CSIRO, Australia’s national science agency, has been solving the nation’s greatest challenges with solutions from science for over 100 years. While many of the challenges are ever present – sustainable energy and resources, food security and quality, growing our future industries, for example – how we are solving those challenges has only accelerated with technology.

CSIRO’s data and digital specialist arm, Data61, is at the forefront in solving our greatest data-driven challenges today. CSIRO’s Data61 works with industry, government and academia – the D61+ Network – to bring together the best research and development capabilities to drive digital innovation at speed and scale for the benefit of Australia. In April 2019, our network model was recognised by the OECD as a global blueprint for digital and open innovation.

Our world-class research expertise includes the technologies transforming every aspect of society and the economy, including artificial intelligence and machine learning, cybersecurity, privacy, blockchain, cyber-physical systems and advanced data analytics.

CSIRO established Data61 in 2016 to help Australia take advantage of an increasingly data-driven economy. In the first three years, we have worked closely with government, industry and partners across the research and innovation sector, to experiment and scale our impact both in Australia and overseas for the benefit of the country.

As we head into our fourth year, our focus is on continuing to use digital and data solutions to accelerate solving Australia’s challenges, helping transform Australian industry and create new opportunities for our economy and communities.

We’ve made significant progress in the last 12 months which are already resulting in positive outcomes for the environment and society. There is a snapshot on pages 9, 10 and 11.

Reports show Australia is lagging behind our OECD peers in capturing the value of digital innovation in areas like investing in digital capital, innovations in business process, growth in our domestic digital industries and in our digital exports. If we can help close this gap, Australia has the opportunity to capture $315b in gross economic value from digital innovation over the next decade and set the foundations for a new era of prosperity, productivity, and quality of life for the country.
WHAT WE DO

Data61 is a trusted advisor to government and industry. We apply data-driven R&D to solve problems and create new value, helping organisations achieve competitive advantage and governments to improve service delivery for citizens. We are helping Australia adapt to global change and improve the way we work and live.

We provide the following services and capabilities in partnership with collaborators from across CSIRO and universities:

**Fundamental and applied research**
We do research with market context to help our partners and the wider Australian industry ecosystem organise, collect and understand their data and make robust decisions from it.

**Strategic and technical advisory**
We provide leadership advisory services and specialised training on risk and best practice. In these services, we take into account emerging research disciplines on: cybersecurity, privacy, artificial intelligence and data ethics.

**Platform and technology development**
We build technologies to help people interact more easily with data, systems and services. We also create new platforms that can be embedded in your organisation to create new value: National Map, Investigative Analytics, Robotics, Confidential Computing.

**Strategic ventures**
We undertake collaborative ventures to commercialise and scale research and technologies with partners and investors.

**Supporting Science Technology, Engineering and Mathematics (STEM) talent**
We support young talent in STEM through our PhD scholarship program and Ribt.net, our jobs matching services for students.
We are working on scientific breakthroughs and new technologies in all data-led research and development domains, organised around three programs of research. These are Analytics and Decision Sciences, Cyber-Physical Systems, and Software and Computational Systems. An additional program focused on Engineering and Design allows us to accelerate the translation of our research into real-world solutions.

<table>
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<tr>
<th>OUR RESEARCH PROGRAMS</th>
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<tbody>
<tr>
<td><strong>Analytics and Decision Sciences</strong></td>
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<tr>
<td>• machine learning and statistical inference</td>
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<td>• risk-adjusted decision-making under uncertainty</td>
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<td>• biological data science</td>
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<td>• computational modelling (combining AI, physics, quantum and biomolecular modelling, scientific workflow and high performance computation)</td>
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<tr>
<td>• market design and digital social science</td>
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<tr>
<td>• computational linguistics and natural language processing</td>
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<tr>
<td>• environmental informatics and natural hazards analytics</td>
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<tr>
<td><strong>Cyber-Physical Systems</strong></td>
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<tr>
<td>• real time in-situ sensing, decision and control</td>
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<tr>
<td>• 3D mapping</td>
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<tr>
<td>• autonomous robotics</td>
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<tr>
<td>• long-term, large scale, distributed sensing</td>
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<td>• AI-enabled computer vision</td>
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Software and Computational Systems

The Software and Computational Systems program helps to develop trustworthy software to help make sense of data and enable it to be shared safely. The research program focuses on next generation technologies in:

- trustworthy and resilient systems
- privacy-enhancing technologies
- distributed trust and analytics platforms
- computational law and RegTech
- computational platforms and trust

Engineering and Design

The Engineering and Design program creates new technology platforms to help people interact more easily with data, systems and services. Teams use rapid validation, continuous deployment and integration methods to iteratively develop technology on mission-driven projects that use or drive research within our organisation. The team has capability groups specialising in user experience, product management and development, operations and functional programming:

- graph analytics engineering
- privacy enhancing systems
- geospatial and regulation systems
- inference systems engineering

Insight Team

Our Insight Team helps governments, industries and communities plan for an uncertain future. The research team analyses emerging trends, drivers and scenarios, and applies modelling approaches to generate insights and inform future strategy and policy decisions. The team focuses on translating research to solve real-world problems for business and policy, and help decision makers better prepare for future challenges and opportunities.
We operate as a network, bringing together the innovation ecosystems of R&D partners in government, corporates both large and small and universities. Through the D61+ Network, we are pioneering a new open innovation model that bridges industry, academia, and universities.

Other countries are now emulating this model, and in April 2019 the OECD recognised Data61 as a global blueprint for digital and open innovation.

THE NETWORK IN ACTION
CORPORATIONS
The D61+ Network promises a single entry point into the national digital innovation ecosystem, with Data61 providing program and project management capability to support multi-disciplinary and multi-university research collaborations. On a case-by-case basis, we also work with corporates individually, to support their understanding of how data driven solutions or research can impact their operations, or generate new opportunities for their organisation.

SMALL AND MEDIUM-SIZED ENTERPRISES
We partner with Australia’s Industry Growth Centres and leading start-up accelerators and incubators to identify high-growth firms with export ambitions and act as a catalyst for emerging high growth potential SMEs. Data61 also supports SMEs by being an active participant in SME Connect’s CSIRO Kick-Start program, and the Cooperative Research Centres Projects (CRC-P) program.

GOVERNMENT
We work with a large number of Australian Government departments and state governments on projects in areas such as data linkage, automation, image analytics and ethical machine learning.
As part of the federal government’s Platforms for Open Data program, Data61 is working with several government agencies on R&D projects that aim to increase the number and availability of high-value datasets between government agencies, and to the public while preserving privacy.
As a trusted advisor to Government, the Data61 team sits on a number of government boards and committees, providing technical insight on digital trends and supporting government in understanding new technology opportunities. These include the Data Integration Partnership for Australia, the Deputy Secretaries Data Group, the Cyber Growth Centre, and the Genomics Health Futures Mission ICT Stream.
As part of the Government’s plans to strengthen Australia’s capability in artificial intelligence and machine learning, Data61 was appointed to deliver two reports: an AI Ethics Framework (published in April 2019) and an AI Technology Roadmap.

UNIVERSITIES
The Data61 University Collaboration Agreement (DUCA) with more than 30 universities acts as a master agreement for research collaborations. Our university network is helping to expand Australia’s total research and innovation capabilities, and is creating a growing cohort of ICT/digital researchers for government and industry collaboration.

30+
Universities in our network

160
Collaborative research projects with universities
Artificial Intelligence (AI) is a broad term used to describe a collection of technologies able to solve problems and perform tasks without explicit human guidance.

AI represents a significant opportunity to boost productivity and improve the national economy through its strong potential to enable industry to make better products, deliver better services, faster, cheaper and safer. We are a leader in artificial intelligence and machine learning research.

**AI at CSIRO**

As Australia’s national science agency, CSIRO’s work in artificial intelligence is 89% more cited than the global average, according to a Normalised Citation Impact, InCites (Web of Science Articles & Reviews, 2014-2018).

AI is being used across all domains including: gene sequencing in crops to improve grains in response to changing environments and market needs. In our oceans, it is used to identify fish species to improve seafood provenance and provide more accurate data for sustainable fishing. In cities, it is used to predict the failure of infrastructure like the Harbour Bridge or water pipes and sewage systems. In hospitals, it helps to forecast demand to ensure access to emergency care.

CSIRO invested AUS19M into an Artificial Intelligence and Machine Learning Future Science Platform, to target AI-driven solutions for areas including food security and quality, health and wellbeing, sustainable energy and resources, resilient and valuable environments, and Australian and regional security.

**Artificial Intelligence: Australia’s Ethics Framework**

We worked with the Australian Government to develop an artificial intelligence ethics framework, to kick-start a national discussion about the future of AI in Australia.

**Machine learning research group**

Machine learning techniques are employed across CSIRO, and our dedicated research group is focussed on discovering the next generation of machine learning algorithms. We perform novel research on cutting-edge aspects of machine learning, including deep learning, and works with partners on real-world projects to solve some of the most challenging technical problems.

**Adversarial machine learning research**

Our team developed a world-first set of techniques to effectively ‘vaccine’ algorithms against adversarial attacks, a significant advancement in machine learning.

**Robotics and Autonomous Systems Research**

Our robotics team is competing in the US Defense Advanced Research Projects Agency’s three-year Subterranean Challenge, the only team selected from outside North America.
Over the past year, we’ve collaborated on a collection of national and industry-leading initiatives.

<table>
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<tr>
<th>Initiative</th>
<th>Description</th>
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<tr>
<td><strong>Consumer Data Standards</strong></td>
<td>CSIRO was appointed by the Treasurer as the Data Standards Body to support the delivery of the Consumer Data Right, a competition and consumer reform announced by the Australian Government in May 2018. The Data Standards Body is responsible for assisting the Data Standards Chair in the development of common technical standards to allow Australians to access data held about them by businesses and direct its safe transfer to others. The body draws on the expertise of CSIRO’s Data61 team.</td>
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<tr>
<td><strong>Robotics Innovation Centre</strong></td>
<td>We expanded our robotics research infrastructure with the launch of our Robotics Innovation Centre in Queensland, now the largest motion capture facility in the southern hemisphere. Our facilities are open for industry use and collaborative projects, and also include dedicated mechanical and electronics engineering laboratories, several high-end rapid prototyping machines, large sheds for indoors systems testing, an open-air UAV flying area and outdoor testing areas including a forest and creek.</td>
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<tr>
<td><strong>Cybersecurity research</strong></td>
<td>As part of a strategic partnership with Defence Science and Technology (DST) Group, we have 25 cybersecurity projects underway, which include research input from 14 universities within our network.</td>
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<tr>
<td><strong>Drought Map</strong></td>
<td>In collaboration with the Government’s Joint Agency Drought Taskforce, we developed the National Drought Map, an online tool that brings together information on drought conditions and associated support measures to help drought-affected areas.</td>
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<tr>
<td><strong>Vietnam’s Future Digital Economy</strong></td>
<td>In partnership with Vietnam’s Ministry of Science and Technology, we launched the Vietnam’s Future Digital Economy report that examines the trends affecting the development of Vietnam’s digital economy until 2045.</td>
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<tr>
<td><strong>Australian National Blockchain</strong></td>
<td>We formed a consortium with law firm Herbert Smith Freehills and IBM to build the Australian National Blockchain – Australia’s first cross-industry, large-scale, digital platform to enable Australian businesses to collaborate using blockchain-based smart legal contracts.</td>
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During FY2018/19, our researchers were involved in the submission or publication of more than 750 research papers, and presented at over 100 conferences.

- Senior research scientist, Dr Yuval Yarom, was part of one of two international teams of security researchers that uncovered ‘Foreshadow’, a hardware vulnerability that can be exploited to bypass Intel Processors’ secure enclaves to access its memory and data
- We formed a consortium with law firm Herbert Smith Freehills and IBM to build the Australian National Blockchain – Australia’s first cross-industry, large-scale, digital platform to enable Australian businesses to collaborate using blockchain-based smart legal contracts
- We partnered with the Commonwealth Bank to successfully trial a new type of smart money, powered by blockchain, which could be used to help manage insurance payouts, budgeting and the management of trusts and charities in Australia
- We worked with the Government’s Joint Agency Drought Taskforce to create the National Drought Map, an online tool that brings together information on drought conditions and associated support measures
- Dr Nick Barnes and our computer vision researchers were involved in Bionic Vision Technologies’ successful clinical trial in Melbourne, which restored a sense of vision in four blind people using a bionic eye
- We are one of seven funded teams and the only one not from the US, selected to compete in the three-year US Defense Advanced Research Projects Agency (DARPA) Subterranean Challenge. In partnership with Emesent and Georgia Tech, the Data61 team participated in a demonstration trial in April, in the US, as part of the first phase of the Challenge
- Developed by Data61 and the University of Sydney’s Concurrent Systems Research Group, an international trial of next-generation Red Belly Blockchain has demonstrated increased speed and energy efficiencies at a global scale
- In collaboration with the Australian Federal Police (AFP) and Monash University, we developed Data Airlock, an innovative solution to enable analytics of harmful, illegal-to-possess and sensitive datasets for the mutual benefit of data custodians and analysts
- We are working with the NSW Department of Finance, Services and Innovation to create a platform that can be used to visualise and interact with a Digital Twin of the entire State
- We partnered with agtech startup Ceres Tag to create a new type of ‘fit bit’ to help farmers to keep track of where their livestock are and what they are doing
- Emesent, Data61’s drone autonomy spin-out, raised $3.5 million in venture capital to commercialise its first product, Hovermap
- The Disease Networks and Mobility (DiNeMo) team developed a new tool to understand and potentially predict how human infectious diseases found overseas might spread in Australia
- The paper “RAMBleed: Reading Bits in Memory Without Accessing Them” by Dr Yuval Yarom in collaboration with researchers from the University of Michigan and TU Graz was accepted to IEEE Symposium on Security and Privacy. The paper demonstrates that the Rowhammer bug, hitherto considered to only affect integrity, can also be used for breaching confidentiality
- Our researchers developed a world-first set of techniques to effectively ‘vaccinate’ algorithms against adversarial attacks, a significant advancement in machine learning research
LEADERSHIP, IDEAS AND GLOBAL IMPACT

- Delivered a Cybersecurity for Directors course with The Australian Institute of Company Directors
- Partnered with the University of New South Wales Australian Graduate School of Management to deliver a course on digital and cybersecurity disruption for boards
- Partnered with Vietnam’s Ministry of Science and Technology to launch the Vietnam’s Future Digital Economy report, a blueprint to fuel Vietnam’s digital economy
- Recognised in an OECD case study on best practice digital and open innovation
- High-profile keynotes and speeches delivered at the AFR Innovation Summit, Vivid Ideas, CEDA, AILA and other events
- Partnered with the Australian Computer Society to publish Blockchain 2030, a report on the future of blockchain in Australia
- Developed an Artificial Intelligence Ethics Framework, published by the Australian Government for public discussion
- Launched The Innovation Imperative (August 2018), the first report from the Q-Foresight program, a joint research initiative between the Queensland Government and D61 to inform long-term strategy and planning
- Liming Zhu spoke at OECD Blockchain policy forum and hosted a lunch with Australia to Germany Ambassador for Germany’s Blockchain ecosystem
Strategic foresight is a structured, evidence-based process for understanding the future. It aims to inform decision makers about plausible future events so that they can make wiser choices. Organisations that use strategic foresight are better prepared for the future and are able to proactively respond to emerging opportunities and risks.

At Data61, our Insight Team works with governments, businesses and communities, to help them use strategic foresight to anticipate and proactively respond to change.

The Insight Team has developed reports across a range of domains this past year, and is responsible for developing the AI Ethics Framework and AI Roadmap for the Commonwealth Government.

**The Innovation Imperative (Q-Foresight)**
A joint initiative with the Queensland Government, this report identifies the risks and opportunities for Queensland over the next two decades.

**Vietnam’s Future Digital Economy**
Developed in partnership with Vietnam’s Ministry of Science and Technology, the report examines the trends affecting the development in Vietnam’s digital economy until 2045.

**Digital Megatrends**

**Blockchain 2030: A look at the future of Blockchain in Australia**
A look at the future of Blockchain in Australia, exploring eight scenarios for future adoption of blockchain technology in Australia.
AWARDS AND RECOGNITION

- Our Smart Infrastructure team won the Eureka Prize for Excellence in Data Science. The team developed a tool that uses data-driven techniques to make intelligent predictions about infrastructure failures, helping prioritise the selection of pipes for maintenance, reduce costs and minimise disruption to water supplies
- The Cross-Domain Desktop Compositor developed by Data61 in collaboration with DST Group won the OpenGov Award for Innovation in Government
- We joined the RISC-V Foundation to provide a compelling security solution for the next-generation Internet of Things and cyber-physical systems using the sel4 microkernel
- Our bushfire evacuation Decision Support System (DSS) currently used in several states across Australia, won Merit Awards at the 2019 Victorian iAwards in three categories: Research and Development Project of the Year, Infrastructure and Platforms Innovation of the Year and Community Service Markets
- The Transport Analytics team also received a Merit award at the 2019 Victorian iAwards for their work on Predictive Analytics for Water Pipe Maintenance
- Accurait, a cloud lease management platform, developed in partnership with Lease Information Systems (LIS), was recognised at the NSW iAwards in two categories: Platforms and Infrastructure; and Business Service Markets
- Data61 and Transport for NSW won the ITS Australia National Research award for developing a prototype artificial intelligence engine for congestion management, which uses deep-learning and big-data analytics to provide real-time foresight of transport network situations
- A paper titled No Security without Time Protection: We Need a New Hardware-Software Contract by Qian Ge, Yuval Yarom and Gernot Heiser won the Best Paper Award at the ACM SIGOPS APSys workshop
- Paulo De Souza, Group Leader for the Cybernetics Group, received a golden Digital Disruptor Award from the Australian Computer Society
- Hanna Suominen was awarded The Jan Beneken Award for ‘Health Text Summarisation’
- ‘Hyperparameter Learning for Conditional Mean Embeddings with Rademacher Complexity Bounds’ won the ‘Best Student Machine Learning Paper’ at ECML 2018, one of the premier European Machine Learning and Data Mining conferences
- Two research papers were accepted at IEEE’s Security and Privacy (S&P) conference: ‘Machine Learning on Distributed Private Data Using Differentially-Private Gradient Queries’ and ‘RAMBleed: Reading Bits in Memory Without Accessing Them’
- A paper titled ‘Lattice-based Zero-Knowledge Proofs (ZKP): New Techniques for Shorter and Faster Constructions and Applications’ accepted at CRYPTO 2019, which is the no.1 conference in Cryptography

LEADING TALENT

- Ribit, our online matchmaking platform that directly connects students to innovative companies with skills they need. They have run over 42 events, connected over 8000 students/job seekers with potential employers, and grew the number of participants on the platform by 20%
- Data61’s PhD Scholarship program run in partnership with our university partners, continued in FY18/19, attracting 80 new starters and creating networks between the next generation of research scientists in Australia
- We also hosted 44 undergraduate vacation scholarship students over summer in FY18/19
Our team is based at 15 CSIRO sites in Australia.

Want to work with us? 
Get in touch at csiroenquiries@csiro.au.

SANDY BAY, TAS
One of our smaller sites, co-located with the University of Tasmania, with a focus on agricultural and ecological research.

SYNERGY, ACT
Immersive Environments Lab and CSIRO innovation hub integrating Data61 with CSIRO Land & Water and Agriculture & Food. Located next to ANU where we collaborate on the 3A Institute.

MARSFIELD, NSW
Radio astronomy, spaces sciences, and ICT site, partnering with Macquarie University, University of Sydney and UTS.

SOUTH EVELEIGH, NSW
Technology centre of high-tech companies and spin-offs integrated with researchers from CSIRO, University of Sydney, UTS and UNSW.

FORTITUDE VALLEY, QLD
Partnership with QLD Government and location of the Functional Programming Lab.

QUEENSLAND CENTRE FOR ADVANCED TECHNOLOGIES, QLD
Resources, energy and advanced technology precinct integrating Data61 robotics, autonomous systems and distributed sensing systems. Home to Data61’s Robotics Innovation Centre and host of the Sixth Wave Alliance.

FLOREAT, WA
We partner with industry, government and universities in the Cybersecurity CRC at Edith Cowan University.

ADELAIDE, SA
Security research and collaborations with University of Adelaide, University of South Australia and Flinders University.

CLAYTON, VIC
Advanced manufacturing precinct, Mixed Reality Lab and collaboration with CSIRO’s Lab 22.

DOCKLANDS, VIC
An Analytics & Decision Sciences and JV hub integrating our capability with FrontierSI, Oceania Cyber Security Centre Limited, and, Digital Agriculture Services.
Contact us
1300 363 400
+61 3 9545 2176
csiroenquiries@csiro.au
data61.csiro.au

As Australia’s national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.