

Matishalin Patel

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Research

2022 → now **University of Hull**, *Lecturer*, Centre for Data Science, AI, and Modelling

I use mathematical models of evolution and computational simulations to understand the evolution of between species mutualisms. I am interested in formalising between species cooperation in a similarly rigorous way as inclusive fitness and kin selection has done for within-species cooperation. Also, I am investigating the behaviour and evolutionary pressures on reinforcement learning agents in the Animal-AI framework with support from the Centre for the Future of Intelligence in Cambridge. I lecture in Biology of organisms, Python programming, and data science. I am the primary MSc project supervisor for around 20 students per year on the MSc in Data Science, AI and Modelling.

2021 → 2022 **University of Cambridge**, *Post-doctoral Research Associate*, Centre for the Future of Intelligence

Using evolutionary theory to understand the foundations of intelligence and use these insights to build better Artificial Intelligence algorithms. I directly implemented artificial agents and evaluated their performance as well as modelling evolutionary pressures on neural architectures in a more general way.

2020 → 2021 **University of Cambridge**, *Post-doctoral Research Associate*, Dept. of Zoology

I developed models to help understand intergroup conflict in mongoose groups. The models used nonlinear optimisation and recursion equations. I worked with field researchers from Exeter to create models informed by the real world behaviours of Banded Mongooses.

2015 → 2019 **University of Oxford**, *DPhil*, Dept. of Zoology, *Helping and Harming*
My DPhil focused on the evolution of altruism and spite. I used mathematical models and computer simulations to explore and predict evolutionary outcomes. In my last two chapters on mutualisms and between species cooperation.

DPhil thesis

title *Helping and Harming*
supervisors Stuart West and Michael Bonsall

description My DPhil focused on the evolution of altruism and spite. I modelled the evolution of a public good (Cry toxin) in a bacterium that infects a seasonally varying host — looking at the short and long term dynamics. I developed theory on the evolution of spiteful behaviour and how it is sometimes conflated with selfishness when fitness effects are mis-partitioned. I investigated how a host can evolve to control the relatedness among its symbionts to force cooperation and reap the benefits.

Education

2015 → 2019 **DPhil Interdisciplinary Biosciences DTP**, *University of Oxford*, Oxford

My DPhil used mathematical techniques such as function optimisation and stability analysis as well as game theory and computer simulations to investigate eco-evolutionary dynamics of various social evolution problems.

2014 → 2015 **MSc. Computational Methods in Ecology and Evolution**, *Imperial College London*, London, *Distinction*

I took modules in multivariate calculus, linear algebra, statistics (linear models, GLMs and ANOVA), Maximum likelihood methods, and Bayesian statistics. The course also covered agent based simulation and evolutionary simulations as well as model fitting and phylogenetic methods.

2011 → 2014 **MA Biological Sciences**, *University of Oxford*, Oxford, *1st*

I focused on: social evolution, behavioural ecology, evolutionary ecology, bio-mechanics, and animal cognition.

Other Qualifications

2024 **Introduction to Mathematical Proofs**, *University of Oxford*, Remote

I learnt the basics of proof reading and making. We covered the basics of logic, set theory, and number theory along with key proofs in the fields. I wrote my final essay on Borel sigma algebras and the Lebesgue measure on the Reals.

2021 **Machine Learning**, *Stanford University*, Remote

I learnt how to implement and interpret supervised and unsupervised machine learning algorithms such as feed-forward neural networks, logistic regressions, K-means, and Support Vector Machines. I also learnt algorithm testing, performance evaluation, and pipeline testing and construction.

Publications

1. Hunt, K. L., Patel, M., Croft, D. P., Franks, D. W., Green, P. A., Thompson, F. J., Johnstone, R. A., Cant, M. A. & Sankey, D. W. E. The Evolution of Democratic Peace in Animal Societies. *Nature Communications* **15**, 6583. ISSN: 2041-1723. <https://www.nature.com/articles/s41467-024-50621-5> (2024) (Aug. 3, 2024).

2. Patel, M. & Ågren, J. A. *Calculating Relatedness: A Pedigree of Definitions* Accepted Article. Cold Spring Harbor Perspectives in Biology, Sept. 5, 2024.
3. Voudouris, K., Alhas, I., Schellaert, W., Crosby, M., Holmes, J., Burden, J., Chaubey, N., Donnelly, N., Patel, M., Halina, M., Hernández-Orallo, J. & Cheke, L. G. *Animal-AI 3: What's New & Why You Should Care* arXiv: 2312.11414 [cs]. <http://arxiv.org/abs/2312.11414> (2024). Pre-published.
4. Patel, M. & West, S. Microbial Warfare and the Evolution of Symbiosis. *Biology Letters* **18**, 20220447. <https://royalsocietypublishing.org/doi/full/10.1098/rsbl.2022.0447> (2023) (Dec. 21, 2022).
5. Karlsson, C., Willis, J. K., Patel, M. & de Perera, T. M. Teleost Fish Use Optic Flow to Estimate Distance Travelled. *Communications Biology*. <https://ora.ox.ac.uk/objects/uuid:9f2e19e7-50b9-4147-83ca-a600885a2abd> (2021) (2021).
6. Patel, M., West, S. A. & Biernaskie, J. M. Kin Discrimination, Negative Relatedness, and How to Distinguish between Selfishness and Spite. *Evolution Letters* **4**, 65–72. ISSN: 20563744. <http://doi.wiley.com/10.1002/evl3.150> (2020) (Feb. 2020).
7. Patel, M., Raymond, B., Bonsall, M. B. & West, S. A. Crystal Toxins and the Volunteer's Dilemma in Bacteria. *Journal of Evolutionary Biology* **32**, 310–319. ISSN: 1420-9101. <https://onlinelibrary.wiley.com/doi/abs/10.1111/jeb.13415> (2019) (2019).
8. Vila, J. C. C., Jones, M. L., Patel, M., Bell, T. & Rosindell, J. Uncovering the Rules of Microbial Community Invasions. *Nature Ecology & Evolution* **3**, 1162–1171. ISSN: 2397-334X. <https://www.nature.com/articles/s41559-019-0952-9> (2019) (Aug. 2019).

Prepared for publication

M. Patel, M. A. Cant, and R. A. Johnstone. Group warfare and environmental harshness. 2024

Teaching

- 2024 → now **Lecturer, Diversity of Life, Biology, Hull**
Teaching a 10-week introductory course to organismal biology and cladistics. The course covers key animal, plant and microbial groups and their defining evolutionary and ecological features.
- 2023 → now **Lecturer, Programming for Data Science and AI, DAIM, Hull**
Teaching a 4-week introductory course (100 students) in Python programming for Data Science and AI/Machine Learning.

- 2022 **Lecturer, Part 1B: Evolution and Animal Diversity, Zoology, Cambridge**
Gave 3 lectures and 1 seminar on Development of Adaptive Behaviour course.
- 2021 → 2022 **Part 1A: Ecology and Evolution Tutor, Lucy Cavendish, Cambridge**
Teaching a group of 3 undergraduate students in weekly supervisions for all three terms of the 2021-2022 academic year.
- 2020 → 2022 **Lecturer, Part II Zoology: Evolution and Behaviour, Cambridge**
Researched and designed a four lecture module on parental care and the fundamentals of social evolution. Using Panopto and Moodle to deliver the course and interact with students.
- 2019 → 2020 **Statistics Tutor, New College, Oxford**
Gave a term of Statistics tutorials to second year undergraduates for two successive years. Tutorials were in groups of 2-4 and each tutorial went over key concepts and past paper examples.
- 2016 → 2019 **Undergraduate Statistics demonstrator, Oxford**
Demonstrator for the undergraduate bio-statistics course: statistical modelling, data management, and R programming skills.
- 2017 → 2019 **Undergraduate Tutor in ecology and social evolution, Oxford**
Tutorials on programming, social evolution, Neutral theory and sensory ecology. Tutorials given to groups of two students at a time, from various Oxford colleges, and tutorial work in essay or problem sheet form.

Talks

- 2023 **The Price equation and Relatedness, Flat Iron Institute, NY, USA, I**
gave a chalk talk on the derivation of the Price equation and Hamilton's Rule along with a short explanation of relatedness and its utility.
- 2023 **Warfare and resources, Yale University, CT, USA, Invited talk to the**
Quantitative Biology Department at Yale, I presented on two recent projects on microbial warfare and mongoose warfare.
- 2023 **Warfare and resources, University of California Davis, CA, USA, In-**
vited talk to the Biology Department at UC Davis, I presented on two recent projects on microbial warfare and mongoose warfare.
- 2021 **Intra-group cooperation and Intergroup conflict in Banded Mon-**
gooses, Max Planck, Germany, Invited talk to the Institute for Evo-
lutionary Biology discussing my postdoctoral work and future plans as part of an internal seminar series
- 2021 **Major Transitions Past and Future, CRI Paris, France, Invited talk to**
the CRI Paris where I presented my thesis work and future research plans in an internal seminar

- 2018 **Crystal Toxins: A volunteers' dilemma**, *EMPSEB 2019*, Conference Talk at EMPSEB 2019 in Granada Spain. I presented the findings from my work on volunteers' dilemmas

█ Funding and Awards

- 2016 **BBSRC Interdisciplinary Bioscience DTP award**, *Oxford University*, £15,000 stipend and £5000 a year research expenses for 4 years
- 2015 **Imperial College Masters Scholarship**, *Imperial College London*, Course fees paid and £10,000

█ Scientific Activities

- 2019 **Symposium Chair Evolution 2019**, Co-chairing a symposium titled "Mathematical models in evolutionary biology". Aimed at exploring the consequences of the premises and axioms we use when developing models
- 2018 **Symposium Chair Evolution 2018**, Co-chaired a symposium titled "Major transitions in individuality and levels of selection"
- 2018 **Poster - Evolution 2018**, Presented a poster of a paper at Evolution 2018 — "Crystal Toxins and the volunteer's dilemma in bacteria."
- 2015 → 2018 **Cheltenham Science festival**, Three years of public outreach at Cheltenham Science Festival, UK

█ Languages

Spanish Intermediate – CEFR B2/C1

█ Computer skills

Proficient Julia, Python, Mathematica, R, \LaTeX .
Intermediate Linux/Unix, Windows, Matlab.

█ Referees

Supervisor Professor Stuart West, Department of Zoology, University of Oxford, stuart.west@biology.ox.ac.uk, +44 (0) 1865 (2) 81998

Manager Dr Domino Joyce, Department of Biology, University of Hull, domino.joyce@hull.ac.uk, +44 (0)1482 466856