Engineering and Physical Sciences Research Council Doctoral Landscape Award

PROJECT TITLE: Data-driven decision making for multi-modal transportation systems

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Project details:

Background and Motivation: The management of multimodal transportation has attracted enormous attention from researchers across a range of disciplines. It is increasingly seen as a viable approach to improving the efficiency, reliability, and sustainability of transportation systems. By integrating different modes—such as buses, trains, shared mobility services, and freight logistics—multimodal transportation has the potential to reduce congestion, enhance user experience, and make the overall system more resilient. However, despite the progress, there are still important research gaps. One key challenge is the predictive coordination of different transport modes. Current systems often struggle to anticipate demand fluctuations, delays, or disruptions in real time, which limits their operational efficiency. Another major issue is the lack of mechanisms for safe and secure data sharing across multiple service providers and platforms. Without this, the potential for more coordinated and intelligent transportation remains unlocked. Environmental sustainability is another area where multimodal transportation could play a significant role but has not been fully explored. The integration of low-carbon vehicles and renewable energy sources could contribute substantially to reducing transportation-related emissions. However, there is limited research on how such integration can be practically achieved and optimized within complex multimodal networks.

Research Aims and Objectives: This project aims to address these research gaps by developing a data-driven framework for decision-making in multimodal transportation systems. Specifically, the objectives are to:

- Explore AI-based predictive models to improve the coordination of different transportation modes and reduce delays.
- Design mechanisms for secure and safe data sharing among multiple service providers.
- Investigate the integration of low-carbon vehicles and renewable energy within multimodal systems to support decarbonization.
- Develop a unified, multi-objective framework that balances efficiency, reliability, and sustainability in transportation operations.

Approach and Expected Outcomes: To achieve these objectives, the project will take a data-driven approach combining advanced AI and optimization techniques with a goal of achieving a more efficient, reliable, and low-carbon transportation. First, data from multiple transport modes will be sourced and analysed to understand system behaviour and identify key patterns. AI models will then be developed to predict congestion, demand, and potential disruptions, enabling proactive coordination across modes. In parallel, secure data-sharing protocols (such as secure multi-party computation) and privacy-preserving AI models (e.g. federated learning) will be explored to allow collaboration between service providers without compromising privacy or operational integrity. Finally, a multi-objective decision making framework will be developed by integrating environmental considerations through modelling energy consumption, emissions, and renewable energy availability, along with other efficiency and reliability factors and considerations.

The expected outcomes from this project include word-leading publications and establishment of strong collaborations with key industry partners such as Transport for London, and National Physical Laboratory.

Project specific entry requirements:

Good BSc/ MSc degrees on subjects with significant quantitative elements

Potential PhD programme of study: PhD in Management

Department: Management

Location: Streatham Court

Please direct project specific enquiries to: Dr Fanlin Meng (f.meng2@exeter.ac.uk)

Please ensure you read the entry requirements for the potential programme you are applying for.

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