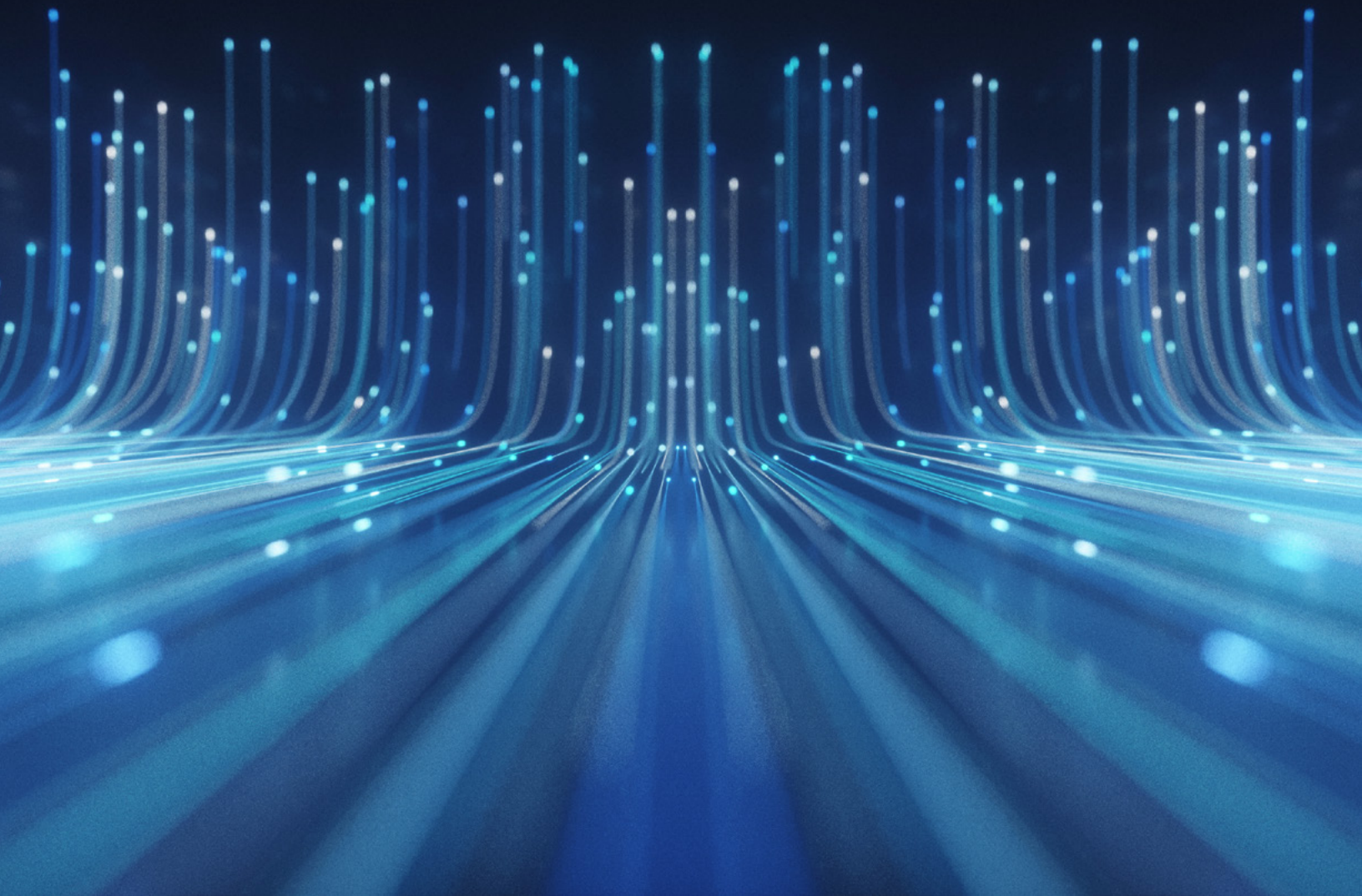


The state of AI in 2022—and a half decade in review

December 2022



The results of this year's McKinsey Global Survey on AI show the expansion of the technology's use since we began tracking it five years ago, but with a nuanced picture underneath.¹ Adoption has more than doubled since 2017, though the proportion of organizations using AI has plateaued between 50 and 60 percent for the past few years. A set of companies seeing the highest financial returns from AI continue to pull ahead of competitors. The results show these leaders making larger investments in AI, engaging in increasingly advanced practices known to enable scale and faster AI development, and showing signs of faring better in the tight market for AI talent. On talent, for the first time, we looked closely at AI hiring and upskilling. The data show that there is significant room to improve diversity on AI teams, and, consistent with other studies, diverse teams correlate with outstanding performance.

Five years in review: AI adoption, impact, and spend

This marks the fifth consecutive year we've conducted research globally on AI's role in business, and we have seen shifts over this period.

First, AI adoption has more than doubled.² In 2017, 20 percent of respondents reported adopting AI in at least one business area, whereas today, that figure stands at 50 percent, though it peaked higher in 2019 at 58 percent.

Meanwhile, the average number of AI capabilities that organizations use, such as natural-language generation and computer vision, has also doubled—from 1.9 in 2018 to 3.8 in 2022. Among these

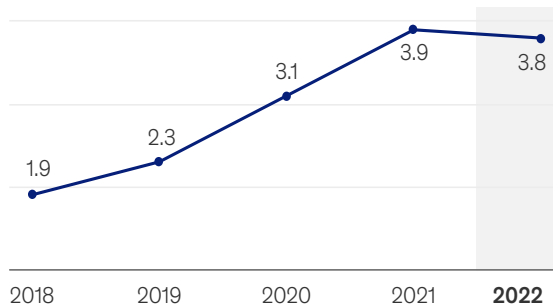
¹ In the survey, we defined AI as the ability of a machine to perform cognitive functions that we associate with human minds (for example, natural-language understanding and generation) and to perform physical tasks using cognitive functions (for example, physical robotics, autonomous driving, and manufacturing work).

² In 2017, the definition for AI adoption was using AI in a core part of the organization's business or at scale. In 2018 and 2019, the definition was embedding at least one AI capability in business processes or products. In 2020, 2021, and 2022, the definition was that the organization has adopted AI in at least one function.

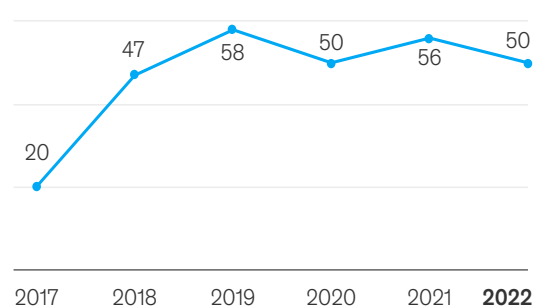
capabilities, robotic process automation and computer vision have remained the most commonly deployed each year, while natural-language text understanding has advanced from the middle of the pack in 2018 to the front of the list just behind computer vision.

Responses show an increasing number of AI capabilities embedded in organizations over the past five years.

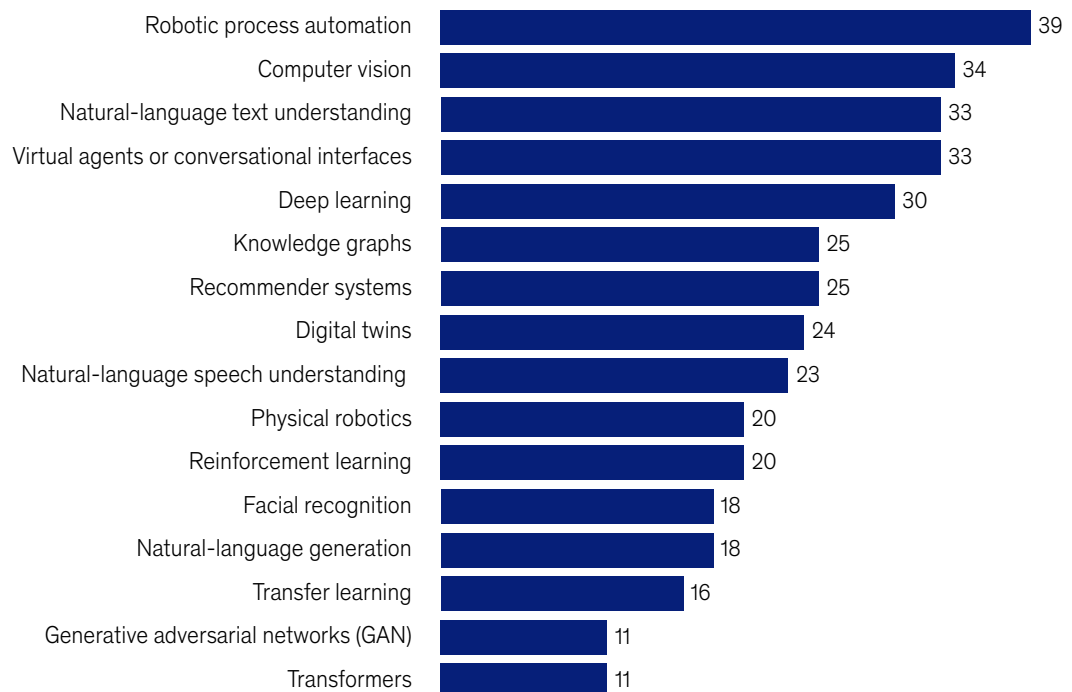
Average number of AI capabilities that respondents' organizations have embedded within at least one function or business unit¹



Share of respondents who say their organizations have adopted AI in at least one function, %



% of respondents who say given AI capability is embedded in products or business processes in at least one function or business unit²



¹ The number of capabilities included in the survey has grown over time, from 9 in 2018 to 15 in the 2022 survey.

² Question was asked only of respondents who said their organizations have adopted AI in at least one function.

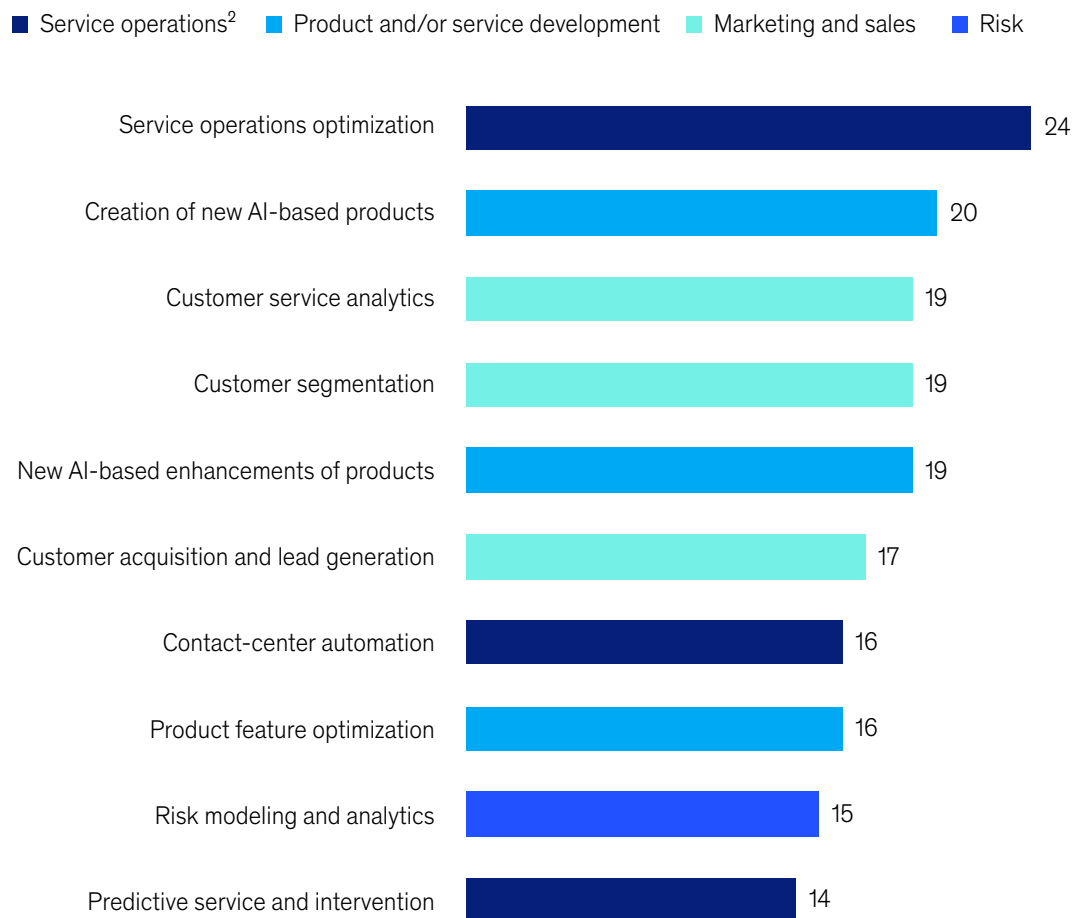
The top use cases, however, have remained relatively stable: optimization of service operations has taken the top spot each of the past four years.

Second, the level of investment in AI has increased alongside its rising adoption. For example, five years ago, 40 percent of respondents at organizations using AI reported more than 5 percent of their digital budgets went to AI, whereas now more than half of respondents report that level of investment. Going forward, 63 percent of respondents say they expect their organizations' investment to increase over the next three years.

The most popular AI use cases span a range of functional activities.



Most commonly adopted AI use cases, by function, % of respondents¹



¹ Out of 39 use cases. Question was asked only of respondents who said their organizations have adopted AI in at least one function.

² Eg, field services, customer care, back office.

The most popular AI use cases span a range of functional activities.

Top use cases

Use cases by function

Most commonly adopted AI use cases within each business function, % of respondents¹

Service operations²



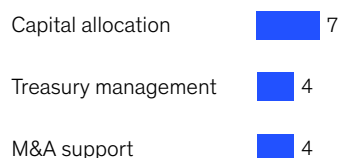
Marketing and sales



Risk



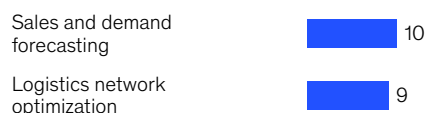
Strategy and corporate finance



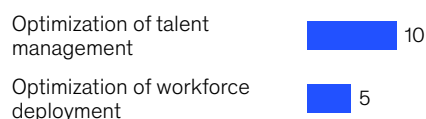
Product and/or service development



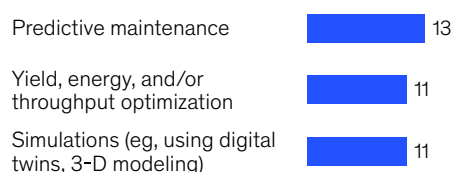
Supply chain management



Human resources



Manufacturing



¹ Question was asked only of respondents who said their organizations have adopted AI in at least one function.

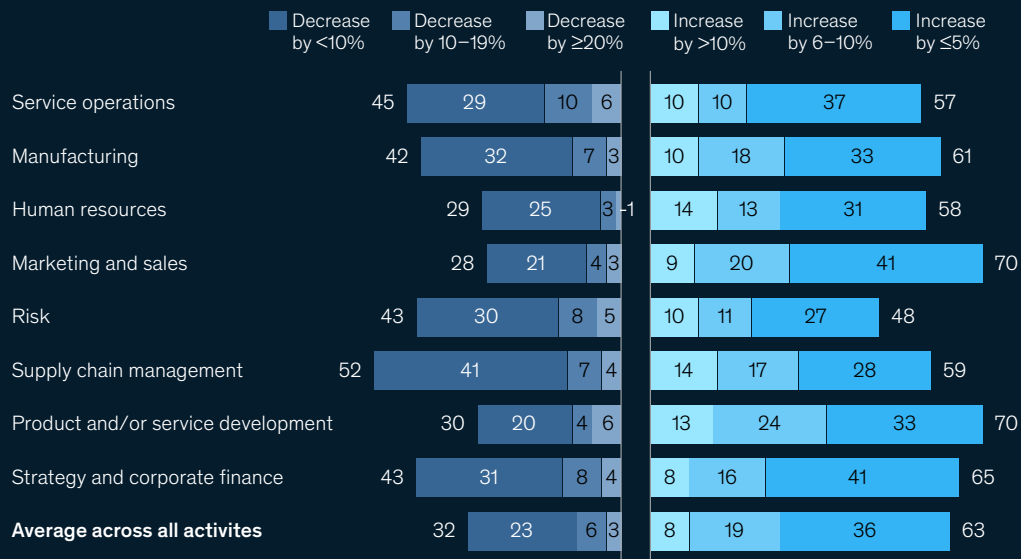
² Eg, field services, customer care, back office.

Third, the specific areas in which companies see value from AI have evolved. In 2018, manufacturing and risk were the two functions in which the largest shares of respondents reported seeing value from AI use. Today, the biggest reported revenue effects are found in marketing and sales, product and service development, and strategy and corporate finance, and respondents report the highest cost benefits from AI in supply chain management. The bottom-line value realized from AI remains strong and largely consistent. About a quarter of respondents report this year that at least 5 percent of their organizations' EBIT was attributable to AI in 2021, in line with findings from the previous two years, when we've also tracked this metric.

Lastly, one thing that has remained concerningly consistent is the level of risk mitigation organizations engage in to bolster digital trust. While AI use has increased, there have been no substantial increases in reported mitigation of any AI-related risks from 2019—when we first began capturing this data—to now.

AI-related cost decreases are most often reported in supply chain management and revenue increases in product development and marketing and sales.

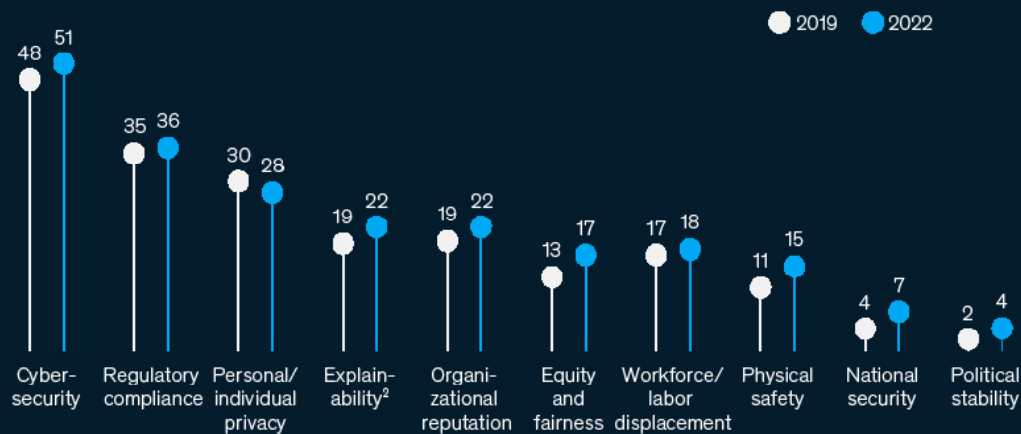
Cost decrease and revenue increase from AI adoption in 2021, by function, % of respondents¹



¹Question was asked only of respondents who said their organizations have adopted AI in a given function. Respondents who said "no change," "cost increase," "not applicable," or "don't know" are not shown.

There has been no substantial increase in organizations' reported mitigation of AI-related risks.

AI risks that organizations consider relevant and are working to mitigate, % of respondents¹



¹Question was asked only of respondents who said their organizations had adopted AI in at least one function; n = 1,151. Respondents who said "don't know/not applicable" are not shown.

²That is, the ability to explain how AI models come to their decisions.



McKinsey commentary

Michael Chui

Partner, McKinsey Global Institute

Over the past half decade, during which we've been conducting our global survey, we have seen the "AI winter" turn into an "AI spring." However, after a period of initial exuberance, we appear to have reached a plateau, a course we've observed with other technologies in their early years of adoption. We might be seeing the reality sinking in at some organizations of the level of organizational change it takes to successfully embed this technology.

In our work, we've encountered companies that get discouraged because they went into AI thinking it would be a quick exercise, while those taking a longer view have made steady progress by transforming themselves into learning organizations that build their AI muscles over time. These companies gradually incorporate more AI capabilities and stand up increasingly more applications progressively faster and more easily thanks to lessons from past successes as well as failures. They not only invest more, but they also invest more wisely, with the goal of creating a veritable AI factory that enables them to incorporate more AI in more areas of the business, first in adjacent ones where some existing capabilities can be repurposed and then into entirely new ones.

There is, at a high level, an emerging playbook for getting maximum value from AI. Each year that we conduct our research, we see a group of leaders engaging in the types of practices that help execute AI successfully. It's paying off in the form of actual bottom-line impact at significant levels. We also see it every day as we guide others on their AI journeys. It's not easy work, but as has been the case with previous technologies, the gains will go to those who stay the course.

**Those taking a longer view
have made steady progress by
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learning organizations that build
their AI muscles over time.**

AI use and sustainability efforts

The survey findings suggest that many organizations that have adopted AI are integrating AI capabilities into their sustainability efforts and are also actively seeking ways to reduce the environmental impact of their AI use (exhibit). Of respondents from organizations that have adopted AI, 43 percent say their organizations are using AI to assist in sustainability efforts, and 40 percent say their organizations are working to reduce the environmental impact of their AI use by minimizing the energy used to train and run AI models. As companies that have invested more in AI and have more mature AI efforts than others, high performers are 1.4 times more likely than others to report AI-enabled sustainability efforts as well as to say their organizations are working to decrease AI-related emissions. Both efforts

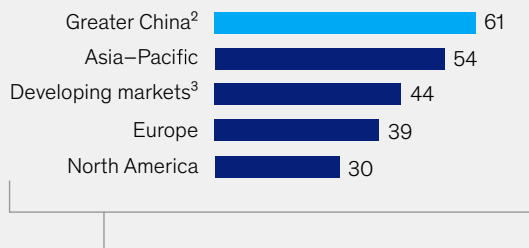
are more commonly seen at organizations based in Greater China, Asia–Pacific, and developing markets, while respondents in North America are least likely to report them.

When asked about the types of sustainability efforts using AI, respondents most often mention initiatives to improve environmental impact, such as optimization of energy efficiency or waste reduction. AI use is least common in efforts to improve organizations' social impact (for example, sourcing of ethically made products), though respondents working for North American organizations are more likely than their peers to report that use.

Exhibit

Organizations are using AI within sustainability efforts and are working to reduce the environmental impact of their AI use.

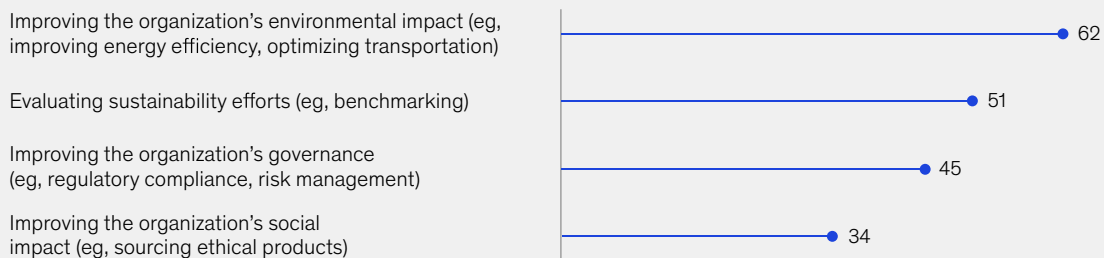
Organizations using AI in their sustainability efforts, % of respondents¹



Organizations taking steps to reduce carbon emissions from their AI use, % of respondents¹



Types of sustainability efforts in which respondents' organizations are using AI⁴



¹ Only asked of respondents whose organizations have adopted AI in at least one function. For organizations based in Greater China, n = 102; for Asia–Pacific, n = 74; for developing markets, n = 118; for Europe, n = 260; and for North America, n = 190.

² Includes respondents in Hong Kong SAR and Taiwan China.

³ Includes respondents in India, Latin America, Middle East, North Africa, and sub-Saharan Africa.

⁴ Only asked of respondents whose organizations have adopted AI in at least one function who said that their organizations are using AI in sustainability efforts; n = 302.

Mind the gap: AI leaders pulling ahead

Over the past five years, we have tracked the leaders in AI—we refer to them as AI high performers—and examined what they do differently. We see more indications that these leaders are expanding their competitive advantage than we find evidence that others are catching up.

First, we haven't seen an expansion in the size of the leader group. For the past three years, we have defined AI high performers as those organizations that respondents say are seeing the biggest bottom-line impact from AI adoption—that is, 20 percent or more of EBIT from AI use. The proportion of respondents falling into that group has remained steady at about 8 percent. The findings indicate that this group is achieving its superior results mainly from AI boosting top-line gains, as they're more likely to report that AI is driving revenues rather than reducing costs, though they do report AI decreasing costs as well.

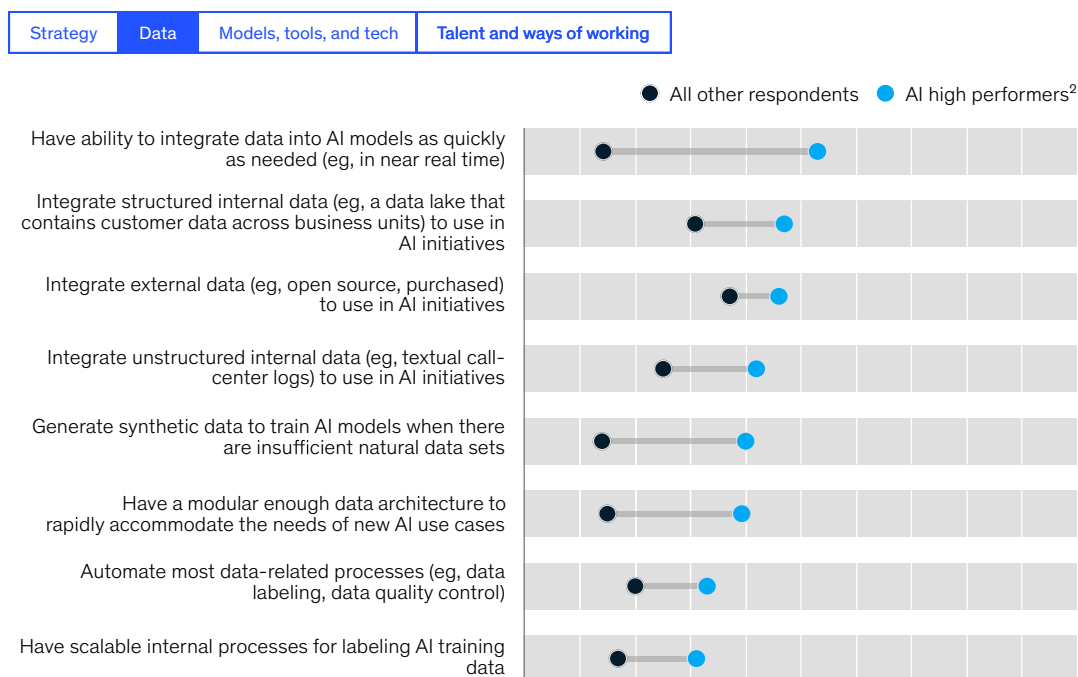
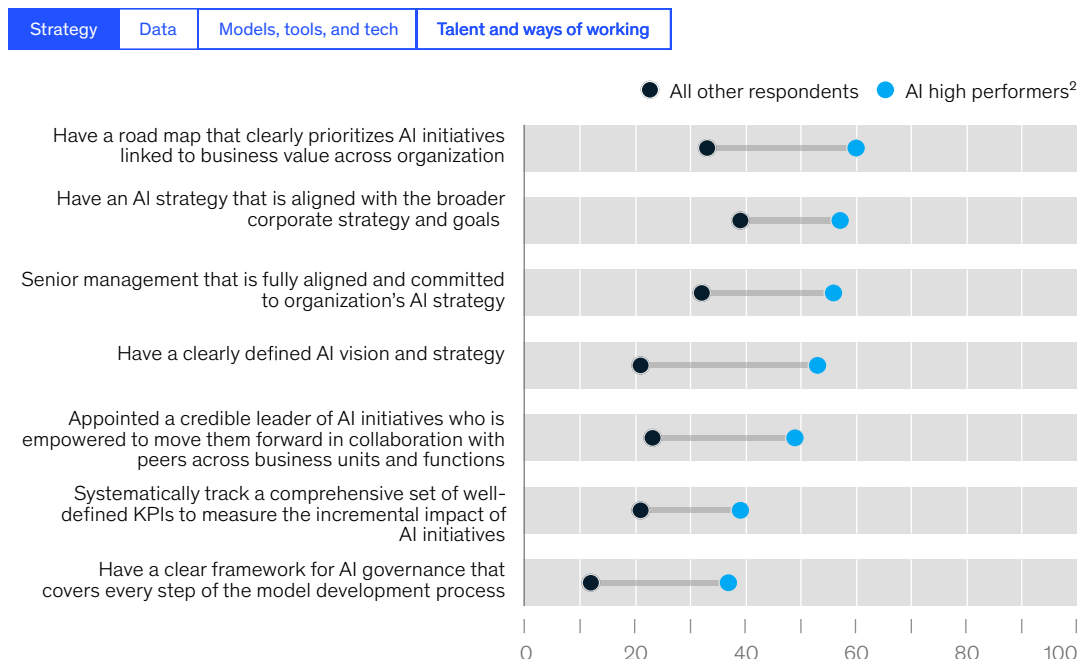
Next, high performers are more likely than others to follow core practices that unlock value, such as linking their AI strategy to business outcomes.³ Also important, they are engaging more often in “frontier” practices that enable AI development and deployment at scale, or what some call the “industrialization of AI.” For example, leaders are more likely to have a data architecture that is modular enough to accommodate new AI applications rapidly. They also often automate most data-related processes, which can both improve efficiency in AI development and expand the number of applications they can develop by providing more high-quality data to feed into AI algorithms. And AI high performers are 1.6 times more likely than other organizations to engage nontechnical employees in creating AI applications by using emerging low-code or no-code programs, which allow companies to speed up the creation of AI applications. In the past year, high performers have become even more likely than other organizations to follow certain advanced scaling practices, such as using standardized tool sets to create production-ready data pipelines and using an end-to-end platform for AI-related data science, data engineering, and application development that they've developed in-house.

High performers might also have a head start on managing potential AI-related risks, such as personal privacy and equity and fairness, that other organizations have not addressed yet. While overall, we have seen little change in organizations reporting recognition and mitigation of AI-related risks since we began asking about them four years ago, respondents from AI high performers are more likely than others to report that they engage in practices that are known to help mitigate risk. These include ensuring AI and data governance, standardizing processes and protocols, automating processes such as data quality control to remove errors introduced through manual work, and testing the validity of models and monitoring them over time for potential issues.

³All questions about AI-related strengths and practices were asked only of the 744 respondents who said their organizations had adopted AI in at least one function, n = 744.

Organizations seeing the highest returns from AI are more likely to follow strategy, data, models, tools, technology, and talent best practices.

Share of respondents reporting their organizations engage in each practice,¹ % of respondents

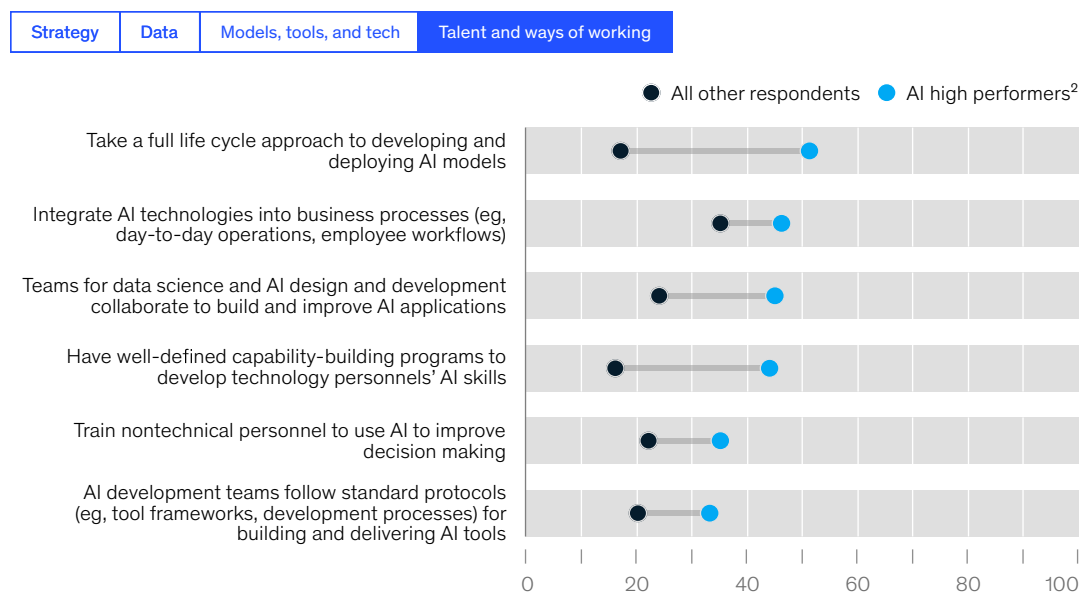
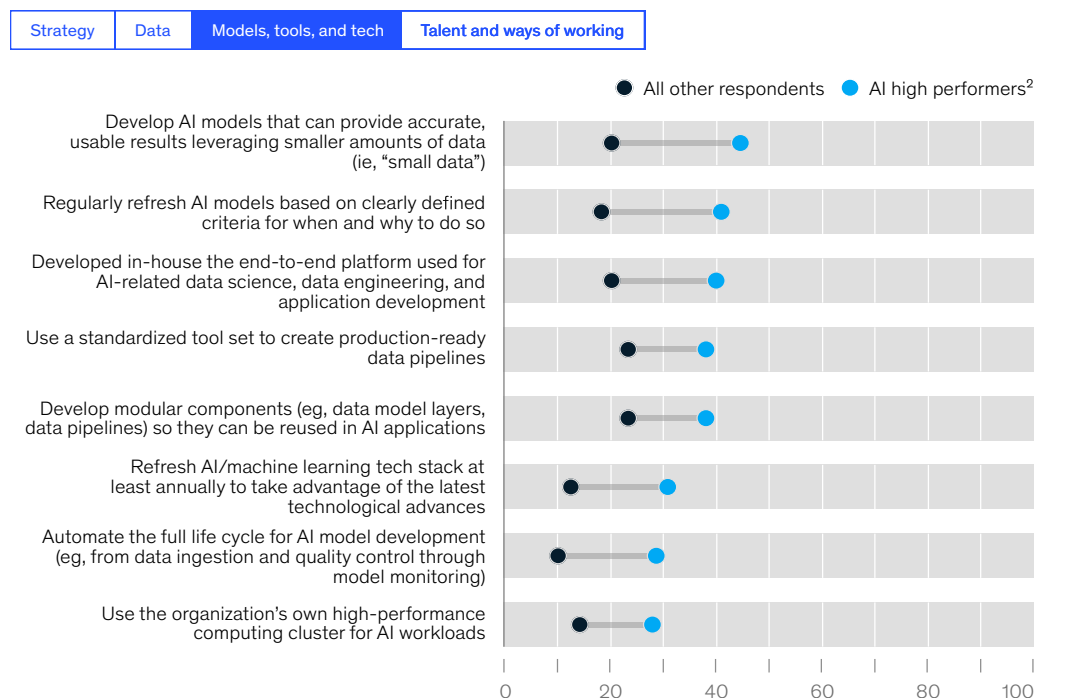


¹ Practices shown here are representative of those with the highest deltas between AI high performers and other respondents. Not all practices are shown.

² Respondents who said that at least 20 percent of their organizations' EBIT in 2021 was attributable to their use of AI.

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¹ Practices shown here are representative of those with the highest deltas between AI high performers and other respondents. Not all practices are shown.

² Respondents who said that at least 20 percent of their organizations' EBIT in 2021 was attributable to their use of AI.

Investment is yet another area that could contribute to the widening of the gap: AI high performers are poised to continue outspending other organizations on AI efforts. Even though respondents at those leading organizations are just as likely as others to say they'll increase investments in the future, they're spending more than others now, meaning they'll be increasing from a base that is a higher percentage of revenues. Respondents at AI high performers are nearly eight times more likely than their peers to say their organizations spend at least 20 percent of their digital-technology budgets on AI-related technologies. And these digital budgets make up a much larger proportion of their enterprise spend: respondents at AI high performers are over five times more likely than other respondents to report that their organizations spend more than 20 percent of their enterprise-wide revenue on digital technologies.

Finally, all of this may be giving AI high performers a leg up in attracting AI talent. There are indications that these organizations have less difficulty hiring for roles such as AI data scientist and data engineer. Respondents from organizations that are not AI high performers say filling those roles has been “very difficult” much more often than respondents from AI high performers do.

The bottom line: high performers are already well positioned for sustained AI success, improved efficiency in new AI development, and a resultingly more attractive environment for talent. The good news for organizations outside the leader group is that there's a clear blueprint of best practices for success.

Respondents at AI high performers are nearly eight times more likely than their peers to say their organizations spend at least 20 percent of their digital-technology budgets on AI-related technologies.



McKinsey commentary

Bryce Hall

Associate partner

Over the years of our research, we've continued to refine our understanding of the specific practices that leading companies are doing well and the capabilities they have in place to capture value from AI. Recently, a new set of “frontier” practices has emerged as organizations shift from experimenting with AI to industrializing it. These include machine learning operations (MLOps) practices such as assetization, or turning elements like code into reusable assets that can be applied over and over in different business applications.

But over the years, we've also consistently seen a set of foundational practices that these organizations are getting right. Through our work, we've learned not to describe these as “basic” practices, because they are some of the most difficult to implement. Many of these involve the people elements that need to be in place for companies to adopt AI successfully, such as having a clear understanding of what specific tech talent roles are needed and successfully integrating AI into business processes and decision making. As proven in many cases, AI engines and people together can create much more value than either can individually.

As the AI frontier advances, we continue to be inspired by some truly innovative applications of AI, such as the use of AI to identify new drugs, create hyperpersonalized recommendations for consumers, and power AI simulations in digital twins to optimize performance across a variety of settings. As individual AI capabilities, such as natural-language processing and generation, continue to improve and democratize, we're excited to see a wave of new applications emerge and more companies capture value from AI at scale.

AI talent tales: New hot roles, continued diversity woes

Our first detailed look at the AI talent picture signals the maturation of AI, surfaces the most common strategies organizations employ for talent sourcing and upskilling, and shines a light on AI's diversity problem—while showing yet again a link between diversity and success.

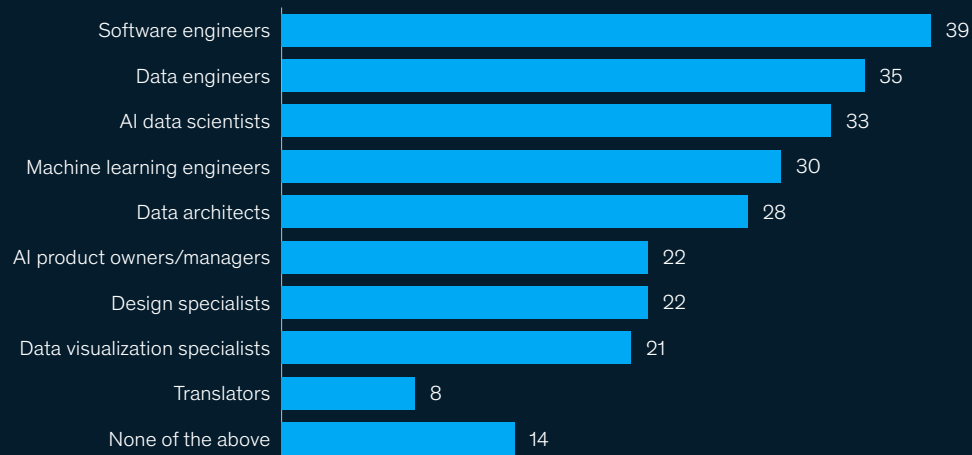
Hiring is a challenge, but less so for high performers

Software engineers emerged as the AI role that survey responses show organizations hired most often in the past year, more often than data engineers and AI data scientists. This is another clear sign that many organizations have largely shifted from experimenting with AI to actively embedding it in enterprise applications.

Unfortunately, the tech talent shortage shows no sign of easing, threatening to slow that shift for some companies. A majority of respondents report difficulty in hiring for each AI-related role in the

Responses suggest that organizations are most often hiring software engineers, data engineers, and AI data scientists.

AI-related roles that respondents' organizations hired, past year, % of respondents¹



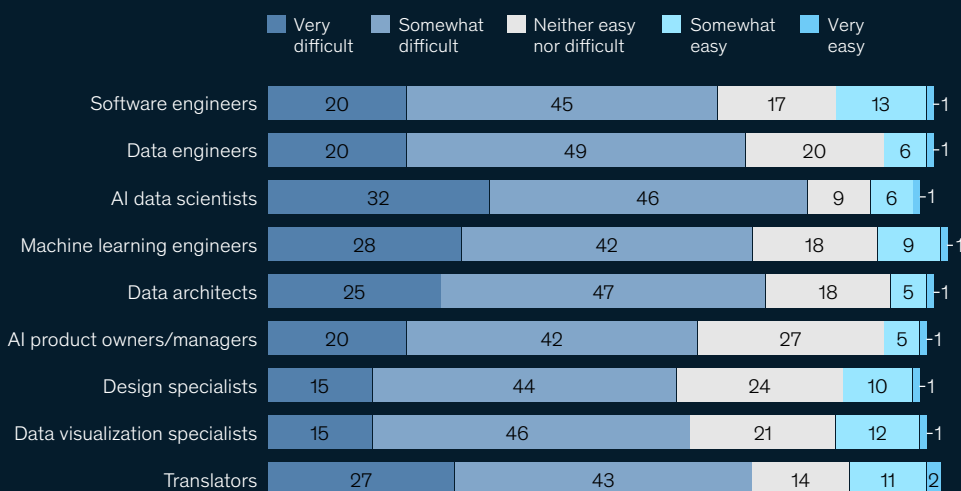
¹Only asked of respondents whose organizations have adopted AI in at least one function. For respondents at AI high performers, n = 51. For all other respondents, n = 413.

past year, and most say it either wasn't any easier or was more difficult to acquire this talent than in years past. AI data scientists remain particularly scarce, with the largest share of respondents rating data scientist as a role that has been difficult to fill, out of the roles we asked about.

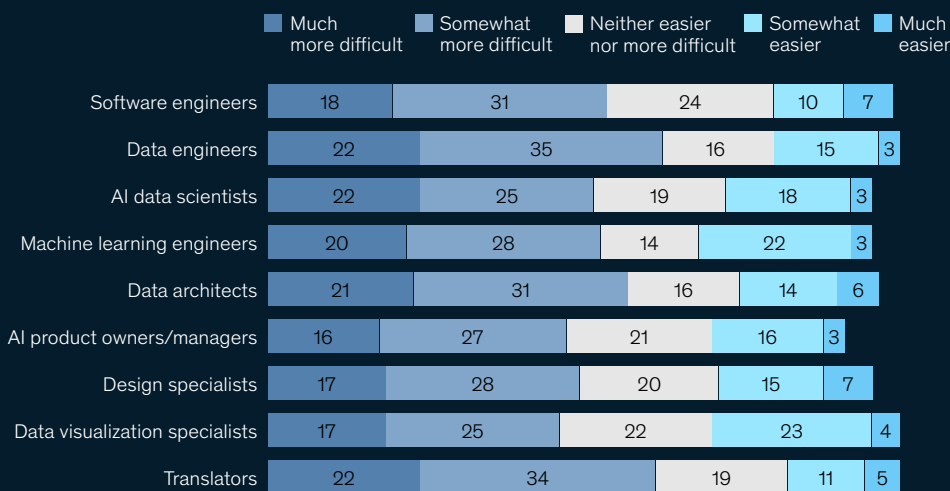
As mentioned earlier, we see some signs that AI high performers have a slightly easier time hiring than other organizations, but they still report difficulty more often than not. What's more evident from the survey findings is their focus on hiring for AI industrialization and business value optimization. For example, they're more than twice as likely to have hired a ML engineer in the past year—a role focused on optimizing the ML models built by data scientists for performance and scalability, as well as automating the machine learning pipeline, from data ingestion to prediction generation. Respondents at high performers are also nearly twice as likely as others to say they have hired an AI product manager to oversee AI application development and adoption and more than three times as likely to have hired an analytics translator, two roles that ensure that AI applications deliver business value.

Most respondents say that hiring for each AI-related role has been difficult in the past year and hasn't become easier over time.

Difficulty in organizations' hiring of AI-related roles, past year, % of respondents¹



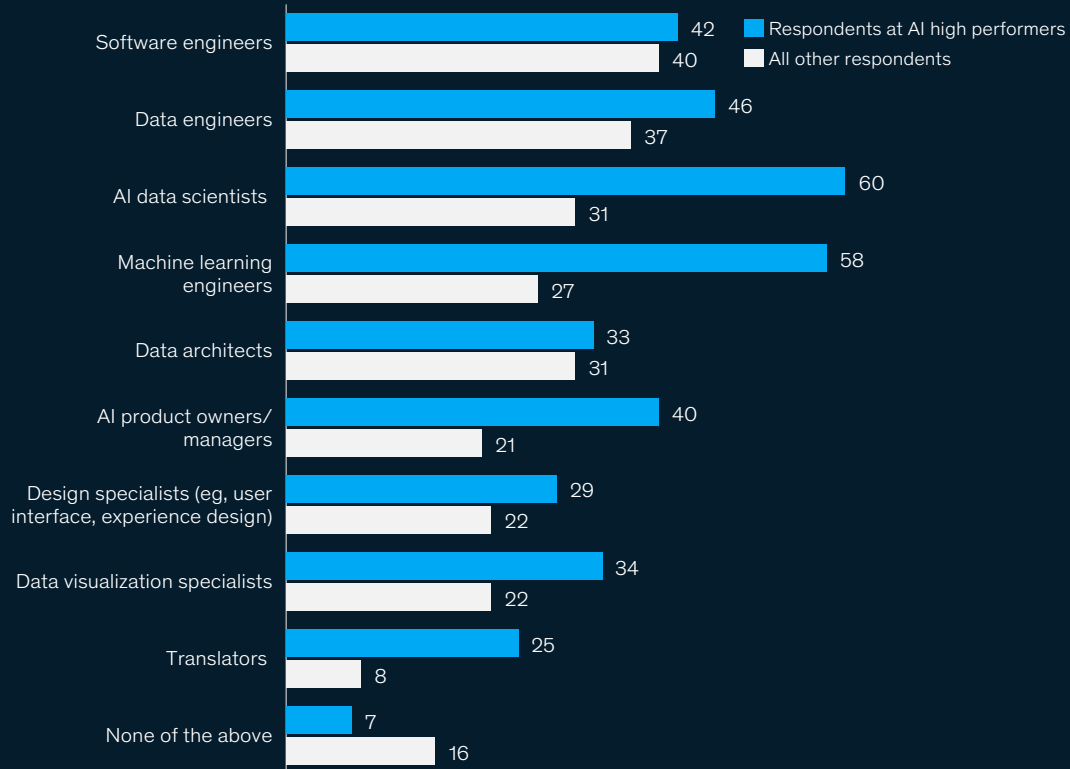
Change of difficulty in organizations' hiring of AI-related roles, past 3 years, % of respondents¹



¹Only asked of respondents whose organizations have adopted AI in at least one function. Figures do not sum to 100%, because respondents who said "don't know" are not shown.

AI high performers are much more likely than others to have hired AI data scientists, machine learning engineers, and translators in the past year.

AI-related roles that respondents' organizations hired, past year, % of respondents¹



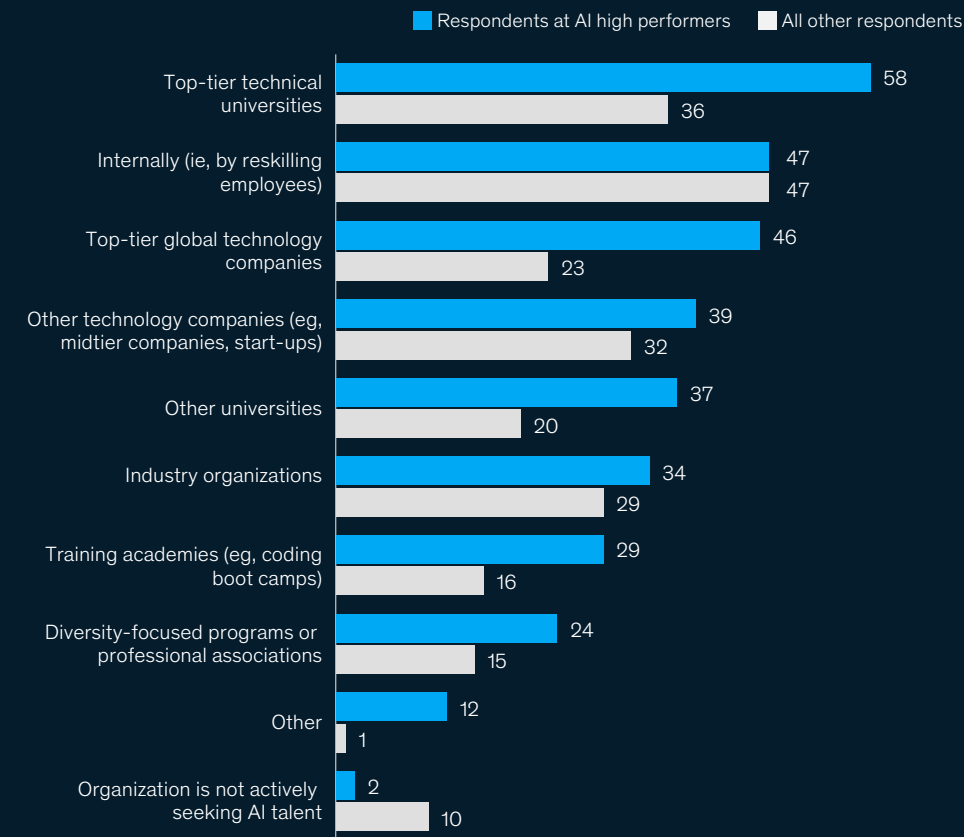
¹Only asked of respondents whose organizations have adopted AI in at least one function. For respondents at AI high performers, n = 51. For all other respondents, n = 413.

Reskilling and upskilling are common alternatives to hiring

When it comes to sourcing AI talent, the most popular strategy among all respondents is reskilling existing employees. Nearly half are doing so. Recruiting from top-tier universities as well as from technology companies that aren't in the top tier, such as regional leaders, are also common strategies. But a look at the strategies of high performers suggests organizations might be best served by tapping as many recruiting channels as possible. These companies are doing more than others to recruit AI-related talent from various sources. The findings show that while they're more likely to recruit from top-tier technical universities and tech companies, they're also more likely to source talent from other universities, training academies, and diversity-focused programs or professional organizations.

Respondents from AI high performers report sourcing AI-related talent in a broader variety of ways than other respondents.

Sources that respondents' organizations are using for AI-related talent, % of respondents¹



¹Only asked of respondents whose organizations have adopted AI in at least one business unit or function. For respondents at AI high performers, n = 51. For all other respondents, n = 413.

Responses suggest that both AI high performers and other organizations are upskilling technical and nontechnical employees on AI, with nearly half of respondents at both AI high performers and other organizations saying they are reskilling as a way of gaining more AI talent. However, high performers are taking more steps than other organizations to build employees' AI-related skills.

Respondents at high performers are nearly three times more likely than other respondents to say their organizations have capability-building programs to develop technology personnel's AI skills. The most common approaches they use are experiential learning, self-directed online courses, and certification programs, whereas other organizations most often lean on self-directed online courses.

High performers are also much more likely than other organizations to go beyond providing access to self-directed online coursework to upskill nontechnical employees on AI. Respondents at high

performers are nearly twice as likely as others to report offering peer-to-peer learning and certification programs to nontechnical personnel.

Increasing diversity on AI teams is a work in progress

We also explored the level of diversity within organizations' AI-focused teams, and we see that there is significant room for improvement at most organizations. The average share of employees on these teams at respondents' organizations who identify as women is just 27 percent. The share is similar when looking at the average proportion of racial or ethnic minorities developing AI solutions: just 25 percent. What's more, 29 percent of respondents say their organizations have no minority employees working on their AI solutions.



Some companies are working to improve the diversity of their AI talent, though there's more being done to improve gender diversity than ethnic diversity. Forty-six percent of respondents say their organizations have active programs to increase gender diversity within the teams that are developing AI solutions, through steps such as partnering with diversity-focused professional associations to recruit candidates. One-third say their organizations have programs to increase racial and ethnic diversity. We also see that organizations with women or minorities working on AI solutions often have programs in place to address these employees' experiences of these employees.

In line with previous McKinsey studies, the research shows a correlation between diversity and outperformance. Organizations at which respondents say at least 25 percent of AI development employees identify as women are 3.2 times more likely than others to be AI high performers. Those at which at least one-quarter of AI development employees are racial or ethnic minorities are more than twice as likely to be AI high performers.



McKinsey commentary

Helen Mayhew

Partner

As I look at these results on talent, I see both how far we've come with AI and how much work is still to be done in some areas.

Five or so years ago, software engineering would not have been classified as the highest-priority AI role because many organizations focused on simply building discrete models as they experimented with the technology. But as the business value became clear, organizations realized the need for insights from AI to be delivered into a front end where people can consume and apply them for impact. The hiring of machine learning (ML) engineers similarly shows the maturation of AI; businesses need this role now because they're working to embed ML into systems regularly and reliably.

On the other hand, despite knowing for close to a decade about the growing need for roles like data scientists and data engineers, we still haven't moved the needle enough on the supply side. Hiring from boot camps is picking up because experienced talent is just not available. It isn't easy to set up learning pathways for this fresh talent, but organizations have little choice. Reskilling efforts are also a big undertaking, but it's necessary to fill the gaps. To meet the need, we actually need many more organizations reskilling than what we're seeing in these results.

The diversity figures are disappointing but sadly unsurprising. Data science is a team sport. Diverse perspectives are important. It has been shown time and again that bias issues will proliferate when organizations lack a diverse enough team to call out issues. And just like other research we've conducted has shown, diversity correlates with strong performance in addition to being the right thing to do. If not careful, with AI, lack of diversity can lead to distrust. Finally, it's important to remember that these AI jobs are among some of the highest paid, and demand will only increase. We risk undermining the progress we've made to date on closing pay gaps for women and ethnic minorities if they are not equally represented in this high-demand skills base. We must continue to find ways to get more women and minorities engaged in STEM in their education years and beyond.

About the research

The online survey was in the field from May 3 to May 27, 2022, and from August 15 to August 17, 2022, and garnered responses from 1,492 participants representing the full range of regions, industries, company sizes, functional specialties, and tenures. Of those respondents, 744 said their organizations had adopted AI in at least one function and were asked questions about their organizations' AI use. To adjust for differences in response rates, the data are weighted by the contribution of each respondent's nation to global GDP.

The survey content and analysis were developed by **Michael Chui**, a partner at the McKinsey Global Institute and a partner in McKinsey's Bay Area office; **Bryce Hall**, an associate partner in the Washington, DC, office; **Helen Mayhew**, a partner in the Sydney office; and **Alex Singla**, a senior partner in the Chicago office, and **Alex Sukharevsky**, a senior partner in the London office, global leaders of QuantumBlack, AI by McKinsey.

They wish to thank Sanath Angalakudati, Medha Bankhwal, David DeLallo, Heather Hanselman, Vishan Patel, and Wilbur Wang for their contributions to this work.

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December 2022
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