Isaac Reid

ir337@cam.ac.uk
isaac-reid.github.io

Research interests

I am interested in problems at the interface of ML, statistical physics and applied mathematics, especially where theoretical results have proved elusive, applications are high-impact, or both.

Education

Machine Learning Group, University of Cambridge *Oct 2022 - present*
PhD in Engineering
Supervisors: Dr Adrian Weller and Prof. Rich Turner
Advisor: Prof. Carl Rasmussen
Subject: Scalable and data-efficient machine learning. Ongoing collaboration with Prof. Krzysztof Choromanski (Google DeepMind and Columbia University, New York).

Physics, University of Oxford *Oct 2017 - Jun 2021*
Master of Physics, MPhys
Grade: First class, 92%, top of Oxford cohort
Modules: Theoretical physics, condensed matter, fluid dynamics, general relativity
Research project: Quantum entanglement barriers in dual-unitary circuits
Supervisor: Dr Bruno Bertini

Publications and select preprints

Variance-Reducing Couplings for Random Features: Perspectives from Optimal Transport
Preprint, under review
Isaac Reid, Stratis Markou, Krzysztof Choromanski, Richard E. Turner, Adrian Weller
Synopsis: Variance reduction in Monte Carlo is really a multi-marginal optimal transport problem, and treating it as such gives us tools to sample more efficiently in Euclidean and discrete space.
https://arxiv.org/abs/2405.16541

Repelling Random Walks
ICLR 2024
Isaac Reid, Eli Berger, Krzysztof Choromanski, Adrian Weller
Synopsis: A QMC scheme that correlates the directions of walkers on a graph, providing better sample efficiency and improving the concentration of a host of statistical estimators
https://arxiv.org/abs/2310.04854

Universal Graph Random Features
ICLR 2024
Isaac Reid*, Krzysztof Choromanski*, Eli Berger*, Adrian Weller
Synopsis: A random feature mechanism to approximate arbitrary functions of a weighted adjacency matrix, unlocking kernel-based learning on very large graphs
https://arxiv.org/abs/2310.04859

Quasi-Monte Carlo Graph Random Features
NeurIPS 2023, accepted as spotlight paper
Isaac Reid, Krzysztof Choromanski, Adrian Weller
Synopsis: A QMC scheme that induces correlations between the lengths of terminating random walks on a graph, with possible applications in bioinformatics and graph-based Transformers
https://arxiv.org/abs/2305.12470

Simplex Random Features
ICML 2023, accepted with oral presentation
Isaac Reid, Krzysztof Choromanski, Valerii Likhosherstov, Adrian Weller
Synopsis: Derivation of an optimal random feature mechanism for unbiased approximation of the Gaussian kernel, motivated by a host of new analytical results and tested with Transformer experiments
https://arXiv.org/abs/2301.13856

Entanglement Barriers in Dual-Unitary Circuits
Phys. Rev. B 104, 014301 – Published 1 July 2021
Isaac Reid, Bruno Bertini
Synopsis: Exact characterisation of the dynamics of quantum entanglement arising after a quantum quench in a many-body, locally interacting system, including both the integrable and completely chaotic regimes
https://arxiv.org/abs/2103.12794

Teaching

Engineering 2P7 *Michaelmas 2023 - Easter 2024*
Synopsis: Supervisions in mathematics for engineers (vector calculus, linear algebra and probability)

Pembroke International Summer Programme *Jun-Aug 2023*
Synopsis: Research project on density ratio estimation in machine learning

Talks

Quasi-Monte Carlo Graph Random Features – NeurIPS@Cambridge, Cambridge *Dec 2023*
Synopsis: Invited talk to accompany NeurIPS spotlight paper

Simplex Random Features – ICML 2023, Honolulu *July 2023*
Synopsis: Oral presentation to accompany paper

Simplex Random Features – Microsoft Research, Cambridge *Jun 2023*
Synopsis: Research talk on ICML paper

Random Features for Kernel Approximation – Machine Learning Group, Cambridge *Mar 2023*
Synopsis: Seminar on random feature methods and recent QMC schemes to improve their convergence

Experience

Student Researcher, Google *May 2024 - present*
Joining Silvio Lattanzi's team for an exciting project, working closely with Krzysztof Choromanski and Avi Dubey

Systems Engineer, Opsydia *Sep 2021 - Sep 2022*
R&D engineer at deep-tech startup specialising in laser technology and adaptive optics, spun out of Oxford University Engineering Department

Research Intern, Max Planck Institute for Dynamics and Self-Organisation, Göttingen *Summer 2020*
Computational study of Bose-Einstein condensation in active matter, applying theoretical results from many-body quantum physics to classical clustering phenomena observed in Kob-Andersen particle dynamics
Supervisors: Dr Benoit Mahault and Prof. Ramin Golestanian

Research Intern, Rudolf Peierls Centre for Theoretical Physics, Oxford *Summer 2019*
Study of relationship between spectral properties of Hessian of loss function and Bayesian prior upon deep neural network initialisation, estimated using random sampling of weights and Gaussian processes
Supervisor: Prof. Ard Louis

Scholarships and awards

G-Research Grant *July 2023*
Financial award to help fund attendance of ICML conference

IQ Capital Deeptech Fellowship *2023*
Advising investment portfolio in tech startups

Trinity College External Studentship *2022-2025*
Full scholarship for a PhD in Machine Learning

Encaenia *Jun 2022*
One of six undergraduate students invited to attend Oxford's historic Encaenia ceremony

Gibbs Prize *2020-2021*
For submitting the highest scoring MPhys research project (87%)

Scott Prize *2017-2021*
For best overall performance in the MPhys (92%)

Scott Prize *2019-2020*
For best performance in the third year (92%)

Winton Capital Prize *2018-2019*
For best performance in the second year (93%)

Hertford College Academic Scholarship *2018-2021*
For performance in first year (88%)

Physics Practical Prize *2018-2020*
For performance in laboratory and computational work