Ákos Balog

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PROFILE

I am a spatial data scientist and computational modeller specialising in agent-based simulation of human behaviour in urban environments, with a focus on translating model outputs into practical, policy-relevant insights. My doctoral research at the University of Liverpool centres on designing, calibrating, and validating a large-scale ABM of individual mobility and spatial choice dynamics, integrating geodemographic data, discrete choice frameworks, and open geospatial pipelines. I have co-developed mobility-focused ABMs at the Barcelona Supercomputing Centre, including LLM-driven synthetic travel diary generation deployed on a national supercomputer, and contributed to pedestrian vulnerability simulation in collaboration with the Municipality of Turin. I bring strong quantitative skills, experience engaging stakeholders across cross-national research projects, and a commitment to interdisciplinary work at the intersection of behavioural science, urban mobility, and public policy.

Research Interests:
Agent-Based Modelling | Urban Mobility Simulation | Behavioural Decision-Making | Sustainability Transitions | Spatial Data Science | Environmental Exposure Assessment | Digital Twins | Policy Analysis | Geodemographic Classification

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EDUCATION

MSc-PhD | Data Analytics and Society | University of Liverpool ***2022 – Present***

"An ABM of Resilient Retail Centre Futures."
Supervisors: Dr Ron Mahabir | Dr Les Dolega | Dr Gabriele Filomena

Engineered scalable ABMs to simulate the interaction between individual mobility behaviour and urban spatial systems. The core methodological contributions are directly transferable to urban mobility and sustainability contexts:

- **Geodemographics:** Processed national-scale administrative and census datasets (LSOAs) using Python and R to develop a novel, small-area geodemographic classification of spatial behaviour, employing advanced clustering algorithms.
- **Simulation Architecture:** Designed and calibrated a large-scale ABM using Python and Mesa. Implemented Sobol sensitivity analysis and batched utility calculations to robustly model individual choice dynamics and spatial competition.
- **Decision Support Framework:** Validated synthetic ABM outputs against real-world performance metrics, bridging the gap between theoretical social simulation and applied, policy-relevant analytics.

BA (Hons) | Geography and Planning (1st Class) | University of Liverpool ***2019 – 2022***

Highest overall mark in cohort.

EMPLOYMENT

Research Assistant | BENEFITS – ABM for Social Policy Outcomes ***2026 – Present***

Institute for Global Prosperity | University College London

Led the technical design of a national-scale ABM (Python/Mesa) to simulate macroeconomic shocks on workless households using Family Resources Survey microdata. Architected a FastAPI backend to run computationally intensive simulations and developed an interactive web dashboard (React/Vite) to communicate regional well-being outcomes to policymakers.

Research Assistant | NightPedSim – Night-Time Pedestrian Movement ***2026 – Present***

University of Liverpool | Municipality of Turin

Co-developed the night-time routing module for PedSimCity, a large-scale Java/GeoMason simulation framework modelling urban pedestrian vulnerability and lighting-aware routing. Built Python data-preparation pipelines to ingest complex spatial datasets (Turin street lighting, census POIs). Developed REST APIs to interface the simulation engine with a live monitoring dashboard for real-time policy scenario testing.

Freelance Data Scientist | Helipad Visibility ML Project ***2026 – Present***

Panomax

Engineered an end-to-end data pipeline (Python) to construct a fog visibility ML dataset for the Mistelbach helipad. Integrated environmental sensor data with image heuristics and Gemini 2 embeddings. Built custom tools to streamline manual QA and dataset iteration, translating raw sensor data into robust predictive inputs.

Research Assistant | Korea–UK Digital Twin Approach for Transport Analysis ***2024 – 2025***

University of Liverpool | Podaris

Contributed to qualitative and computational analysis within a cross-national research project. Designed, conducted, and analysed 38 semi-structured stakeholder interviews (UK and South Korea) to map governance structures, institutional roles, data ecosystems, and stakeholder incentives. Contributed to a transferable digital twin maturity framework and synthesised findings into policy-facing recommendations on data governance, KPIs, interoperability, and citizen engagement.

Teaching Assistant ***2022 – Present***

University of Liverpool

Assist and lead in the delivery of undergraduate and master's level modules, including Geographic Information Science; Geographic Data Science; Web Mapping and Advanced Visualisation; Study Skills and GIS; and Urban Design.

Statistics Tutor ***2022 – Present***

University of Liverpool

Provide one-to-one and group tutoring in statistical methods, supporting undergraduate and postgraduate students in applying quantitative techniques to coursework and research.

Data Science Intern ***2023***

Liverpool City Region Combined Authority

VISITING RESEARCHER

Barcelona Supercomputing Centre ***February 2026 – May 2026***

Barcelona, Spain

Developed agent-based models integrating large language models to generate synthetic travel diaries conditioned on demographic attributes, capturing realistic mobility behaviour across urban contexts. Deployed and executed large-scale simulations on the MareNostrum supercomputer, optimising workflows for high-performance computing environments.

Pusan National University ***September – December 2024***

Busan, South Korea

Contributed to a PRISMA-guided systematic literature review and implemented Sentence-BERT natural language processing models to quantify relationships between transport challenges, technological solutions, and policy strategies.

PEER-REVIEWED JOURNAL ARTICLES

- Son, H., Jang, J., Park, J., **Balog, A.**, Ballantyne, P., Kwon, H.R., Singleton, A., Hwang, J. (2025). Leveraging Advanced Technologies for (Smart) Transportation Planning: A Systematic Review. *Sustainability*, 17(5), 2245. DOI.
- **Balog, A.**, Dolega, L., Mahabir, R., Williamson, P., Ballantyne, P. 2026. Understanding Consumer Behaviour: A Geodemographic Approach to Retail Insights. *International Journal of Retail & Distribution Management*. (Accepted)

UNDER REVIEW

- **Balog, A.**, Filomena, G., Dolega, L., Mahabir, R. Under Review. Exploring Retail Competition and Consumer Behaviour: An Agent-Based Model of Metropolitan Retail Centres. *Cities*. DOI. (Second round of revisions)
- **Balog, A.**, Melios, G., Aslam, N.S., Tzivanakis, N., Moore, H. Under Review. Network Contagion and the Persistence of Inequality: An Empirically Grounded Agent-Based Model of Unemployment Recovery. *Social Networks*. (Awaiting review)
- Kwon, H.R., Ballantyne, P., **Balog, A.**, Jang, J., Son, H., Hwang, J., Singleton, A. Under Review. A framework for transport digital twin design and implementation for urban decision-making: Lessons from twin cities in the United Kingdom and South Korea. *Harvard Data Science Review*. (Submitted for special issue)

WORKING PAPERS

- **Balog, A.**, Murphy, J., Reyes, P., Cucchietti, F. In progress. Using LLMs to Generate Synthetic Mobility Data. Target journal: *Urban Transitions*.
- Filomena, G., **Balog, A.**, Garofani, G., Nausto, A. In progress. Nighttime PedSim City: Developing an ABM of Nighttime Walking for Policy Testing Scenarios. Target journal: *Cities*.
- **Balog, A.**, Filomena, G., Dolega, L., Mahabir, R. In progress. From Visitation to Performance: Empirical Validation of an Agent-Based Model of Retail Centre Competition. Target journal: *Computers, Environment and Urban Systems*.

INVITED TALKS

BSC Seminar Series
Barcelona Supercomputing Centre, Barcelona, Spain – 29 April 2026
"Exploring the Potential of LLMs in Mobility ABMs"

XJTU–XJTLU–UoL Convergence Camp
Innovation Harbour Campus, Jiaotong University, Xi'an, China – 18 April 2026
"Validating Geographic Agent-Based Models: Retail Centres"

ABM in Sustainable Consumption Research – A Network Workshop
Aarhus University, Copenhagen, Denmark – 13 March 2026
"Exploring Retail Competition, Accessibility and Consumer Behaviour: Agent-Based Model of Retail Centres"

UoL–PNU Joint Seminar on Urban and Transportation Planning and Digital Twins
University of Liverpool, UK – 5 February 2026
"Building towards a Digital Twin of Retail Centres"

Pets at Home
Manchester, UK – 9 September 2025
"ABM for Retail: Practical Examples From Modelling Retail Centres"

Department of Urban Planning and Engineering Seminar Series
Hanyang University, Seoul, South Korea – 5 November 2024
"Developing an open, national-level, small-area geodemographic classification of consumer behaviour for grocery shopping"

Korea Research Institute for Human Settlements
Sejong City, South Korea – 18 October 2024
"A framework for transport digital twin design and implementation for urban decision-making"

Pusan National University Seminar Series
Busan, South Korea – 8 October 2024
"A Practical Introduction to Agent-Based Modelling"

CONFERENCE AND WORKSHOP ORGANISATION

UK–South Korea Bilateral R&D Conference II: Digital Twins and Data-Driven Transport Planning

January 2025

Co-led event coordination; assembled the workshop programme; supported delivery; and coordinated post-conference project outputs.

Postgraduate Conference

May 2024

Co-led programme organisation, timetabling, event delivery, awards, session themes, and post-conference report.

AWARDS

- FSE Faculty Travel Bursary (2026), XJTU–XJTLU–UoL Doctoral Wisdom Convergence Camp.
- Turing Community Award (2024), Alan Turing Institute.

TECHNICAL SKILLS

- **Python (Advanced):** Data cleaning/manipulation, ABM development (Mesa), spatial analysis, data visualisation.
- **R (Intermediate):** Data cleaning and visualisation, cartography, spatial analysis.
- **QGIS/ArcGis (Advanced):** GIS, spatial analysis, cartography.
- **Java (Beginner/Intermediate):** MASON and GeoMason for ABM development.

PERSONAL

- **Member |** European Social Simulation Association
- **Former Planning Engagement Volunteer |** PLACED
- **Languages:** Native Hungarian speaker; fluent English
- **Leadership & Sport:** Two-time Water Polo Club President (University of Liverpool); Full Colours for Outstanding Service and Performance; British Water Polo League Division 3 Champion; Qualified Swim Teacher and Water Polo Coach.

REFERENCES

Dr Ron Mahabir
Lecturer in Geographic Data Science | University of Liverpool
ron.mahabir@liverpool.ac.uk

Dr Les Dolega
Senior Lecturer in Geographic Data Science | University of Liverpool
les.dolega@liverpool.ac.uk

Dr Nikolaos Tzivanakis
Senior Research Fellow: IGP Data Lead | UCL Institute for Global Prosperity
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