INSIGHTS COMPASS 2023

# Unleashing Artificial Intelligence's true potential: How generative AI could empower innovation, redefine productivity, and transform the workforce

Market Insights
by statista

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# How will recent advances in Artificial Intelligence redefine industries, unlock incredible creative potential, and redefine human competence?

In a world filled with fading fads like cryptocurrencies and NFTs, Artificial Intelligence (AI) is quietly emerging as a true game-changer. Recent advancements in generative AI, most notably with the introduction of ChatGPT, have given AI a momentous boost. Experts believe that this technology has the potential to not only solve real-world problems but also revolutionize various sectors, from healthcare and education to entertainment. AI is ready to shape our destiny, much like how the steam engine transformed society.

But this AI revolution goes beyond simple chatbots. Generative AI, at the forefront of this transformation, is set to contribute a staggering $4.31 trillion to the market by 2030. Language models like GPT-4 are making waves by achieving human-level performance in assessments and even outperforming attorneys on the bar exam.

However, this exciting shift towards AI-powered work comes with consequences. While AI can automate mundane tasks and enhance productivity, it also poses a risk of job displacement. Roles that involve routine and repetitive work are particularly vulnerable, necessitating a shift in job requirements and responsibilities.

Despite the challenges, the future of AI exudes promise and vast possibilities. As AI continues to evolve and expand, it will not only enhance economic performance but also positively impact global GDP. We stand on the precipice of a new era, where innovative technology and human potential converge to reshape industries and unlock new frontiers.

For the Insights Compass, we have compiled both external data as well as a vast body of our own, proprietary data. Our own research and market analyses are accessible outside the Insights Compass in even greater depth and are bundled into a targeted product family. Statista Market Insights provide 700,000+ data stats on 1,000+ markets, 700+ reports, and cover 190+ countries and regions. Statista Consumer Insights contains data from 2,000,000+ interviews, covering 56 countries and 500+ industries and topics as well as 15,000+ brands. Statista Company Insights provides data about 70 million companies, which is clustered into 100+ industries and condensed into 1,000+ reports depicting 20+ different financial KPIs.

# Selected topics explored in this publication:

**AI is the new electricity**
If Big Data is the new oil, then AI is the new electricity, as it enables many developments. A lot of complexity can be reduced by AI, due to the recent developments in Generative AI. With more programs utilizing multimodal capabilities across images, text, and sound, Generative AI will continue to improve at a parabolic pace. AI will redefine how businesses interact with their customers.

**AI shaping the economy**
Despite the rather bad general economic situation, the growth of AI-focused companies and their increasing market value, driven by innovation and growing funding, has helped to stabilize parts of the economy and offset the lack of growth in other sectors. AI will have a crucial impact on the GDP by boosting economic performance. At the moment AI-focused companies are driving the majority of growth in the overall tech-sector, while more traditional sectors like financials or energy continue to face challenges.

**Business moats in the AI race**
In the race for AI dominance, the key to winning lies in hardware innovation, particularly in the development of the fastest chips and biggest cloud capabilities. As the importance of tailored hardware solutions becomes increasingly evident, major players in the AI industry are investing heavily in building their own chip manufacturing capabilities. Application companies are growing topline revenues very quickly but often struggle with retention, product differentiation, and gross margins. Most model providers, though responsible for the very existence of this market, haven't yet achieved large commercial scale.

**Generative AI content flood**
As generative AI continues to propel the content creation space forward, the cost of generating digital content will decrease massively, leading to a flood of content in many areas. This could raise concerns about the trustworthiness of media when content becomes inaccurate, misleading, or even malicious with the need for human verification in order to ensure accuracy and reliability. In general, the ethical use of AI, with a focus on transparency will become more important.

**The changing world of work**
In the near future, the use of AI in the workplace will become ubiquitous, with not using AI being seen as outdated as writing letters today. While AI will increase efficiency and productivity, leading to a boost in economic output, real experts will still be relevant as AI has a tendency towards homogeneity and may not be able to provide the same level of diversity and innovation as human experts.

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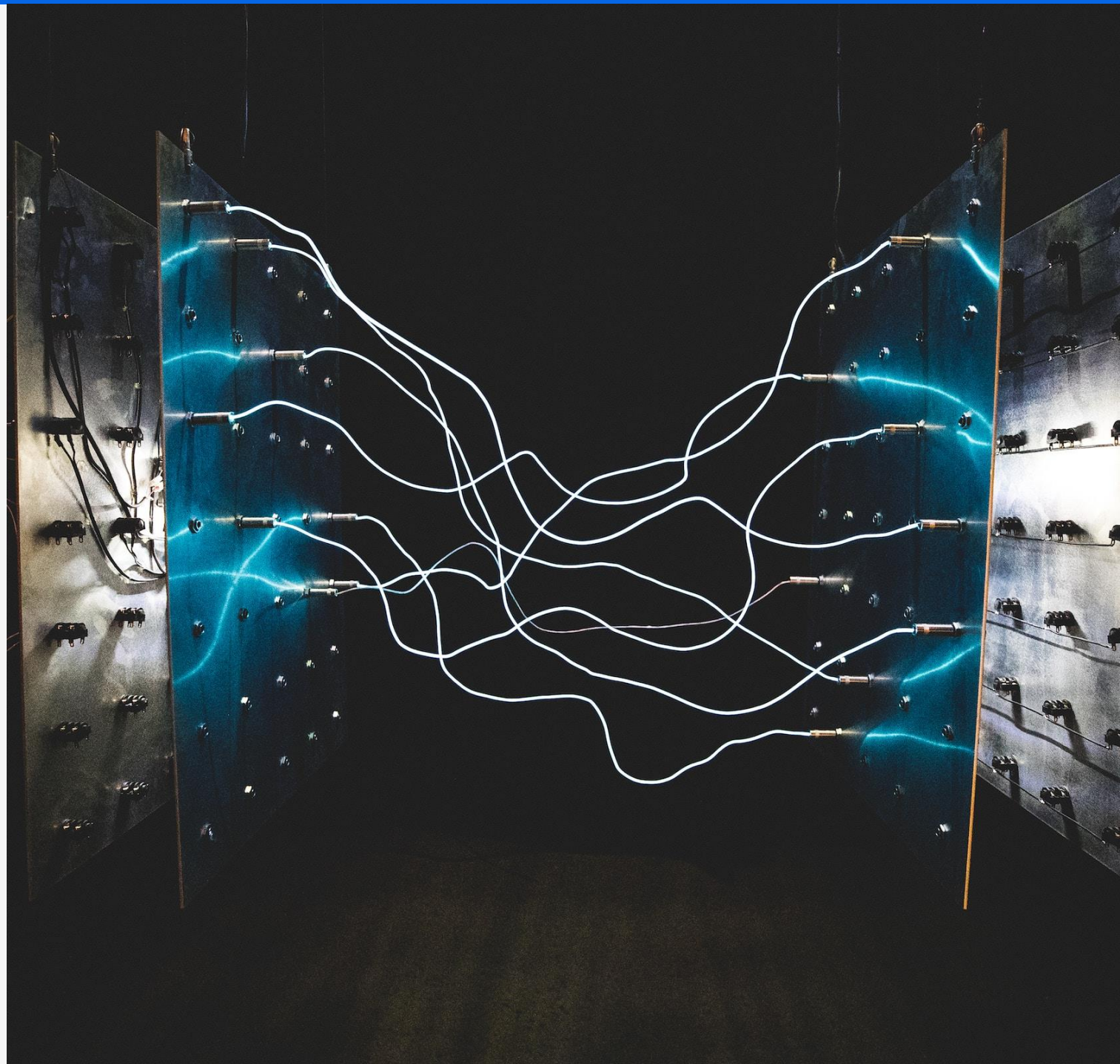
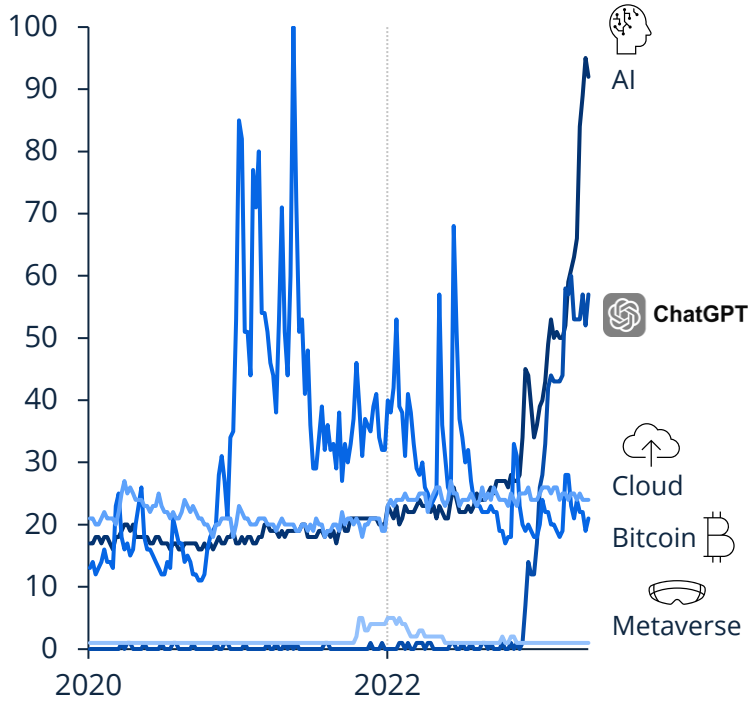
# If Big Data is the new oil, AI is the new electricity

Unlike other current buzzing topics such as cryptocurrencies, NFTs, and Web 3.0, which have tended to lose importance as a result of the difficult economic situation, Artificial Intelligence (AI) appears to be having a breakout moment thanks to recent advances in generative AI, particularly by the release of ChatGPT. AI is a strong technology capable of solving real-world issues and simplifying complicated activities across a wide range of businesses, stimulating change in a variety of fields, from healthcare to education to entertainment. As a consequence, many experts are convinced that AI is here to stay and will impact humanity's destiny in ways similar to the steam engine. Chatbots such as GPT are only the tip of the iceberg when it comes to AI advancements in recent years. AI is seeing a rush in invention and development, with new tools and technologies appearing on a daily basis. In the next few years, AI will continue to evolve and expand, enhance economic performance, and add to global GDP.

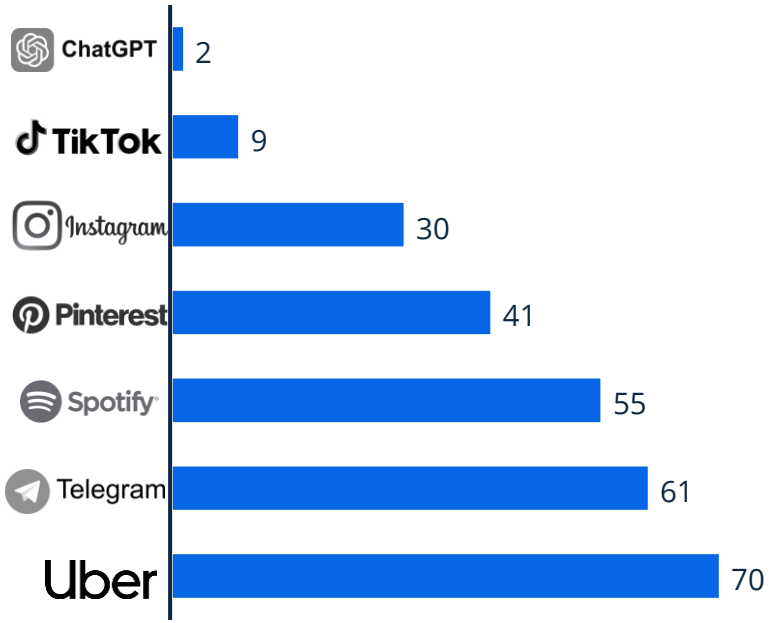


# With the breakthrough of Generative AI, we are now able to see that AI is more than just a buzzword and has the potential to solve many real-world problems

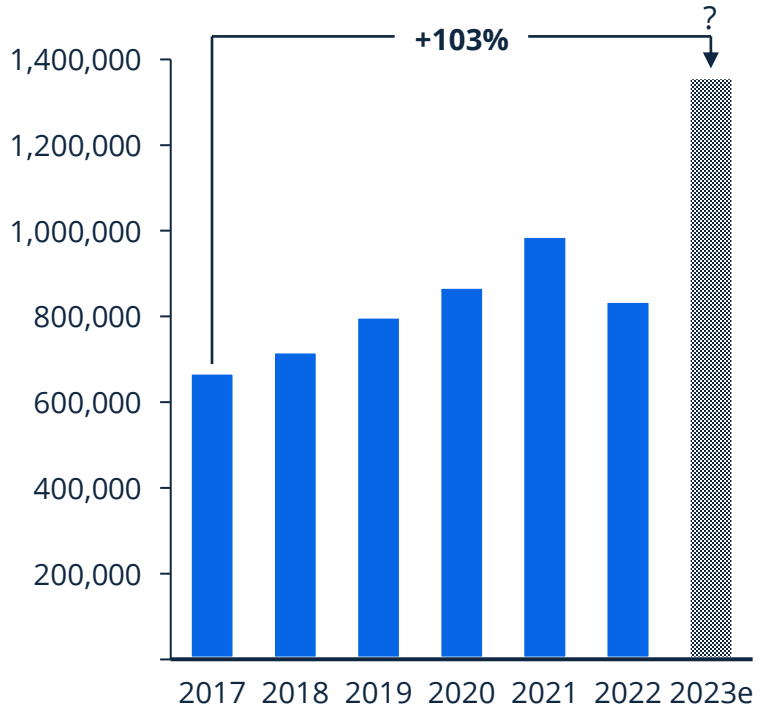
**Google trends search interest over time for selected topics(1)**




**Months it took selected apps to hit 100 million monthly users**




**Number of published AI research papers**



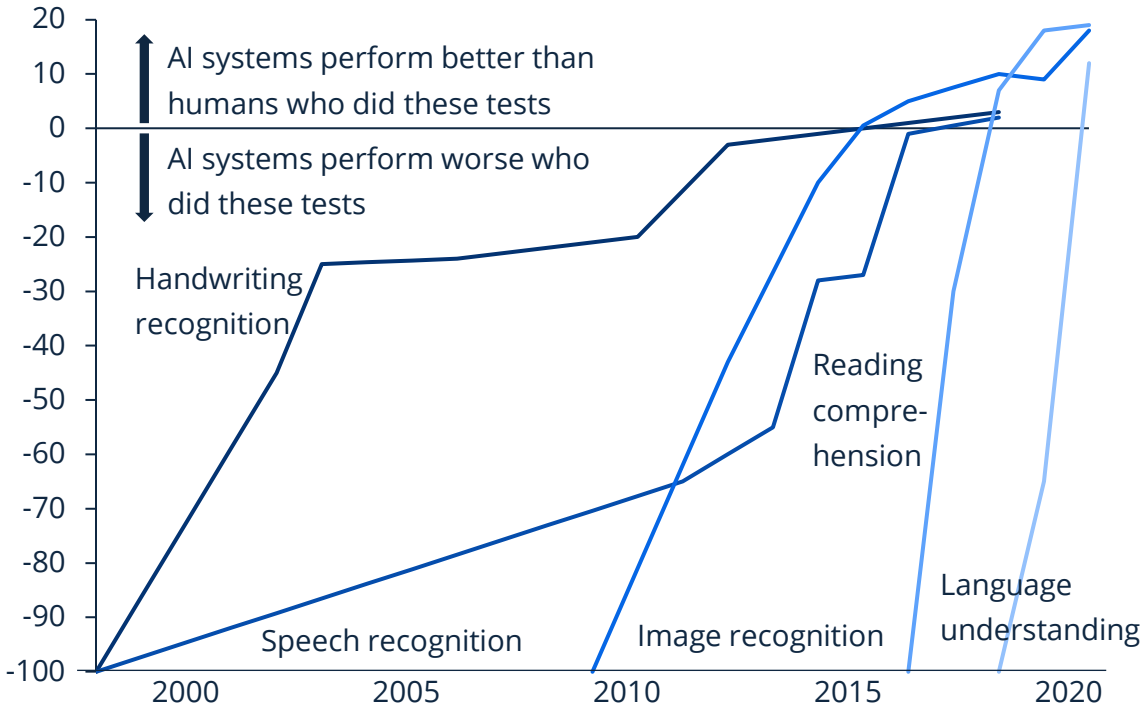



**Notes:** (1) Numbers represent search interest relative to the highest point on the chart for the given region and time. A value of 100 is the peak popularity for the term. A value of 50 means that the term is half as popular. A score of 0 means that there was not enough data for this term

**Sources:** Google Trends; OECD; Company information

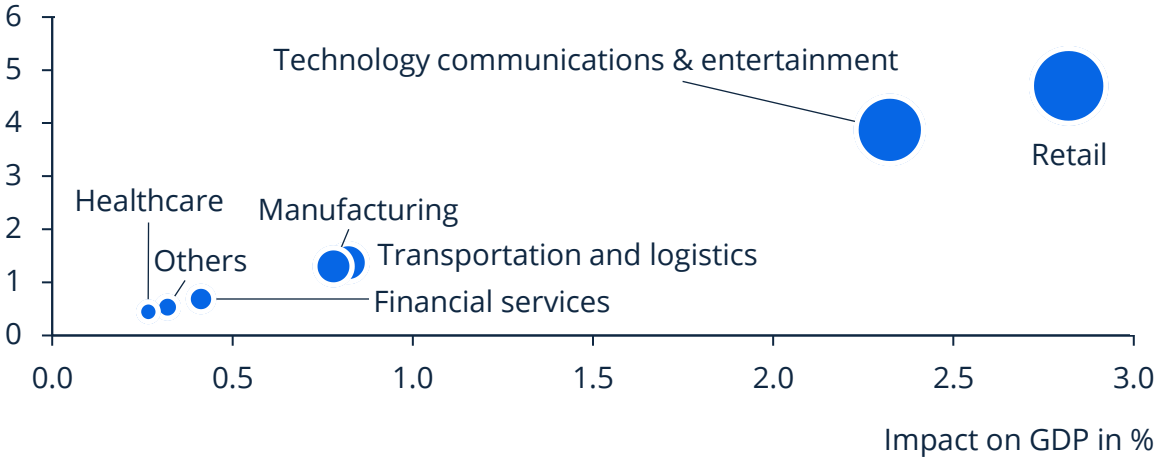
# AI is here to stay, and no one will be able to avoid it: everyday AI will become as ubiquitous and necessary as electricity

**Test scores of the AI relative to human performance(1)**




**Jobs exposed to AI and industries' AI impact on GDP in 2030**


**Potential AI market value by industry in 2030 in trillion US$(2)**






**Notes:** (1) Human performance, as the benchmark, is set to zero. The capability of each AI system is normalized to an initial performance of -100. (2) values are based on estimations from Statista Market Insights, June 2023

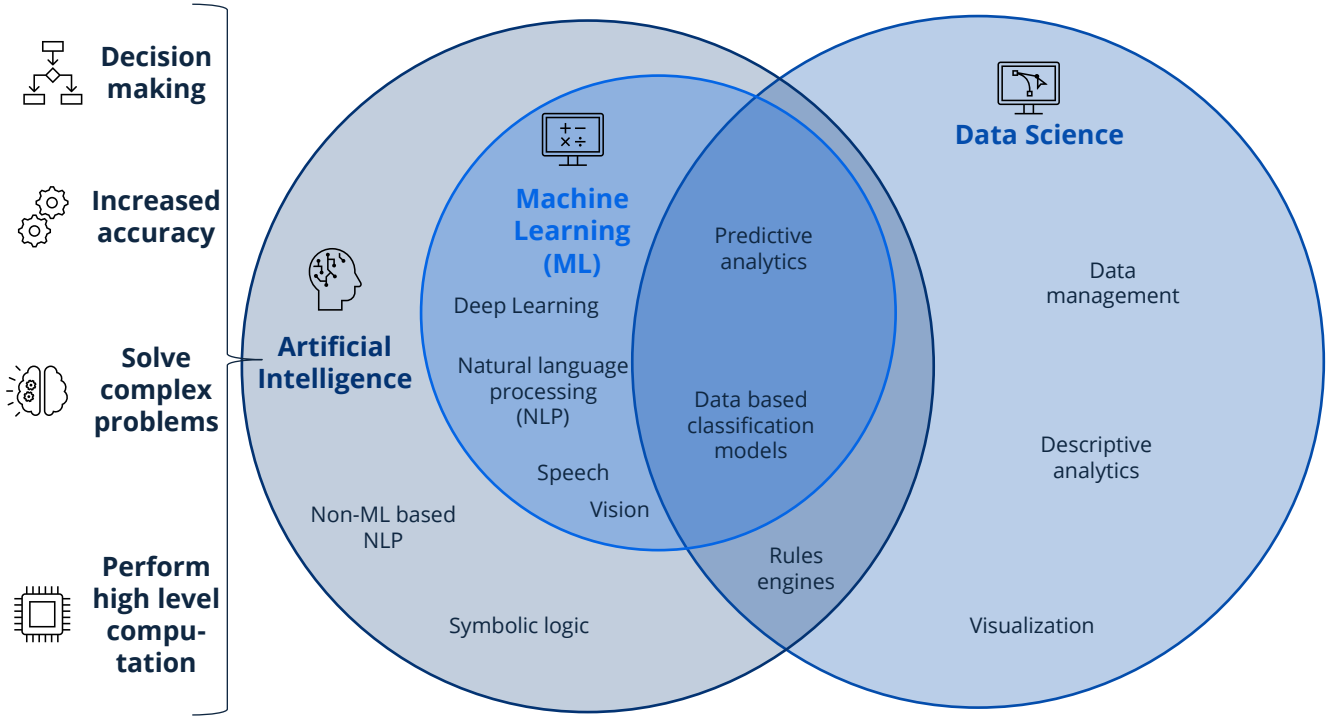
**Sources:** Ourworldindata; Open AI; Statista Market Insights, June 2023

# General-purpose AI technology focuses on creating systems and machines capable of solving problems that normally require human intelligence

## What is AI?

- An interdisciplinary branch of computer science, AI focuses on developing intelligent systems and machines that can solve complex problems, specifically those that typically require human intelligence.
- AI as a broader field, incorporates both data science and machine learning, along with other areas such as natural language processing, computer vision, and robotics. Whereas data science provides the foundation for understanding and working with data, machine learning enables AI systems to learn from that data and make intelligent decisions and/or perform tasks. AI expands beyond the scope of data science and machine learning to include the simulation of human intelligence, reasoning, perception, and interaction with the environment.
- AI technology is used to automate tasks and processes that are too complex for traditional computers to perform. This includes performing data analysis, forming predictions and decisions, and even developing systems that can interact with humans in a natural, conversational manner.
- AI is being used across a wide range of industries, from healthcare and finance to transportation and logistics. For instance, finance AI technology is used to automate customer service, analyze data to provide personalized recommendations, and detect fraud in financial transactions.

## AI location in family of general-purpose technologies






**Sources:** Ourworldindata; UK Government; Statista Market Insights, June 2023

# In the past few years, AI has come a long way, with Chat GPT being only the tip of the iceberg with the beginning of phase 4: self-aware machines

**AI timeline with selected events**

**Eliza (1965)**

First chatbot released by Joseph Weizenbaum

**Siri (2008)**

Apple's virtual assistant with a voice interface

**Alexa (2014)**

Amazon's virtual assistant

**Chat GPT (2022)**

Chatbot model released by OpenAI

**Logic Theorist (1956)**

Designed to prove mathematical theorems

**Backpropagation Algorithm (1986)**

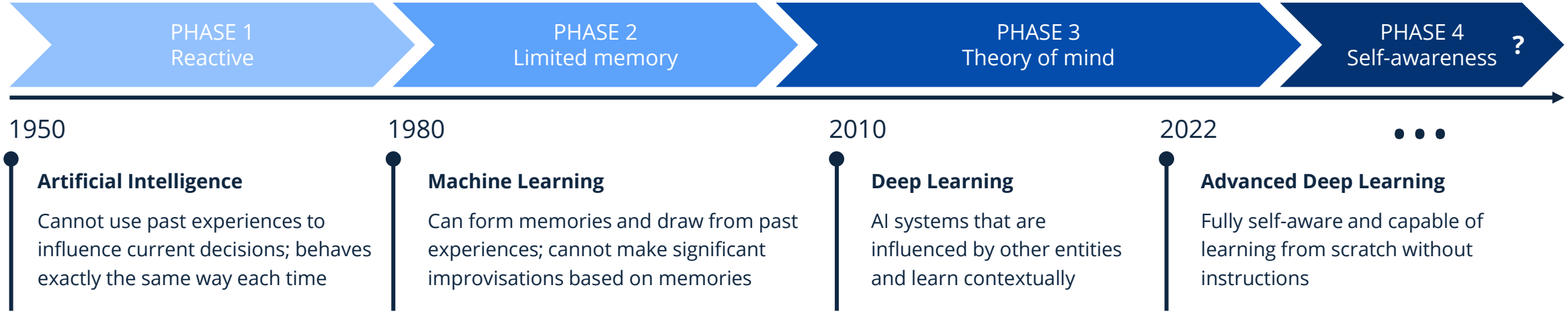
Revolutionized the field of neural networks

**Deep Blue (1997)**

IBM's supercomputer to surpass human expertise in complex games

**Waymo (2017)**

Google's autonomous car fleet test with 500 minivans




**Artificial Intelligence**

Cannot use past experiences to influence current decisions; behaves exactly the same way each time

**Machine Learning**

Can form memories and draw from past experiences; cannot make significant improvisations based on memories

**Deep Learning**

AI systems that are influenced by other entities and learn contextually

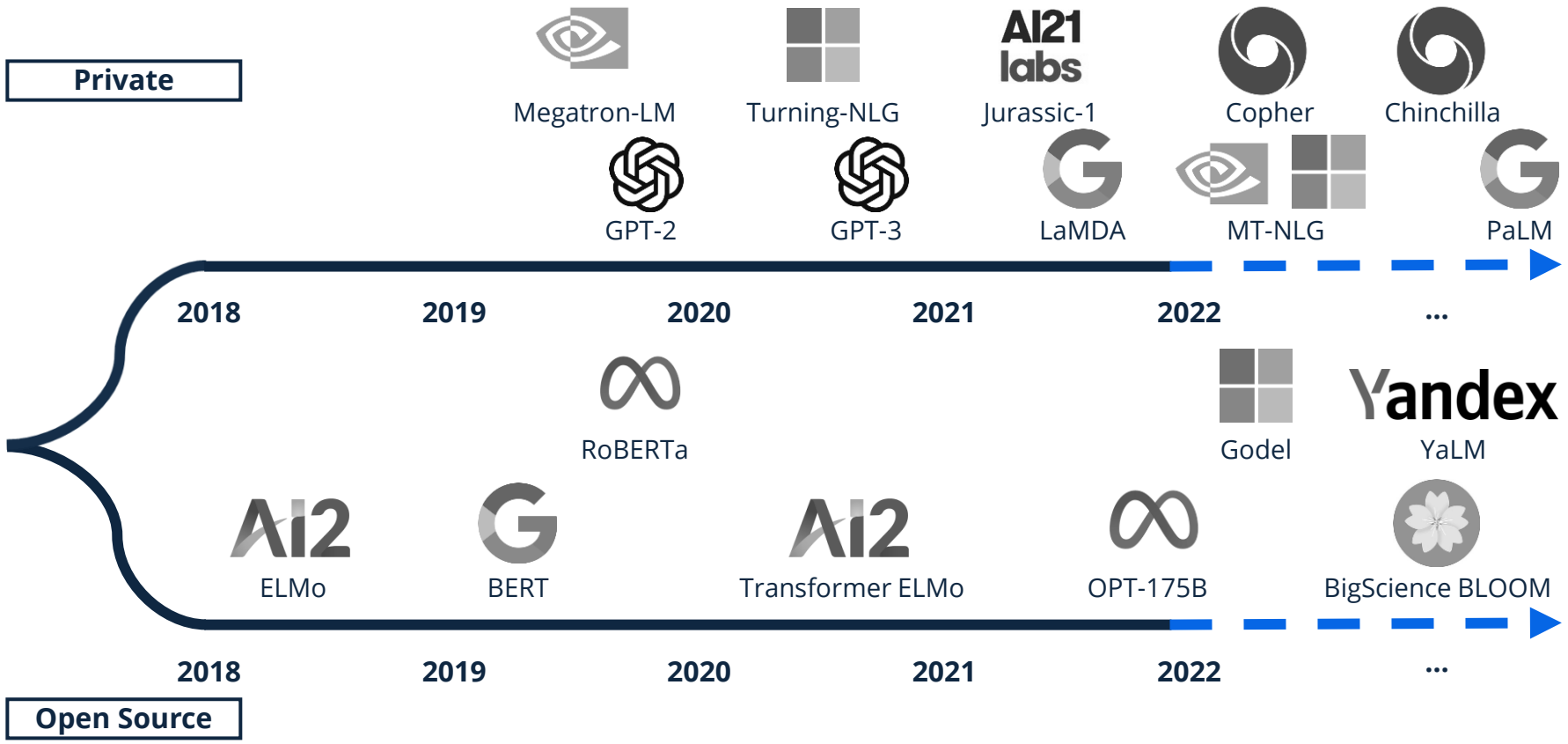
**Advanced Deep Learning**

Fully self-aware and capable of learning from scratch without instructions



**Sources:** Govtech; Ourworldindata; Simplilearn; Statista Market Insights, June 2023

# The field of generative machine learning has recently experienced an explosion of new tools and technology




**Growth in AI models has accelerated**

- Access to private APIs and open-source models drive progress for generative machine learning
- In contrast to previous years, developers now have the opportunity to access private APIs, such as those provided by OpenAI and AI21 Labs, as well as open-source models for generative machine learning
- In fact, within the last month, both Meta and Huggingface have shown support by sponsoring open-source models

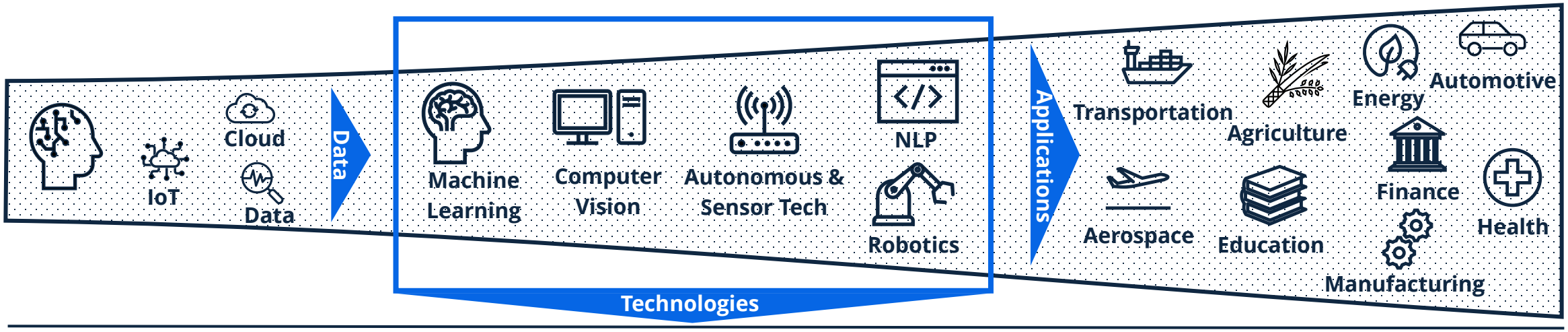


**Notes:** ELMo, BigScience BLOOM and LaMDA are language-based models, while GPT-2 and GPT-3, Transformer ELMo and BERT are transformer-based language models. Language-based models generally refer to models focused on understanding and generating human language, while transformer language-based models specifically indicate models that utilize the transformer architecture to process language sequences.

**Sources:** Bessemer Venture Partners

# AI infrastructure lays the foundation for a diverse range of AI technologies to be applied to a range of industries

**The expansion of AI from infrastructure to industry**




**Machine Learning**
Involves designing algorithms and models that enable computer systems to automatically learn and improve from data without explicit programming

**Computer Vision**
Is focused on developing algorithms and techniques that enable computers to extract meaningful information and understand visual data from images or videos

**Autonomous & Sensor Tech**
Refers to the development of systems and devices that can operate and perceive their environment without human intervention, utilizing various sensors to gather and interpret data

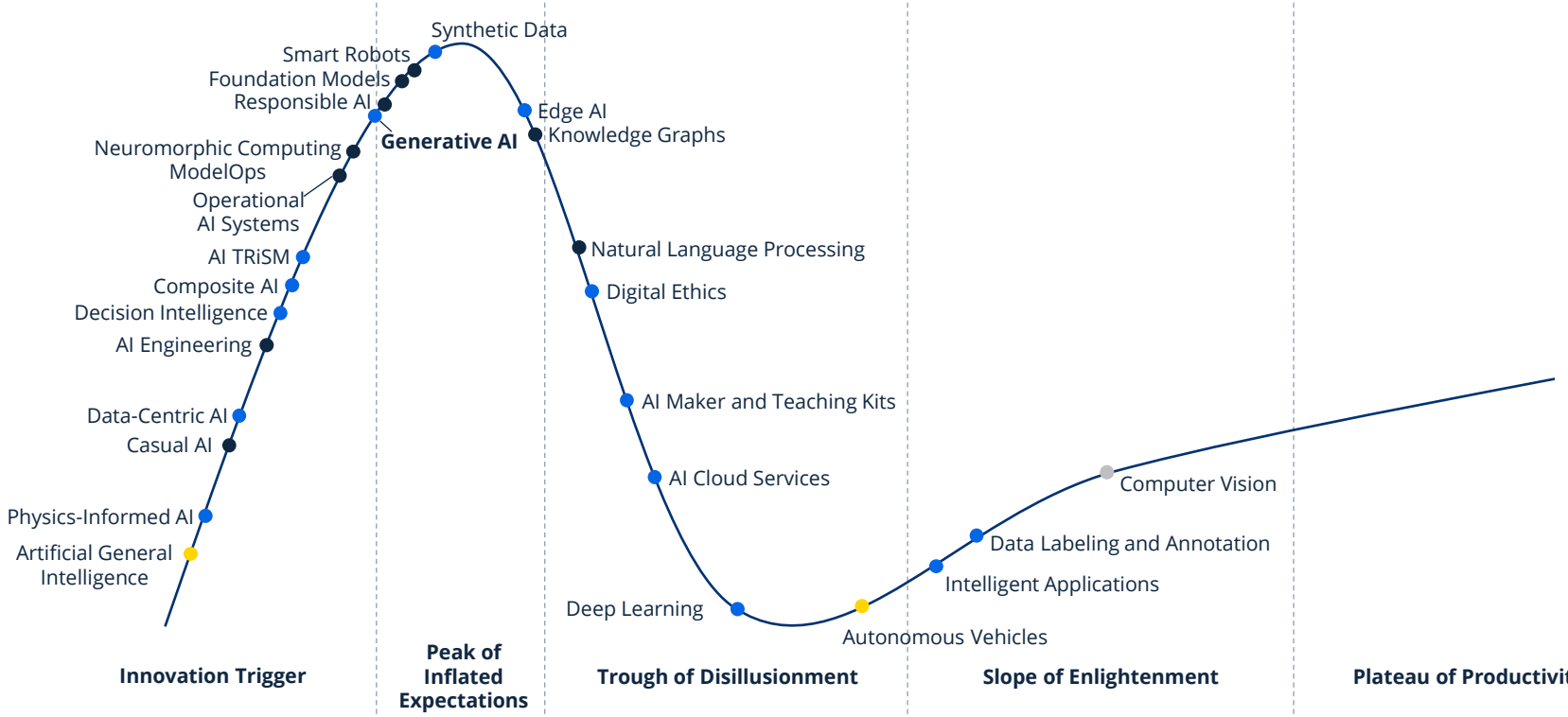
**Natural Language Processing**
Involves the interaction between computers and human language, enabling machines to understand, interpret, and generate natural language text or speech

**AI Robotics**
Focuses on the development of intelligent machines and systems that can perceive, reason, learn, and make decisions autonomously

**Sources:** Allianz global; Statista Market Insights, June 2023

# While certain AI disciplines, such as computer vision, are well underway, others, such as Generative AI and AI Engineering, are still in the innovation trigger phase

**Gartner Hype Cycle for Artificial Intelligence 2022**




Plateau will be reached: <2 years · 2-5 years · 5-10 years · <10 years

**4 main categories of AI innovations**

- **Data-centric AI:** Disrupts traditional data management by enriching training data, employing techniques such as synthetic data(1) and knowledge graphs(2), leading to improved ML(3) outcomes
- **Model-centric AI:** Enhances learning efficiency and knowledge representations with Composite AI, while Causal AI uses causal graphs and simulations for causality testing
- **Application-centric AI:** Optimizes decision-making processes by improving transparency and sustainability; Edge AI(4) is embedded in IoT endpoints that offer operational efficiency and reduced latency
- **Human-centric AI:** Focuses on making ethical and value-based decisions, while digital ethics addresses privacy and bias concerns

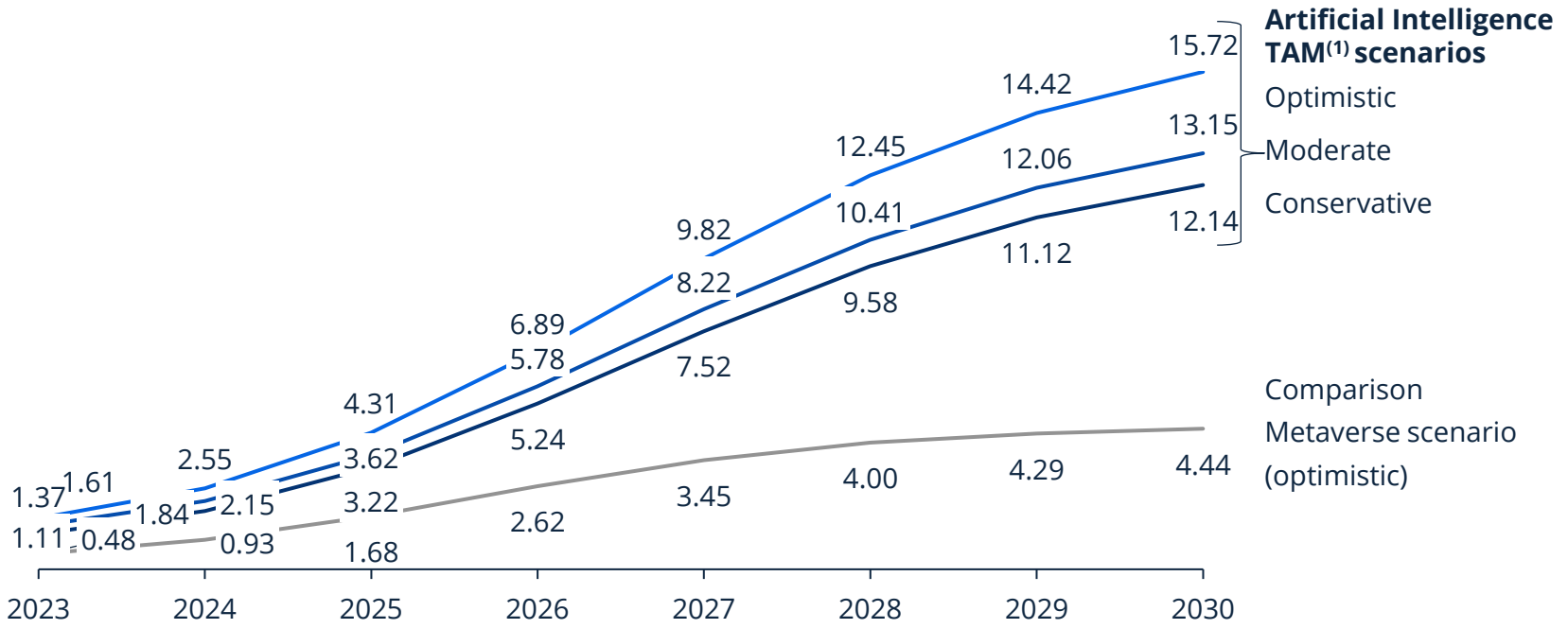


**Notes:** (1) Synthetic data replicates the characteristics of real-world data, serving as a privacy-preserving substitute for sensitive information. (2) Knowledge graphs are structured representations of information that capture relationships, entities, and attributes, enabling advanced data analysis and knowledge discovery. (3) Machine Learning (4) Edge AI allows for real-time data analysis directly at the source, without relying heavily on cloud.

**Sources:** Gartner

# In an optimistic scenario, the total addressable AI market in 2030 might be close to US$16 trillion

**Comparison of AI total addressable market scenarios and Metaverse (optimistic) scenario in trillion US$**




The scenario analysis shows the potential market value for AI. We assume different scenarios to account for a different adoption across potential markets:

- The scenarios account for a certain shift of AI into all applicable markets for an estimated lower and higher adoption over time
- Applicable markets in this sense are markets such as digital health and manufacturing where AI could play a role
- A percentage share for several industries where a shift to AI can take place is calculated according to industry impact, maturity, impact over time, and overall use of AI

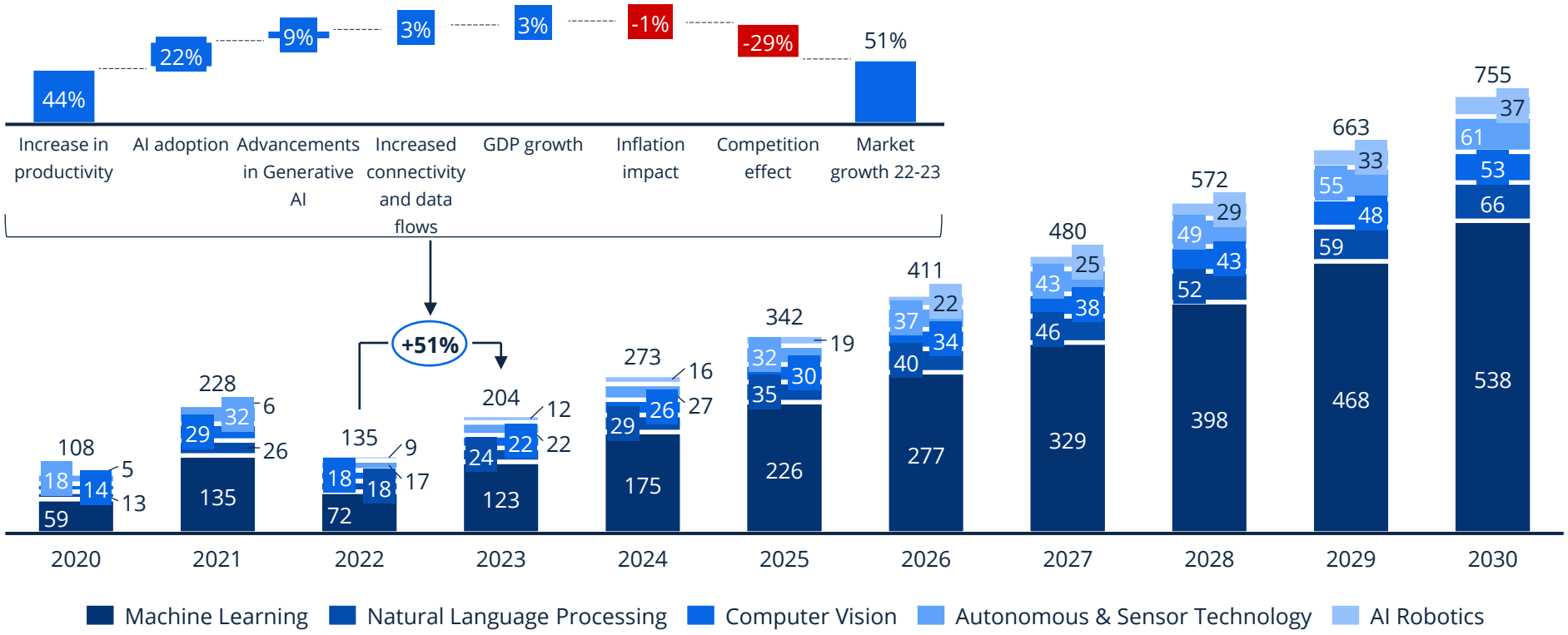


**Notes:** (1) Total Addressable Market

**Sources:** Statista Market Insights, June 2023

# As AI propels industries and reshapes the business landscape through increased productivity, it could reach a market value of US$755bn in 2030

**Global AI market value[1] development in billion US$ and YoY growth rate explanation[2] for 2022-2023**




**Tech markets CAGR 2020-2027**

| | |
|---|---|
| **AI** | **23.7%** |
| IoT | 20.5% |
| Cloud | 18.6% |
| Cybersecurity | 9.9% |
| Semiconductors | 8.0% |
| IT Services | 7.8% |
| Robotics | 6.2% |
| Software | 6.1% |

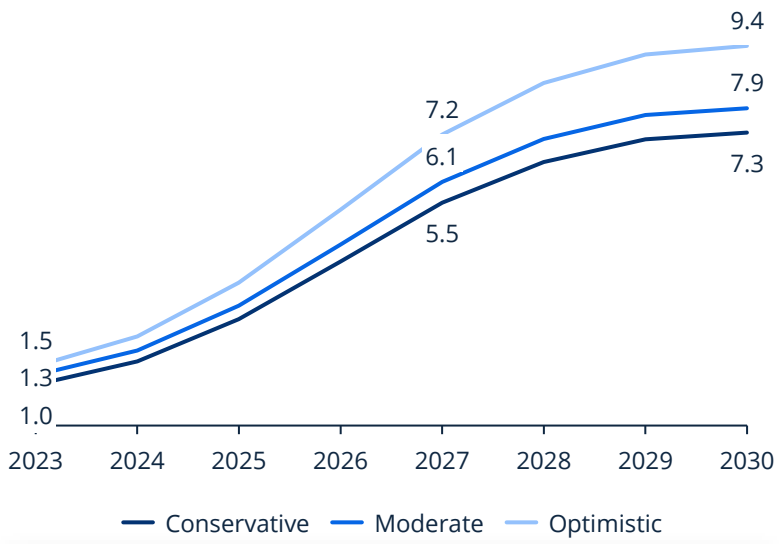


**Notes:** (1) Value in this case is different to market revenues as we use funding data for our calculations. Hence, the displayed values in the chart are based on funding amount for respective companies in the market. (2) GDP growth and inflation impact are considered as macroeconomic factors, whereas the other factors impact the market on a microeconomic level. Data is based on third-party research and Statista Market Insights analysis.

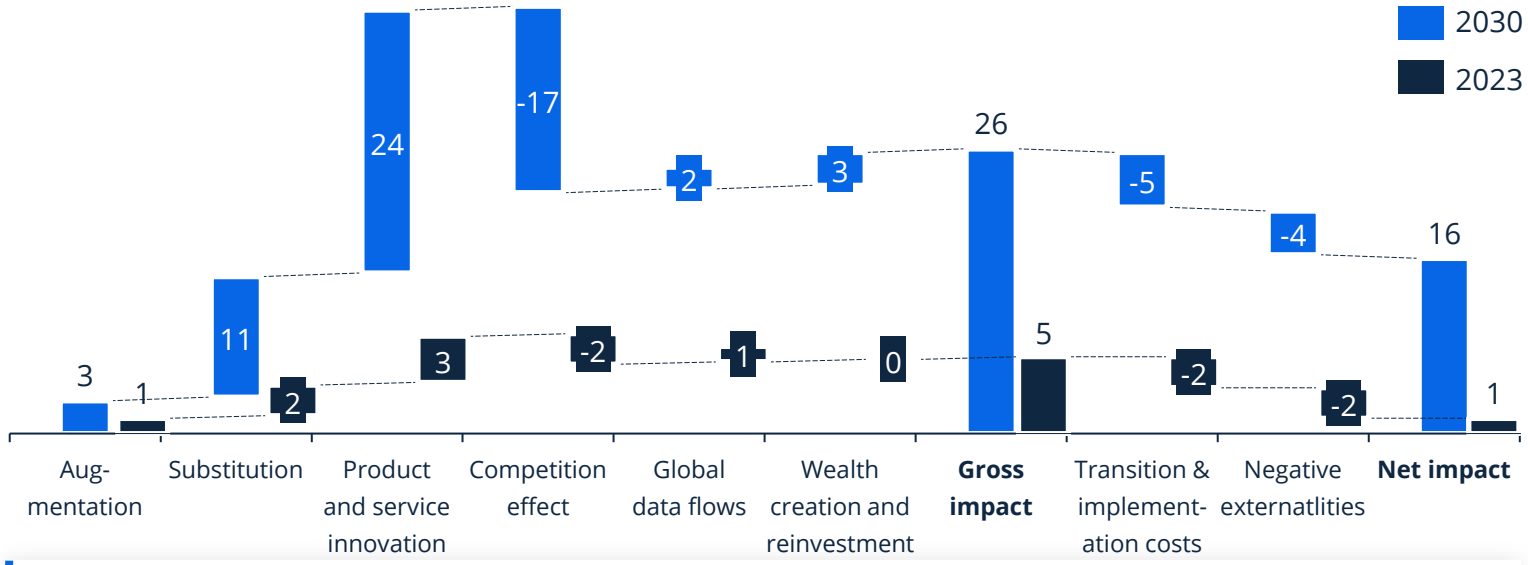
**Sources:** Statista Market Insights, June 2023

# AI will have a crucial impact on the GDP by boosting economic performance and especially with regard to product and service innovation

**Impact of the potential AI market on GDP in %**




**Breakdown of economic impact, cumulative boost vs. today in %[1]**




The outcome of the different scenarios is calculated and based on different assumptions for the adoption of AI. The numbers show the potential % share the AI market could have on the total GDP.

AI will have an immediate impact on the economy (categorized according to eight disparate factors) and lead to an overall impact of more than 1%. However, it is anticipated that by 2030, advancements in AI's output and applicability will lead to an overall boost of the economy of approximately 16%, especially with regard to product and service innovation.

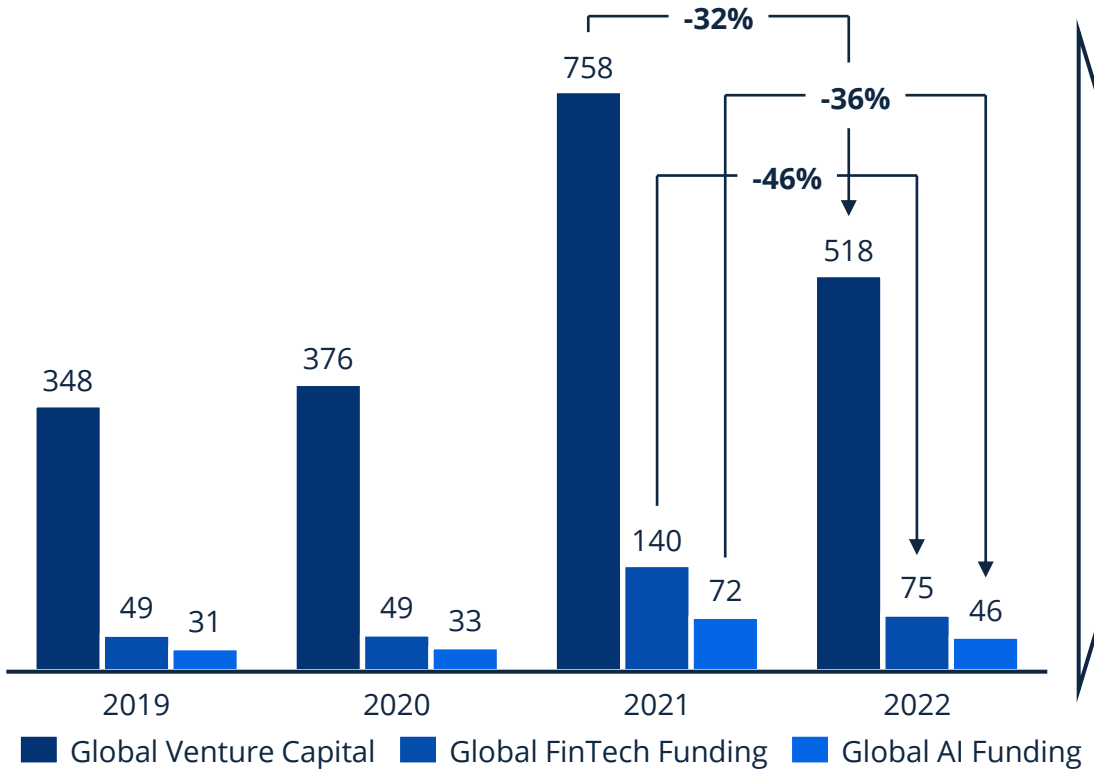


**Notes:** (1) Augmentation, Substitution, product and service innovation and competition effects are impacts on the production channel side, whereas global data flows and connectedness, wealth creation and reinvestment, transition and implementation costs and negative externalities are impacts on the externality channels.

**Sources:** Statista Market Insights, June 2023; McKinsey

# Nearly all markets are currently witnessing a plunge in investments, whereas AI has recently experienced a burst of activity

**Funding value in billion US$ across markets over time**




BUT

**Development of the AI market in the past 90 days (June 2023)[1]**


Even though funding is decreasing, there has been a lot of activity in past few months for AI. Investments will go up again in 2023 and exceed the 2022 values. As of *May* 2023, US$28.3 billion in funding has been made available for AI.



**Notes:** (1) Data comes from Crunchbase, AI companies funded in the last 3 months as of 1st June 2023

**Sources:** Dealroom; CB Insights; Crunchbase

# Successful venture capitalists that specialize in new technologies, such as a16z and Y-Combinator, are now essentially focused on AI

**a16z's investment strategy**

**27 funds**

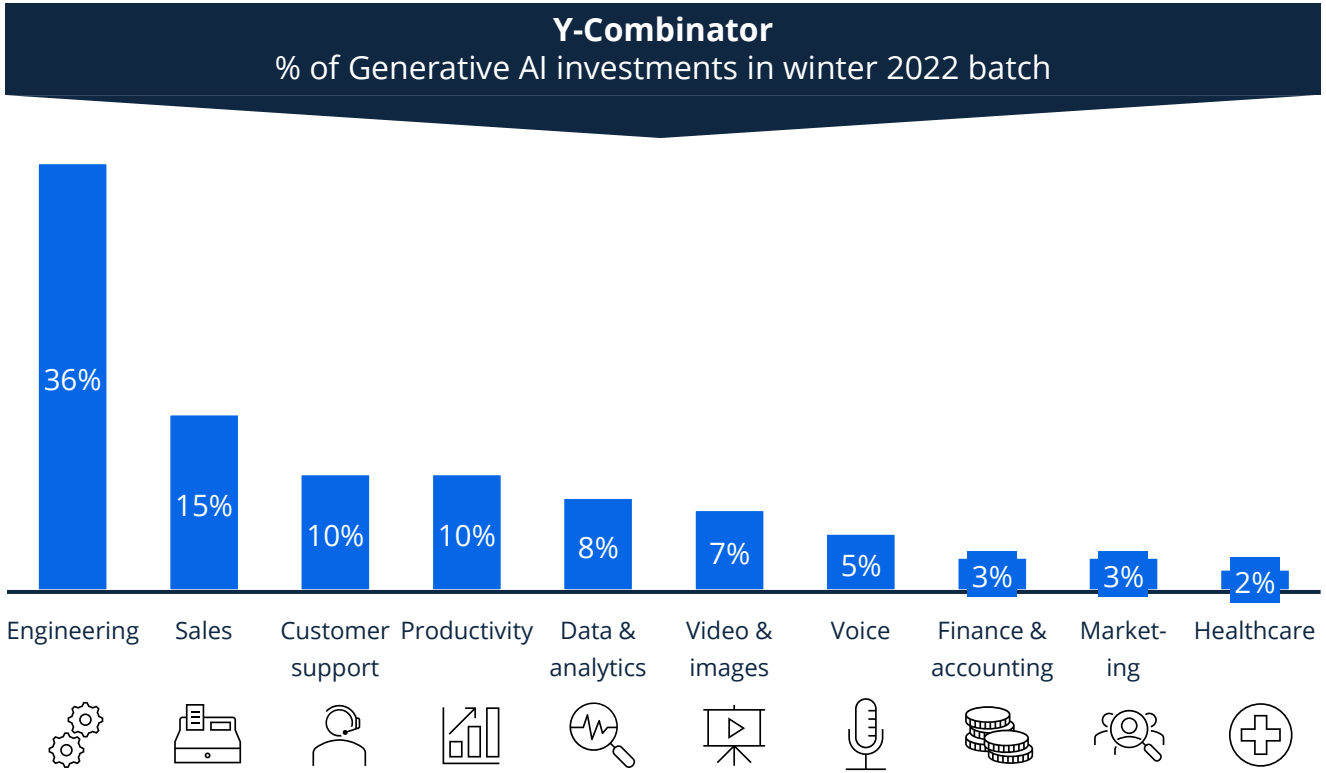
**Currently funding over 690 companies**

**Total fund raised $32.4 bn.**

**Latest investment: $300m in Open AI**

The venture capital firm Andreessen Horowitz (a16z) specialize early-stage and growth-stage investments in technology companies across various sectors, including software, internet, biotechnology, fintech, artificial intelligence, blockchain, and more. a16z has made investments in a wide range of AI-focused companies involved in machine learning, natural language processing, computer vision, and robotics, among others.

**Y-Combinator's investments in Generative AI**

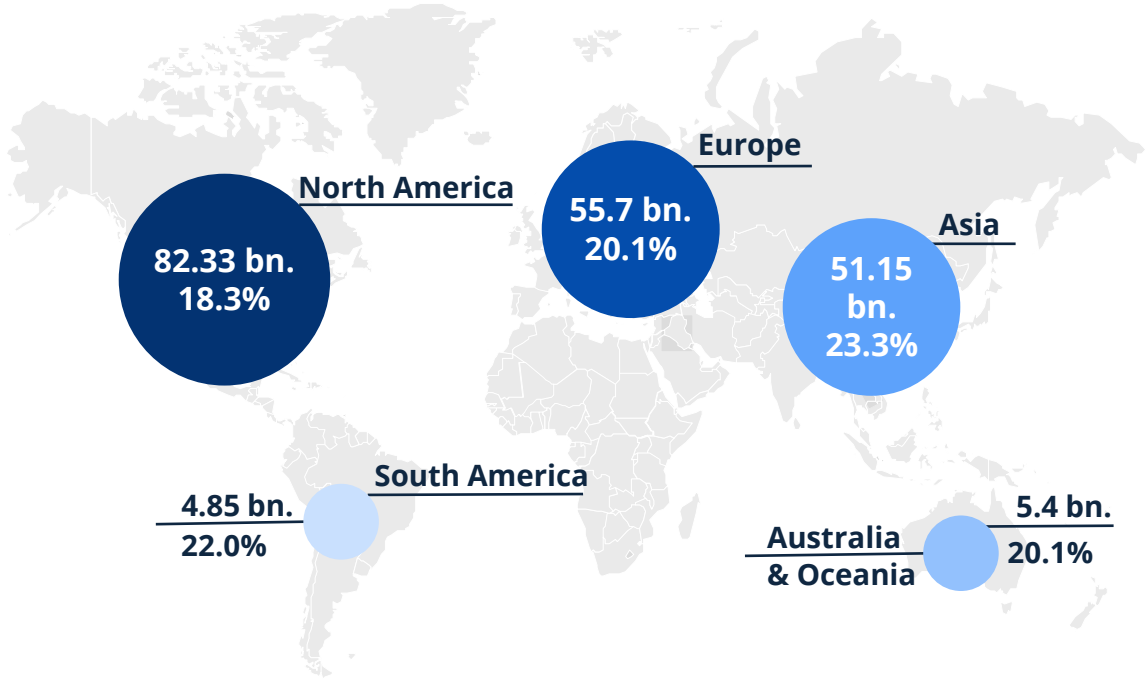




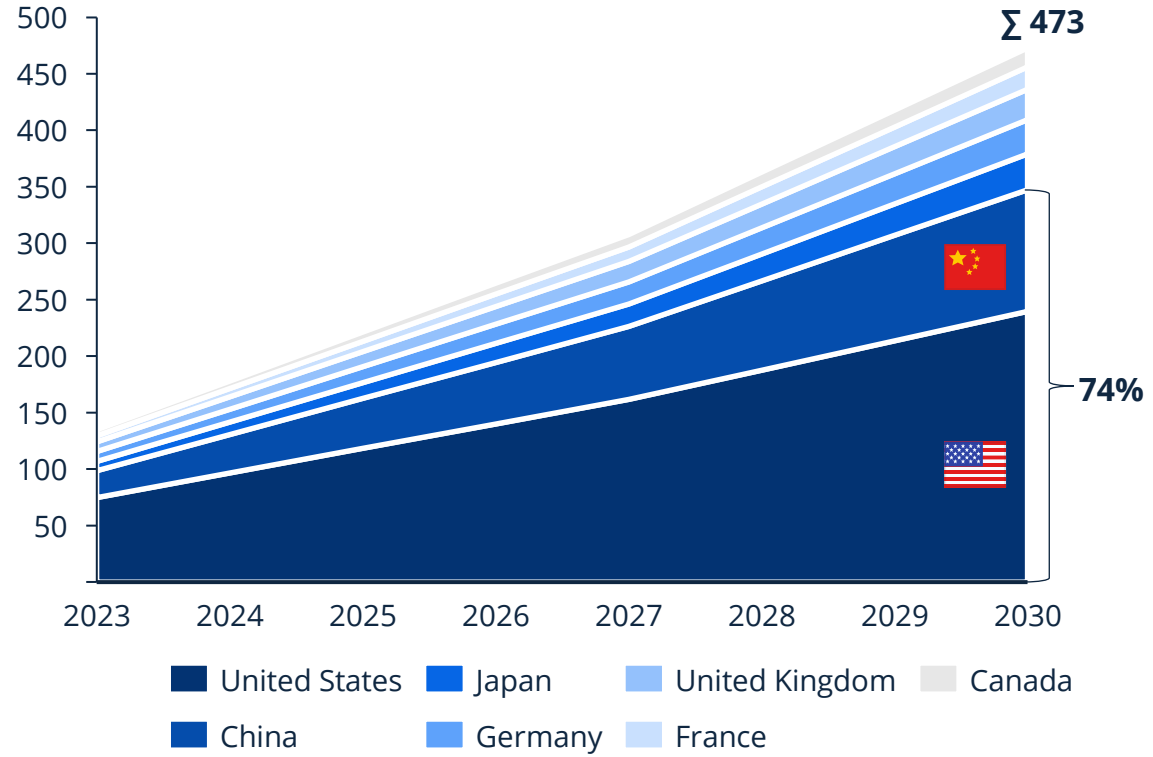

**Sources:** Dealroom; Crunchbase; CB Insights; Company information

# The U.S. has the highest demand for AI investments and will continue to be the market leader, but the most rapid growth will be in China

**AI investment size in 2023 in US$ and CAGRs between 2023 and 2030 by region**




**Countries with highest AI investments forecasted to 2030 in billion US$**





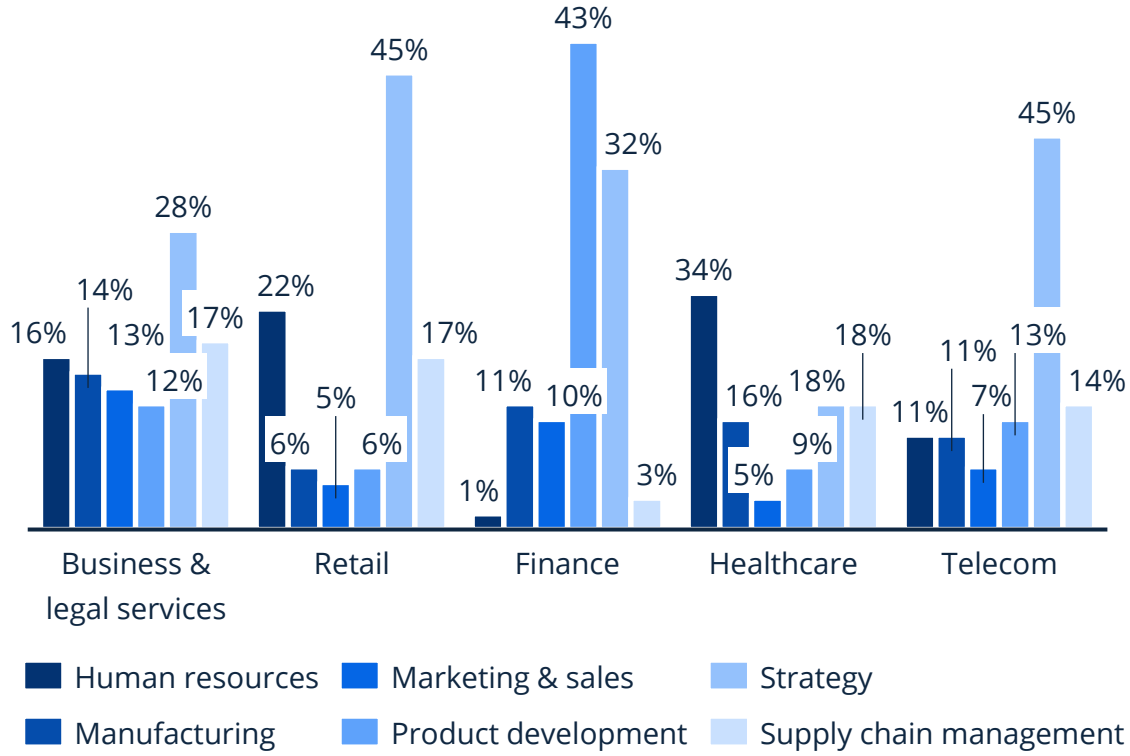

**Sources:** Statista Market Insights, June 2023

# So far, the prevalent reason for deploying AI technologies across sectors has been to aid strategy and product creation

**Share of investments across industries based on technology types in 2022**

| | Machine learning | Computer Vision | NLP(4) | Autonomous & Sensor-tech | Robotics |
|---|---|---|---|---|---|
| Business & Legal services | 10% | 7% | 1% | 26% | 0% |
| Retail | 6% | 6% | 4% | 4% | 5% |
| Finance | 15% | 2% | 0% | 8% | 0% |
| Healthcare | 12% | 20% | 3% | 9% | 4% |
| Telecom | 2% | 0% | 0% | 1% | 0% |
| Entertain-ment(1) | 5% | 2% | 1% | 14% | 0% |
| Public-sector(2) | 18% | 17% | 52% | 20% | 18% |
| Other industries(3) | 32% | 45% | 39% | 18% | 73% |

**Share of AI adoption by industry and their functions in 2022**



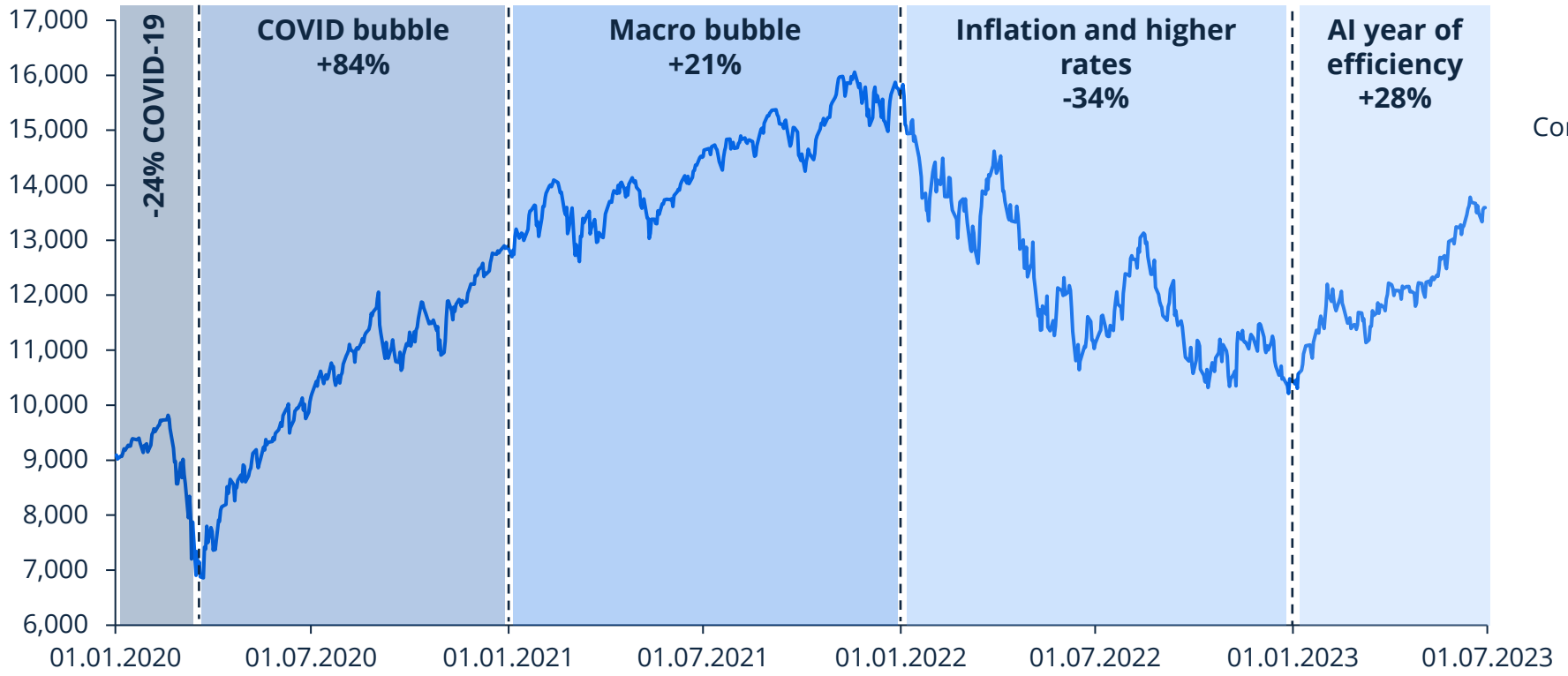



**Notes:** (1) Entertainment includes Media, Gaming, Event tech, Dating & Music industries (2) Public Sector includes Transportation, Energy and Real estate industries (3) Other industries include security, semiconductors, education, sports, hosting & robotics (4) NLP : Natural Language Processing

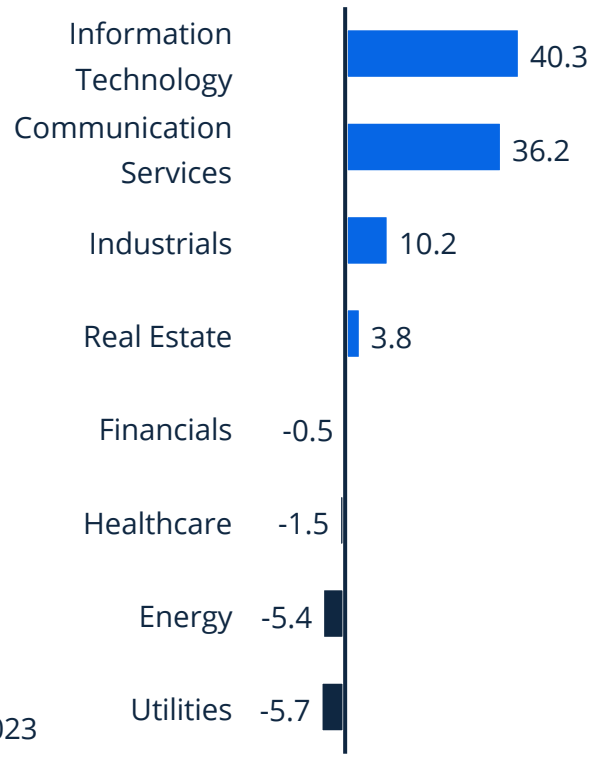
**Sources:** Stanford University; Statista Market Insights, June 2023

# The year of efficiency, proclaimed by many AI-focused companies, shows a market rebound led by the tech sector as "old economy" stocks still struggle

**NASDAQ performance by different stages**




**S&P 500 sectors YTD(1) returns**



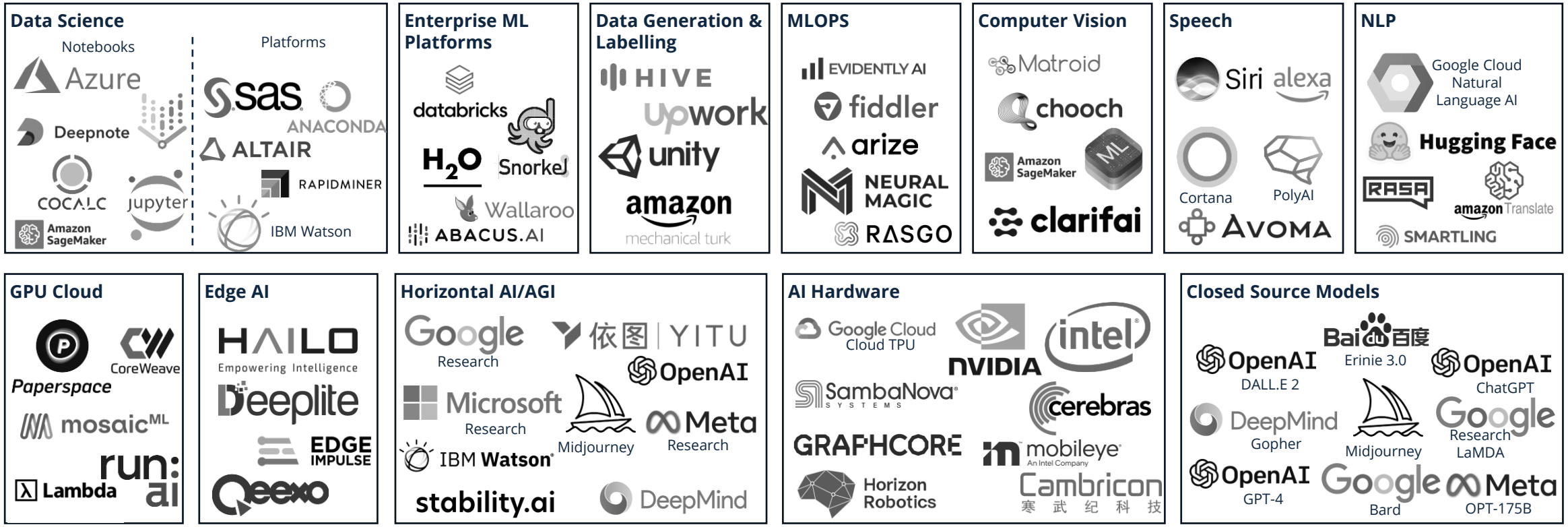



**Notes:** (1) 30th June 2023

**Sources:** macrotrends; lazyportfolioetf; Coatue

# As market potential and demand grows, tech giants compete for control in the AI ecosystem

**Selected key players in the AI space**

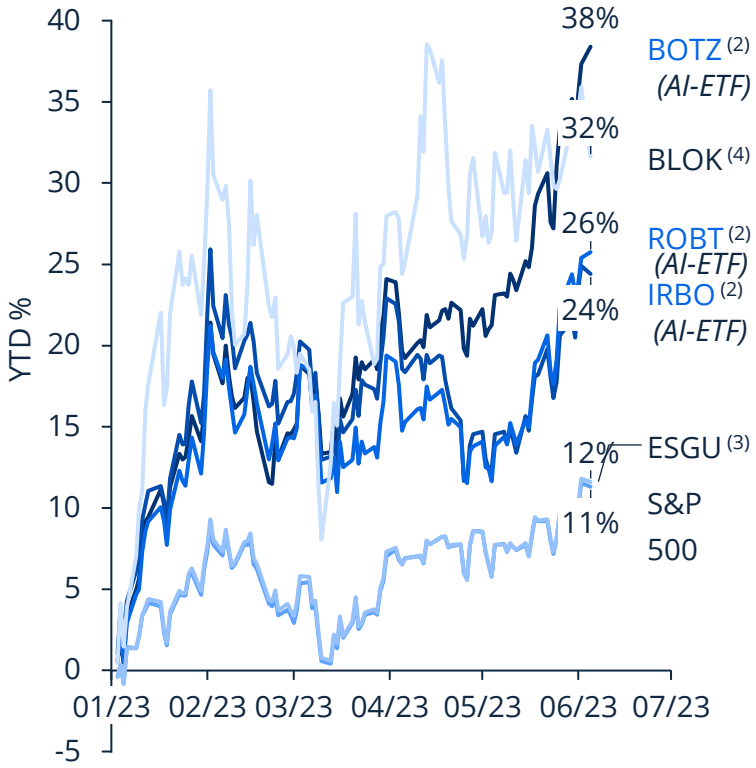




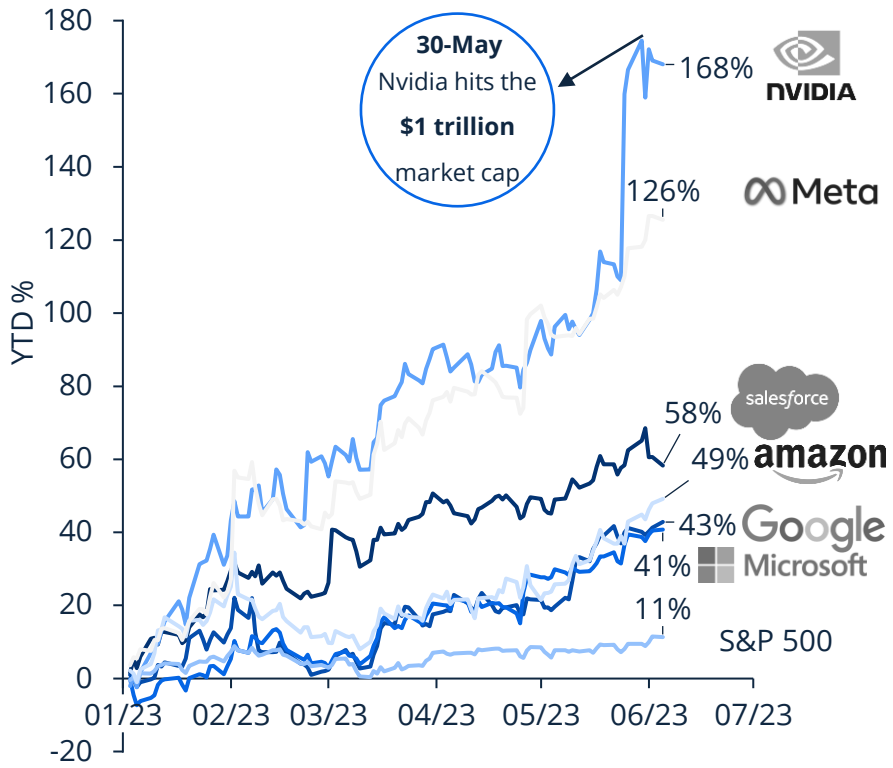

**Sources:** Company information; Statista Market Insights, June 2023

# AI ETFs outpace traditional index, meanwhile, AI-focused companies drive S&P 500 surge

**YTD (1) returns of selected ETFs**




**Market performance of AI-focused companies in the S&P 500**




The S&P 500 rallies by an impressive **11.31%** as of 05-Jun-2023, primarily driven by gains made by prominent technology companies fueled by the AI frenzy. These six companies constitute a combined weight of **26.3%** in the index, making them significant contributors to its overall performance.

A recent analysis by Societe Generale focused on 20 stocks held by AI-related exchange-traded funds, which have seen a 40% growth in assets under management this year. If these stocks were removed from the S&P 500, the index's performance would decline by approximately **10%** points, pushing stocks into negative territory for the year.

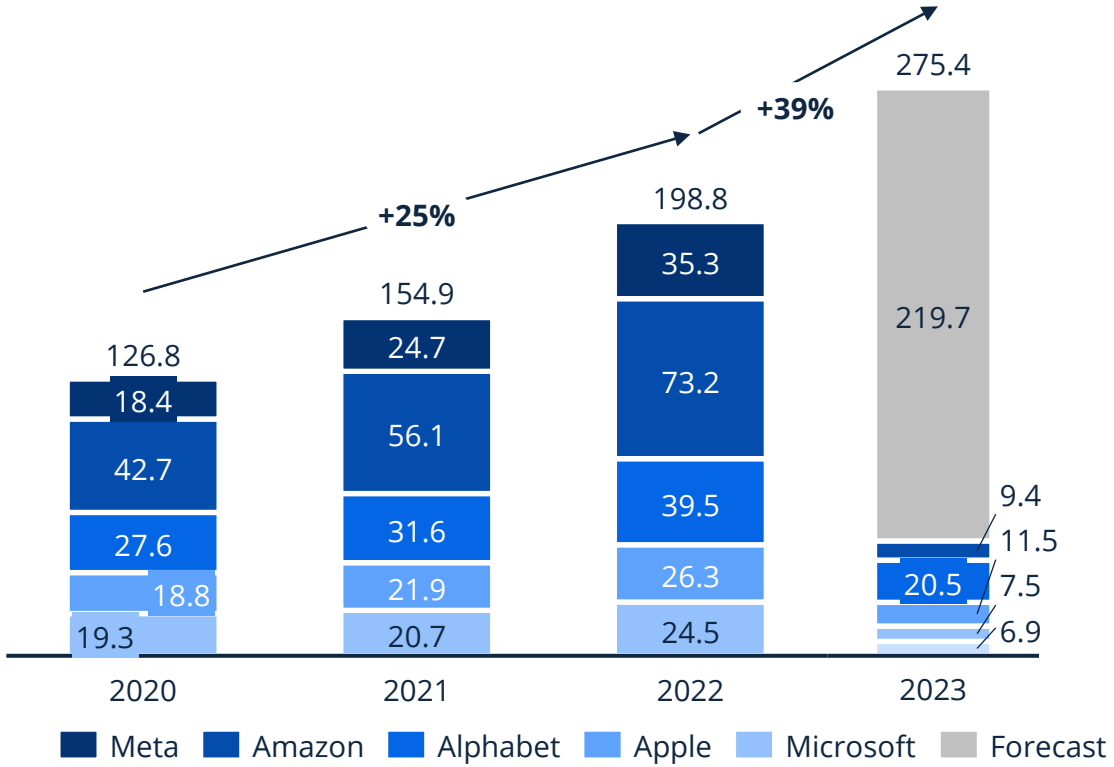


**Notes:** (1) YTD – Year-to-date : YTD return is the amount of profit (or loss) realized by an investment since the first trading day of the current calendar year (2) BOTZ, ROBT & IRBO are ETFs with high exposure to AI related technology and companies (3) ESGU is an ETF that incorporates environmental, social, and corporate governance considerations into their investment approach (4) BLOK is an ETF with exposure to crypto and crypto related companies

**Sources:** Statista Market Insights, June 2023; Reuters; Societe Generale

# Through AI, spending on R&D has skyrocketed across industries

**R&D spending by big tech companies in billion US$(1)**




Higher R&D spending than **Germany** in 2022 (143.1 bn.)

Higher R&D spending than **automotive** in 2022 (124 bn.)

Higher R&D spending than **GDP in Hungary** in 2022 (198 bn.)

- Microsoft Expanded partnership with OpenAI, launched Bing AI and Microsoft 365 Copilot, reported 2,500 Azure OpenAI customers, and expects AI to drive cloud growth.
- Alphabet Combined DeepMind and Google Brain, launched chatbot Bard, showcased AI-focused search functions, and aims to boost cloud revenues with AI.
- amazon Investing in generative AI and LLMs, launched AWS Bedrock for LLMs, and will use AI to drive advertising business growth.
- Meta Focused on AI for R&D and Metaverse topics, monetized content with AI recommendations, and leverages AI for business messaging and WhatsApp profitization.
- Apple Focused previously on hardware, expanded services segment, uses AI in products but needs to innovate in order to maintain market advantage.



**Notes:** (1) numbers are from the first quarter of 2023

**Sources:** Macrotrends; Statischtisches Bundesamt; R&D WORLD; ceoworld

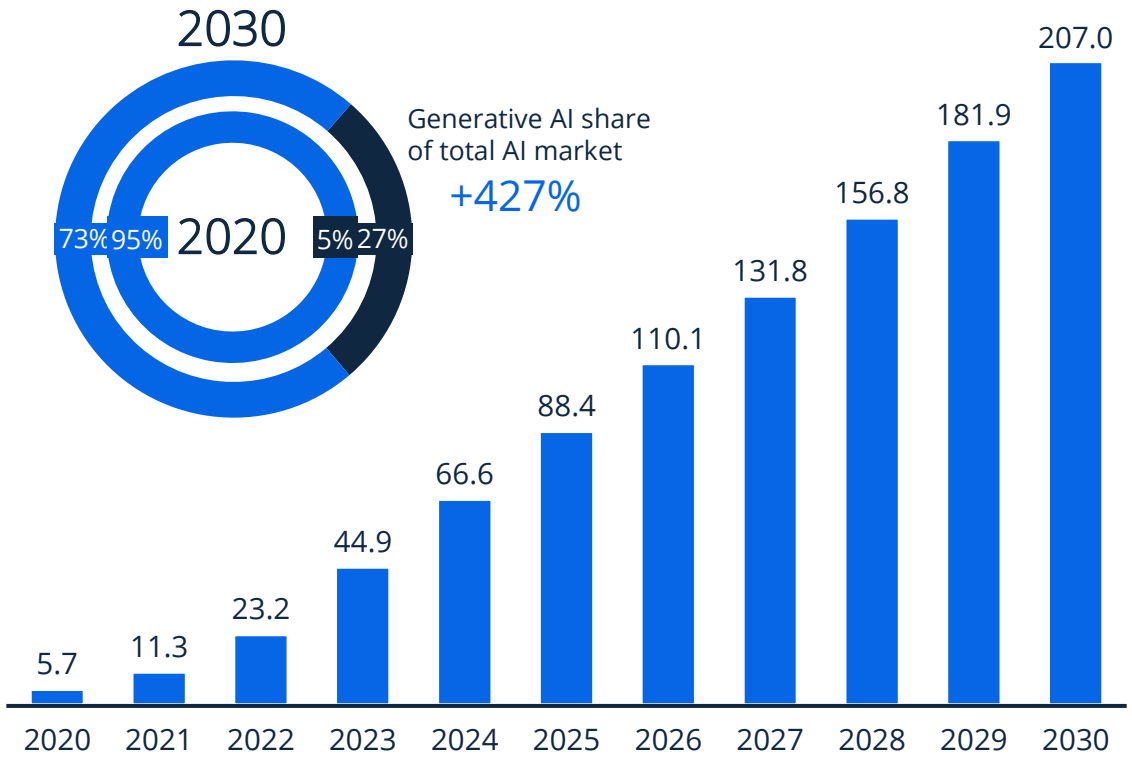
# A steam-engine moment to the computer age, generative AI is boosting efficiency and creativity to unprecedented heights

In the ever-evolving landscape of AI-advancements, one field stands out for its meteoric rise and transformative potential: generative AI. With predictions pointing to a staggering US$4.31 trillion contribution to the market by 2030, the growth of generative AI is nothing short of extraordinary. Large language models (LLMs), lying at the center of this transformation, continuing to grow in size and cost, changing the laws of what's possible. GPT-3 has set new records after being trained on a massive 45 terabytes dataset. GPT-4 not only outperformed more than 90% of practicing attorneys on the bar exam, but also displayed "human-level performance" in a variety of professional assessments. The consequences are mind-boggling, since generative AI now has the capacity to redefine human competence. The surge in funding within the generative AI sector is a testament to its promising future. With average funding amounts per round skyrocketing. As we stand at the precipice of a new era, generative AI holds the key to unlocking boundless creative potential.

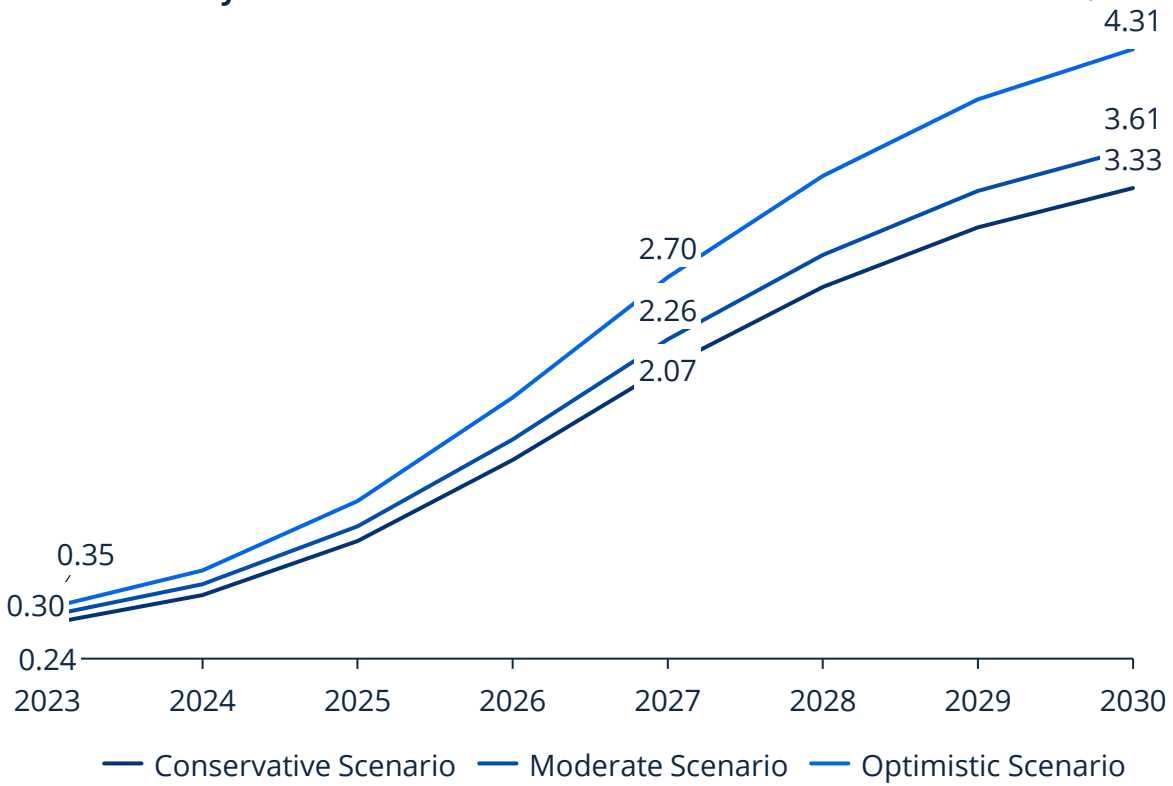


# Generative AI is the fastest growing category in the AI market with the potential to generate US$4.31 trillion by 2030

**Generative AI market value[1] in billion US$ and share of total AI market**




**Scenario analysis for total adressable Generative AI market in trillion US$**



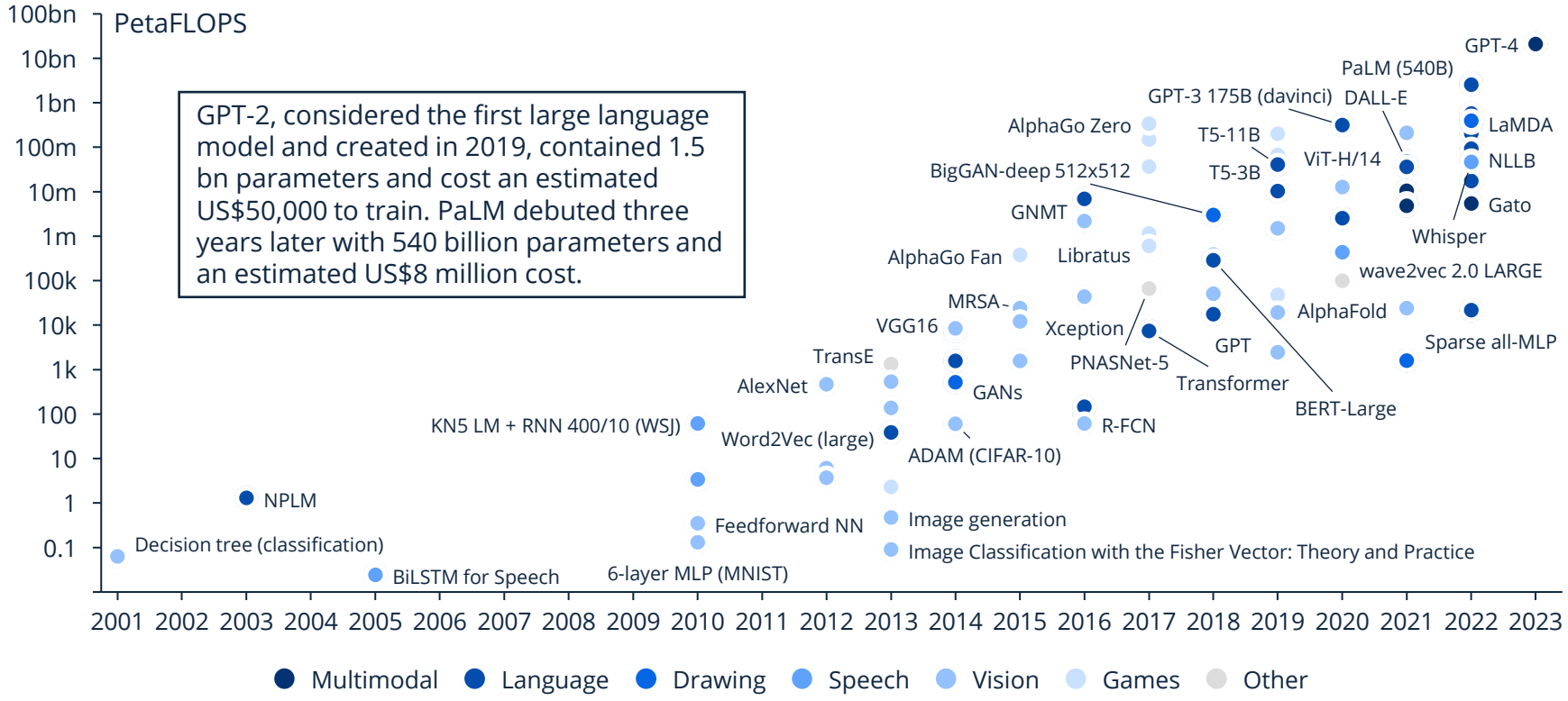



**Notes:** (1) Value in this case is different to market revenues as we use funding data for our calculations. Hence, the displayed values in the chart are based on funding amount for respective companies in the market.

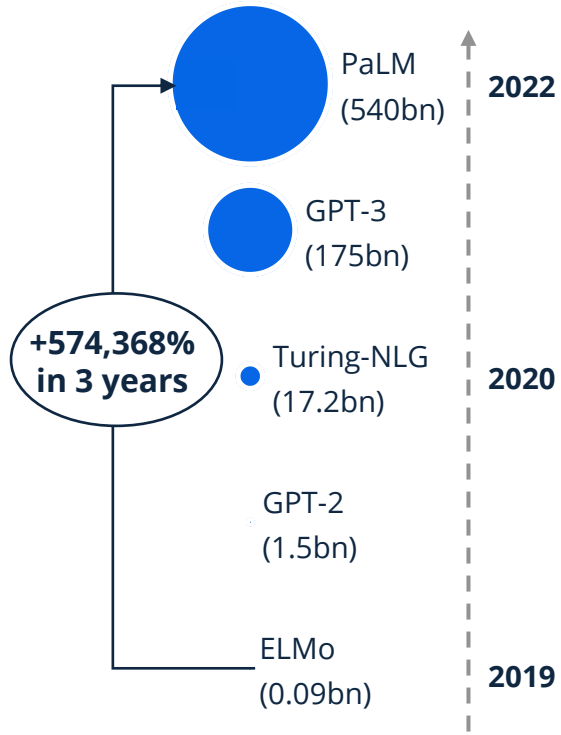
**Sources:** Statista Market Insights, June 2023

# Large language models (LLMs) as the algorithmic basis for many generative AI applications continue to rapidly expand in terms of scale and cost

**Computation used to train notable artificial intelligence systems**




**Language Model size in billions of parameters**






**Notes:** Computation is measured in total petaFLOP, which is $10^{15}$ floating-point operations.

**Sources:** ourworldindata; cmte

# It has been documented that the GPT-3 model was trained on approximately 45 terabytes of pure text data from multiple AI training datasets

**GPT-3 Training data**

| Dataset | Content | Raw size (tokens, ~words, in billions) | Weight (in training mix) | Composition (actual % of total content mass) | Amplification (or suppression) |
|---|---|---|---|---|---|
| Common Crawl | web corpus, incl. images, links = 3.2bn pages | 410 | 60% | 82% | -0.27 |
| WebText2 | external reddit links = 45m high quality pages | 19 | 20% | 4% | +5.00 |
| Books1 & Books 2 | selection of 200k books | 67 | 15% | 13% | +0.15 |
| Wikipedia | knowledge base in English lang. | 3 | 5% | 1% | +5.00 |

**Thompson's analysis of the individual sources of GPT-3 training data**

| CommonCrawl | |
|---|---|
| Google Patents | 0.48% |
| The New York Times | 0.06% |
| Los Angeles Times | 0.06% |
| The Guardian | 0.06% |
| Public Library of Science | 0.06% |
| Forbes | 0.05% |
| Huffington Post | 0.05% |
| Patents.com | 0.05% |
| Scribd | 0.04% |
| Other | 99.09% |

| WebText2 (Reddit links) | |
|---|---|
| Google | 3.4% |
| Archive | 1.3% |
| Blogspot | 1.0% |
| GitHub | 0.9% |
| The New York Times | 0.7% |
| Wordpress | 0.7% |
| Washington Post | 0.7% |
| Wikia | 0.7% |
| BBC | 0.7% |
| Other | 89.9% |

| Books1 & Books2 | |
|---|---|
| Romance | 26.1% |
| Fantasy | 13.6% |
| Science Fiction | 7.5% |
| New Adult | 6.9% |
| Young Adult | 6.8% |
| Thriller | 5.9% |
| Mystery | 5.6% |
| Vampires | 5.4% |
| Horror | 4.1% |
| Other | 18.0% |

| English Wikipedia | |
|---|---|
| Biography | 27.8% |
| Geography | 17.7% |
| Culture & Arts | 15.8% |
| History | 9.9% |
| Biology, Health, Medicine | 7.8% |
| Sports | 6.5% |
| Business | 4.8% |
| Other society | 4.4% |
| Science & Math | 3.5% |
| Education | 1.8% |

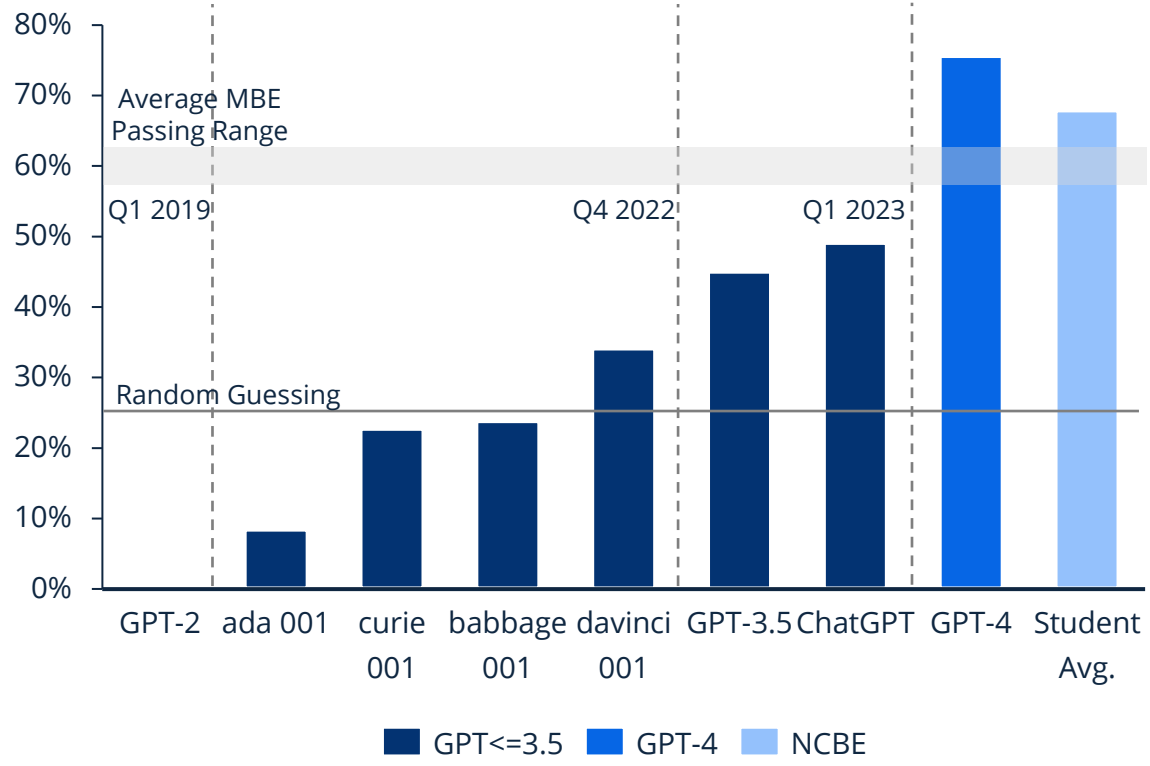


**Notes:** AI training systems measure data size in "tokens". A token equates to roughly 4 ASCII text characters. The average word in the English language equates to a length of 4.7 characters. For this reason, we can do a simplified translation, and basically equate the technical term "token" with the human term "word".

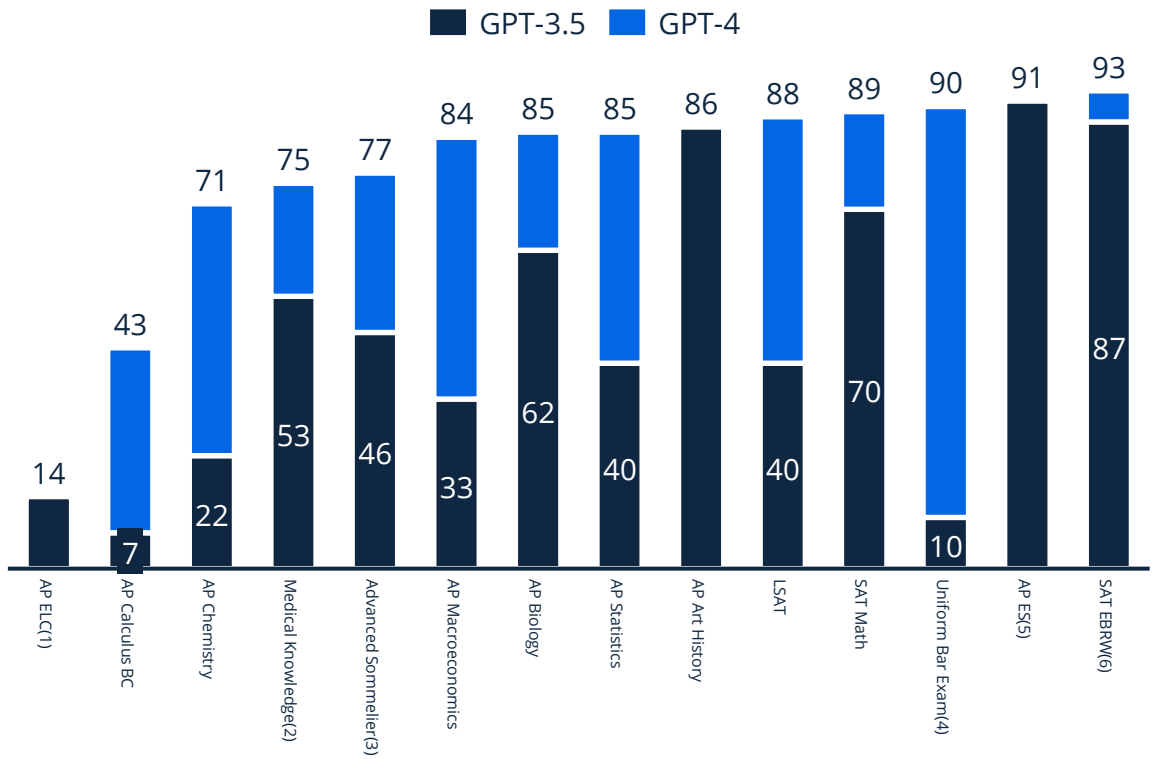
**Sources:** lifearchitect; gregoreite

# Released in March 2023, GPT-4 recently outsmarted 90% of law students on the bar exam and demonstrated human-level abilities on other professional exams

**Progression of GPT Models on the Multistate Bar Exam (MBE)**




**Exam results from GPT-3.5 and GPT-4 estimated percentile lower bound**




28 **Notes:** (1) English Language and Composition (2) Self-Assessment Program (3) Theory knowledge (4) MBE+MEE+MPT (5) Environmental Science (6) Evidence-Based Reading & Writing

**Sources:** GPT-4 Passes the Bar Exam - Daniel Martin Katz, Michael James Bommarito, Shang Gao and Pablo David Arredondo, Brian Wang (nextbigfuture)

# Depending on its type, Generative AI has the capacity to produce a range of outcomes in the form of images (video), text, or audio

**Generative AI**

| Generating content and ideas | Improving efficiency | Personalizing experiences |
|---|---|---|
| Creating new, unique outputs across a range of modalities, such as a video advertisement or even a new protein with antimicrobial properties. | Accelerating manual or repetitive tasks, such as writing e-mails, coding, or summarizing large documents. | Creating content and information tailored to a specific audience, such as chatbots for personalized customer experiences or targeted advertisements based on specific customer behavior patterns. |

**Types**

| Image (video) generation | Text generation | Audio generation |
|---|---|---|
| Midjourney<br>DallE | ChatGPT<br>Hugging Face | Tacotron 2<br>WaveGAN |

**Examples of Generative AI technology**

| | Input | Output |
|---|---|---|
| Chat GPT | "Write a limerick about data taking over the world, include the word egg" | "Data taking over the world, it's true it's growing like an egg that's due, It's everywhere we go, it's taking over slow. But it's the future, there's nothing we can do" |
| Midjourney | prompt for image generation, such as rabbit wearing a hat | creating fictional and realistic pictures based on input prompts  |
| Codex | „Write a script to change a website's background color in Python" | Python code for changing the website's background color |



**Sources:** BCG; Visual Capitalist

# With a total of six different modalities, there exists a vast number of applications and use cases that improve processes in a variety of fields

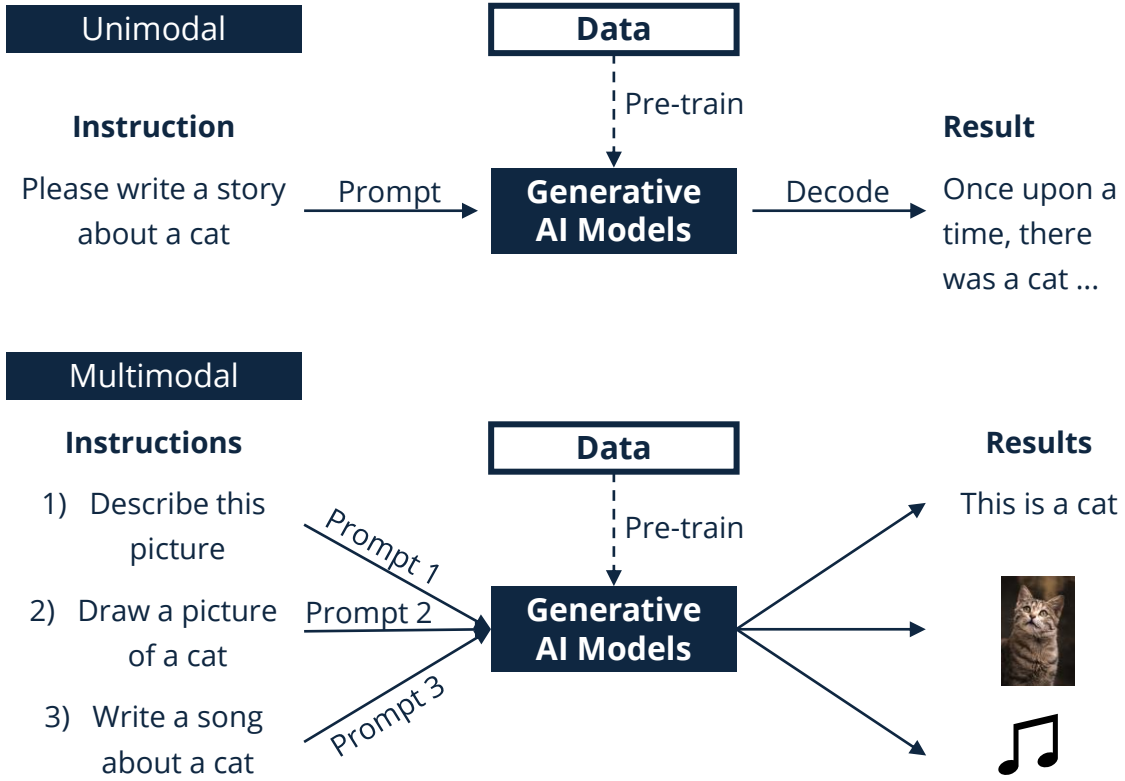
| Text | Code | Image | Audio | 3-D or other | Video |
|---|---|---|---|---|---|
| • Content writing<br>• Chatbots or assistants<br>• Search<br>• Analysis and synthesis | • Code generation<br>• Application prototype and design<br>• Data set generation | • Stock image generator<br>• Image editor | • Text to voice generation<br>• Sound creation<br>• Audio editing | • 3-D object generation<br>• Product design and discovery | • Video creation<br>• Video editing<br>• Voice translation<br>• Face swaps |
| Creative writing prompts and language translation to break barriers and assist writers in generating new stories or translating text accurately | Code autocompletion for developers, suggesting contextually relevant code snippets, and code refactoring to improve code quality, readability | Image style transfer for artistic transformations and image captioning for automatic tagging, content summarization, for visually impaired individuals | Music generation for creating new melodies or tracks and speech synthesis for realistic human-like speech, enabling voice assistants and personalized voice messages | 3D object generation for creating virtual objects and environments in various applications, such as gaming, simulation, and virtual reality experiences | Video synthesis for generating new videos based on existing footage and video captioning for automatic video summarization, search, and content understanding |



**Sources:** McKinsey

# Within generative AI there exist two models, and their approaches vary according to the use case

**Unimodal and multimodal Generative AI models(1)**




**Technology used in Generative AI models**

| Generative Adversarial Networks **(GANs)** | Variational Autoencoders **(VAEs)** | **Flow-based Generative Models** |
|---|---|---|
| • GANs are highly effective in generating realistic multimedia, including deepfakes, movie dubs, and images from text descriptions.<br>• They utilize a generator network to create content and a discriminator network to assess the realism of the generated data.<br>• Through iterative training, GANs continuously improve their ability to generate data that closely resembles reality. | • VAEs are commonly used in signal analysis tasks.<br>• They utilize encoder and decoder networks within an autoencoder framework.<br>• VAEs focus on efficient data representation and reconstruction, minimizing errors between original and reconstructed data.<br>• Used for cleaning data, predictive analysis, data compression, and reducing data dimensionality. | • Flow-based generative models are commonly used for generative AI tasks.<br>• A flow-model architecture is used to map a simple distribution to a complex data distribution.<br>• Flow-based models learn the mapping through invertible transformations, allowing efficient sampling and likelihood estimation.<br>• Used for generating realistic images, text, and other types of data. |

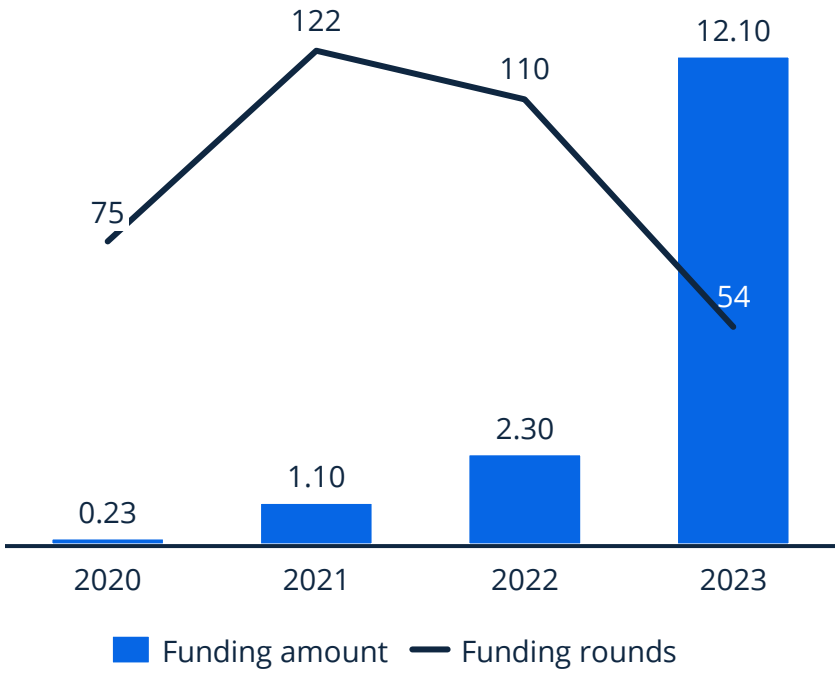


**Notes:** (1) Unimodal models and multimodal models. Unimodal models receive instructions from the same modality as the generated content modality, whereas multimodal models accept cross-modal instructions and produce results of different modalities

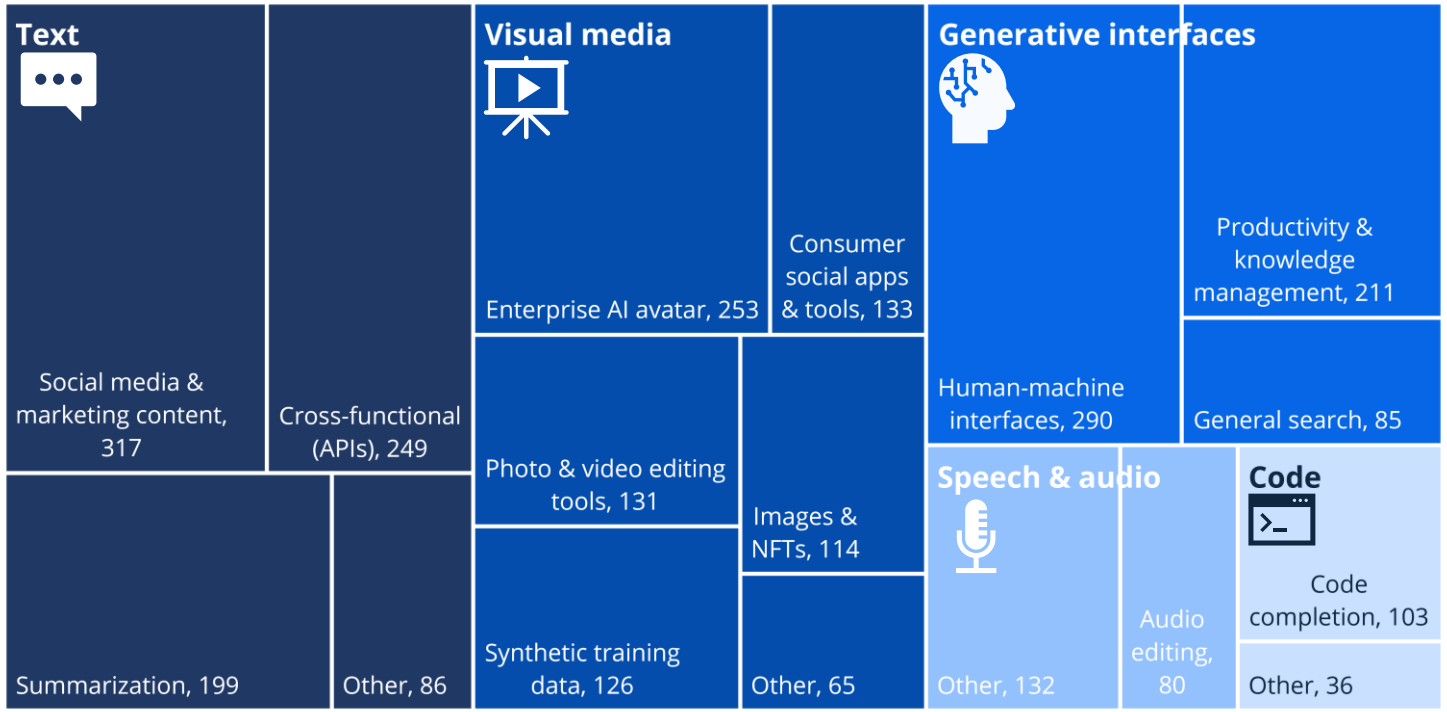
**Sources:** AIMultiple; J. ACM; TechTarget

# The number of funding rounds plummeted in 2023, whereas the average funding amount per round significantly increased

**Funding amount in billion US$ and number of funding rounds for Generative AI**




**Distribution of funding for Generative AI in million US$ for 2021 to 2022**

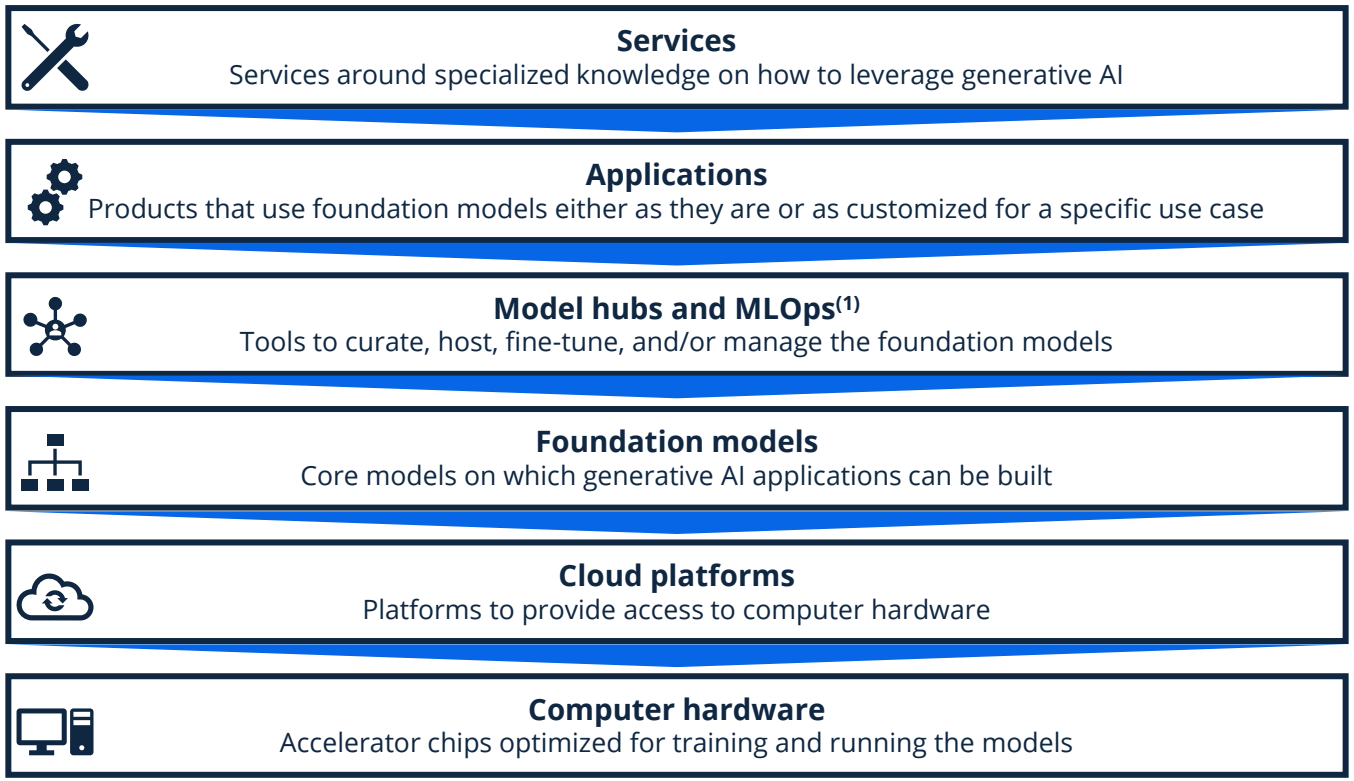




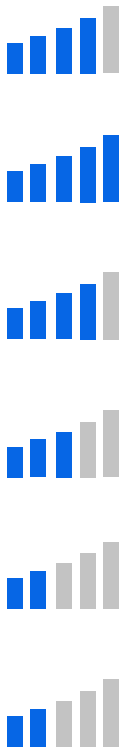

**Sources:** Dealroom; CB Insights

# Services and applications will have the most opportunities for new entrants in the next three to five years

**Generative AI value chain**




**Opportunity size for new entrants in the next 3-5 years**



- The development of generative AI systems has led to the emergence of a new value chain, similar to traditional AI but with some notable differences.
- Generative AI systems are more complex than traditional AI systems and create in higher costs, longer development time, and greater expertise requirements. This poses challenges for new entrants and small companies across the value chain.
- Tech giants and incumbents are expected to dominate many areas of the generative AI value chain, therefore limiting opportunities for new players.
- Applications have the biggest opportunity because companies that utilize specialized or proprietary data to fine-tune applications can gain a significant competitive advantage over those that do not.

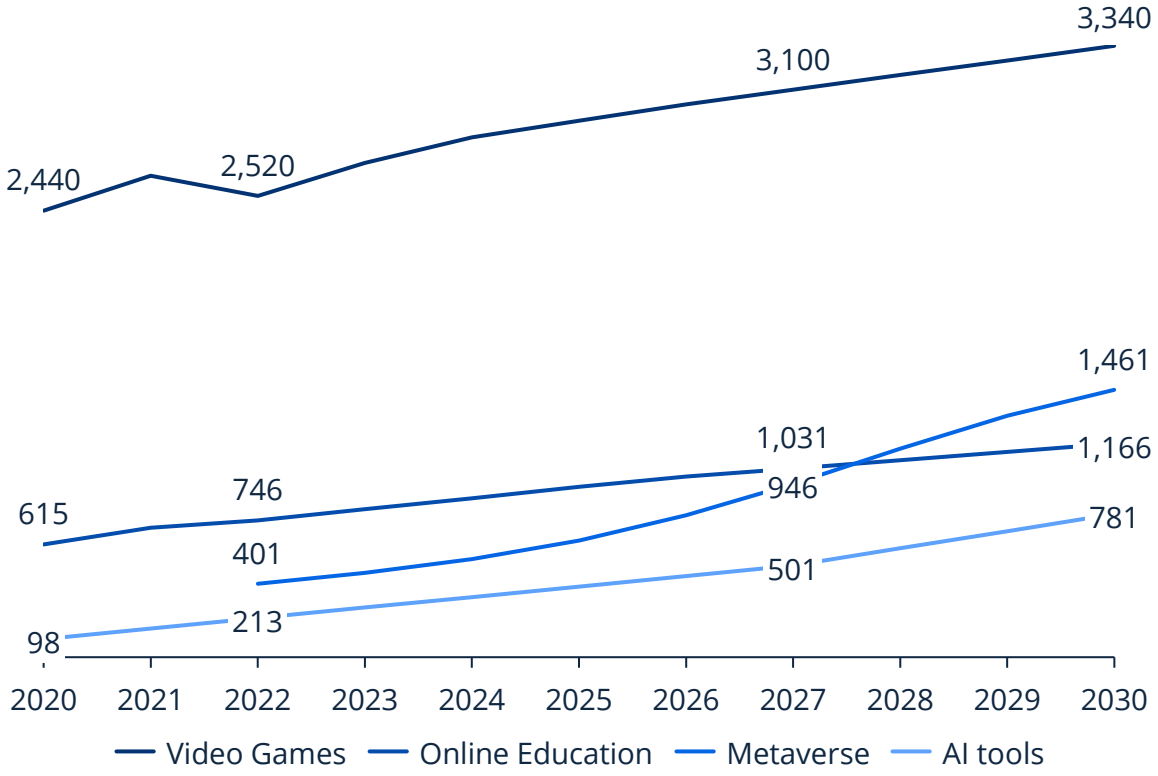


**Notes:** (1) Machine Learning Operations

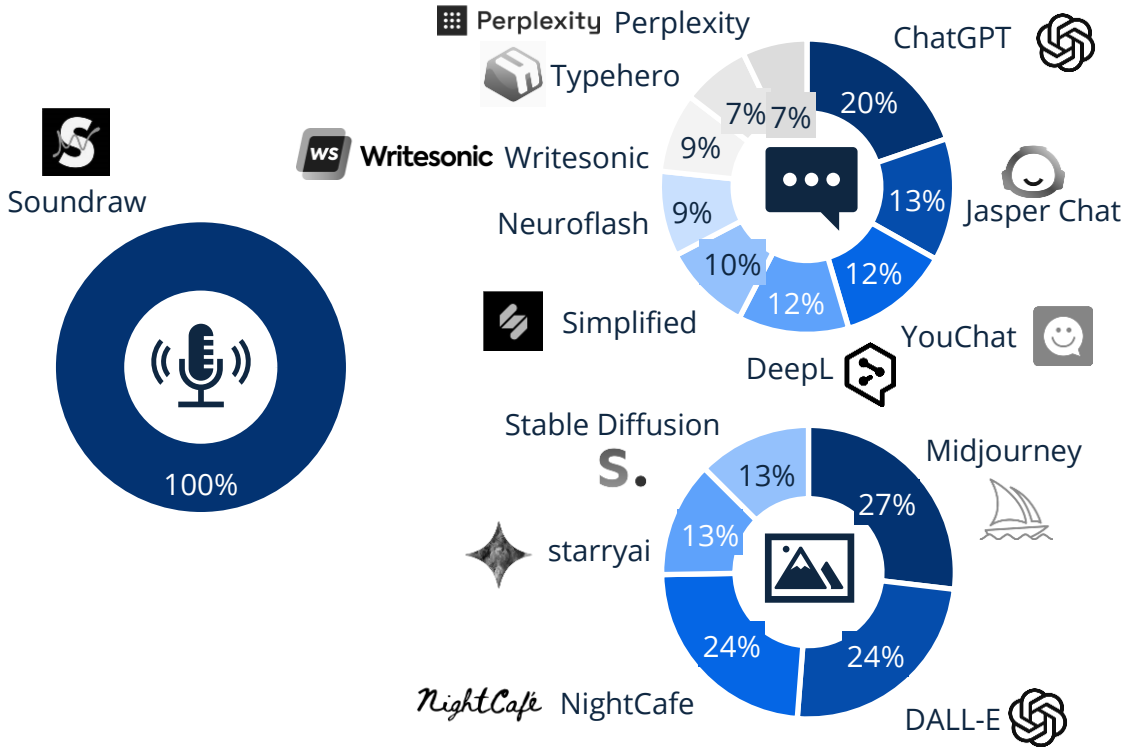
**Sources:** McKinsey

# Generative AI tools will acquire more and more users in the future as tools are continuously added to execute a variety of functions

**Number of AI tools users compared to other categories in million**




**Share of different AI tools by application type 2023(1)**




34 **Notes:** (1) shares are the average from the U.S., the UK, and Germany, which represent almost 50% of the market

**Sources:** Statista Market Insights, June 2023; Statista Consumer Insights 2023

# Large companies across various industries are already using Generative AI for their benefit

## Industrials

- **Building design,** auto-generation architectural plans
- **Manufacturing & product design,** accelerate design and development
- **Infrastructure design,** buildout optimization
- **Materials discovery,** identify and test new material
- **Synthetic data for auto. driving,** produce data to train and test
- **Procurement,** write sourcing plans

General Electric

uses AI algorithms to predict maintenance needs for industrial equipment, helping to optimize maintenance schedules and reduce unplanned downtime

## Finance

- **Conversational finance,** can perform financial tasks and transactions
- **Financial analysis,** analyze financial data and information at scale
- **Synthetic data generation,** improve financial models and ensure compliance

PayPal

utilizes AI-powered algorithms to detect and prevent fraudulent transactions, protecting users from financial losses

## Retail

- **Virtual photoshoots,** virtual fashion models to display items
- **3D product catalogs,** convert 2D images or text to 3D objects
- **Customer service support,** assist customer service agents
- **E-commerce product descriptions,** text generation for better description
- **Personalized marketing content,** scale visual content creation

amazon.de

is widely known for its recommendation system, which uses AI algorithms to suggest products based on customer preferences and purchase history

## Gaming

- **Graphics,** creating artwork in 2D and 3D
- **Characters,** create believable characters
- **Audio,** create dialogs and music for games

OpenAI

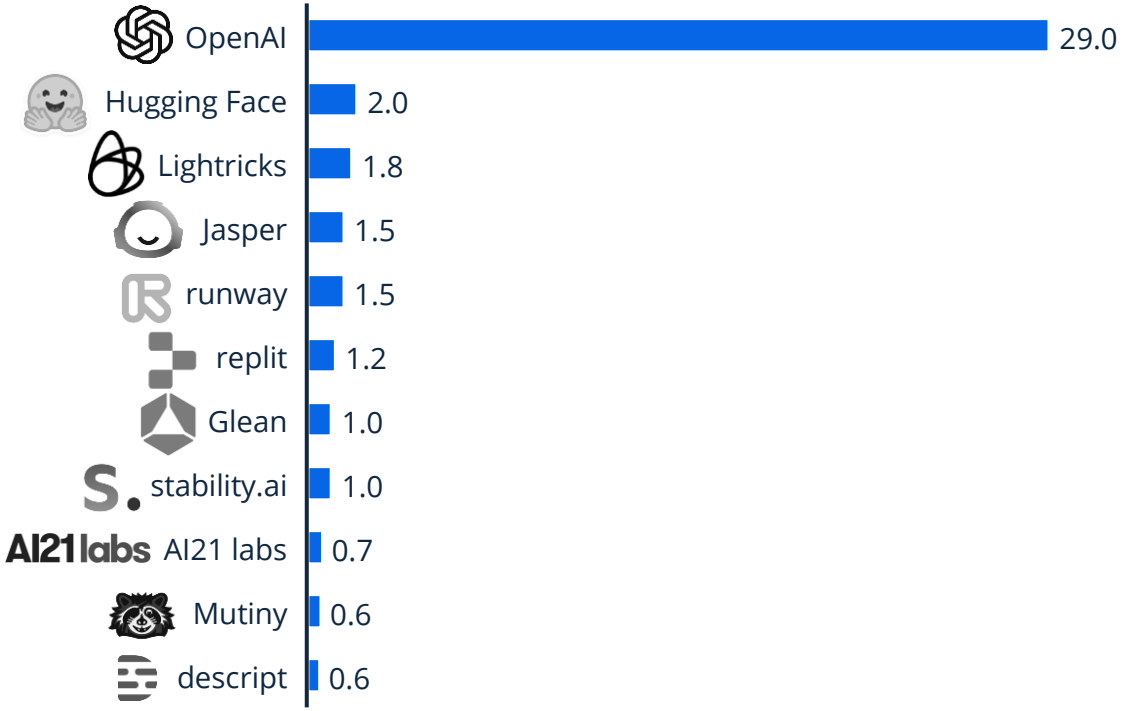
The OpenAI Dota team demonstrated advanced AI capabilities by defeating professional human players in the popular multiplayer online battle arena game Dota 2



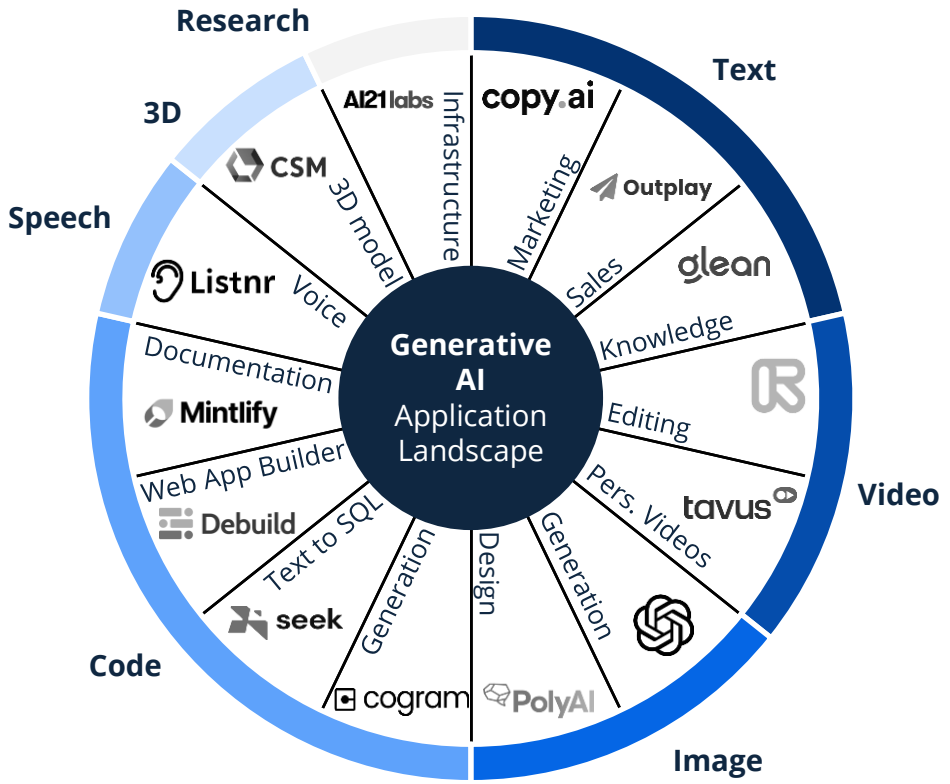
**Sources:** CB Insights; a16z

# OpenAI is by far the most valuable generative AI company based on its wide range of tools and uses

**Most valuable generative AI companies as of June 2023 by billion US$**




**Application landscape for generative AI**

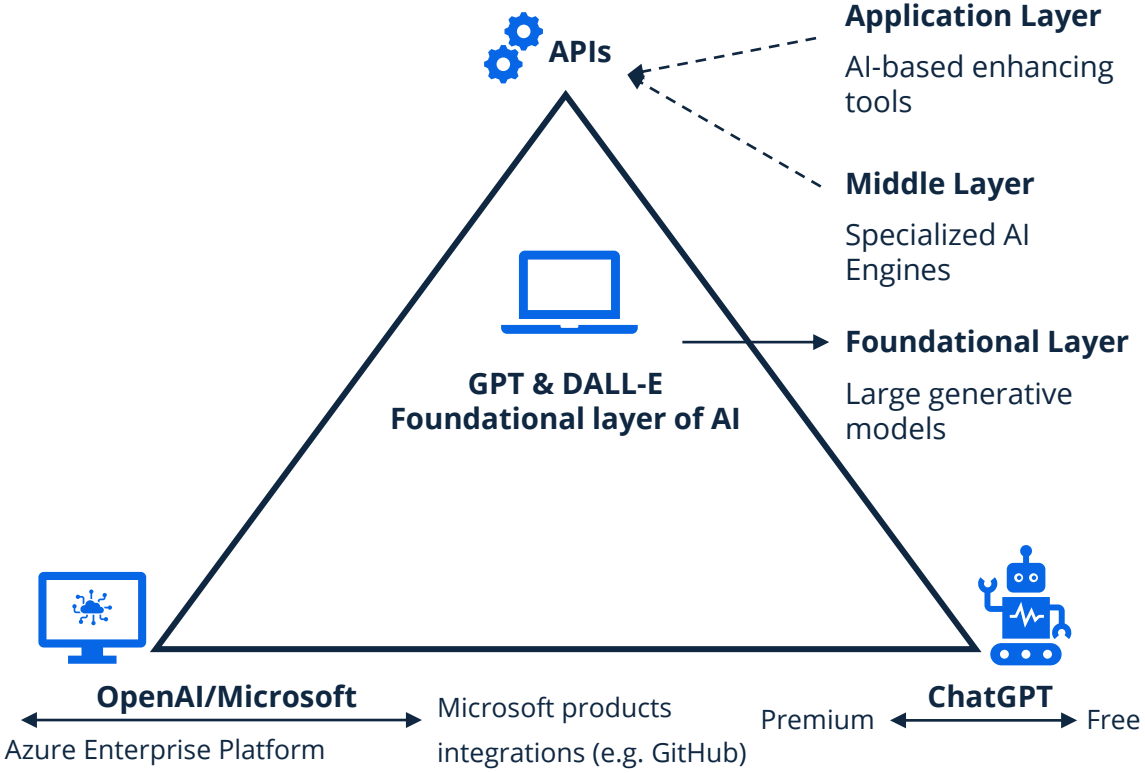





**Sources:** Company information; Statista Company Insights, June 2023

# With its tools Chat GPT and DALL-E, OpenAI is the pioneer in the AI world and has been heavily funded by Microsoft since joining forces

## OpenAI business model




## Advantages and disadvantages of OpenAI

+

- **Improves efficiency through automation**
- **Saves costs and increases productivity**
- **Can be integrated into apps, easy accessibility**
- **Enables problem-solving and scientific research**
- **Plans to release open source LLM**

−

- **Limited online browsing capabilities**
- **Potential for misuse**
- **Data privacy and AI bias concerns**
- **Little transparency and accountability**

Total funding amount **US$ 11.3 billion**, 11 billion by Microsoft

Over **12 investors**, including Thrive Capital and Andreessen Horowitz, reached **US$ 29 billion in valuation**



**Sources:** CB Insights; Crunchbase; Company information

# Microsoft goals in generative AI are ambitious and extensive, as demonstrated by its strategic partnership with OpenAI

**Microsoft's AI infrastructure**

**AI Services**

| Trained Services | Conversational AI | Custom Services |
|---|---|---|
| Cognitive Services | BOT Framework | Azure ML |

**AI Infrastructure**

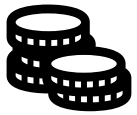
| | | | |
|---|---|---|---|
| Data Lake | | SQL Server | Cosmos DB |
| Banch AI | DVSM | Spark | ACS |

**AI Tools**

| | |
|---|---|
| Azure ML Studio | Azure ML Workbench |
| Azure Notebooks | VS Code Tools for AI |

**Deep Learning Frameworks**

| | |
|---|---|
| TensorFlow | Caffe 2 |
| Cognitive Toolkit | |



Total funding amount **US$ 11 billion** to OpenAI

Investing further in startups and using partnerships to become a pioneer in **generative AI**

**Microsoft's AI approach**

- **Responsible AI design and use:** Microsoft commits to a responsible AI design, guided by principles of fairness, reliability, safety, privacy, security, inclusiveness, transparency, and accountability, and supports democratic law-making processes to regulate AI use.
- **AI research:** The subsidiary Microsoft Research focuses on advancing AI through multidisciplinary collaboration, developing large-scale models that are efficient, adaptable, and intuitive, and applying their findings to solve real-world problems.
- **AI infrastructure:** Through Azure AI, Microsoft provides an optimized infrastructure for running large AI models, facilitating AI supercomputing and developing solutions that meet enterprise-level requirements for privacy, security, and responsible AI.
- **AI for social good:** Microsoft's AI for Good initiative utilizes AI to tackle global societal challenges, providing funding, technology, and expertise to accelerate progress in fields like accessibility, climate change, health disparities, and more.



**Sources:** Company information

# Google is building an open and innovative partner ecoystem by offering tools in a comprehensive suite for developers, researchers, and organizations

## Advantages and disadvantages of Google's Bard

**+**

- **Multilingual support**
- **Integration with Google Assistant**
- **Enhanced interaction with future image capabilities**

**–**

- **Limited language support, not all language**
- **Dependency on the underlying foundation model**
- **Potential ethical concerns**

## Google's AI investments and plans

**What is hinging Goolge's AI plans?**

- Innovator's dilemma
  - SERP Ads business model
  - Cost of revenue higher for AI
  - Protection of "truth brand"
  - Content explosion?
- Content classification (original vs. generative AI)
- Authorship could be more important
- Moats:
  - Data & feedback loops (20-30x)
  - Chrome
  - Android

Google's AI strategy revolves around developing advanced artificial intelligence technologies that aim to enhance various aspects of our lives. The company focuses on leveraging vast amounts of data and applying machine learning techniques to improve user experiences, automate tasks, and provide personalized recommendations. What sets Google's AI apart is its commitment to open-source initiatives, thereby promoting collaboration and innovation, as well as its investments in cutting-edge research and development to push the boundaries of AI capabilities.

Google recently invested **300 million US$** in Anthropic AI

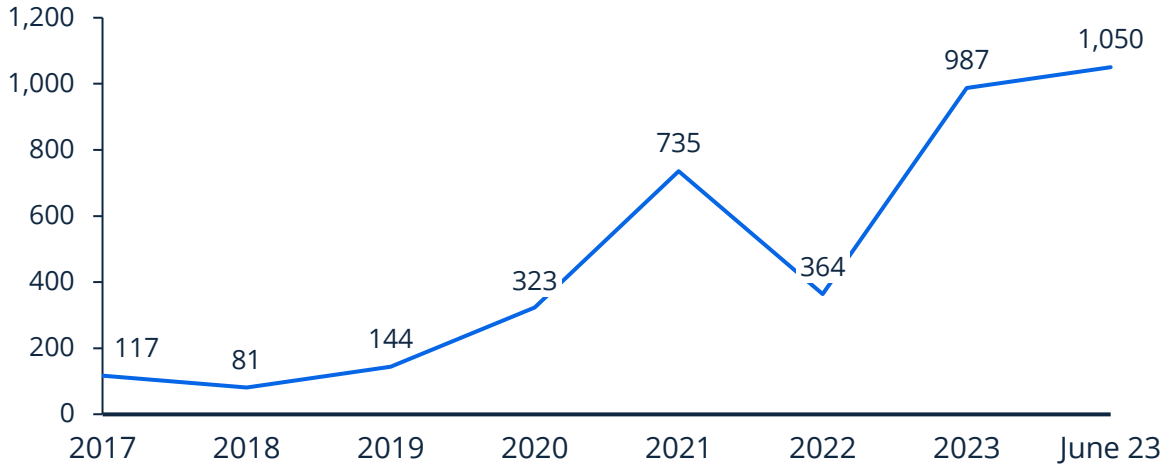
Google helped enable OpenAI have raised **US$1.3 billion** in startup funding and already created 2 unicorns



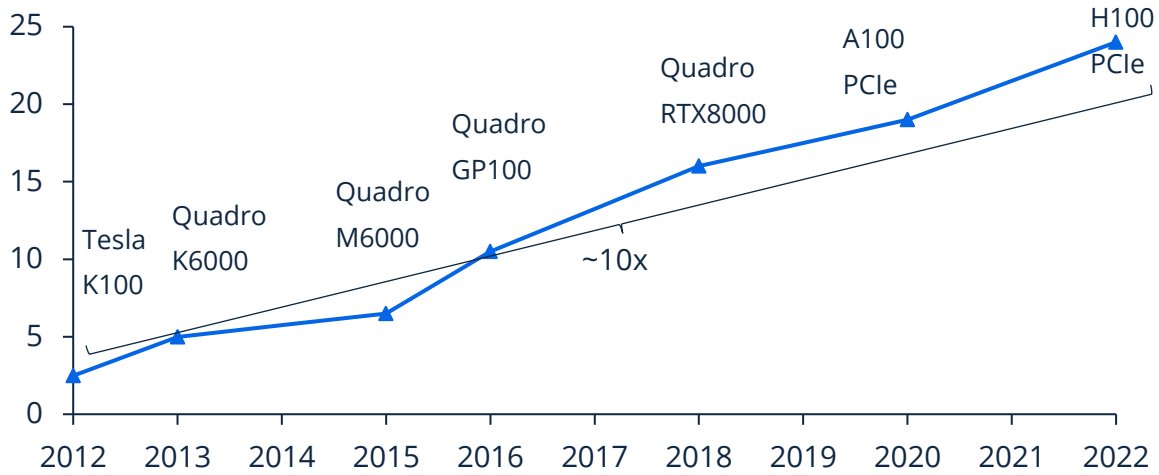
**Sources:** Google; Visualcapitalist

# Nividia is taking a leading role in the global AI market by providing powerful GPUs to AI companies

**Nvidia's company valuation in billion USD**




**Nvidia GPU Performance measured in TFLOPS(1)**




Nvidia is actively engaged in partnerships and collaborations with companies across multiple industries for its artificial intelligence (AI) initiatives. In the healthcare sector, Nvidia has been working alongside the medical products giant Medtronic and the biotech leader Amgen. Additionally, Nvidia has automotive projects in progress with China's BYD and Europe's BMW. In the telecom industry, AT&T has implemented Nvidia's AI technologies to enhance its operations. Moreover, Nvidia has become involved with semiconductors by collaborating with ASML, TSMC, and Synopsys to develop advancements in computational lithography.



**Notes:** (1) TFLOP, or teraflop, is a direct mathematical measurement of a computer's performance

**Sources:** FourWeekMBA; VentureBeat; Globalxetfs

# TMSC plays a crucial role in the general AI market, as they are the key component for manufacturing and providing adequate chips for processing

**Importance of the chip market and dominance of TSMC(1)**

TSMC is a crucial player in the global semiconductor industry, responsible for manufacturing advanced AI chips that power key technologies, including GPUs for companies like Nvidia, as well as AI chips for Google, AMD, Amazon, and others. The concentration of chip production is a result of the specialization and economies of scale required in the complex chip fabrication process. TSMC's dominance stems from its ability to invest heavily in cutting-edge chip manufacturing due to its high chip volume, creating a virtuous cycle that sustains its lead. Its position is further reinforced by its "Grand Alliance" partnerships with various companies across the chip supply chain, solidifying its unmatched specialization and industry influence. The reliance on TSMC highlights the vulnerability and dependence of the digital world on this single company.

**7.6 billion USD in** funding in 2022

**505 billion USD** market cap

**YTD stock price development in USD and revenue in billion USD of TSMC**

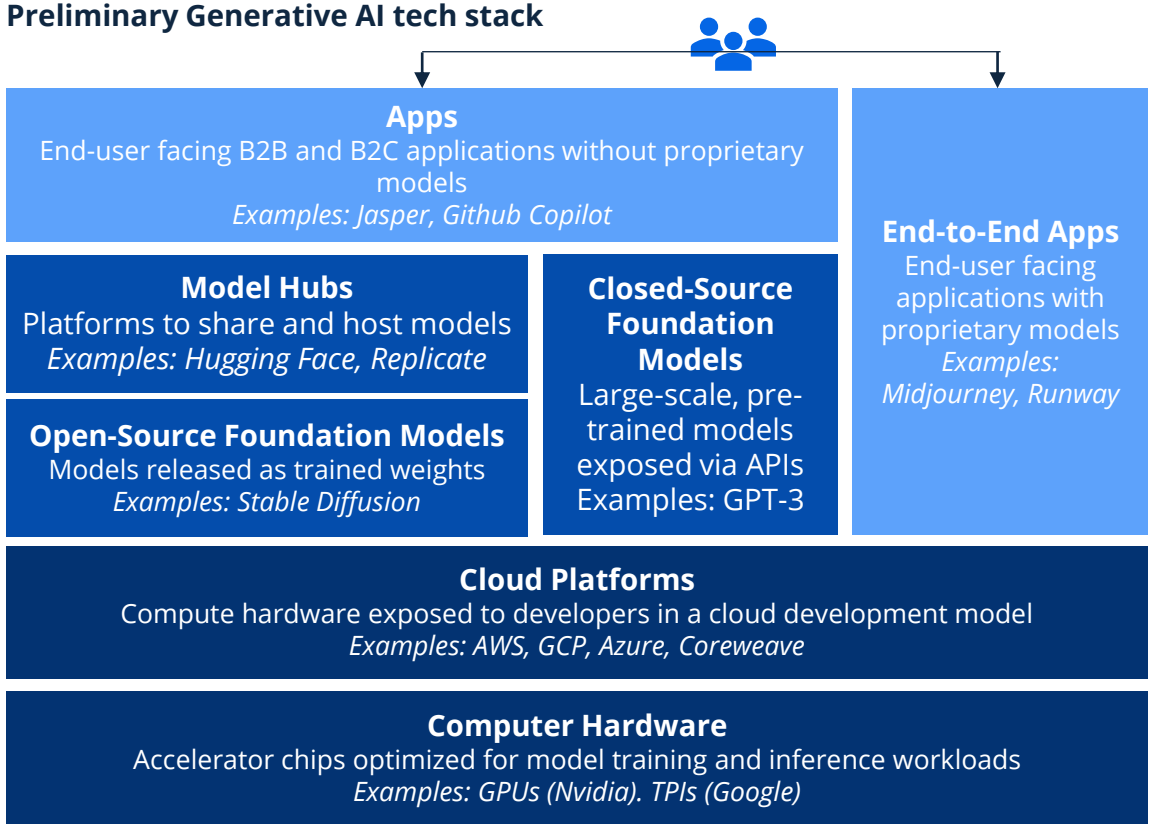



**Notes:** (1) Taiwan Semiconductor Manufacturing Company

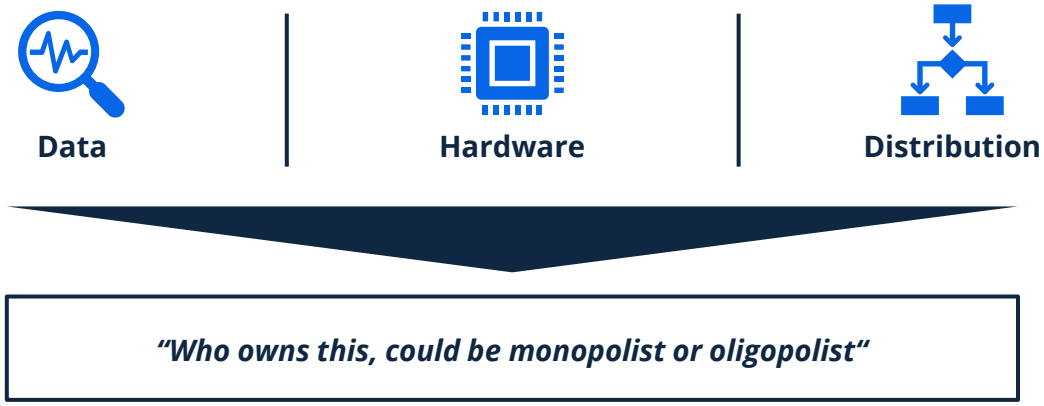
**Sources:** Yahoo Finance; Forbes; companiesmarketcap

# In order to create moats in Generative AI, providing the right infrastructure will be a crucial component

**Preliminary Generative AI tech stack**




**Generative AI crucial components to create moats**



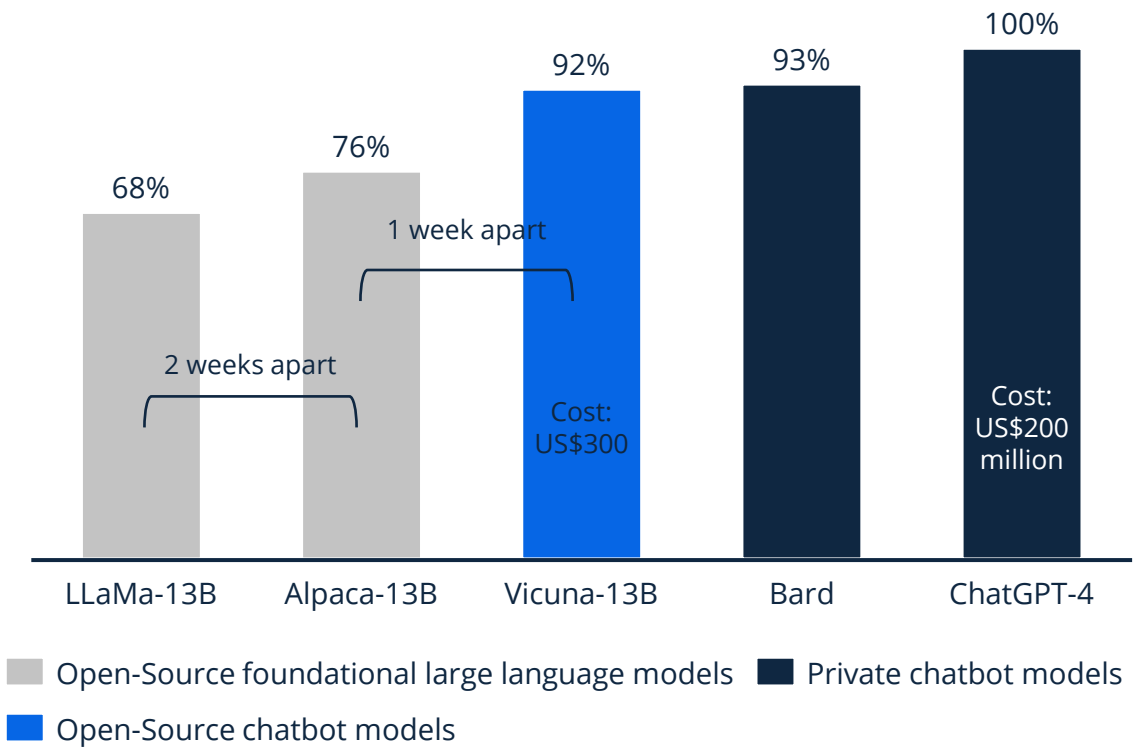

Generative AI heavily relies on cloud-hosted GPUs or TPUs, making infrastructure companies crucial players in the market. Approximately 10-20% of generative AI revenue flows to cloud providers, who invest billions of dollars in capital expenditure to maintain competitive platforms. **Nvidia** stands out as a major winner, benefiting from its strong moats built through GPU architecture, software ecosystem, and academic usage. Its GPUs are cited significantly more in research papers than top AI chip startups combined.



Sources: a16z

# As Generative AI open-source models advance in speed, customization, privacy, and capabilities, they become increasingly competitive

**Relative response quality assessed by GPT-4[1]**




- For developers who were earlier denied access to LLMs[2], the floodgates are now open for exploration and application creation. Applications are starting to bloom.
- Open-Source models with crowd-sourced LLMs achieve comparable performance to cost-intensive proprietary models from major players such as OpenAI and Google. Open-source models can be faster (also in terms of development), more customizable, more private, and more capable.
- New techniques, like diffusion models, shrink down the costs required to train and run inference. The research community continues to create algorithms and larger models. Developer access moves from closed beta to open beta, and in certain circumstances, open source.
- A leaked internal Google document from May 2023 claimed open-source AI will outcompete major players like Google and OpenAI: "We Have No Moat, And Neither Does OpenAI"
- In the long run, large models aren't more capable than small models. Quality scales better than size.

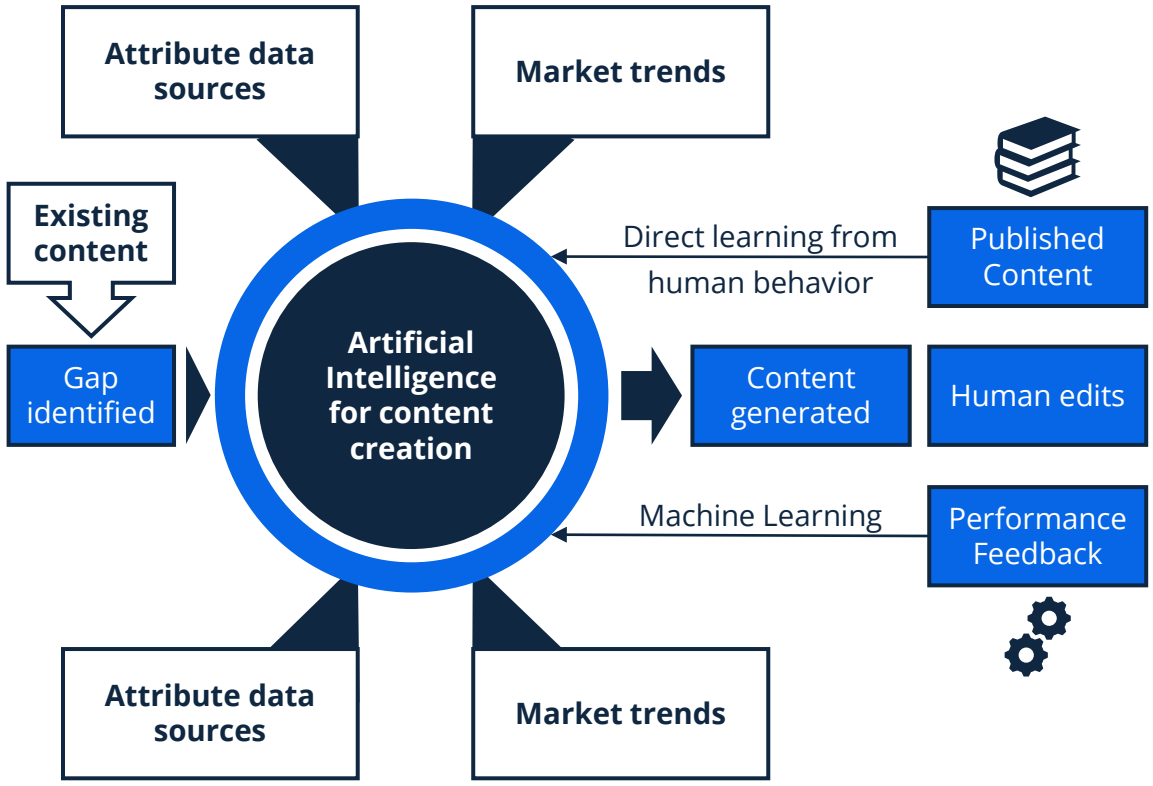


**Notes:** (1) GPT-4 grades LLM outputs (2) At the beginning of March the open-source community got their hands on their first really capable foundation model, as Meta's LLaMA was leaked to the public.

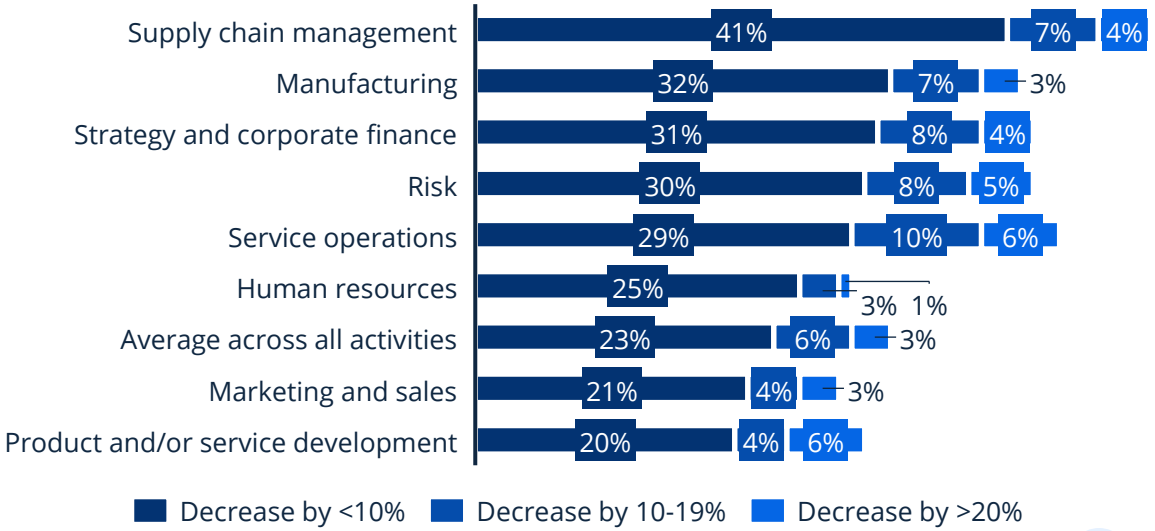
**Sources:** lmsys; semianalysis

# AI will fuel the content market by enabling the creation of digital content at lower costs across functions and industries

**AI and machine learning for content creation**




**Cost reduction due to AI by function**



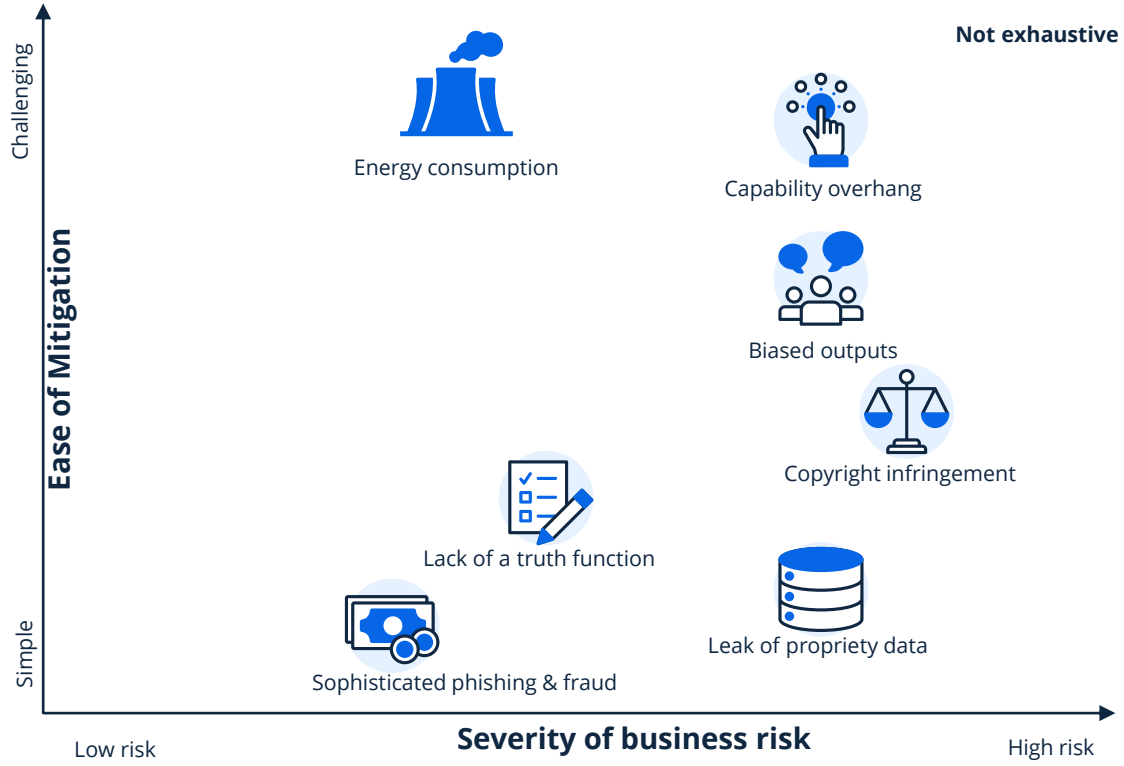

Generative AI developments are only propelling the space forward. Content creation and distribution solutions are quickly incorporating generative AI to expedite content creation and creative processes at an unprecedented rate. **More digital content will be created at a lower cost.**



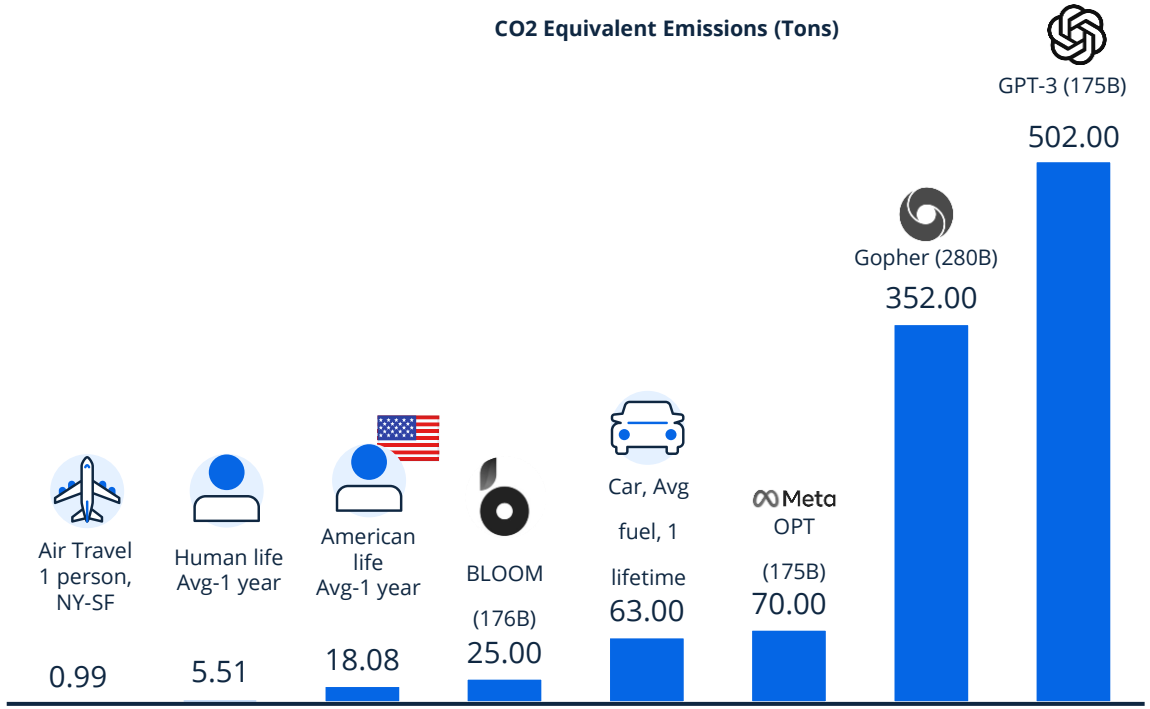
**Sources:** Analytics Vidhya; McKinsey

# With all its benefits, Generative AI also brings some risks, mainly CO2 emissions and capability overhangs

## Risks of Generative AI




## Environmental impact of AI development(1)






**Notes:** (1) Number of parameters which consists out of layers and biases are in brackets behind or below the respective model name

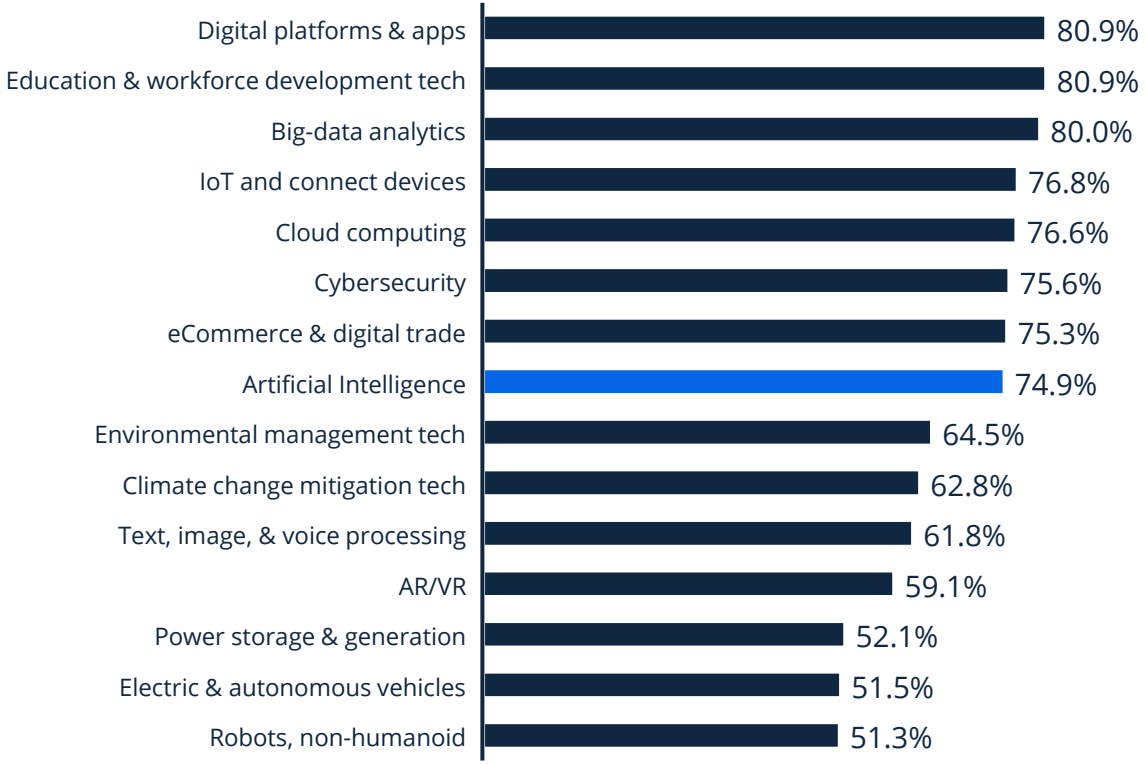
**Sources:** Morning Consult; SIT; BCG Analysis; Sandford University

# The double-edged sword of AI: Will we lose our jobs or become extremely productive?

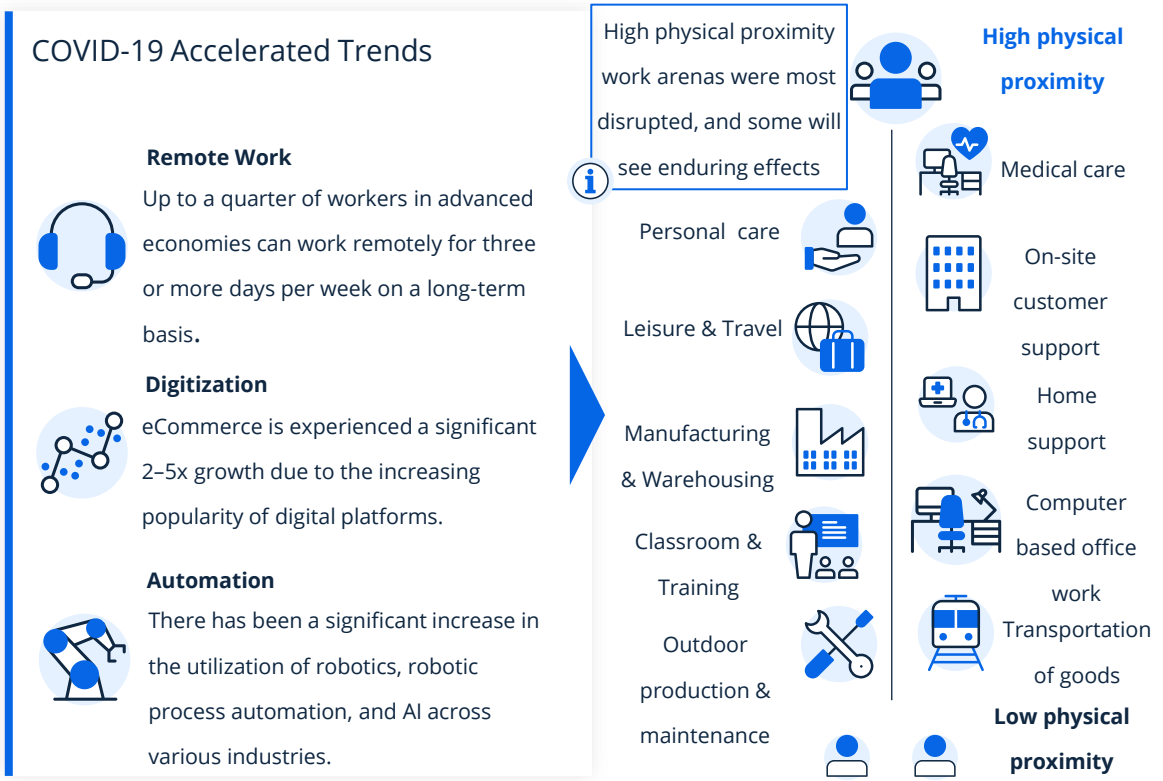
The deluge of data, emails, meetings, and notifications in today's fast-paced world has exceeded our ability to digest them. However, the increasing usage of AI could provide a solution to this daunting dilemma, revolutionizing the way we operate. Businesses are using AI to cut expenses, boost productivity, and drive revenue development. AI is transforming businesses throughout the world by automating monotonous work and complementing human skills. Generative AI has played a pivotal role in accelerating technology towards human-level competency while bolstering productivity. Nevertheless, this shift towards AI-powered work comes with consequences. Employers anticipate significant workforce restructuring as many job tasks become susceptible to automation. Roles that involve routine and repetitive work are at the forefront of this risk, necessitating a shift in job requirements and responsibilities.

# The pandemic catalyzed the fourth industrial revolution, unleashing rapid adoption of transformative technologies like AI

## Ranking of technologies likely to be adopted by companies from 2023-2027 (1)




## COVID-19 disrupted and redefined current workplaces



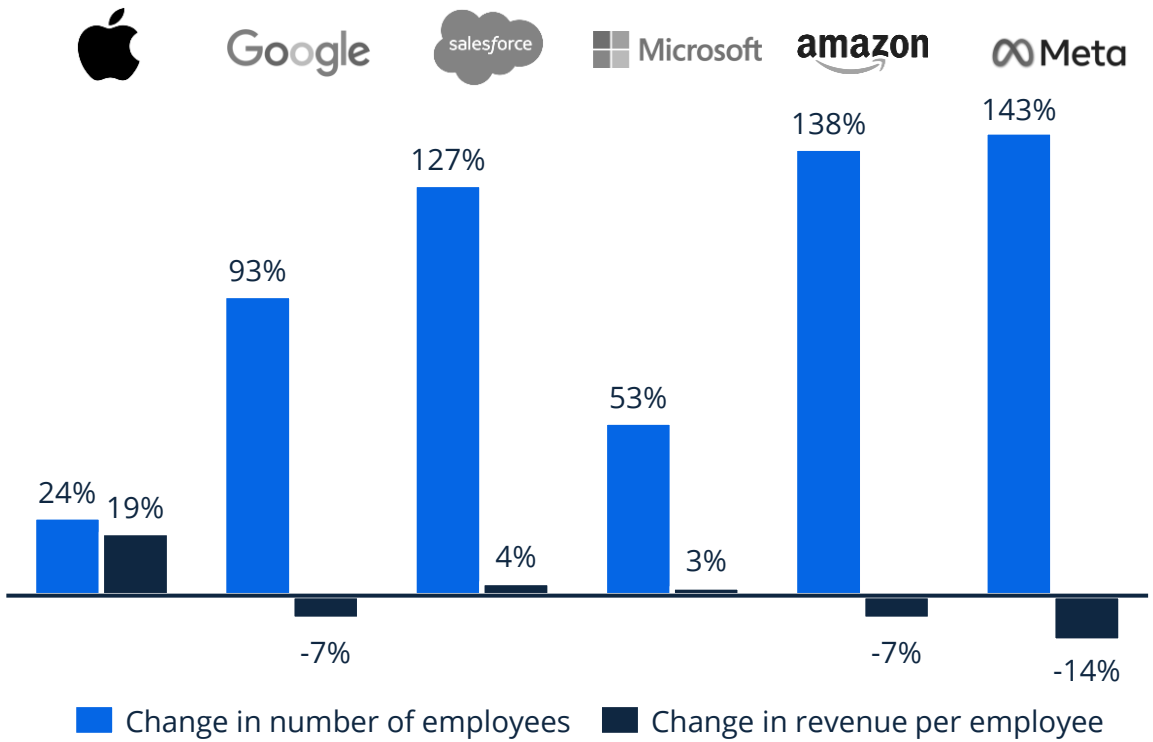



**Notes:** (1) Worldwide; November 2022 - February 2023; 803 global companies.; Responses represent over 11.3 million employees worldwide

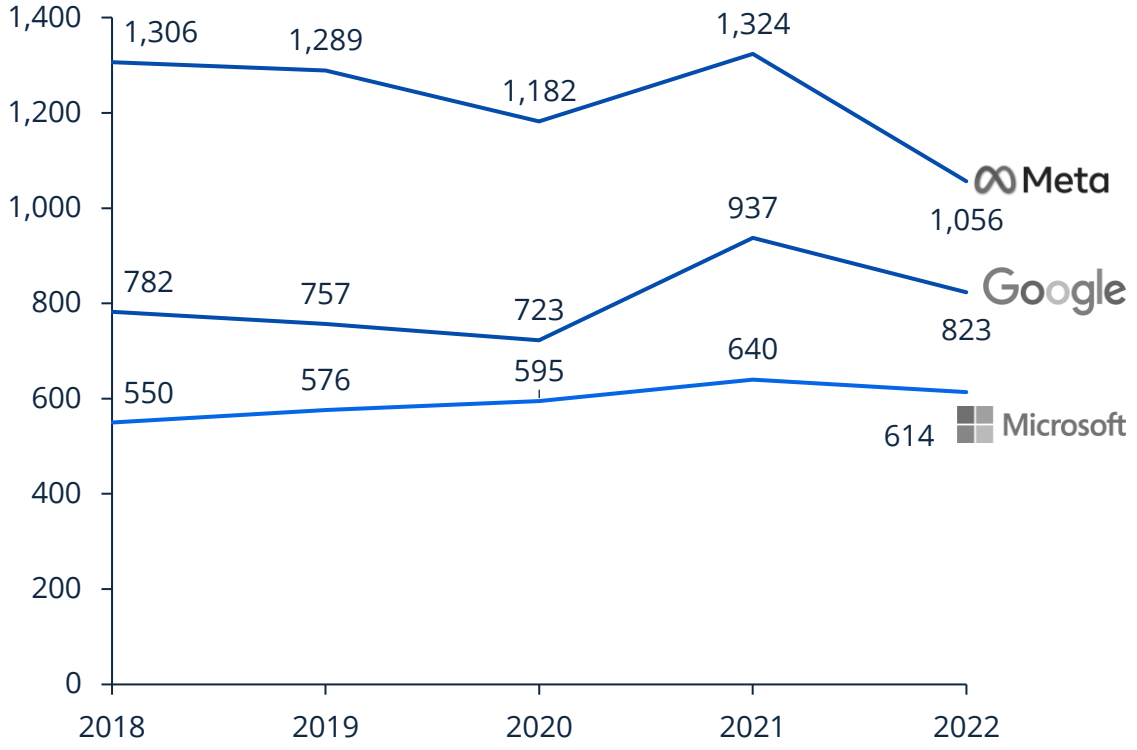
**Sources:** Mckinsey; World Economic Forum

# Despite increased hiring in the tech industry, generally it is observed that profitability per resource is still on the decline

**Change in number of employees and revenue per employee from 2018 to 2022**




**Gross profit per employee in thousand US$**

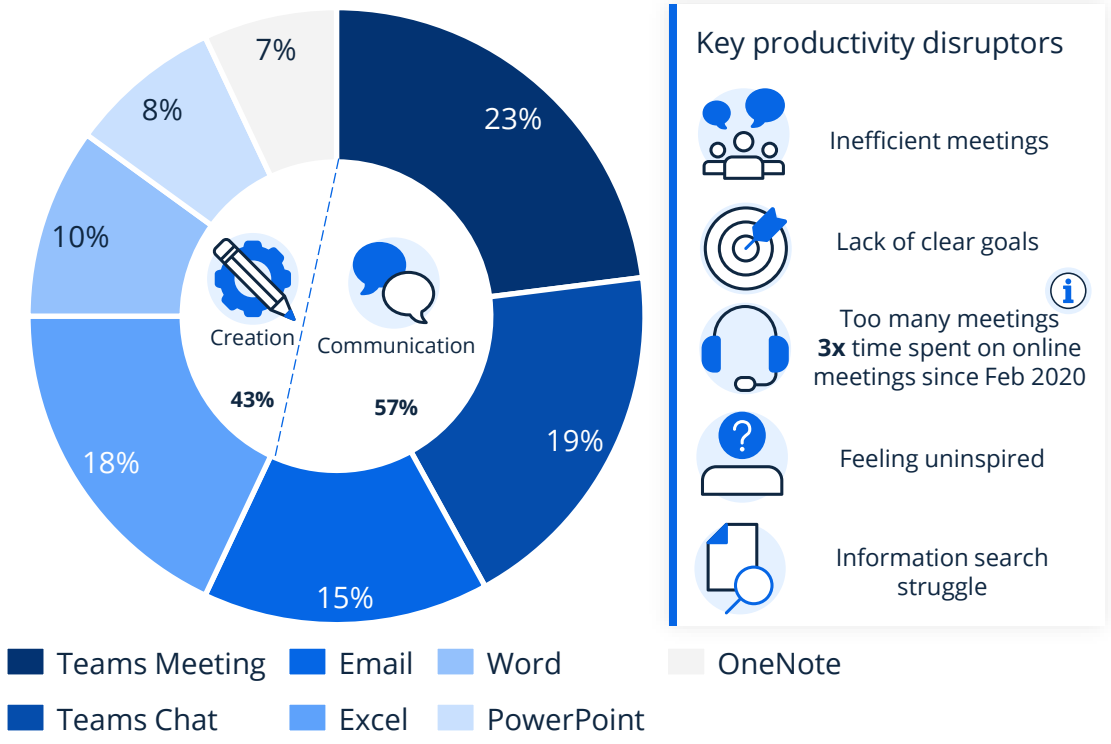





**Sources:** Statista Company Insights 2023; Stock Analysis; Macrotrends

# The inflow of data, emails, meetings, and notifications are outpacing humans' ability to process, for which increasing AI adoption could be a solution

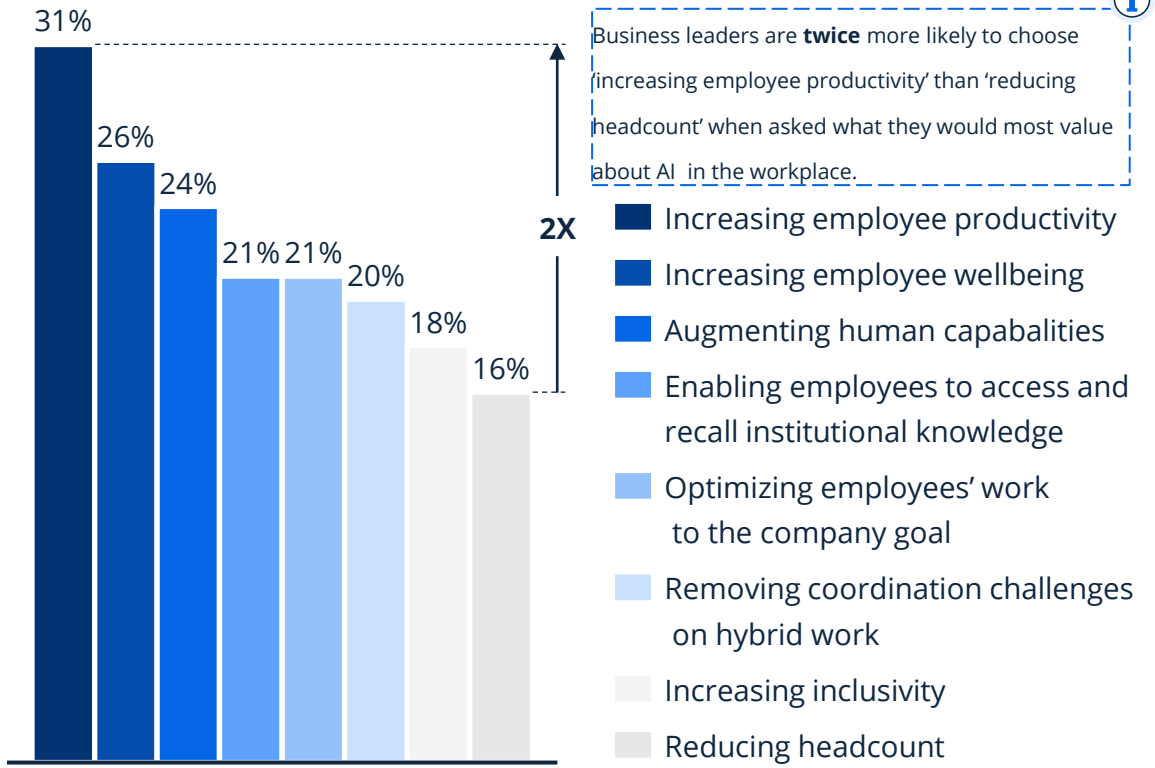
**Percent share of time spent on Microsoft 365(1)**




Key productivity disruptors

- Inefficient meetings
- Lack of clear goals
- Too many meetings **3x** time spent on online meetings since Feb 2020
- Feeling uninspired
- Information search struggle

**Opinions of business leaders on adoption of AI in workplaces (2)**



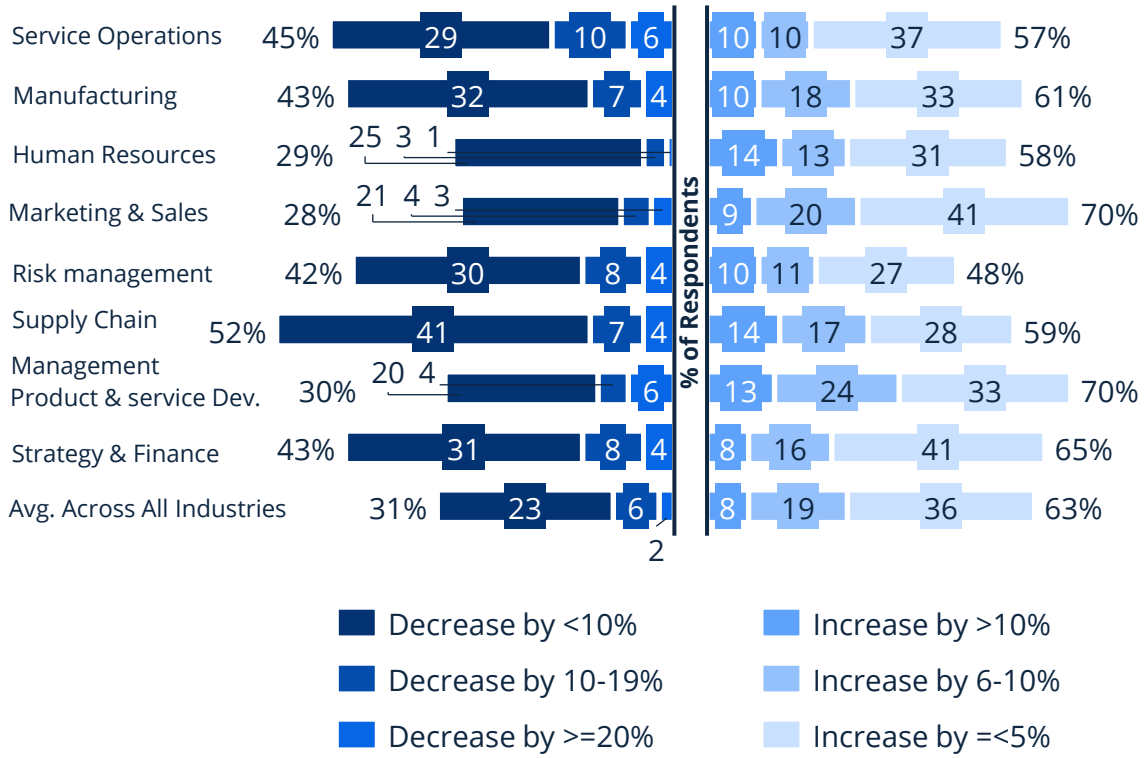



**Notes:** (1) Collaboration patterns in Microsoft 365 in a rolling 28-day period ending in March 2023 excluding weekends (2) Survey question: If the growth of artificial intelligence (AI) in the workplace could lead to the following benefits, which would add the most value to your workplace?

**Sources:** Microsoft Work Trend Index

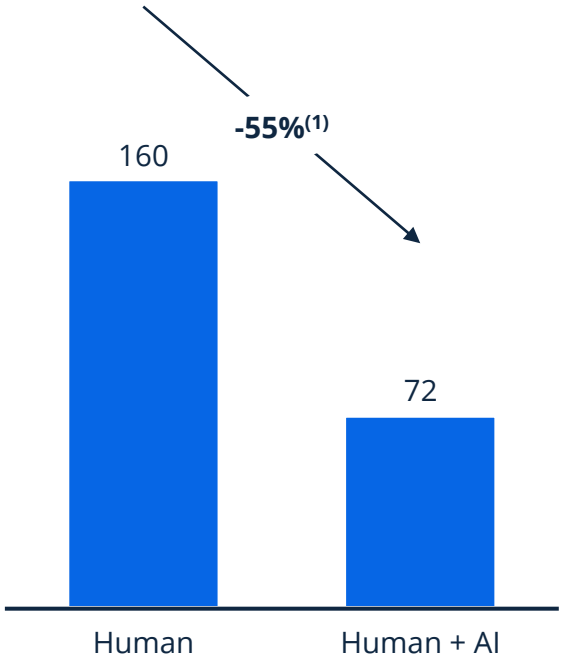
# One of the top use cases for gaining a competitive edge is harnessing AI for cost reduction, increased productivity, and revenue growth

## Cost decrease and revenue increase from AI adoption by function in 2021




## AI-Human productivity gains in selected professions

### Time to complete coding tasks in minutes 2022 (1)




### Time and cost to complete design tasks

**Human**
Cost: $150
Time: 5 hours

**Generative AI**
Cost: $0.08
Time: <1 minute

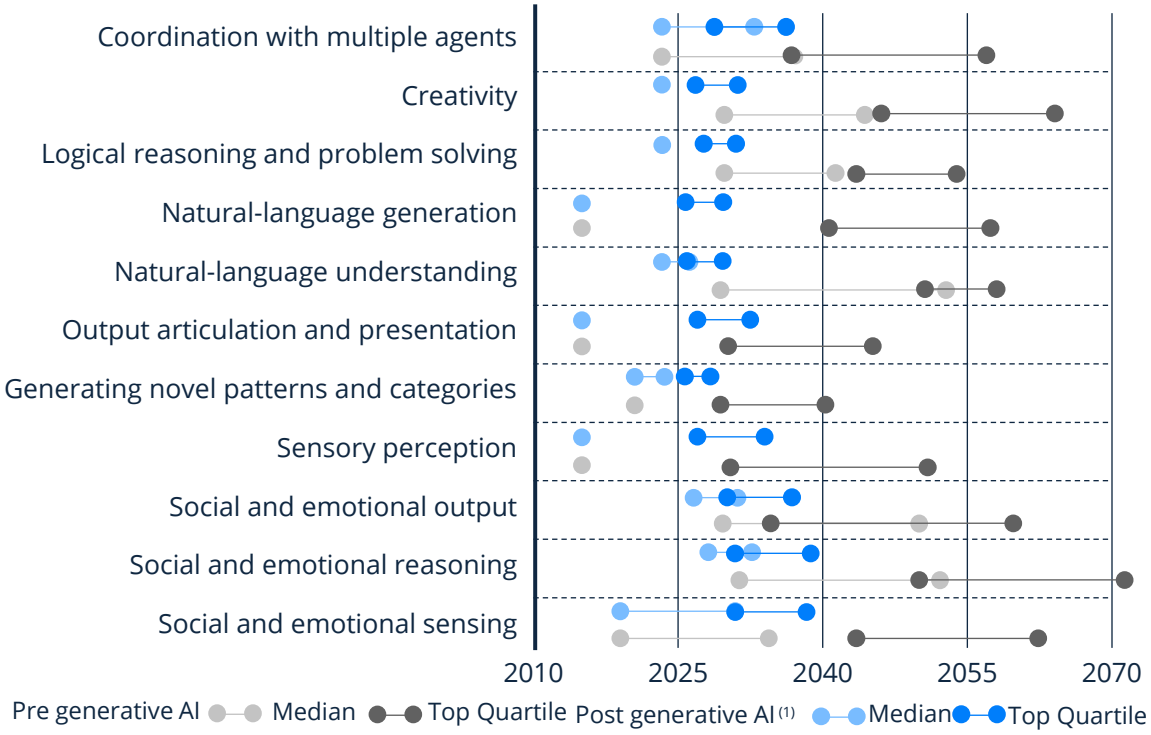


**Notes:** (1) Based on data from GitHub

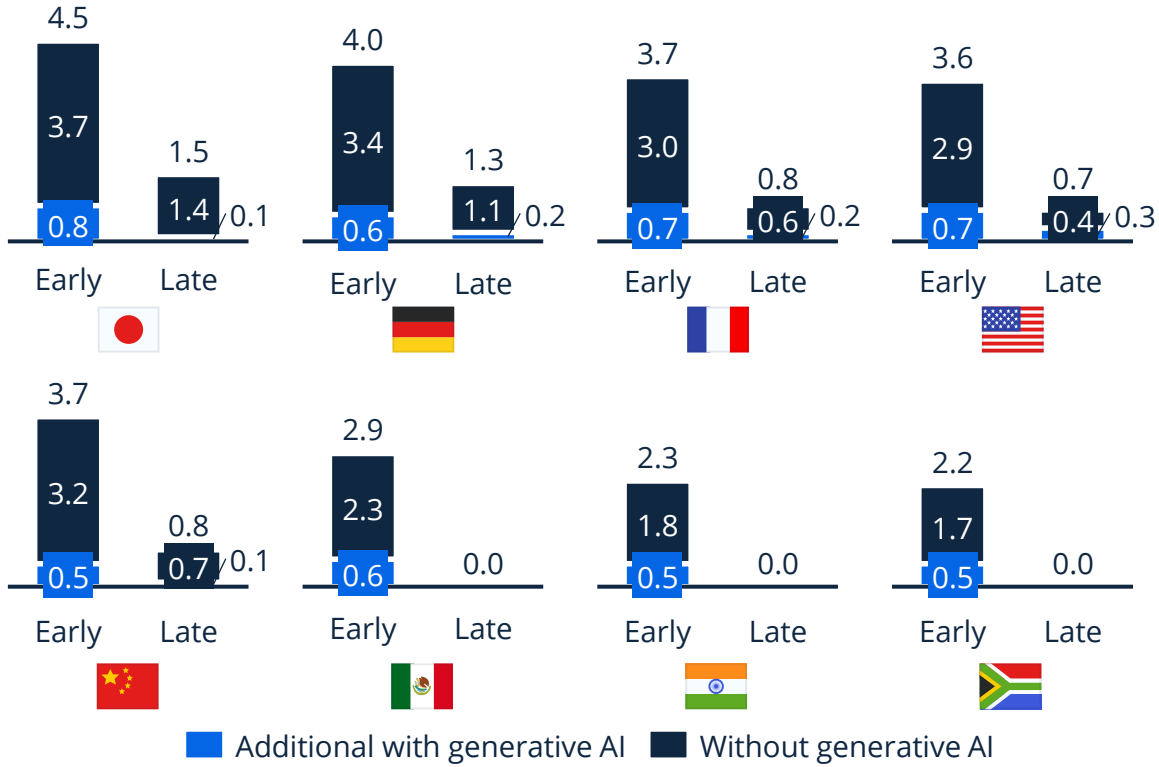
**Sources:** Stanford AI index report; ARK Investment Management LLC; OpenAI

# Generative AI accelerates technology toward human-level competency, while increasing productivity in a lot of countries

**Technical capabilities, level of human performance achievable by technology**




**Productivity impact from automation by scenario, 2022-40, CAGR(2) in %**



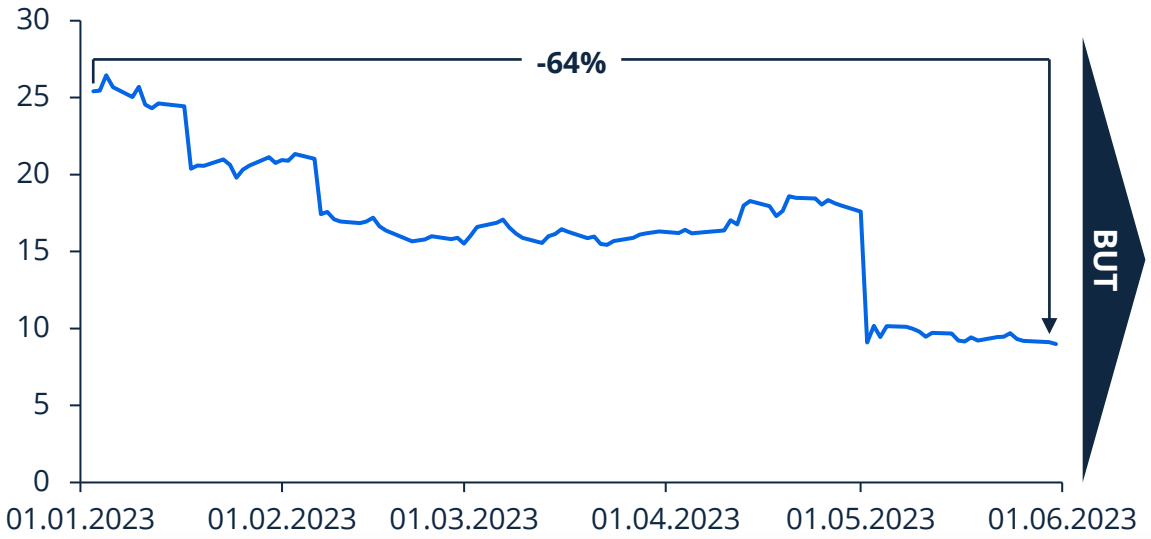



**Notes:** (!) Estimates post generative AI developments (2) CAGR: Compound Annual Growth Rate

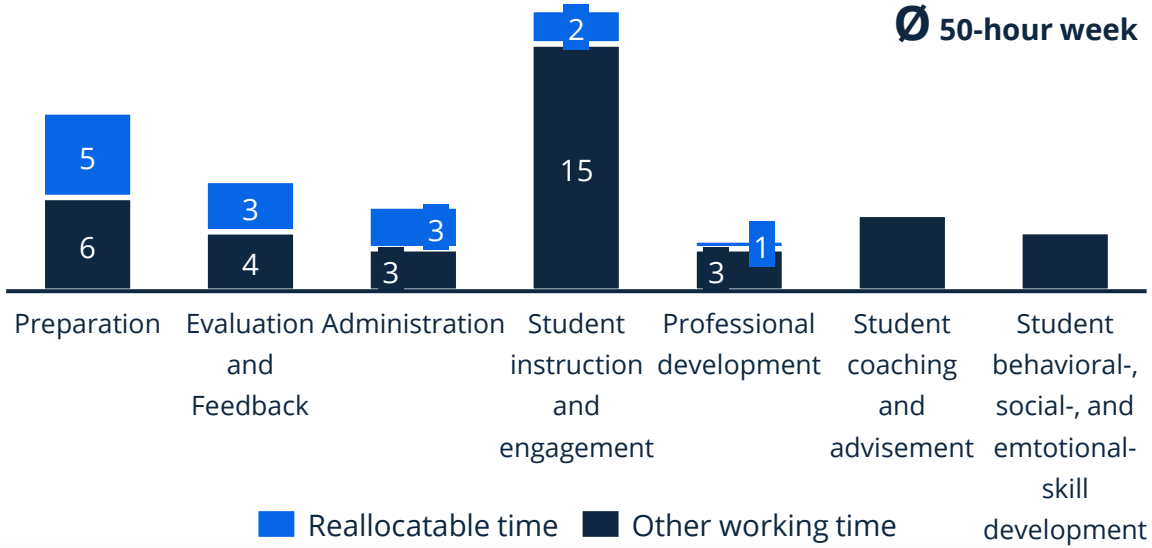
**Sources:** McKinsey

# Education will be one of the most impacted industries as it will witness a change in technology and possibilities

**Chegg's YTD stock price in US$[(1)]**




**AI technology impact on teachers' work**




25% of jobs will be negatively impacted in the next five years, with AI predicted to affect 300 million jobs. Chegg, an educational company, experienced a decline in shares and revenue due to the rise of AI alternative ChatGPT. The WEF study suggests a critical shift in the global labor market, with a net loss of 14 million roles and 26 million administrative positions cut due to AI. Goldman Sachs predicts that while AI may disrupt the workforce, it also creates innovation, leads to new jobs, and provides cost savings for businesses.



**Notes:** (1) Chegg is an online learning platform that provides educational resources, tutoring services, and study materials to students.

**Sources:** Yahoo Finance; Forbes; McKinsey; Goldman Sachs

# Verizon is boosting operational effectiveness and revenue growth in the telco sector with its AI transformation

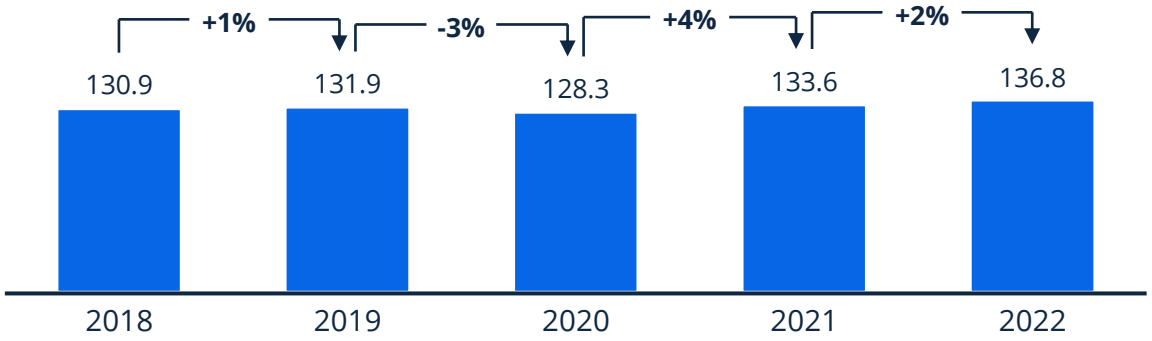
Verizon Communications is a multinational company operating in the telecommunications industry. The company is founded in 2000 and headquartered in New York.

- Initiated in 2019, Verizon 2.0 marked a strategic pivot for Verizon towards a greater focus on AI. This innovative strategy has not only transformed operations but also optimized the workforce structure.

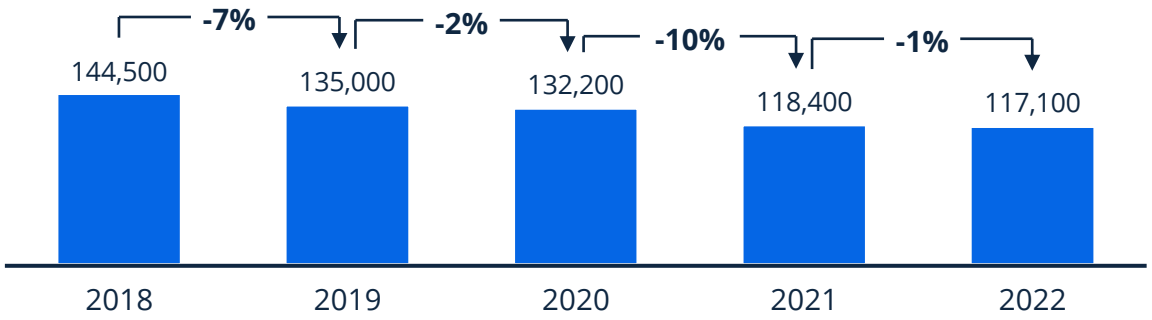
Illustrations of this include chatbots, messaging or voice-controlled applications that can competently answer a multitude of customer queries just as a human assistant would, as well as AI's capability to conduct tasks such as call handling and network diagnostics.

In the years following the launch of Verizon 2.0, the company witnessed a significant decrease in staff numbers. Meanwhile, an upward trend in global revenue might signal heightened operational productivity.

**Verizon global revenue(1) in billion US$**




**Verizon number of employees(2)**



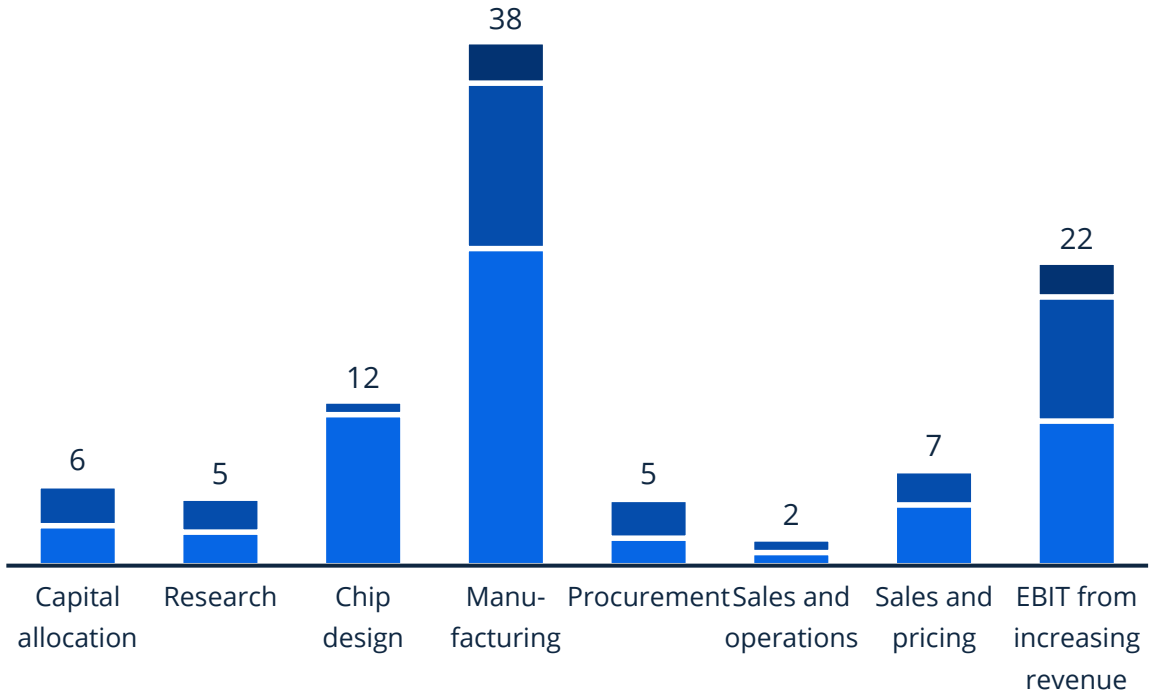



**Notes:** (1) Gross sales and other operating revenue, not including discounts, returns, and allowances. Arrow shows relative difference in % (2) Number of both full- and part-time employees in the company

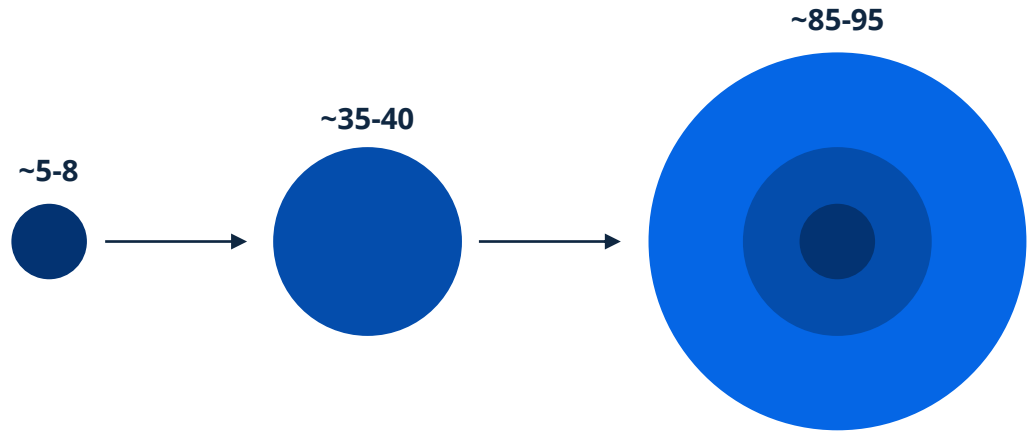
**Sources:** Market data by Quandl and WBV 2023; Statista Company Insights 2023

# AI will have a huge impact on the semiconductor industry, primarily in manufacturing, generating up to US$95 billion for companies

**Impact on earnings EBIT by semiconductor key activities in US$ billion**




**Impact of artificial intelligence on semiconductors EBIT in US$ billion**




Current gains | Near-term potential(1) | Long-term potential(2)

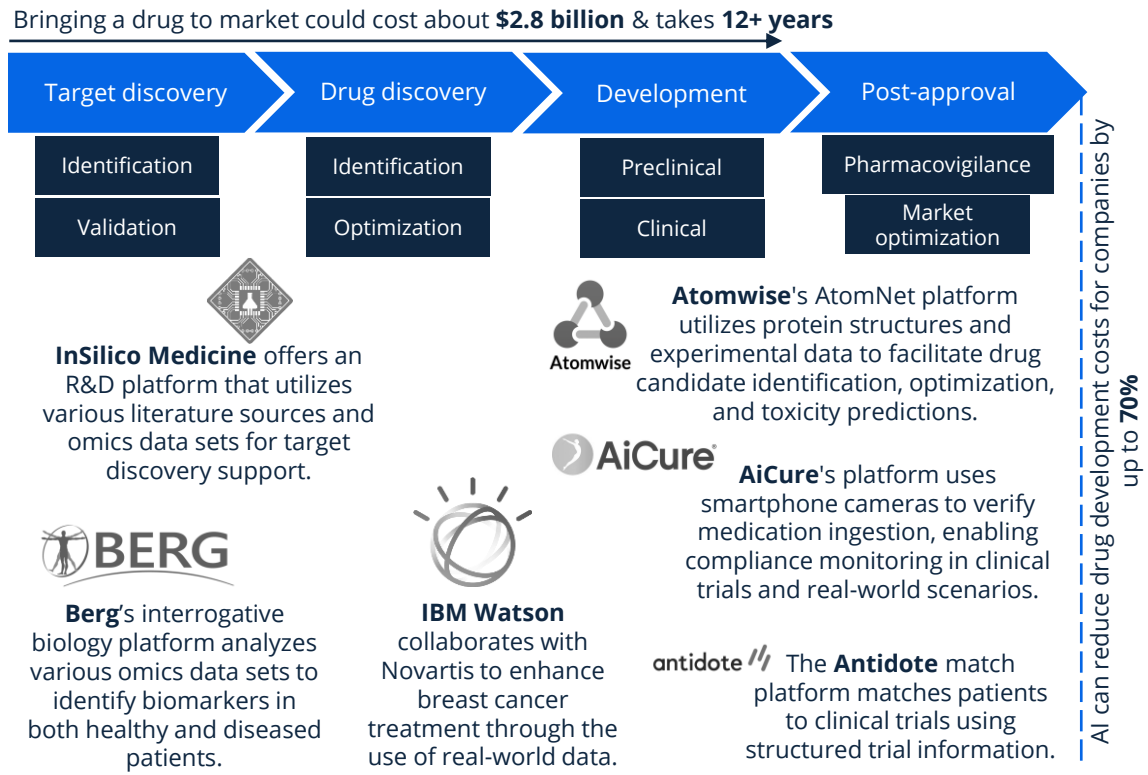


**Notes:** (1) Refers to the next 2-3 years (2) Refers to 4 years or more

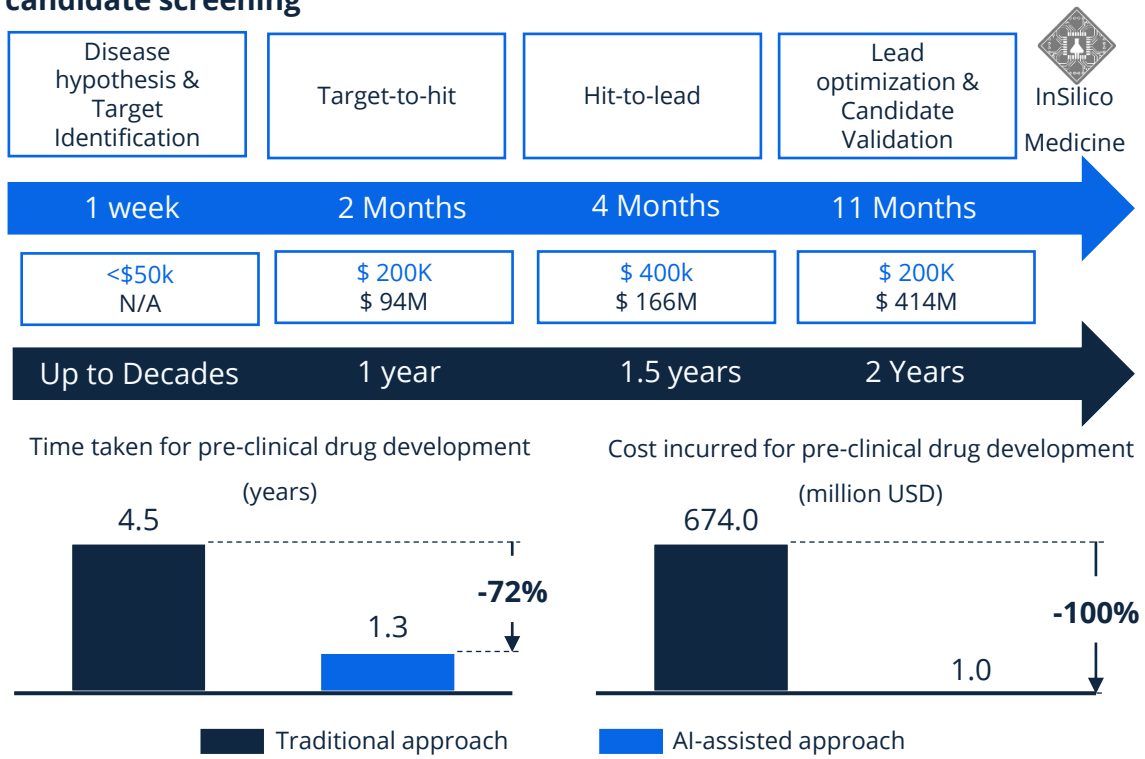
**Sources:** McKinsey

# Healthcare uses AI and machine learning to expedite the development of new medications and minimize expenses

## AI companies active across the drug lifecycle




## AI-assisted (Insilico Medicine platform) versus Traditional Pre-clinical candidate screening

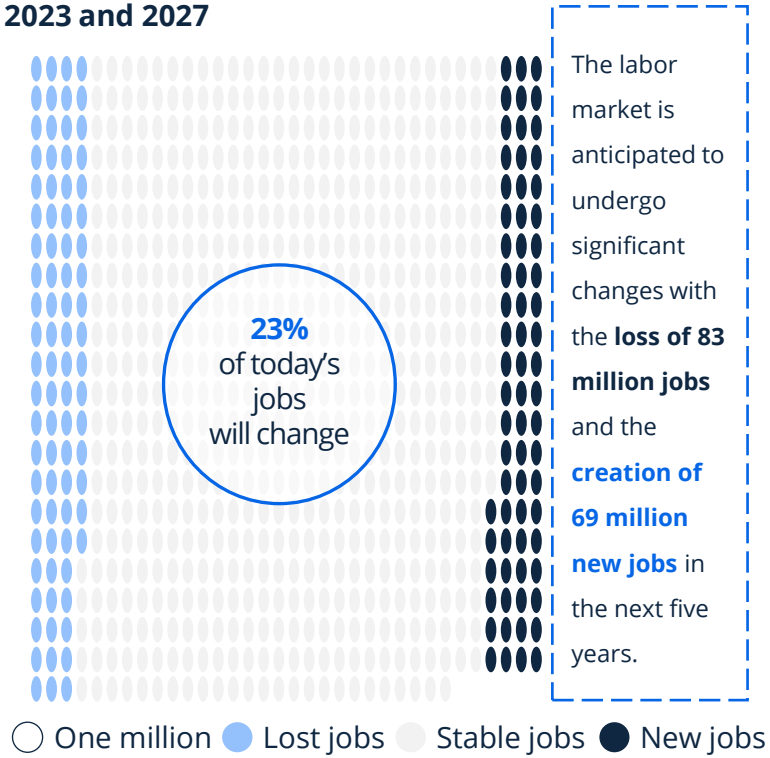




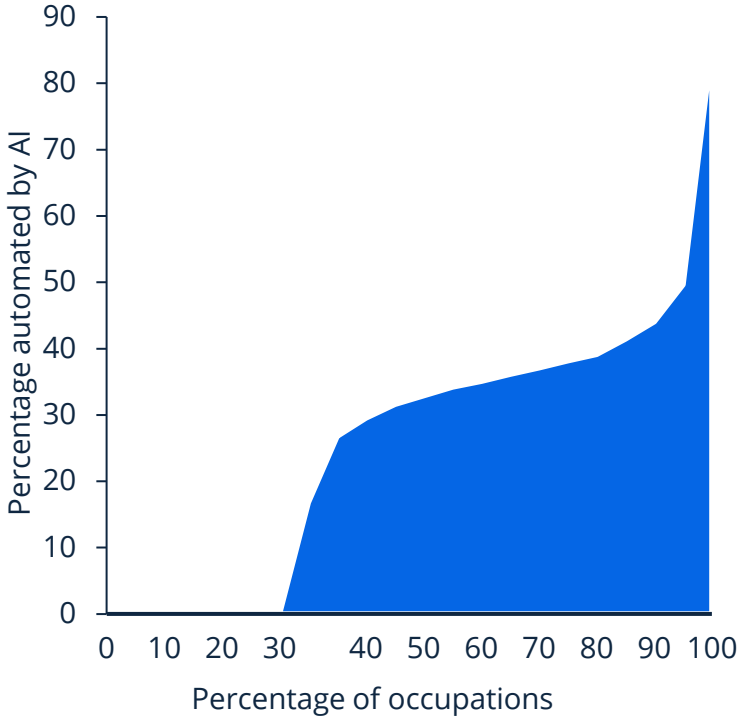

**Sources:** L.E.K research; Deep Pharma Intelligence; Insider Intelligence

# Employers expect significant workforce restructuring with several job tasks at the risk of automation

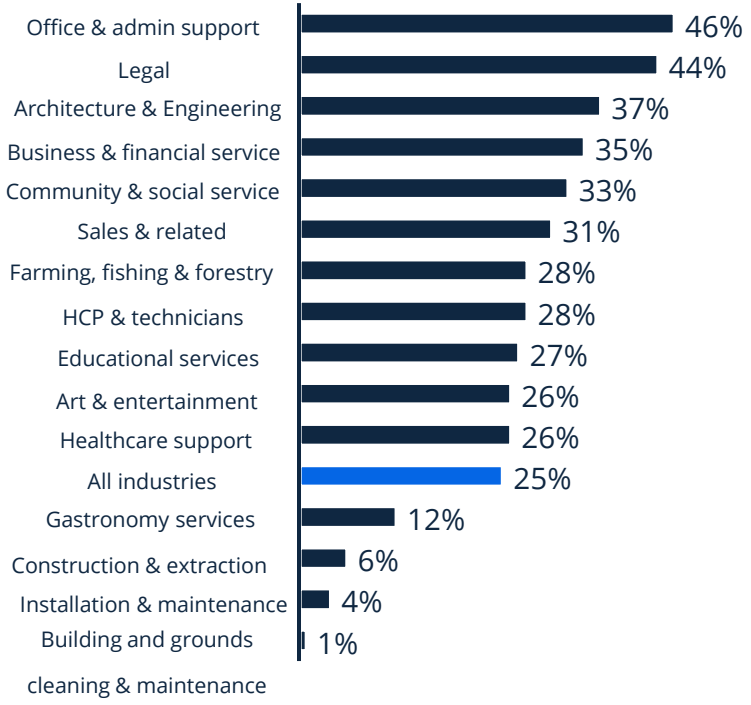
**Projected job creation and displacement between 2023 and 2027**




**Share of current occupational workload exposed to automation by AI**




**Current work tasks that could be automated by AI in the U.S. & Europe**



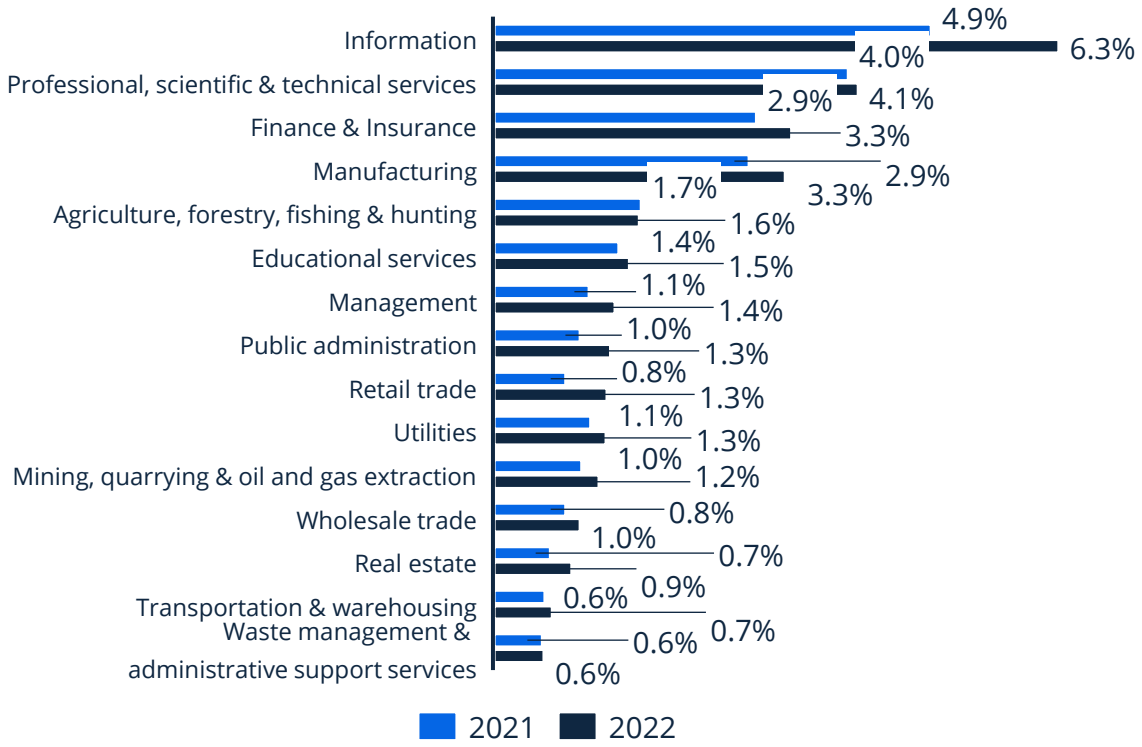



**Sources:** World Economic Forum analysis of the labor-market prospects for 673 million employees out of a global ILO dataset comprising 820 million employees using the Future of Jobs Survey 2023.

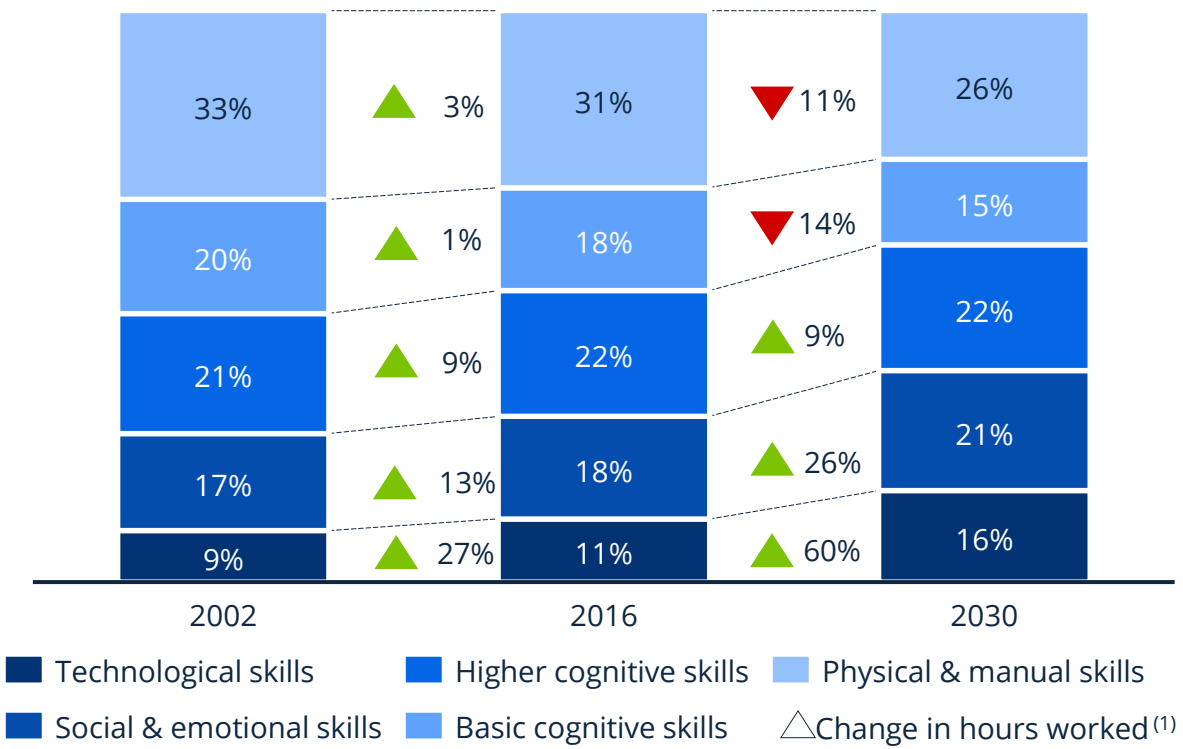
**Notes:** World Economic Forum; Goldman Sachs

# A growing demand for AI expertise is expected along with an estimated shift towards social, emotional, and technological skills

**AI job posting in the U.S. by sector in % of all job postings**




**Evolution in skill categories in % of time**



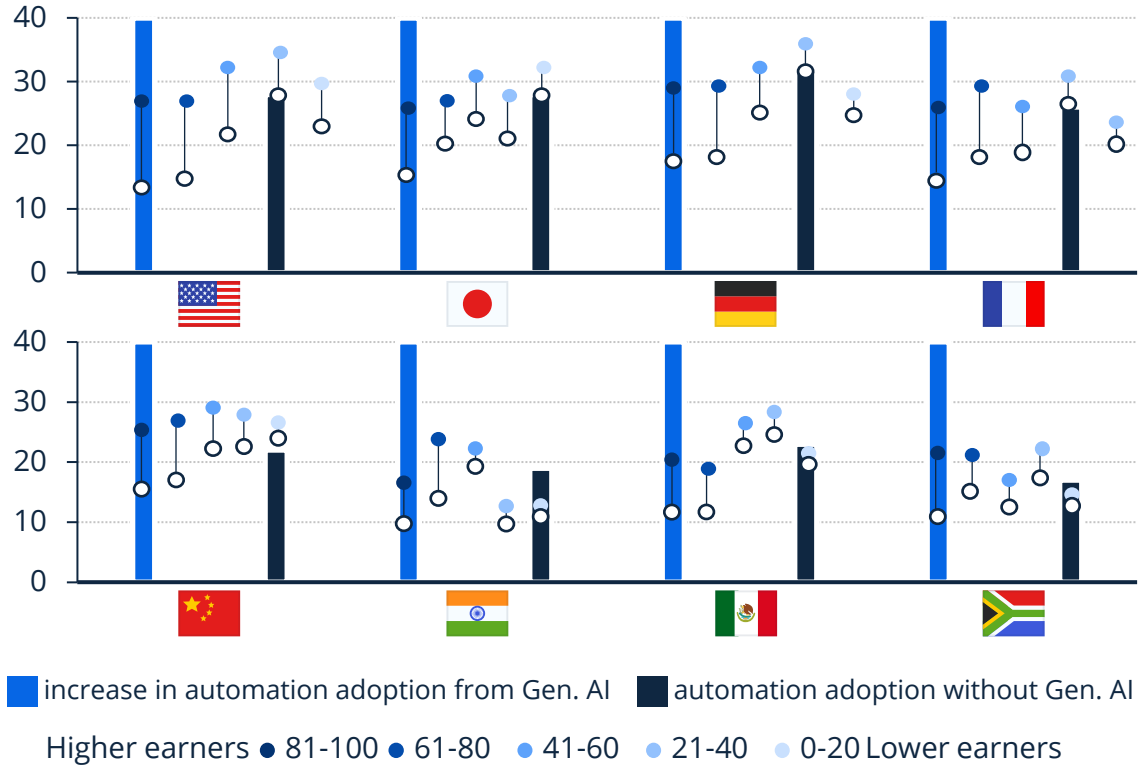



**Notes:** (1) Change in hours worked (% difference)

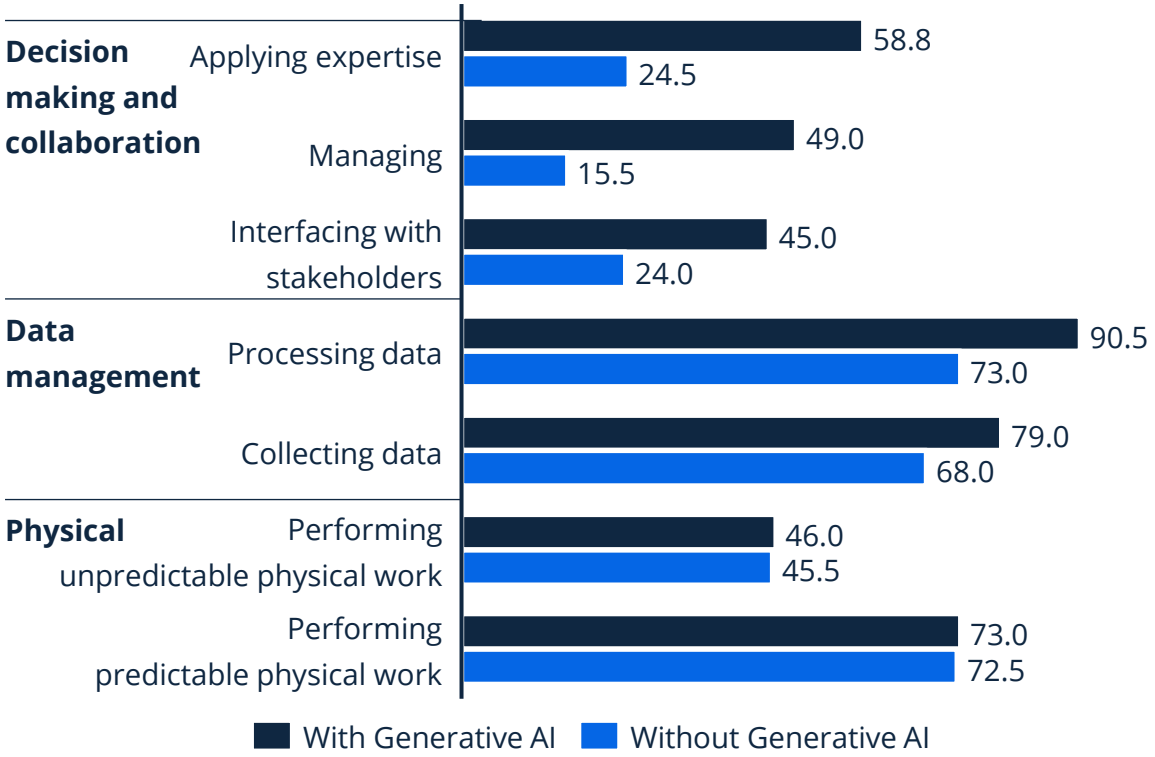
**Sources:** Mckinsey, U.S: Bureau of Labor statistics; Lightcast 2022

# The impact of automation is estimated to shift dramatically on high-wage jobs with advancements in Generative AI

**Automation adoption per wage quintile, midpoint scenario, in % in 2030**




**Overall technical automation potential, midpoint scenarios, in % 2023**

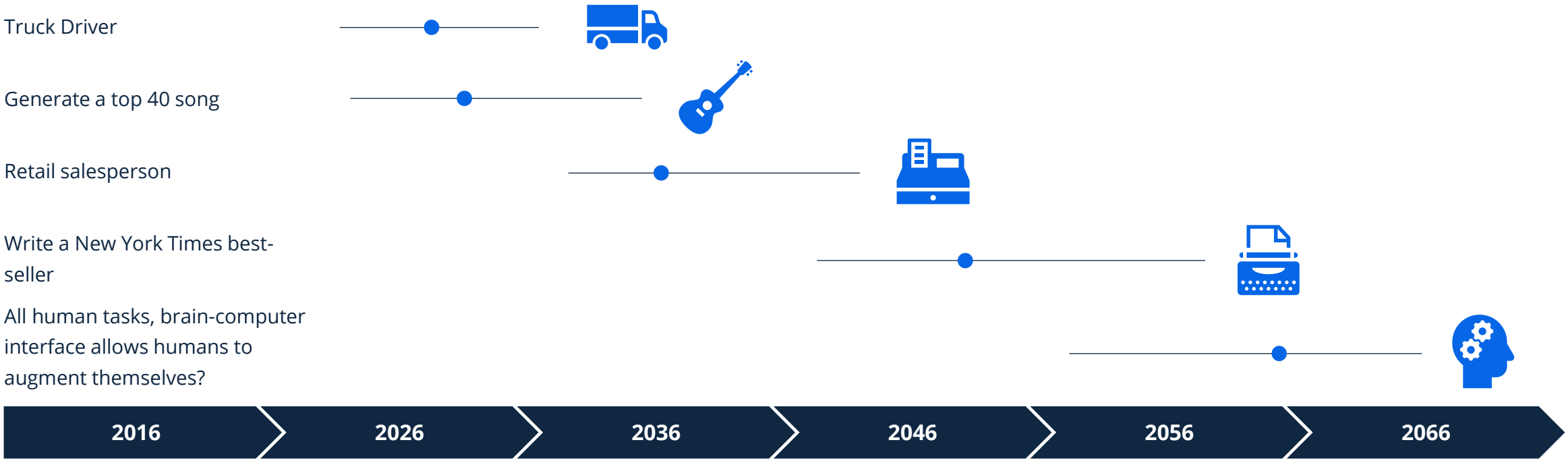





**Sources:** McKinsey Global Institute analysis; McKinsey

# As we move into the future, we could see a transition to where AI will perform the majority of human tasks and enhance our capabilities

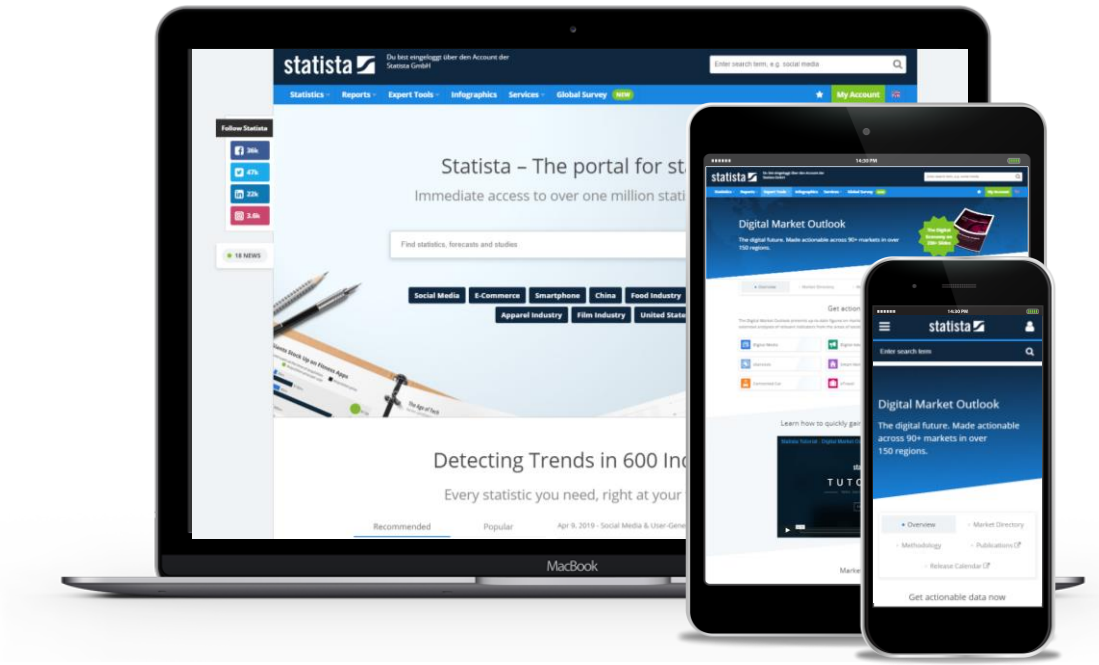
**Timeline for tasks that machines will perform**






Sources: dls.tld

# Our products



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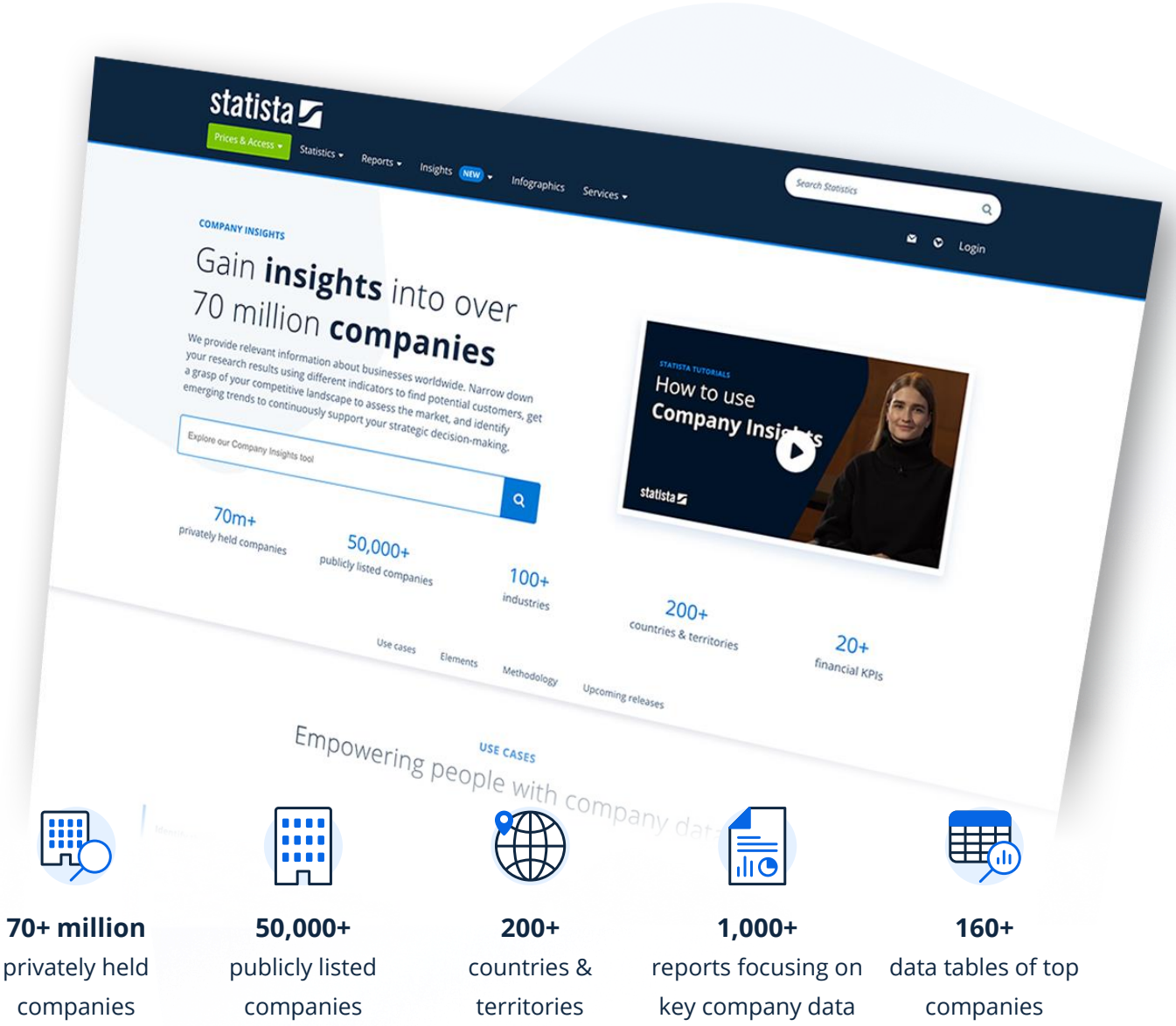


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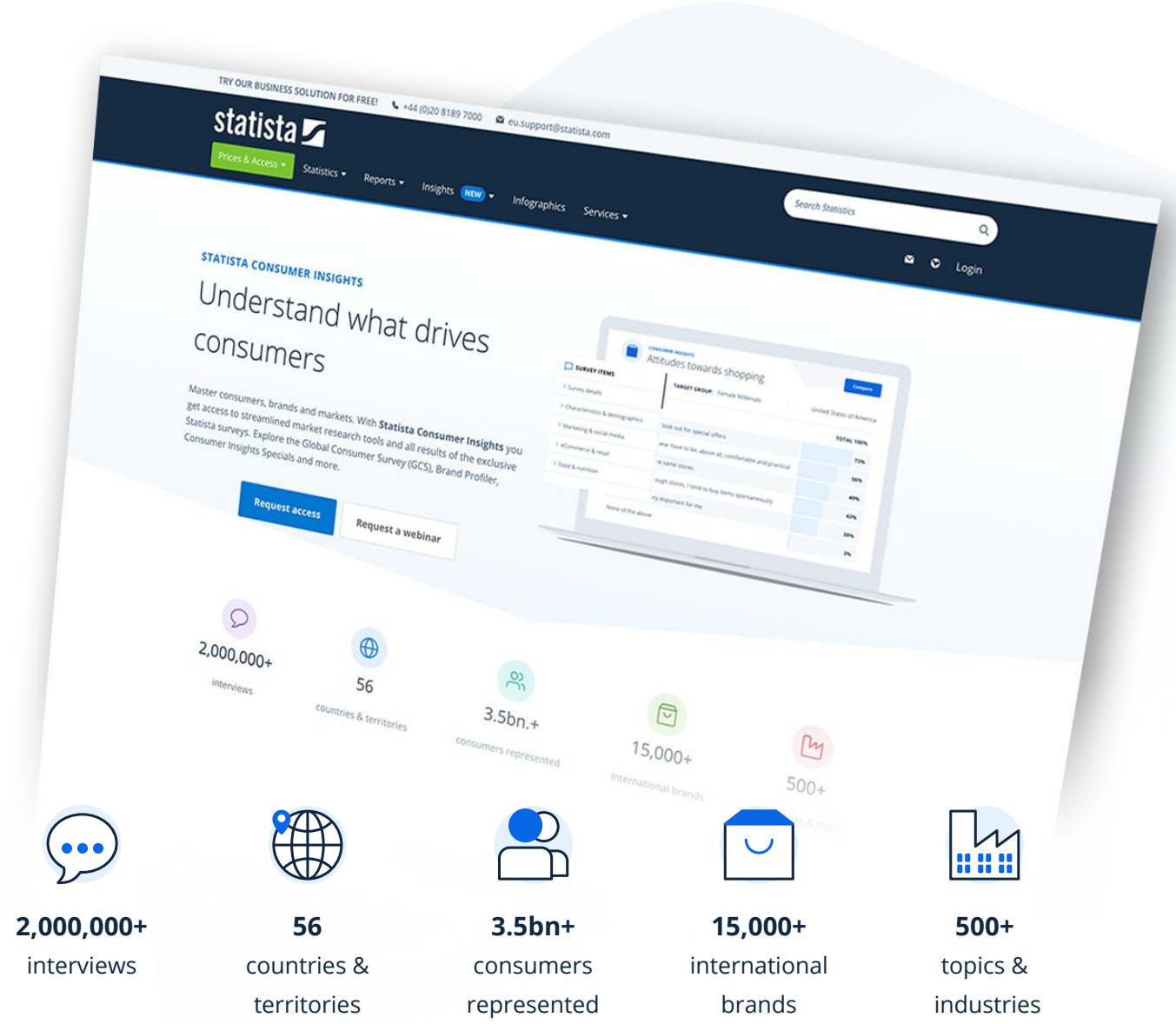


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