

Alex Gower

Math & Algorithms Group, Nokia Bell Labs and Theoretical Condensed Matter Group, University of Cambridge

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EDUCATION

Nokia Bell Labs and University of Cambridge, Jesus College

Sep 2022 – Present

PhD, Project Title: “The Physics of Machine Learning on Oscillator Ising Machines”

University of Oxford, Lincoln College

Oct 2018 – Jun 2022

MMathPhys: Master of Mathematical and Theoretical Physics, Distinction (73%)

BA: Physics, First Class (82%, Ranked 1st in Cohort of ~200 in Second Year Examinations)

TECHNICAL SKILLS

Programming: Python, Julia, Java, MATLAB, FORTRAN, R, C++

Libraries: PyTorch, TensorFlow, XGBoost, LightGBM, InterpretML, NumPy, Pandas, Hyperopt, TransformerLens

Technologies: Django, Android Studio, Git, SLURM, Hugging Face, Jupyter, Google Colab, Bash, AWS

RELEVANT EXPERIENCE

Nokia Bell Labs and University of Cambridge

PhD Researcher

Sep 2022 – Present

- Researching Equilibrium Propagation and energy-based machine learning, spanning analog neuromorphic hardware (Oscillator Ising Machines), extensions to generative modelling (flow matching), and theoretical analysis of glassy dynamics on rugged energy landscapes

Math & Algorithms Group

Nokia Bell Labs

- Introduced Gradient Equilibrium Propagation (GradEP), extending EP to train energy gradients rather than energy minima, and demonstrated the first EP-trained flow matching generative model (FlowEqProp) — **Best Paper Award, ICONS '26**
- Developed a novel EP learning algorithm for Oscillator Ising Machines (MLP and CNN architectures), achieving SoTA neuromorphic accuracy on MNIST/FashionMNIST while maintaining hardware-constraint resilience (*ICONS 2025, NeurIPS 2025 ML4PS*); now being implemented on hardware with Nokia and Eindhoven University
- Researching extensions of EP to more expressive energy-based architectures (modern Hopfield networks, energy transformers) for scaling EP-trained generative models
- Engineered OIM performance for combinatorial optimization problems (Max-SAT, Max-Cut, spin-glass models) using dimensional annealing and memory dynamics algorithms
- Collaboratively developed a GNN model to learn optimal Max-SAT clause weights for combinatorial optimisation
- Optimized large-scale ML simulations by implementing multi-threaded Julia/PyTorch hybrid processing pipeline with custom memory management, reducing computational runtime by 10x on distributed HPC clusters

Theoretical Condensed Matter Group

University of Cambridge

- Authored paper on rugged energy landscapes (submitted to *Nat. Phys.*) in which slow gradient descent dynamics on a toy energy (loss) landscape are analysed, uncovering a saddles-to-minima topological crossover in the critical point connectivity which is suppressed (and fast dynamics recovered) upon the addition of ‘swap moves’
- Supervised a Master’s student dissertation project investigating saddles-to-minima topological crossovers and high dimensional route suppression in kinetically constrained Ising models
- Supervised Statistical Mechanics and Mathematical Methods undergraduate course classes for 3 years

Alan Turing Institute & UK Ministry of Justice

Machine Learning Technical Project Lead

Aug 2025 – Mar 2026

- Built short-horizon violence risk models (LightGBM, XGBoost, EBM) using 1,500+ engineered features across 20M+ records, improving recall by 50% over prior baselines and achieving state-of-the-art short-term violence forecasting performance
- Built reduced-feature interpretable EBM models suitable for high-stakes decision-making, and surfaced actionable risk factors from feature importances to inform frontline operations
- Built several MoJ products using LLM pipelines for semantic incident categorisation and case note surfacing

MARS Alignment Research Programme

Research Fellow

Cambridge AI Safety Hub

Dec 2024 – May 2025

- Completed research programme evaluating frontier LLM abilities in model compression, mechanistic interpretability and feature steering for ML R&D tasks using InspectAI framework

ADDITIONAL TRAINING

ELLIS Cambridge Summer School on Probabilistic Machine Learning

University of Cambridge

Selected Participant

Jul 2026

- Selected for competitive week-long summer school covering probabilistic modelling, uncertainty quantification in deep learning, generative models, and decision-making under uncertainty; presented at poster session

Machine Learning Workshops

G-Research

Workshop Attendee

Apr 2025

- Completed G-Research ML workshops on gradient boosting, XGBoost, and quantitative finance applications

MPhil Machine Learning and Machine Intelligence

University of Cambridge

PhD Student Auditor

Sep 2023 – Present

- Completed courses in the Machine Learning and Machine Intelligence Master's course including Probabilistic and Bayesian Machine Learning, Computational Statistics and Deep Learning and Structured Data

Cambridge AI Safety Hub

University of Cambridge

Fellowship Graduate

Sep 2024 – Sep 2025

- Completed intensive AI safety fellowship with projects in LLM interpretability, covering topics including transformers, RLHF, RAG, mechanistic interpretability, and agent architectures

PROJECTS

itsgiving | [Website](#)

2025

- Built NLP semantic college matching system using custom word embeddings and by fine-tuning a HuggingFace LLM DistilBERT, enabling natural language queries to match prospective students with colleges based on social media language data

Odin | [Android App Store](#)

2016

- Developed 3 language learning and flashcard apps (20K+ downloads) using Java and Android Studio; won national 'Apps for Good' competition

Oppia | [Website](#)

2016

- Contributed to 'Oppia' (an open-source education website) while mentored by Google software engineer

ADDITIONAL RESEARCH EXPERIENCE

Quantum Matter in High Magnetic Fields Group

University of Oxford

Undergraduate and Graduate Research Assistant:

Jun 2021 – Aug 2022

- Co-authored two Physical Review B papers on multi-band superconductivity and impurity effects in FeSe, developing theoretical models and a MATLAB pipeline (tight-binding, multi-band, DFT) to extract band parameters from quantum oscillation and upper critical field experiments

ISIS Neutronics Group

Science Technology and Facilities Council

Nuclear Analysis Summer Student

Jun 2020 – Sep 2020

- Enhanced FETCH2 radiation modeling codebase (following unit and continuous integration testing practices); corrected critical cross-section handling errors and presented benchmarking results at Imperial College conference

PUBLICATIONS

- **Alex Gower**. FlowEqProp: Training Flow Matching Generative Models with Gradient Equilibrium Propagation. In *Proc. of ICONS '26*, p60–66. IEEE Press, 2026. doi:10.1145/3822454.3822485 [**Best Paper Award**]
- **Alex Gower**. Learning at the Speed of Physics: Equilibrium Propagation on Oscillator Ising Machines. Presented at NeurIPS 2025: Machine Learning and the Physical Sciences (ML4PS) Workshop. arXiv:2510.12934
- **Alex Gower**. How to train an Oscillator Ising Machine using Equilibrium Propagation. In *Proc. of ICONS '25*, p229–234. IEEE Press, 2025. doi:10.1109/ICONS69015.2025.00042
- **Alex Gower**, Oliver Hart, and Claudio Castelnovo. Saddles-to-minima topological crossover and glassiness in the Rubik’s Cube, Oct 2024. arXiv:2410.14552
- Z. Zajicek, S. J. Singh, H. Jones, P. Reiss, M. Bristow, **A. Gower** et al. Drastic effect of impurity scattering on the electronic and superconducting properties of Cu-doped FeSe. *Physical Review B*, 105(11):115130, Mar 2022.
- M. Bristow, **A. Gower**, A. I. Coldea et al. Multiband description of the upper critical field of bulk FeSe. *Physical Review B*, 108(18):184507, Nov 2023.

OTHER SKILLS AND INTERESTS

Acrobatic Gymnastics (Cambridge University Double Blue), Jesus College Graduate Social Officer, Charity (LincZambia)