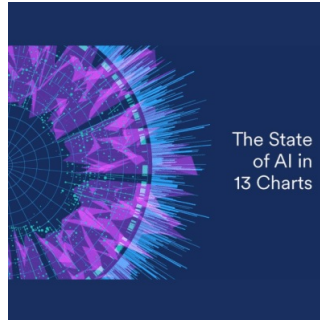**AI Index: State of AI in 13 Charts**
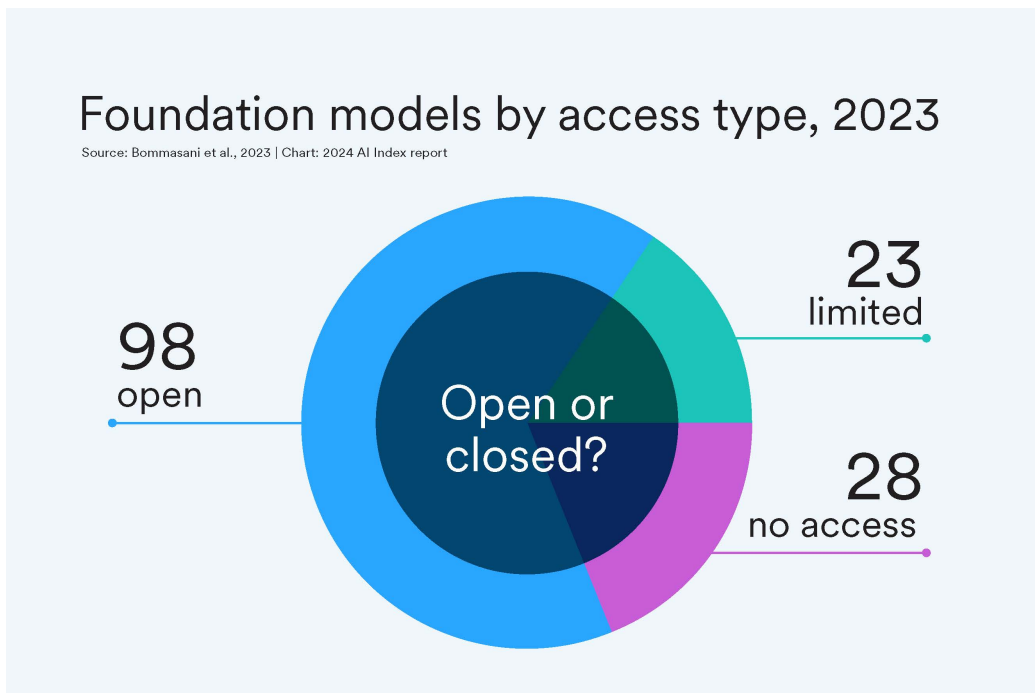

In the new report, foundation models dominate, benchmarks fall, prices skyrocket, and on the global stage, the U.S. overshadows.

This year's AI Index — a 500-page report tracking 2023's worldwide trends in AI — is out.

The index is an independent initiative at the Stanford Institute for Human-Centered Artificial Intelligence (HAI), led by the AI Index Steering Committee, an interdisciplinary group of experts from across academia and industry. This year's report covers the rise of multimodal foundation models, major cash investments into generative AI, new performance benchmarks, shifting global opinions, and new major regulations.

Don't have an afternoon to pore through the findings? Check out the high level here.

Foundation models by access type, 2023
Source: Bommasani et al., 2023 | Chart: 2024 AI Index report

98 open
23 limited
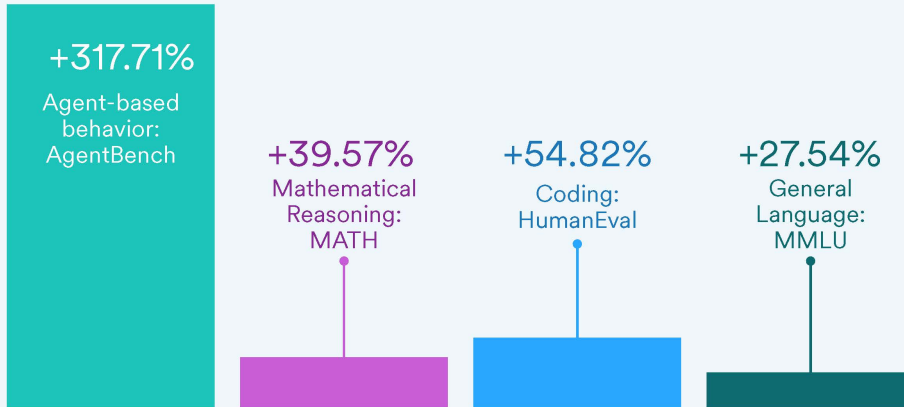28 no access

Open or closed?

A Move Toward Open-Sourced

This past year, organizations released 149 foundation models, more than double the number released in 2022. Of these newly released models,

65.7% were open-source (meaning they can be freely used and modified by anyone), compared with only 44.4% in 2022 and 33.3% in 2021.

Performance difference of top closed vs. open models on select benchmarks

Source: AI Index, 2024 | Chart: 2024 AI Index report

+317.71%
Agent-based behavior: AgentBench

+39.57%
Mathematical Reasoning: MATH

+54.82%
Coding: HumanEval

+27.54%
General Language: MMLU

But At a Cost of Performance?

Closed-source models still outperform their open-sourced counterparts. On 10 selected benchmarks, closed models achieved a median performance advantage of 24.2%, with differences ranging from as little as 4.0% on mathematical tasks like GSM8K to as much as 317.7% on agentic tasks like AgentBench.

Number of foundation models by organization, 2023

Source: Bommasani et al., 2023 | Chart: 2024 AI Index report

Google
18

Meta
11

Microsoft
9

OpenAI
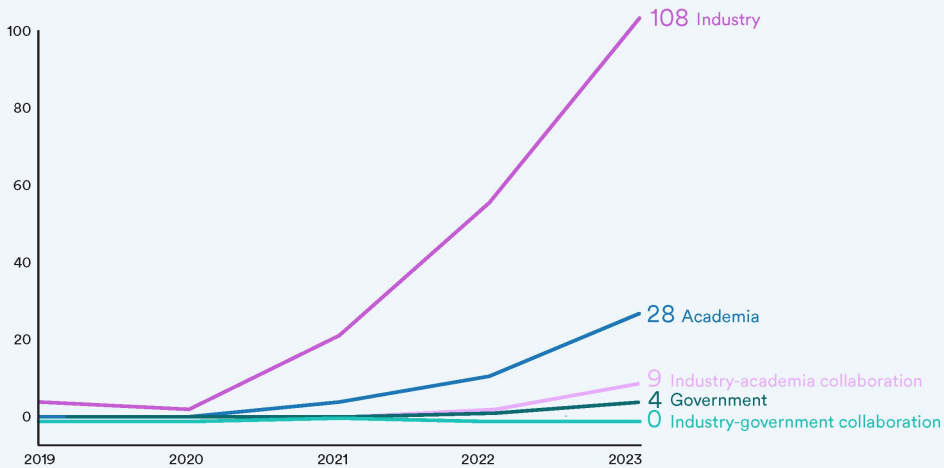**7**

together.ai
5

Hugging Face
4
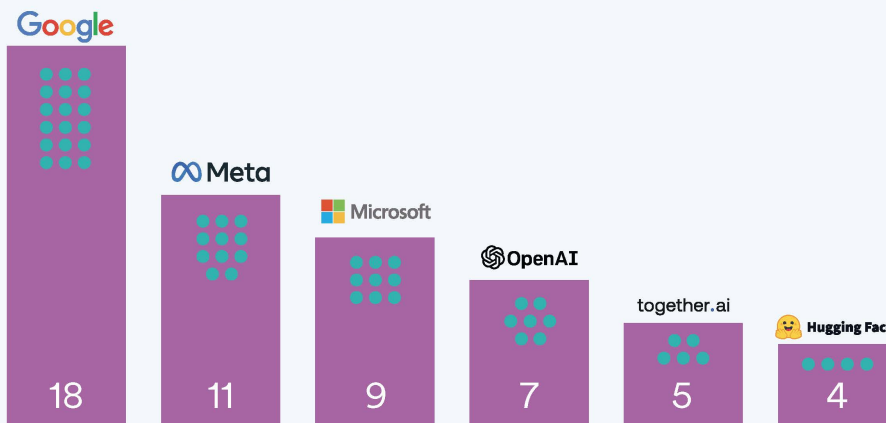
Biggest Players

Industry dominates AI, especially in building and releasing foundation models. This past year Google edged out other industry players in releasing the most models, including Gemini and RT-2. In fact, since 2019, Google has led in releasing the most foundation models, with a total of 40, followed by OpenAI with 20. Academia trails industry: This past year, UC Berkeley released three models and Stanford two.

Number of foundation models by sector

Source: Bommasani et al., 2023 | Chart: 2024 AI Index report

- 108 Industry
- 28 Academia
- 9 Industry-academia collaboration
- 4 Government
- 0 Industry-government collaboration

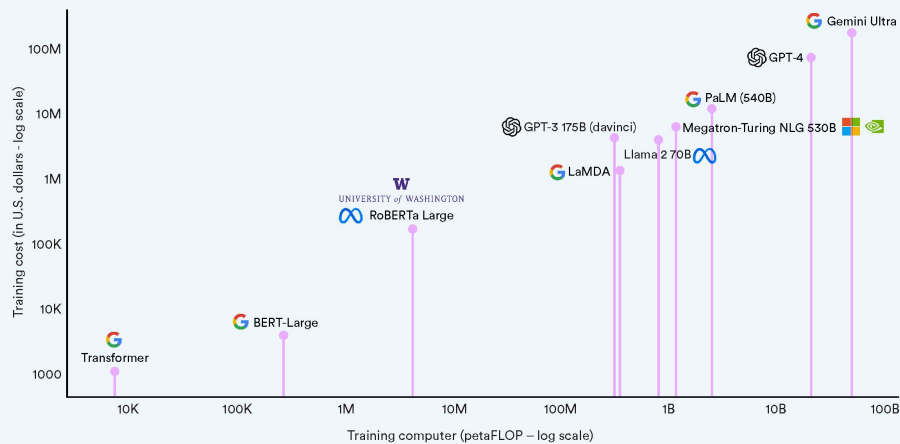2019 · 2020 · 2021 · 2022 · 2023

Industry Dwarfs All

If you needed more striking evidence that corporate AI is the only player in the room right now, this should do it. In 2023, industry accounted for 72% of all new foundation models.

Estimated training cost and compute of select AI models

Source: Epoch, 2023 | Chart: 2024 AI Index report

Training cost (in U.S. dollars – log scale)

Training computer (petaFLOP – log scale)

- Gemini Ultra
- GPT-4
- PaLM (540B)
- GPT-3 175B (davinci)
- Megatron-Turing NLG 530B
- Llama 2 70B
- LaMDA
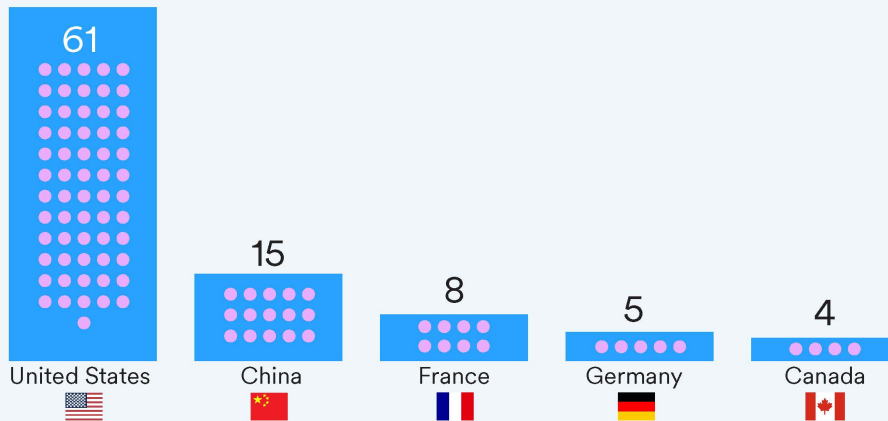- RoBERTa Large
- BERT-Large
- Transformer

Prices Skyrocket

One of the reasons academia and government have been edged out of the AI race: the exponential increase in cost of training these giant models. Google's Gemini Ultra cost an estimated $191 million worth of compute to train, while OpenAI's GPT-4 cost an estimated $78 million. In comparison, in 2017, the original Transformer model, which introduced the architecture that underpins virtually every modern LLM, cost around $900.

Number of notable machine learning models by country, 2023

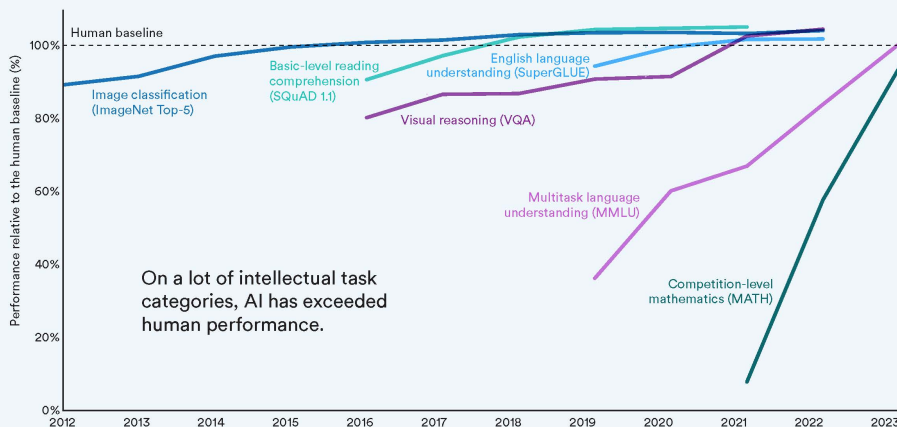| 61	15	8	5	4
United States 🇺🇸	China 🇨🇳	France 🇫🇷	Germany 🇩🇪	Canada 🇨🇦

What AI Race?

At least in terms of notable machine learning models, the United States vastly outpaced other countries in 2023, developing a total of 61 models in 2023. Since 2019, the U.S. has consistently led in originating the majority of notable models, followed by China and the UK.

Select AI Index technical performance benchmarks vs. human performance

Performance relative to the human baseline (%)

Human baseline — 100%

- Image classification (ImageNet Top-5)
- Basic-level reading comprehension (SQuAD 1.1)
- English language understanding (SuperGLUE)
- Visual reasoning (VQA)
- Multitask language understanding (MMLU)
- Competition-level mathematics (MATH)

On a lot of intellectual task categories, AI has exceeded human performance.

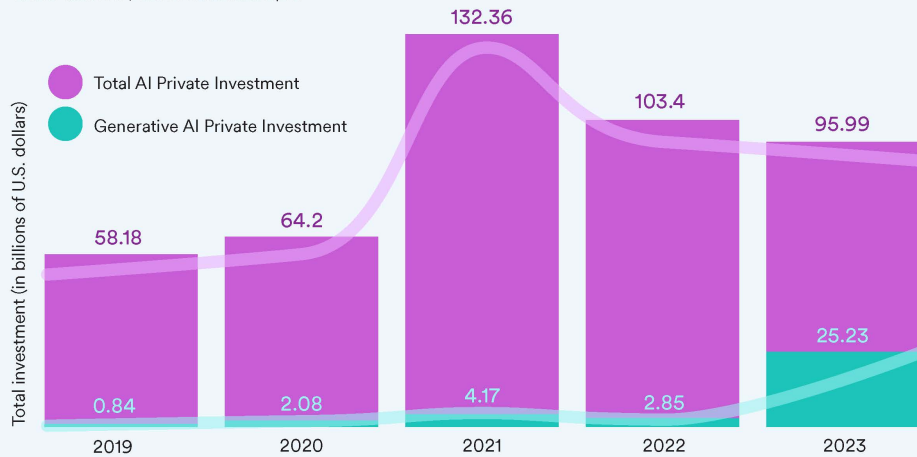2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023

Move Over, Human

As of 2023, AI has hit human-level performance on many significant AI benchmarks, from those testing reading comprehension to visual reasoning. Still, it falls just short on some benchmarks like competition-level math. Because AI has been blasting past so many standard benchmarks, AI scholars have had to create new and more difficult challenges. This year's index also tracked several of these new benchmarks, including those for tasks in coding, advanced reasoning, and agentic behavior.

Private investment in generative AI

Total investment dips, but GenAI investment sees surge

Total investment (in billions of U.S. dollars)

- ⬤ Total AI Private Investment
- ⬤ Generative AI Private Investment

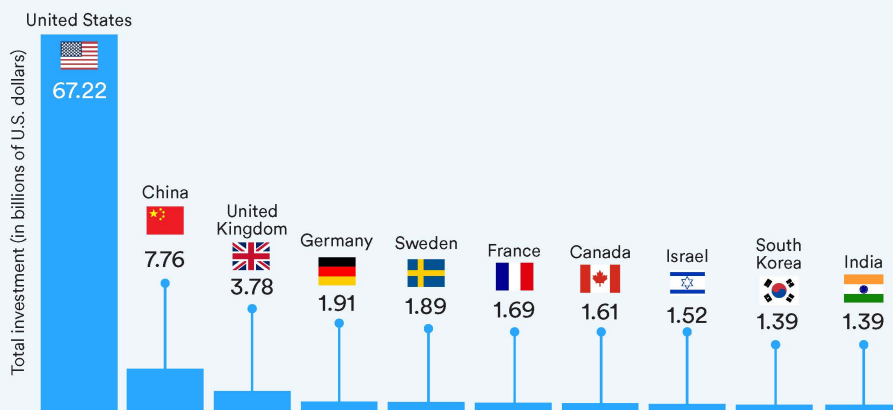|	2019	2020	2021	2022	2023
Total AI Private Investment	58.18	64.2	132.36	103.4	95.99
Generative AI Private Investment	0.84	2.08	4.17	2.85	25.23

Private Investment Drops (But We See You, GenAI)

While AI private investment has steadily dropped since 2021, generative AI is gaining steam. In 2023, the sector attracted $25.2 billion, nearly ninefold the investment of 2022 and about 30 times the amount from 2019 (call it the ChatGPT effect). Generative AI accounted for over a quarter of all AI-related private investments in 2023.

Private investment in AI by geographic area, 2023

Total investment (in billions of U.S. dollars)

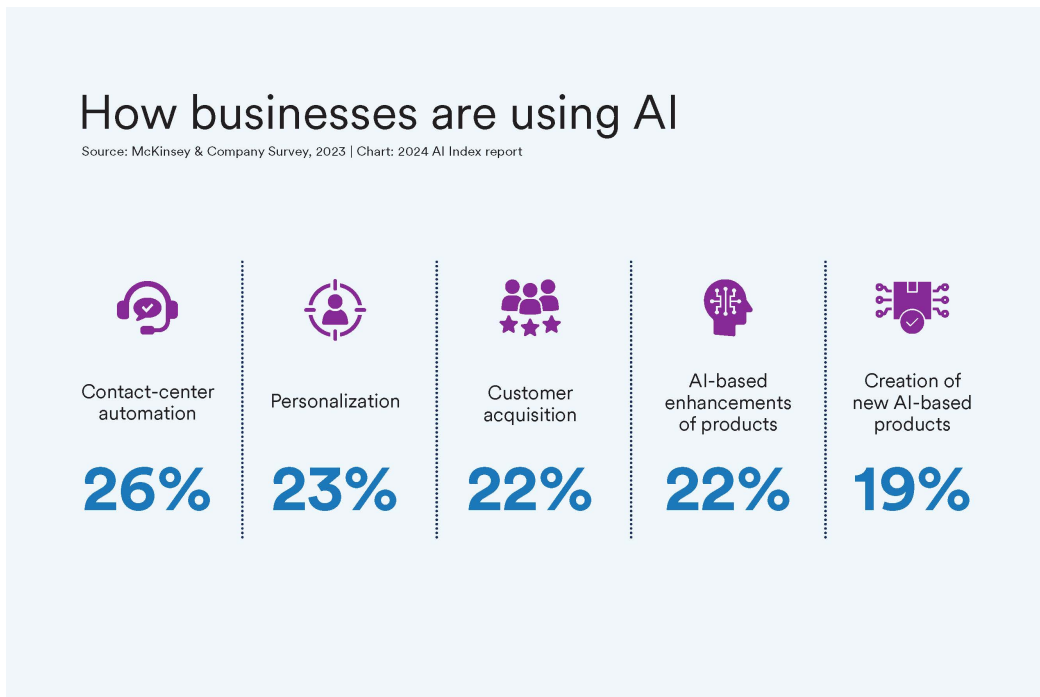| Country	Investment
United States	67.22
China	7.76
United Kingdom	3.78
Germany	1.91
Sweden	1.89
France	1.69
Canada	1.61
Israel	1.52
South Korea	1.39
India	1.39

U.S. Wins $$ Race

And again, in 2023 the United States dominates in AI private investment. In 2023, the $67.2 billion invested in the U.S. was roughly 8.7 times greater than the amount invested in the next highest country, China, and 17.8 times the amount invested in the United Kingdom. That lineup looks the same when zooming out: Cumulatively since 2013, the United States leads investments at $335.2 billion, followed by China with $103.7 billion, and the United Kingdom at $22.3 billion.

How businesses are using AI

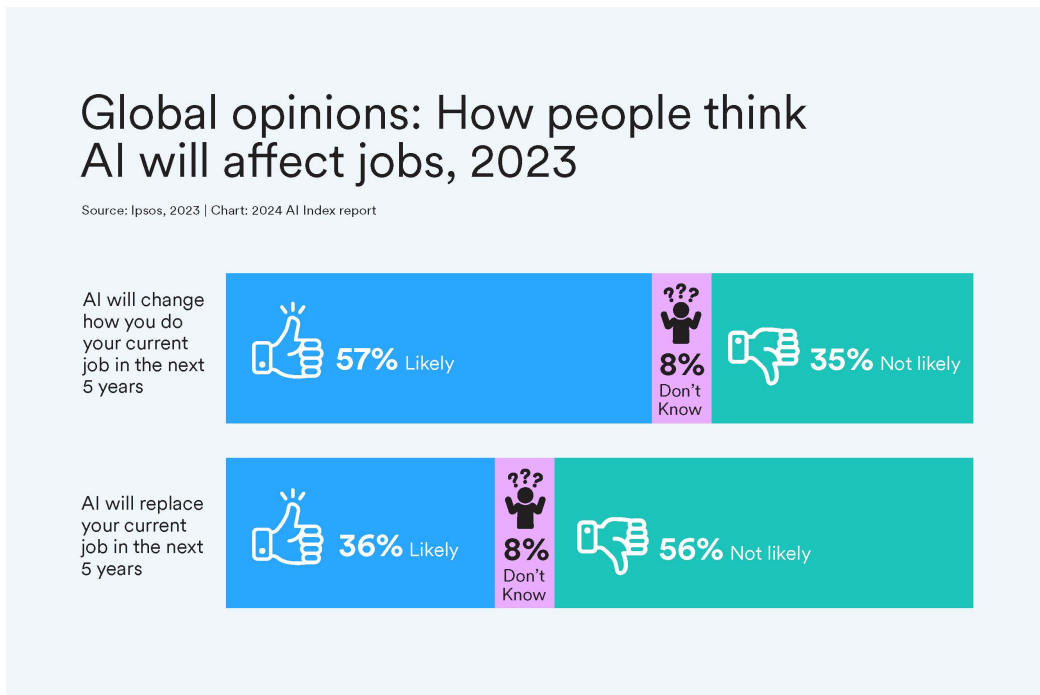| Contact-center automation	Personalization	Customer acquisition	AI-based enhancements of products	Creation of new AI-based products
26%	**23%**	**22%**	**22%**	**19%**

Where is Corporate Adoption?

More companies are implementing AI in some part of their business: In surveys, 55% of organizations said they were using AI in 2023, up from 50% in 2022 and 20% in 2017. Businesses report using AI to automate contact centers, personalize content, and acquire new customers.

Global opinions: How people think AI will affect jobs, 2023

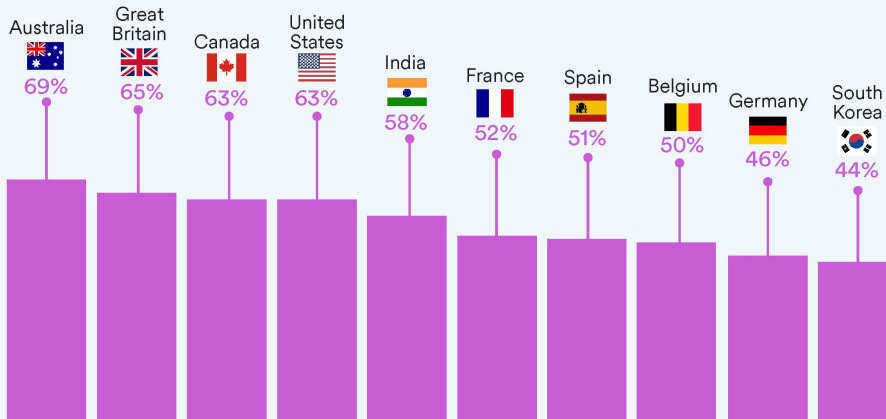| AI will change how you do your current job in the next 5 years	**57%** Likely	**8%** Don't Know	**35%** Not likely
AI will replace your current job in the next 5 years	**36%** Likely	**8%** Don't Know	**56%** Not likely

Younger and Wealthier People Worry About Jobs

Globally, most people expect AI to change their jobs, and more than a third expect AI to replace them. Younger generations — Gen Z and millennials — anticipate more substantial effects from AI compared with older generations like Gen X and baby boomers. Specifically, 66% of Gen Z compared with 46% of boomer respondents believe AI will significantly affect their current jobs. Meanwhile, individuals with higher incomes, more education, and decision-making roles foresee AI having a great impact on their employment.

Global opinions: Where people say AI makes them nervous, 2023

Source: Ipsos, 2023 | Chart: 2024 AI Index report

| Australia	Great Britain	Canada	United States	India	France	Spain	Belgium	Germany	South Korea
69%	65%	63%	63%	58%	52%	51%	50%	46%	44%

While the Commonwealth Worries About AI Products

When asked in a survey about whether AI products and services make you nervous, 69% of Aussies and 65% of Brits said yes. Japan is the least worried about their AI products at 23%.

Number of AI-related regulations in the United States

Source: AI Index, 2023 | Chart: 2024 AI Index report
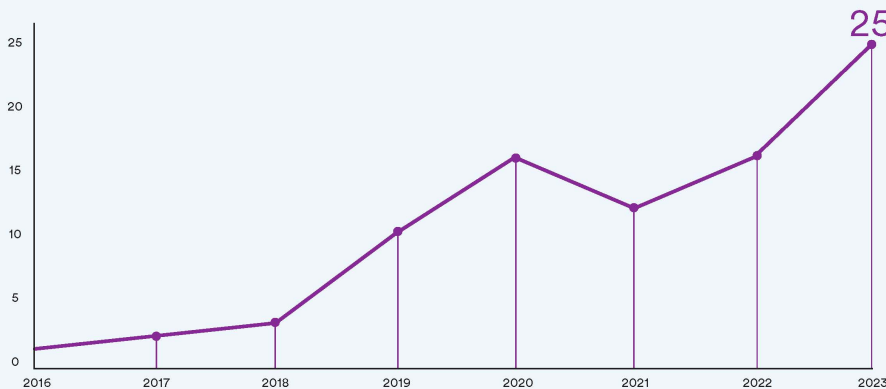
Regulation Rallies

More American regulatory agencies are passing regulations to protect citizens and govern the use of AI tools and data. For example, the Copyright Office and the Library of Congress passed copyright registration guidance concerning works that contained material generated by AI, while the Securities and Exchange Commission developed a cybersecurity risk management strategy, governance, and incident disclosure plan. The agencies to pass the most regulation were the Executive Office of the President and the Commerce Department.

The [AI Index](#) was first created to track AI development. The index collaborates with such organizations as LinkedIn, Quid, McKinsey, Studyportals, the Schwartz Reisman Institute, and the International Federation of Robotics to gather the most current research and feature

important insights on the AI ecosystem.

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