AI and the digital divide: Trends in AI and the story patent and non-patent data tell us

Irene Kitsara/World Intellectual Property Organization (WIPO)

Artificial intelligence and the next generation of competences :
How Digital – and Artificial Intelligence will impact jobs and competences profiles?

The World Conference on Intellectual Capital for Communities

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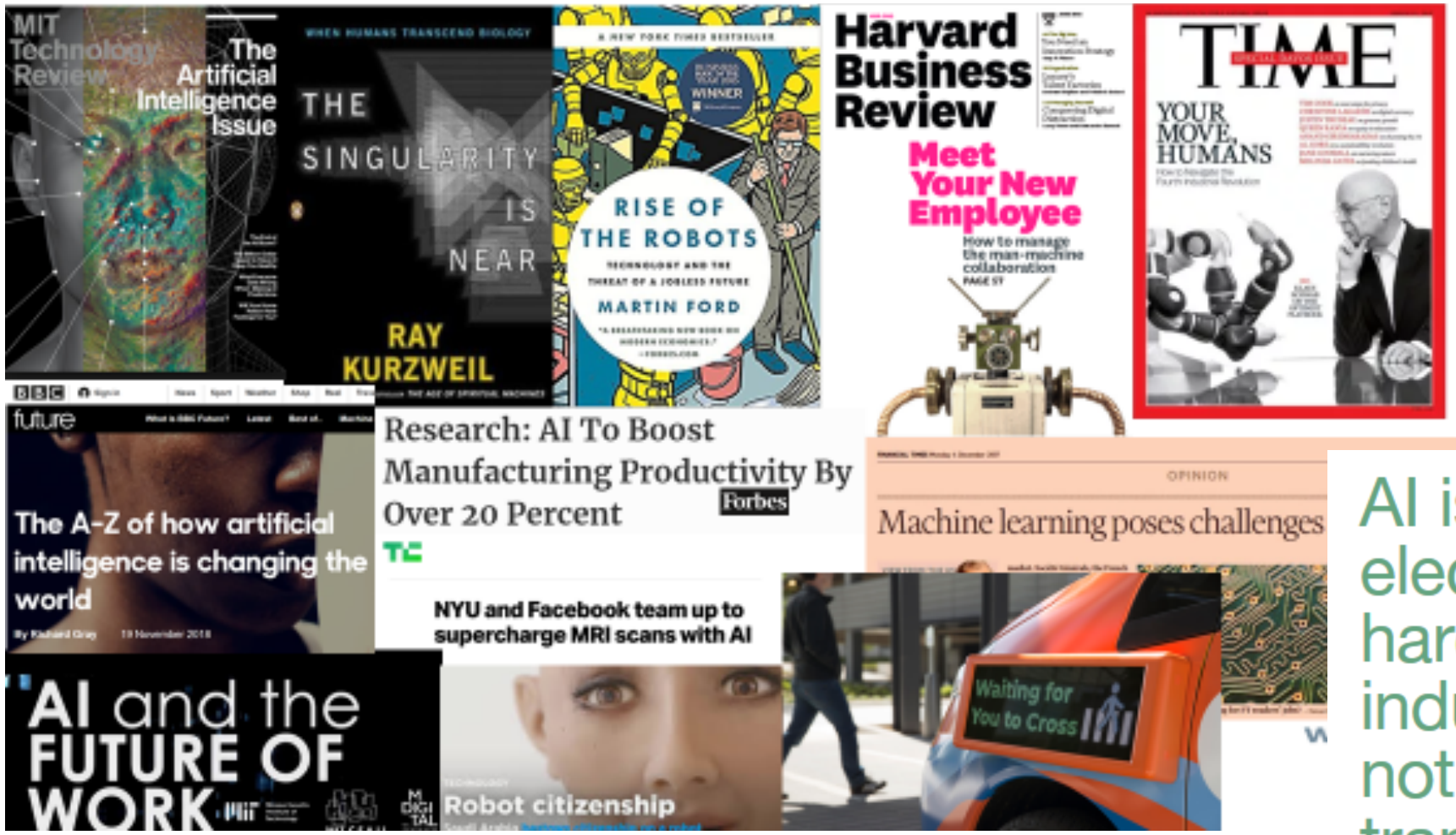
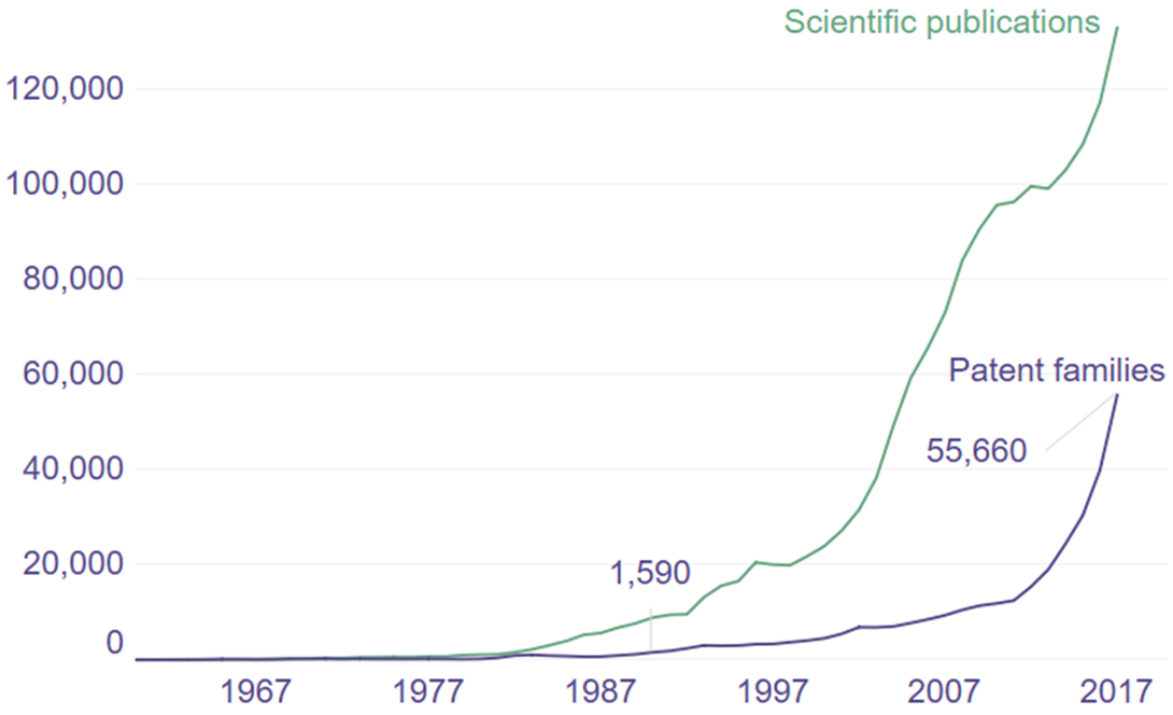
AI: Revolutionizing and impacting every aspect of our lives



AI is the new electricity. I can hardly imagine an industry which is not going to be transformed by AI.

Andrew Ng, Landing AI and deeplearning.ai

AI-related patents and scientific publications



Extensive and fast growing use of the patent system:

- **340,000 patent families**
- > 50% of AI-related patents after 2013

- **1.6 mio scientific publications**
- Boom in patent filings ~10y after scientific publications (exception: deep learning)
- Decrease in ratio of scientific papers to inventions:

  from 8:1 in 2010 to 3:1 in 2016

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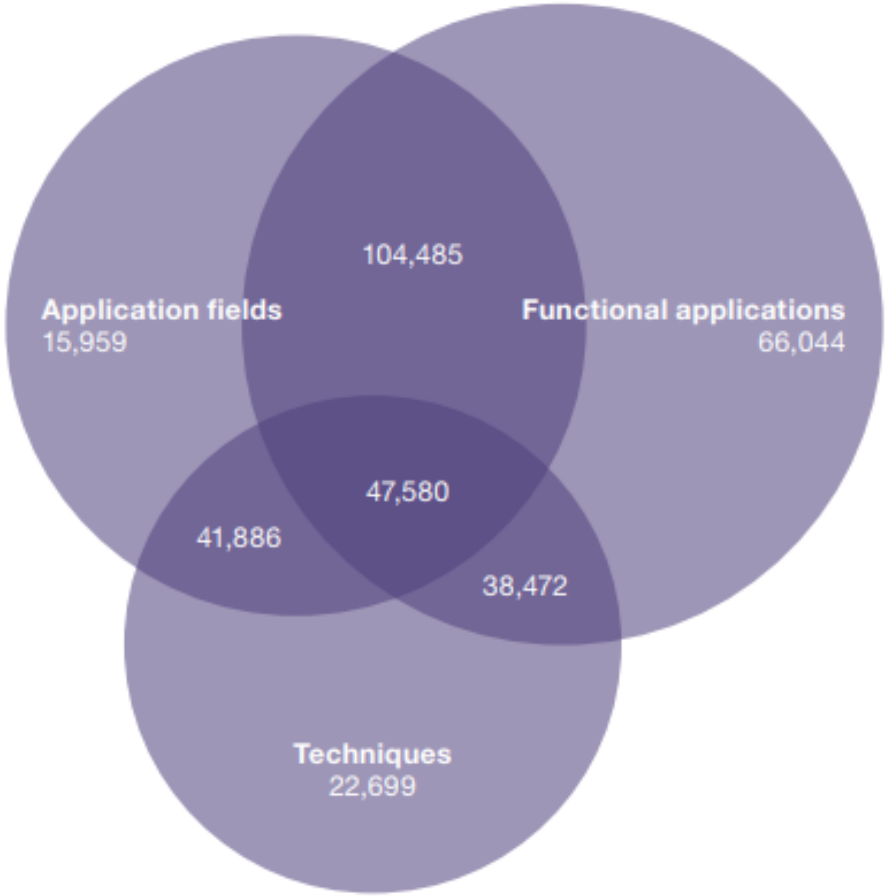
What are AI-related patent applications about?

AI techniques: the "how" of AI: advanced forms of statistical and mathematical models (e.g. machine learning, fuzzy logic) allowing the computation of tasks typically performed by humans

AI functional applications: the "what" of AI: functions such as speech or computer vision which can be realized using one or more AI techniques.

AI application fields: different fields, areas or disciplines where AI techniques or functional applications may find application (e.g. transportation, agriculture, banking, customer service).

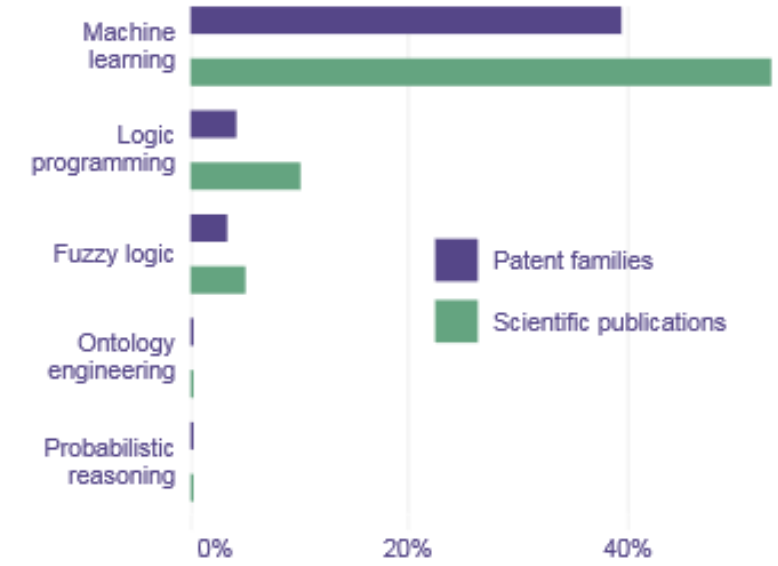
From scientific research to industrial applications of AI



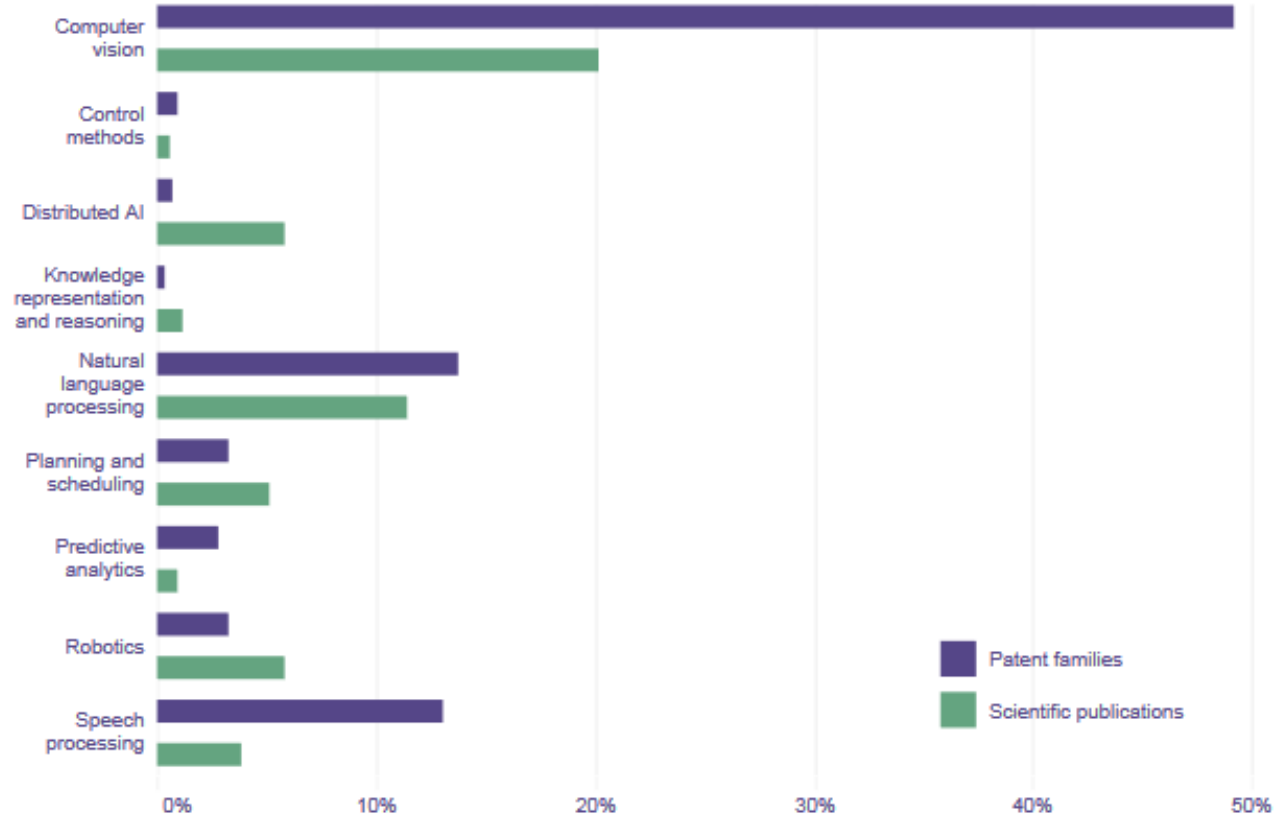
- 70% of patent dataset mention a combination of at least an AI technique with a functional application and/or an application field

From scientific research to industrial applications of AI

The share of scientific publications is generally higher than patent families for AI techniques



AI functional applications are generally more highly represented in patent families than they are in scientific publications



Note: A patent or scientific publication may refer to more than one category

Trends: AI Techniques (patents)

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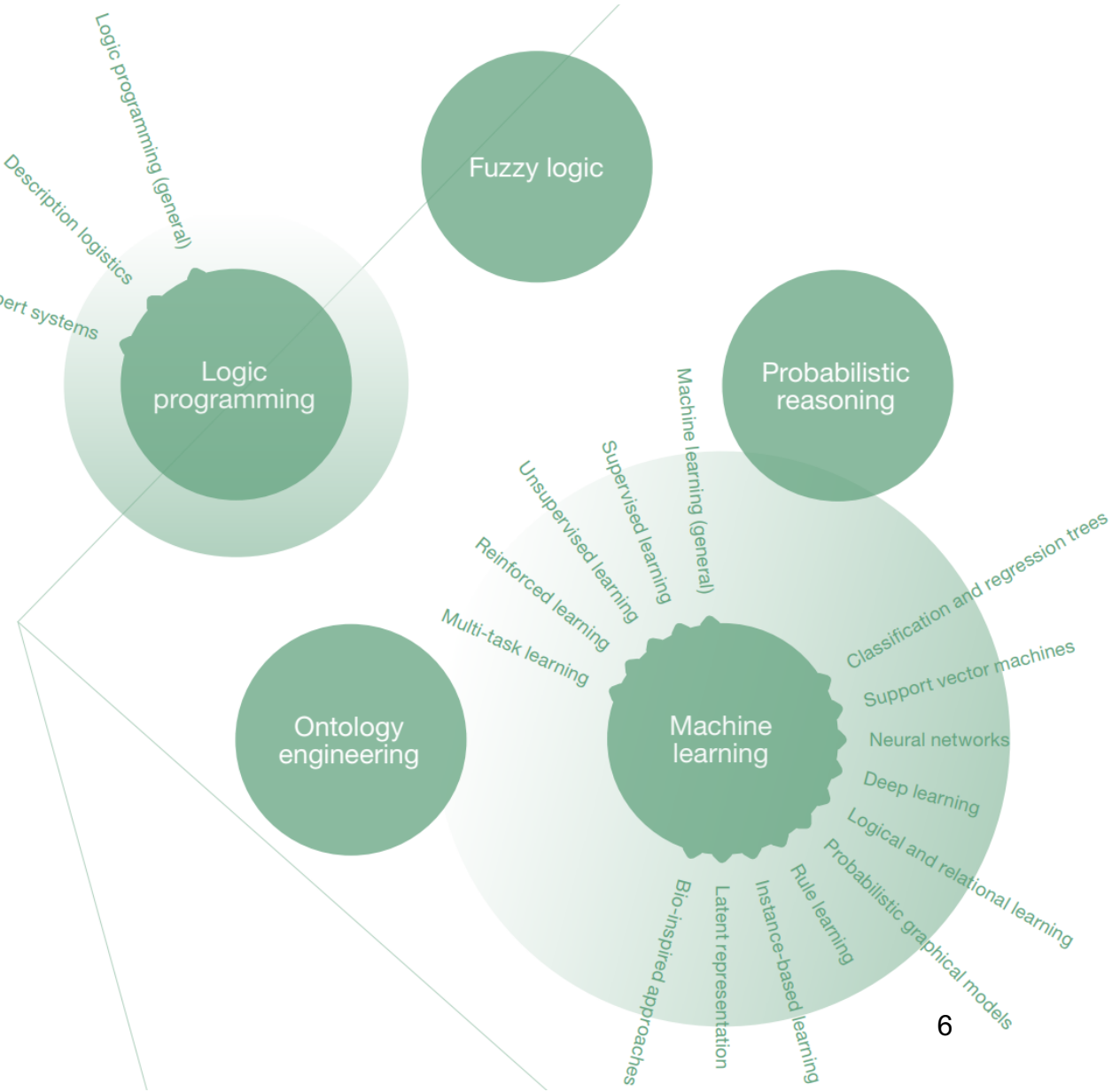
- **Machine Learning (ML) dominance:**

40% of all AI-related patents and
90% of techniques-related patents

- **Trends within ML*:**

Deep learning 175%

Neural networks: 46%



** all trends refer to 2013-2016 average annual growth rate*

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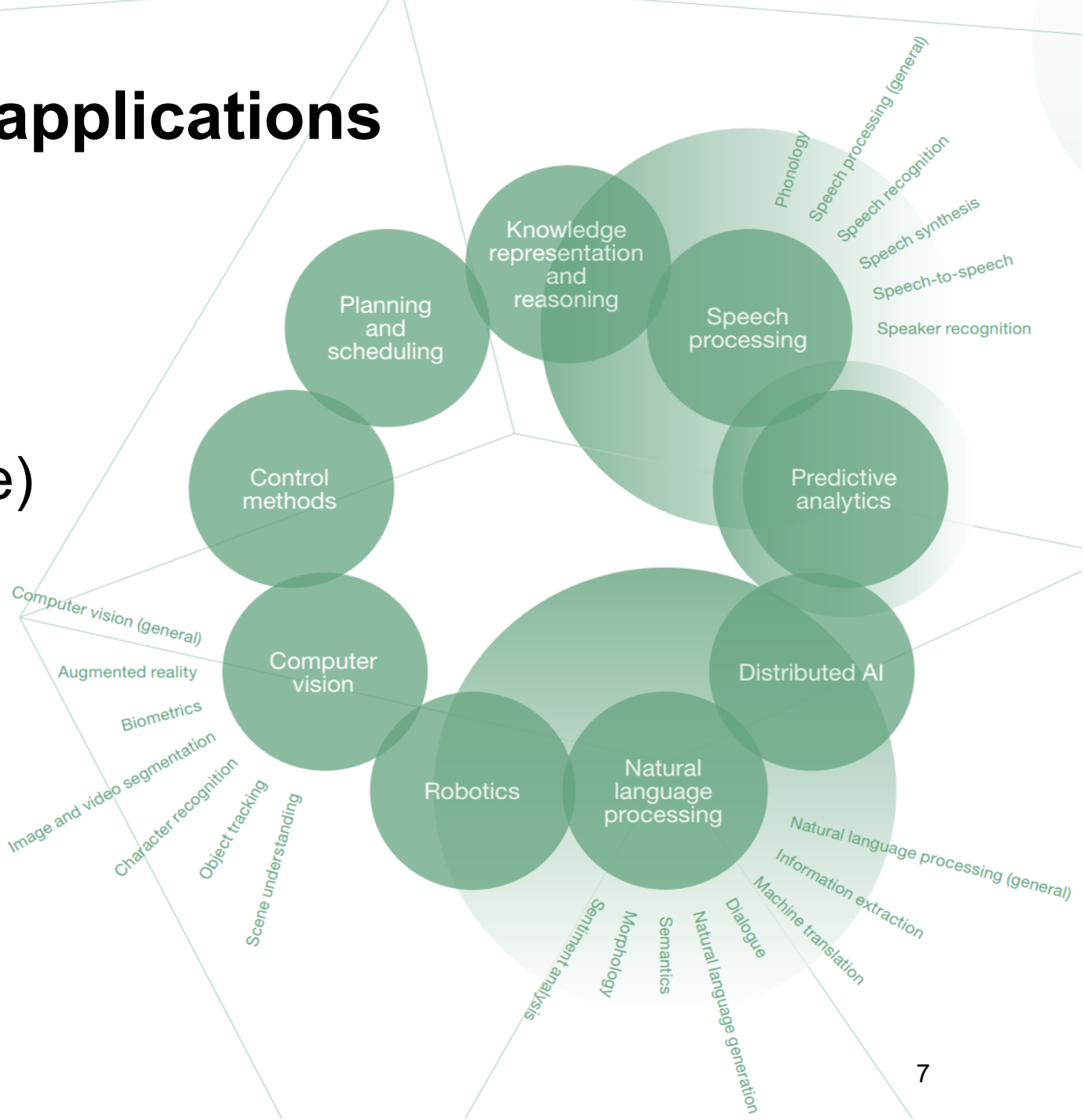
Trends: Functional applications

- **Computer vision: 49%** of all AI-related patents (24% growth rate)

- Highest growth rates:
  - **Robotics (55%)**
  - **Control methods (55%)**

(most frequently mentioned in connection with transportation)



AI Application fields: revolutionizing everything

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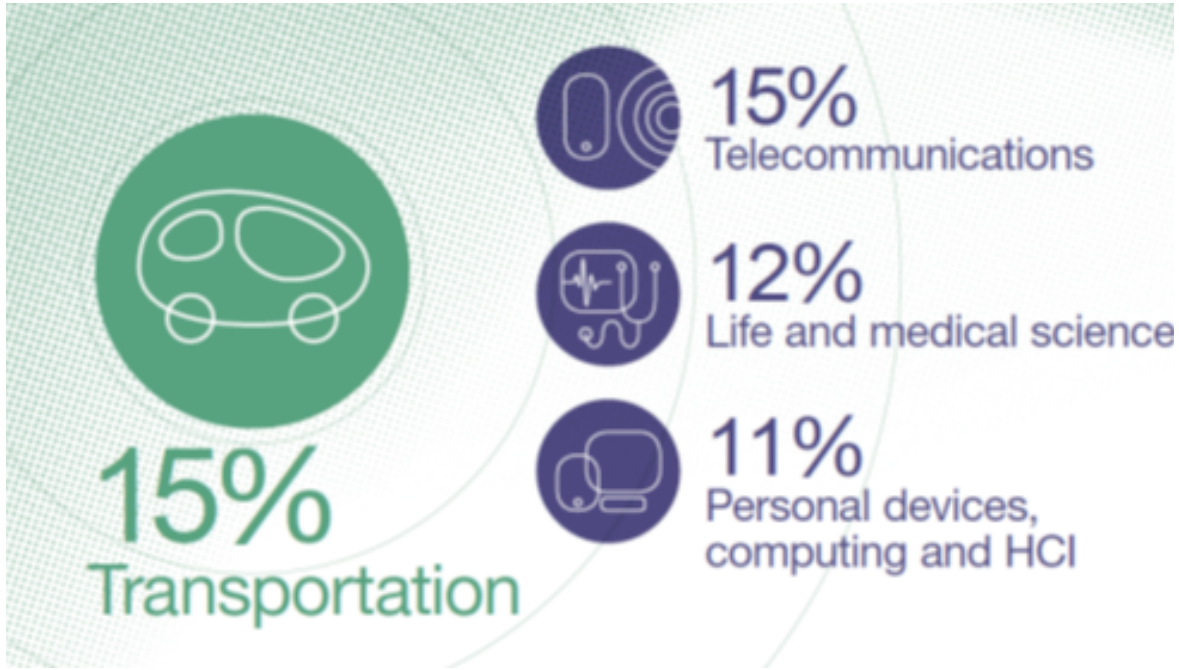
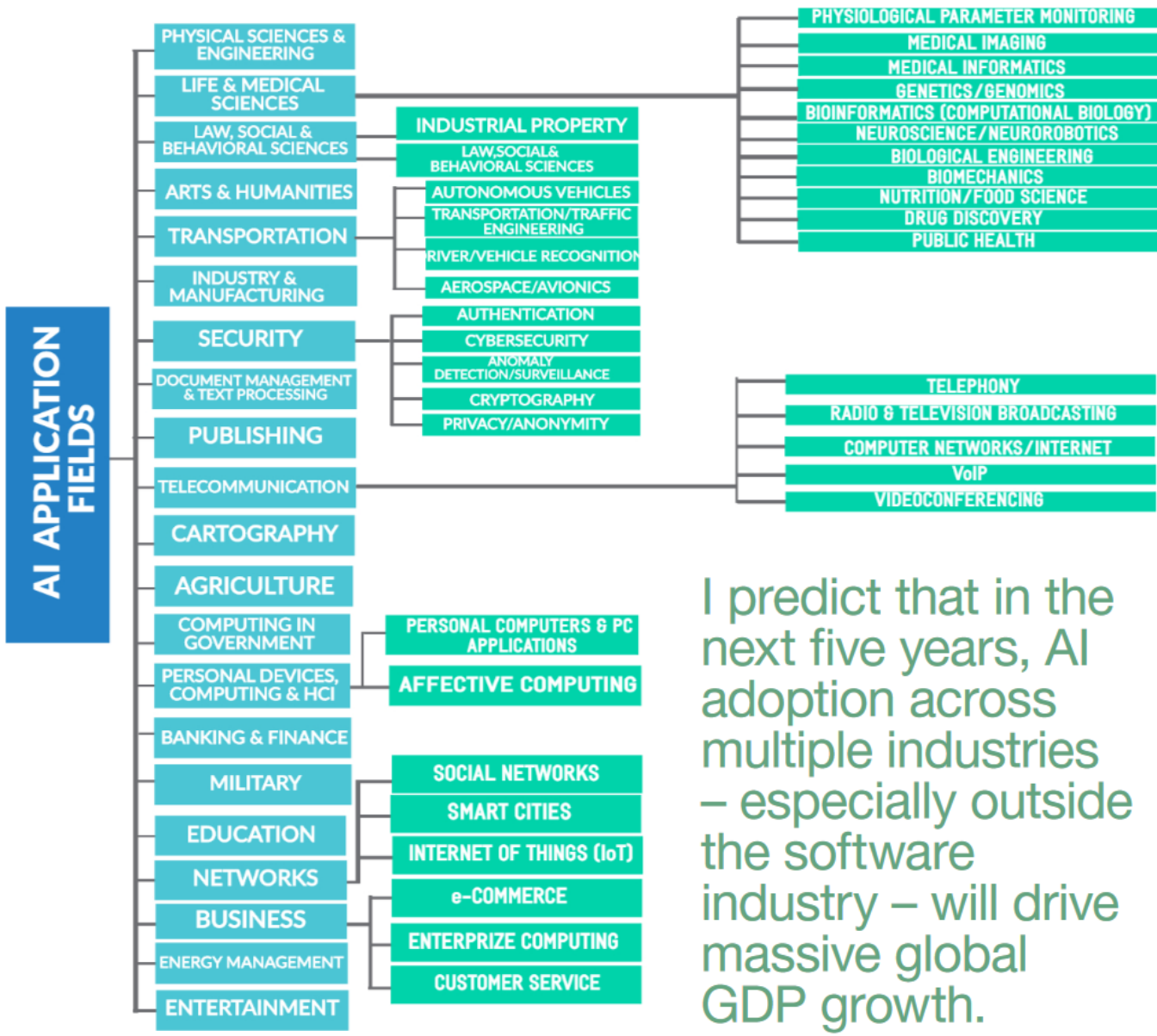
- 20 application fields
- 62% of AI patents refer to ≥ field
- Top 4 categories

(42% of all AI patents):





I predict that in the next five years, AI adoption across multiple industries – especially outside the software industry – will drive massive global GDP growth.

Andrew Ng, Landing AI and deeplearning.ai

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AI Application fields growth rates

Field categories

- **Transportation: 32.9%**
- Agriculture: 32.3%
- Computing in government: 30.3%
- Banking and finance 27.7%
- Telecommunications: 23%

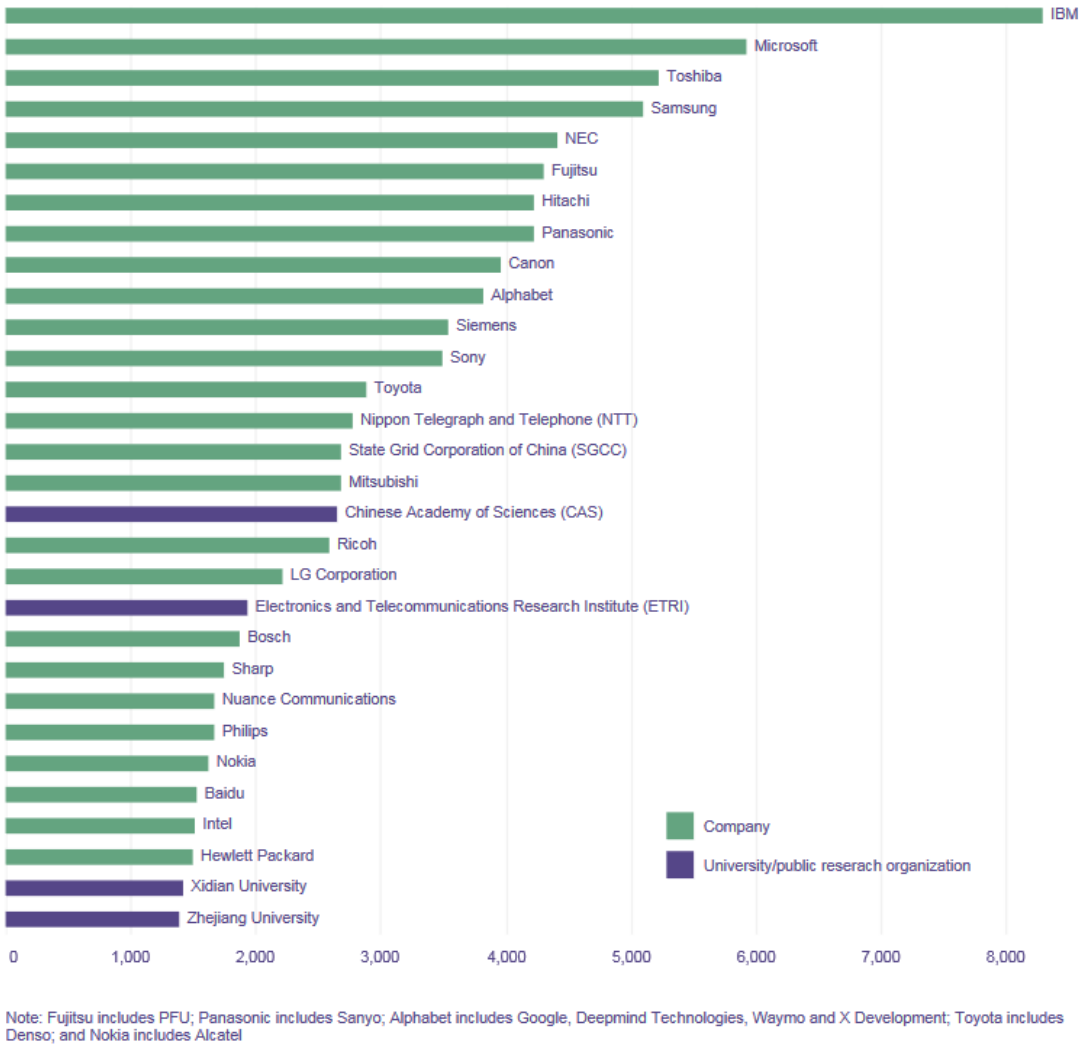
Sub-categories

- **Aerospace/avionics: 66.7%**
- **Autonomous vehicles: 42.2%**
- **Smart cities: 46.9% (networks)**
- **Affective computing: 37.7%**

(HCI: emotion recognition)

The AI average annual growth rates for 2013-2016 are remarkably higher than the 10% observed for patents across all areas of technology in the same period

Key players in AI (patents)



Note: Fujitsu includes PFU; Panasonic includes Sanyo; Alphabet includes Google, Deepmind Technologies, Waymo and X Development; Toyota includes Denso; and Nokia includes Alcatel

- Top patent applicants: mainly big corporations
- Wide patent portfolio spreading across different areas; top applicants in most of them
- Specialized players (Baidu in deep learning, Facebook, Tencent in networks, Toyota and Bosch in transportation)
  - Specialization/products/market
  - Industry-specific data

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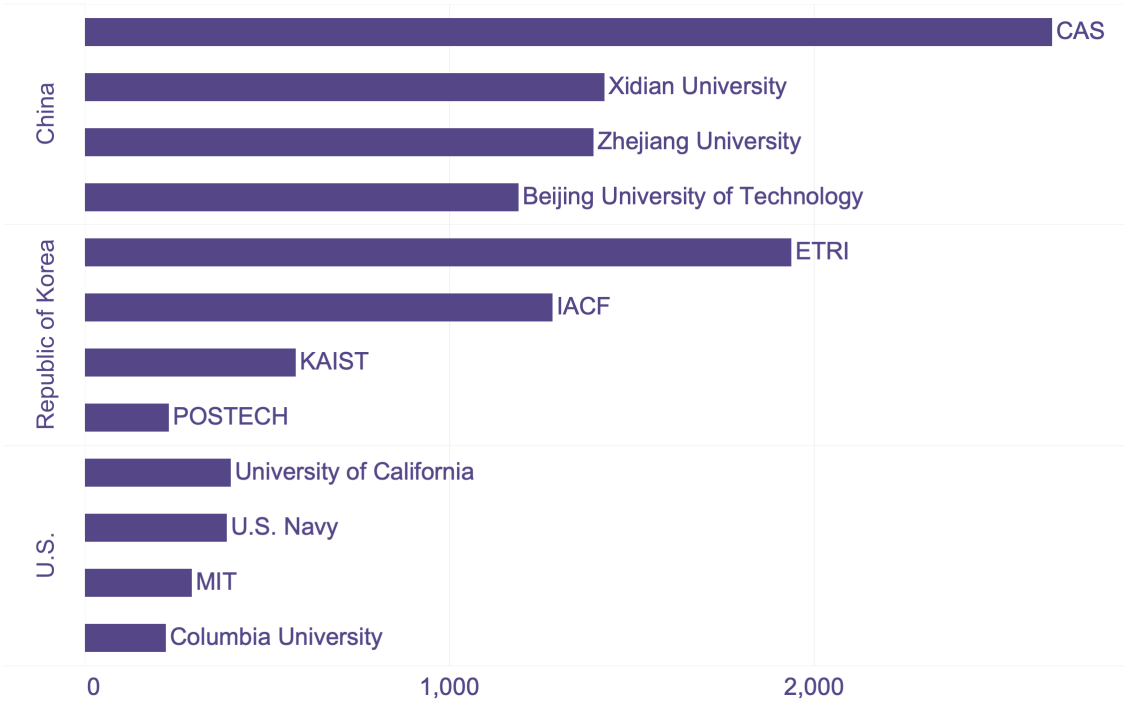
Top academic players in AI (patenting)

Key academic players



- **Top 20 academic patent applicants: 17** patent applicants are **Chinese** (and **3 Korean**)
- **Top 500 patent applicants: 167** are academic institutions; **over 100 Chinese**, **20 US** and **20 KR**, **4 JP** and **4 EU public research organizations**
- Universities leading patenting activity in selected AI areas, e.g. **unsupervised learning, distributed AI and neuroscience/neurorobotics**

Geographical distribution of AI patent filing and publishing activity

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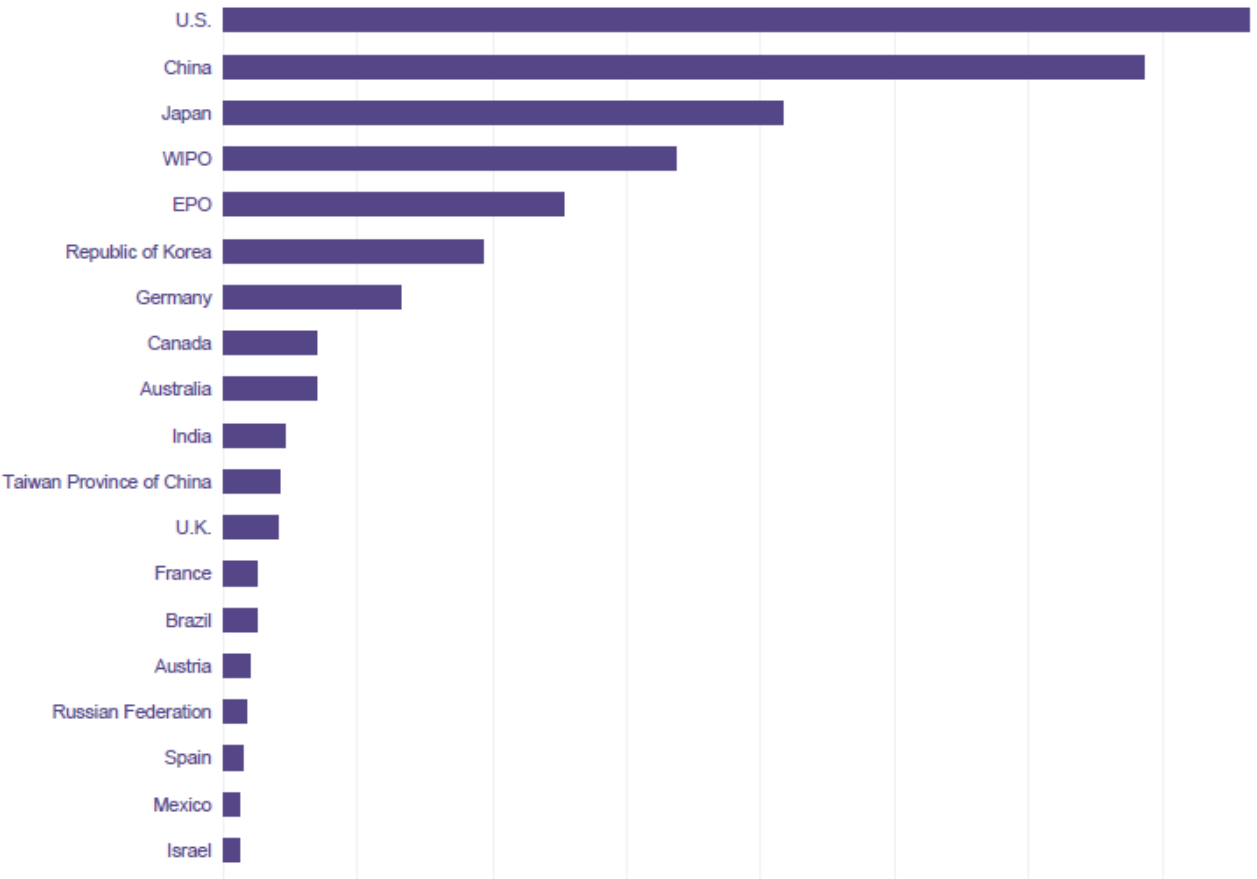
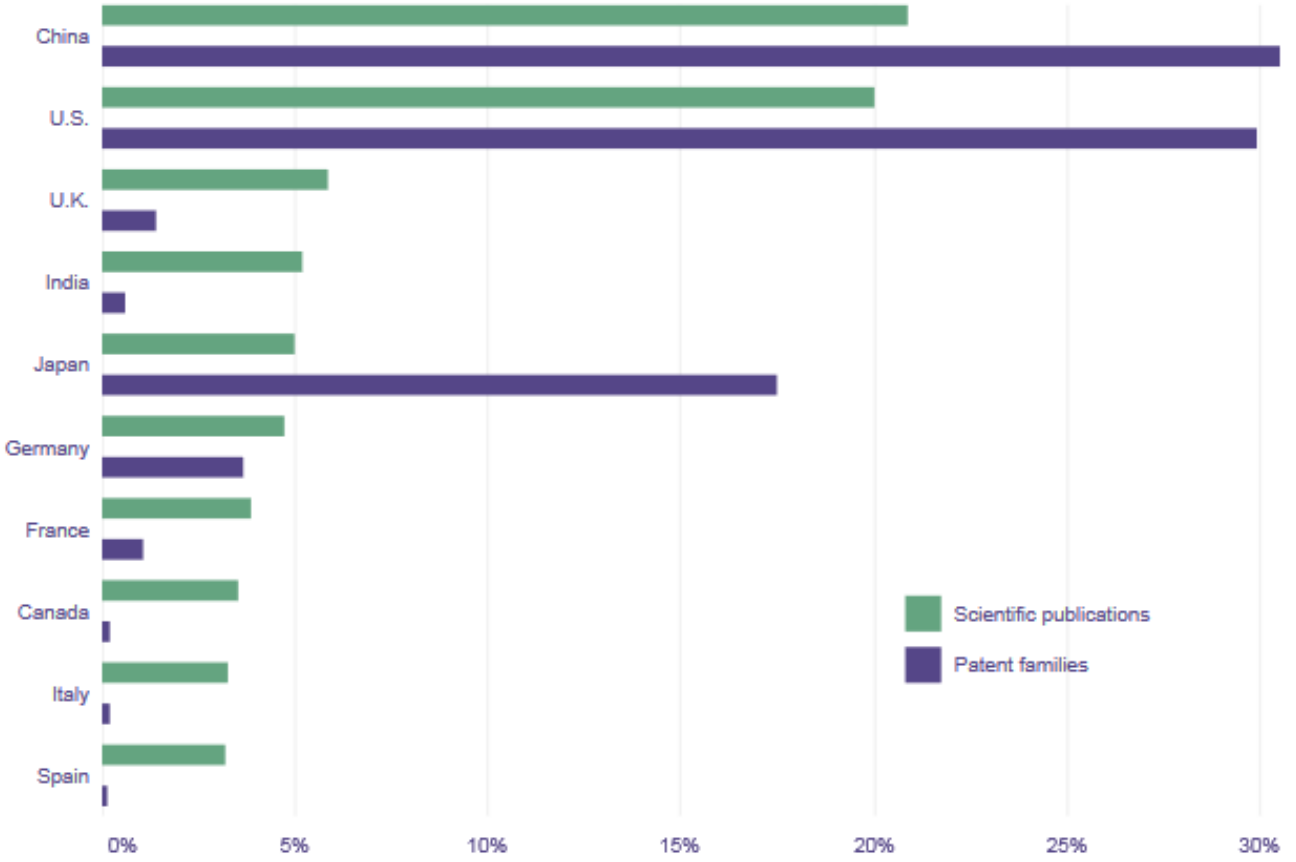
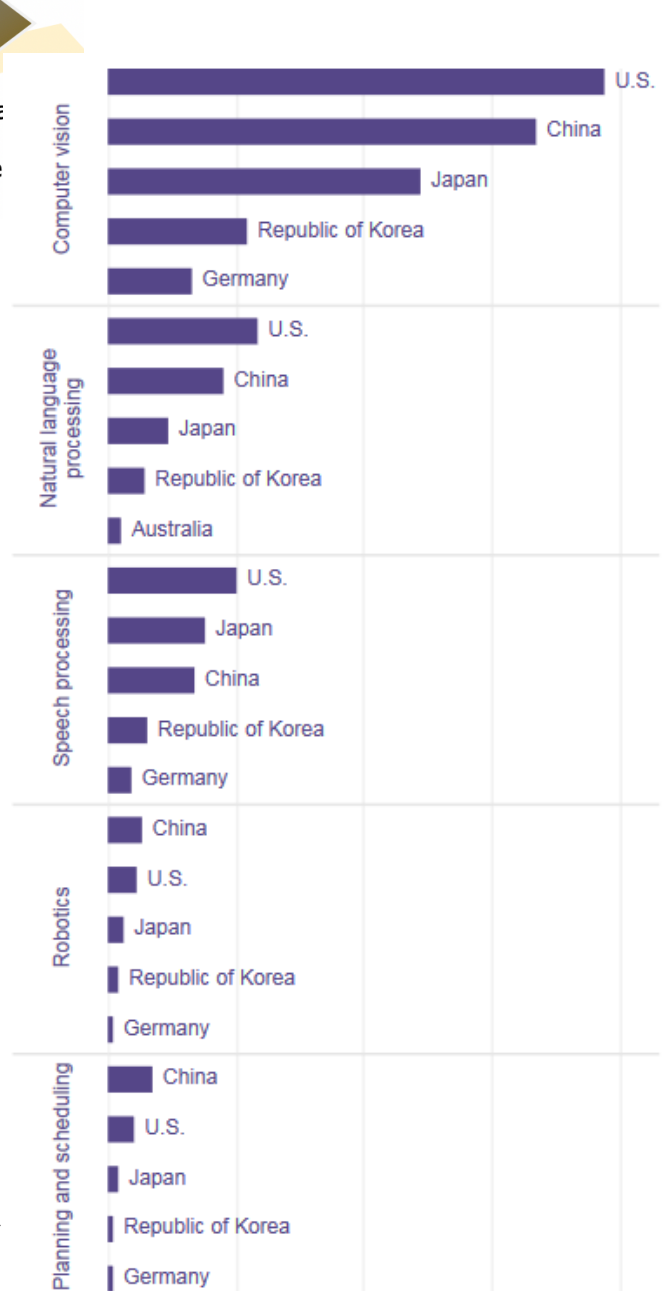
Top patent offices of filing

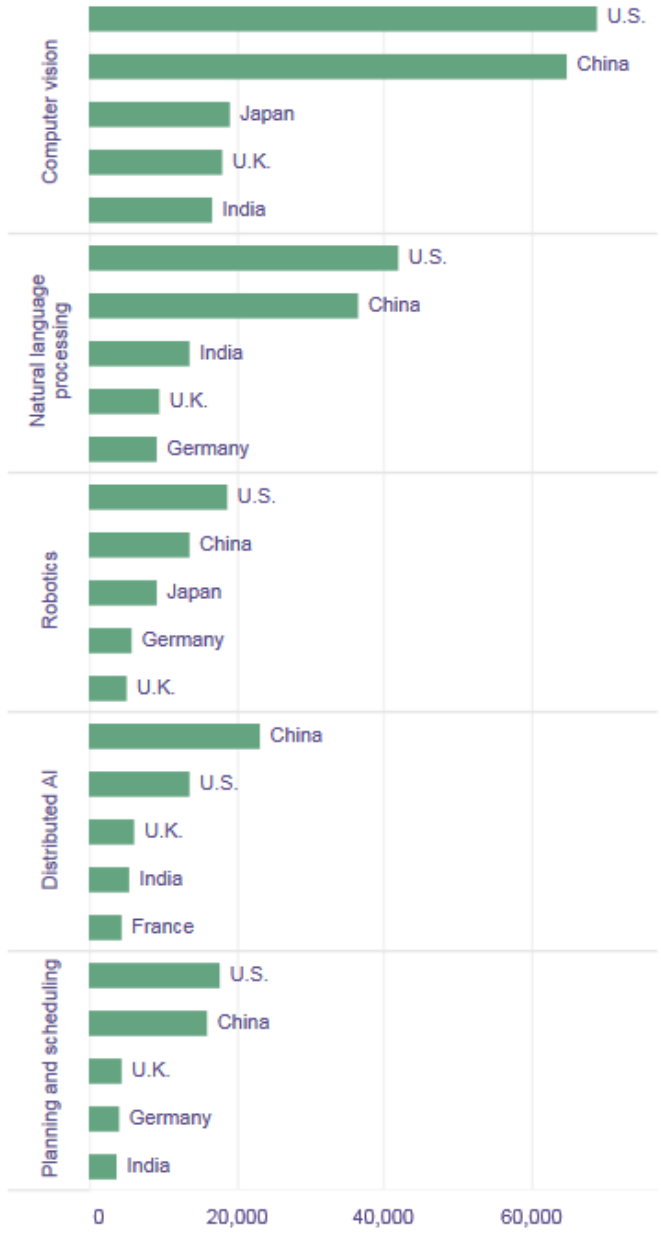


Top locations of entities authors are affiliated to vs. locations patents are filed in



Geography of AI: patent filing vs. publication activity





Dominance of few corporate players in specific geographic areas

- Patentability criteria across different jurisdictions
- (Lack of) awareness about IP system
- Culture or IP strategy
- Grace period/lack thereof
- Ownership/access to data
- Funding
- AI talent

Investment and acquisitions

- Heavy investment by the private sector in the US and CN
- Acquisition of startups for AI technology and/or talent by big corporations
- Top AI researchers acquired by private companies
- Some public investment initiatives at national and regional level

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AI creating a new digital divide or bridging it? Challenges and opportunities

- Application of AI across different industries – AI revolutionizing all fields of technology with a great impact on business, individuals and society
- From academic research to industrial applications – building on academia leadership in specific areas, acquisition of talent and niche technologies
- AI enhancing other emerging technologies (robotics, IoT, augmented reality….): indication of future applications
- Application of existing AI to priority areas in different countries (development and/or adaptation) and creating human-centric AI for the benefit of all (corporations or local players); use of patented technologies in other jurisdictions (public domain)
- AI talent – necessary for AI development and implementation (future workforce)
- Funding (public and private) and business ecosystems
- Access to data and use of specialized data (regulation)
- Supportive ecosystem (policy, education, business, legislation)

https://www.wipo.int/tech_trends/en/artificial_intelligence

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