# ICT and ICS sector: preliminary status assessment

Supporting background information for:

Preparing for Australia's digital future: A strategic plan for Information and Communications Sciences, Engineering and related Technologies

February 2018

# Contents

This document provides a very brief national overview of Australia's digital research and policy space by summarising three major controls: our research strengths, the capability of our workforce, and our current national policy settings.

While this approach does not provide a thorough situation analysis, it does provide a relevant point of comparison for recommendations about the future. **The metrics used in this approach were used in ways that they may not have been designed for, so the results should not be used in any way other than as informative background information.**

# 1 Current Australian digital research capability

Digital technology research is a truly international endeavour, and so are the industries that apply it. There appears to be greater value in international benchmarking than in domestic benchmarking, yet this remains difficult and not uniformly conducted. Australia is therefore passing up an opportunity to ensure its limited research budget is directed towards areas that have the biggest impact in the areas that are most likely to adopt it.

This section presents a high level snapshot of relevant research strengths in Australian universities and research institutions by summarising both the amount and quality of research at a national level:

- A direct survey of the online presence of universities and research institutions was undertaken to provide an indication of research activity in Australia. This measure relies on self-reporting and assumes that the number of groups working in an area is a reflection of the amount of research occurring.
- The Australian Research Council's research evaluation framework, the Excellence in Research for Australia (ERA), provides an independent but limited measure of the 'quality' of research. It is neither tailored to digital sectors nor indicates commercial impact or innovation translation success, so its use as a measure of research quality may not align with readers' interpretations or associations with the term 'quality'. Nevertheless, it is a standardised, non-subjective, nationally consistent metric that can be used for the indicative purposes we require.
- Results extracted from the SCImago Journal & Country Rank[1], a publicly available portal that uses information contained in the Scopus® database.

These measures are inherently limited: they are not intended nor appropriate for comparisons between institutions and are aggregated to provide only the national overview that is intended.

## 1.1 Research quantity: self-reported activity

A survey of the websites of all universities and institutions undertaking some form of relevant research collated topic areas where each institution claimed to have a strength. The existence of a research centre, an institute, or a laboratory or other group of researchers working in a common area was interpreted as signalling a strength in an area. However, individual researchers working alone or in small groups without a significant profile were generally not included, and classified research that is not promoted online was also omitted: this is a limitation of our method.

[1] SCImago Journal & Country Rank: http://www.scimagojr.com

Raw data was collected across all institutions in Australia and the number of 'strong' research groups were counted for 21 different research areas across the digital technology sector. These 21 research areas provide a reasonable differentiation between the various areas of research strength claimed online by the institutions. A total of 170 strong research groups were identified, as shown in Table 1.1.

**Table A.1:** Aggregated data on Australian research quantity publicly reported by research institutions in 2017.

| Research Area | Number of Strong Research Groups |
|---|---|
| Data Mining, big data, data analytics, visualization | 17 |
| Sensor networks, IOT, geolocation and surveillance | 17 |
| Artificial intelligence and machine learning | 16 |
| Robotics, autonomy and embedded systems | 13 |
| Modelling, simulation and optimization | 11 |
| Wireless and mobile | 10 |
| Computational Biology | 9 |
| Machine-user Interfaces | 9 |
| Health analytics | 9 |
| Data management and security | 8 |
| Optical communications and photonics | 7 |
| Software Engineering | 7 |
| Quantum devices and quantum computing | 6 |
| Cyber security | 6 |
| Computer Vision | 5 |
| Networks and society | 5 |
| Cloud Computing | 4 |
| Networking technologies | 3 |
| Decision sciences | 3 |
| Defence communications | 3 |
| Cryptomathematics | 2 |
| **Total** | **170** |

## 1.2Research quality: strengths identified using ERA data

The ERA provides a score from 1 to 5 for each university in Australia across all research fields. Eleven research areas using the ERA's field of research (FOR) code system were selected as relevant to the present study. All ERA data in those fields were selected and the average taken for the scores of all institutions in Australia in research areas where those institutions received a non-zero score in the ERA.

Note that the FOR code system, while providing a useful set of reference data over time, also introduces a number of limitations when used for this purpose. The codes are generally quite broad and do not give the level of differentiation between research activities as the 21 fields identified in Section 1.4.1.1. The field of research code system also eliminates double counting by forcing researchers to choose a single code that best reflects each funded activity, but this means interdisciplinary research may not be completely captured, for example when agricultural research develops new robotic capabilities or when medical research develops new computational methods for genome analyses. Notwithstanding these limitations, Table 1.2 shows a broad national overview of the average score for each of the 11 FOR codes that relate directly to relevant research.

**Table A.2:** Aggregated data on Australian research quality reflected in 2016 ERA ratings.

| Field of Research Code | Average Score |
|---|---|
| 0206 Quantum physics | 4.66 |
| 0103 Numerical and computational mathematics | 4.34 |
| 0906 Electrical and electronic engineering | 4.29 |
| 1005 Communication technologies | 4.2 |
| 0805 Distributed computing | 3.67 |
| 0801 AI and image processing | 3.4 |
| 0803 Computer software | 3.4 |
| 0802 Computation theory and mathematics | 3.38 |
| 0806 Information systems | 3.36 |
| 0804 Data format | 3.34 |
| 1203 Design practice and management | 2.86 |

## 1.3Research quality: strengths identified using Scimago

Scimago[2] provides a comprehensive tool for comparing journals and countries across a range of scientific fields and sub-fields. The data covers the period 1996 to 2016, and includes the number of documents, the number of citations, the average number of citations per document, and the H index. Across all of Computer Science, the H index for Australian publications is 253, and Australia ranks 9th in the world. Table 1.X lists the top 15 countries

**Table A.3:** Country rankings by H index across all of computer science.

| Rank | Country | H index |
|---|---|---|
| 1 | United States | 807 |
| 2 | United Kingdom | 383 |
| 3 | Germany | 342 |
| 4 | Canada | 330 |
| 5 | France | 312 |
| 6 | China | 290 |
| 7 | Italy | 264 |
| 8 | Netherlands | 259 |
| 9 | Australia | 253 |
| 10 | Switzerland | 252 |
| 11 | Israel | 243 |
| 12 | Spain | 231 |
| 13 | Japan | 231 |
| 14 | Hong Kong | 228 |
| 15 | Singapore | 209 |

[2] SCImago Journal & Country Rank http://www.scimagojr.com/

From this data, it appears that Australia's Computer Science research is reasonably competitive. All countries ranked above Australia have larger populations than Australia, and a number of countries ranked below Australia (e.g. Spain and Japan) have populations higher than Australia. Note however that the two countries immediately following Australia in the ranking (Switzerland and Israel; Switzerland by a single index point) have populations less than half of Australia's population and are relatively very competitive.

With respect to individual research areas, Australia's research strengths, measured in terms of H-index are in the areas of Information Systems, Signal Processing, Human-Computer Interactions, Computational Theory and Mathematics, as well as hardware and applications areas such as Networks and Communications. Overall, research in Software, Computer Vision, Artificial Intelligence, and Computer Graphics and CAD does not appear as strong (below Australia's overall average H index) but still internationally competitive considering the small size of our research sector.

**Table A.4:** Australia's global ranking by H index (a proxy for research strength), by individual research area.

| Sub-field | Global Rank |
|---|---|
| Information Systems | 7 |
| Signal Processing | 7 |
| Hardware and Architecture | 7 |
| Human-Computer Interactions | 8 |
| Computer Networks and Communication | 8 |
| Computer Science Applications | 8 |
| Computational Theory and Mathematics | 8 |
| Software | 10 |
| Computer Science (Miscellaneous) | 10 |
| Computer Vision and Pattern Recognition | 11 |
| Artificial Intelligence | 12 |
| Computer Graphics and CAD | 18 |

## 1.4Research quality and quantity: a national overview

It is difficult to draw direct comparisons between the 'quantity' and 'quality' of Australian research in ICS and ICT for many reasons. Notwithstanding, agreement between the various measures appears to be greater than the discrepancies, which provides a level of confidence that the assessments are at least qualitatively indicative. Areas of disagreement between the measures may even be informative: for example, Information Systems ranks highly on Scimago's scale, but does not score well in the ERA.

The first national observation to make regarding this assessment of research quality and quantity in Australian ICS and ICT is that there is insufficient information to provide definitive answers at a fine scale. Complaints from the business and government sectors, and even academics, regarding the difficulty of finding relevant research capability in Australia thus appear to be well-founded.

*Possible action:* undertake a characterisation of ICS and ICT-related research in Australia. Match it to industry and business. Identify overlap and gaps.

Despite the noticeable lack of granular information, it is possible to make a number of broad observations:

- Quantum devices and quantum computing is a strong activity in a relatively small number of centres in Australia, but an area where the research is of top quality. This is clearly an area of great strength in Australia.
- Much of the research in the top six research areas listed by number of research groups fall broadly into FOR codes with average ERA scores above 4.0 and H indexes above 8. In short, this shows that Australia is already quite good at focussing on our strengths (or, alternatively, that Australian universities readily respond to, and optimise, their performance metrics).
    - The exception is Artificial Intelligence, which is ranked weakly by the ERA and by international H index compared to the rest of the ICS and ICT research areas, but is prominently self-reported on Australian university web sites.
- Information Systems ranks highly by H index at a national scale, but not by the ERA.
- In addition to the research considered here, there are extensive bodies of private or classified research that are not captured in this study. For example, Australia has a small but high-quality classified cryptomathematics research capability.
- In broad terms, Australia has existing research strengths in many areas. In particular there are significant strengths (both in quantity and quality) in the following areas:
    - Quantum devices and quantum computing
    - Data Mining, big data, data analytics, visualization
    - Sensor networks, IOT, geolocation and surveillance
    - Modelling, simulation and optimization
    - Wireless and mobile
    - Robotics, autonomy and embedded systems
    - Artificial intelligence and machine learning

An alternative view can be taken in economics[3]:

> "We argue that competitiveness can't be condensed down to a single number—although productivity growth is the best performance indicator to measure improvement—but rather is an attribute that we observe. Competitive economies are ones that are open to the world, attracting investment and people. ...
>
> Competitiveness can wither and atrophy, and there is some evidence that this has been the case in Australia in recent years, notwithstanding 25 years of economic growth. Should that be sustained over the longer run it will be detrimental to living standards. It requires constant vigilance on the part of all players—industry, government, education providers, and the science and research community—to renew themselves and strive to lift their game."

The same argument can be applied to research impact—that it is not amenable to metrics, and that metrics are attributes we observe after the fact rather than being real-time measures. Research quality and quantity must instead be framed in terms of relevance and impact, which are difficult, non-static concepts.

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[3] Office of the Chief Economist: Australian Industry Report 2016: https://industry.gov.au/Office-of-the-Chief-Economist/Publications/AustralianIndustryReport/index.html

## 1.5Current Australian digital workforce capability

ICT alone employed approximately 628,000 workers in 2015[4] and 640, 000 workers in Australia in 2016[5] which is projected to grow at 2 percent for the next few years, compared to 1.4 percent for the rest of the Australian workforce.

Digital technologies are inherently international and is shaped much more strongly by global rather than local influences. Being relatively insensitive to local actions, there are limited ways in which industry, government and training providers can intervene in this sector to create local impacts[6].

52 percent of the current ICT workforce works outside of directly ICT-related industries. Current workforce destinations for IT graduates were partially reviewed by the Australian Chief Scientist in 2016[7] (page 126). The report (based on 2011 census data) shows that the top destinations for IT graduates in Australia are:

- Heath care and social assistance
- Transport, postal and warehousing
- Manufacturing
- Wholesale trade
- Retail trade
- Information, Media and Telecommunications
- Education and training
- Public administration and safety
- Financial and insurance services
- Professional, scientific and technical services

In turn, this shows that IT graduates are already propagating throughout the Australian economy. As the proportions of IT-qualified workers increases in any given field or economic sector, it would be expected that those fields or sectors would develop the capability to:

- Lead ICT- and ICS-driven transformations
- Rapidly adopt advances from overseas

The ICT jobs that are in high demand include a mix of technical and business-related roles, and while employers are demanding a range of ICT-specific skills, there is also increasing demand for ICT workers with more general skills. Generic ICT skills and 'digital literacy' have also emerged as highly desired skills for jobs across the economy, and are also central to the process of learning, as primary, secondary and tertiary educational institutions increasingly utilise technology in the delivery of educational programs. At the same time, however, many Australian businesses, particularly small to medium-sized enterprises (SMEs), are still not engaging effectively with ICT, and many businesses are also report difficulty recruiting capable, confident, work-ready ICT specialists.

[4] Australia's digital pulse 2016: https://www.acs.org.au/content/dam/acs/acs-publications/PJ52569-Australias-Digital-Pulse-2016_LAYOUT_Final_Web.pdf

[5] Australia's digital pulse 2017: https://www.acs.org.au/content/dam/acs/acs-publications/Australia's%20Digital%20Pulse%202017.pdf

[6] Australian Workforce and Productivity Agency, 2013: ICT Workforce Study: https://docs.education.gov.au/system/files/doc/other/ict-workforce-study-2013.pdf

[7] Office of the Chief Scientist, 2016: http://www.chiefscientist.gov.au/wp-content/uploads/Australias-STEM-workforce_full-report.pdf

The Australian Workforce and Productivity Agency's ICT Workforce Study also noted that our workforce supply side is in trouble:

- the ICT industry carries a legacy of negative perceptions of desk-bound, repetitive, isolating jobs,
- skills supply is limited by the low levels of female and mature-aged workers in the ICT workforce
- many students who pursue an ICT education experience difficulty in finding employment in the sector upon graduation, and many graduates use their qualifications to pursue other careers outside ICT.
- employers complaining that tertiary graduates do not possess the desired combination of technical and complementary business and communication skills to contribute effectively in the workplace
- despite the increasing complexity of ICT services and the growing demand for these skills, the engagement and investment of industry in ICT skills development remains low

Six solutions to workforce development problems were proposed as:

- Change and improve perceptions of ICT careers
- Improve the quality of ICT teaching in schools and tertiary education institutions, and excite students in ICT careers
- Improve the suitability of tertiary graduates for entry-level positions
- Increase the quantity of workers with ICT-intensive skills
- Increase the quantity of workers with the functional knowledge of ICT required to work with ICT specialists
- Ensure that employers of ICT workers, including employers of ICT contractors, support ongoing skills development and the effective utilisation of skills in a fastmoving and rapidly changing sector

# 2 Current ICSET policy and program status

A large number of policies and programs constitute 'Australia's position' on ICSET-related issues. This section provides a brief outline of some of them.

## 2.1National Science and Research Priorities

http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Pages/default.aspx

The National Science and Research Priorities[8] are reviewed every two years: currently they are food, soil and water, transport, **cybersecurity**, energy, resources, advanced manufacturing, environmental change, health.

While cybersecurity is the only priority that is directly within the scope of ICT and ICS, the role of ICSET as an underpinning capability for all of them must not be forgotten.

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[8] National Science and Research Priorities: http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Pages/default.aspx

## 2.2 National Innovation and Science Agenda:

The agenda comprises four key pillars, collectively worth $1.1 billion over 4 years[9].

- Providing tax breaks for business
- Refocussing university funding towards industry collaboration
- STEM education and visa reforms[10], to develop and attract the right skills to Australia
- Reforming government to lead by example.

The Agenda also coordinates a number of new and existing programs managed by a range of agencies.

Note that various state governments also have active STEM education programs, with NSW[11] and Victoria[12] providing notable examples.

## 2.3 National Collaborative Research Infrastructure Strategy (NCRIS)

The 2016 National Research Infrastructure Roadmap[13] outlines the future direction of the NCRIS program[14], which drives research excellence and collaboration between 35 000 researchers, government and industry to deliver practical outcomes.

## 2.4 Commonwealth Science Council

The Commonwealth Science Council[15] provides strategic advice to government on science and technology issues and building stronger collaboration between scientists, researchers and industry. The Council is Chaired by the Prime Minister, with the Minister for Industry, Innovation and Science as Deputy Chair. Australia's Chief Scientist, Dr Alan Finkel, is the Executive Officer.

## 2.5 Innovation and Science Australia

Innovation and Science Australia[16] is an independent statutory board established in October 2016, with responsibility for providing strategic whole-of-government advice to the Government on all science, research and innovation matters. The Board complements the Commonwealth Science Council.

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[9] Australian Government National Innovation and Science Agenda: https://www.innovation.gov.au/page/agenda

[10] Administered by the Department of Education: https://www.education.gov.au/inspiring-all-australians-digital-literacy-and-stem

[11] STEM-NSW: http://www.stem-nsw.com.au

[12] VicSTEM: http://www.education.vic.gov.au/about/programs/learningdev/vicstem/Pages/default.aspx

[13] Department of Education and Training 2016: https://www.education.gov.au/2016-national-research-infrastructure-roadmap

[14] Department of Education and Training: https://www.education.gov.au/national-collaborative-research-infrastructure-strategy-ncris

[15] Commonwealth Science Council: http://www.chiefscientist.gov.au/commonwealth-science-council/

[16] Innovation and Science Australia: https://industry.gov.au/Innovation-and-Science-Australia/Pages/default.aspx

Innovation and Science Australia conducted a recent Performance Review of the Australian Innovation, Science and Research System[17] and followed up with the report: Australia 2030: Prosperity through Innovation[18], which was intended to serve as a strategic plan for the Australian innovation, science and research system[19].

## 2.6 Digital Transformation Agency

The Digital Transformation Agency[20] is a government-focussed entity intended to make it easy for people to deal with government, by helping government transform services to be simple, clear and fast. It recently developed a Digital Service Standard[21] to aid in its mission.

## 2.7 Department of Industry, Innovation and Science

**Office of the Chief Scientist**

Among other roles, the Office of the Chief Scientist provides various benchmarking and other analyses of STEM education and workforce development in Australia, including a Position Paper on Science, Technology, Engineering and Mathematics in the National Interest: A Strategic Approach[22] and advice to governments (to provide an evidence base for policy development)[23].

The Office of the Chief Scientist managed the development of the National Research Infrastructure Roadmap.

The current Chief Scientist has also been a vocal contributor to the public discourse on technologies such as AI and other ICSET related issues[24].

**Cooperative Research Centres**

AusIndustry manages the Cooperative Research Centres (CRC) Program[25], which is a competitive, merit based grant program that supports industry-led and outcome-focused collaborative research partnerships between industry, researchers and the community. It also supports CRC-Projects for short term, industry-led collaborative research.

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[17] Innovation and Science Australia: https://industry.gov.au/Innovation-and-Science-Australia/Documents/ISA-system-review/index.html

[18] Innovation and Science Australia: https://www.industry.gov.au/Innovation-and-Science-Australia/Australia-2030/Pages/default.aspx

[19] Innovation and Science Australia: https://industry.gov.au/Innovation-and-Science-Australia/Pages/2030-Strategic-Plan.aspx

[20] Digital Transformation Agency: https://www.dta.gov.au

[21] Digital Transformation Agency: https://www.dta.gov.au/standard/

[22] Office of the Chief Scientist 2013: http://www.chiefscientist.gov.au/wp-content/uploads/STEMstrategy290713FINALweb.pdf

[23] Office of the Chief Scientist: http://www.chiefscientist.gov.au/advice-to-government/

[24] See, for example: https://theconversation.com/finkels-law-robots-wont-replace-us-because-we-still-need-that-human-touch-82814

[25] AusIndustry: https://www.business.gov.au/assistance/cooperative-research-centres-programme

**Industry Growth Centres**

The Industry Growth Centre (IGCs) initiative "enables national action on key issues such as collaboration, commercialisation, international engagement, skills and regulation reform"[26]. As such, they are capable of simultaneously addressing research, development, education and policy/regulatory considerations—the broad suite of considerations beyond the science and research that are important in this report.

Industry Growth Centres (IGCs) appear to be based on sound policy principles, yet feedback is mixed about the actual impact—ranging from highly effective to unclear value for money. Program design varies considerably from centre to centre, and good design is important. The current six IGCs under the National Innovation and Science Agenda are far too early in their life cycle to evaluate, but experience from US and UK show ICT-related centres can be effective. As a general rule, the better-defined the industry the more effective the IGC.

The authors were not able to determine the procedural rigour of the process for deciding the current six IGCs, yet note that the decision to include a cybersecurity IGC in the current suite was underpinned by a trusted evidence base in the form of Australia's cyber security strategy[27] and is an identified National Science and Research Priority[28].

The role of IGCs in accelerating specific aspects of the wider ICSET research, development and industry space has clear potential that should not be limited to cyber security. However, IGCs appear to be effective over a somewhat narrower scope than the whole of ICSET. IGCs could be particularly effective when employed as a combination of:

- A coordinated series of IGCs, using the priorities identified in this strategic plan as a starting point.
- Integrate ICT- and ICS-intensive innovation into each of the current (and all future) IGCs, to accelerate Australia's ICSET-enabled transformation across all sectors.

**Business Research and Innovation Initiative (BRII).**

Under the NISA, the Department of Industry, Innovation and Science administered a pilot program[29] to encourage businesses to develop more innovative solutions to government policy and service delivery problems, rather than simply procuring them.

**Incubator Support**

AusIndustry administers an incubator program[30] to help new businesses establish and grow.

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[26] Industry Growth Centres: https://industry.gov.au/industry/Industry-Growth-Centres/Pages/default.aspx

[27] Australia's Cyber Security Strategy: https://cybersecuritystrategy.pmc.gov.au/assets/img/PMC-Cyber-Strategy.pdf

[28] Australia's Science and Research Priorities: http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Pages/default.aspx

[29] https://www.business.gov.au/assistance/business-research-and-innovation-initiative

[30] AusIndustry: https://www.business.gov.au/assistance/incubator-support

**Global Innovation Strategy**

The Global Innovation Strategy[31] brings a range of internationally focussed initiatives together, including:

- 'Landing Pads' in five international cities to provide market-ready startups with a short-term (90 day) operational base.
- Seed funding to support global SME-to-researcher collaborations to enable viable projects to grow and test commercialisation through the Global Connections Fund.
- Funding to assist Australian businesses and researchers to collaborate with global partners on research and development projects through the Global Innovation Linkages program.
- Building regional linkages in the Asia-Pacific through the Regional Collaborations Program.

## 2.8 Productivity Commission and the Department of the Prime Minister and Cabinet

The Productivity Commission has undertaken a considerable amount of research on ICSET-related issues in the Australian economy, including two major recent research papers:

- Digital Disruption: What do governments need to do?[32]
- Data availability and use[33]. A cross agency taskforce is currently considering this report.

Numerous submissions made by the Productivity Commission to various inquiries also provide detailed analyses of the effect (and potential) of AI, big data and other digital technologies on the Australian economy.[34]

## 2.9 Department of Health and the Australian Digital Health Authority

The Department of Health and the Australian Digital Health Authority champion Australia's National Digital Health strategy[35].

## 2.10 Department of Infrastructure and Regional Development

The Department of Infrastructure and Regional Development are the Commonwealth entity responsible for land transport reform and will be foundational to the development any autonomous transport systems in Australia—one of the highest profile digital transformations expected in the next few years. It currently supports this role through international engagement and has also, together with state governments, supported the development of the iMOVECRC[36].

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[31] Department of Industry, Innovation and Science: https://www.industry.gov.au/innovation/Global-Innovation-Strategy/Pages/default.aspx

[32] Productivity Commission 2016: https://www.pc.gov.au/research/completed/digital-disruption

[33] Productivity Commission 2017: https://www.pc.gov.au/inquiries/completed/data-access#report

[34] See, for example: http://www.pc.gov.au/research/supporting

[35] Australia's National Digital Health Strategy: https://www.digitalhealth.gov.au/australias-national-digital-health-strategy

[36] iMOVECRC: https://imovecrc.com

## 2.11 Department of Education

**Australian Curriculum: Digital Technologies**

The Department of Education administers an Australian Curriculum: Digital Technologies initiative[37] to provide Australian teachers with a world class curriculum to prepare students for the challenges of the digital economy.

**Australian Digital Technologies Challenges**

The Government is funding the Australian Digital Technologies Challenges for Year 5 and 7 students. The University of Sydney is developing an online series of 18 free, structured, progressive teaching and learning activities and challenges for all year 5 and 7 students, aligned to the Australian Curriculum. The initiative includes lesson plans, professional learning and online support for teachers and is funded to 2020. The first four challenges are now available on the Australian Computing Academy[38].

**Education Council**

All states and territories have endorsed a nationally agreed STEM education policy[39].

## 2.12 Learned Academies

The Australian Academy of Technology and Engineering[40] administers a Global Connections Fund[41] which aims to provide initial funding support to promote Australian researchers and small to medium enterprises (SMEs) collaboration.

The Australian Academy of Science[42] administers a Regional Collaborations Program[43], which aims to fund Australian participants from eligible organisations to collaborate with regional and international science, research and innovation partners on solutions to shared regional challenges within the Asia–Pacific regions.

## 2.13 The Australian Research Council

**ARC Linkage**

The ARC runs the ARC Linkage program to help link university research with industry[44].

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[37] Australian Government Department of Education: https://www.education.gov.au/inspiring-all-australians-digital-literacy-and-stem

[38] Australian Computing Academy: https://aca.edu.au

[39] Education Council 2015: http://www.educationcouncil.edu.au/site/DefaultSite/filesystem/documents/National%20STEM%20School%20Education%20Strategy.pdf

[40] Australian Academy of Technology and Engineering: https://www.atse.org.au

[41] Global Connections Fund: https://globalconnectionsfund.org.au

[42] Australian Academy of Science: https://www.science.org.au

[43] Australian Academy of Science: https://www.science.org.au/opportunities/travel/grants-and-exchange/regional-collaborations-programme

[44] Australian Research Council Linkage Program: http://www.arc.gov.au/linkage-projects

**Research impact assessment**

The ARC ran a pilot research impact assessment in mid-2017. The measures that were tested are being reviewed ahead of the first full national assessment in 2018[45].

## 2.14 CSIRO

Besides engaging directly in industry-relevant research as part of its charter, CSIRO runs a number of programs that could be relevant to AI and ML, and to facilitating the changes that society is experiencing.

**CSIRO Innovation Fund**

The CSIRO Innovation Fund is a joint government–private sector fund intended to help Australia's home-grown innovations become successful businesses[46].

**CSIRO ON accelerator program**

CSIRO ON[47] is an innovation accelerator program that intends to discover innovative research that addresses industry-related challenges in the areas of food and agriculture, advanced manufacturing, medical technologies, cybersecurity, mining technology and energy. It then aims to steer it towards high-potential innovative ventures.

**Data61**

CSIRO's Data61[48] is Australia's leading data innovation group which was officially formed in 2016 from the integration of CSIRO's Digital Productivity flagship and the National ICT Australia Ltd (NICTA). Its mission is to create Australia's data-driven future.

## 2.15 Policy statements and administrative arrangements

**Australian Government Public Data Policy Statement**

The Australian Government Public Data Policy Statement was published in December 2015. Australian Government entities are now required to make appropriately anonymised, non-sensitive data open by default[49].

The Digital Marketplace is an ecosystem where government buyers can publish briefs with their requirements, suppliers can respond, and two-way collaboration can take place.

**The Digital Marketplace**

The Marketplace[50] is intended to provide an alternative model of government procurement, in which suppliers can pitch creative ideas to solve problems. This provides businesses the chance to develop innovative digital solutions for government, and allows two-way collaboration to occur.

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[45] Australian Research Council: http://www.arc.gov.au/ei-pilot-overview

[46] Australian Government, Innovation: https://www.innovation.gov.au/page/csiro-innovation-fund

[47] ON:Innovation: http://oninnovation.com.au

[48] Data61: http://www.data61.csiro.au

[49] Department of the Prime Minister and Cabinet: https://www.pmc.gov.au/resource-centre/data/australian-government-public-data-policy-statement

[50] https://www.innovation.gov.au/page/digital-marketplace

**AI-based decision making**

A large number of decisions that were previously made by Ministers or their delegates in the bureaucracy who are believed to be human, are explicitly allowed by legislation to be delegated to machines. According to the ABC, there are 29 pieces of enabling legislation[51], although their consistency with the Australian Government's recent Digital Service Standard has not yet been established.

## 2.16 Parliamentary activities

The *Parliamentary Joint Committee on Law Enforcement* is currently holding an inquiry on 'the impact of new and emerging information and communications technology (ICT)'[52].

Its Terms of Reference are:

- challenges facing Australian law enforcement agencies arising from new and emerging ICT;
- the ICT capabilities of Australian law enforcement agencies;
- engagement by Australian law enforcement agencies in our region;
- the role and use of the dark web;
- the role and use of encryption, encryption services and encrypted devices; and
- other relevant matters.

A number of current and completed Parliamentary Inquiries[53] may also provide useful background, considering they also serve as a record of public views at the time of writing.

## 2.17 State and territory government initiatives

Most state and territory governments have active programs and policy development that relate, directly or indirectly, to the digital transformations that are forecast for Australia.

## 2.18 Other initiatives

A number of initiations have not been covered directly here but should also be considered, including:

- https://www.innovation.gov.au/page/innovation-connections
- https://www.innovation.gov.au/page/innovation-agriculture-and-regional-areas
- https://www.innovation.gov.au/page/inspiring-nation-scientists
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