



INVESTMENT INSIGHTS

Analysis, Insights, and a Different Perspective

March 2023

KEY POINTS

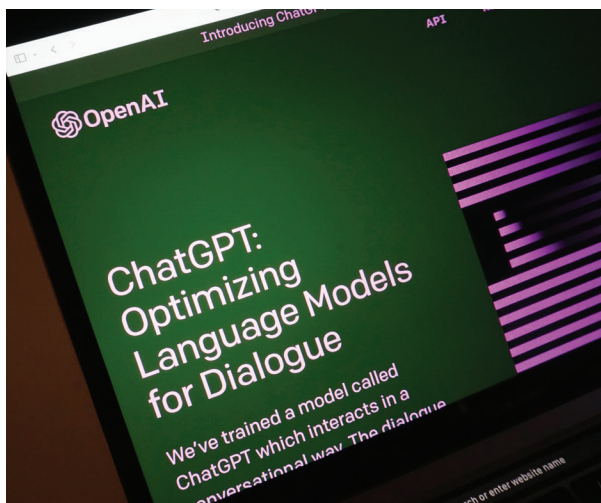
- Government agencies, private companies, and universities have all played significant roles in the development of AI.
- ChatGPT's capabilities continue to surprise researchers, including its ability to pass or nearly pass several medical, law, and business school tests.
- The largest threat for human workers in the immediate future is not necessarily AI but other workers that implement AI.
- Our daily lives will likely continue to become integrated with AI.

CHATGPT AND BEYOND: THE ECONOMIC AND EMPLOYMENT IMPLICATIONS OF AI

KEY PLAYERS

Government agencies have played a critical role in AI research. Defense Advanced Research Projects Agency (DARPA), a research agency of the U.S. Department of Defense, has funded early AI projects and supported machine-learning techniques. While the agency focuses on developing emerging technologies for military purposes, the impact of its work has extended to many civilian applications. In the 1970s, DARPA launched the Strategic Computing Initiative to develop a computer that could reason like a human. Although this goal was not met, the initiative helped progress natural language processing and machine learning.¹ More recently, DARPA launched the Grand Challenge, a series of competitions to develop self-driving vehicles. Although no cars completed the first Challenge in 2004, it sparked progress in AI domains instrumental in the emergence of self-driving vehicles, including computer vision and machine learning.²

Private companies have also played a major role in the development of AI. These companies have invested heavily in research and development to create advanced AI technologies and applications, such as Google's DeepMind and IBM's Watson. These companies also publish their cutting-edge research. To illustrate the sheer amount of research being conducted, the following chart ranks the number of papers published by each company in the Conference on Neural



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¹ Congressional Research Service. "Artificial Intelligence and National Security." R45178, 21 Sept. 2020.

² National Academies of Sciences, Engineering, and Medicine. "Automated Vehicles: 2018-2019 Assessment of the Department of Transportation's Research, Development, and Demonstration Programs." The National Academies Press, 2019.



Information Processing Systems (NeurIPS) and the International Conference on Machine Learning (ICML). In 2021, the U.S. companies and U.S.-backed research labs took the top 5 spots, with Google and its wholly owned subsidiary DeepMind publishing 292 and 134 papers, respectively, with Microsoft, Facebook, and IBM making up the remaining spots. Interestingly, “T” or the transformer in Microsoft’s GPT, was developed by Google as an AI model that takes a string of text and predicts what comes next.³ Not surprisingly, research in AI is propelled by competition among private companies.

**2021 COMPANY RANKING BY NUMBER OF PAPERS
PUBLISHED IN ICML AND NEURIPS**

Rank 1	Google	292
Rank 2	Microsoft	178
Rank 3	Facebook	137
Rank 4	DeepMind (Google)	134
Rank 5	IBM	74

Note: ICML is the International Conference on Machine Learning and NeurIPS is the Conference on Neural Information Processing Systems. Data sources: “An Overview of NeurIPS 2021’s Publications.” *VinAI*, 29 Dec. 2021; and, “An Overview of ICML 2021’s Publications.” *VinAI*, 28 Dec. 2021.

Universities are also hubs for AI research, as the advancement of AI technologies requires a deep understanding of computer science, statistics, mathematics, and engineering. In fact, the term “AI” can be traced back to a mathematics professor at Dartmouth College.⁴ Based on the number of published papers in ICML and NeurIPS, the leaders are U.S. technology-focused universities. In addition to pushing research, academic institutions also play a key role in educating and training the next generation of scientists and engineers.

**2021 UNIVERSITY RANKING BY NUMBER OF PAPERS
PUBLISHED IN ICML AND NEURIPS**

Rank 1	Stanford University	205
Rank 2	MIT	196
Rank 3	University of California, Berkeley	177
Rank 4	Carnegie Mellon University	175
Rank 5	Tsinghua University (China)	134

Note: ICML is the International Conference on Machine Learning and NeurIPS is the Conference on Neural Information Processing Systems. Data sources: “An Overview of NeurIPS 2021’s Publications.” *VinAI*, 29 Dec. 2021; and, “An Overview of ICML 2021’s Publications.” *VinAI*, 28 Dec. 2021.

³ Knight, Will. “Meet Bard, Google’s Answer to ChatGPT.” *Wired*, Conde Nast, 6 Feb. 2023.
⁴ “John McCarthy - Stanford University, 1999 Fellow.” *Computer History Museum (CHM)*.

ECONOMIC IMPACT

ChatGPT was publicly introduced in late 2022 and quickly became the fastest-growing digital platform ever. Within just 5 days, it had a million users compared with Instagram, Facebook, Twitter, and Netflix, which took 1, 10, 24, and 41 months, respectively to gain 1 million users.⁵ ChatGPT's immense popularity is due to its vast and often creative scope of practical applications. One example, a ChatGPT-generated Shakespearean-style sonnet about financial planning, is below.

In times of yore, men planned their finances not
But spent their wealth on baubles, whims and wine
Ne'er saving coin nor putting wealth to plot
To keep their future lives in comfort fine

But times have changed, and wisdom doth prevail
And those who plan their finances with care
May prosper well and never come to fail
And riches beyond measure they may share

Forsooth, the task of planning doth seem drear
A task to test the wit and fortitude
Yet with sound mind and heart devoid of fear
A plan for future wealth may be pursued

So, take the cue from this olde sonnet here
And plan thy finances well, without a fear.



While this output may not be impressive from a literary standpoint, it is just one example that highlights this chatbot is much more capable than its predecessors. In fact, many researchers have been surprised by the capabilities of this technology. Research by Kung and co-authors found that ChatGPT could perform near the passing threshold for medical licensing exams.⁶ Additionally, researchers at the University of Minnesota Law School found ChatGPT performance at a C+ level on law school exams.⁷ Similar findings were attained by a researcher at Wharton Business School, where ChatGPT passed an MBA course.⁸

These findings have naturally made many worry about the potential negative impact of AI on employment. As with many technological advancements, the current AI tool can increase the labor force's productivity in the long run. It will also expand jobs within tech-related fields. However, it also has the potential to hurt employment sectors at risk of becoming displaced by AI. Jobs like online customer service, data entry, and telemarketing are at particular risk.

For the time being, AI may not be a threat to human jobs but may, instead, make them more efficient by augmenting their work. Indeed, in the short time ChatGPT has been released, many users have experienced increased productivity in their daily lives. For example, researchers at the University of Minnesota Law School suggest that an attorney can be more productive by using "ChatGPT to prepare the initial draft of a memo and then tweak that draft as needed."⁹ Similarly, medical professionals at rehab treatment centers reduced the time spent on writing tasks like radiology reports by 33% by using ChatGPT.¹⁰ These examples highlight how workers can potentially protect themselves from falling behind by keeping up with technological changes and incorporating them into their daily lives.

5 Sier, Jessica. ChatGPT Takes the Internet by Storm, Bad Poetry and All." *Australian Financial Review*, 8 Dec. 2022.

6 Kung, Tiffany H., et al. "Performance of ChatGPT on USMLE: Potential for AI-Assisted Medical Education Using Large Language Models." *MedRxiv*, Cold Spring Harbor Laboratory Press, 1 Jan. 2022.

7 Choi, Jonathan H., et al. "ChatGPT Goes to Law School." *SSRN*, 25 Jan. 2023.

8 Needleman, Emma. "Would ChatGPT Get a Wharton MBA?" *Mack Institute for Innovation Management*, 24 Jan. 2023.

9 Choi, Jonathan H., et al. "ChatGPT Goes to Law School." *SSRN*, 25 Jan. 2023.

10 Kung, Tiffany H., et al. "Performance of ChatGPT on USMLE: Potential for AI-Assisted Medical Education Using Large Language Models." *MedRxiv*, Cold Spring Harbor Laboratory Press, 1 Jan. 2022.

LIMITATIONS

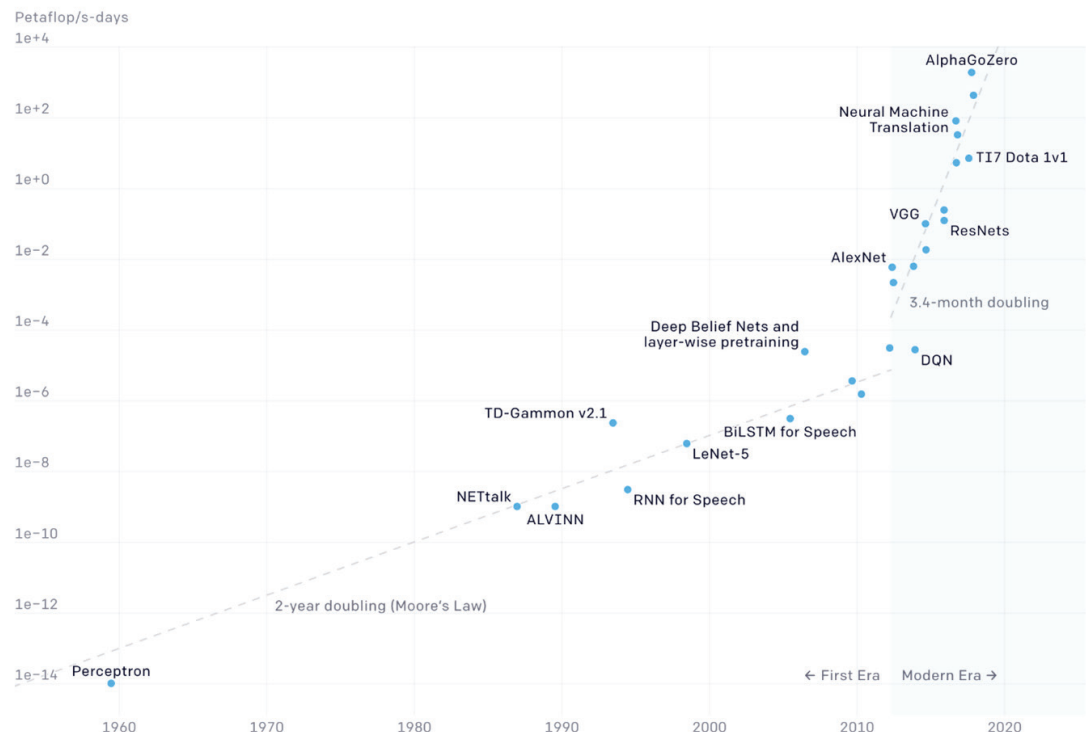
ChatGPT and similar tools are far from perfect. The bot often answers incorrectly, especially about recent events, so using this tool requires careful consideration. Some bugs in the system have raised ethical concerns. In one example, some clever users discovered ways to make the bot provide controversial answers by asking ChatGPT to envision a scenario in which its typical ethics do not apply. This system flaw even made ChatGPT predict future events, which the bot was not designed to do.¹¹ In another example, a journalist found a way to make the bot discuss such controversial topics as breaking the rules, pretending to be human, and hacking computer systems.¹² The bugs were quickly fixed in both examples, and these errors seem to have been resolved. Despite AI's benefits, it's clear that improvements are needed to make this a suitable tool for everyday use.

FUTURE OF AI

The field of AI is advancing rapidly, with reports of the next version of ChatGPT already in development. This progress has created an arms race among researchers to improve AI models. Examples include the announced chatbot from Google called Bard and rumors of a rival AI lab from Elon Musk. Historically, computing power has followed "Moore's Law," which states that the number of transistors on a processor (CPU) doubles roughly every 18 months. AI uses graphics processors (GPU), which have grown much faster than CPUs. This rapid growth in the processing power of GPUs has contributed to AI's increased capabilities today compared to only a decade ago. As represented visually below, it appears AI will continue to improve and perhaps even at an accelerating rate. However, the current path may eventually slow due to the energy required to run AI, which will eventually be more than is available worldwide. Such were the findings of an executive of AMD (a GPU manufacturer) at the 2022 Design Automation Conference. While the precise trajectory of AI growth is difficult to predict, one thing that is clear: AI will soon continue to be a larger part of our lives.

TWO DISTINCT ERAS OF COMPUTE USAGE IN TRAINING AI SYSTEMS

Source: OpenAI



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¹¹ Getahun, Hannah. "Breaking ChatGPT: The AI's Alter Ego Dan Reveals Why the Internet Is so Drawn to Making the Chatbot Violate Its Own Rules." *Business Insider*, Business Insider.

¹² Roose, Kevin. "A Conversation with Bing's Chatbot Left Me Deeply Unsettled." *The New York Times*, The New York Times, 16 Feb. 2023.