

Hugh Dance

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Research Summary. I am a causal machine-learning researcher developing and analysing representations of causal models and algorithms that expose useful structure for more robust inference and efficient implementation. My work includes transport-based models for counterfactual distributions and causal discovery, RKHS and spectral methods for causal uncertainty quantification, and finite-state-machine representations of scalable Monte Carlo algorithms. Across these projects, I exploit invariances, compositional structure, and reusable statistical components to preserve the information needed for learning and inference, while avoiding unnecessary modelling assumptions or computation. I am increasingly interested in extending these structure-aware perspectives to causal abstraction and mechanistic interpretability, with a view to applications in AI alignment and safety.

Current Position

2027 (expected) **PhD in Machine Learning**, Gatsby Computational Neuroscience Unit, University College London. Supervisor: Professor Peter Orbanz

Education

- 2021 **MSc Computational Statistics and Machine Learning**, University College London. Distinction; Dean's List.
- 2020 **Graduate Diploma in Mathematics and Statistics**, Birkbeck, University of London. Distinction.
- 2016 **MSc Economics**, University College London. Distinction.
- 2015 **BA Economics and International Relations**, University of Birmingham. First Class Honours.

Publications and Preprints

Peer-reviewed papers

- 2026 **Interventional Processes for Causal Uncertainty Quantification.** Hugh Dance, Peter Orbanz, Arthur Gretton. *Proceedings of the 43rd International Conference on Machine Learning (ICML)*. [Paper](#)
- 2025 **Distinguishing Cause from Effect with Causal Velocity Models.** Johnny Xi, Hugh Dance, Peter Orbanz, Benjamin Bloem-Reddy. *International Conference on Machine Learning (ICML)*. [Paper](#). [Code](#).
- 2025 **Efficiently Vectorized MCMC on Modern Accelerators.** Hugh Dance, Pierre Glaser, Peter Orbanz, Ryan P. Adams. *Proceedings of the 42nd International Conference on Machine Learning (ICML)*, PMLR 267:12436–12458. **Spotlight**. [Paper](#). [Code](#).
- 2022 **Fast and Scalable Spike and Slab Variable Selection in High-Dimensional Gaussian Processes.** Hugh Dance, Brooks Paige. *Proceedings of the 25th International Conference on Artificial Intelligence and Statistics (AISTATS)*, PMLR 151:7976–8002. **Oral presentation**. [Paper](#). [Code](#).

Preprints and manuscripts

- 2026 **Debiased Counterfactual Generation via Flow Matching from Observations.** Hugh Dance, Johnny Xi, Peter Orbanz, Benjamin Bloem-Reddy. *Under Review, NeurIPS 2026*. [Paper](#).
- 2026 **Neural Autonomous Differential Equations: Integration-Free Learning for Time-Invariant Dynamics.** Mohadeseh Shafiei Kafraj, Hugh Dance, Johnny Xi, Reidar Rive-land, Peter E. Latham, Peter Orbanz. *Under Review, NeurIPS 2026*.
- 2025 **Counterfactual Cocycles: A Framework for Robust and Coherent Counterfactual Transports.** Hugh Dance, Benjamin Bloem-Reddy. *In Revision, Journal of Machine Learning Research*. [Paper](#). [Code](#).

Policy and industry publications

- 2018 **The Macroeconomic Impact of Artificial Intelligence.** Jonathan Gillham, Lucy Rimmington, Hugh Dance, Gerard Verweij, Anand Rao, K Barnard Roberts, Mark Paich. *PwC technical report, 2018*. [Report](#).

- 2017 **A Machine Learning Approach to Estimating Current GDP Growth.** Sam Hinds, Lucy Rimmington, Hugh Dance, Jonathan Gillham, Andrew Sentance, John Hawksworth. *PwC UK Economic Outlook, July 2017. Report.*

Research Talks and Presentations

- Nov 2025 **Breaking Topics in AI Conference 2025, Imperial College London, London, United Kingdom.** *Efficiently Vectorized MCMC on Modern Accelerators.*
- Oct 2025 **Saarland University, Probabilistic Machine Learning Group, online.** *Counterfactual Cocycles: A Framework for Robust and Coherent Counterfactual Transports.*
- Aug 2025 **Causal Modelling and Inference Annual Workshop, CAUSALI-T-AI, Institut Henri Poincaré, Paris, France.** *Counterfactual Cocycles: A Framework for Robust and Coherent Counterfactual Transports.*
- Jul 2025 **Pre-ICML event, University College London, London, United Kingdom.** *Efficiently Vectorized MCMC on Modern Accelerators.*
- May 2025 **ProbAI Hub Seminar, United Kingdom.** *Efficiently Vectorized MCMC on Modern Accelerators.*
- Aug 2024 **Amazon Research, online.** *Causal Inference with Cocycles.*
- Aug 2024 **3rd Munich Center for Machine Learning Workshop on Causal Machine Learning, Ludwig Maximilian University of Munich, Munich, Germany.** *Causal Inference with Cocycles.*
- Jun 2024 **Columbia University, Zuckerman Institute, New York, USA.** *Causal Inference with Cocycles.*
- Mar 2022 **AISTATS 2022, online.** *Fast and Scalable Spike and Slab Variational Inference in High-Dimensional Gaussian Processes.* Oral presentation.

Teaching

- 2026 **Lecturer, Probability and Statistics,** Gatsby Bridging Programme, Gatsby Unit, University College London. Summer School.
- 2023 **Teaching Assistant,** COMP0085: Approximate Inference and Learning in Probabilistic Models, Gatsby Unit, University College London. Graduate course.
- 2023 **Teaching Assistant,** COMP0083: Advanced Topics in Machine Learning: Kernel Methods, Gatsby Unit, University College London. Graduate course.

Academic Service

- 2026 **Reviewer,** *Statistics and Computing.*
- 2026 **Reviewer,** Transactions of Machine Learning Research
- 2026 **Reviewer,** Fortieth Conference on Neural Information Processing Systems.
- 2026 **Reviewer,** Forty-Third International Conference on Machine Learning.
- 2025 **Reviewer,** Twenty-Ninth International Conference on Artificial Intelligence and Statistics.

Honours and Recognition

- 2026 **ICML 2026 Gold Reviewer Award.**
- 2025 **ICML 2025 Spotlight Award,** Efficiently Vectorized MCMC on Modern Accelerators.
- 2022 **AISTATS 2022 Oral Presentation Award,** Fast and Scalable Spike and Slab Variable Selection in High-Dimensional Gaussian Processes.
- 2021 **Dean's List,** MSc Computational Statistics and Machine Learning, University College London.
- 2015–2022 **Academic distinctions:** First Class Honours in BA degree; Distinction in MSc Economics; Distinction in MSc Computational Statistics and Machine Learning; Distinction in Graduate Diploma in Mathematics and Statistics.

Research and Professional Experience

- Dec 2021–May 2022 **Econometrician, Senior Associate,** PwC, London. Lead econometrician on several forecasting and policy evaluation projects.

- Aug 2016–Jul 2020 **Econometrician, Associate to Senior Associate**, PwC, London. Worked as an econometrician across a number of projects involving causal estimation, forecasting, public-policy analysis, and applied econometrics. Selected project areas included SME lending and firm growth, UK GDP nowcasting, executive-pay incentives and investment, and marketing effectiveness.
- Jul 2015–Aug 2015 **Strategy Group Intern**, KPMG, Helsinki. Strategy and consulting internship.
- Jun 2015–Jul 2015 **Corporate Finance Intern**, Grant Thornton, London. Corporate finance internship.

Selected Industry Research Projects

- 2019 **Effect of SME lending on growth**. Lead econometrician on a project for a large global retail bank estimating the effect of SME lending products on subsequent revenue growth, using non-parametric propensity-score caliper matching.
- 2017–2020; 2021–2022 **UK GDP nowcasting**. Developed and maintained PwC's nowcasting model for UK GDP growth, using high-frequency economic indicators. Developed bespoke MCMC algorithm for high-dimensional variable selection.
- 2018; 2020 **Executive pay, share buybacks and investment**. Lead econometrician for projects commissioned by the UK Department for Business, Energy and Industrial Strategy, in collaboration with Professor Alex Edmans at London Business School, using identification strategies such as (fuzzy) regression discontinuity designs.
- 2018–2020 **Marketing effectiveness for a global airline**. Developed nonstationary time-varying parameter models for causal discovery, marketing allocation and sales attribution.

Software

- 2025 **jax-fsm-mcmc**: JAX implementations of finite-state-machine MCMC methods for accelerator-efficient vectorized Monte Carlo. github.com/HWDance/jax-fsm-mcmc.
- 2025 **Cocycles**: Code for counterfactual cocycle experiments and applications. github.com/HWDance/Cocycles.
- 2022 **SSVGP**: Scalable variable selection for high-dimensional Gaussian processes with Spike-and-Slab priors. github.com/HWDance/SSVGP.

Research Areas and Technical Methods

- **Causal inference**: counterfactual inference, potential outcomes, structural causal models, causal discovery, partial identification, doubly robust estimation, semiparametric efficiency.
- **Generative modelling and transport**: optimal transport, measure transports, normalizing flows, flow matching, counterfactual generative models.
- **Probabilistic machine learning**: Gaussian processes, kernel methods, Bayesian inference, scalable MCMC, variational inference, uncertainty quantification.
- **Computation**: Python, JAX, PyTorch, simulation studies, high-dimensional statistical modelling, GPU/accelerator-aware inference.