

Matthew Craigie

Education

University of Queensland

2022 – 2025

PhD in Machine Learning and Cosmology

I developed robust deep learning models suitable for analysing a variety of cosmology datasets for a range of scientific goals.

- I proposed and developed the Neural Field Scattering Transform (NFST), an extension of the wavelet scattering transform that implements a neural field filter to robustly extract information from cosmological fields. The NFST achieves a $4\times$ improvement over traditional deep learning methods for the task of parity violation detection.
- I developed a novel approach to modelling galaxy intrinsic alignments with probabilistic deep learning. I demonstrated this technique's effectiveness on simulations, setting the stage for application to observational datasets to improve ongoing weak lensing studies of cosmology.
- I developed several new deep learning model interpretation technique and utilised existing methods, providing insight into model decision-making processes and physical insight from cosmological deep learning models.

University of Queensland

2017 – 2021

Bachelor of Advanced Science (Honours Class I), Major in Physics

- GPA: 6.55 / 7.00

Publications

- **M. Craigie** et al. Learning Intrinsic Alignments from Local Galaxy Environments. Submitted to *Phys. Rev. D*. (2025)
- **M. Craigie** et al. Learning Balanced Field Summaries of the Large-Scale Structure with the Neural Field Scattering Transform. Submitted to *Phys. Rev. D*. (2025)
- **M. Craigie** et al. Unsupervised Searches for Cosmological Parity Violation: Improving detection power with the Neural Field Scattering Transform. *Phys. Rev. D*. (2024)
- P. Taylor, **M. Craigie** & Y.-S. Ting. Unsupervised searches for cosmological parity violation: An investigation with convolutional neural networks. *Phys. Rev. D*. (2024)
- Y. Shendryk, **M. Craigie** et al. A Satellite-Based Methodology for Harvest Date Detection and Yield Prediction in Sugarcane. *IGARSS* (2020)

Conference Presentations

- **Parity Violation From Home Conference** (2024) - Parity Violation in Cosmology, Contributed Speaker
- **COSMO21 Conference** (2024) - Statistical Methods and Cosmology, Contributed Speaker
- **EDSU-Tools Conference** (2024) - Tools in Cosmology and Particle Physics, Contributed Speaker
- **AI4PHYS Conference** (2024) - AI Methods in Astrophysics, Contributed Speaker (Fireslide)
- **ASA Conference** (2024) - Astronomical Society of Australia, Contributed Poster
- **Workshop for Artificial Intelligence** (2022) - University of Queensland, Contributed Speaker

Other Research Experience

CSIRO

2019-2020

Research Internship

Tested and implemented a range of machine learning models for predicting sugar cane crop yield from satellite imagery, laying the foundation for subsequent conference paper. Directly engaged with stakeholders, explaining results to farmers and gathering data in the field.

Selected as one of 70 high school students across the world to participate in the MIT Research Science Institute Program. Worked in the Harvard CfA for a 5-week research project, computing the cosmological relative velocity between baryonic matter and dark matter for the Milky Way.

Technical Skills

- **Programming Languages:** Python, C++
- **AI & Deep Learning:**
 - *Packages:* PyTorch, Pyro, PyG
 - *Architectures:* CNN, WST, Transformer, GNN, Neural Fields
 - *Deep Learning Interpretability Methods*
- **High-Performance Computing:** Slurm Job Scheduler, Distributed Training

Awards and Honors

- Australian Tertiary Admission Rank 99.95 (the highest possible rank, indicating a top 0.05% student in Australia)
- Vice-Chancellor's Scholarship, University of Queensland (UQ's most prestigious scholarship)
- 5 × Dean's Commendation, University of Queensland
- MIT RSI Oral Presentation Finalist (top 10 presentation from 70 high-achieving students from across the world)

Grants and Funding

- **Invited Speaker** (2025) - CCAPP Seminar at the Ohio State University
- **Early Career Scientist Travel Support Grant** (2024) - Dark Energy Spectroscopic Instrument Collaboration Meeting
- **Invited Speaker Accommodation Grant** (2024) - EDSU-Tools Conference

Outreach

- Solar Telescope Demonstration Volunteer - Laura Street Festival, Brisbane
- Solar Eclipse Public Engagement Volunteer - King George Square, Brisbane

References

Prof. Tamara Davis

Arc Laureate Fellow, University of Queensland

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Prof. Yuan-Sen Ting

Associate Professor, Ohio State University

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Dr. Rossana Ruggeri

Lecturer in Physics, Queensland University of Technology

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