RICARDO CANNIZZARO

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OBJECTIVE

Fifth-year causal ML & robotics PhD Student at Oxford Robotics Institute | Aerial autonomous systems Defence Research Scientist at Australia Defence Science & Technology | 10+ years experience building AI/ML-empowered software and hardware systems that perceive, understand, make decisions and generate explanations autonomously in complex real-world applications. | Passionate about STEM education, outreach, diversity and inclusion | **Seeking PhD internship roles in causal AI/ML**

Research Interests: Probabilistic generative causal modelling, Bayesian causal inference, deep learning, multi-modal generative AI models (latent diffusion, transformers; text, image, causal variables), causal representation learning (encoder/decoders, VAEs), counterfactual attribution & explanations, probabilistic programming, autonomy assurance, probabilistic planning under uncertainty, explainable AI, robot knowledge representation & reasoning

EDUCATION

DPhil (PhD) Engineering Science, Oxford Robotics Institute, University of Oxford   *Expected 2024*
Supervisor: Prof Lars Kunze & Prof Nick Hawes, Cognitive Robotics Group & Goal-Oriented Long-Lived Systems (GOALS) group. Funded by Defence Science and Technology Group Australia.

I am researching probabilistic generative causal models to encode robot formal knowledge representations and world uncertainty, built from domain expertise and learned from data. I am investigating the use of (deep) causal learning and causal Bayesian inference for prediction, decision-making, and causal explanations for robots operating in challenging complex, uncertain, and partially-observable real-world environments; and (continuing research from my MSR PhD internship) software-based multi-modal generative AI models used in causally-complex domains including folk physics and folk psychology. I am exploring the benefits of applying these methods to assure the trustworthy and explainable autonomy of robots undertaking tasks in manipulation, assistive robotics and mine survey applications; and building AI tools to aid concept artists during the creative process of video games development.

Courses: Oxford Scientific Entrepreneurship Course, Oxford Language Centre Italian Fast-Track Course Parts 1-2

Bachelor of Engineering (Robotics & Mechatronics)(Hons), Swinburne University, Australia   *2013 - 2016*
First Class Honours - GPA 4.0/4.0. Highest achieving graduate (Dux). Industry-based learning year with DSTG.

Bachelor of Science (Mechatronic Systems), University of Melbourne, Melbourne, Australia   *2010 - 2012*
Awarded the Kwong Lee Dow scholarship for demonstrating excellence in leadership and academia

WORK EXPERIENCE

Summer PhD Research Intern   May 2024 - Aug 2024
Microsoft Research   *Microsoft Global HQ, Redmond, WA, USA*

- Undertook a 12-week research project to investigate solutions to the well-known causal reasoning limitations of multi-modal generative AI models (e.g., Stable Diffusion), drawing inspiration from the causal ML literature
- Worked under the mentorship of Dr Robert Ness and Dr Emre Kiciman in the AI for Industries and AI Resilience research groups within Microsoft Research
- Implemented novel deep-learning architectures, training methods, loss functions, and diffusion-based model training and deployment workflows using DL libraries including PyTorch, Pyro probabilistic programming language, HuggingFace, and Weights and Biases
- Created a research plan and delivered mid- and end-of-internship research presentations

- Performed qualitative evaluations of novel methods and compared against baseline methods, to demonstrate qualitative improvements of causal reasoning in content generation
- Advocated for diversity and inclusion (D&I) by proactively participating in D&I events, such as speaking on a Microsoft Research Internship D&I panel

Robotics Specialist (Defence Research Scientist) (S&T 3/4 Above)   Sep 2020 - Present
(S&T 3/4 Below)   Jan 2017 - Aug 2020
Australian Defence Science and Technology Group (DSTG)   *Melbourne, Australia*

- Performed R&D of aerial autonomous systems for the Australian Defence Force and provided trusted advice
- Undertook deputy manager role for the Fishermans Bend Flight Laboratory, performed lab training and inductions, maintained critical scientific infrastructure, and ensured health and safety compliance
- Published papers at top-tier international and Australian conferences (e.g., ICRA, Australasian Conference on Robotics and Autonomous Systems) on topics including robot swarming and teaming, navigation and SLAM
- Supported 5+ key strategic robotics and autonomy research agreements with local and international partners across academia, industry and government/Defence. Performed UAS technology demonstrations at four international Defence joint trials in Australia, US, Canada, and Singapore.

Defence Research Scientist Cadet   Jul 2015 - Dec 2016
Australian Defence Science and Technology Group (DSTG)   *Melbourne, Australia*

- Contributed to aerial autonomous systems R&D outcomes for the Australian Defence Force
- Empirically validated a novel chemical source localisation with a bespoke sensor and ground robot using hardware design, C++/ROS/MATLAB software, and signal processing skills

PROJECTS

- **Causal Reasoning & Explanations for Robot Manipulation:** [Project]
- **Causal Discovery, Inference & Counterfactual Explanations for Drones in Mines:** [Project]
- **Causally-Informed POMDP Planning for Robots Under Confounded Decision-Making:** [Project]
- **Decentralised MCTS for Robot Intelligence, Surveillance & Reconnaissance Missions:** [Project]
- **Scaleable Multi-Robot Exploration & Return in Apriori Unknown Environments:** [Project]
- **Team ORIon Team Lead (2021/22)** [Project]
- **Team ORIon Task-Level Planning Sub-Team Lead (2021/22):** [Project]
- **Autonomous Drone Navigation & Mapping in Mixed GNSS-Available Environments:** [Project]
- **Random-Finite-Set-based SLAM algorithm for drones with scanning & solid-state LIDARS:** [Project]

AWARDS & FUNDING

- USD $250 IEEE Robot Learning TC travel grant for the IROS 2023 *Causality for Robotics workshop*
- USD $305 IEEE Robotics and Automation Society (RAS) member support program grant for IROS 2023
- £340 St Edmund Hall Postgraduate College Grant for IROS 2023 conference attendance
- £350 St Edmund Hall Postgraduate College Grant for the Causal Learning and Reasoning conference 2023
- DST Group PhD Study Support Programme Award for doctoral research at the University of Oxford on causal inference for the assurance of robot autonomy (3-year PhD stipend funding + 1-year extension)
- Best Paper Award at the ICRA 2021 *Robot Swarms in the Real World Workshop*

ACADEMIC TALKS

- Invited talk: Causality for confounded POMDP robot planning, IROS 2023 *Causality for Robotics workshop*

- Gave a series of Cognitive Robotics Group lab research overview presentations and demonstrations to international visitors at the Oxford Robotics Institute as part of official ICRA 2023 lab tours

ACADEMIC SERVICE

- Assisted coordination of the ICRA 2023 Multidisciplinary Approaches to Co-Creating Trustworthy Autonomous Systems workshop. Recorded workshop discussion minutes, coordinated breakout groups, social media coverage

- Manuscript reviews: ICRA 2025, IROS (2022-2024), KI - Künstliche Intelligenz Journal (2023)

TEACHING

- Final Year Research Project Co-supervisor, University of Oxford Masters of Engineering Science (2021-2024)

  - Co-supervised four projects on: causal discovery, causal Bayesian planning and natural language counterfactual explanation methods for 1) robot manipulation tasks, and 2) autonomous drones in mines

  - Wrote project proposals and on-boarding materials, performed candidate selection, delivered educational tutorials. Provided guidance on research methods, project management, robotics and causal ML expertise.

- Teaching Assistant, University of Oxford third-year Information Engineering Systems course (2021/22)

  - Taught three tutorial class cohorts on topics: image & digital signal processing, estimation, inference

  - Consistently rated outstanding for quality of teaching and student support from student evaluations

SKILLS

AI/ML/CS Skills	Probabilistic generative causal modelling, causal Bayesian inference, deep learning, multi-modal generative AI models, latent diffusion, transformers, causal representation learning, VAEs, counterfactual attribution & explanations, probabilistic programming, autonomy assurance, probabilistic planning under uncertainty, stochastic variational inference, explainable AI, robot knowledge representation & reasoning, graph theory, POMDP planning, MCTS, search, stochastic shortest-path algorithms, image & signal processing, finite state machines, behaviour trees, estimation, perception, SLAM
Software Skills	C++, Python, OOP, software design patterns, Pyro PPL, PyTorch, pgmpy, ROS, MATLAB, bash, tmux, Linux networking, Linux/Windows/Mac OS, VSCode, Git
Robotics Skills	Robot systems design & deployment, field trial coordination, simulation & verification, UAS design, flight controller firmware design, sensor & actuator integration, control
Soft Skills	Leadership, management, research project management, scientific entrepreneurship

LEADERSHIP

- A 15+ year demonstrated record of leadership and teamwork ability. Demonstrated skills in planning, organising, communicating, managing resources, motivation, conflict resolution, stakeholder liaison.

- Have undertaken many leadership positions in work, university and volunteer contexts

- Project management: organised several large-scale events with 100+ attendees: youth camps, outreach events

- Executive Committee Member, Young Scientists of Australia Melbourne Chapter Inc. (2008-2019)

  - Immediate Past President (2016-2019), President (2013-2016), Social Coordinator (2009-2012)

  - As President, I led the 12-person executive committee to realise the organisation's goal of promoting science to the youth of Australia by delivering science outreach and social events for our 200+ membership base

- Under my leadership, the organisation annually delivered 12 social events and provided 40+ staff members across five 3-day STEM outreach programs for secondary school students. I further expanded the member services and outreach activities, directing the creation of 7 new initiatives.

PUBLICATIONS

- A Causal Bayesian Network and Probabilistic Programming Based Reasoning Framework for Robot Manipulation Under Uncertainty. **Ricardo Cannizzaro**, Michael Groom, Jonathan Routley, Robert Osazuwa Ness, Lars Kunze. Submitted to IEEE ICRA 2024. [Paper]

- Aloft: Self-Adaptive Drone Controller Testbed. Calum Imrie, Rhys Howard, Divya Thuremella, Nawshin Mannan Proma, Tejas Pandey, Paulina Lewinska, **Ricardo Cannizzaro**, Richard Hawkins, Colin Paterson, Lars Kunze, Victoria Hodge. In Proceedings - 2024 IEEE/ACM 19th Symposium on Software Engineering for Adaptive and Self-Managing Systems, SEAMS 2024, pp. 70–76. [Paper]

- CAR-DESPOT: Causally-Informed Online POMDP Planning for Robots in Confounded Environments. **Ricardo Cannizzaro**, Lars Kunze. IEEE/RSJ IROS 2023. [Paper]

- Towards a Causal Probabilistic Framework for Prediction, Action-Selection & Explanations for Robot Block-Stacking Tasks, **Ricardo Cannizzaro***, Jonathan Routley*, Lars Kunze. IEEE/RSJ IROS 2023 Workshop on Causality for Robotics. [Paper]

- Towards Probabilistic Causal Discovery, Inference & Explanations for Autonomous Drones in Mine Surveying Tasks. **Ricardo Cannizzaro***, Rhys Howard*, Paulina Lewinska, Lars Kunze. IEEE/RSJ IROS 2023 Workshop on Causality for Robotics. [Paper]

- An Upper Confidence Bound for Simultaneous Exploration and Exploitation in Heterogeneous Multi-Robot Systems. Ki Myung Brian Lee, Felix Kong, **Ricardo Cannizzaro**, Jennifer L Palmer, David Johnson, Chanyeol Yoo, Robert Fitch. IEEE ICRA 2021. [Paper]

- Decentralised Intelligence, Surveillance, and Reconnaissance in Unknown Environments with Heterogeneous Multi-Robot Systems. Ki Myung Brian Lee, Felix H Kong, **Ricardo Cannizzaro**, Jennifer L Palmer, David Johnson, Chanyeol Yoo, Robert Fitch. IEEE ICRA 2021 Workshop on Robot Swarms in the Real World: From Design to Deployment. [Paper]

- ColMap: A Memory-Efficient Occupancy Grid Mapping Framework. Alex Fisher, **Ricardo Cannizzaro**, Madeleine Cochrane, Chatura Nagahawatte, Jennifer L Palmer. Robotics and Autonomous Systems 2021. [Paper]

- Evaluation of LIDAR and X-Band Radar Sensors in a Particle-Dense Environment. **Ricardo Cannizzaro**, Meaghan G Smith, Alexander W Blain, Thomas Baum, Kelvin Nicholson, Jennifer L Palmer. AIAC18: 18th Australian International Aerospace Congress (2019): HUMS-11th Defence Science and Technology (DST) International Conference on Health and Usage Monitoring (HUMS 2019): ISSFD-27th International Symposium on Space Flight Dynamics (ISSFD) 2019. [Paper]

- Experimental Validation of a Random-Finite-Set-Based SLAM Algorithm for Micro UAS. **Ricardo Cannizzaro**, Madeleine Cochrane, Lance Fang, Jennifer L Palmer. Australasian Conference on Robotics and Automation (ACRA) 2019. [Paper]

- Data Ferrying with Swarming UAS in Tactical Defence Networks. Robert Hunjet, Bradley Fraser, Thomas Stevens, Laura Hodges, Karina Mayen, Jan Carlo Barca, Madeleine Cochrane, **Ricardo Cannizzaro**, Jennifer L Palmer. IEEE ICRA 2018. [Paper]

- Source Localisation with a Bernoulli Particle-Filter-Based Bearings-Only Tracking Algorithm. Jennifer L Palmer, **Ricardo Cannizzaro**, Branko Ristic, Thomas Cheah, Chatura Nagahawatte, John Gilbert, Sanjeev Arulampalam. Australasian Conference on Robotics and Automation (ACRA) 2015. [Paper]