Matthew Danish

 \square m.r.danish@tue.nl • in matthew-danish • \square mrd

Research Profile

My research spans ML, computer vision, and programming languages, with a particular focus on developing practical AI systems that are both efficient and safe. Key areas include: privacy-preserving computer vision systems in a resource-constrained edge computing context and ML for spatial imagery processing and human perception modeling. I have extensive experience in bridging academic research with industrial applications through collaborations with Bloomberg L.P., Microsoft Research, and the Met Office (UK), and a strong commitment to open source software and FAIR data.

Experience

Eindhoven University of Technology

Researcher 3 (Mathematics & Computer Science)

Utrecht University

Researcher (Human Geography & Spatial Planning)

- Designed and implemented the full stack of the Percept mobile web app, collecting ~20,000 responses.
- Assembled a ML pipeline to analyze environmental and geographic data together with perception data, applying vision and spatial data tools to process and filter 700,000 Mapillary street view images.
- Co-authored papers on computer vision and street view perception surveys with research team.

Cambridge University

Research Associate (Digital Technology Group / Systems Research Group) Sep 2015-Dec 2022

- Created DeepDish, privacy-preserving 'intelligent sensor' software running lightweight object detection and tracking models for real-time monitoring of people and vehicle flows, using low-power (~7 W) edge computing devices to achieve MOTA scores within 18-25% of a full-strength workstation with GPU.
- Initiated and designed an intelligent sensor system reconstructing in real-time a model of room occupancy from indoor video feed, to be fused with other data streams for air quality monitoring.
- Developed many of the main modules of the CamFort lightweight verification, modernization and static analysis tools for research into automated software evolution of scientific Fortran programs.
- O Worked on Fortran-Src, an industrial-strength open-source parser and analyzer for Fortran versions 66 though 2003, written in Haskell, now used internally by commercial partners such as Bloomberg, L.P.
- Consulted with the Met Office weather forecasting service and developed automated tools to analyze their very large Fortran code base to find hidden bugs and improve code quality.
- Led an academic/industrial (Microsoft Research, Bloomberg L.P.) team to write a paper and research proposal on using hybrid ML algorithms to analyze and generate specifications for scientific programs.
- Lectured in an international series of Fortran Modernisation workshops for scientists in the UK, Spain and Germany, which were hosted by representatives from the Numerical Algorithms Group, Ltd.
- \odot Negotiated for a £99,000 research funding donation from a corporate partner, hired a research assistant.
- Chaired the departmental Research Staff Forum and organized regular social events.

Cambridge Cycling Campaign

Charity Trustee (volunteer role)

 \odot Advised a 1,600+ member charity, hiring and managing employees. Led multi-year campaigns using technical knowledge of urban design and policy while communicating effectively with many stakeholders.

Boston University

PhD, Computer Science

• Dissertation: Terrier: An embedded operating system using advanced types for safety.

Built OSes with virtualization-based and programming language-based program safety measures.

Carnegie-Mellon University

Research Programmer, Robotics Institute BS, Logic and Computation

Pittsburgh, Pennsylvania, USA June 2004–June 2008 Aug 2000–May 2004

Sep 2008–May 2015

Boston, Massachusetts, USA

Cambridge, UK

2016-2022

Cambridge, UK

Utrecht, NL

Jan 2023–Jan 2025

Eindhoven, NL

Mar 2025-

Skills

Machine Learning: Hands-on experience with PyTorch-based ML model training and evaluation for computer vision and beyond, including fine-tuning LLMs and developing CLIP-based algorithms. Deployed TensorFlow with Google Edge TPUs. Used AutoML for human perception modeling.

Programming: Haskell, C, Python, PostgreSQL/PostGIS, R, Java, HTML/CSS/JS and more. Linux systems programming, HPC (e.g. Snellius), Parallel and Distributed programming.

Communication: Presented at numerous workshops, conferences and meetings. Experienced at policy discussions with elected officials from the level of city councillor up to MP. Authored several op-ed columns in local newspapers and frequent articles for the charity's regular magazine.

Leadership and Management: Led team of authors on several papers and proposals. Secured \pounds 99,000 donation from corporate partner for my research, and used it to hire a research assistant. Chaired the Computer Laboratory Research Staff Forum. Volunteered 6 years as a charity trustee, hiring employees, leading campaigns and managing relationships with many other stakeholders.

Additional Roles & Awards

EdgeSys workshop (co-hosted with EuroSys): Publicity Chair (2021), Presenter (2020, 2022) New Wiseman Award 2019: Received for outstanding contributions to the Computer Laboratory. Campaigner of the year 2018: Received for volunteer work with Cambridge Cycling Campaign. Debian: Software package maintainer for the ATS language and several small Lisp packages.

Projects

Percept: Toolkit for preparing and deploying street view perception survey (mobile) web apps.
DeepDish: 'Intelligent sensor' edge computing software for object detection and tracking.
CamFort: Static analysis and verification tool for scientific Fortran programs.

Fortran-Src: Haskell library for parsing and generation of historical & modern Fortran programs.
Terrier: Embedded ARM OS incorporating the ATS language for advanced type safety features.
ATS: Functional programming language with linear and dependent types (former group member).
Quest: Real-time OS with virtualisation-based sandbox features (former group member).
Adaptive City: Real-time urban & indoor sensor data processing platform (former group member).

Appendix: Selected Publications

- M. Danish, S. Labib, B. Ricker, and M. Helbich, "A citizen science toolkit to collect human perceptions of urban environments using open street view images," *Computers, Environment and Urban Systems*, vol. 116, p. 102207, 2025.
- [2] M. Helbich, M. Danish, S. Labib, and B. Ricker, "To use or not to use proprietary street view images in (health and place) research? that is the question," *Health & Place*, vol. 87, p. 103244, 2024.
- [3] J. Brazauskas, C. Jensen, M. Danish, I. Lewis, and R. Mortier, "Cerberus: Privacy-preserving crowd counting and localisation using face detection in edge devices," in *Proceedings of the 7th International Workshop on Edge Systems, Analytics and Networking*, pp. 25–30, 2024.
- [4] M. Danish, R. Verma, J. Brazauskas, I. Lewis, and R. Mortier, "DeepDish on a Diet: Low-Latency, Energy-Efficient Object-Detection and Tracking at the Edge," in *Proceedings of the 5th International Workshop on Edge Systems, Analytics and Networking*, 2022.
- [5] M. Danish, J. Brazauskas, R. Bricheno, I. Lewis, and R. Mortier, "DeepDish: multi-object tracking with an off-the-shelf Raspberry Pi," in *Proceedings of the Third ACM International Workshop on Edge Systems, Analytics and Networking*, 2020.
- [6] M. Danish, M. Allamanis, M. Brockschmidt, A. Rice, and D. Orchard, "Learning units-of-measure from scientific code," in 2019 IEEE/ACM 14th International Workshop on Software Engineering for Science (SE4Science), 2019.
- [7] M. Danish, D. Orchard, and A. Rice, "Incremental units-of-measure verification," *arXiv preprint* arXiv:2406.02174, 2018.
- [8] D. Orchard, M. Contrastin, M. Danish, and A. Rice, "Verifying spatial properties of array computations," *Proceedings of the ACM on Programming Languages*, 2017.
- [9] M. Contrastin, A. Rice, M. Danish, and D. A. Orchard, "Units-of-measure correctness in Fortran programs," *Computing in Science & Engineering*, vol. 18, no. 1, pp. 102–107, 2015.
- [10] M. Danish and H. Xi, "Using lightweight theorem proving in an asynchronous systems context," in NASA Formal Methods Symposium, pp. 158–172, Springer, 2014.
- [11] M. Danish, H. Xi, and R. West, "Applying language-based static verification in an ARM operating system," *ACM SIGBED Review*, vol. 10, no. 2, pp. 16–16, 2013.
- [12] M. Danish, Y. Li, and R. West, "Virtual-CPU scheduling in the Quest operating system," in 17th IEEE Real-Time and Embedded Technology and Applications Symposium, 2011.
- [13] M. Danish and H. Xi, "Operating System Development with ATS," in *Proceedings of the International Workshop on Programming Languages Meets Program Verification, PLPV*, 2010.