

# Joseph Rance

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## Research Interests

My interest is in researching more efficient, robust, and trustworthy machine learning algorithms, motivated by a fascination with how complex, intelligent behaviour can emerge using simple learning rules. In particular, I want to understand how we can close the gap in the statistical efficiency and ability to generalise, between the learning rules used by humans and machines, which could significantly improve both AI safety and training costs.

## Education

### University of Oxford

DPhil in Engineering Science

2025-

- Research area: Machine Learning
- Supervisors: Philip Torr, Adel Bibi

### University of Cambridge

MEng in Computer Science

2021-2024

- Distinction in all modules and dissertation
- Dissertation: *Cost-Aware Drug Design by Optimising Backward Policies of GFlowNets*
- Supervisors: Miruna Cretu, Pietro Liò

BA in Computer Science

2021-2024

- First Class in all three years, prize for highly commended dissertation
- Dissertation: *Evaluating attacks on fairness in Federated Learning* (link)
- Supervisors: Filip Svoboda, Nicholas Lane.

## Publications

**Can Private Machine Learning Be Fair?** (link)

[Joseph Rance](#), Filip Svoboda

The 39th Annual AAAI Conference on Artificial Intelligence, 2025

**Augmentation Backdoors** (link)

[Joseph Rance](#), Yiren Zhao, Ilia Shumailov, Robert D. Mullins

ICLR 2023 Workshop on Backdoor Attacks and Defenses in Machine Learning

**Cost-Aware Drug Design by Optimising Backward Policies of GFlowNets**

[Joseph Rance](#)

Dissertation, 2025

**Evaluating attacks on fairness in federated learning** (link)

[Joseph Rance](#)

Dissertation, 2024

## Experience

### Software Engineering Intern, Microsoft

Summer 2023

- Designed and implemented performance upgrades to the Azure-for-Operators MLOps codebase for a 75% cost reduction by processing low-priority data during off-peak times.
- Advocated for a more general implementation that can be made open-source (link).
- Presented my work to audiences of more than 30 managers and engineers.
- Led a student team during the Microsoft global hackathon to train a reinforcement learning agent to optimise server scheduling on Azure.

### Research Intern, University of Cambridge

Summer 2022

- Developed and tested three new backdoor attacks, which were the first to use compromised data augmentation functions as an attack vector. Our attacks include one of the first methods for inserting backdoors with in-distribution data.
- Presented our paper at the ICLR BANDS workshop.
- Supervisors: Yiren Zhao, Ilia Shumailov, Robert Mullins.

### Student Volunteer, AI4Good organisation

Summer 2020

- Worked as part of a team to simulate the spread of coronavirus in refugee camps.
- Produced a library of metrics to help evaluate the accuracy of our simulation, which was used to inform decisions made in real camps.

## Other Projects

<b>Scaling laws for model pruning based on information theory</b>	2025
<ul style="list-style-type: none"><li>• Bounded the information content of two well known computer vision tasks using deep learning.</li><li>• Showed that influence functions can efficiently estimate mutual information between a model and its dataset.</li><li>• Identified a linear relationship between the max size of a pruned model and the information content of its dataset.</li><li>• Submitted as undergraduate coursework (combination of L46 and L193).</li></ul>	
<b>GFlowNets for proof assistants</b>	2025
<ul style="list-style-type: none"><li>• Worked with another student to use GFlowNets to prove mathematical theorems with Lean.</li><li>• Our best model was able to produce correct proofs with a &gt;25% success rate.</li><li>• Submitted as undergraduate coursework (R171).</li></ul>	
<b>Persistent model tagging using the dying ReLU trick</b>	2025
<ul style="list-style-type: none"><li>• Proposed <i>conditionally-dead</i> subnetworks - sets of weights that use the dying ReLU problem to force their gradients to 0 - to build backdoors that are resistant to gradient-descent-based unlearning.</li></ul>	
<b>Automatic Entrepreneur</b>	2023
<ul style="list-style-type: none"><li>• Worked in a team of six students to generate reports on companies based on automatically scraped data.</li><li>• Integrated LLMs into the generation pipeline and then used Flask to build an interactive web app.</li></ul>	
<b>Robotic arm with object detection</b>	2020
<ul style="list-style-type: none"><li>• Led a team of six students to build an autonomous robot arm that used computer vision to identify objects with an onboard camera and pick them up.</li><li>• This project was funded by the Jack Petchey Achievement Award.</li></ul>	
<b>Using reinforcement learning to evaluate decision making in the sport of fencing</b>	2020
<ul style="list-style-type: none"><li>• Developed a set of RL agents to generate tactical policies for the sport of fencing.</li><li>• Achieved a 20% improvement in match outcome prediction over the naïve, score-based method.</li></ul>	

## Skills

**Languages:** Python (TensorFlow, PyTorch), OCaml, Rust, Java, SQL, C/C++, Bash, Prolog, C#, JavaScript, TypeScript, Go, RISC-V assembly, SystemVerilog,  $\LaTeX$

**Tools:** Git, Linux (Ubuntu), Docker, Slurm, Azure, AWS

## Awards & Achievements

### Awards:

- ESPRC IDLA Research Studentship
- Robinson College Scholarship
- CST Department Award for Highly Commended Part II Dissertation
- Jack Petchey Achievement Award
- Arkwright Engineering Scholarship
- Cambridge Hawks Award
- Cambridge full blue

### Competition Results:

- **2nd** UKMT Team Maths Challenge regional finals
- **15th** Aix-en-Provence U20 fencing world cup 2023 (as part of the Belgian team)
- **1st** BUCS Fencing Premier League South (as part of the Cambridge team)