JAMES FOSTER
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PROFILE

Lecturer (assistant professor) in mathematics at the University of Bath with a research focus on the numerical analysis of stochastic differential equations and the applications of differential equations to machine learning. Additionally, member of DataSig team (datasig.ac.uk) and visiting collaborator at the Alan Turing Institute.

RESEARCH

- *ARCANE: Scalable design of cubature formulae for simulating SDEs without Monte Carlo error*, with Thomas Coxon and Peter Koepernik. Ongoing work, but expected to appear as a preprint on arxiv by March 2026.
- *Generative Modelling of Lévy Area for High Order SDE Simulation*, with Andraž Jelinčič, Jiajie Tao, William Turner, Tom Cass and Hao Ni (2025). SIAM Journal on Mathematics of Data Science, 7(4):1541–1567.
- *Reversible Deep Equilibrium Models*, with Sam McCallum and Kamran Arora (2025). arxiv.org/abs/2509.12917.
- *Underdamped Langevin MCMC with third order convergence*, with Max Scott, Dáire O'Kane and Andraž Jelinčič (2025). Accepted by the Journal of Machine Learning Research (JMLR), subject to minor revisions. arxiv.org/abs/2508.16485.
- *Efficient, Accurate and Stable Gradients for Neural ODEs*, with Sam McCallum. (2025). arxiv.org/abs/2410.11648.
- *Approximating the signature of Brownian motion for high order SDE simulation* (2025). To be published in Stochastic Analysis and Applications 2025 (an upcoming conference proceedings published by Springer). arxiv.org/abs/2409.10118.
- *On the convergence of adaptive approximations for stochastic differential equations*, with Andraž Jelinčič (2025). arxiv.org/abs/2311.14201.
- *Single-seed generation of Brownian paths and integrals for adaptive and high order SDE solvers*, with Andraž Jelinčič and Patrick Kidger (2025). arxiv.org/abs/2405.06464.
- *Subtle variation in sepsis-III definitions markedly influences predictive performance within and across methods*, with Samuel Cohen, Peter Foster, Hang Lou, Terry Lyons, Sam Morley, James Morrill, Hao Ni, Edward Palmer, Bo Wang, Yue Wu, Lingyi Yang and Weixin Yang (2024). Scientific Reports, 14(1920).
- *High order splitting methods for SDEs satisfying a commutativity condition*, with Gonçalo dos Reis and Calum Strange (2024). SIAM Journal on Numerical Analysis, 62(1):500–532.
- *Brownian bridge expansions for Lévy area approximations and particular values of the Riemann zeta function*, with Karen Habermann (2023). Combinatorics, Probability and Computing, 32(3):370–397.
- *An asymptotic radius of convergence for the Loewner equation and simulation of SLE traces via splitting*, with Terry Lyons and Vlad Margarint (2022). Journal of Statistical Physics, 189(18).
- *The shifted ODE method for underdamped Langevin MCMC*, with Terry Lyons and Harald Oberhauser (2021). arxiv.org/abs/2101.03446.
- *Efficient and Accurate Gradients for Neural SDEs*, with Patrick Kidger, Xuechen Li and Terry Lyons. Neural Information Processing Systems 2021.
- *The Signature Kernel is the solution of a Goursat PDE*, with Cristopher Salvi, Thomas Cass, Terry Lyons and Weixin Yang (2021). SIAM Journal on Mathematics of Data Science, 3(3):873–899.
- *Neural SDEs as Infinite-Dimensional GANs*, with Patrick Kidger, Xuechen Li, Harald Oberhauser and Terry Lyons. International Conference on Machine Learning 2021.
- *Neural Rough Differential Equations for Long Time Series*, with James Morrill, Cristopher Salvi, Patrick Kidger and Terry Lyons. International Conference on Machine Learning 2021.
- *Neural Controlled Differential Equations for Irregular Time Series*, with Patrick Kidger, James Morrill and Terry Lyons. Neural Information Processing Systems 2020 (Spotlight).
- *An optimal polynomial approximation of Brownian motion*, with Terry Lyons and Harald Oberhauser (2020). SIAM Journal on Numerical Analysis, 58(3):1393–1421.

EDUCATION

University of Oxford, Worcester College — October 2016 – October 2021
DPhil in Mathematics — *(Thesis published online in 2020)*

- DPhil thesis on the topic of Numerical approximations for stochastic differential equations can be found online.
- Under the supervision of Prof. Terry Lyons and Prof. Harald Oberhauser, discovered a new relationship between Brownian motion and a class of orthogonal polynomials that has applications to numerical methods for SDEs.
- A Matlab demonstration of this result can be found at chebfun.org/examples/stats/RandomPolynomials.html.

University of Oxford, St John's College — October 2012 – September 2016
MMath in Mathematics — *MMath (First Class Hons), BA (First Class Hons)*

ACADEMIC PRIZES

- IMA Leslie Fox Prize for Numerical Analysis 2025 (joint first) awarded for research on SDE splitting methods.
- Presented a poster in the STEM for Britain 2021 competition (finalist in the mathematical sciences category)
- G-Research PhD Prize in Maths and Data Science awarded for research on numerical methods for SDEs (2020).

PROFESSIONAL EXPERIENCE

University of Bath, Department of Mathematical Sciences — August 2022 – Present
Lecturer in Applied and Numerical Mathematics — *Bath*

University of Oxford, Mathematical Institute — May 2020 – July 2022
Postdoctoral Research Associate in Rough Path Theory for Applications — *Oxford*

J.P. Morgan Chase & Co, Global Credit Markets — June 2016 – September 2016
Quantitative Research Intern (12 weeks) — *London*

Credit Suisse International, Fixed Income Division — June 2015 – August 2015
Quantitative Summer Analyst (10 weeks) — *London*

Shell U.K. Limited, Development Engineering Department — June 2014 – September 2014
Reservoir Engineer Intern (12 weeks) — *Aberdeen*

Altera Europe Limited, European Technology Centre — September 2013
Intern (1 month) — *High Wycombe*

Roxar Limited, Software Solutions Division — June 2013 – August 2013
Summer Intern (9 weeks) — *Oxford*

RESEARCH TALKS

- *Efficient, Accurate and Stable Gradients for Neural Differential Equations*. Beijing Institute of Mathematical Sciences and Applications (BIMSA) Computational Math Seminar, 09/10/2025.
- *High order splitting methods for SDEs*. Workshop "Milstein's method: 50 years on", University of Nottingham, 30/06/2025.
- *High order splitting methods for SDEs satisfying a commutativity condition*, IMA Leslie Fox Prize Meeting, University of Strathclyde, 23/06/2025.
- *Efficient, Accurate and Stable Gradients for Neural Differential Equations*, Workshop on "Recent Developments in Theoretical Machine Learning", Imperial College London, 13/01/2025.
- *Splitting methods and generative modelling for high order SDE simulation*. One World Stochastic Numerics and Inverse Problems seminar, 27/11/2024.
- *An improved Runge-Kutta method for SDEs with additive noise*, Meeting on "Directions in Rough Analysis", Oberwolfach Research Institute for Mathematics, Germany, 07/11/2024.
- *On the convergence of adaptive approximations for SDEs*, Workshop on "New Impacts of Rough Analysis", University of Warwick, 25/07/2024.
- *Algebraically reversible solvers for neural differential equations*, Conference on "Signatures of paths and images", Hotel Lysebu, Oslo, 10/06/2024.
- *Using GANs to improve the simulation of stochastic differential equations*, Joint seminar ("Optimisation and Numerical Analysis" & "Data Science and Computational Statistics"), University of Birmingham, 08/02/2024.

- *High order splitting methods for SDEs*, Stochastic Analysis Seminar, Imperial College London, 30/01/2024.
- *On the convergence of adaptive approximations for SDEs*, CUWB Conference, Playa del Carmen, Mexico, 08/01/2024.
- *High order numerical methods for SDEs*, North-East and Midlands Stochastic Analysis (NEMSA) Seminar, Oxford, 26/09/2023.
- *Markov Chain Cubature for Bayesian Inference*, Minisymposium on "Methodological advancement in rough paths and data science", International Congress on Industrial and Applied Mathematics (ICIAM), 24/08/2023.
- *High order splitting methods for SDEs satisfying a commutativity condition*, Invited session on "Numerical methods for SDEs" at the Conference on Stochastic Processes and Applications, Lisbon, Portugal, 24/07/2023.
- *Markov Chain Cubature for Bayesian Inference*, BIRS Workshop on "New interfaces of Stochastic Analysis and Rough Paths", 08/09/2022.
- *Applications of high order SDE solvers in machine learning*, Dagstuhl Seminar on "Differential Equations and Continuous-Time Deep Learning", Schloss Dagstuhl, Wadern, Germany, 16/08/2022.
- *Neural Stochastic Differential Equations for Time Series Modelling*, "ICMS at Oxford" workshop on Advances in N-body Computations, 11/04/2022.
- *A high order method for underdamped Langevin MCMC*, International Conference on Monte Carlo Methods and Applications, 18/08/2021.
- *Log-signatures and Neural Rough Differential Equations*, ICERM Workshop on Applications of Rough Paths: Computational Signatures and Data Science, 7/03/2021.
- *Understanding randomness with polynomials*, STEM for Britain – Mathematical sciences category, 03/03/2021.

TEACHING EXPERIENCE (BATH)

- Colecturer (with Eike Mueller) for a first year undergraduate course on "Programming for Mathematics" (2025)
- Lecturer (or unit convenor) for a new graduate course on "Applied Machine Learning" (2024–25)
- Lecturer (or unit convenor) for a second year undergraduate course on "Numerical Analysis" (2023 – present)
- Lecturer (or unit convenor) for a SAMBa PhD course on "Applied Stochastic Differential Equations" (2023-24)
- Delivered a lecture and coursework on "Brownian motion and Stochastic Differential Equations" as part of a first year undergraduate course called "Connections" (2023). Tutor for first year programming labs (2023-25)
- Supervisor for SAMBa Interdisciplinary Research Project on "Multiscale Flow in Porous Media" (2023-24)
- Supervisor on eight separate reading courses on SDEs or machine learning for SAMBa PhD students (2022-24)
- Contributed to exam and coursework marking for the undergraduate course "Numerical analysis" (2022-24)
- Seminar leader for "Foundations", an introductory course on university mathematics for students (2022-23)

TEACHING EXPERIENCE (OXFORD)

- Contributed to the exam marking for the undergraduate course "Probability, Measure and Martinagles" (2022)
- Tutor for the undergraduate courses: Information Theory (2021, 2022) and Communication Theory (2018)
- Member of selection committee for undergraduate admissions at Worcester College (2017, 2019, 2020)
- Graduate lecturer at Worcester College, tutoring Linear Algebra and Real Analysis (2017 – 2018)
- Teaching assistant for courses on Financial Derivatives (2017) and Communication Theory (2016, 2017)

PHD STUDENTS

- Timothy Herschell (Bath). Primary supervisor with Tony Shardlow as secondary supervisor (2025 – present).
- Samuel McCallum (Bath). Primary supervisor with Neill Campbell as secondary supervisor (2024 – present).
- Maximilian Scott (Bath). Primary supervisor with Chris Budd as the secondary supervisor (2024 – present).
- Andraž Jelinčič (Bath). Primary supervisor with Neill Campbell as secondary supervisor (2023 – present).
- Peter Crew (Bath). Secondary supervisor with Avi Mayorcas as lead supervisor (2025 – present).
- Dáire O'Kane (Bath). Secondary supervisor with Avi Mayorcas as lead supervisor and Chris Budd as third supervisor (2023 – present).

- Thomas Coxon (Loughborough, Engineering). Secondary supervisor with Eve Zhang as the lead supervisor (2023 – present).
- Calum Strange (Edinburgh). Secondary supervisor with Gonçalo dos Reis as the lead supervisor (2021-2023). The first half of Calum's thesis is on the topic of Path-based splitting methods for SDEs and is available online.
- Aaron Fordonnell (Bath, Engineering). Secondary supervisor with Benjamin Metcalfe as the lead supervisor and Matthew Nunes as third supervisor (2023 – 2025).

SUPERVISION OF STUDENT PROJECTS

- Nathan Evans (Bath, BSc). Summer project on the "Structured Noise to Reduce Deep BSDE Training Loss", jointly funded by the LMS and the University of Bath. The report and Python code are available online (2025)
- William Warren (Bath, BSc). Bsc project on "Numerical methods for stochastic differential equations" (2025)
- Dylan Nimmo (Bath, MSc). Masters project on the "Deep BSDE method for high-dimensional PDEs" (2024-25)
- William Warren (Bath, BSc). Summer project on "Using recombination for creating cubature formulae" (2024)
- Samuel McCallum (Bath, PhD). Reading course on "Parameter inference for SDEs from time series data" (2024)
- Kamran Arora (Bath, PhD). Reading course on "High order splliting methods for SDEs and SPDEs" (2024)
- Yasir Abdi (Bath, PhD). Reading course on "Interacting particle optimization for sampling problems" (2024)
- Julia Zysko (Bath, MSc). Masters project on "Numerical methods for stochastic differential equations" (2023-24)
- Joshua Abbs (Bath, MSc). Masters project on "Cutting-Edge Audio Deepfake Generation Techniques" (2023)
- Sébastien Vol (Telecom SudParis, MEng). Summer internship on "SDE Cubature for Derivative Pricing" (2023)
- Pablo Arratia Lopez (Bath, PhD). Reading course on "Parameter inference for SDEs from snapshot data" (2023)
- Daniel Burrows (Bath, PhD). Project on "Clustering algorithms for SDE-based particle methods" (2022-23)
- Patrick Fahy (Bath, PhD). Reading course on "High order numerical methods for additive noise SDEs" (2022)
- Veronika Chronholm (Bath, PhD). Reading course on "Multilevel Monte Carlo for high order methods" (2022)
- Guannan Chen (Bath, PhD). Reading course on "Neural Differential Equations" with Lisa Kreusser (2022)
- Pablo Arratia Lopez (Bath, PhD). Reading course on "Neural Differential Equations" with Pranav Singh (2022)
- Andraž Jelinčič (Oxford, MMathCompSci). Masters project on "GAN-based Lévy area Simulation" (2022-23)
- Akira Terada (Edinburgh, MSc). Masters project on "High order Antithetic Multilevel Monte Carlo" (2022)
- Katie Zhang (Oxford, MMath). Summer project on "Cubuture for SDEs" and funded by Marshall Wace (2022)
- Matthew Young (UCL, MSc). Summer project on "Cubuture for SDEs" as part of UNIQ+ Internship (2022)

ORGANISATION AND SERVICE

- Organiser of the Numerical Analysis seminar at the University of Bath (2024 – present).
- Lead organiser of an ICMS Strategic Workshop on New Directions for Stochastic Differential Equations and Machine Learning at the Bayes Centre, University of Edinburgh (3 - 7 June 2024).
- Member of organising committee for a conference on Modern Topics in Stochastic Analysis and Applications at Imperial College London (22 - 26 April 2024). Editor for the conference proceedings (to be published in 2025).
- Member of organising committee for a workshop on Dynamics, Data and Deep learning (25 - 26 March 2024).
- Internal PhD examiner at the University of Bath for Ivan Cheltsov – who is expected to graduate in 2026.
- Reviewer of a proposal for a Leverhulme Trust Research Project.
- Reviewer for the International Centre for Mathematical Sciences (ICMS) "Research in Groups" programme.
- Reviewer for the SIAM Journal on Numerical Analysis, SIAM Journal on Mathematics of Data Science and the SIAM Journal on Control and Optimization.
- Reviewer for SIAM Journal on Financial Mathematics and the Risk Journal on Computational Finance.
- Reviewer for International Conference on Neural Information Processing Systems (NeurIPS), 2021 and 2022. Received a NeurIPS Outstanding Reviewer Award in 2021 (given to the top 8% of reviewers)
- Reviewer for International Conference on Learning Representations (ICLR), 2022.