# Isaac Reid

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## 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

**Repelling Random Walks**
*Preprint, under review*
**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**
*Preprint, under review*
**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*
*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

**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

**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 climate-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