, and corporate executives globally. Indeed, many recent national programs to advance the development of artificial intelligence refer to China as a competitive threat.

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**FIGURE 5: DATA MATURITY DRIVES AI**

Pioneers are far more likely to see data as a corporate asset and report that data issues are on the agenda of senior management.

How does data affect AI?

![Data Maturity Drives AI](image-url)
asset. Pioneers are more likely than their less sophisticated peers to have strong, company-wide data governance systems and centralized data lakes. Their management teams are cognizant of data issues and view data as a corporate asset. (See Figure 5, page 7.) (Respondents to the Chinese survey centralize data even more. See sidebar, “China’s Big Push Into AI,” page 7.) Committing thoroughly to the application of AI means devoting more attention to data issues. Our interviews with individual business executives included numerous discussions of data issues, especially in companies that have been in business a long time and grew through mergers and acquisitions. While several interviewees noted the “treasure troves” of data they could draw on for AI applications, some reported frustration with even simple projects. At Anheuser-Busch InBev, for example, Festetics acknowledges, “I wish we would have looked at data quality much earlier. We used to spend a large amount of time on getting data and making it ready.” But the experience caused the company to change its approach for the better: “We felt everything we had was no longer upgradeable, so we looked at data from this perspective: How would we enable data for analytics if we were to start the company today?” he says. “This allowed us to make data more readily available to run algorithms to gain insights into consumer preferences, optimize our offerings for customers, and produce our product with reduced energy and waste.”

Festetics’ comment points to an advantage many Pioneers enjoy: robust data capabilities. Consider a large insurance company like Allianz or Netherlands-based Nationale-Nederlanden (NN) Group, for example.4 As CEO of NN Group’s home market, David Knibbe is responsible for about two-thirds of the company’s operations, which include 18 countries. He notes the company started in 1845, “and I’m not saying we have all the data since then, but we have enormous amounts of data.” As an insurance provider with a strong background in actuarial science, the company is more comfortable than many other businesses when it comes to creating models for data-driven decision-making. The same is true of Chevron, where subsurface operations have long relied on high-performance computers. “Back in the early days of the Cray [supercomputer], it was us and the government that were the biggest consumers of CPU,” Chevron’s Braun notes, “and for decades that was true.” Given that Chevron engineers and scientists are “really good at applying this kind of technology,” he says, “letting the machines help with more data-driven decisions — it’s going to be very natural to them.”

Pioneers also have more top management involvement in and commitment to AI initiatives compared with other groups. In identifying the top three barriers to AI adoption in their organization, relatively few Pioneers said they feel constrained by “lack of leadership support” or an “unclear business case” for AI-related efforts. (See Figure 6.) As is the case with many business initiatives requiring new investment, leadership support and a business case are critical. Asked to name what spelled the difference between...
successful and unsuccessful projects he had seen, Harald Rudolph, head of Daimler strategy, didn’t hesitate: “Next to fostering an understanding of AI throughout the entire organization, it is important to get the top management’s attention and make them aware of and excited about the potential of this set of technologies.”

Looking deeper into the data, we find that Pioneers are the least likely to be held back by a lack of leadership support. Whether early successes led to that support or, conversely, leadership support was a critical factor in achieving those first, case-making victories, top management attention is another advantage Pioneers hold.

Will the pursuit of artificial intelligence prove to be another situation where leading enterprises, having established a healthy head start, increase the gap between themselves and their less mature peers? At the moment, this is an open question. With rapidly evolving and unfamiliar technology, “fast-following” might work, whereby followers let others forge ahead with experiments and learn from their successes and failures. But those hoping to fast-follow others’ pioneering work without taking risks themselves should beware: Pioneers, by deepening their commitments to AI, are establishing positions in both customer and labor markets that may make it hard for others to draft off of their hard work. The many advantages reported by Pioneers suggest that early AI movers may be especially hard to catch.

**Pioneers Are Eager to Scale AI Throughout Their Enterprise**

NN Group’s Knibbe is one CEO directing his personal attention to his organization’s AI agenda. Even in a situation that would distract most CEOs — managing a recent major acquisition (of Delta Lloyd Group, previously one of NN’s main competitors) — he stays on top of AI developments. “You don’t have the capacity during such a large-scale integration to bet on a lot of things,” he says. But as one of his “big bets” for the combined entity’s future, AI remains a personal focus of his.

Long before AI technology found its way into much practical business use, Knibbe was confident that it would prove valuable: “It is, for us, very clear that there should be a lot of benefits, given where the math and the science already is. It seems that all of that is way ahead of business application. So, I was convinced that there would be a lot of reasons to invest in this, whether it’s in process improvements, customer analytics, customer behavior.” NN Group’s first, small-scale experiments made rapid progress, and the company moved ahead with implementing various solutions — and “what we’ve seen is, where we did it, it worked well,” he says.

The challenge, as Knibbe sees it now, is to take his company’s use of artificial intelligence to scale. And in this respect, he is typical of many respondents from Pioneer companies. Certain about the promise of AI, he wants to go beyond point solutions and pursue AI systematically, as an overall source of competitive advantage.

What does scaling require? Many efforts simultaneously: creating a strategic vision, taking stock of current capabilities, building AI-supporting processes and platforms, instilling AI understanding into the business, and cultivating AI-related activities. It’s a complex undertaking. Most executives have yet to consider, at a deep level, how to scale AI in their business. “People don’t really understand what enterprise AI is,” says Inderpal Bhandari, global chief data officer at IBM. “They do have a good sense of it in the consumer context, and they

“Next to fostering an understanding of AI throughout the entire organization, it is important to get the top management’s attention and make them aware of and excited about the potential of this set of technologies.”

— Harald Rudolph, head of Daimler strategy, Daimler
also had a good sense of AI in the context of point solutions like facial recognition and stuff like that. But they don’t really understand from an enterprise context exactly what that could look like.”

No Scale Without Strategy
A company cannot successfully deploy AI throughout the enterprise unless management has a strategy. Pioneers are more likely to recognize the need for such a strategy. (See Figure 7.) At Daimler, for example, Rudolph says coming up with an AI strategy has been his priority. “We are developing clear target pictures for each and every function, making sure that they have ambitious but achievable targets and a clear roadmap leading to them,” he says. Having a strategy in place, Rudolph believes, is “the key lever to implement AI technologies to improve existing processes along the entire value chain as well as developing new products and services to delight our customers. For us, this is of utmost importance.”

Taking Stock of Activity
Another important step toward managing AI at scale is simply getting a handle on all of the AI activity going on in a sprawling enterprise. As an example, consider Mayo Clinic. The health care organization has about 65,000 employees spread across five U.S. states. Its operations include major destination medical centers in three different states and the Mayo Clinic Health System, which has many practices in a 120-mile radius around Rochester, Minnesota. There is also the Mayo Clinic Care Network, an affiliated practice network that spans 50 sites across the country and beyond. Clark Otley, MD, described an ongoing effort by his colleague Wyatt Decker, MD, an emergency medicine physician who is now CEO of Mayo Clinic in Arizona and leading artificial intelligence efforts across the whole organization. “What Dr. Decker is trying to do is catalog and get a handle on all the different efforts that are going on across the institution,” Otley reports. “In the preliminary assessment, he collected evidence that there are probably about 250 ongoing artificial intelligence initiatives, projects, and research programs, very disseminated across the entire enterprise.” The challenge, Otley says, is to “take an enterprise approach to this so that we develop artificial intelligence in a way that synergizes across our campuses rather than causing redundancy or confusion across the geographic distribution.”

Peter Batt, IT undersecretary at the German Federal Ministry of the Interior, explains how his office took stock of where German government agencies are...
The wide-ranging feedback was a big surprise to us. There are AI applications, albeit some are still early stage, across many institutions, such as the German Patent and Trade Mark Office, German Archaeological Institute, Federal Police, Federal Office for Information Security, Federal Institute of Sport Science, Federal Statistical Office of Germany, Federal Criminal Police Office, Federal Agency for Cartography and Geodesy, Federal Ministry of Justice, Federal Ministry of Finance, not to mention Defense, the Federal Ministry of Health, Robert Koch Institute, and more. And the technology is used to improve the service for society.

Building Processes and Platforms for AI at Scale

Gorkem Koseoglu, global head of robotics and artificial intelligence at Dutch bank ING, is particularly thoughtful about how the company will take its AI capabilities to scale, even as he acknowledges there is a long way to go: “For each of these areas, gradually we’ll move to more standardized models. As a bank, obviously we are not a greenfield technology company, so we don’t have the luxury to say, ‘OK, I’m going to go back and work on a universal banking model that will solve everything — and it will take me five years.’ But in a typical two-speed process, while we are meeting current business needs, we at the same time are trying to converge into these core models.”

What kinds of processes is Koseoglu envisioning? He says an example is “trying to build what could be the core models when it comes to price — as in, what could be the core model that we can use across the segments that will give us the capabilities to do lending pricing for all our customers in a smart way?” Such models must be built “with the idea that they become our core components of the company, and we’ll keep on investing in those as core capabilities,” he adds. “Not as a project, but they are basically our core skills, and we will dedicate resources to continuously improve them. That is the vision. We also realize that it’s an evolution.”

Lu Hao, a former Google research scientist and now chief innovation officer at Chinese AI innovator YITU Technology, says that because of YITU’s AI focus, a core part of his job is to ensure that all of the infrastructural elements are in place for AI development to proceed smoothly. YITU is an exception, however. It is still rare for companies to have built platforms for their AI application development in the way that AI-driven companies have. More typical is the situation at Spain-based Amadeus IT Group. Marion Mesnage, who is in charge of the company’s research, innovation, and ventures, says the company “ultimately wants to standardize AI systems and platforms” to ensure that it is getting the most from its AI investments. “It starts with having good data platforms,” she notes, which is the current focus. Pioneers are starting to develop standards for what protocols should be used, what processes should be followed, and how processes should be documented.

Joseph Sirosh, CTO of AI in Microsoft’s WW Commercial Business group, says the software company is “building a complete AI platform that allows it to build and operate ‘systems of intelligence.’ ” The platform includes “components to ingest data to build AI models, to deploy them in production, to manage them, monitor them, report on how they are performing using dashboards, take in feedback from the actions being taken, learn from that, and continue that cycle — the iterative learning loop,” he says. Sirosh contends that it is “incredibly important for enterprises to not just look at the first phase of AI, which is taking data, analyzing it, creating predictions using AI methods — which is, in fact, one of the easier parts of enterprise deployment — but translating that into operational deployment with the ability to debug and test such models in production and the ability to roll back and substitute new models if the older model doesn’t work and so on.” For Sirosh, AI taken to scale means “the enterprise has an AI-oriented architecture capable of constantly running AI experiments reliably, with continuous integration and deployment, and then learning from those experiments and continuing to improve its operations.”
Driving AI Understanding and Action Into the Business

In some organizations, one approach to unifying disparate AI activities is to centralize expertise in order to decentralize AI understanding and action. A colocated group of professionals well-educated in basic AI technologies can develop and maintain standards and help educate business professionals throughout the organization about AI. Efforts to scale AI systems and initiatives are more likely to succeed at organizations that are full of people who understand the promise of AI and know something about what effective AI deployments require.

Several business leaders we interviewed described efforts to bring nontechnical employees in the organization to a new level of awareness and enthusiasm. At ING, Koseoglu says, “We are investing a lot on the training of the businesspeople because one thing we learned is, actually, it’s not only about getting more data science resources but, more importantly, what we call the translators — in our case, the product owners.” His group is training businesspeople to think about potential use cases for AI, and also about the change management that should go along with the solutions they develop. “We have a plan to train more than 3,000 people in the coming two years in the organization, and those may be — well, those are the critical people for scaling up.” Raphael Micha, head of corporate strategy development at Bosch, advocates for “transforming business with AI following a bottom-up and top-down approach.”

At Pfizer, Julie Schiffman, vice president of business analytics, developed the Interactive Analytics Studio, which is designed to engage business colleagues in thinking about the potential of AI. “We’ve actually taken a conference room and converted it into a lab where we bring cross-functional teams together to look at data in real time using interactive screens and systems,” she explains. “What we are finding is that has completely changed the game for how we drive insights across the scientific and commercial community.” Compared with the traditional “PowerPoint culture,” she says, sessions like these help her team “beat our own cycle

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**FIGURE 8: AI IS PREDICTED TO AFFECT ALL AREAS**

Among the highest expectations for AI in the next five years is that it will bring new levels of intelligence to product and service offerings, but companies of all sizes also see ways to use AI to enhance internal business processes.
time for driving insights. By bringing colleagues together in one room from multiple disciplines to review and test initial hypotheses, team members develop new questions that we have an opportunity to answer in real time.” Schiffman believes that this active, get-up-out-of-your-chair approach to engagement has helped the pharmaceutical company evolve and make AI and advanced analytics “not as much of a black box.” She is convinced that great projects start when her analytics experts sit down with colleagues who have deep business domain experience and good data is brought into the equation that they can review together. “When you pull that recipe together,” she says, “some magic can happen.”

A common theme among all of these examples is that scaling AI in the enterprise demands new ways to engage business experts with technology.

Pioneers Prioritize Revenue-Generating Applications Over Cost-Saving Ones

How should executives prioritize business operations that could be improved with AI? Judging from our survey results and interviews with business leaders, many executives believe their choices are almost unlimited. As Mayo Clinic’s Otley puts it, “I don’t know that there’s the sweetest spot for artificial intelligence. I think it’s going to be broadly applicable across everything we do.” Survey respondents anticipate opportunities to apply AI to all five functional areas we asked about. (See Figure 8, page 12.)

Clariant’s Fuenfstueck has a disciplined view about how to prioritize projects when so many operations could benefit from AI’s vast potential. With new AI capabilities, she says, “we are sure that almost everything you can touch, you can optimize. If you take a process that is very complex but repeats itself all the time and has varying outputs, you can always observe which input parameter yields which output and develop machine learning algorithms based on that.” So far, Fuenfstueck claims, “almost every topic that the team has touched has benefited.” At the same time, she is clear on the point that choices about where to use AI must be made strategically. In Clariant’s case, she explains, “the team has to touch what they consider to have the highest yield or the highest benefit for putting effort into it.”

Fuenfstueck makes a compelling argument that this highest benefit will come from revenue-focused initiatives rather than in efforts to improve the efficiency of internal processes. This is “because any NPV [net present value] of an external business by far outperforms any internal one.” She points out that failing to jump on an internal process improvement opportunity means “you just miss out on a year of EBITDA [earnings before interest, taxes, depreciation, and amortization] improvement.” A much higher penalty is incurred by missing an opportunity in the external market. “If you were late with a new business model, somebody else will have driven it and you will have lost your chance forever,” Fuenfstueck says. “So, this has to be the rule of prioritization.”

While Clariant first developed its familiarity with AI by applying it to cost-saving opportunities — for example, by optimizing yields and reducing energy costs in large chemical plant production processes — Fuenfstueck stresses that Clariant quickly moved to revenue-boosting opportunities with AI. Among the examples she mentioned are complex pricing applications, churn analysis in the customer portfolio, new delivery forms that significantly speed up Clariant’s ability to meet customer demand, and even a new service line operating on a wholly different business model. In that second wave of AI projects, she says, Clariant was “taking this knowledge of being able to optimize processes within the company and bringing it now to our customers to help them optimize their processes.” Creating an AI solution that provides “add-on value that allows us to differentiate in a classic chemical-selling business is for us priority No. 2,” she says. An even lower priority is “just bringing something offline to online.” For Clariant, those types of projects aren’t worth devoting scarce resources to. “Priority No. 1,” she says, is coming up with “completely new business models and really new services, just based on digital.”
RESEARCH REPORT ARTIFICIAL INTELLIGENCE IN BUSINESS GETS REAL

“I think this is one of the most exciting, value-added, and competitive parts of our business for the future.”

— Bill Braun, CIO, Chevron

Our survey shows that Pioneers (and Investigators) heavily emphasize using AI to develop new revenue-generating offerings and capabilities. In comparison, Experimenters and Passive enterprises focus more on AI applications that reduce costs. (See Figure 9.) In the future, a larger percent of all maturity groups expect AI to produce cost savings.

For managers in young enterprises or new ventures within old organizations, using AI to increase revenues (or, in the case of social enterprises, to achieve their fundamental purpose) is an obvious priority. They do not have long-established, internal processes that need to be integrated with new AI applications and systems. For example, in our interviews with Theresa Johnson, product manager at Airbnb, and Yufeng Zhang, vice president of global business at China-based Horizon Robotics, there was little mention of resources going to improve the efficiency of legacy processes — few legacy processes exist to improve. Or consider OPTEL, a Canadian technology company with a mission to build a sustainable world through smarter supply chains. Using end-to-end traceability systems based on advanced AI, OPTEL connects the various segments of the supply chain and provides much-needed visibility over the path of products in a wide range of industries. The company helps fight problems such as counterfeit medicines, unsafe or fraudulent food items, and unnecessary waste. As OPTEL’s president, Louis Roy, puts it, “For an organization like ours, the use of AI is the key to fulfilling our core value proposition to customers and humanity. Without it, we can’t achieve our goal.”

Our survey results and executive interviews suggest that managers recognize both the opportunities as well as the risks of using AI — to different degrees. Asked whether they perceive AI as a strategic opportunity or a risk to their organization, respondents could choose one answer or the other, or both. In

FIGURE 9: PIONEERS FOCUS ON REVENUE-GENERATING OPPORTUNITIES
In the recent past, most businesses have used AI to increase revenues. In the future, more managers expect AI to reduce costs.

<table>
<thead>
<tr>
<th></th>
<th>IN THE PAST THREE YEARS</th>
<th>IN THE NEXT FIVE YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost Reduction</strong></td>
<td>37% 41% 25% 19%</td>
<td>52% 45% 41% 28%</td>
</tr>
<tr>
<td><strong>Revenue Increase</strong></td>
<td>63% 59% 75% 81%</td>
<td>40% 55% 59% 72%</td>
</tr>
</tbody>
</table>

Percentage of respondents indicating revenue increases and cost reductions.
2017, 83% answered that it was either pure opportunity (50%) or a combination of opportunity and risk (33%). This year, optimism was even higher, with 88% giving one of those answers. Interestingly, however, there was a six percentage point jump in the subset who saw AI as a mixed blessing (39%). This may reflect a dawning recognition that the same AI advantage a company is excited to pursue becomes a risk if a competitor acts faster and deploys first. As Chevron’s Braun says, “I think this is one of the most exciting, value-added, and competitive parts of our business for the future, and so we are passionately going to apply this and use it as part of our differentiation. I think it does give us the ability to outcompete. But if we are lagging on it, it gives our competitors the ability to do that to us.”

AI Is Creating Both Fear and Hope Among Workers

What will be the effects of artificial intelligence on the workplace? Our survey respondents expect AI will have a large impact on the skills employees will need on the job. (See Figure 10.) At the same time, they remain cautiously optimistic about AI’s overall effect on the workforce.

An overwhelming percentage of respondents (82%) believe AI will help their organization improve productivity. Despite those expectations, managers’ opinions about the prospect of labor reductions from AI-related productivity improvements are decidedly mixed. In fact, they are almost exactly evenly split: 47% agreed with the statement “Our organization’s workforce will be reduced” because of AI in the next five years.

Some employees worry that the age of artificial intelligence will mean reductions in the workforce. Rudolph says Daimler takes those concerns seriously and that organizations should take a proactive approach. “We are in a very lucky position,” he says, in that “our company is operating in a global growth industry. Therefore, we are in a much better position to handle any changes on the employment side.”

Rudolph notes that, in his strategic role thinking about the company’s use of AI, he gets asked, “How many people will we have to replace? How many will we have to lay off?” And he understands that his answer needs to be “not a diplomatic one but a very serious one: No one, at this point, can be entirely sure how AI is influencing the overall workforce. New products are being and will be developed, demanding new skills and probably also creating new job opportunities. We need to look at the processes one by one and understand that artificial intelligence will surely change the way we work but not necessarily lead to workforce reduction.”

Rudolph’s level of uncertainty about the future of any given job at Daimler mirrors the survey results overall. The uncertainty around workforce reductions results from the clash of two perspectives. On one hand, past experience with automating technologies might reassure workers that, at least at some point, the result will be not fewer but rather more job opportunities. On the other hand, given that machines are already doing knowledge work, workers might
reasonably doubt that many higher-level tasks will be left for humans to do. (In China, such skepticism is not uncommon.)

Linda Jojo, chief digital officer at United Airlines, summarizes the tension perfectly: “History shows that there’s always a fear of new technologies, whether it was the word processor or the computer replacing the typewriter, through to tablets versus laptops,” she says. “The result people feared doesn’t tend to happen. It’s usually that people just do different and higher-valued tasks and jobs, supported by the technology, or jobs that no one even envisioned because the technology then enabled them. I believe that will happen over time. But right now, that unknown makes it a difficult concept.”

On the topic of AI’s likely effect on jobs, this year’s survey results and the sentiments expressed in our executive interviews are similar to last year’s. Even with a year of additional experience and understanding about AI, these unknown aspects still make it difficult to project forward.

How exactly these effects of AI on the future of work will come together is an important unknown aspect. For example, while most respondents believe AI will require other existing workers in their organization to change their skill sets in the coming five years, relatively few are fearful that AI will take away some of their own tasks in that time frame. In fact, more than twice as many are hopeful that AI would do so, no doubt picturing AI taking over the parts of their jobs that are mundane and repetitive so that they can instead work on more creative tasks.

This mix of hope and fear contributes to the uncertainty. In roles that involve a healthy dose of both menial and strategic or creative tasks, the hope is that AI will take over the menial tasks, creating more time to focus on more interesting work. Garriga of Allianz believes “the moment when people realize that this is a productivity gain and that they can focus more on non-menial, value-adding tasks, the resistance comes down. Then it’s a gain, and it’s not about AI replacing humans. It’s about making people more efficient and letting them focus on the really important tasks for our customers.” At the Mayo Clinic, Otley says the philosophy is to “automate the easy” and “augment the hard.” That is, tasks that people find mind-numbingly dull are fair game for AI solutions — but so are tasks they find mind-bendingly difficult. His strong belief is that humans will still be integral to the work that goes on in medical settings, not just in terms of patient care, but also to the process of interpreting large masses of data.

Analyzing the survey results by job type helps clarify some of the unknowns. For example, office and operations workers, along with business analysts, are most likely to agree that “AI will cause us to reduce our workforce within five years.” Experts and specialists, followed by business analysts, are most fearful that AI will take over some of their own job tasks. According to Bonny Simi, president of JetBlue Technology Ventures, the corporate venture arm of the airline, this same expectation is driving much investment in AI companies by venture capitalists, who are gravitating to enterprise solutions that automate the kinds of repetitive, internal work processes that all companies tend to have. Advancing AI, Simi is convinced, will mean that some people’s jobs go away. “You’ll always have controllers and accountants,” she allows, “but now you won’t have as many data entry people and so on. It’s the lower-level positions that will be automated, and retraining will be needed to up-skill workers to fill demand for higher-skilled roles.”

That scenario isn’t hypothetical; it is a reality in some organizations. At ING, for example, the deployment of AI applications in the area of back-office data entry led to the replacement of 400 full-time employees. According to ING’s Koseoglu, the company taught software how to handle back-office data entry tasks that the workers and others had been doing.

Conclusion: Dying Myths, Emerging Realities

The MIT SMR-BCG 2018 Artificial Intelligence Global Executive Study and Research Report makes
the case that, as a subset of businesses around the world succeed in securing business value from artificial intelligence, their pioneering efforts are encouraging them to go further. Having experimented with point solutions and seen impressive results, they now aspire to scale up and build systemic competitive advantages with AI.

Today, companies are taking many approaches to adopting AI. Christian Guttmann, executive director of the Nordic Artificial Intelligence Institute, says he has observed a “huge variation” in how leaders are starting to deal with AI’s opportunities and challenges. With high-profile cases driving new levels of enthusiasm, the next five years will see increased investments in pursuit of AI-enabled advantages. As a result, Guttmann sees “enormous need by leaders of large corporations, as well as the government entities, to make sense of all of this.”

One way to think about the findings of this report is in terms of what myths the research serves to disprove. It may be that some commonly held notions about business uses of AI have outlived their usefulness.

**Myth:** The benefits of AI are perpetually just out of reach.  
**Reality:** AI is currently providing real value in real organizations, not just lab demonstrations in technology organizations.

**Myth:** Widely available sophisticated AI tools will level the playing field.  
**Reality:** Pioneers are increasing their investment in AI, widening the gap with others.

**Myth:** Companies that see success with AI flourish via small-scale experiments.  
**Reality:** AI leaders are increasing their investments in AI and creating strategies for taking AI to industrial scale.

**Myth:** The greatest promise of enterprise artificial intelligence is the ability to take mundane knowledge work and automate it, yielding unprecedented operational cost savings.  
**Reality:** Keenly aware of competitive dynamics, leaders are applying AI to develop new offerings that focus on revenue creation.

**Myth:** Senior managers view AI as a tool that will help them achieve workforce reductions.  
**Reality:** The higher the manager’s role in the corporate hierarchy, the less likely he or she will see AI as a cause of job losses.

Early AI adopters in business have seen their pioneering efforts rewarded and are pushing forward, having gained both competence and greater perspective on the possibilities. Based on the benefits of early applications, we heard great enthusiasm — but also clear-eyed appreciation of the challenges of increasing AI investments and realizing value at scale. We also heard many open questions: Do Pioneers already have an unassailable advantage? What is the effect of aggressive AI adoption in China on the rest of world? How will AI affect economic growth? What are the implications of AI on the future of work?

As Chevron’s Braun told us, “It’s springtime for AI, and we’re anticipating a long summer.” We look forward to revisiting this research in 2019 and reporting on emerging patterns.

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REFERENCES


4. The insurance industry has other Pioneers, too, that see AI as a critical element in the digital transformation of their businesses. In last year’s report, we featured the story of Ping An Insurance, the second largest insurer in China. See Ransbotham, “Reshaping Business With Artificial Intelligence.”

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[ARTIFICIAL INTELLIGENCE]

The Fundamental Flaw in AI Implementation

Many executives are enthusiastic about the business potential of machine learning applications. But business leaders often overlook a key issue: To fully unlock the benefits of artificial intelligence, you’ll need to upgrade your people’s skills — and build an empowered, AI-savvy workforce.

BY JEANNE ROSS

There is no question that artificial intelligence (AI) is presenting huge opportunities for companies to automate business processes. However, as you prepare to insert machine learning applications into your business processes, I recommend that you not fantasize about how a computer that can win at Go or poker can surely help you win in the marketplace. A better reference point will be your experience implementing your enterprise resource planning (ERP) system or another enterprise system. Yes, effective ERP implementations enhanced the competitiveness of many companies, but many other companies found the experience more of a nightmare. The promised opportunity never came to fruition.

Why am I raining on the AI parade? Because, as with enterprise systems, AI inserted into businesses drives value by improving processes through automation. But eventually, the outputs of most automated processes require people to do something. As most managers have learned the hard way, computers can process data just fine, but that processing isn’t worth much if people are feeding them bad data in the first place or don’t know what to do with information or analysis once it’s provided.

With my fellow researchers, Cynthia Beath, Monideepa Tarafdar, and Kate Moloney, I’ve been studying how companies insert value-adding AI algorithms into their processes. As other researchers and managers have also observed, we are finding that most machine learning applications augment, rather than replace, human efforts. In doing so, they demand changes in what people are doing. And in the case of AI — even more than was true with ERP systems — those changes eliminate many nonspecialized tasks and create skilled tasks that require good judgment and domain expertise.

For example, fraud detection applications may reduce the time that people spend looking for anomalies but increase requirements for deciding what to do about those anomalies. An AI application might allow financial analysts to spend less time extracting data on financial performance, but it adds value only if someone spends more time considering the implications of that performance. With the help of AI applications, customer service staff can spend fewer hours resolving routine problems, but they are more likely to improve operations if at least some of that saved time is reallocated to better understanding the problems customers are experiencing with the company’s most recent offerings.

Many leaders think that they will generate value from AI by recruiting more data scientists. Of course, there’s a shortage of data scientists — and some of them are more attracted to the challenge of building an application that wins at poker than solving a business need. Others will be inspired to find a cure for cancer or to mitigate global
warming. So financial services and insurance companies attempting to uncover fraud and technology companies hoping to improve customer satisfaction will be fighting over the remaining talent.

But recruiting data scientists is not your biggest challenge. Data scientists can develop useful algorithms, but domain experts are needed to help train the machine to recognize important patterns and understand new data. Domain experts include top analysts, contract managers, salespeople, recruiters, and other specialists who are not only experts at their jobs but are also acutely aware of how they deliver excellence. That may involve just a few key people for a given application, but they’d better be good. And we still haven’t gotten to the really hard part!

Ultimately, you need people who can use probabilistic output to guide actions that make your company more effective. Probabilistic outputs are no problem when, say, an application such as Salesforce .com Inc.’s AI tool, Einstein, indicates that one lead has a 95% chance of converting into a sale while another has a 60% chance. The salesperson knows what to do with that information. But what’s the next step when a recruiter learns from an AI application that a job candidate has a 50% likelihood of being a good fit for a particular opening?

When a machine learning application is helping a lawyer identify potentially relevant legal precedents, helping a vendor management team ensure compliance with a contract, or helping a banker decide whether a customer qualifies for a loan, the machine is taking over mundane tasks. Machines can surely learn to develop spreadsheets and search large databases for relevant information. But to generate competitive advantage from machine learning applications, you’ll need to upgrade your employees’ skills. You’ll also need to redesign their accountabilities, so that they are empowered and motivated to deploy machines when limits, which tend to leave parts of the tasks — the parts that don’t fit the algorithms well — to people. When a machine detects fraud or predicts customer or employee churn with 90% accuracy, people must address the other 10% — and that will be the toughest 10%. The machine will assuredly take care of the easy cases.

Addressing the toughest instances is particularly challenging because AI algorithms can produce indecipherable results. When a machine learning algorithm decides who gets a loan and who doesn’t, forget about trying to cut the budget. Machine learning is not a substitute for human intelligence, because, as organizations, we need to be able to understand why we’re doing what we’re doing.

Machine intelligence is not a substitute for human intelligence, because, as organizations, we need to be able to understand why we’re doing what we’re doing.

Companies are succeeding with AI by partnering smart machines with smart people who are learning how to take advantage of what those machines can do. In short, AI implementation success depends on your ability to hire and develop problem-solvers, equip them with data (and potentially AI), and then empower them to actually solve problems. Note that addressing skill requirements this way may well require major changes to your existing hiring and development practices.

Companies that view smart machines purely as a cost-

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Jeanne Ross is a principal research scientist at the MIT Center for Information Systems Research (csir.mit.edu) in Cambridge, Massachusetts. Comment on this article at http://sloanreview.mit.edu/x/59212.

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The threat that automation will eliminate a broad swath of jobs across the world economy is now well established. As artificial intelligence (AI) systems become ever more sophisticated, another wave of job displacement will almost certainly occur.

It can be a distressing picture.

But here’s what we’ve been overlooking: Many new jobs will also be created — jobs that look nothing like those that exist today.

In Accenture PLC’s global study of more than 1,000 large companies already using or testing AI and machine-learning systems, we identified the emergence of entire categories of new, uniquely human jobs. These roles are not replacing old ones. They are novel, requiring skills and training that have no precedents. (Accenture’s study, “How Companies are Reimagining Business Processes with IT,” will be published this summer.)

More specifically, our research reveals three new categories of AI-driven business and technology jobs. We label them trainers, explainers, and sustainers. Humans in these roles will complement the tasks performed by cognitive technology, ensuring that the work of machines is both effective and responsible — that it is fair, transparent, and auditable.

**Trainers**

This first category of new jobs will need human workers to teach AI systems how they should perform — and it is emerging rapidly. At one end of the spectrum, trainers help natural-language processors and language translators make fewer errors. At the other end, they teach AI algorithms how to mimic human behaviors.

Customer service chatbots, for example, need to be trained to detect the complexities and subtleties of human communication. Yahoo Inc. is trying to teach its language processing system that people do not always literally mean what they say. Thus far, Yahoo engineers have developed an algorithm that can detect sarcasm on social media and websites with an accuracy of at least 80%.

Consider, then, the job of “empathy trainer” — individuals who will teach AI systems to show compassion. The New York-based startup Kemoko Inc., d/b/a Koko, which sprung from the MIT Media Lab, has developed a machine-learning system that can help digital assistants such as Apple’s Siri and Amazon’s Alexa address
SUSTAINERS
The final category of new jobs our research identified — sustainers — will help ensure that AI systems are operating as designed and that unintended consequences are addressed with the appropriate urgency. In our survey, we found that less than one-third of companies have a high degree of confidence in the fairness and auditability of their AI systems, and less than half have similar confidence in the safety of those systems. Clearly, those statistics indicate fundamental issues that need to be resolved for the continued usage of AI technologies, and that’s where sustainers will play a crucial role.

One of the most important functions will be the ethics compliance manager.

Companies that deploy advanced AI systems will need a cadre of employees who can explain the inner workings of complex algorithms to nontechnical professionals.

Explainers
The second category of new jobs — explainers — will bridge the gap between technologists and business leaders. Explainers will help provide clarity, which is becoming all the more important as AI systems’ opaqueness increases. Many executives are uneasy with the “black box” nature of sophisticated machine-learning algorithms, especially when the systems they power recommend actions that go against the grain of conventional wisdom. Indeed, governments have already been considering regulations in this area. For example, the European Union’s new General Data Protection Regulation, which is slated to take effect in 2018, will effectively create a “right to explanation,” allowing consumers to question and fight any decision made purely on an algorithmic basis that affects them.

Companies that deploy advanced AI systems will need a cadre of employees who can explain the inner workings of complex algorithms to nontechnical professionals. For example, algorithm forensics analysts would be responsible for holding any algorithm accountable for its results. When a system makes a mistake or when changes to the input variables and observations how they alter that decision. With that information, the algorithm forensics analyst can pinpoint the data that led to a particular result.

So, for instance, if an expert recruiting system has identified the best candidate for a research and development job, the analyst using LIME could identify the variables that led to that conclusion (such as education and deep expertise in a particular, narrow field) as well as the evidence against it (such as inexperience in working on collaborative teams). Using such techniques, the forensics analyst can explain why someone was hired or passed over for promotion. In other situations, the analyst can help demystify why

SUSTAINERS
The final category of new jobs our research identified — sustainers — will help ensure that AI systems are operating as designed and that unintended consequences are addressed with the appropriate urgency. In our survey, we found that less than one-third of companies have a high degree of confidence in the fairness and auditability of their AI systems, and less than half have similar confidence in the safety of those systems. Clearly, those statistics indicate fundamental issues that need to be resolved for the continued usage of AI technologies, and that’s where sustainers will play a crucial role.

One of the most important functions will be the ethics compliance manager.
The Jobs That Artificial Intelligence Will Create  (Continued from page 15)

**REPRESENTATIVE ROLES CREATED BY AI**

Accenture’s global study of more than 1,000 large companies identified the emergence of three new categories of uniquely human jobs.

<table>
<thead>
<tr>
<th>TRAINERS</th>
<th>EXPLAINERS</th>
<th>SUSTAINERS</th>
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<tr>
<td><strong>Customer-language tone and meaning trainer</strong></td>
<td><strong>Context designer</strong></td>
<td><strong>Automation ethicist</strong></td>
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<tr>
<td>Teaches AI systems to look beyond the literal meaning of a communication by, for example, detecting sarcasm.</td>
<td>Designs smart decisions based on business context, process task, and individual, professional, and cultural factors.</td>
<td>Evaluates the noneconomic impact of smart machines, both the upside and downside.</td>
</tr>
<tr>
<td><strong>Smart-machine interaction modeler</strong></td>
<td><strong>Transparency analyst</strong></td>
<td><strong>Automation economist</strong></td>
</tr>
<tr>
<td>Models machine behavior after employee behavior so that, for example, an AI system can learn from an accountant’s actions how to automatically match payments to invoices.</td>
<td>Classifies the different types of opacity (and corresponding effects on the business) of the AI algorithms used and maintains an inventory of that information.</td>
<td>Evaluates the cost of poor machine performance.</td>
</tr>
<tr>
<td><strong>Worldview trainer</strong></td>
<td><strong>AI usefulness strategist</strong></td>
<td><strong>Machine relations manager</strong></td>
</tr>
<tr>
<td>Trains AI systems to develop a global perspective so that various cultural perspectives are considered when determining, for example, whether an algorithm is “fair.”</td>
<td>Determines whether to deploy AI (versus traditional rules engines and scripts) for specific applications.</td>
<td>“Promotes” algorithms that perform well to greater scale in the business and “demotes” algorithms with poor performance.</td>
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Individuals in this role will act as a kind of watchdog and ombudsman for upholding norms of human values and morals — intervening if, for example, an AI system for credit approval was discriminating against people in certain professions or specific geographic areas. Other biases might be subtler — for example, a search algorithm that responds with images of only white women when someone queries “loving grandmother.” The ethics compliance manager could work with an algorithm forensics analyst to uncover the underlying reasons for such results and then implement the appropriate fixes.

In the future, AI may become more self-governing. Mark O. Riedl and Brent Harrison, researchers at the School of Interactive Computing at Georgia Institute of Technology, have developed an AI prototype named Quixote, which can learn about ethics by reading simple stories. According to Riedl and Harrison, the system is able to reverse-engineer human values through stories about how humans interact with one another. Quixote has learned, for instance, why stealing is not a good idea and that striving for efficiency is fine except when it conflicts with other important considerations. But even given such innovations, human ethics compliance managers will play a critical role in monitoring and helping to ensure the proper operation of advanced systems.

The types of jobs we describe here are unprecedented and will be required at scale across industries. (For additional examples, see “Representative Roles Created by AI.”) This shift will put a huge amount of pressure on organizations’ training and development operations. It may also lead us to question many assumptions we have made about traditional educational requirements for professional roles.

Empathy trainers, for example, may not need a college degree. Individuals with a high school education and who are inherently empathetic (a characteristic that’s measurable) could be taught the necessary skills in an in-house training program. In fact, the effect of many of these new positions may be the rise of a “no-collar” workforce that slowly replaces traditional blue-collar jobs in manufacturing and other professions. But where and how these workers will be trained remain open questions. In our view, the answers need to begin with an organization’s own learning and development operations.

On the other hand, a number of new jobs — ethics compliance manager, for example — are likely to require advanced degrees and highly specialized skill sets. So, just as organizations must address the need to train one part of the workforce for emerging no-collar roles, they must reimagine their human resources processes to better attract, train, and retain highly educated professionals whose talents will be in very high demand. As with so many technology transformations, the challenges are often more human than technical.

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Justifying Human Involvement in the AI Decision-Making Loop

SAM RANSBOTHAM

Despite their increasingly sophisticated decision-making abilities, AI systems still need human inputs.

In 1983, during a period of high Cold War tensions, Soviet information systems abruptly sounded an alert that warned of five incoming nuclear missiles from the United States. A lieutenant colonel of the Soviet Air Defense Forces, Stanislav Petrov, faced a difficult decision: Should he authorize a retaliatory attack? Fortunately, Petrov chose to question the system's recommendation. Instead of approving the retaliation, he decided that a real attack was unlikely based on several outside factors — one of which was the small number of “missiles” reported by the system — and moreover, even if it was real, he didn't want to be the one to complete the destruction of the planet. After his death in May 2017, a profile credited him with “quietly saving the world” by not escalating the situation.

As it happens, Petrov was right — the mistake was a failure of the computer system to distinguish the sun's reflection off clouds from the light signatures relevant to a missile launch. Retaining a human mind in this decision-making loop may have saved mankind.

With increases in potential for decision-making based on artificial intelligence (AI), businesses face similar (though hopefully less consequential) questions about whether and when to remove humans from their decision-making processes.

There are no simple answers. As the 1983 incident demonstrates, a human can add value by scrutinizing a system's results before action. But long before that, people also had a foundational role in developing the algorithms underlying the classification system and selecting the data used to train and evaluate the efficacy of the resulting system. In this case, humans could have added more value by helping the classification system prevent
misclassification. Yet this training and development role doesn’t seem to make the news in the way that the intervention role does. We don’t know how many times nuclear warning systems operated amazingly well to keep from raising false alarms — we only know when they didn’t. People also add value by helping AI learn in the first place.

Before we humans get too cozy in these roles, we should be careful before extrapolating too much from this sample size of one. If humans are looking for justification for our continued involvement, the prevention of calamity is certainly valid. The resulting emotional appeal derived from an anecdote with unacceptable consequences ("think of the children!") is compelling. But as guidance for normal business practice, the scenario may not have much in common with the use of AI in modern business practices.

A lot has changed in 34 years. While far from perfect, there have been huge improvements in AI. Building off vast training data, prediction is much more accurate in many scenarios. Now, systems would be much less likely to misinterpret sunlight on high-altitude clouds as incoming missiles. In business, accuracy continues to improve in areas such as loan default risk, fraudulent credit card transactions, and even in less concrete (but important) decisions about potential performance of job candidates. AI continues to improve, and the clear advantage that humans once held is diminishing.

Additionally, most scenarios that businesses face are, I hope, not as consequential as nuclear counter-attack. In the prior examples, missteps will incur costs but are most likely recoverable. The repercussions of incorrect AI decisions may be far more tolerable.

One perspective to consider is: If the machines ruled the world, when would they want our assistance? In the nuclear attack scenario, the machines could predict — and identify as a negative, an unwanted outcome — the prospect of worldwide destruction. They would want our help to prevent it. We can gain insight into if and when to remove humans from an AI decision-making loop by thinking about when machine overlords would still want to retain our help to improve their decision-making.

With immature AI, the machines would recognize their own areas of inaccuracy and request our help. For example, if there are insufficient observations, humans can likely build off our breadth of experience to infer lessons from other cases in ways that machines cannot (yet). Classification does not have to be binary (missile or no missile); systems can request human help when uncertain.

When instantaneous decisions are required, there may not be time to involve humans. But business decisions often differ considerably from other AI applications like robots and self-guiding machines. While the pace of business may be ever-accelerating, many business decisions still have time for a second opinion where human general knowledge of context can add value. AI can continue to learn by asking humans to corroborate (when time allows) or by asking for additional training to correct errors (when time does not allow).

Machines may also need our help when we know the data that we’ve trained them on is imperfect. Our knowledge of the data provenance may help the machines understand their limits. We may also understand more about the underlying biases (such as sexism or racism) embedded in the “right” answers in training data that we
I’d like to work to correct. But as demonstrated by the recent success of AlphaGo Zero at training itself and creating its own algorithms, human roles may be diminishing here as well, particularly for narrow tasks.

I’m glad Stanislav Petrov was a human in the loop in 1983. For now, at least, human involvement is still needed in developing AI decision-making capabilities, particularly for initial development and training. As AI progresses, we will gain a better understanding of where humans can and cannot add value.

**About the Author**

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Could AI Be the Cure for Workplace Gender Inequality?

MEGAN BECK AND BARRY LIBERT

Artificial intelligence is beginning to replace many of the workplace roles that men dominate. The parts of those jobs that will have staying power are those that rely more heavily on emotional intelligence — skills in which women typically excel.

Many researchers are reporting, and our research confirms, that artificial intelligence (AI) will reshape our economy — and the roles of workers and leaders along with it. Jobs that don’t disappear will see a significant shift as the tasks that are easily and inexpensively accomplished by robots become automated. The work that remains will very likely focus on relating. To adapt and prosper, the smart worker will invest in “human relating” skills — empathy, compassion, influence, and engagement. For simplicity, let’s call these emotional quotient (EQ) skills. These are skills in which women commonly excel.

Gender differences are a sensitive topic and we address them in this article with trepidation. There is a fine line between understanding commonalities and stereotyping, and the debate about nature versus nurture is robust. But whether you believe that men and women, on average, have different types of brains (as Simon Baron-Cohen, a British clinical psychologist and professor of developmental psychopathology at the University of Cambridge, has theorized) or that gender differences are a result of cultural norms and conditioning (as numerous other studies have explored), the real-world results are similar: Men and women, on average, excel in different dimensions and take on different roles in the workforce. By no means does that suggest that men and women are not equal — just different.

It is clear that men have quite an advantage in the working world — just check out the latest research by McKinsey & Co. on gender equality in the workplace.
Men have greater representation among leadership roles, greater presence in higher-paid industries, hold nearly 80% of board seats, and earn higher compensation on average, even for the same jobs.

We believe that AI has the ability to help level the playing field. It will do so, we think, by replacing many roles and functions where men typically dominate.

**Jobs That Currently Demand High EQ Are Dominated by Women**

An examination of common occupations by gender in the U.S. by the Department of Labor reveals some unsurprising data. Women predominate in jobs that involve relating, caretaking, and providing services, making up more than 80% of the country’s school teachers, nurses and home health aides, social workers, and secretaries and administrative assistants. Men outweigh women in fields that tend to be physical, STEM- and finance- related, and more isolated rather than relational, such as truck drivers, janitors, laborers, and software developers. Men are also better represented in higher-paying, often analytical fields, such as law, medicine, and engineering.

One perspective on the ways that different skill sets play out at work is the empathizing-systemizing theory, which measures people's inclinations to empathize (identify, understand, and respond to the mental states of others) and to systemize (analyze, understand, and predict system). According to Baron-Cohen, the theory's author, women score higher on empathizing and men higher on systemizing. A recent Korn Ferry report aligns with this point of view: It found that women score higher than men on 11 out of 12 key emotional intelligence competencies. These include demonstrating empathy, conflict management, and coaching/mentoring.

**EQ Is Likely to Become a Critical Job Differentiator in More Roles**

Differences in current skills and roles mean that the evolving AI economy is going to affect men and women differently.

We all know that changes due to AI are imminent, and that some roles will likely disappear over the next decade. This will not be limited to any particular industry or pay grade. Robots will replace not only truck drivers and stock pickers, but also radiologists, consultants, and financial planners (all of which are traditionally male-dominated roles).

The jobs, or the parts of jobs, likely to have more staying power in the AI economy are those that rely more heavily on EQ — abilities such as empathy, persuasion, and inspiration. AI may determine that your radiology scans indicate cancer, but a human will likely sit down with you and help create a treatment plan that suits your goals and lifestyle. AI may suggest operational improvements within a company, but a human will be more effective at persuading the leadership team to tackle the problem. Chinese technologist Kal-Fu Lee predicts that AI will probably wipe out 50% of jobs within a decade, but adds that nothing can replace human-to-human interaction: “Touching one's heart with your heart is something that machines, I believe, will never be good at,” he told CNBC.
Research has suggested that these relating skills, where men lag women, will put men at a workplace disadvantage in the AI economy. They won’t be as successful as women unless they embrace these differentiator skills of empathizing, mentoring, and engagement.

**Three Steps to Prepare for the EQ Revolution**

Given this prognosis, all of us — men, women, and the organizations we work with — need to pay real attention to these often-neglected EQ skills.

Although we tend to think of relating skills as innate and static, this is incorrect. Just like any job skill, a person’s emotional intelligence can be improved with some effort. Here are three steps to get started:

1. **Figure out what you're working with.** What is your EQ baseline? Many sharp, effective people have low EQ but have no idea they need to improve because they simply haven’t paid attention to the subtle indicators from their peers. Most of us are very hesitant to criticize someone's interpersonal skills directly because such feedback can be perceived as an unwelcome critique. This means that you should **pay attention to couched feedback** you’ve been given, especially comments along the lines of, “You are difficult to work with,” “You are too argumentative,” “You need to do a better job ‘reading the room.’”

2. **Admit to yourself the importance of EQ.** Emotional intelligence has been undervalued in the marketplace since...forever. Although every job has an EQ component, employees and managers are more often trained and assessed on “systemizing” skills — perhaps because they are simpler to measure. For example, doctors are well trained on identifying and treating disease. But they are not well trained on personalizing treatment to suit a patient’s preference and lifestyle, nor on influencing patients to take steps such as changing diet or exercise. If you want to grow your EQ, you must first change your mental model about what is important in your work. Is getting the diagnosis right the most important measure of success? Or is it actually improving someone's health? Recognize that making an impact on the world almost always involves human interaction.

3. **Practice and train your EQ.** Research shows that attention and training programs can affect one's emotional intelligence. Identify the parts of your job that allow you to practice understanding, coaching, encouraging, and influencing others — these are the parts of your role likely to persist over the next decade — and direct your energy to these interpersonal opportunities. Find a coach who will give you honest feedback and mentoring, or find a training program. We naturally take these steps with many job skills, but are hesitant to do so with EQ for two reasons: None of us want to admit our EQ needs work, and we have the idea that our EQ is inborn and unchangeable. We are wrong on both accounts.

Whether it is genes or training that inclines women to empathize, relate, and engage more than men is irrelevant. As AI-based tools become integrated into roles across levels and industries, these “soft” skills will become more important for earning hard dollars.

Companies and organizations need to be aware of this shift in job skills, as it will affect hiring, managing, and training employees. Those who can't adjust will see their skills become irrelevant, from the boardroom to the
manufacturing floor. There are many things that people will not be able to do as effectively as the robots that are moving into our workplaces, so it’s time to focus on what people can do best — understanding and relating to each other.

**About the Authors**

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How to Thrive — and Survive — in a World of AI Disruption

ERIK BRYNJOLFSSON

The challenge we face today is not a “world without work” but a world with rapidly changing work.

The pace of progress in AI and machine learning is accelerating rapidly. In the past month alone, these are just a few of the news items I’ve seen:

• DeepMind Technologies Ltd. in London, U.K., has developed a system to scan 1 million images from eye scans and is training itself to spot early signs of degenerative eye conditions.

• Rethink Robotics Inc. of Boston, Massachusetts, founded by former MIT AI Lab director, Rodney Brooks, made massive upgrades to its Sawyer robots to help nonexperts program routines that instruct the robot how to carry out complex tasks.

• H&R Block’s tax preparers began using IBM’s Watson computer system to maximize customer deductions. Watson “knows” thousands of pages of federal tax code and will continually update changes as they occur.

• NuTonomy Inc. of Cambridge, Massachusetts, a startup developing self-driving cars based on technology from MIT, has launched a small fleet of autonomous taxis in Boston.

• Forward, a San Francisco, California, startup founded by Google’s former special projects director, is attempting to shift traditional health care away from immediate and reactive care procedures, to proactive care through the use of AI and wearable sensors.

Deep learning and neural networks have dramatically improved in effectiveness and impact, leading to human-level performance in many aspects of vision, conversational speech, and problem-solving. As a result,
industries are in the midst of a major transformation and more is on the way.

But there’s also a backlash brewing. Median income in America is lower now than in the past 15 years, and wealth is concentrated at the highest levels. As seen in the recent U.S. elections, there is dissatisfaction with the uneven distribution of the benefits of technological progress. IDE research bears out the chasms many are feeling.

Rumblings about robots replacing more and more human work have been heating up — with legitimate concerns. In 2014 when I published The Second Machine Age with Andrew McAfee, we anticipated much of this progress, but the pace has accelerated beyond expectations. This isn’t the first time automation has transformed factories, of course, but with today’s robust AI technologies, automation is starting to creep into fields that require less repetitive manual labor and once seemed immune to this shift, such as law, education, and journalism. Today’s advances are augmenting human minds, not just muscles.

In the midst of all these wonders, it is important to remember that there’s no shortage of important work that can be done only by humans. And that will remain true for many years. The challenge we face today is not a “world without work” but a world with rapidly changing work. The response, then, isn’t simply replacing income for workers being displaced by technology, but preparing them to do new jobs that are desperately needed in education, health care, infrastructure, environmental cleanup, entrepreneurship, innovation, scientific discovery, and many other areas.

How? Too many business and labor leaders, as well as politicians, have become complacent. They fear a future that will disrupt current models and economies. But the solution to disruption isn’t to protect the past from the future or to freeze the old ways of doing things. That’s guaranteed to fail. The best path forward is to adopt emerging tools and models that not only create goods and services but overall prosperity.

Developing AI products and services in a timely, competitive way, doesn’t have to conflict with deploying — and re-deploying — the workforce. Instead of thinking of AI as a zero-sum game, or a way to automate existing jobs and services, forward-thinking executives recognize that technology adds value by expanding jobs and boosting productivity. When technology complements human workers, makes them more productive, and also cuts costs, businesses and employees are better off.

Remember that historically, technology has both destroyed and created jobs. We need to shift today’s conversation more toward job-creation solutions where automation is more than just replacing current labor with capital investments.

Two examples from the IDE’s 2016 Inclusive Innovation Challenge illustrate how this might be done: At 99Degrees Custom Inc., based in Lawrence, Massachusetts, regional “speed factories” use robotics and lean and agile development tactics to help the young apparel company respond to demand, reduce inventory, and innovate ahead of competitors. At the same time, it trains a skilled, local workforce, pays better wages, and invests in the career advancement of its workers.

In a very different case, the giant German software company, SAP, launched Africa Code Week two years ago to empower young Africans with coding skills. Last year, more than 430,000 youth in 30 countries in Africa and
four countries in the Middle East took part in Africa Code Week and Refugee Code Week. SAP says that in the long term, the effort will “help close the information and communication technology skills gap in the regions,” spurring economic growth and stability. It is also an integral part of SAP’s vision to help improve people’s lives.

There are many approaches to thriving in the evolving AI world, but all require determination and resourcefulness. Some efforts might focus on areas where humans still have the advantage over machines — intangible characteristics and interpersonal skills such as creativity, empathy, teamwork, planning, problem-solving, and leadership. Others might build sensor-based systems to help us reduce energy use through greater efficiency and lower cooling bills, or to enrich our cultural life. All are part of what 20th century economist Joseph Schumpeter called “creative destruction.”

The emerging AI future will be a far cry from today’s business as usual — but it doesn’t have to be a time of panic. With a clear commitment to sharing the prosperity of the digital economy, and with confident investments in a rapidly emerging future, the next few decades will be the best in human history, for the many, not just the few.

About the Author

Erik Brynjolfsson is the Schussel Family Professor of Management Science at the MIT Sloan School of Management and Director of the MIT Initiative on the Digital Economy. MIT IDE hosted the AI and Machine Learning Disruption Timeline Conference on March 8, 2017, to showcase these emerging technologies and demonstrate their potential. The Disruption Timeline Conference will bring together leaders from industry, academia, and government to tackle some of the tough challenges associated with AI and to debate what the future may hold.
What to Expect From Artificial Intelligence

To understand how advances in artificial intelligence are likely to change the workplace — and the work of managers — you need to know where AI delivers the most value.

BY AJAY AGRAWAL, JOSHUA S. GANS, AND AVI GOLDFARB

Major technology companies such as Apple, Google, and Amazon are prominently featuring artificial intelligence (AI) in their product launches and acquiring AI-based startups. The flurry of interest in AI is triggering a variety of reactions — everything from excitement about how the capabilities will augment human labor to trepidation about how they will eliminate jobs. In our view, the best way to assess the impact of radical technological change is to ask a fundamental question: How does the technology reduce costs? Only then can we really figure out how things might change.

To appreciate how useful this framing can be, let’s review the rise of computer technology through the same lens. Moore’s law, the long-held view that the number of transistors on an integrated circuit doubles approximately every two years, dominated information technology until just a few years ago. What did the semiconductor revolution reduce the cost of? In a word: arithmetic.

This answer may seem surprising since computers have become so widespread. We use them to communicate, play games and music, design buildings, and even produce art. But deep down, computers are souped-up calculators. That they appear to do more is testament to the power of arithmetic. The link between computers and arithmetic was clear in the early days, when computers were primarily used for censuses and various military applications. Before semiconductors, “computers” were humans who were employed to do arithmetic problems. Digital computers made arithmetic inexpensive, which eventually resulted in thousands of new applications for everything from data storage to word processing to photography.

AI presents a similar opportunity: to make something that has been comparatively expensive abundant and cheap. The task that AI makes abundant and inexpensive is prediction — in other words, the ability to take information you have and generate information you didn’t previously have. In this article, we will demonstrate how improvement in AI is linked to advances in prediction. We will explore how AI can help us solve problems that were not previously prediction oriented, how the value of some human skills will rise while others fall, and what the implications are for managers. Our speculations are informed by how technological change has affected the cost of previous tasks, allowing us to anticipate how AI may affect what workers and managers do.

Machine Learning and Prediction

The recent advances in AI come under the rubric of what’s known as “machine learning,” which involves programming computers to learn from example data or past experience. Consider, for example, what it takes to identify objects in a basket of groceries. If we could describe how an apple looks, then we could program a computer to recognize apples based on their color and shape. However, there are other objects that are apple-like in both color and shape. We could continue encoding our knowledge of
apples in finer detail, but in the real world, the amount of complexity increases exponentially.

Environments with a high degree of complexity are where machine learning is most useful. In one type of training, the machine is shown a set of pictures with names attached. It is then shown millions of pictures that each contain named objects, only some of which are apples. As a result, the machine notices correlations — for example, apples are often red. Using correlates such as color, shape, texture, and, most important, context, the machine references information from past images of apples to predict whether an unidentified new image it’s viewing contains an apple.

When we talk about prediction, we usually mean anticipating what will happen in the future. For example, machine learning can be used to predict whether a bank customer will default on a loan. But we can also apply it to the present by, for instance, using symptoms to develop a medical diagnosis (in effect, predicting the presence of a disease). Using data this way is not new. The mathematical ideas behind machine learning are decades old. Many of the algorithms are even older. So what has changed?

Recent advances in computational speed, data storage, data retrieval, sensors, and algorithms have combined to dramatically reduce the cost of machine learning-based predictions. And the results can be seen in the speed of image recognition and language translation, which have gone from clunky to nearly perfect. All this progress has resulted in a dramatic decrease in the cost of prediction.

**The Value of Prediction**

So how will improvements in machine learning impact what happens in the workplace? How will they affect one’s ability to complete a task, which might be anything from driving a car to establishing the price for a new product? Once actions are taken, they generate outcomes. (See “The Anatomy of a Task.”) But actions don’t occur in a vacuum. Rather, they are shaped by underlying conditions. For example, a driver’s decision to turn right or left is influenced by predictions about what other drivers will do and what the best course of action may be in light of those predictions.

Seen in this way, it’s useful to distinguish between the cost versus the value of prediction. As we have noted, advances in AI have reduced the cost of prediction. Just as important is what has happened to the value. Prediction becomes more valuable when data is more widely available and more accessible. The computer revolution has enabled huge increases in both the amount and variety of data. As data availability expands, prediction becomes increasingly possible in a wider variety of tasks.

Autonomous driving offers a good example. The technology required for a car to accelerate, turn, and brake without a driver is decades old. Engineers initially focused on directing the car with what computer scientists call “if then else” algorithms, such as “If an object is in front of the car, then brake.” But progress was slow; there were too many possibilities to codify everything. Then, in the early 2000s, several research groups pursued a useful insight: A vehicle could drive autonomously by predicting what a human driver would do in response to a set of inputs (inputs that, in the vehicle’s case, could come from camera images, information using the laser-based measurement method known as LIDAR, and mapping data). The recognition that autonomous driving was a prediction problem solvable with machine learning meant that autonomous vehicles could start to become a reality in the marketplace years earlier than had been anticipated.

**Who Judges?**

Judgment is the ability to make considered decisions — to understand the impact different actions will have on outcomes in light of predictions. Tasks where the desired outcome can be easily described and there is limited need for human judgment are generally easier to automate. For other tasks, describing a precise outcome can be more difficult, particularly when the desired outcome resides in the minds of humans and cannot be translated into something a machine can understand.

This is not to say that our understanding of human judgment won’t improve and therefore become subject to automation. New modes of machine learning may find ways to examine the relationships between actions and outcomes, and then use the information to improve predictions. We saw an example of this in 2016, when AlphaGo, Google’s DeepMind artificial intelligence program, succeeded in beating one of the top players in the world in the game of Go. AlphaGo honed its capability by analyzing thousands of human-to-human Go games and playing against
In cases where whole decisions can be clearly defined with an algorithm, we expect to see computers replace humans. This will take longer in areas where judgment can’t be easily described, although as the cost of prediction falls, the number of such tasks will decline.

**Employing Prediction Machines**

Major advances in prediction may facilitate the automation of entire tasks. This will require machines that can both generate reliable predictions and rely on those predictions to determine what to do next. For example, for many business-related language translation tasks, the role of human judgment will become limited as prediction-driven translation improves (though judgment might still be important when translations are part of complex negotiations). However, in other contexts, cheaper and more readily available predictions could lead to increased value for human-led judgment tasks. For instance, Google’s Inbox by Gmail can process incoming email messages and propose several short responses, but it asks the human judge which automated response is the most appropriate. Selecting from a list of choices is faster than typing a reply, enabling the user to respond to more emails in less time.

Medicine is an area where AI will likely play a larger role — but humans will still have an important role, too. Although artificial intelligence can improve diagnosis, which is likely to lead to more effective treatments and better patient care, treatment and care will still rely on human judgment. Different patients have different needs, which humans are better able to respond to than machines. There are many situations where machines may never be able to weigh the relevant pros and cons of doing things one way as opposed to another way in a manner that is acceptable to humans.

**The Managerial Challenge**

As artificial intelligence technology improves, predictions by machines will increasingly take the place of predictions by humans. As this scenario unfolds, what roles will humans play that emphasize their strengths in judgment while recognizing their limitations in prediction? Preparing for such a future requires considering three interrelated insights:

1. **Prediction is not the same as automation.** Prediction is an input in automation, but successful automation requires a variety of other activities. Tasks are made up of data, prediction, judgment, and action. Machine learning involves just one component: prediction. Automation also requires that machines be involved with data collection, judgment, and action. For example, autonomous driving involves vision (data); scenarios given sensory inputs, what action would a human take? (prediction); assessment of consequences (judgment); and acceleration, braking, and steering (action). Medical care can involve information about the patient’s condition (data); diagnostics (prediction); treatment choices (judgment); bedside manner (judgment and action); and physical intervention (action). Prediction is the aspect of automation in which the technology is currently improving especially rapidly, although sensor technology (data) and robotics (action) are also advancing quickly.

2. **The most valuable workforce skills involve judgment.** In many work activities, prediction has been the bottleneck to automation. In some activities, such as driving, this bottleneck has meant that human workers have remained involved in prediction tasks. Going forward, such human involvement is all but certain to diminish. Instead, employers will want workers to augment the value of
The future’s most valuable skills will be those that are complementary to prediction — in other words, those related to judgment.

Prediction; the future’s most valuable skills will be those that are complementary to prediction — in other words, those related to judgment. Consider this analogy: The demand for golf balls rises if the price of golf clubs falls, because golf clubs and golf balls are what economists call complementary goods. Similarly, judgment skills are complementary to prediction and will be in greater demand if the price of prediction falls due to advances in AI. For now, we can only speculate on which aspects of judgment are apt to be most vital: ethical judgment, emotional intelligence, artistic taste, the ability to define tasks well, or some other forms of judgment. However, it seems likely that organizations will have continuing demand for people who can make responsible decisions (requiring ethical judgment), engage customers and employees (requiring emotional intelligence), and identify new opportunities (requiring creativity).

Judgment-related skills will be increasingly valuable in a variety of settings. For example, if prediction leads to cheaper, faster, and earlier diagnosis of diseases, nursing skills related to physical intervention and emotional comfort may become more important. Similarly, as AI becomes better at predicting shopping behavior, skilled human greeters at stores may help differentiate retailers from their competitors. And as AI becomes better at anticipating crimes, private security guards who combine ethical judgment with policing skills may be in greater demand. The part of a task that requires human judgment may change over time, as AI learns to predict human judgment in a particular context. Thus, the judgment aspect of a task will be a moving target, requiring humans to adapt to new situations where judgment is required.

3. Managing may require a new set of talents and expertise.

Today, many managerial tasks are predictive. Hiring and promoting decisions, for example, are predicated on prediction: Which job applicant is most likely to succeed in a particular role? As machines become better at prediction, managers’ prediction skills will become less valuable while their judgment skills (which include the ability to mentor, provide emotional support, and maintain ethical standards) become more valuable.

Increasingly, the role of the manager will involve determining how best to apply artificial intelligence, by asking questions such as: What are the opportunities for prediction? What should be predicted? How should the AI agent learn in order to improve predictions over time? Managing in this context will require judgment both in identifying and applying the most useful predictions, and in being able to weigh the relative costs of different types of errors. Sometimes there will be well-acknowledged objectives (for example, identifying people from their faces). Other times, the objective will be less clear and therefore require judgment to specify the desired outcome. In such cases, managers’ judgment will become a particularly valuable complement to prediction technology.

Looking Ahead

At the dawn of the 21st century, the most common prediction problems in business were classic statistical questions such as inventory management and demand forecasting. However, over the last 10 years, researchers have learned that image recognition, driving, and translation may also be framed as prediction problems. As the range of tasks that are recast as prediction problems continues to grow, we believe the scope of new applications will be extraordinary. The key challenges for executives will be (1) shifting the training of employees from a focus on prediction-related skills to judgment-related ones; (2) assessing the rate and direction of the adoption of AI technologies in order to properly time the shifting of workforce training (not too early, yet not too late); and (3) developing management processes that build the most effective teams of judgment-focused humans and prediction-focused AI agents.

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