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McKinsey Explainers

What's the future of generative AI? An early view in 15 charts

Generative AI has hit the ground running—so fast that it can feel hard to keep up. Here's a quick take pulled from our top articles and reports on the subject.

August 2023

Since the release of ChatGPT in November 2022, it's been all over the headlines, and businesses are racing to capture its value. Within the technology's first few months, McKinsey research found that generative AI (gen AI) features stand to add up to $4.4 trillion to the global economy—annually.

The articles and reports we've published in this time frame examine questions such as these:

— What will the technology be good at, and how quickly?

— What types of jobs will gen AI most affect?

— Which industries stand to gain the most?

— What activities will deliver the most value for organizations?

— How do—and will—workers feel about the technology?

— What safeguards are needed to ensure responsible use of gen AI?

In this visual *Explainer*, we've compiled all the answers we have so far—in 15 McKinsey charts. We expect this space to evolve rapidly and will continue to roll out our research as that happens. To stay up to date on this topic, register for our email alerts on "artificial intelligence" here.

McKinsey research has found that generative AI features stand to add up to $4.4 trillion to the global economy—annually.

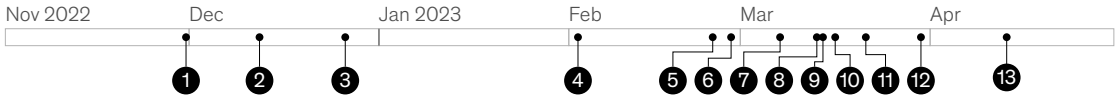
Gen AI finds its legs

The advanced machine learning that powers gen AI–enabled products has been decades in the making. But since ChatGPT came off the starting block in late 2022, new iterations of gen AI technology have been released several times a month. In March 2023 alone, there were six major steps forward, including new customer relationship management solutions and support for the financial services industry.

Source: What every CEO should know about generative AI

Generative AI has been evolving at a rapid pace.

Timeline of major large language model (LLM) developments following ChatGPT's launch



1 **Nov 30, 2022:** OpenAI's ChatGPT, powered by GPT-3.5 (an improved version of its 2020 GPT-3 release), becomes the first widely used text-generating product, gaining a record 100 million users in 2 months

2 **Dec 12:** Cohere releases the first LLM that supports more than 100 languages, making it available on its enterprise AI platform

3 **Dec 26:** LLMs such as Google's Med-PaLM are trained for specific use cases and domains, such as clinical knowledge

4 **Feb 2, 2023:** Amazon's multimodal-CoT model incorporates "chain-of-thought prompting," in which the model explains its reasoning, and outperforms GPT-3.5 on several benchmarks

5 **Feb 24:** As a smaller model, Meta's LLaMA is more efficient to use than some other models but continues to perform well on some tasks compared with other models

6 **Feb 27:** Microsoft introduces Kosmos-1, a multimodal LLM that can respond to image and audio prompts in addition to natural language

7 **Mar 7:** Salesforce announces Einstein GPT (leveraging OpenAI's models), the first generative AI technology for customer relationship management

8 **Mar 13:** OpenAI releases GPT-4, which offers significant improvements in accuracy and hallucinations mitigation, claiming 40% improvement vs GPT-3.5

9 **Mar 14:** Anthropic introduces Claude, an AI assistant trained using a method called "constitutional AI," which aims to reduce the likelihood of harmful outputs

10 **Mar 16:** Microsoft announces the integration of GPT-4 into its Office 365 suite, potentially enabling broad productivity increases

11 **Mar 21:** Google releases Bard, an AI chatbot based on the LaMDA family of LLMs

12 **Mar 30:** Bloomberg announces an LLM trained on financial data to support natural-language tasks in the financial industry

13 **Apr 13:** Amazon announces Bedrock, the first fully managed service that makes models available via API from multiple providers in addition to Amazon's own Titan LLMs

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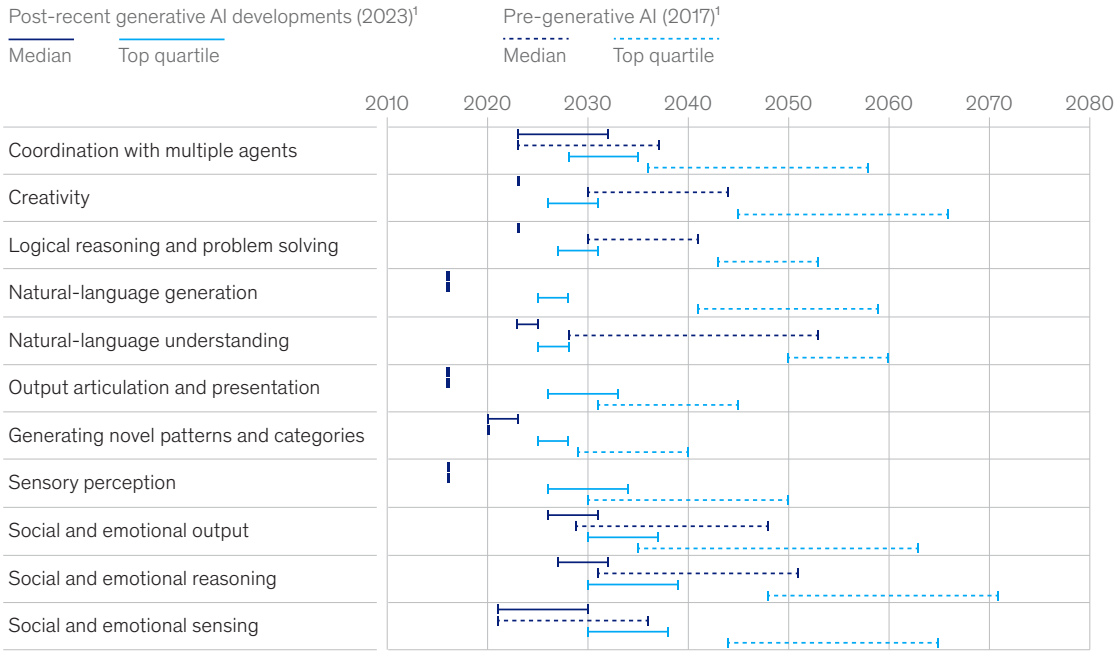
The road to human-level performance just got shorter

For most of the technical capabilities shown in this chart, gen AI will perform at a median level of human performance by the end of this decade. And its performance will compete with the top 25 percent of people completing any and all of these tasks before 2040. In some cases, that's 40 years faster than experts previously thought.

Source: The economic potential of generative AI: The next productivity frontier

Due to generative AI, experts assess that technology could achieve human-level performance in some capabilities sooner than previously thought.

Estimated range for technology to achieve human-level performance, by technical capability



[1]Comparison made on the business-related tasks required from human workers.
Source: McKinsey Global Institute occupation database; McKinsey analysis

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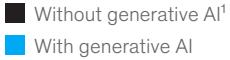
And automation of knowledge work is now in sight

Previous waves of automation technology mostly affected physical work activities, but gen AI is likely to have the biggest impact on knowledge work—especially activities involving decision making and collaboration. Professionals in fields such as education, law, technology, and the arts are likely to see parts of their jobs automated sooner than previously expected. This is because of generative AI's ability to predict patterns in natural language and use it dynamically.

Source: The economic potential of generative AI: The next productivity frontier

Advances in technical capabilities could have the most impact on activities performed by educators, professionals, and creatives.

Impact of generative AI on technical automation potential in midpoint scenario, 2023



Occupation group	Overall technical automation potential, comparison in midpoint scenarios, 2023, %	Share of global employment,[2] %
Educator and workforce training	15 → 54	4
Business and legal professionals	32 → 62	5
STEM professionals	28 → 57	3
Community services	39 → 65	3
Creatives and arts management	28 → 53	1
Office support	66 → 87	9
Managers	27 → 44	3
Health professionals	29 → 43	2
Customer service and sales	45 → 57	10
Property maintenance	29 → 38	4
Health aides, technicians, and wellness	34 → 43	3
Production work	73 → 82	12
Food services	70 → 78	5
Transportation services	42 → 49	3
Mechanical installation and repair	61 → 67	4
Agriculture	59 → 63	21
Builders	49 → 53	7
Overall	51 → 63	100

Note: Figures may not sum, because of rounding.
[1]Previous assessment of work automation before the rise of generative AI.
[2]Includes data from 47 countries, representing about 80% of employment across the world.
Source: McKinsey Global Institute analysis

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Apps keep proliferating to address specific use cases

Gen AI tools can already create most types of written, image, video, audio, and coded content. And businesses are developing applications to address use cases across all these areas. In the near future, we expect applications that target specific industries and functions will provide more value than those that are more general.

Source: Exploring opportunities in the generative AI value chain

There are many applications of generative AI across modalities.

Generative AI use cases, nonexhaustive

Modality	Application	Example use cases
Text	Content writing	Marketing: creating personalized emails and posts Talent: drafting interview questions, job descriptions
	Chatbots or assistants	Customer service: using chatbots to boost conversion on websites
	Search	Making more natural web search Corporate knowledge: enhancing internal search tools
	Analysis and synthesis	Sales: analyzing customer interactions to extract insights Risk and legal: summarizing regulatory documents
Code	Code generation	IT: accelerating application development and quality with automatic code recommendations
	Application prototype and design	IT: quickly generating user interface designs
	Data set generation	Generating synthetic data sets to improve AI models' quality
Image	Stock image generator	Marketing and sales: generating unique media
	Image editor	Marketing and sales: personalizing content quickly
Audio	Text to voice generation	Trainings: creating educational voiceover
	Sound creation	Entertainment: making custom sounds without copyright violations
	Audio editing	Entertainment: editing podcast in post without having to rerecord
3-D or other	3-D object generation	Video games: writing scenes, characters Digital representation: creating interior-design mockups and virtual staging for architecture design
	Product design and discovery	Manufacturing: optimizing material design Drug discovery: accelerating R&D process
Video	Video creation	Entertainment: generating short-form videos for TikTok Training or learning: creating video lessons or corporate presentations using AI avatars
	Video editing	Entertainment: shortening videos for social media E-commerce: adding personalization to generic videos Entertainment: removing background images and background noise in post
	Voice translation and adjustments	Video dubbing: translating into new languages using AI-generated or original-speaker voices Live translation: for corporate meetings, video conferencing Voice cloning: replicating actor voice or changing for studio effect such as aging
	Face swaps and adjustments	Virtual effects: enabling rapid high-end aging; de-aging; cosmetic, wig, and prosthetic fixes Lip syncing or "visual" dubbing in postproduction: editing footage to achieve release in multiple ratings or languages Face swapping and deep-fake visual effects Video conferencing: real-time gaze correction

Some industries will gain more than others

Gen AI's precise impact will depend on a variety of factors, such as the mix and importance of different business functions, as well as the scale of an industry's revenue. Nearly all industries will see the most significant gains from deployment of the technology in their marketing and sales functions. But high tech and banking will see even more impact via gen AI's potential to accelerate software development.

Source: The economic potential of generative AI: The next productivity frontier

Generative AI will affect business functions differently across industries.

Generative AI productivity impact by business functions[1]

Low impact — High impact

	Total, % of industry revenue	**Total,** $ billion	Marketing and sales	Customer operations	Product R&D	Software engineering	Supply chain and operations	Risk and legal	Strategy and finance	Corporate IT[2]	Talent and organization
			760–1,200	340–470	230–420	580–1,200	290–550	180–260	120–260	40–50	60–90
Administrative and professional services	**0.9–1.4**	150–250									
Advanced electronics and semiconductors	**1.3–2.3**	100–170									
Advanced manufacturing[3]	**1.4–2.4**	170–290									
Agriculture	**0.6–1.0**	40–70									
Banking	**2.8–4.7**	200–340									
Basic materials	**0.7– 1.2**	120–200									
Chemical	**0.8–1.3**	80–140									
Construction	**0.7–1.2**	90–150									
Consumer packaged goods	**1.4–2.3**	160–270									
Education	**2.2–4.0**	120–230									
Energy	**1.0– 1.6**	150–240									
Healthcare	**1.8–3.2**	150–260									
High tech	**4.8–9.3**	240–460									
Insurance	**1.8– 2.8**	50–70									
Media and entertainment	**1.8– 3.1**	80–130									
Pharmaceuticals and medical products	**2.6–4.5**	60–110									
Public and social sector	**0.5–0.9**	70–110									
Real estate	**1.0–1.7**	110–180									
Retail[4]	**1.2–1.9**	240–390									
Telecommunications	**2.3–3.7**	60–100									
Travel, transport, and logistics	**1.2–2.0**	180–300									
		2,600–4,400									

Note: Figures may not sum to 100%, because of rounding. [1]Excludes implementation costs (eg, training, licenses). [2]Excluding software engineering. [3]Includes aerospace, defense, and auto manufacturing. [4]Including auto retail. Source: Comparative Industry Service (CIS), IHS Markit; Oxford Economics; McKinsey Corporate and Business Functions database; McKinsey Manufacturing and Supply Chain 360; McKinsey Sales Navigator; Ignite, a McKinsey database; McKinsey analysis

So understanding the use cases that will deliver the most value to your industry is key

Our report, *The economic potential of generative AI: The next productivity frontier*, contains spotlight sections detailing how to identify the use cases with the highest value potential in the banking, life sciences, and retail and consumer-packaged-goods industries. These provide a good framework for assessing your own industry.

Source: The economic potential of generative AI: The next productivity frontier

Generative AI could deliver significant value when deployed in some use cases across a selection of top industries.

Selected examples of key use cases for main functional value drivers (nonexhaustive)

Value potential of function for the industry – High – Low

	Total value potential per industry, $ billion (% of industry revenue)	Value potential, as % of operating profits[1]	Product R&D, software engineering	Customer operations	Marketing and sales	Other functions
Banking	200–340 (3–5%)	9–15	**Legacy code conversion** Optimize migration of legacy frameworks with natural-language translation capabilities	**Customer emergency interactive voice response (IVR)** Partially automate, accelerate, and enhance resolution rate of customer emergencies through generative AI–enhanced IVR interactions (eg, for credit card losses)	**Custom retail banking offers** Push personalized marketing and sales content tailored for each client of the bank based on profile and history (eg, personalized nudges), and generate alternatives for A/B testing	**Risk model documentation** Create model documentation, and scan for missing documentation and relevant regulatory updates
Retail and consumer packaged goods[2]	400–660 (1–2%)	27–44	**Consumer research** Accelerate consumer research by testing scenarios, and enhance customer targeting by creating "synthetic customers" to practice with	**Augmented reality–assisted customer support** Rapidly inform the workforce in real time about the status of products and consumer preferences	**Assist copy writing for marketing content creation** Accelerate writing of copy for marketing content and advertising scripts	**Procurement suppliers process enhancement** Draft playbooks for negotiating with suppliers
Pharma and medical products	60–110 (3–5%)	15–25	**Research and drug discovery** Accelerate the selection of proteins and molecules best suited as candidates for new drug formulation	**Customer documentation generation** Draft medication instructions and risk notices for drug resale	**Generate content for commercial representatives** Prepare scripts for interactions with physicians	**Contract generation** Draft legal documents incorporating specific regulatory requirements

[1]Operating profit based on average profitability of selected industries in the 2020–22 period.
[2]Includes auto retail.

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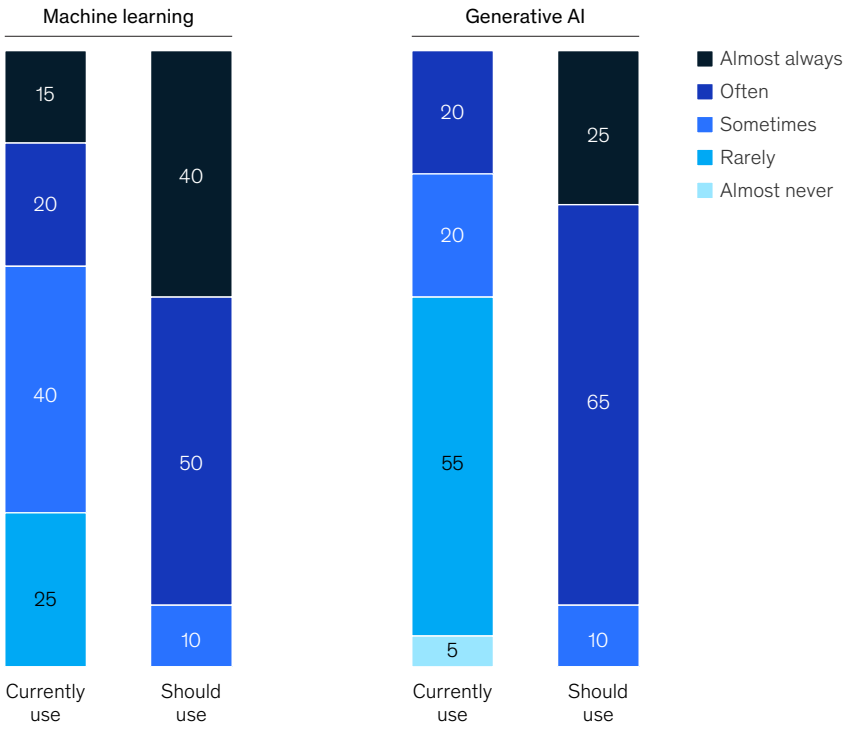
Despite gen AI's commercial promise, most organizations aren't using it yet

When we asked marketing and sales leaders how much they thought their organization should be using gen AI or machine learning for commercial activities, 90 percent thought it should be at least "often." That's hardly surprising, given that marketing and sales is the area with the most potential for impact, as we saw earlier. But 60 percent said their organizations rarely or never do this.

Source: AI-powered marketing and sales reach new heights with generative AI

Commercial leaders are already leveraging generative AI use cases—but most feel the technology is underutilized.

Reported use of technology at organization[1] and level at which respondents think it should be used,[2]
% of respondents at commercially leading organizations



[1]Senior executives in significant global B2B and B2C sales and marketing organizations across a wide range of industries and company maturity levels were asked: *To what extent is your organization using machine learning/generative AI solutions?*
[2]Q: *How much do you think your organization should be using machine learning/generative AI solutions?*

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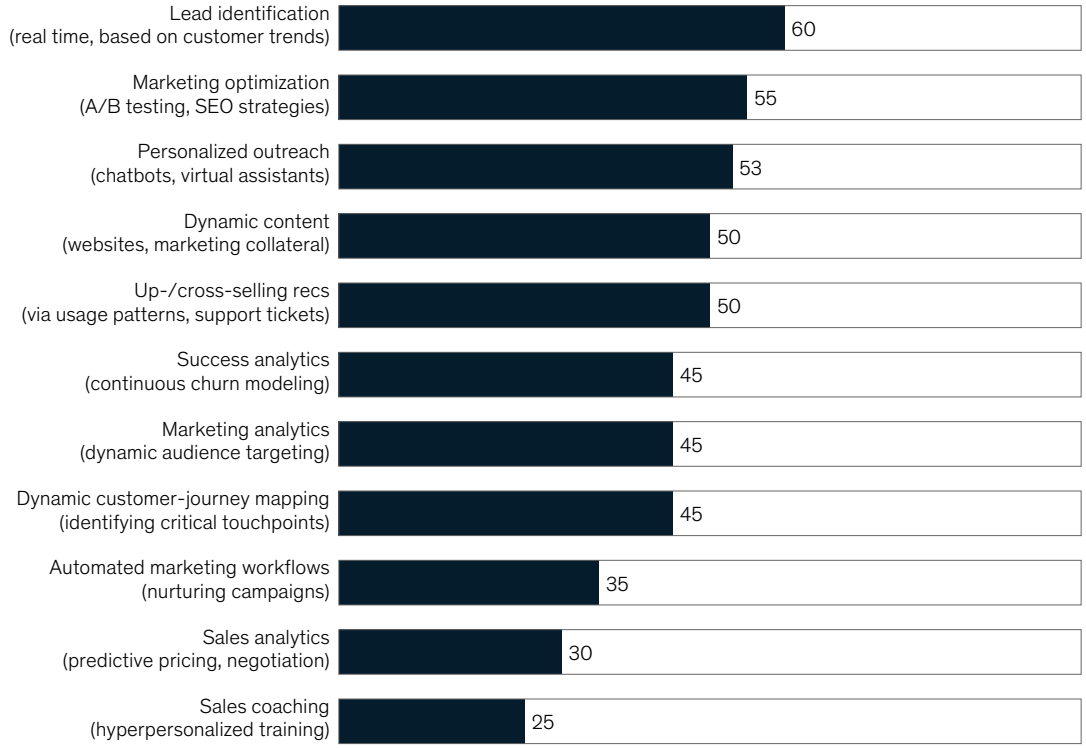
Marketing and sales leaders are most enthusiastic about three use cases

Our research found that marketing and sales leaders anticipated at least moderate impact from each gen AI use case we suggested. They were most enthusiastic about lead identification, marketing optimization, and personalized outreach.

Source: AI-powered marketing and sales reach new heights with generative AI

Commercial leaders are cautiously optimistic about generative AI use cases, anticipating moderate to significant impact.

Share of respondents estimating the impact of generative AI on use case as "significant" or "very significant,"[1] % of respondents at commercially leading organizations



[1]Senior executives in significant global B2B and B2C sales and marketing organizations across a wide range of industries and company maturity levels were asked: *Please share your estimated ROI/impact these tools would have if implemented in your organization.*
Source: McKinsey analysis

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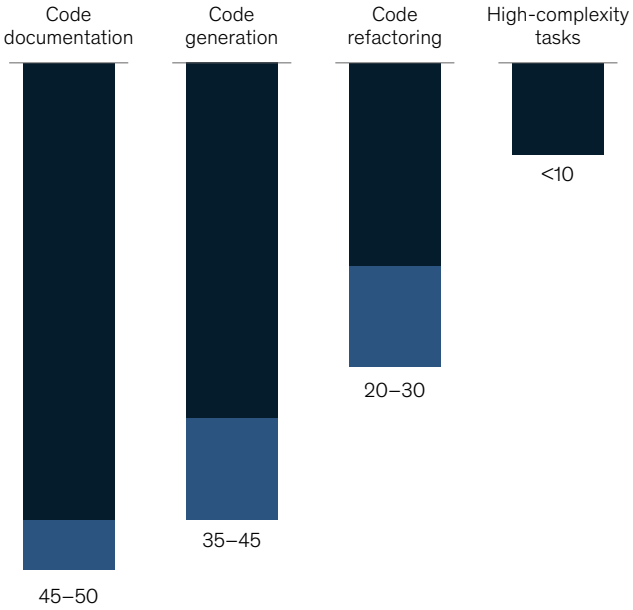
Software engineering, the other big value driver for many industries, could get much more efficient

When we had 40 of McKinsey's own developers test generative AI–based tools, we found impressive speed gains for many common developer tasks. Documenting code functionality for maintainability (which considers how easily code can be improved) can be completed in half the time, writing new code in nearly half the time, and optimizing existing code (called code refactoring) in nearly two-thirds the time.

Source: Unleashing developer productivity with generative AI

Generative AI can increase developer speed, but less so for complex tasks.

Reduction in task completion time using generative AI,[1] %



[1]Compared with task completion without the use of generative AI.
Source: McKinsey analysis

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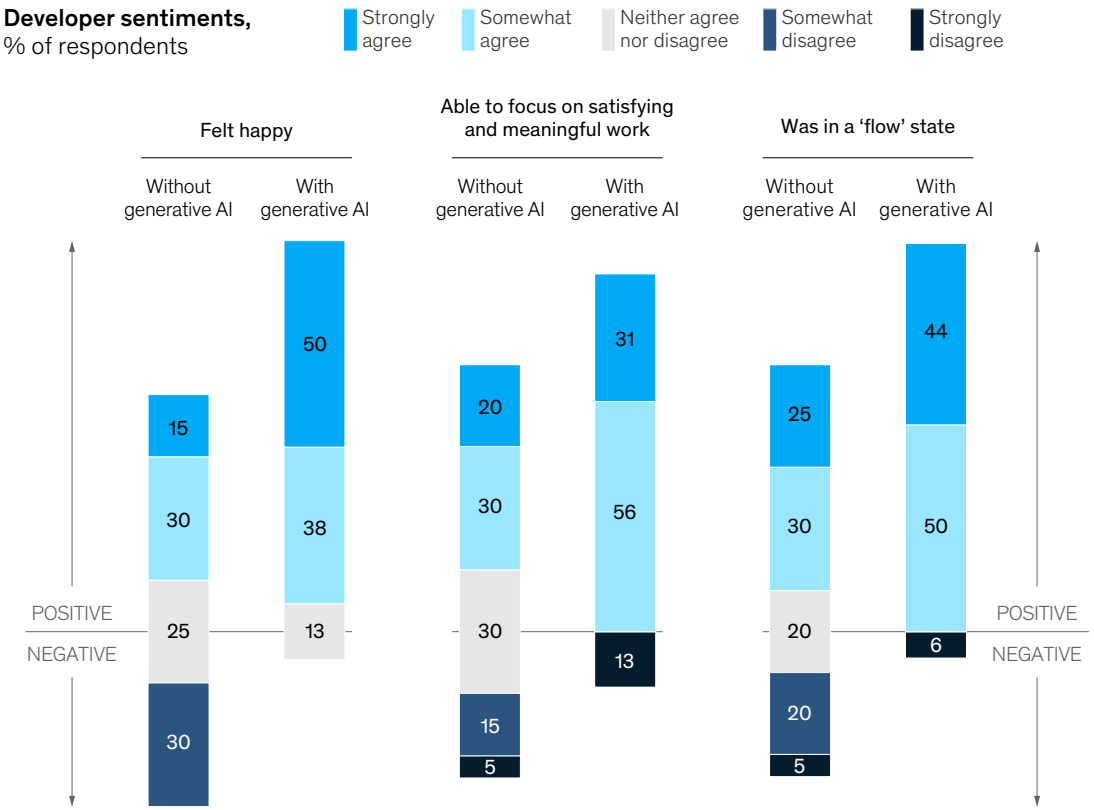
And gen AI assistance could make for happier developers

Our research found that equipping developers with the tools they need to be their most productive also significantly improved their experience, which in turn could help companies retain their best talent. Developers using generative AI–based tools were more than twice as likely to report overall happiness, fulfillment, and a state of flow. They attributed this to the tools' ability to automate grunt work that kept them from more satisfying tasks and to put information at their fingertips faster than a search for solutions across different online platforms.

Source: Unleashing developer productivity with generative AI

Generative AI tools have potential to improve the developer experience.



Note: Figures may not sum to 100%, because of rounding.

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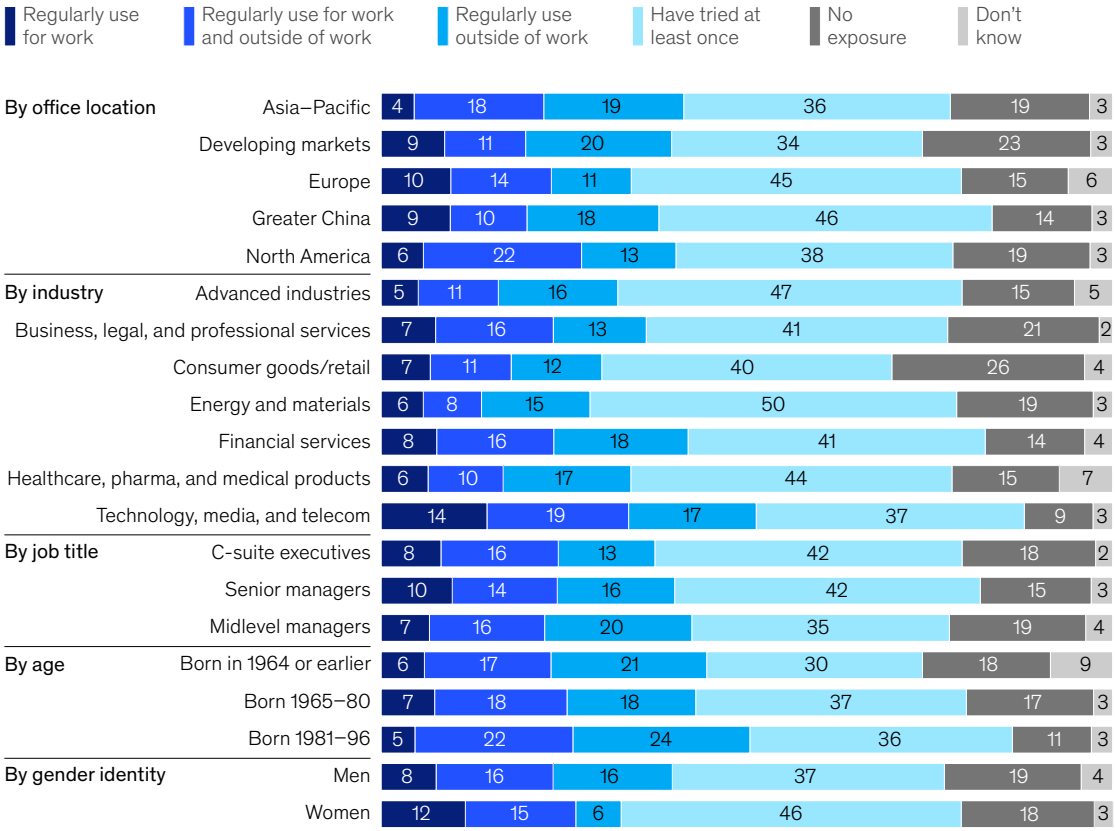
Momentum among workers for using gen AI tools is building

A new McKinsey survey shows that the vast majority of workers—in a variety of industries and geographic locations—have tried generative AI tools at least once, whether in or outside work. That's pretty rapid adoption less than one year in. One surprising result is that baby boomers report using gen AI tools for work more than millennials.

Source: The state of AI in 2023: Generative AI's breakout year

Respondents across regions, industries, and seniority levels say they are already using generative AI tools.

Reported exposure to generative AI tools, % of respondents



Note: Figures may not sum to 100%, because of rounding. In Asia–Pacific, n = 164; in Europe, n = 515; in North America, n = 392; in Greater China (includes Hong Kong and Taiwan), n = 337; and in developing markets (includes India, Latin America, and Middle East and North Africa), n = 276. For advanced industries (includes automotive and assembly, aerospace and defense, advanced electronics, and semiconductors), n = 96; for business, legal, and professional services, n = 215; for consumer goods and retail, n = 128; for energy and materials, n = 96; for financial services, n = 248; for healthcare, pharma, and medical products, n = 130; and for technology, media, and telecom, n = 244. For C-suite respondents, n = 541; for senior managers, n = 437; and for middle managers, n = 339. For respondents born in 1964 or earlier, n = 143; for respondents born between 1965 and 1980, n = 268; and for respondents born between 1981 and 1996, n = 80. Age details were not available for all respondents. For respondents identifying as men, n = 1,025; for respondents identifying as women, n = 156. The survey sample also included respondents who identified as "nonbinary" or "other" but not a large enough number to be statistically meaningful.
Source: McKinsey Global Survey on AI, 1,684 participants at all levels of the organization, April 11–21, 2023

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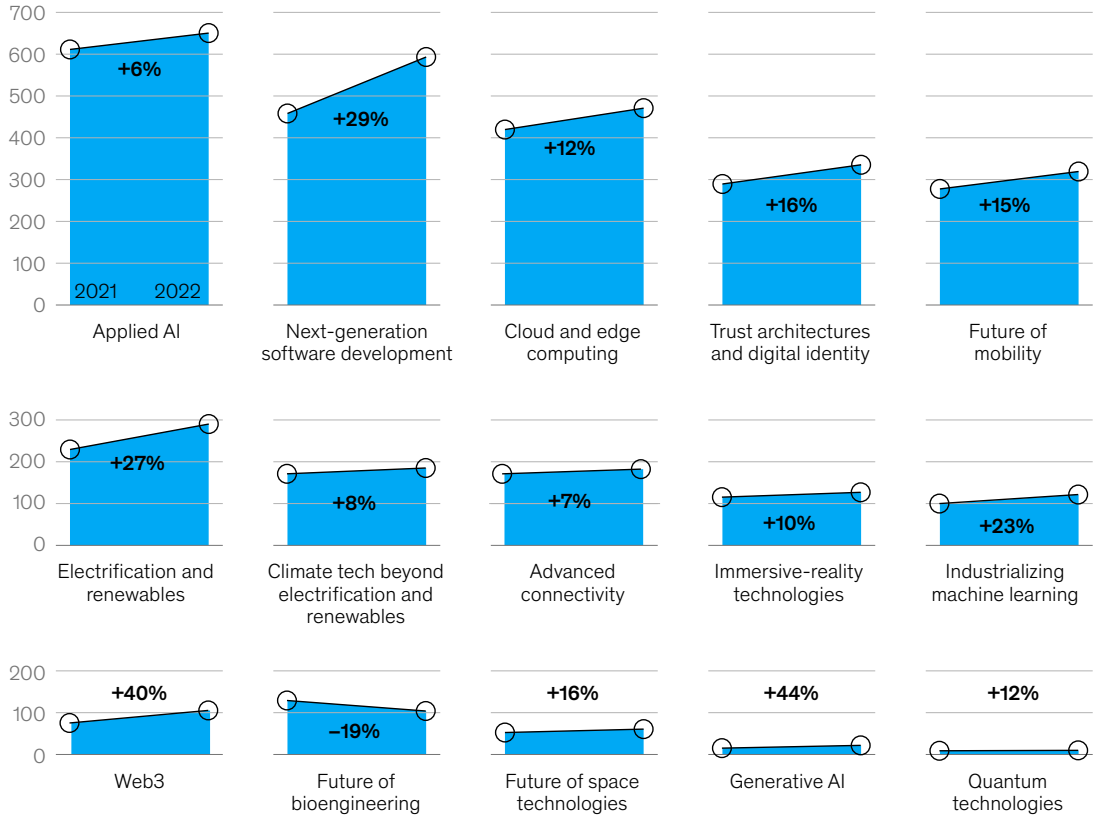
But organizations still need more gen AI–literate employees

As organizations begin to set gen AI goals, they're also developing the need for more gen AI–literate workers. As generative and other applied AI tools begin delivering value to early adopters, the gap between supply and demand for skilled workers remains wide. To stay on top of the talent market, organizations should develop excellent talent management capabilities, delivering rewarding working experiences to the gen AI–literate workers they hire and hope to retain.

Source: McKinsey Technology Trends Outlook 2023

Job postings for fields related to tech trends grew by 400,000 between 2021 and 2022, with generative AI growing the fastest.

Tech trend job postings, 2021–22,[1] thousands



[1]Out of 150 million surveyed job postings. Job postings are not directly equivalent to numbers of new or existing jobs.
Source: McKinsey's proprietary Organizational Data Platform, which draws on licensed, de-identified public professional profile data

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Organizations should proceed with caution

The possibilities of gen AI are thrilling to many. But like any new technology, gen AI doesn't come without potential risks. For one thing, gen AI has been known to produce content that's biased, factually wrong, or illegally scraped from a copyrighted source. Before adopting gen AI tools wholesale, organizations should reckon with the reputational and legal risks to which they may become exposed. One way to mitigate the risk? Keep a human in the loop; that is, make sure a real human checks any gen AI output before it's published or used.

Source: The state of AI in 2023: Generative AI's breakout year

Inaccuracy, cybersecurity, and intellectual property infringement are the most-cited risks of generative AI adoption.

Generative AI–related risks that organizations consider relevant and are working to mitigate, % of respondents[1]

[1]Asked only of respondents whose organizations have adopted AI in at least 1 function. For both risks considered relevant and risks mitigated, n = 913.
Source: McKinsey Global Survey on AI, 1,684 participants at all levels of the organization, April 11–21, 2023

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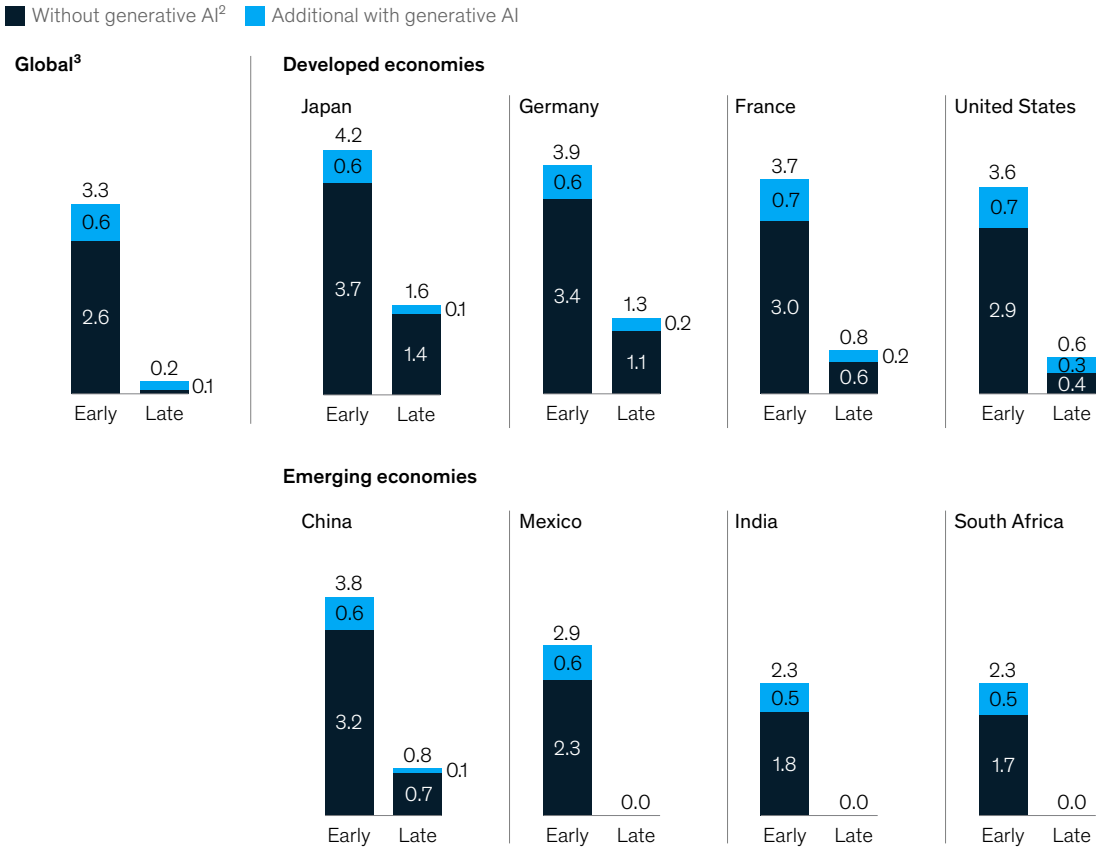
Gen AI could ultimately boost global GDP

McKinsey has found that gen AI could substantially increase labor productivity across the economy. To reap the benefits of this productivity boost, however, workers whose jobs are affected will need to shift to other work activities that allow them to at least match their 2022 productivity levels. If workers are supported in learning new skills and, in some cases, changing occupations, stronger global GDP growth could translate to a more sustainable, inclusive world.

Source: The economic potential of generative AI: The next productivity frontier

Generative AI could contribute to productivity growth if labor hours can be redeployed effectively.

Productivity impact from automation by scenario, 2022–40, CAGR,[1] %



Note: Figures may not sum, because of rounding.
[1]Based on the assumption that automated work hours are reintegrated in work at productivity level of today.
[2]Previous assessment of work automation before the rise of generative AI.
[3]Based on 47 countries, representing about 80% of world employment.
Source: Conference Board Total Economy database; Oxford Economics; McKinsey Global Institute analysis

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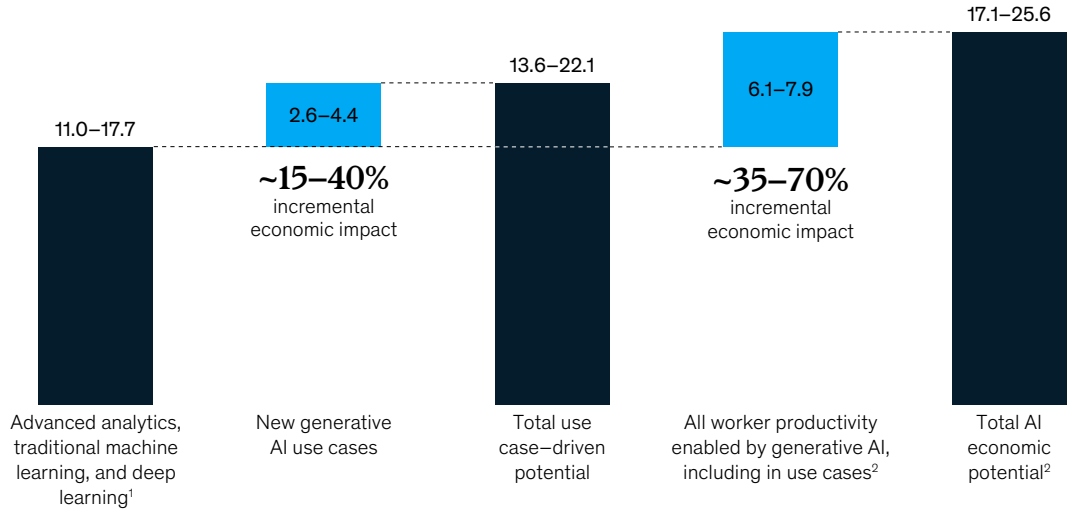
Gen AI represents just a small piece of the value potential from AI

Gen AI is a big step forward, but traditional advanced analytics and machine learning continue to account for the lion's share of task optimization, and they continue to find new applications in a wide variety of sectors. Organizations undergoing digital and AI transformations would do well to keep an eye on gen AI, but not to the exclusion of other AI tools. Just because they're not making headlines doesn't mean they can't be put to work to deliver increased productivity—and, ultimately, value.

Source: The economic potential of generative AI: The next productivity frontier

Generative AI could create additional value potential above what could be unlocked by other AI and analytics.

AI's potential impact on the global economy, $ trillion



[1]Updated use case estimates from "Notes from the AI frontier: Applications and value of deep learning," McKinsey Global Institute, April 17, 2018.
[2]The range of potential value from the combined impact of new generative AI use cases and the increased worker productivity they could enable is $6.1 trillion to $7.9 trillion, including revenue impacts conservatively translated into productivity impact as difference between total impact and cost-isolated impact.

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