

# Arnau Quera-Bofarull

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## WORK EXPERIENCE

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### Senior Researcher

Nov 2024 – Present

*Macrocism*

*New York, USA*

- Developing a one-to-one agent-based model of technological progress and energy markets in US and Canada.

### Senior Research Associate

Feb 2022 – Oct 2024

*Department of Computer Science, University of Oxford*

*Oxford, UK*

- Pioneered the use of differentiable programming for agent-based models using PyTorch, Jax, and Julia, demonstrating performance gains up to 40,000x. [11, 15, 13].
- Developed BLACKBIRDS [1, 14], a package for Bayesian calibration of differentiable stochastic simulators.
- Applied BLACKBIRDS to calibrate agent-based models in financial settings [12].
- Developed tools for end-to-end scenario generation under uncertainty with agent-based models [10].

### Research Fellow

Jun. 2023 – Present

*Institute for New Economic Thinking, University of Oxford*

*Oxford, UK*

### Research Affiliate

May 2023 – Present

*MIT Media Lab*

*Cambridge, USA*

- Adapted secure multi-party computation protocols to enable privacy-preserving simulation, calibration, and analysis of agent-based models [9].

### Volunteer Researcher

Oct 2020 – Sep 2022

*United Nations Global Pulse*

*New York, USA*

- Developed policy tools through agent-based models for the prevention of epidemic spread in refugee camps [6, 3].

### PhD Researcher

Mar 2020 – Sep 2022

*Institute for Data Science, Durham University*

*Durham, UK*

- Led the development of JUNE, a one-to-one agent-based model for simulating COVID-19 spread in England used by the national health services to inform public policy [5, 4].

### PhD Researcher

Oct 2017 – Feb 2022

*Institute for Computational Cosmology, Durham University*

*Durham, UK*

- Developed Julia and Python HPC code for the simulation of UV line-driven outflows from black holes [7, 2].

### Graduate Research Fellow

Dec 2019 – Mar 2020

*Center for Computational Sciences, University of Tsukuba*

*Tsukuba, Japan*

### PhD Intern

Apr 2019 – Jun 2019

*Boeing Digital Aviation & Analytics*

*Frankfurt, Germany*

### PhD Intern

Apr 2018 – May 2018

*Ibex Innovations*

*Sedgefield, UK*

- Innovated a convolutional neural network for X-ray medical image segmentation [16].

## EDUCATION

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### University of Durham

Durham, UK

*PhD in Astrophysics*

*Oct. 2017 – July 2022*

### University of Heidelberg

Heidelberg, Germany

*MSc in Physics*

*Oct. 2015 – August 2017*

### University of Barcelona

Barcelona, Spain

*BSc in Physics*

*Sep. 2010 – June 2015*

### University of Barcelona

Barcelona, Spain

*BSc in Mathematics*

*Sep. 2010 – June 2015*

## TECHNICAL SKILLS

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**Programming Languages:** Python, Julia, C

**Frameworks:** PyTorch, Jax, Tensorflow, Numpyro, Pyro, PyTorch Geometric, Flux.jl, SciML, Turing.jl, MPI

**Machine Learning:** Bayesian inference, variational inference, normalizing flows, graph neural networks, differentiable programming, probabilistic programming, secure multi-party computation

**Developer Tools:** Git, test-driven development, continuous integration, Slurm, Linux, Docker

**Languages:** English (Proficiency), Spanish (Native), Catalan (Native), German (Intermediate), Japanese (Beginner)

## Journal Publications

- [1] **Quera-Bofarull, A.** et al. **2023e**. “BlackBIRDS: Black-box Inference foR Differentiable Simulators”. In: *Journal of Open Source Software* 8.89. DOI: 10.21105/joss.05776.
- [2] **Quera-Bofarull, A.** et al. **2023g**. “Qwind3: UV Line-Driven Accretion Disc Wind Models for AGN Feedback”. In: *Monthly Notices of the Royal Astronomical Society* 518.2. ISSN: 0035-8711. DOI: 10.1093/mnras/stac3171.
- [3] Aylett-Bullock, J., [...], **Quera-Bofarull, A.**, et al. **2022a**. “Epidemiological Modelling in Refugee and Internally Displaced People Settlements: Challenges and Ways Forward”. In: *BMJ Global Health* 7.3. ISSN: 2059-7908. DOI: 10.1136/bmjgh-2021-007822.
- [4] Vernon, I., [...], **Quera-Bofarull, A.**, et al. **2022b**. “Bayesian Emulation and History Matching of JUNE”. In: *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 380.2233. DOI: 10.1098/rsta.2022.0039.
- [5] Aylett-Bullock, J., [...], **Quera-Bofarull, A.**, et al. **2021a**. “June: Open-source Individual-Based Epidemiology Simulation”. In: *Royal Society Open Science* 8.7. DOI: 10.1098/rsos.210506.
- [6] Aylett-Bullock, J., [...], **Quera-Bofarull, A.**, et al. **2021b**. “Operational Response Simulation Tool for Epidemics within Refugee and IDP Settlements: A Scenario-Based Case Study of the Cox’s Bazar Settlement”. In: *PLOS Computational Biology* 17.10. ISSN: 1553-7358. DOI: 10.1371/journal.pcbi.1009360.
- [7] **Quera-Bofarull, A.** et al. **2020**. “Qwind Code Release: A Non-Hydrodynamical Approach to Modelling Line-Driven Winds in Active Galactic Nuclei”. In: *Monthly Notices of the Royal Astronomical Society* 495.1. ISSN: 0035-8711, 1365-2966. DOI: 10.1093/mnras/staa1117.
- [8] Cuesta-Lazaro, C., **Quera-Bofarull, A.** et al. **2018**. “Gravitational Corrections to Light Propagation in a Perturbed FLRW Universe and Corresponding Weak-Lensing Spectra”. In: *Monthly Notices of the Royal Astronomical Society* 477.1. ISSN: 0035-8711. DOI: 10.1093/mnras/sty672.

## Conference Proceedings

- [9] Chopra, A., **Quera-Bofarull, A.** et al. **2024a**. “Private Agent-Based Modeling”. In: *Proceedings of the 2024 International Conference on Autonomous Agents and Multiagent Systems*.
- [10] Dyer, J., **Quera-Bofarull, A.** et al. **2024b**. “Population Synthesis as Scenario Generation for Simulation-Based Planning under Uncertainty”. In: *Proceedings of the 2024 International Conference on Autonomous Agents and Multiagent Systems*.
- [11] Chopra, A., [...], **Quera-Bofarull, A.**, et al. **2023a**. “Differentiable Agent-Based Epidemiology”. In: *Proceedings of the 2023 International Conference on Autonomous Agents and Multiagent Systems*. International Foundation for Autonomous Agents and Multiagent Systems. ISBN: 978-1-4503-9432-1.
- [12] Dyer, J., **Quera-Bofarull, A.** et al. **2023b**. “Gradient-Assisted Calibration for Financial Agent-Based Models”. In: *Proceedings of the Fourth ACM International Conference on AI in Finance*. Association for Computing Machinery. ISBN: 9798400702402. DOI: 10.1145/3604237.3626857.
- [13] **Quera-Bofarull, A.** et al. **2023c**. “Some Challenges of Calibrating Differentiable Agent-Based Models”. In: *International Conference on Machine Learning – Differentiable Almost Everything Workshop*. DOI: 10.48550/arXiv.2307.01085.
- [14] **Quera-Bofarull, A.** et al. **2023d**. “Bayesian Calibration of Differentiable Agent-Based Models”. In: *International Conference on Learning Representations – AI4ABM Workshop*. DOI: 10.48550/arXiv.2305.15340.
- [15] **Quera-Bofarull, A.** et al. **2023f**. “Don’t Simulate Twice: One-shot Sensitivity Analyses via Automatic Differentiation”. In: *Proceedings of the 2023 International Conference on Autonomous Agents and Multiagent Systems*. International Foundation for Autonomous Agents and Multiagent Systems. ISBN: 978-1-4503-9432-1.
- [16] Bullock, J., Cuesta-Lázaro, C., and **Quera-Bofarull, A.** **2019**. “XNet: A Convolutional Neural Network (CNN) Implementation for Medical X-Ray Image Segmentation Suitable for Small Datasets”. In: *Medical Imaging 2019: Biomedical Applications in Molecular, Structural, and Functional Imaging*. Vol. 10953. SPIE. DOI: 10.1117/12.2512451.

## INVITED TALKS

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### **Differentiable Programming for Agent-Based Models**

*Agent-based models for epidemic insights, University of Cambridge*

Dec 2024

*Cambridge, UK*

### **Differentiable agent-based models**

*2nd Workshop on robust agent-based modeling, University of Oxford*

July 2024

*Oxford, UK*

### **Differentiable agent-based models**

*Machine Learning for Global Health Network*

February 2024

*Remote*

### **Automatic differentiation for epidemiological modeling**

*Moritz Kraemer's lab*

January 2024

*Oxford, UK*

### **Differentiable SIR models**

*Pandemic Sciences Institute*

December 2023

*Oxford, UK*

### **JUNE: Modelling the spread of Covid-19 in England**

*Public Health England modelling group*

September 2020

*Cambridge, UK*

### **Simulating UV line-driven winds in AGNs**

*University of Hokkaido*

February 2020

*Hokkaido, Japan*

### **Computer vision for X-ray medical image segmentation**

*Rutherford Appleton Laboratory*

March 2019

*Oxford, UK*