Artificial intelligence (AI) algorithms and hardware accelerators

Artificial intelligence (AI) algorithms are computer algorithms that perform tasks normally requiring human intelligence.
AI hardware accelerators are computer hardware optimised and purpose built to run algorithms faster, more precisely or using less energy than is possible using non-optimised general purpose computer hardware.

Key Sectors

Influences all sectors of the economy, including:

- Agriculture
- Banking & Finance
- Communications
- Defence & Defence Industry
- Energy & Environment
- Health
- Transport & Logistics
- Education & Research
- Mining & Resources
- Manufacturing
- Space

Estimated impact on national interest	Low	Med	High
Economic Prosperity			X
National Security			X

Key Australian Government Actions

Initiatives

- AI Action Plan
- Digital Economy Strategy
- National Manufacturing Strategy
- DESE Digital Technologies Hub
- Cyber Security Strategy 2020
- CSIRO Data61 AI and ML Future Science Platform
- AI Ethics Framework

Regulations

- Competition and Consumer Act 2010
- Defence and Strategic Goods List 2021

Example Outcomes

- Fast, automated analysis of medical imaging
- Real-time decision support and expert systems across all sectors
- Faster and more detailed weather and climate models
- High efficiency, high reliability radio communications
- Low power 'smart' sensors
- Commodification of automated live language translation and captioning
- Privacy-preserving, energy efficient on device machine vision and speech recognition
- Real-time, high-resolution machine vision and object classification
- Significant energy and time savings for machine learning tasks

Underpinning Science

ANZ Standard Research Classification Category

- Applied computing
- Applied mathematics
- Artificial intelligence
- Computer vision and multimedia computation
- Data management and data science
- Electrical engineering
- Electronics, sensors and digital hardware
- Machine learning
- Materials Engineering
- Pure mathematics
- Software engineering
- Theory of computation

Example Applications

Readiness Level – Now

- New products, particularly computing components, systems and processes created by AI and which can be patented
- Virtual assistants
- Energy-efficient on-device speech-to-text
- Robots navigating simple human environments
- Synthetic data and deepfakes
- Cyber security defence

Readiness Level – 2–5 years

- Smart weapons
- Autonomous cyber security for defence
- High-speed computer vision for vehicles and drones
- Personalised online learning
- Creating high quality synthetic data to train machine learning models on
- On-device natural language processing
- On-sensor media processing
- Multiple AI systems working together

Readiness Level – Beyond 5 years

- Neuromorphic computing
- Physical autonomous assistants
- Learn-by-watching systems
- Artificial general intelligence
- Training new machine learning models entirely on a portable device
- Fully self-driving vehicles

Australia's place in the world

Australia ranks 15th globally for research impact, led by the University of Melbourne. The United States has the highest research impact for artificial intelligence, with seven of the top 10 performing research institutions, 4 of which are private companies. The United States has significantly higher amounts of venture capital (VC) investment compared to second ranked China. Australia is unranked, globally, for VC investment. Patent activity has been increasing at around 36% p.a. since 2016, with near equal global leaders China and the United States both holding approximately 100 times more patent families than Australia, which ranks 21st worldwide.

Artificial intelligence is being advanced in multiple Australian industry sectors, particularly in banking & finance, transport & logistics, communications and health. Australia is currently world leading on the development and deployment of AI Ethics Principles and has piloted these principles with 6 companies. Australia is a member of the Global Partnership on Artificial Intelligence (GPAI) and the AUKUS (Australia, United Kingdom, United States) alliance has an emphasis AI collaboration.
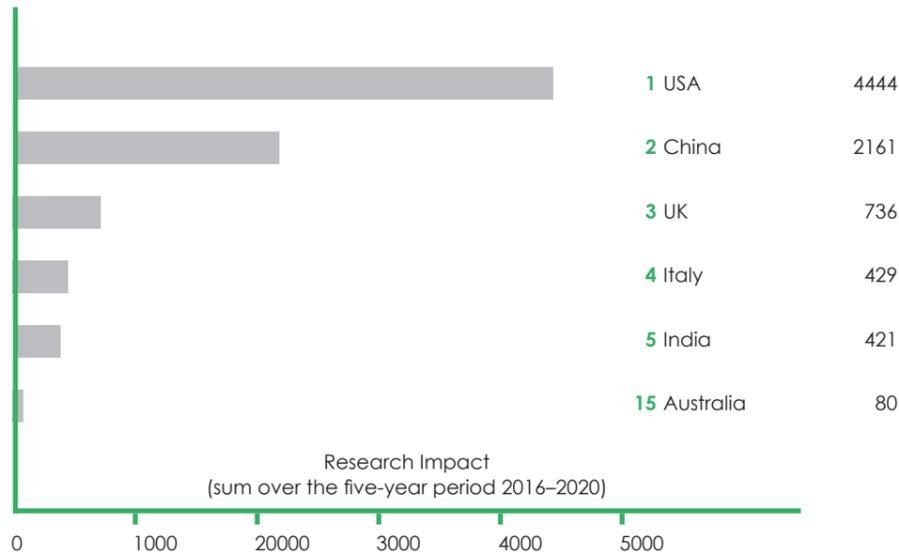
Opportunities and Risks

Artificial intelligence (AI) holds great promise for Australia's economy, security and society, from improved productivity through increased automation, enhanced cyber security, and increased worker productivity and fulfilment by allowing workers to focus on more creative or high value-add tasks. Building AI capability in Australia will help elevate Australia to a world-leading digital economy, and raise our position in the development and adoption of AI. AI capability also ensures we are able to counter national security threats, and increase our defence capabilities, through smarter military systems and operations.

With the opportunities AI promises, there are also significant risks. AI developed from poorly written or applied algorithms and biases can result in faulty decision-making that could harm people, machinery or critical infrastructure. Furthermore, poorly implemented algorithms can give rise to security issues.

AI can also be used to mount malicious cyber-attacks or spread AI-generated synthetic media (deepfakes) and mis/dis-information at unprecedented scale. Vulnerabilities in AI-based systems can also be exploited to undermine public confidence in AI-based tools and services. Australia is working with international like-minded partners to mitigate these risks.
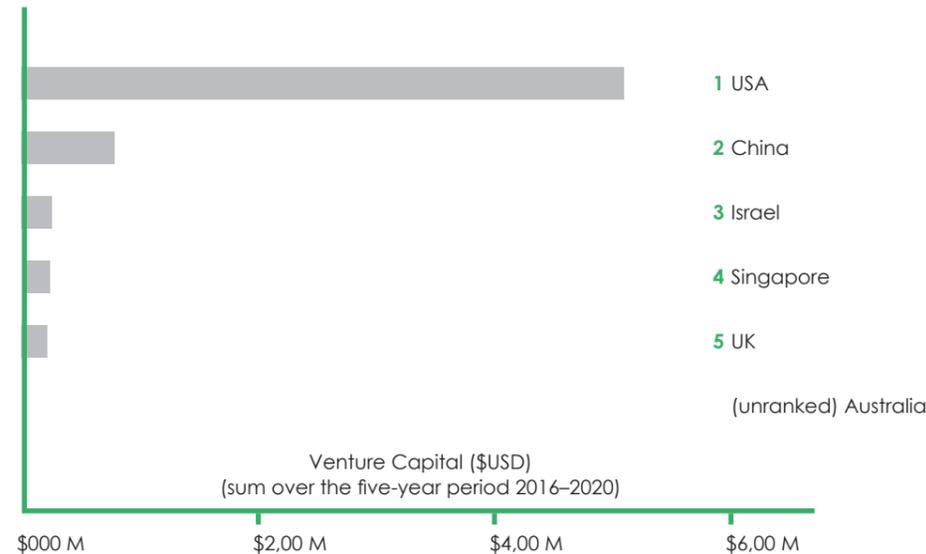
Research Impact (RI)

The United States has the highest research impact in this area, with Australia ranked 15th globally. Total volume of published research has increased at around 15% p.a., over the 5 year period 2016–2020, with 19% of research involving international collaboration.

Rank	Country	Research Impact
1	USA	4444
2	China	2161
3	UK	736
4	Italy	429
5	India	421
15	Australia	80

Research Impact
(sum over the five-year period 2016–2020)

The research impact provides an indication of the productivity of a country or institution. Here, productivity was assumed to be represented by the volume of publications (i.e. scholarly output) as an indicator of the resources & facilities, and the level of interest in the publications as an indicator of quality.
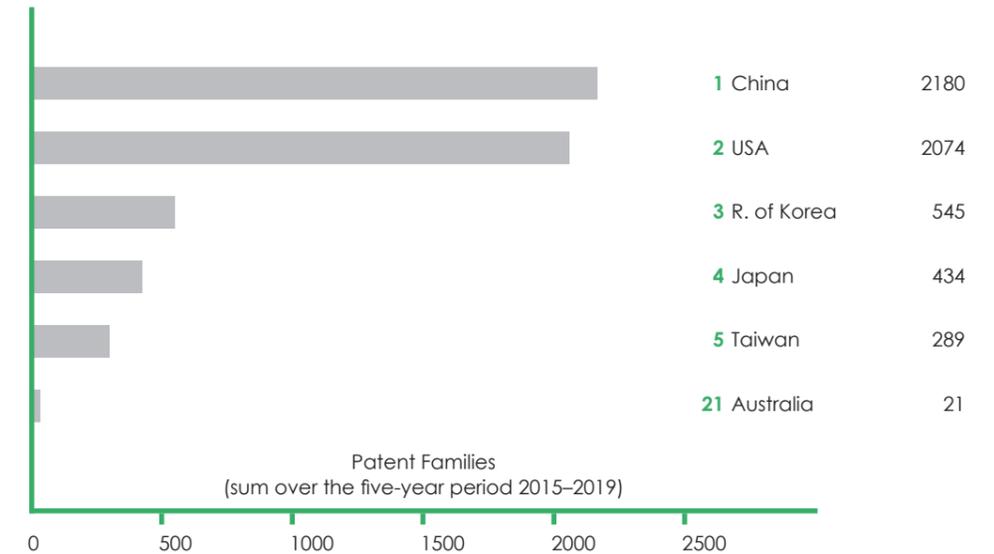
VC Investment

Australia is unranked for relative venture capital (VC) investment in this area, while the United States has the highest amount of investment in this area. Investment in this area has been growing at 16% p.a. since 2016.

Rank	Country
1	USA
2	China
3	Israel
4	Singapore
5	UK
(unranked)	Australia

Venture Capital ($USD)
(sum over the five-year period 2016–2020)

Data from Crunchbase. The Crunchbase database provides a partial view of the global VC landscape. However the quantity, quality and richness of the data are considered to be statistically significant, and indicative of global trends.

Patents – International

The number of patents filed annually in this field has increased by 36% from 2015 to 2019. Most patents in this field were filed by applicants or inventors from China and the United States. Australia ranks 21st.

Rank	Country	Patent Families
1	China	2180
2	USA	2074
3	R. of Korea	545
4	Japan	434
5	Taiwan	289
21	Australia	21

Patent Families
(sum over the five-year period 2015–2019)

Research Institutions – International

The United States has 7 institutes in the top 10 international institutions, including several private companies, Nvidia, Hewlett-Packard, IBM and Intel.

Rank	Top International Institution	Research Impact
1	Nvidia | United States	846
2	Tsinghua University | China	776
3	Hewlett-Packard | United States	764
4	Massachusetts Institute of Technology | United States	587
5	University of California at Santa Barbara | United States	519
6	Chinese Academy of Sciences | China	458
7	IBM | United States	457
8	Intel | United States	421
9	Huazhong University of Science and Technology | China	245
10	Stanford University | United States	233

Research Institutions – Australia

Within Australia, the University of Melbourne has the highest research impact.
No Australian institute is ranked in the top 50 international institutions.

Rank	Top Australian Institution	Research Impact
1	University of Melbourne	25
2	Queensland University of Technology	17
3	University of Sydney	12
4	Monash University	10
5	University of Technology Sydney	9
6	University of Adelaide	7
7	Southern Cross University	3
8	University of Queensland	2
9	Macquarie University	2
10	Deakin University	1

Patents – Australia

Top 5 Australian Patent Applicants	Patent Families
Ocean Logic	2
n/a (private citizen applicants only)	1
University of Sydney	1
n/a (private citizen applicants only)	1
Commonwealth of Australia	1

Patents filed by Australian businesses, 2015–2019.