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AI in biotechnology:

An analysis of USPTO patent applications, 2002–2023

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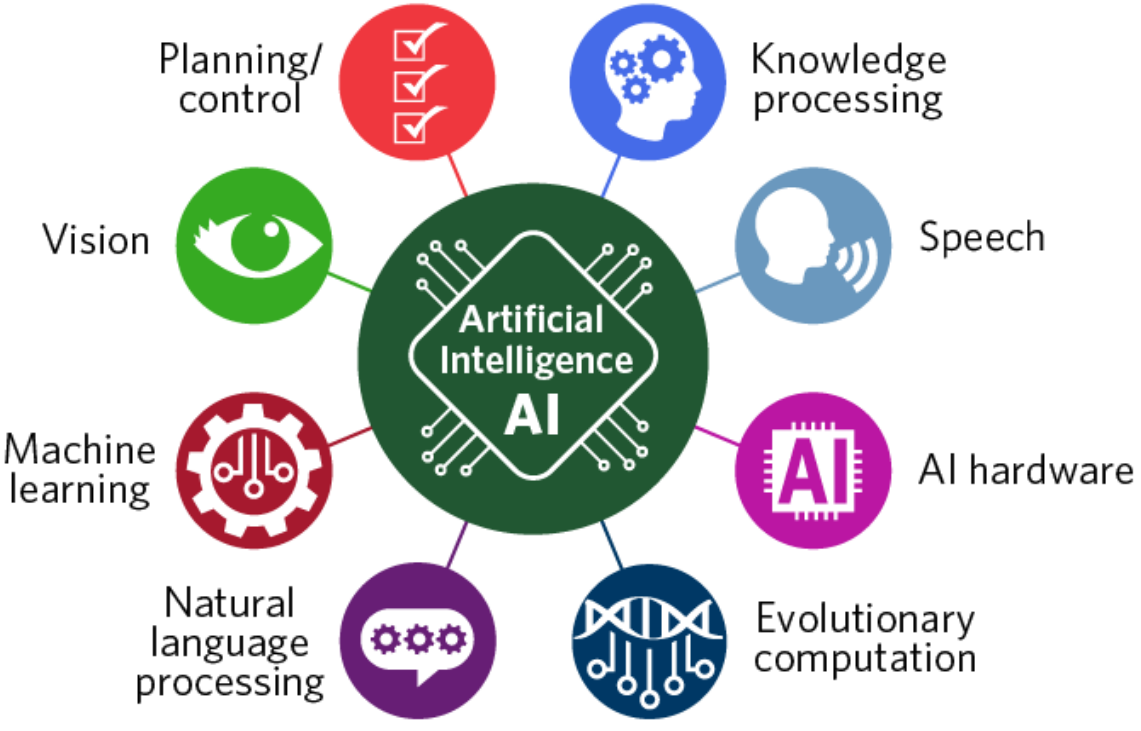
Background: Office of the Chief Economist (OCE) AI studies

- USPTO IP Data Highlights report *Inventing AI: Tracing the diffusion of artificial intelligence with U.S. patents*, October 2020
  - Uncovers substantial diffusion of AI across technologies, inventor-patentees, organizations, and geography
- Nature Biotechnology article *Discovering value: Women's participation in university and commercial AI invention,* January 2024
  - Shows that women's participation in patenting – both in AI and other technologies – is growing and is associated with more diverse teams and patents with higher economic value
  - Finds that more can be done to diversify the innovation ecosystem, especially in the university sector and biotech AI, where women's participation is associated with substantial value

The AI patent dataset (AIPD)

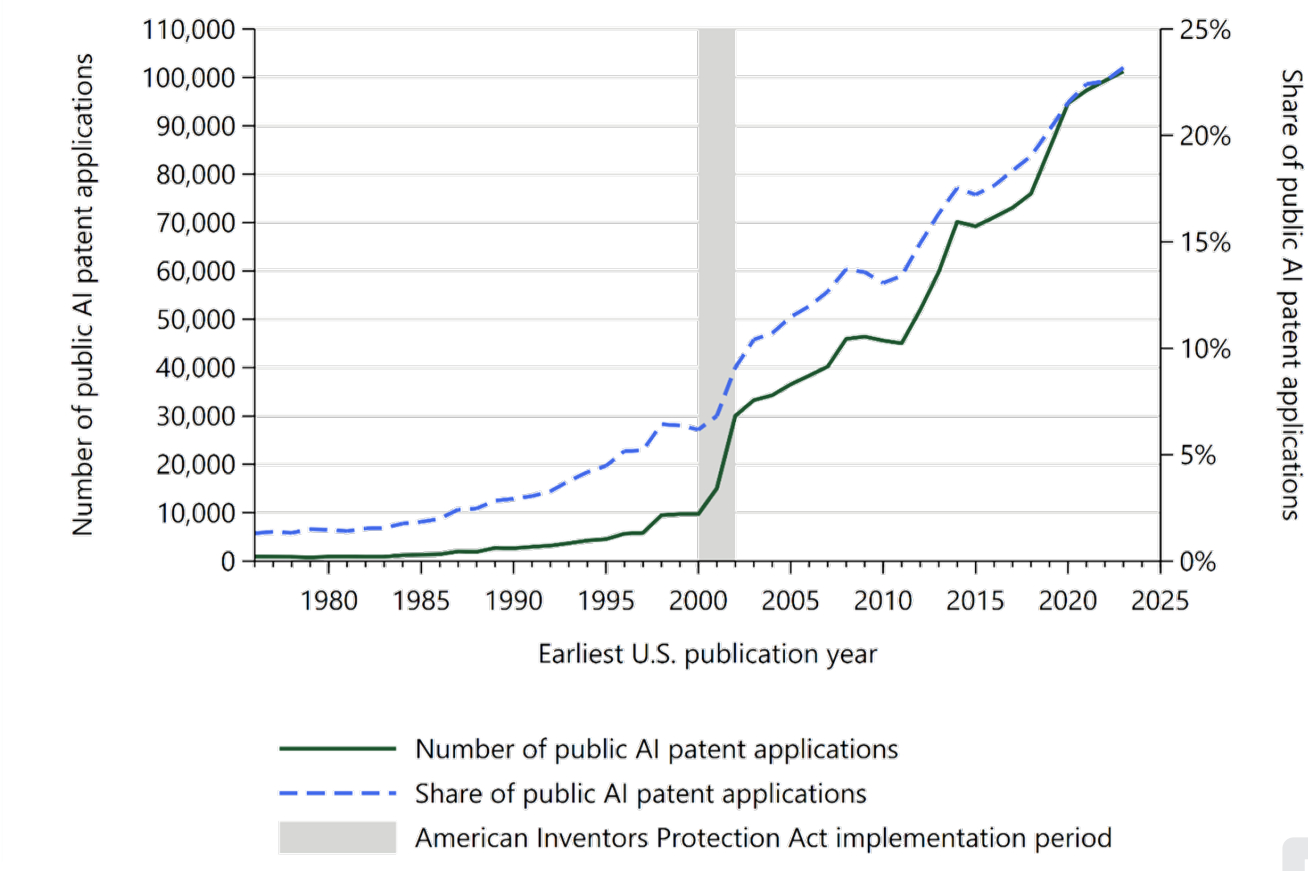
- Journal of Technology Transfer article *Identifying artificial intelligence (AI) invention: A novel AI patent dataset*, November 2021
  - Public release of the AIPD
  - The AIPD has been downloaded over 5,000 times, relied upon by over 70 scientific articles, and used to inform a variety of policy discussions, including the USPTO's AI/ET strategic partnership and the agency's 2022 report to Congress on subject matter eligibility.
- The *AIPD 2023 update*
  - Extends the AIPD by identifying which of 15.4 million U.S. patent documents (patents and pre-grant publications) published from 1976 through 2023 contain AI
  - Identifies AI in patent documents with improved AI methodology

Definition of AI



Other definitions of AI are useful for AI policy making and operational processes at the USPTO. This definition of AI is from the *Inventing AI* report and is not the official definition used by the USPTO.

Volume and share of public U.S. AI patent applications, 1976–2023



The earliest U.S. publication year is either the year of the first pre-grant publication for a granted or, if there is no pre-grant publication, the year a granted patent was published.

Updated findings from *Inventing AI*

- Across the eight AI technology components, the largest growth over the five-year period between 2018 and 2023 was in machine learning, rising from nearly 12,000 applications in 2018 to almost 29,000 in 2023, a 142% increase.
- Patents containing AI appeared in about 55% of all technology subclasses used by the USPTO in 2018 and spread to around 60% by 2023.
- In 2023, U.S. assignees received the largest number of AI patents at 48,243, followed by Japan (6,088) and China (4,200).
- Over the five-year period from 2018 to 2023, the number of patents assigned to U.S. individuals and organizations grew 35%, while the number assigned to Japan increased by 18%, and the number to China rose by 151%.

Definition of biotechnology AI

- Biotechnology defined as being within Technology Center 1600 (TC1600) – "Biotechnology and organic chemistry"
  - Included technologies: Isolated and recombinant proteins/enzymes, herbicides, drugs, bioinformatics, recombinant DNA and RNA, immunology, gene regulation, drug delivery, etc.
- A patent document is classified as **biotechnology AI** if:
  - the document is AI in the AIPD, and
  - it is examined in TC1600
- Note: excludes plant patents (not classified in the AIPD)

This definition of biotechnology AI is used for purpose of this analysis only (e.g., the Nature Biotechnology article referenced earlier used a slightly different definition).

AI in biotechnology

Examples

U.S. Patent Application No. 17/265,708

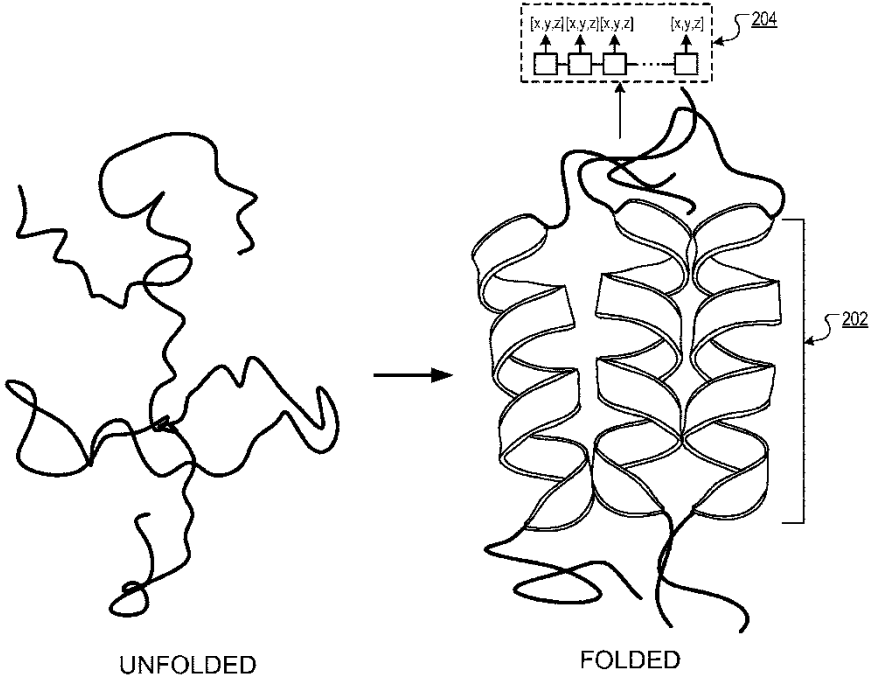
Machine learning for determining protein structures

- Applicant: DeepMind Technologies Limited

Classified* in:

- G16B15/20: Protein or domain folding

*One of several classification areas



U.S. Patent No. 11,893,498

Subset conditioning using variational autoencoder with a learnable tensor train induced prior

- Assigned to Insilico Medicine

Classified* in:

- G16B15/30: Drug targeting using structural data; Docking or binding prediction

*One of several classification areas

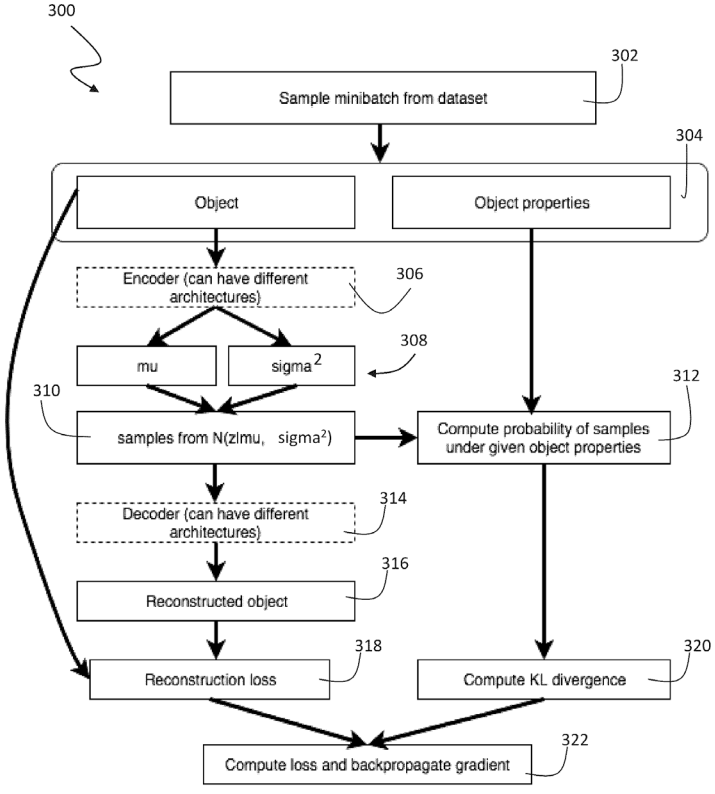
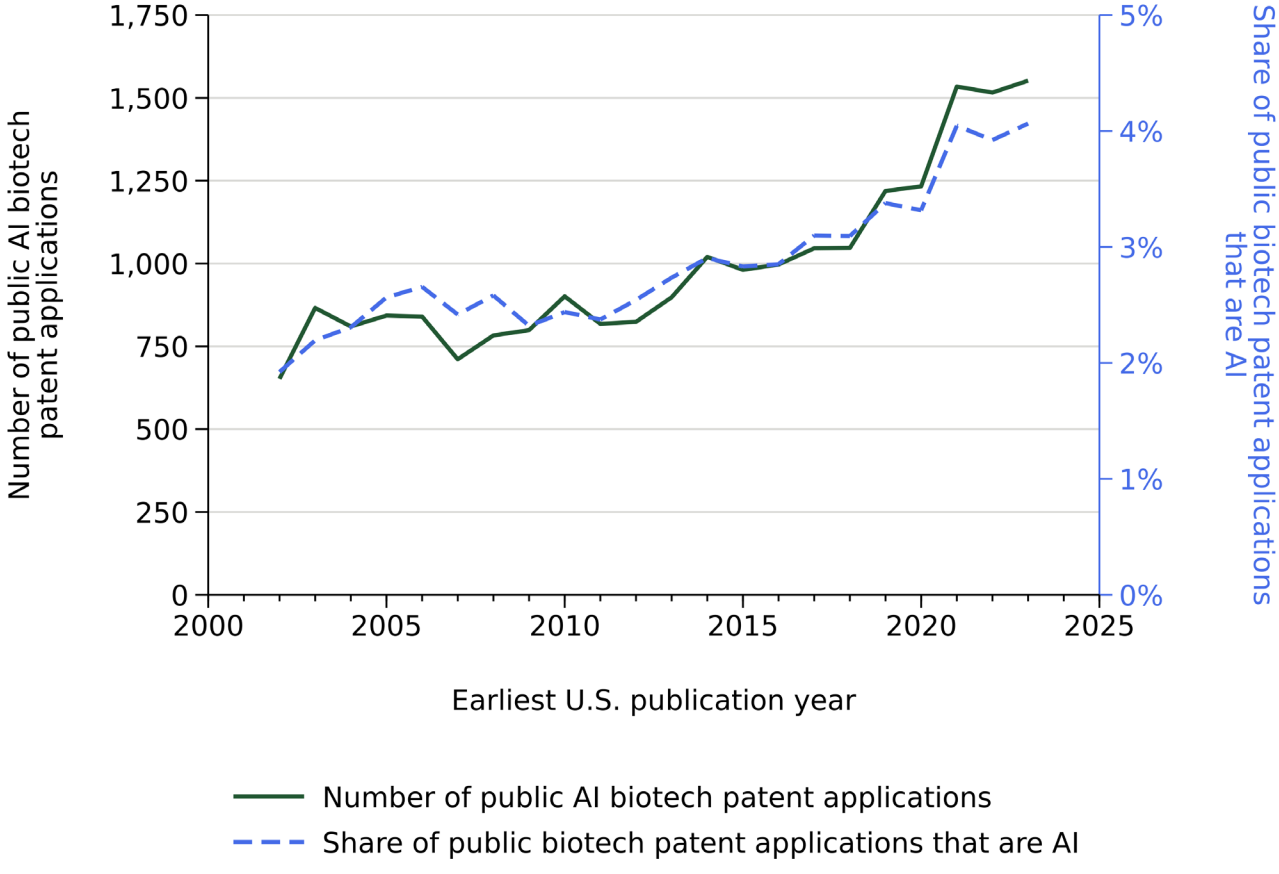


Fig. 3A

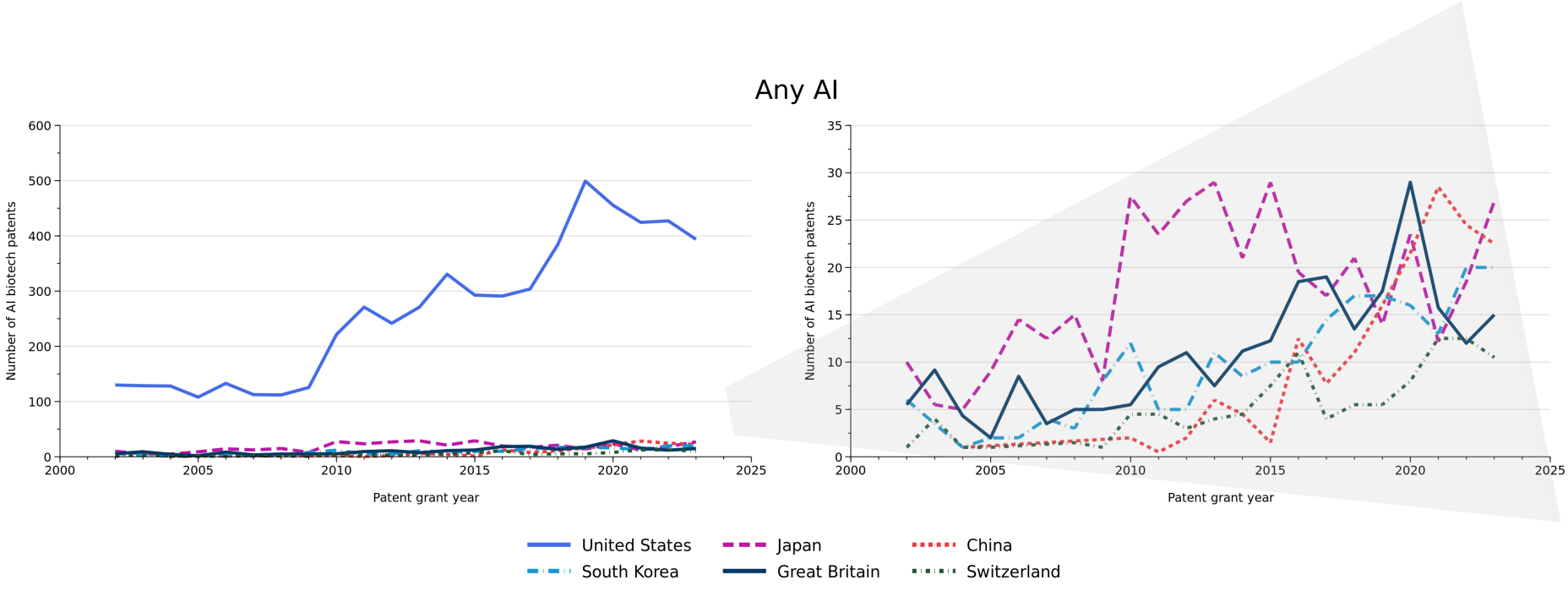
AI in biotechnology

Volume and share of public U.S. patent applications and patents

Volume and share of public U.S. biotechnology AI patent applications, 2002–2023



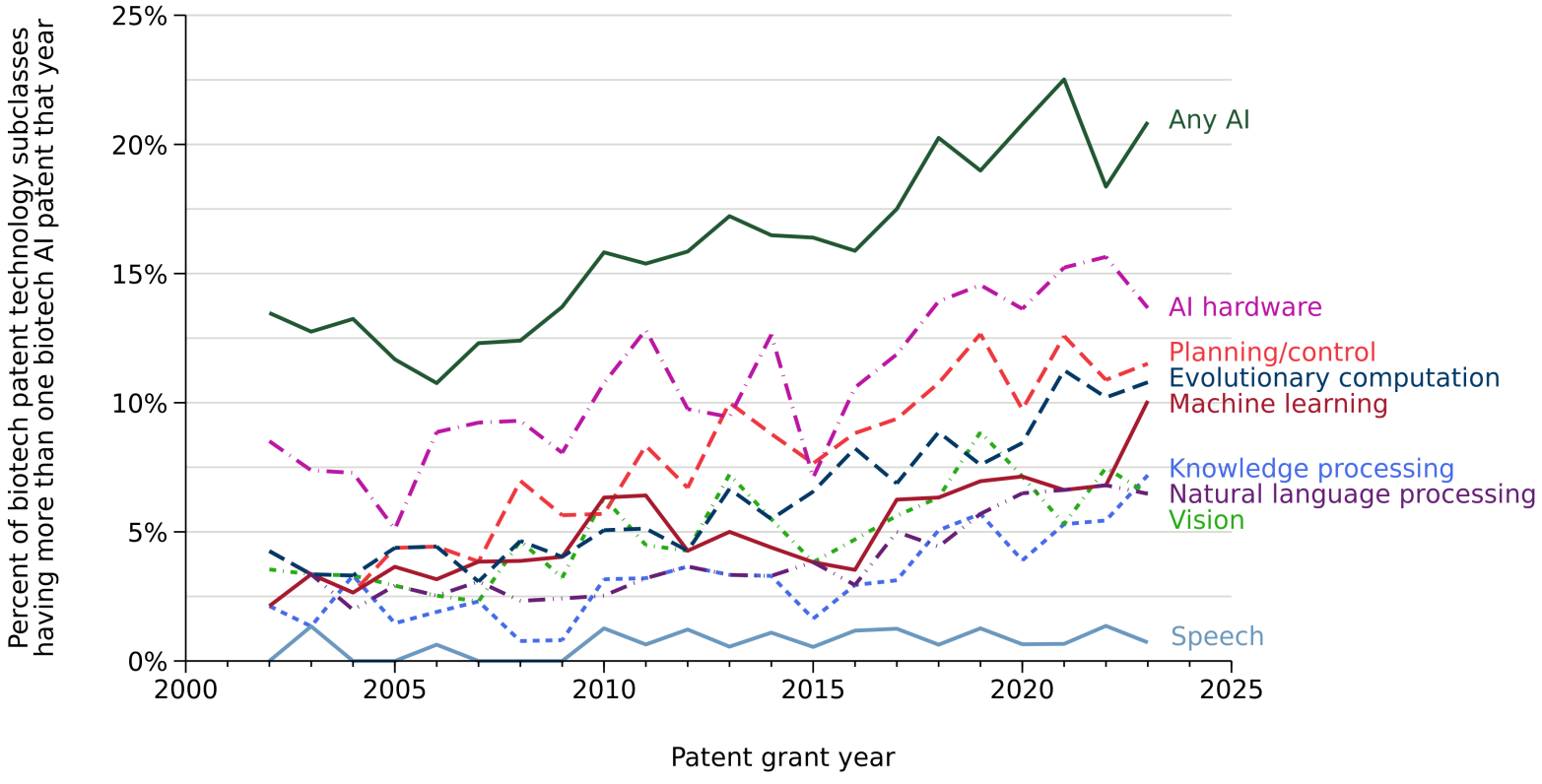
Growth of U.S. and top 5 foreign country patent owners-at-grant (in 2023) of U.S. AI biotechnology patents, 2002–2023



AI in biotechnology

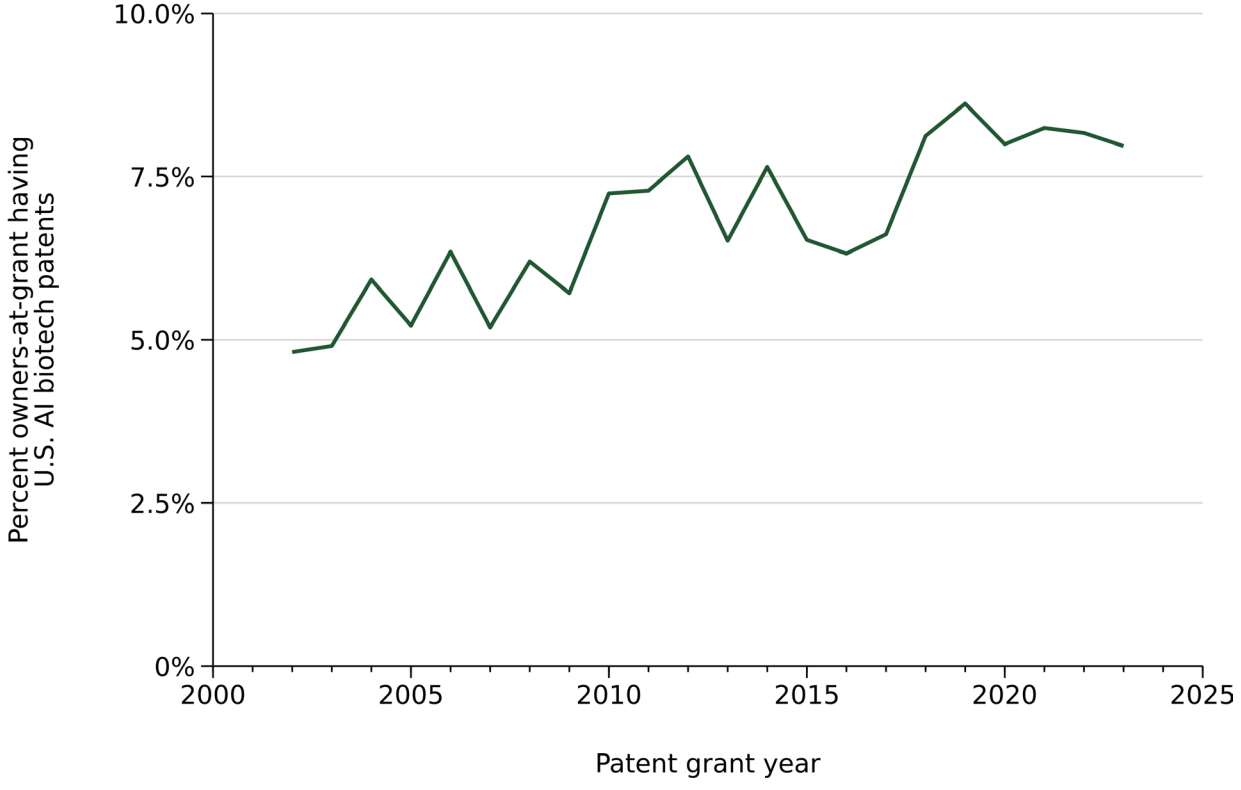
Diffusion of AI technology

Diffusion of biotechnology AI across biotechnology patent technology subclasses, overall and by AI component, 2002–2023



16 Includes only the first technology subclass listed on biotechnology patents.

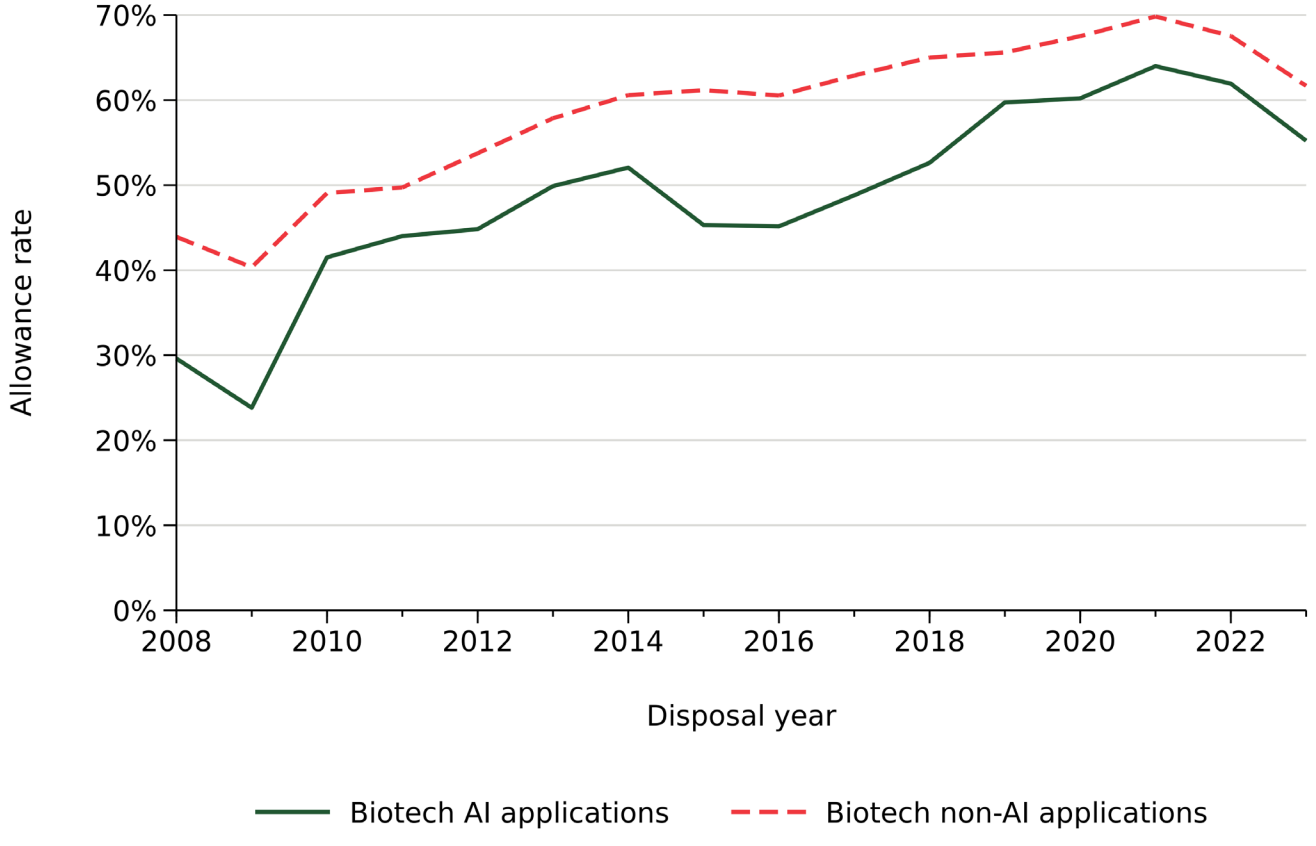
Diffusion of AI across U.S. based biotechnology assignees, 2002–2023



AI in biotechnology

Allowance rates

Patent application allowance rates, 2008–2023, biotechnology



The allowance rate is the number of allowances over the number of disposals by disposal year.

Conclusion

- AI is increasingly used in biotechnology, although to a lesser degree than technology overall.
  - Between 2018 and 2023, biotechnology AI public applications increased by about 48%, while the increase in AI overall was 33%.
  - In 2023, about 23% of all public patent applications included AI, while only about 4% of biotech applications did.
- Biotechnology AI patenting is diffusing across technologies and owners-at-grant.
  - In 2023, 20.8% of biotech patent technology sub-classes contained AI.
  - About 8% of biotechnology owners-at-grant patented in biotech AI in 2023
- Allowance rates for AI in biotechnology have trended similarly to all AI applications in recent years, and AI biotech allowance rates are slightly lower than non-AI biotech allowance rates.

Thank you!

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