

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

- *Single-seed generation of Brownian paths and integrals for adaptive and high order SDE solvers*, ongoing with Andraž Jelinčič and Patrick Kidger. Experiments for CIR model and Langevin Monte Carlo can be found [here](#).
- *Markov Chain Cubature for Bayesian Inference*, ongoing with Thomas Coxon, Daniel Burrows, Tom Lovett, Harald Oberhauser and Terry Lyons. JAX software can be found at github.com/tttc3/MCCube (with [slides](#)).
- *On the convergence of adaptive approximations for stochastic differential equations*. arxiv.org/abs/2311.14201.
- *High order splitting methods for SDEs satisfying a commutativity condition*, with Gonalo dos Reis and Calum Strange (2024). *SIAM Journal on Numerical Analysis*, 62(1):500–532.
- *Generative Modelling of Levy Area for High Order SDE Simulation*, with Andraž Jelinčič, Jiajie Tao, William Turner, Tom Cass and Hao Ni (2023). arxiv.org/abs/2308.02452.
- *Brownian bridge expansions for Levy 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

DPhil in Mathematics

October 2016 – October 2021

(*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.
- Awarded the G-Research PhD Prize in Maths and Data Science for research into numerical methods for SDEs.
- Presented a [poster](#) in the STEM for Britain 2021 competition (finalist in the mathematical sciences category)
- Awarded full EPSRC studentship which includes a maintenance grant and covers both college and tuition fees.

University of Oxford, St John’s College

MMath in Mathematics

October 2012 – September 2016

MMath (First Class Hons), BA (First Class Hons)

PROFESSIONAL EXPERIENCE

University of Bath, Department of Mathematical Sciences <i>Lecturer in Applied and Numerical Mathematics</i>	August 2022 – Present <i>Bath</i>
University of Oxford, Mathematical Institute <i>Postdoctoral Research Associate in Rough Path Theory for Applications</i>	May 2020 – July 2022 <i>Oxford</i>
J.P. Morgan Chase & Co, Global Credit Markets <i>Quantitative Research Intern (12 weeks)</i>	June 2016 – September 2016 <i>London</i>
Credit Suisse International, Fixed Income Division <i>Quantitative Summer Analyst (10 weeks)</i>	June 2015 – August 2015 <i>London</i>
Shell U.K. Limited, Development Engineering Department <i>Reservoir Engineer Intern (12 weeks)</i>	June 2014 – September 2014 <i>Aberdeen</i>
Altera Europe Limited, European Technology Centre <i>Intern (1 month)</i>	September 2013 <i>High Wycombe</i>
Roxar Limited, Software Solutions Division <i>Summer Intern (9 weeks)</i>	June 2013 – August 2013 <i>Oxford</i>

SELECTION OF RESEARCH TALKS

- *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.
- *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)

- Lecturer (or unit convenor) for a second year undergraduate course on “Numerical Analysis” (2023 – present)
- Lecturer (or unit convenor) for a graduate level 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 (2023-24)
- 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

- Andraž Jelinčič (Bath). Primary supervisor with Neill Campbell as secondary supervisor (2023 – present).
- Dáire O’Kane (Bath). Primary supervisor with Chris Budd as the secondary supervisor (2023 – present).
- Aaron Fordonnell (Bath, Engineering). Secondary supervisor with Benjamin Metcalfe as the lead supervisor and Matthew Nunes as third 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.

MASTERS AND OTHER GRADUATE SUPERVISION

- Samuel McCallum (Bath, PhD). Reading course on “Parameter inference for SDEs from snapshot data” (2024)
- Kamran Arora (Bath, PhD). Reading course on “High order splitting methods for SDEs and SPDEs” (2024)
- Yasir Abdi (Bath, PhD). Reading course on “Interacting particle optimization for sampling problems” (2024)
- Thomas Coxon (Loughborough, PhD). Project on “Markov Chain Cubature for Bayesian Inference” (2023-24)
- 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 “Cubature for SDEs” and funded by Marshall Wace (2022)
- Matthew Young (UCL, MSc). Summer project on “Cubature for SDEs” as part of UNIQ+ Internship (2022)

ORGANISATION AND SERVICE

- Organiser (with Dr Aaron Pim) of the [Numerical Analysis seminar](#) at the University of Bath (2024 – present).
- Recently led an application for an ICMS Strategic Workshop on [New Directions for Stochastic Differential Equations and Machine Learning](#). The proposal was accepted and the workshop will take place in 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).
- Member of organising committee for a workshop on [Dynamics, Data and Deep learning](#) (25-26 March 2024).
- Reviewer for the International Centre for Mathematical Sciences (ICMS) “Research in Groups” programme.
- Reviewer for SIAM Journal on Mathematics of Data Science and 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.