Oliver M. Cliff

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I currently work as a postdoctoral researcher within the Complex Systems Research Group at University of Sydney. Originally pursuing a career in field robotics, my focus has more recently shifted to studying the distributed computation of complex systems, quantifying computation through data-driven methods in a diverse range of applications: from robotic soccer to salmonella epidemics. My studies of distributed and autonomous systems have culminated in 14 peer-reviewed articles in high impact venues such as *Science Robotics* and *Science Advances*, over 390 citations, and an h-index of ten (Google Scholar). My research has been featured both online and in print at a number of media outlets such as *Nature*, *Forbes*, *The Sydney Morning Herald*, *ABC*, and many more.

Education

2013 –2018 **Ph.D.** at *University of Sydney*,
Complex Systems and Robotics.
Supervisors: A/Prof. Robert Fitch and Prof. Mikhail Prokopenko.

2008 –2012 **B.E. (Hons)** at *University of Sydney*,
Mechatronic (Space) Engineering.
Honours thesis supervisor: Dr. Sildomar Monteiro.

Professional appointments

2019 –pres. **Postdoctoral Researcher** at *University of Sydney*,
Complex Systems Research Group.
Supervisors: A/Prof. Joseph Lizier and Dr. James M. Shine.

- Studying the information processing of the brain through non-invasive techniques such as fMRI and Granger causality. These measures are to be used in clinical trials for predicting the future onset of neurodegenerative diseases in patients.
- Derived the finite-sample distribution for fundamental measures of dependence between multivariate Gaussian processes. This can be used to infer the significance of these measurements, where before statistical inference yielded an increased false positive rate.

2017 –2018 **Research Associate** at *University of Sydney*,
Complex Systems Research Group.
Supervisors: Prof. Mikhail Prokopenko and A/Prof. Joseph Lizier.

- Analysed time series data on Salmonella in Australia using network theory to predict severity of new strains [1]. By studying their evolution through network theory, we showed the genetic composition exhibited a bifurcation, beyond which strains would become 'superbugs'.
- Designed and implemented a C++ program for simulating influenza epidemics in Australia using census and mobility data [3, 6]. The simulator is intended for government policy recommendation and epidemic prevention and shows how Australia's unique demographics affect disease spread.

Publications

Journals

[1] **Oliver M. Cliff**, Vitali Sintchenko, Tania C. Sorrell, Kiranmayi Vadlamudi, Natalia McLean, and Mikhail Prokopenko. "Network Properties of Salmonella Epidemics". In: *Scientific Reports* 9.1 (2019), p. 6159.

[2] **Oliver M. Cliff**, Debbie Saunders, and Robert Fitch. "Robotic Ecology: Tracking Small Animals with an Autonomous Aerial Vehicle". In: *Science Robotics* 3.23 (2018).

[3] **Oliver M. Cliff**, Nathan Harding, Mahendra Piraveenan, E. Yagmur Erten, Manoj Gambhir, and Mikhail Prokopenko. "Investigating Spatiotemporal Dynamics and Synchrony of Influenza Epidemics in Australia: An Agent-based Modelling Approach". In: *Simulation Modelling Practice and Theory* 87 (2018), pp. 412–431.

[4] **Oliver M. Cliff**, Mikhail Prokopenko, and Robert Fitch. "Minimising the Kullback-Leibler Divergence for Model Selection in Distributed Nonlinear Systems". In: *Entropy* 20.2 (2018), p. 51.

[5] Graeme Best, **Oliver M. Cliff**, Timothy Patten, Ramgopal R. Mettu, and Robert Fitch. "Dec-MCTS: Decentralized Planning for Multi-robot Active Perception". In: *International Journal of Robotics Research* 38.2–3 (2018).

[6] Cameron Zachreson, Kristopher M. Fair, **Oliver M. Cliff**, Nathan Harding, Mahendra Piraveenan, and Mikhail Prokopenko. "Urbanization Affects Peak Timing, Prevalence, and Bimodality of Influenza Pandemics in Australia: Results of a Census-calibrated Model". In: *Science Advances* 4.12 (2018), eaau5294.

[7] **Oliver M. Cliff**, Joseph T. Lizier, X. Rosalind Wang, Peter Wang, Oliver Obst, and Mikhail Prokopenko. "Quantifying Long-range Interactions and Coherent Structure in Multi-agent Dynamics". In: *Artificial Life* 23.1 (2017), pp. 34–57.

[8] **Oliver M. Cliff**, Mikhail Prokopenko, and Robert Fitch. "An Information Criterion for Inferring Coupling in Distributed Dynamical Systems". In: *Frontiers in Robotics and AI* 3.71 (2016).

Conferences and Collections

[9] Graeme Best, **Oliver M. Cliff**, Tim Patten, Ramgopal R. Mettu, and Robert Fitch. "Decentralised Monte Carlo Tree Search for Active Perception". In: *Proc. of WAFR*. 2016.

[10] Benjamin Hefferan, **Oliver M. Cliff**, and Robert Fitch. "Adversarial Patrolling with Reactive Point Processes". In: *Proc. of ARAA ACRA*. 2016.

[11] **Oliver M. Cliff**, Robert Fitch, Salah Sukkarieh, Debra L. Saunders, and Robert Heinsohn. "Online Localization of Radio-Tagged Wildlife with an Autonomous Aerial Robot System". In: *Proc. of RSS*. 2015.

[12] **Oliver M. Cliff**, Joseph T. Lizier, X. R. Wang, Peter Wang, Oliver Obst, and Mikhail Prokopenko. "Towards Quantifying Interaction Networks in a Football Match". English. In: *RoboCup 2013: Robot World Cup XVII*. Ed. by Sven Behnke, Manuela Veloso, Arnoud Visser, and Rong Xiong. Vol. 8371. Lecture Notes in Computer Science. Springer Berlin Heidelberg, 2014, pp. 1–12.

[13] **Oliver M. Cliff** and Sildomar T. Monteiro. "Evaluating Techniques for Learning a Feedback Controller for Low-cost Manipulators". In: *Proc. of IEEE/RSJ IROS*. 2013, pp. 704–709.

[14] Mikhail Prokopenko, Oliver Obst, Peter Wang, David Budden, and **Oliver M. Cliff**. "Gliders2013: Tactical Analysis with Information Dynamics". In: *RoboCup 2013 Symposium and Competitions: Team Description Papers*. 2013.

Theses

[15] **Oliver M. Cliff**. *Information-theoretic Reasoning in Distributed and Autonomous Systems*. Ph.D Thesis. 2019.

[16] **Oliver M. Cliff**. *Evaluating GPDP for Learning the Control a Robotic Arm*. Honours Thesis. 2013.

Presentations

- "Controlling the Increased False Positive Rate of Granger Causality Tests in fMRI." NeuroEng 2019, University of Adelaide, SA, Australia.
- "Tracing the Evolution of Non-typhoidal Salmonella: Is a New Superbug Emerging?" New Advances in Bio-complexity, 2019, University of Sydney, NSW, Australia.
- "Introducing the AceMod Simulator: Australian Census-based Epidemic Modelling." Complexity, Criticality & Computation (C^3 2017) Int. Biannual Symp., University of Sydney, NSW, Australia.
- "Complex Systems in Robotics." IEEE Multi-Robot Systems Summer School (MRSSS 2016), National University of Singapore, Singapore.
- "Online Localization of Radio-Tagged Wildlife with an Autonomous Aerial Robot System." Robotics: Science and Systems (RSS 2015), Sapienza University of Rome, Rome, Italy.
- "Evaluating Techniques for Learning a Feedback Controller for Low-Cost Manipulators." IEEE/RSJ Int. Conf. on Intelligent Robots and Systems (IROS 2013), Tokyo Big Sight, Tokyo, Japan.
- "Quantifying Interaction Networks in a Football Match." CSIRO's *BiG Day In*, 2013, Macquarie University, NSW, Australia.

Media and print coverage

- O.M. Cliff et al. (2019) [2] was featured as the cover of Science Robotics 3.23.
- O.M. Cliff et al. (2019) [1] appeared in: Seven News, and Foodprocessing.
- O.M. Cliff et al. (2018) [3] and C. Zachreson et al. (2018) [6] appeared in: The Sydney Morning Herald, Medical Xpress, and News.com.au.
- O.M. Cliff et al. (2015) [11] appeared in: Nature, Forbes, Australian Broadcasting Company (ABC), Australian Geographic, Business Insider Australia, and more.
- O.M. Cliff et al. (2013) [12] appeared in: T. Bossomaier et al. "An Introduction to Transfer Entropy: Information Flow in Complex Systems." 2016. Cham: Springer.

Research service

Reviewer

- Advances in Neural Information Processing Systems (NeurIPS).
- IEEE Int. Conf. on Robotics and Automation (ICRA).
- IEEE Int. Conf. on Intelligent Robots and Systems (IROS).
- Int. Conf. on Field and Service Robotics (FSR).
- Entropy.

Contributer to grants

- Australian Research Council's *Discovery Project No. DP160102742* [3, 6].
- Australian Research Council's *Discovery Project No. DP140104203* [9, 5].
- Defence Science and Technology Group's *System-Level Active Perception* grant [9, 5].
- Australian Research Council's *Linkage Project No. LP120100448* [11].

Supervision

- Co-supervisor for Benjamin Hefferan's honours thesis.

Honors & awards

2013–2018 Research training program (RTP) stipend for postgraduate studies ($30k p.a.).
2015 Top-up scholarship recipient ($10k) (*University of Sydney, AMME*).
2013 Graduated first class honours in BE (Mechatronic) (Space).
2012 Best Technical Paper award for RoboCup 2013 [12].

Teaching

2016 **Mechatronics 3 (MTRX3700)** at *University of Sydney*,
School of Aeronautical, Mechanical, and Mechatronic Engineering.
Lecturer: A/Prof. David C. Rye.

- Designing and implementing microprocessor-based products in C and Assembly.

2013–2015 **Operating Systems and Machine Principles (COMP2129)** at *University of Sydney*,
School of Information Technologies.
Lecturer: Dr. John Stavrakakis.

- Fundamentals of programming and parallel computing; taught in C, in a Unix environment.

2015 **Data Structures (INFO1105)** at *University of Sydney*,
School of Information Technologies.
Lecturer: Dr. John Stavrakakis.

- Foundations of computer science (data abstractions and recursion) in Java.

Research experience

2013–2014 **Research Assistant** at *University of Sydney*,
Australian Centre for Field Robotics.
Supervisor: A/Prof. Robert Fitch.

- Designed and tested an aerial robot system for radio frequency tracking of small dynamic animals [11, 2]. The system is written in C++ and operates in real time, efficiently tracking to high precision.

2013 **Research Projects Officer** at *CSIRO*,
ICT Centre, Marsfield.
Supervisor: Prof. Mikhail Prokopenko.

- Solved the problem of digital communication with compression algorithms for the RoboCup 2D simulation league for the Australian team, Gliders2013 [14].
- The successor to the Gliders2013, went on to win the RoboCup 2D simulation world cup in 2014, using these algorithms.

2012–2013 **Vacation Scholarship Student** at *CSIRO*,
ICT Centre, Marsfield
Supervisor: A/Prof. Joseph Lizier.

- Quantified interaction networks between agents in a simulated football match by studying their information dynamics. These interaction network were capable of visualising the information flow between the agents [12, 7].

Software

Proficient

- C/C++, MATLAB, Python, Bash, LaTeX, Robotic Operating System (ROS).

Familiar

- Java, R, Assembly