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 ongoing research interests are in the following areas: 1) Bayesian optimal experimental design and active learning, particularly for designing science experiments and improving AI interactions with humans, 2) causal machine learning for industrial and biological decision making, 3) contrastive representation learning, 4) probabilistic programming. My work has been published in top machine learning conferences and journals.

EXPERIENCE

2021 – PRESENT | MICROSOFT RESEARCH CAMBRIDGE

Postdoc Researcher

I work in Team Azua at Microsoft Research Cambridge. We specialise in efficient decision making. My research topics of focus are causal machine learning and Bayesian experimental design. We are particularly interested in the end-to-end causal pipeline, that combined discovery and inference.

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 experimentatal design using policies. I also studied contrastive representation learning through the lenses of mutual information and invariance. During my fourth year, I helped to supervise one masters 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. We developed an approach for counterfactual inference and data integration using conditional VAEs that can be applied to a range of computational biology problems.

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, and investigate causal inference using observational data as a way to improve patient outcomes.

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. My essay was entitled 'New advances in causal inference' and examined causal inference by invariant prediction.

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.

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—from Quantum Mechanics to Galois Theory. My focus tended towards applied maths in its broadest sense. I particularly enjoyed Dynamical Systems, Mathematical Biology and Applied Probability.

PUBLICATIONS

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** .

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.**

Adam Foster, Árpi Vezér, Craig A Glastonbury, Páidí Creed, Sam Abujudeh, Aaron Sim. Contrastive Mixture of Posteriors for Counterfactual Inference, Data Integration and Fairness. **arXiv:2106.08161.**

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.

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 and is also public.

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

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

DAD. We open-sourced our Deep Adaptive Design implementation that uses PyTorch and Pyro.

Code is available on my GitHub (`@ae-foster`).