DAIRNet

2023
Annual Report

PARTNERS

Australian Government
Defence

**NEXT GENERATION
TECHNOLOGIES FUND**

**University of
South Australia**

Contents

Director's report

Dr Mel McDowall
Director - DAIRNet

Dear colleagues, supporters, and members of the Defence AI ecosystem, It is my pleasure to present to you our annual report for 2023.

Artificial intelligence (AI) is a rapidly moving field, not just the technical aspects, but the legalities of use, policy, checks, balances, and even AI literacy. It truly is a multi-disciplinary area, requiring contributions from different sectors and expertise. A specific example of the need for a multi-disciplinary approach is the rise in responsible AI initiatives, from private and government sectors, and both domestically and internationally.

In addition, 2023 has been a dynamic year in Defence, with the release of the Defence Strategic Review (DSR), the Advanced Strategic Capabilities Accelerator (ASCA) and further details about AUKUS Pillar II, advanced capabilities. AI and other emerging technologies feature heavily across all three and DAIRNet continues to provide support and host initiatives that align with Defence priorities.

I see DAIRNet as having many functions, we are the concierge, brokers and the facilitators of networking between Defence and the broader AI ecosystem. We assist with the concept to capability journey and increasingly ensuring new solutions are developed in a co-design manner, involving experts from academia, industry and end-users.

Our activities are driven by our strategic objectives of research impact; people and talent; and integration and evolution. These in turn, are guided by Defence priorities.

In 2023 we focused on increasing and building the Defence AI ecosystem further. Some highlights for me include:

- The inaugural Responsible AI co-design workshop, where experts from academic and Defence identified shared definitions and key aspects involved in the responsible use of AI in Defence context
- Early in the year we hosted the DAIRNet Showcase and networking function, a forum for the lead researchers of DAIRNet supported projects to present the outcomes of their work to a Defence audience
- The establishment of the Defence AI Key Stakeholder Group, with representation from almost 40 different areas within Defence, who have an interest in AI and emerging technologies.
- In the interest of sharing knowledge, we initiated the Defence AI seminar series, a forum for researchers and end-users to share their work at an OFFICIAL level and to stimulate collaboration.

The 2024 calendar is already packed! We have many initiatives in the pipeline and we invite the Defence and AI ecosystems to participate.

Thank you to everyone who has reached out to learn more about DAIRNet and to help inform how we can best support Defence AI. We have enjoyed engaging with different members of the community, hearing about their research, interests, needs and solutions and look forward to supporting the network in the future.

I would like to thank members of the DAIRNet management team, both past and present, and continued support from Defence and academia.

I look forward to continuing our work and making even more significant contributions to our field in the coming year.

Sponsor's report

Recent advancements in generative AI have shone a spotlight on Artificial Intelligence over the last year. Increased scale in terms of data and compute has enabled, for example, large language models with seemingly new abilities to think and reason. The prospect of having an all-knowing advisor which can guide decision making is enchanting; but it is at this point that one must ask questions like "what is going on under the hood?" and "how should I use this?"

The first question relates to understanding the technology itself, while the second to the concept of responsible use of AI; the latter must be informed by the former. AI is a vast field covering many technologies each with different strengths and weaknesses. The super-human information processing and conversational prowess of large language models do not actually grasp the concepts which they portray, rather they form their sentences probabilistically word by word, which, even with good data and a large training time still results in unpredicted fabricated responses; additionally, responses lack transparency, with the AI unable to be audited to determines how the output was generated. Behaviour trees on the other hand, a different class of AI, are only able to process inputs they are created to deal with and based on input branch to a decision pre-encoded by the designer. Behaviour trees have been shown to have utility in autonomous system/agent control, providing explainable, repeatable, and reliable output albeit over a much narrower problem set. Ensuring the responsible application of these varying technologies is highly dependent on understanding such differences, and associated risk profiles. This is not a simple "we must be responsible when using AI" it must come from a deep understanding of the technology.

It is clear that AI is a critical technology for Defence, offering a wide range of applications that can enhance decision-making, optimize operations, and improve overall efficiency. From a technology standpoint, Defence must consider the unique nature of its operating environment. It is one of deliberate adversarial action and deception. Operators are presented with previously unencountered situations and tactics (for which there is no previous representative data), and the environment is contested from a communications, GPS, and physical perspectives. Such considerations pose challenges for many AI approaches, invalidating assumptions made in their creation. Such gaps offer an exciting area for innovation and S&T advancement.

Addressing the issues above is critical to realising the AI revolution within Defence. Revolution is not simply a matter of employing AI to replace a human operator. AI must be integrated with operators as symbiotic human-machine teams and together these teams have the potential to fundamentally change the manner in which Defence operates, optimising effectiveness and efficiency. This Human Machine partnership offers a pathway for the development of significant Defence capability scaling to meet anticipated threats.

Understanding which flavour of AI is best suited for various problems, addressing the technological gaps and associated risks are important in maintaining Defence's standing as an informed and responsible user of AI technology, committed to its legal obligation under international humanitarian law. Innovation and collaboration with the academic and industry sectors plays a pivotal role in addressing these challenges. DAIRNet provides this pathway; created to cohere and coordinate efforts so as to focus and drive AI advancement to address the challenges posed by the Defence context, DAIRNet is the key enabling body for engagement with academia and industry in AI Innovation, Science and Technology.

Dr Rob Hunjet
Program Leader: Artificial Intelligence and Quantum Information Sciences
Cyber Intelligence and National Security Division
Defence Science and Technology Group
Department of Defence

Sponsor's report

Distinguished Professor Marnie Hughes-Warrington AO

Standing Acting Vice Chancellor and Deputy Vice Chancellor: Research and Enterprise University of South Australia

The Defence Artificial Intelligence Research Network, DAIRNet, is a transformational national initiative which brings together thought leaders from Defence, academia and industry to provide strategic advice and innovative AI solutions to Defence, and to support the next generation of Defence AI researchers.

DAIRNet has continued to encourage collaboration and innovation within the Defence sector in 2023 by facilitating much needed and impactful activities across Defence, academia and industry. These activities included cutting-edge Defence AI seminars, symposiums, responsible AI workshops, conferences, research project calls and international visits. As research and technology advance, the DAIRNet network has ensured that the responsible and ethical use of AI has been front of mind to enhance decision making and operational capabilities.

A highlight of 2023 was the International Federated Hackathon, held in December in Adelaide at UniSA Mawson Lakes campus, supported by DAIRNet. The event attracted participants from the US, UK and Australia. They focused on simulating real-world problems in a co-located environment. The event allowed the team to gain invaluable experiences on processes, techniques, and platforms to share resources, reinforcing the importance of international cooperation and knowledge sharing to address complex challenges in defence technology.

DAIRNet continues to support research impact for Defence, assisting with the concept to capability journey. To date, DAIRNet has supported $13 million in funding, supporting 59x Defence-related projects. In 2023, two projects received Phase 2 funding to continue research in patterns in noisy and dynamic data. Professor Siobhan Banks from the University of South Australia—with the project title: "Statistical machine learning algorithm for early detection of infection using data from consumer wearables"—and Professor Truyen Tran from Deakin University, with the project title—"Coupled self-supervised learning and deep reasoning for improved processing of noisy and dynamic multimodal data from multiple sources". DAIRNet is a valuable network for collaboration on AI ideas and technologies within the Defence AI ecosystem.

DAIRNet are pleased to share the 2023 achievements with you and we look forward to working together to advance this critical capability for Australia in 2024.

DAIRNet

About DAIRNet

DAIRNet is an initiative of the Department of Defence and managed in partnership with the University of South Australia. Our activities are driven by our mission and vision statements, and our objectives.

Our **mission** is to connect Defence opportunities with next generation AI solutions.

Our **objectives** are:

Our **vision** is by empowering innovation and collaboration across diverse national AI capabilities, we will develop safe and secure AI solutions to provide advantages for Defence.

People & talent

Strategy: sustain a talent pipeline to grow domestic AI capabilities and Defence AI-ready specialists

Research impact

Strategy: supporting R&D and providing the platform in which AI-users work alongside researchers and developers

Integration & evolution

Strategy: bringing together and supporting the broader Defence and AI ecosystems

DAIRNet achievements

59 Projects commenced

18 Publications

11 Project supported students

27 Projects completed

7 Women in AI supported

36 Prototypes and products developed

$13M Research funding awarded

28 Organisations funded

2 Follow on projects

1000 Active subscribers

DAIRNet

Snapshot of 2023

January

Research Call #5: Patterns in Noisy Data
Phase 2 projects commenced by Professor Siobhan Banks, UniSA and Professor Truyen Tran, Deakin University

February

DAIRNet Showcase: 8th February
- 67x in person individuals attended
- 50x virtual individual logins
- 10x research presentations
- 25x organisations represented

Inaugural Key Stakeholder Group meeting: 15th February (in person)

TAP meeting:
9th February (in person)
Identification of AI research priorities and Sovereign strengths

March

Inaugural Defence AI Seminar Series: 30th March
- 11x seminars
- 10x organisations represented
- 45 plus attendees per seminar

May

Responsible AI workshop: 17th May
- 36x individuals attended
- 60 plus members of future RAI community
- Co-design of key principles and definitions
- 6x research opportunity statements co-designed

August

ADM Defence and Industry Symposium: 8th August

Science Alive: 5th – 6th August
- Attended by primary and secondary school students for "STEM DAY OUT" and public visitors

September

Defence Connect Awards
Dr Mel McDowall, finalist of the Female Defence Leader of the Year

October

Visit from Alan Turing Institute (UK): 23rd October
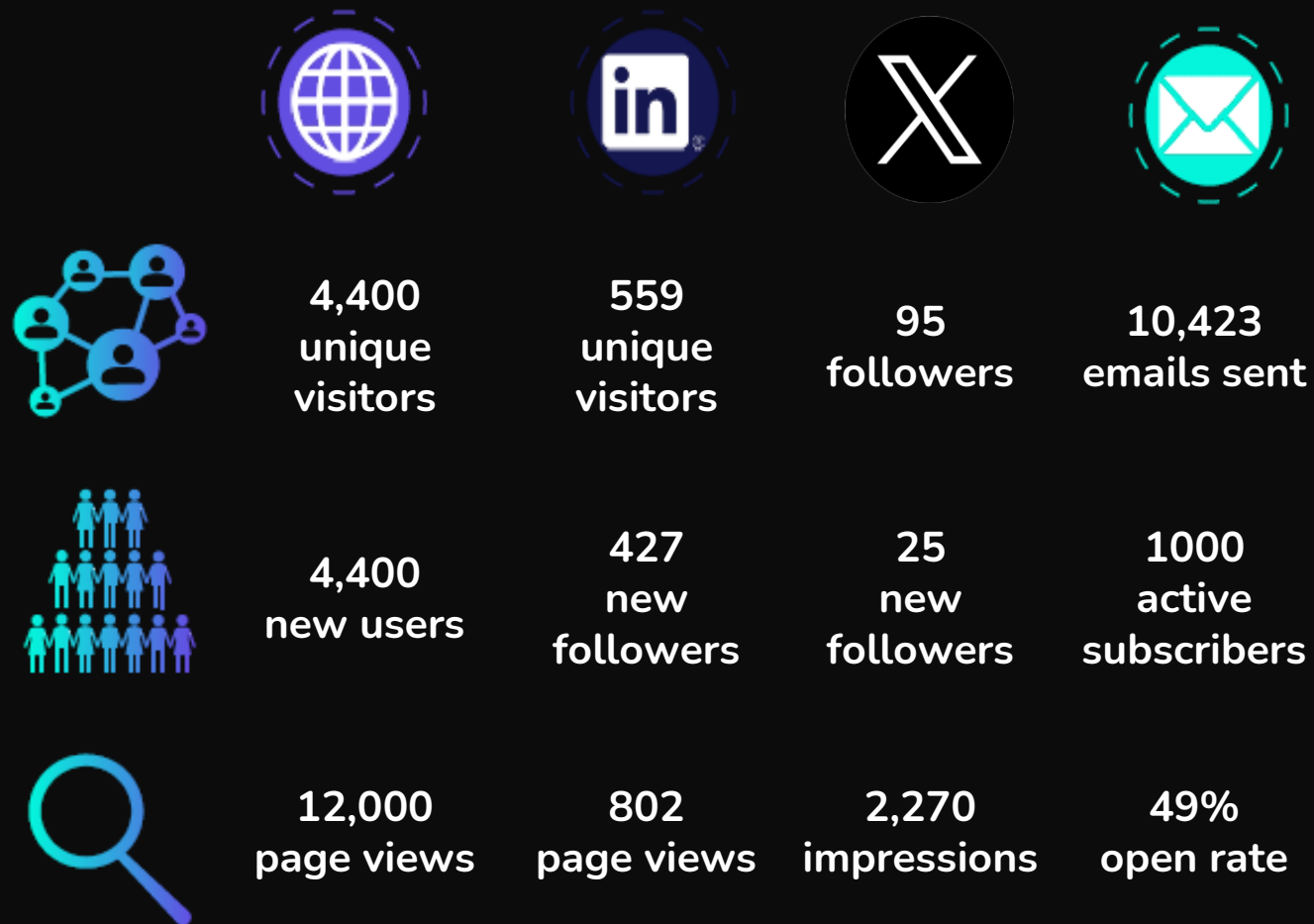Established ongoing relationships

November

Defence AI Symposium (part of AJCAI): 27th November
- 96x in person individuals attended
- 47x organisations represented from Defence, academia and industry
- 58x registrations for the symposium only

December

International Federated Hackathon:
4th – 10th December
- Encouraged collaboration and idea exchange
- Simulated real-world problems
- Shared resources and developed code in co-location

DAIRNet

Engagement in 2023

DAIRNet primarily engages with stakeholders using four types of media: website, direct email campaigns, LinkedIn and X.

	Website	LinkedIn	X	Email
	4,400 unique visitors	559 unique visitors	95 followers	10,423 emails sent
	4,400 new users	427 new followers	25 new followers	1000 active subscribers
	12,000 page views	802 page views	2,270 impressions	49% open rate

DAIRNet

Defence AI seminar series

Aligning with the DAIRNet strategies of research impact, integration and evolution, and an initiative of the Key Stakeholder Group, in 2023 DAIRNet commenced hosting a fortnightly Defence AI Seminar Series. These seminars are a multi-sector and multi-discipline forum to present and discuss all aspects of Defence AI, from data and algorithms to responsible AI and capability.

11 seminars about the general field of AI including topics such as generative AI

10 different organisations represented, including Defence, DSTG, University and Industry

45 plus virtual attendees per seminar

Facilitation of networking between Defence, Academics and Industry

Defence AI seminar series

Presenter/s	Organisation	Title
Professor Saeid Nahavandi and Lieutenant Colonel Marcus Doherty, CSM Marcus Doherty	Institute for Intelligent Systems Research and Innovation and RICO - Future Land Warfare Branch	Autonomous Leader Follower Convoy and Army Quantum Technology Roadmap
Kyla Quinn	ASD - Data and Analytic Services Branch	ML and AI in production: Are a cloud and some data scientists enough?
Professor Liming Zhu	CSIRO's Data 61	Responsible/Trustworthy AI in the Era of Foundation Models
Dr Simon Ng and Katherine Head	Trusted Autonomous Systems Defence CRC	Engineering Autonomous Systems - Standards, Certification and Assurance
COL Damian Copeland	Australian Defence Force - Military Legal Services	Article 36 Weapons Review of Autonomous Weapon
Dr Surya Nepal	CSIRO's Data 61	AI for Critical Infrastructure Protection and Resilience
Dr Piyush Madhamshettiwar	Department of Transport NSW	Operationalising responsible AI in Defence and Intelligence
Dr Christina Boshuijzen van Burken	UNSW	Values and military autonomous systems
LTCOL Adam J Hepworth	RICO	Robotic and autonomous systems implementation and coordination
Dr Zena Assaad	ANU	Assuring AI: Challenges and Opportunities
Dr Truyen Tran	Deakin University	Generative AI: Shifting the AI Landscape

DAIRNet showcase

Held in February, the DAIRNet Showcase provided the opportunity for researchers to share outcomes of their work and highlight how their research offers solutions to Defence. Researchers presented their work using the Bottom-Line Up Front (BLUF) format.

10 research presentations

67 in person and 50 virtual logins

25 organisations represented

Facilitation of networking between Defence and academics

Responsible AI workshop

Held in May, DAIRNet hosted a Responsible AI workshop, facilitated by Yellow Hat Consulting and Astryx. The workshop brought together experts in responsible AI (legal, ethical, human factor and AI assurance), AI-ML technicians and end-users to undertake a multi-disciplinary scoping exercise. The group developed agreed definitions and components of RAI.

Responsible AI workshop

During the workshop, participants developed shared definitions and components of Defence Responsible AI.

"Responsible AI is an ecosystem of principles and practices to create and operationalise human and AI systems"

Trust: A relationship between cognitive systems (agents/humans and artificial). Delegation of tasks and accepting risks requires trust in context.

Traceability: End to end transparency, from input data to the output of the decision and the selection of output of the model-to-model commands and/or training data.

Governance and controls: Flexible and iterative policies, processes and practices to enable agile design and implementation of systems, applying responsible AI.

Lawful usage: Complies with existing laws and common practice, within contexts.

Assignment of responsibility: Assignment of accountability for different aspects and levels of AI systems and activities.

Responsible AI workshop

The scope of the workshop was to identify research opportunities to inform the responsible use of AI in Defence.

6 research opportunities co-designed

36 in person attendees

60 plus members of a future Responsible AI community

Co-design of key principles and definitions

Science Alive

In August, DAIRNet used gamification to educate and increase awareness of AI and data science in school children.

DAIRNet symposium

In November, DAIRNet hosted a Defence AI Symposium as part of the 36th Australian Joint Conference on Artificial Intelligence (AJCAI) at the University of Queensland. The symposium provided a platform for the exchange between the Australian Defence and AI communities, exploring priorities, opportunities and commonalities.

Highlights included a presentation from GPCAPT David Clyde from the Joint Capabilities Group about assurance of AI systems to enable trusted decision support and concluded with a panel discussion with representatives from Army, Air Force, Navy and Joint Capabilities Group.

96 registrations

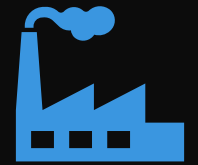**60% of attendees registered for symposium only**

9 presentations from 16 speakers and panellists

27% of attendees from Defence, 7% from DSTG

35% of attendees from Universities

31% of attendees from Industry

DAIRNet research programs

DAIRNet continued to support research impact for Defence, assisting with the concept to capability journey.

To date, DAIRNet have supported **four** NGTF **research programs**, AI for Decision Making and current state reports for Defence. This amounts to **$13 million** in funding, supporting **59x** Defence-related projects. A full list of DAIRNet-supported projects can be found in the appendices.

In 2023, **two projects** received **Phase 2 funding** to continue research into **Patters in Noisy and Dynamic Data**:

- Prof Siobhan Banks (UniSA) project title: Statistical machine learning algorithm for early detection of infection using data from consumer wearables.
- Prof Truyen Tran (Deakin University) project title: Coupled self-supervised learning and deep reasoning for improved processing of noisy and dynamic multimodal data from multiple sources.

Autonomous processing & reasoning
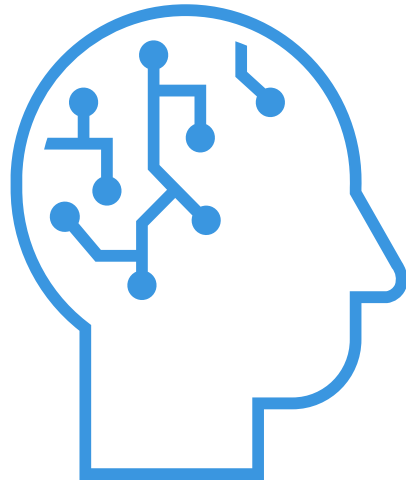
Human-AI interaction

Distributed multi-domain networks

Patterns in noisy & dynamic data

Research impact

Professor Siobhan Banks, University of South Australia

Project title: Statistical machine learning algorithm for early detection of infection using data from consumer wearables.

In operational and contested environments, it is vitally important to know the health status of personnel and to detect onset of an infectious disease. Off-the-shelf, consumer smartwatches and wearables are used widely by personnel, and collect thousands of hours of data continuously, at low cost and low burden. What if we could make use of this passively recorded physiological and behavioural data to detect the earliest molecular and cellular physiological events, caused by pathogen exposure, even prior to active infection?

Study Aim: Apply statistical machine learning to validate unified study design and analysis approaches to generate an algorithm that can be applied to data from off-the-shelf, consumer wearables for early detection of a modelled immune response that precedes active infection.

Outcomes: 1) New data processing pipeline for managing large sets of continuous data; 2) Identification of the consumer wearables and signals that can be used to detect immune responses that precede infection; 3) A statistical machine learning algorithm that can be applied to consumer wearables to identify changes in physiology and behaviour to detect early onset of immune responses.

AI Innovations led by Industry Partner Dr Zygmunt Szpak, IVAI: This project will use Riemannian manifolds for FDA. Under this approach, functions are represented as points in Riemannian space. Geodesics in this space correspond to optimal deformations that align one function onto another. The geodesic distances provide a basis for optimally matching, deforming, comparing, averaging, and inferring functions.

A pivotal technical contribution of this proposal will involve producing novel Statistical Machine Learning (SML) algorithms by tailoring techniques from robust statistics to the FDA framework. Although there are some recent algorithms for detecting outliers in FDA, these are applicable to functional data already temporally registered. The functional data emerging from the current study, on the contrary, will require jointly registering multiple curves against each other while considering that there are outlying curves. So that the immune responses we are targeting don't get filtered as statistical outliers, we will register all the "healthy" curves and construct the average healthy curve and its standard deviation envelopes.

We will then register the immune response signals against this average healthy curve and construct test statistics to inform how likely one would encounter the immune response signal, considering the healthy distribution. Thus, advancing the state-of-the-art in robust statistics within a Riemannian framework will enable us to fuse and register diverse noisy data sources corrupted by outliers. In particular, the combination of FDA and robust statistics will help obtain the sought-after separation between variability in sensor readings due to the diversity of everyday activities an individual performs and genuine changes in physiological responses due to inflammation. The more these two sources of sensor variability are discerned, the higher the chance that the SML approach will identify stable patterns of inflammation that predict a biological threat.

Research impact

Professor Truyen Tran, Deakin University

Project title: Coupled self-supervised learning and deep reasoning for improved processing of noisy and dynamic multimodal data from multiple sources.

The primary focus of the project lies in the development of an innovative framework aimed at autonomously learning data representation and enhancing cross-channel reasoning, thereby facilitating real-time informed decision-making within the Defence sector.

Throughout the reporting period, we successfully implemented, tested, and documented advanced models capable of handling noisy temporal data generated by complex large-scale sensor networks. Specifically, we developed and delivered to DSTG, the UNITED framework. This framework offers three approaches for embedding multi-sensor data into a unified representation space, considering varying data characteristics such as strong/weak sensor coupling and short/long-range dependencies. The framework provides support for a range of downstream tasks including forecasting, annotation, classification, and outlier detection. Rigorous evaluations were conducted across multiple case studies, encompassing forecasting electricity consumption for hundreds of households, solar power production for thousands of

plants, annotations and classifications of computer network events, as well as employing various sampling strategies and anomaly detection techniques. Collaborating closely with DSTG personnel, we have facilitated the technology transfer process to align with their specific requirements.

As we transition into Phase 3, spanning from October 2023 to June 2024, our focus shifts towards developing neural memory architectures to enable cross-channel reasoning capabilities. This involves the creation of a versatile memory module capable of reading, storing, retrieving, and answering arbitrary queries on data from distant past instances. Our progress in this direction signifies a significant stride towards the objective of enabling real-time informed decision-making for Defence applications. The project's advancements hold considerable promise for enhancing data fusion techniques and decision support mechanisms, with far-reaching implications across various operational domains.

Governance

The government and management of DAIRNet ensures representation from all relevant stakeholders, including Defence, the DAIRNet Management Team and foundation university members. As the DAIRNet network grows, committees and membership will evolve to ensure representation of our stakeholders.

DAIRNet Management Team

The Management Team implements decisions made by the management committee and coordinates the network on behalf of the Department of Defence. The team is from the University of South Australia and the Defence Science and Technology Group (DSTG) and is the main point of contact for Universities, researchers and other stakeholders.

Current members

- Dr Mel McDowall, Director of DAIRNet
- Dr Ralph Gailis, Associate Director of DAIRNet
- Associate Professor Belinda Chiera, Research Lead
- Dr Gary Hanly, DAIRNet Liaison
- Mr Will Partridge, Project Officer
- Ms Jacinta Lamacchia, DAIRNet Communications and Events Lead

DAIRNet would like to thank and acknowledge previous members and alumni

- Mr Igor Sefer, Research Project Management Officer
- Ms Aleesa Clough, DAIRNet Project Officer
- Dr Adi Chopra, Scientific Advisor, NAVIGATE Program, DSTG
- Dr Jesmin Rupa, Lead Investigator, AI Landscape Report

Governance

Governance Panel

The Governance Panel provides strategic direction to the DAIRNet Management Committee and ensures that DAIRNet activities align with the broader Defence AI strategic direction. Members of the Governance Panel represent DAIRNet, DSTG and key stakeholders within the Department of Defence.

The Governance Panel was used as the sponsorship group for the responsible AI workshop and decided on the top priorities and mechanism through which DAIRNet activities can be communicated to the AI Board.

Current members:
Chair: Dr Robert Hunjet, Program Lead, AI, DSTG
- Mr Simon Joyce, Assistant Secretary Data Governance and Services, Data Division, Associate Secretary Group
- Dr Mel McDowall, Chair of the DAIRNet Management Committee
- CDRE Stu Watters, Director general Joint Command, Control, Communications and Computers (JC4), Joint Capabilities Group
- AIRCDRE Di Turton, Director General Intelligence Capability Integration, Defence Intelligence Group
- Mr Andrew Hodgkinson, Assistant Secretary DSR Policy and Engagement

Management Committee

The Management Committee coordinates implementation of the direction provided by the Governance Panel. The Management Team and the DAIRNet panels, committees and working groups report to the Management Committee.

The Management Committee provides the primary link between DAIRNet and the Department of Defence.

Current members:
Chair: Dr Mel McDowall, Director of DAIRNet
- Dr Ralph Gailis, Deputy Program Leader AI, DSTG
- Dr Gary Hanly, DSTG Liaison to DAIRNet, DSTG
- Mr Philip Keane, Assistant Director Strategic Programs, Science Partnerships, DSTG
- Mr Jim Mitkas, Director Strategic Engagement, National Partnerships, Science Partnerships, Science Engagement and Impact Division, DSTG
- Mr Matt Opie, Director Defence and Space, UniSA
- Dr Sebastien Hebert, Senior Manager: Business Development Enterprise Partnerships Unit, UniSA
- Dr Sebastien Wong, AI Strategy and Leadership, DSTG

DAIRNet

Governance

Technical Advisory Panel

The Technical Advisory Panel provides advice on sovereign research strengths, suggested DAIRNet symposium topics, assistance with AI glossary and identifies future priorities. The panel also play a critical role in the development and assessment of research calls and activities conducted within the network, such as education and outreach and the identification of trends.

Current members:
Chair: A/Prof Belinda Chiera, Deputy Director, Industrial AI Research Centre, UniSA

- Dr Ralph Gailis, Specialist Science Advisor for AI, DSTG
- Prof Markus Stumptner, Chair, DAIRNet Technical Advisory Panel, Director Industrial AI Research Centre, UniSA
- Dr Axel Bender, STaR Shot Leader Operating in CBRN Environments, DSTG
- Dr Angela Consoli, Chief Defence Scientist Fellow, DSTG
- Prof Christopher Fluke, Swinburne University of Technology
- Prof Matt Garratt, University of NSW Canberra
- A/Prof Yuan-Fang Li, Monash University
- Dr Glennn Moy, Research Specialist AI and Machine Learning, DSTG
- Prof Flora Salim, University of New South Wales
- Dr Daniel Salmond, Group Leader Information Warfare Command & Control, DSTG
- Prof John Thangarajah, RMIT University
- Prof Michael Webb, The University of Adelaide

Key Stakeholder Group

DAIRNet has established the Defence AI Key Stakeholders Group.

This group brings together representatives from across the Defence and AI ecosystems, enabling a concerted effort to empower and evolve Defence AI capability.

The group reports to the DAIRNet Management Committee and function as an advisory body to inform the Defence AI Innovation, Science and Technology (IS&T) Program.

Technical Advisory Panel (TAP)

TAP collaboration initiatives to aid in the development of an efficient ecosystem.

Strong relationships with key government agencies and stakeholders, by offering expertise, resources and support to help them identify, understand and address their most pressing AI-related challenges.
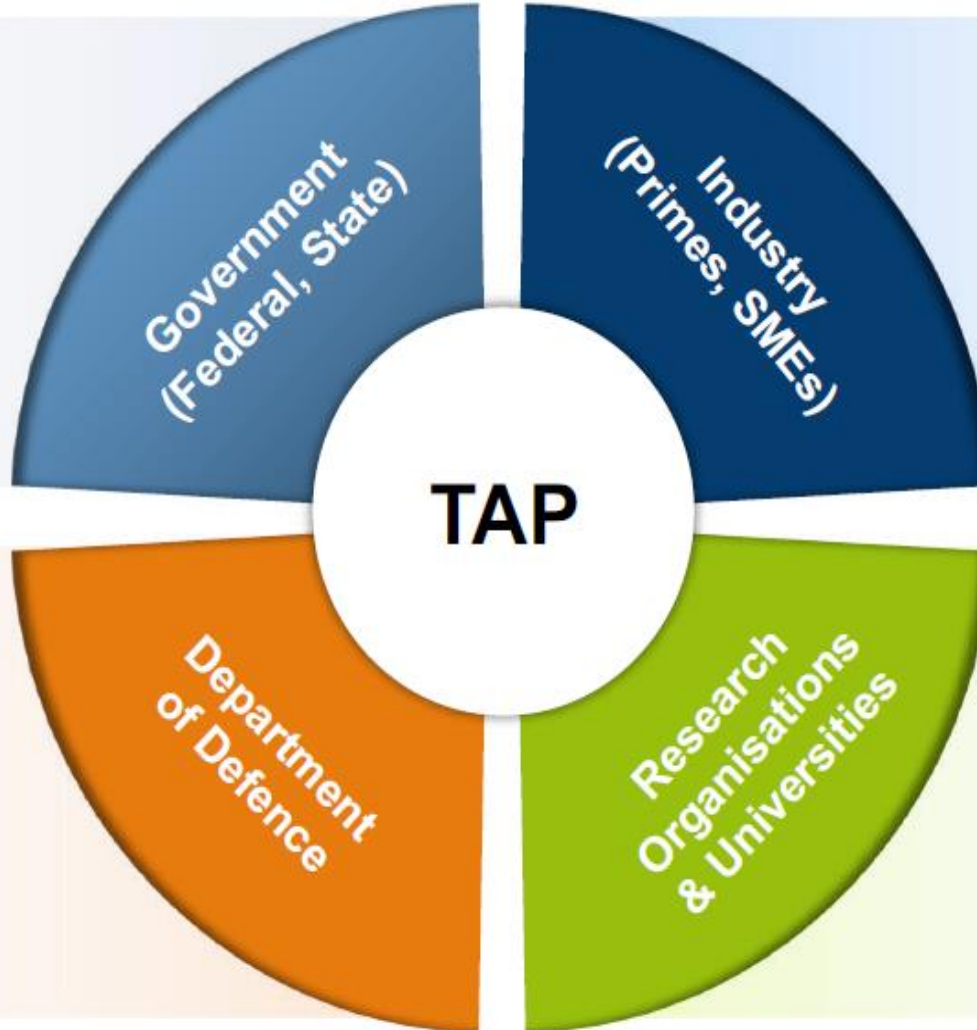
Provide support and resources to assist industry partners in developing their own AI capabilities and offer training and education to help them stay up-to-date with the latest AI technologies and best practices.

Delivering tangible results and demonstrate its effectiveness in solving real-world AI challenges that will help to establish the organisation as a trusted and reliable partner for the defence industry in the field of AI.

Strong focus on R&D leveraging the AI technologies and methodologies to develop cutting-edge solutions as well as collaboration with other leading research organisations to ensure alignment with global trends and best practices in the field.

Government (Federal, State)

Industry (Primes, SMEs)

Department of Defence

Research Organisations & Universities

TAP

DAIRNet

Defence Key Stakeholder Group

The Key Stakeholder Group identified potential bottlenecks that may limit Australia's ability to innovate and deliver into Defence AI capability. The issues highlighted were categorised into three themes.

The group represent an opportunity to enable the construction of a cohesive and shared narrative about the efforts necessary and the mechanisms to deliver them. Advice that this diverse group offers can then be readily used by decision makers to guide strategic priorities and investments.

- Requirements and opportunities for a Defence AI Academy to upskill new and existing talent through courses, internships and secondments.

- Identify current talent and infrastructure gaps in achieving a successful Sovereign Defence AI Ecosystem that works beyond Australia's geographic borders and with allies.

- Policies and guidelines required to enable a successful Sovereign Defence AI Ecosystem that integrates best practices overseas and meets requirements of legal/compliance frameworks.

Appendices

DAIRNet events

Date	Objective(s)	Name	Deliverable	Organiser	Format	Location	Involvement
7/02/2023	Integration & Evolution	Defence AI Key Stakeholders Group meeting	Governance	DAIRNet	Hybrid	UniSA	Organiser
8/02/2023	Research Impact Integration & Evolution	DAIRNet Showcase	Conference	DAIRNet	Hybrid	Edinburgh	Organiser
9/02/2023	Research Impact	Technical Advisory Panel workshop	Governance	DAIRNet	In person	UniSA	Organiser
30/03/2023	Research Impact	Defence AI Seminar: RICO	Seminar	DAIRNet	Virtual	Virtual	Organiser
11/05/2023	Research Impact	Defence AI Seminar: ASD	Seminar	DAIRNet	Virtual	Virtual	Organiser
17/05/2023	Research Impact Integration & Evolution	Responsible AI Workshop	Workshop	DAIRNet	In person	Canberra	Organiser
25/05/2023	Research Impact	Defence AI Seminar: Data 61	Seminar	DAIRNet	Virtual	Virtual	Organiser
8/06/2023	Research Impact	Defence AI Seminar: TAS	Seminar	DAIRNet	Virtual	Virtual	Organiser
22/06/2023	Research Impact	Defence AI Seminar: DSTG	Seminar	DAIRNet	Virtual	Virtual	Organiser
6/07/2023	Research Impact	Defence AI Seminar: Defence Legal	Seminar	DAIRNet	Virtual	Virtual	Organiser
4/08/2023	People & Talent	Science Alive!	AI Academy	National Science Week	In person	Adelaide	Exhibitor
8/08/2023	Research Impact	ADM Defence and Industry Research Symposium	Conference	Australian Defence Magazine and UniSA	In person	Adelaide	Invited Speaker
16/08/2023	Research Impact Integration & Evolution	AIML research Showcase	Conference	University of Adelaide	In person	Adelaide	Attendee

DAIRNet events - continued

Date	Objective(s)	Name	Deliverable	Organiser	Format	Location	Involvement
17/08/2023	Research Impact	Defence AI Seminar: CSIRO	Seminar	DAIRNet	Virtual	Virtual	Organiser
29/08/2023	Research Impact	Chief of Army Symposium	Conference	Army	In person	Perth	Attendee
31/08/2023	Research Impact	Defence AI Seminar: NSW Transport	Seminar	DAIRNet	Virtual	Virtual	Organiser
6/09/2023	Integration & Evolution	Murdoch University seminar	Seminar	Murdoch University	Virtual	Virtual	Invited Speaker
14/09/2023	Research Impact	Defence AI Seminar: Values and military autonomous systems	Seminar	DAIRNet	Virtual	Virtual	Organiser
21/09/2023	People & Talent	Defence Connect Awards	Awards	Defence Connect	In person	Canberra	Finalist
12/10/2023	Research Impact	Defence AI Seminar: RICO	Seminar	DAIRNet	Virtual	Virtual	Organiser
23/10/2023	Research Impact	Visit from Alan Turing Insitute (UK)	International Visit	DAIRNet	In person	Adelaide	Organiser
9/11/2023	Research Impact	Defence AI Seminar: ANU/TAS	Seminar	DAIRNet	Virtual	Virtual	Organiser
10/11/2023	People & Talent	Women in Innovation Awards	Awards	Women in Innovation SA	In person	Adelaide	Winner
27/11/2023	Research Impact Integration & Evolution	Defence AI Symposium	Conference	DAIRNet	In person	Brisbane	Organiser
4/12/2023	Research Impact Integration & Evolution	AI Tool Kit workshop	Workshop	DSTG	In person	Adelaide	Host
7/12/2023	Research Impact	Defence AI Seminar: Deakin Uni	Seminar	DAIRNet	Virtual	Virtual	Organiser

Research projects - current

Lead Researcher	Organisation	Funding Initiative	Project Title
Yuan-Fang Li	Monash University	NGTF Call 1: Autonomous processing and reasoning	RUSH: Reasoning and Learning under Soft and Hard Data.
Anna Ma-Wyatt	The University of Adelaide	NGTF: Human - AI interaction	Modelling, Monitoring and Moderating Human-AI Interaction.
Christopher Fluke	Swinburne University of Technology	NGTF: Human - AI interaction	Artificial Intelligence as the Most Valuable Player: Enabling cyber-human teams to achieve decision superiority.
Hung Nguyen	The University of Adelaide	NGTF: Distributed multi-domain networks	Machine learning solutions for BGP-based software defined combat clouds.
Matt Selway	University of South Australia	NGTF: Distributed multi-domain networks	Advanced Integrated Modelling Environment for Self-Adaptive Software Systems (AIME).
Siobhan Banks	University of South Australia	NGTF: Patterns in noisy and dynamic data	Statistical machine learning algorithm for early detection of infection using data from consumer wearables.
Truyen Tran	Deakin University	NGTF: Patterns in noisy and dynamic data	Coupled self-supervised learning and deep reasoning for improved processing of noisy and dynamic multimodal data from multiple sources.

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Research projects - completed

Lead Researcher	Organisation	Funding Initiative	Project Title
Paul Black	Federation University Australia	AI for Decision Making	Security Patch Identification Using Compiled Updates and Release Notes.
Maiken Ueland	University of Technology Sydney	AI for Decision Making	Using AI for real-time victim detection in mass disasters.
Nayyar Zaidi	Deakin University	AI for Decision Making	Discretization Inspired Defence Methods for Adversarial Attacks on Cyber Security Domain Data.
Jingge Zhu	The University of Melbourne	AI for Decision Making	Generalisation of learning algorithms: theory and efficient implementations from an information-theoretic point of view.
Charles Martin	Australian National University	AI for Decision Making	Open-Form Music Composition for Synchronised and Coordinated Action.
Sebastien Miellet	University of Wollongong	AI for Decision Making	The influence of trust in the algorithm on AI explanations use and decision-making.
Yuan-Fang Li	Monash University	AI for Decision Making	Cross-lingual text summarisation with a plan.
Flora Salim	University of New South Wales	AI for Decision Making	Online learning-based forecasting with irregular time-series data.
Son Lam Phung	University of Wollongong	AI for Decision Making	New Deep Networks for Iris-based Post-Mortem Identification.
Mohd Fairuz Shiratuddin	Murdoch University	AI for Decision Making	Multi-Layered Adaptive FCMs for High- and Low-Level Decision Making.
Mingyu Guo	University of Adelaide	AI for Decision Making	Abstract Game Prototype for Cyber Attack/Defence.
Mingyu Guo	University of Adelaide	AI for Decision Making	Tackling the TTCP CAGE challenge using Monte-Carlo planning for large-scale POMDPs.
Flora Salim	University of New South Wales	AI for Decision Making	A general time-series representation learning pipeline with self-supervised learning.
Nhat Nguyen	The University of Adelaide	AI for Decision Making	A Decentralised Combined and Hybrid Approach for Multi-agent Decision Making.
Matt Duckham	RMIT University	NGTF Call 1: Autonomous processing and reasoning	NEXUS: Explainable and Unified Spatial Reasoning and Sensor Fusion.

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Prototypes and products

Lead Researcher	Organisation	Funding Initiative	Partners	Prototype Summary	TRL Level	Student Involvement
Jingge Zhu	The University of Melbourne	AI for Decision Making	Non-Defence Industry	It is an algorithm implemented in software that can be further modified or improved.	TRL 1-3	Yes - one PhD or Masters student
Sebastien Miellet	University of Wollongong	AI for Decision Making	UOW and UNSW	Developing an evidence-based prototype of software supporting Human-AI teaming for optimal decision-making, taking into account both AI biases and human cognitive biases.	TRL 5	
Yuan-Fang Li	Monash University	AI for Decision Making	DSTG	Developed a multilingual text summarisation model based on the PPO algorithm.	TRL 1-3	Yes - one Honours or undergraduate student
Guoxin Su	University of Wollongong	AI for Decision Making	UoW	It is a research software tool which advances the technology of software verification. It uses GPU and multiple CPU cores to accelerate the verification algorithms.	TRL 1-3	Yes - one PhD or Masters student
Yuang-Fang Li	Monash University	NGTF Call 1: Autonomous processing and reasoning	DSTG	Developed a proof-of-concept system for constructing probabilistic knowledge graphs from text and applied it to the maritime events domain. The source code, system and accompanying report/manual have been delivered to the DST Group.	TRL 4	Yes - one PhD or Masters student

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Prototypes and products - continued

Lead Researcher	Organisation	Funding Initiative	Partners	Prototype Summary	TRL Level	Student Involvement
Hung Nguyen	The University of Adelaide	NGTF Call 3: Distributed multi-domain networks	Defence	Developed a prototype of a multi-bearer management solution using machine learning. The solution autonomously manages traffic on multiple communication bearers to maintain high throughput in disruptive and contested environments.	TRL 1-3	
Matt Selway	The University of South Australia	NGTF Call 3: Distributed multi-domain networks	Defence	PoC graphical modelling environment and runtime environment demonstrating the goal-oriented, context-driven management of systems to support self-integration. The architecture is broadly applicable allowing the modelling of a variety of scenarios. Example scenarios included the re-configuring of software systems on Kubernetes (or similar), dynamic and model-driven integration of new sensors (extensible to other data sources). The PoC was also partially translated into the future systems architectures being developed by DST Group.	TRL 1-3	
Truyen Tran	Deakin University	NGTF Call 5: Patterns in noisy and dynamic data	Non-Defence Industry	The prototype is capable of processing multiple temporal data channels (up to 5,000) and performs a variety of downstream tasks such as event annotation, forecasting, anomaly detection and classification.	TRL 1-3	Yes - one PhD or Masters student

Follow-on projects

DAIRNet provided seed funding to support the below projects, resulting in a proof of concept to continue further research.

Lead Researcher	Organisation	Funding Initiative	Project Name	Project Description	Student Involvement
Paul Black	Federation University Australia	AI for Decision Making	Classifying Security Patches in Compiled Programs: A Study Utilizing Pseudocode Features and Source Code.	Continuing work on the AI4DM project in preparation for a journal paper.	
Son Lam Phung	University of Wollongong	AI for Decision Making	Multi-modal satellite-based vessel surveillance via optical and synthetic aperture radar imaging.	The project aim is to establish space-based surveillance capability by developing a novel multi-modal deep learning system for detecting, recognising, and tracking sea vessels from satellite optical and synthetic aperture radar images. Utilising and extending the Siamese Deep Network that was investigated in the AI4DMI project.	Yes, three PhD students

Awards

Women in Innovation Award

Congratulations to Dr Mel McDowall, award winner of the technology category

The Women in Innovation Awards recognise South Australian women contributing to the state's innovation economy by creating jobs, revenue and solutions to address some of the world's biggest problems and creating positive change.

Criteria for the Technology Category:
- Anything created by a human that can make our lives easier or solve a problem
- Reshaping an industry, streamlining processes, new materials or products
- Media and mobile application development telephony
- Cameras, appliances, computer audio
- Online applications
- Musical instruments
- Software

Publications – peer reviewed journal articles

Lead Researcher	Organisation	Citation	DOI:
Matt Duckham	RMIT University	Duckham M, Gabela J, Kealy A, Kyprianou R, Legg J, Moran B, Rumi SK, Salim FD, Tao Y, Vasardani M (2023) Qualitative spatial reasoning with uncertain evidence using Markov logic networks, International Journal of Geographical Information Science, 37(9): 2067-2100	10.1080/13658816.2023.2231044
Charles Martin	Australian National University	Martin CP, Hunter A, Schuetze B, Wang Y (2023) Composing Interface Connections for a Networked Touchscreen Ensemble, 4th International Symposium on the Internet of Sounds; 1-5.	10.1109/IEEECONF59510.2023.10335226
Matt Selway	The University of Souith Australia	Morgan R, Pulawski S, Selway M, Mayer W, Grossmann G, Stumptner M, Ghose A, Kypriano R (2023) Modeling Rates of Change and Aggregations in Runtime Goal Models, Data & Knowledge Engineering, 147: 102205	10.1016/j.datak.2023.102205
Hung Nguyen	The University of Adelaide	Phu A, Li B, Ullah F, Huque TI, Naha RK, Babar A, Nguyen H (2023) Defending SDN against packet injection attacks using deep learning, Computer Networks, 234: 109935.	10.48550/arXiv.2301.08428

Publications – conference proceedings

Lead Researcher	Organisation	Citation	DOI:
Flora Salim	University of New South Whales	Liu J, Deldari S, Xue H, Nguyen V, Salim FD (2023) Self-supervised Activity Representation Learning with Incremental Data: An Empirical Study, 24th IEEE International Conference on Mobile Data Management (MDM), Singapore, Singapore, 2023, pp. 39-44	10.48550/arXiv.2305.00619
Yuan-Fang Li	Monash University	Moghimifar F, Shiri F, Haffari R, Li YF, Nguyen V (2023) Few-shot Domain-Adaptative Visually-fused Event Detection from Text, 26th International Conference on Information Fusion (FUSION):1-8	10.23919/FUSION52260.2023.10224213
Guoxin Su	University of Wollongong	Robinson T, Su G (2023) Multi-objective Task Assignment and Multiagent Planning with Hybrid GPU-CPU Acceleration, NASA Formal Methods: 260-277.	10.1007/978-3-031-33170-1_16
Nayyar Zaidi	Deakin University	Zhou J, Zaidi N, Zhang , Montague P, Kim J, Li G (2023) Leveraging Generative Models for Combating Adversarial Attacks on Tabular Datasets, 27th Pacific-Asia Conference on Knowledge Discovery and Data Mining, 13935: 147-158	doi.org/10.1007/978-3-031-33374-3_12

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