Adam Foster

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RESEARCH STATEMENT

I am interested in devising machine learning and AI algorithms that will ultimately have impact in natural science, industry and society. My research interests are in the following areas: 1) Bayesian optimal experimental design and active learning, particularly for designing science experiments, 2) applying probabilistic machine learning to natural science, with a focus on models for reactions and catalysis, including quantum models and their approximations, 3) probabilistic programming as an emerging abstraction for probabilistic AI. My work has been published in top machine learning conferences and journals.

EXPERIENCE

2021 – PRESENT | MICROSOFT RESEARCH CAMBRIDGE

Senior Researcher

I work in Team Causica at Microsoft Research Cambridge. We specialise in efficient decision making. My research topics of focus are causal machine learning and Bayesian experimental design. I played a major role in developing deep learning methods for end-to-end causal inference, and led a project applying Bayesian experimental design to real-world testing of our causal models. We have done significant work to demonstrate the potential of our technology to improve real-world decision making for collaborators within Microsoft and beyond.

2017 – 2021 | UNIVERSITY OF OXFORD, UNIVERSITY COLLEGE

DPhil Statistical Machine Learning

I completed my DPhil in the Oxford Computational Statistics and Machine Learning group, under the supervision of Yee Whye Teh and Tom Rainforth. A large part of my work in Oxford was on Bayesian optimal experimental design: how do we design experiments that will be most informative about the process being investigated? I worked on efficient estimators of expected information gain, a key objective function in experimental design, as well as sequential adaptive experimental design using policies. I also studied contrastive representation learning through the lenses of mutual information and invariance. I published numerous papers in top machine learning venues and delivered oral presentations at ICML 2021 and 2022. During my fourth year, I helped to supervise one master's students and three first year DPhil students.

SUMMER 2020 | BENEVOLENTAI

AI Science intern

I investigated deep representation learning methods for single-cell RNA sequence data in genomics. Inspired by several 'grand challenges' in computational biology, we developed an approach for data integration, and counterfactual inference to predict the effects of drugs and gene knock-outs. Our work received an ICML oral.

SUMMER 2018 | UBER AI LABS

Research intern

I interned with the Pyro team under the supervision of Noah Goodman. My contributions to the probabilistic programming language Pyro were part of a project to automate optimal experimental design for adaptive experimentation in science. We investigated estimators for mutual information in Bayesian experimental design, and implemented them in Pyro. Our work was published at NeurIPS 2019.

2016 – 2017 | ROAM ANALYTICS

Machine learning engineer

Through the Silicon Valley Internship Program, I spent a year in San Francisco working for a startup as a machine learning engineer. I helped build a knowledge graph of medical and pharmaceutical concepts and data. I went on to use MinHash as a way to search large data in sublinear time.

2015 – 2016 | UNIVERSITY OF CAMBRIDGE, QUEENS' COLLEGE

MMath Mathematics

Grade Distinction | **Rank** 6th | **Awards** 2016 Wishart Prize, 2016 Foundation Scholarship

In Part III, "the oldest and most famous mathematics examination in the world", I chose to focus on statistics and probability. I was ranked 6th in a cohort of ∼250. I took courses in Advanced Probability, Stochastic Calculus, Modern Statistical Methods, Advanced Financial Models and Applied Stats.

2012 – 2015 | UNIVERSITY OF CAMBRIDGE, QUEENS' COLLEGE

BA Mathematics

Grade First | **Rank** 14th | **Awards** 2014, 2015 Foundation Scholarship; 2015 Colton Prize, 2013 Braithwaite Prize

During my undergraduate years at Cambridge I studied a broad range of pure and applied mathematics. My focus tended towards applied maths and theoretical physics. My Part II courses included Principles of Quantum Mechanics, Dynamical Systems, Classical Dynamics, Mathematical Biology and Applied Probability.

SUMMER 2015 | UCLA INSTITUTE FOR PURE AND APPLIED MATHEMATICS

Research in industrial projects for students

I led a team of four students on a project sponsored by the USC Shoah Foundation. We used Latent Dirichlet Allocation for topic modelling, and developed an extension of the model suited to our particular data modalities.

PUBLICATIONS

Desi R. Ivanova, Joel Jennings, Cheng Zhang, Adam Foster. Efficient Real-world Testing of Causal Decision Making via Bayesian Experimental Design for Contextual Optimisation. **ICML 2022 Workshop on Adaptive Experimental Design and Active Learning in the Real World.**

Ning Miao, Emile Mathieu, Yann Dubois, Tom Rainforth, Yee Whye Teh, Adam Foster, Hyunjik Kim. Learning Instance-Specific Data Augmentations. **arXiv:2206.00051** .

Tomas Geffner, Javier Antoran, Adam Foster, Wenbo Gong, Chao Ma, Emre Kiciman, Amit Sharma, Angus Lamb, Martin Kukla, Nick Pawlowski, Miltiadis Allamanis, Cheng Zhang. Deep End-to-end Causal Inference. **arXiv:2202.02195** .

Adam Foster, Árpi Vezér, Craig A Glastonbury, Páidí Creed, Sam Abujudeh, Aaron Sim. Contrastive Mixture of Posteriors for Counterfactual Inference, Data Integration and Fairness. **ICML 2022 (oral)**

Desi R Ivanova, Adam Foster, Steven Kleinegesse, Michael U Gutmann, Thomas Rainforth. Implicit Deep Adaptive Design: Policy-Based Experimental Design without Likelihoods. **NeurIPS 2021.**

Emile Mathieu, Adam Foster, Yee Whye Teh. On Contrastive Representations of Stochastic Processes. **NeurIPS 2021.**

Takashi Goda, Tomohiko Hironaka, Wataru Kitade, Adam Foster. Unbiased MLMC stochastic gradient-based optimization of Bayesian experimental designs. **SIAM Journal on Scientific Computing (Vol. 44). 2021.**

Adam Foster, Desi R Ivanova, Ilyas Malik, Tom Rainforth. Deep Adaptive Design: Amortizing Sequential Bayesian Experimental Design. **ICML 2021 (long presentation).**

Adam Foster, Rattana Pukdee, Tom Rainforth. Improving Transformation Invariance in Contrastive Representation Learning. **ICLR 2021.**

Adam Foster, Martin Jankowiak, Matthew O'Meara, Yee Whye Teh, Tom Rainforth. A Unified Stochastic Gradient Approach to Designing Bayesian-Optimal Experiments. **AISTATS 2020.**

Adam Foster, Martin Jankowiak, Eli Bingham, Paul Horsfall, Yee Whye Teh, Tom Rainforth and Noah D Goodman. Variational Bayesian Optimal Experiment Design. **NeurIPS 2019 (spotlight).**

Ben Bloem-Reddy, Adam Foster, Emile Mathieu, and Yee Whye Teh. Sampling and inference for beta neutral-to-the-left models of sparse networks. **UAI 2018.**

CODE

Pyro OED. I am the main author of the `pyro.contrib.oed` subpackage, which supports automated experimental design for models written in Pyro. Our Deep Adaptive Design implementation that uses PyTorch and Pyro is also open source.

PyTorch SimCLR and InvCLR. I wrote an open-source PyTorch implementations of SimCLR. The PyTorch implementation of our invariant constrastive learning algorithm, InvCLR, extends the SimCLR implementation.

DoWhy. I added support for categorical treatments in DoWhy regression estimators.

Datasketch. I contributed Redis support to the Locality Sensitive Hashing library Datasketch.