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Oral and Poster Presentation Abstracts

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ORAL PRESENTATION

ORAL PRESENTATION

Stream 1 - Electric, Automated and Shared Mobility

Session 1.1 Electric Vehicles and Environmental Impacts of Transport

Optimizing the deployment of chargers for electric fleet considering heterogeneous chargers and electric vehicles

Hao Hu, *University of Wollongong (UOW)*

Electric vehicles have been identified with great potential to reduce greenhouse gas emissions and alleviate the heavy reliance on fossil fuels. However, the limitation of driving range and the need for sufficient charging infrastructures prevent their adoption. Many chargers yield huge capital investment, resulting in a waste of resources, while fewer chargers may not satisfy the charging demand. Therefore, it is critical to optimise the deployment of chargers to provide adequate charging services. This study investigated the deployment of heterogeneous chargers for government-owned fleets considering heterogeneous electric vehicles. Mixed-integer linear programming (MILP) is proposed to describe the charging activities of the government fleet within the planning horizon considering multiple practical factors, such as power grid limitation, backbone site capacity, time-varying electricity price and so on. A solution framework is proposed to solve the model efficiently, which incorporates Benders decomposition and branch-and-bound framework. The performance of the proposed method is compared with the commercial solver, Gurobi, which shows significant improvement in both computational time and optimality gap among medium and large-scale cases. Numerical studies with sensitivity analysis are conducted on real-world data provided by NSW Treasury, Australia, to analyse the impact of related factors. The numerical results provide a valuable reference for governments to deploy charging infrastructure and schedule charging activities in an optimal way.

A Pricing Determination for Pricing Balancing the Charging Demand of Electric Vehicle

Qi Wang, *Western Sydney University (WSU) & University of Wollongong (UOW)*

In this paper, a novel game-theoretic model for the complex interactions between charging stations and electric vehicle (EV) users in a road network is investigated. In this game, on the one hand, charging stations (acting as leaders) need to decide their respective prices in order to optimize their revenues while ensuring EVs participation. On the other hand, EV users as followers need to decide on their charging strategy in order to optimize the trade-off between the benefits of charging and the associated costs.

“Door-to-door” carbon emission calculation for airlines - Its decarbonisation potential and impact

David Li, *University of Sydney (USYD)*

We conducted a literature review and developed an aviation travel-chain emission model using real-world data. This model considers both air and ground segments, such as airport ground transport connections, for a comprehensive “door-to-door” air-travel carbon calculation. We investigated different carbon calculation methods and found that when measuring ground segments against the flight, ground CO2 emissions can have a significant impact, up to 22% of total trip emissions. We also conducted scenario studies to explore strategies for practical decarbonisation in transportation. One scenario suggests that the cost of sustainable aviation fuel (SAF) is comparable to a typical airport rail surcharge, making the latter a “low-hanging fruit” decarbonisation option for airlines.

Session 1.2 Autonomous System and Relevant Technologies

A Reinforcement Learning Model for Autonomous Agent Navigation in Grid-Based Environments

Abdullah Zareh Andaryan, *University of Sydney (USYD)*

The advancement of mobile information technologies, coupled with connected sensors, and the Internet of Things (IoT), holds promise for the development of smart infrastructure and services in future cities. These advancements are leading to the emergence of autonomous vehicles (AVs), sparking speculation about how these technologies could benefit future transportation by creating safer and less congested roads. However, alongside the excitement and promise, the vision of a smart city with AVs in the future (perhaps not so distant) raises questions regarding how transportation systems consisting of a mixture of humans, human-driven vehicles, and mobile robots will be managed, particularly in spaces where their paths cross.

The turn of the twenty-first century witnessed a notable shift in urban street design, driven by a paradigm change towards city center regeneration, traffic calming, and neo-traditional concepts. This transformation has led to emergence of shared streets, reflecting a growing emphasis on accommodating diverse urban interests beyond favoring motor vehicles. Shared streets incorporate various features to limit vehicle dominance within urban environments, such as shared surfaces and leveraging streetscapes and on-street parking. Unlike traditional traffic-calming measures that focus on physical interventions solely on the carriageway, shared streets aim to create a harmonious coexistence between various road users, including pedestrians and slower-speed users, without segregating them.

While significant progress has been made in AV technology, the interactions between AVs and vulnerable road users, such as pedestrians and cyclists, in ”shared spaces” require substantial development before these vehicles can merge seamlessly into regular traffic. This study presents an approach to address this challenge by developing a reinforcement learning (RL) model capable of training autonomous agents to navigate complex grid-based spaces efficiently and adaptively. The core of the model is based on the integration of deep Q-networks (DQN) with recurrent neural networks (RNN), allowing the agent to capture both spatial and temporal dependencies within the grid environment. This combination enables the agent to learn not only optimal paths but also to exhibit adaptive behavior in response to dynamic changes in the environment.

A Dynamic-Confidence 3D Multi-Object Tracking Method based on Spatio-Temporal Association

Ruihao Zeng, *University of Sydney (USYD)*

Multi-object tracking (MOT), also known as multi-target tracking (MTT), assumes a vital role in applications such as connected and autonomous vehicles (CAVs) and autonomy through infrastructure (ATI). Serving as a mid-level task within these systems, MOT establishes foundational data for downstream applications, including environmental understanding, behavior analysis, and intelligent decision-making. The primary objectives of MOT include detecting and localizing multiple objects within a given scenario, distinguishing their unique identities, and generating accurate tracking trajectories.

To enhance the perception capabilities of autonomous agents operating in complex scenes, we propose an innovative online 3D MOT method based on point cloud data, which improves the prediction performance and implements a new data association mechanism. The method employs a constant acceleration model and incorporates orientation angle variation. Simultaneously, the offsets resulting from the motion of the probe agent are nullified through the utilization of the calibration matrix. After undergoing Kalman filter smoothing, this method can effectively and accurately estimate the future states (position, orientation, velocity, acceleration, etc.) of target objects, mitigating the issue of direction oscillation in the object detection stage. To tackle the bidirectional pairing problem between predicted and candidate targets in complex scenarios, we introduce a novel spatio-temporal feature-based data association model. This model leverages a dynamic confidence threshold to address tracking temporarily occluded objects.

Through extensive evaluations of the KITTI dataset, our method surpasses state-of-the-art methods. The method performance is further validated on the nuScenes dataset, solidifying the robustness and effectiveness of our proposed approach.

Price of Anarchy of Traffic Assignment with Exponential Cost Functions

Jianglin Qiao, *Western Sydney University (WSU) &University of Wollongong (UOW)*

The rapid evolution of technology in connected automated and autonomous vehicles offers immense potential for revolutionizing future intelligent traffic control and management. This potential is exemplified by the diverse range of control paradigms, ranging from self-routing to centralized control. However, the selection among these paradigms is beyond technical consideration but a delicate balance between autonomous decision-making and holistic system optimization. A pivotal quantitative parameter in navigating this balance is the concept of the "price of anarchy" (PoA) inherent in autonomous decision frameworks. This paper analyses the price of anarchy for road networks with traffic of CAV. We model a traffic network as a routing game in which vehicles are selfish agents who choose routes to travel autonomously to minimize travel delays caused by road congestion. Unlike existing research in which the latency function of road congestion was based on polynomial functions like the well-known BPR function, we focus on routing games where an exponential function can specify the latency of road traffic. We first calculate a tight upper bound for the price of anarchy for this class of games and then compare this result with the tight upper bound of the PoA for routing games with the BPR latency function. The comparison shows that as long as the traffic volume is lower than the road capacity, the tight upper bound of the PoA of the games with the exponential function is lower than the corresponding value with the BPR function. Finally, numerical results based on real-world traffic data demonstrate that the exponential function can approximate road latency as close as the BPR function with even tighter exponential parameters, which results in a relatively lower upper bound.

Game-theoretic Modelling of Integrated Longitudinal and Lateral Vehicle Maneuvers

Zhaohan Wang, *University of Sydney (USYD)*

Microscopic traffic modelling plays a crucial role in understanding and optimizing urban mobility, as it provides valuable insights into the intricate maneuvers of individual vehicles. In this paper, we propose an innovative approach that employs game theory and receding horizon prediction to model the microscopic behaviours of vehicles. Most importantly, our model integrates the longitudinal and lateral decision-making processes into one unified objective, allowing simultaneous consideration of car-following and lane-changing maneuvers. The vehicle dynamic is modelled using a kinematic bicycle model, a simple yet efficient structure for modelling purposes. To account for the rationality and prediction ability of drivers, we assume they can foresee a short period into the future and act accordingly to optimize their individual payoffs. The multifaceted decision-making processes inherent in human drivers are encapsulated by leveraging level-k game theory, which enables the representation of multiple levels of rationality among the involved players. The resulting framework has been calibrated on vehicle trajectory data from the HighD dataset. The calibrated model reproduces trajectories with low disparities and correctly identifies macroscopic traffic patterns. Our approach offers a realistic depiction of real-world traffic scenarios by considering the interactions between drivers. Furthermore, by fitting the model to real data, we gain insights into the factors that influence drivers' preferences. Ultimately, this research will be used as a testbed to design an optimal controller for autonomous vehicles operating in both human-driven and mixed traffic environments.

Emerging Mobility in Smart Cities Empowered by Blockchain and Deep Data

Ruiyi Zhao, *University of New South Wales (UNSW)*

In the ever-evolving landscape of Mobility-as-a-Service (MaaS), it faces complex logistical challenges, from delivery inefficiencies to infrastructure gaps. This research navigates these intricacies, leveraging ethics, blockchain, and MaaS to address these issues.

Ethics, the moral compass guiding societal values, represents a pivotal role within the realm of decentralisation-a fundamental aspect of blockchain technology. Beyond facilitating transactions, blockchain's disruptive capabilities prompt profound reflections on governance norms, ushering in discussions concerning trust, transparency, and sustainability. This intricate interplay between decentralisation and ethical governance lays the foundation for critical discourse.

Blockchain, serving as the linchpin of this technological trinity, offers a decentralised haven that transcends conventional intermediaries. Its immutable ledger, enabled by smart contracts, provides transparency and efficiency, instilling trust within an increasingly interconnected world. The integration of blockchain's decentralised architecture with MaaS ushers in a new era characterised by operational excellence, streamlined transactions, and the democratisation of mobility services.

The framework of Emerging Mobility in Smart Cities Empowered by Blockchain and Deep Data extends far beyond the confines of conventional approaches. It encapsulates the very essence of decentralisation, ethical governance, and trust-building mechanisms. This paradigm shift challenges preconceived notions, fostering innovative solutions that not only optimise last-mile delivery, exemplified by the innovative Last-Mile Delivery Application (LDMA) developed within this research but also reconfigure the very fabric of MaaS itself.

As this research forges ahead, it casts a spotlight on the transformative potential residing at the intersection of Ethics, Blockchain, and MaaS. This convergence promises a holistic evolution of these interconnected domains, underpinning the realisation of Emerging Mobility in Smart Cities. Through the fusion of blockchain's ethical underpinnings and the power of deep data, this research serves as a guide to smart cities toward a sustainable and empowered future, where urban mobility seamlessly aligns with the needs and aspirations of its residents.

Session 1.3 Shared Mobility and Mobility as a Service

Learning from the Literature: Insights for Regulating E-scooters in New South Wales, Australia

Yuting Zhang, *University of Sydney (USYD)*

As e-scooters become more widespread worldwide, there has been a heated debate regarding their utilisation and governance among supporters and opponents. This paper aims to provide an evidence review of shared e-scooters worldwide, and investigates how existing evidence may inform long-term policies on shared e-scooters in New South Wales, Australia. The research involves a rapid style review of relevant literature on shared e-scooters within the broader micromobility context. The evidence review focuses on three themes that emerged from the NSW context: 1) safety, from the perspectives of risky rider behaviours, vehicle safety, and infrastructure, and effective regulation; 2) where shared e-scooters fit into the modal landscape, i.e., whether journeys shift to e-scooters from walking/cycling, public transport, or private cars; and 3) what are the social and environmental impacts on sustainability. This paper provides policy recommendations for NSW on shared e-scooter management.

Multi-tiered ridesourcing services in the e-hailing market

Guipeng Jiao, *University of Sydney (USYD)*

In an e-hailing market, Transport Network Companies (TNCs) provide on-demand point-to-point transport solutions such as ridesourcing services. The TNCs utilize digital platforms to match passengers who need a ride to drivers who want to provide a service. Improving the operational efficiency of such platforms has been one of the main objectives for the TNCs. A more efficient platform not only generates more profit, but also has other positive externalities such as reduced passenger pickup time, less passenger cancellations, lower deadheading, and higher driver income.

In this study, we introduce an operational strategy whereby the platform offers multi-tiered ridesourcing services. The different tiered ridesourcing services are characterized by the different passenger waiting times and different prices. By providing multi-tiered services, the passenger with lower value of time can get a cheaper ride but with a longer waiting time. Whereas passengers with higher value of time get a better ride with shorter waiting time at a higher cost. In its essence, the strategy would keep passengers who opted for the lower tiered service on hold, until an exceptionally good match appears, thus improving the overall matching efficiency. To this end, we further propose a matching algorithm, and a pricing algorithm. The matching algorithm aim to optimally matches passengers to drivers, given the passengers choice of service tier. The pricing algorithm aim to optimally price the different tiers of service, so that the overall profit can be maximized.

We show that the proposed strategy improves the profitability of the platform as expected, and at the same time it also improves the key performance indicators for other stakeholders.

Integrated operator and user-based rebalancing in dockless shared e-micromobility systems

Elnaz Emami, *University of Sydney (USYD)*

This research investigates the rebalancing problem within a dockless e-bike sharing system, which employs both operator-based and user-based strategies. The operator-based rebalancing involves operators deploying the fleet of rebalancing trucks to relocate e-bikes across different areas while recharging the depleted batteries of e-bikes. In contrast, user-based rebalancing relies on encouraging users to actively participate in rebalancing activities in exchange for a reward, which is in the form of a reduced rental fee. The formulation takes into consideration individual e-bike attributes like their location and charge level to optimize rebalancing decisions. We proposed a mixed-binary-nonlinear rebalancing program (MBNRP). The proposed model determines e-bikes that should be repositioned by a fleet of repositioning trucks or users with the objectives of minimizing operational costs and unmet demand while maximizing the system's profitability. To solve this optimization problem, we employed the Branch and Bound method. To evaluate the performance of the proposed integrated rebalancing method, we subsequently conducted simulations of an e-micromobility sharing system that incorporates the proposed rebalancing approach and performed numerical studies using data from Manhattan, New York City. The results demonstrate that the proposed approach significantly improves system performance in comparison with other benchmarks associated with different rebalancing approaches, all the while delivering high-quality solutions in a remarkably short computation time.

Mobility-as-a-Service (MaaS) and the potential of multi-services

Aitan M. Militao, *University of Sydney (USYD)*

Conceptually, Mobility-as-a-service (MaaS) has the potential to deliver societal sustainable outcomes in terms of social inclusion, equity and environmental sustainability, such as helping to decarbonise the transport sector, and this is perhaps one of the main reasons for MaaS to receive growing interest from researchers, practitioners and governments around the world; However, the limited evidence suggests that the need for financially incentivising MaaS users using discounts to travel more sustainably might be a key aspect that decides whether MaaS could achieve sustainability through commercial viability and scalability. Recent research also suggests that promoting green(er) travel through non-financial incentives is possible if we extend MaaS from a multi-modal to a multi-service platform. That is, subscription bundles could include non-mobility services in addition to mobility services. The multi-service model can provide an opportunity for the creation of different business models and an option to increase the commercial viability of MaaS. This research aims to identify what services are potentially the best fit for MaaS from the perspective of international “thought leaders in the MaaS space”, including high-level employees of private and government-based MaaS initiatives and renowned academics researching MaaS, and from the perspective of regular people that are potential MaaS users. The services identified from this study will be presented to users in the second stage through a stated preference (SP) experiment.

Stream 2 - Active, Safe and Freight Transportation

Session 2.1 Innovations of Safety in Transport Systems

Railway safety deterioration as a potential hazard

Weiting Hong, *University of Sydney (USYD)*

Although a considerable number of studies have contributed to the development of railway safety, endeavours persist to further improve railway safety in light of technology, infrastructure, and operational practices. This project explores the under researched hazard of railway safety deterioration within railway systems. The analysis explores how the railway industry in different jurisdictions addresses railway hazards and commitments to enhance safety culture. An overview of how the industry conducts safety knowledge retrieval, processing, and dissemination and its implications for learning behaviours and safety culture is discussed. The triangulation method is used to examine the learning behaviours of railway industries in the UK, the USA, Canada and Australia. The methodology involves analysis of co-referencing of railway accident reports, review of literature from other high reliability industries, stakeholder workshops and participant surveys, aiming to facilitate valuable dialogue and understand the learning behaviours and potential barriers. The result shows the significance of a robust safety culture in promoting a safe environment with rigorous legislative frameworks and thorough learning from historical accidents. Critically, this project identifies the potential deterioration of railway safety culture as another underlying hazard due to barriers and limited incentives for cross-jurisdictional learning and the dynamic nature of environments. Neglecting to learn across jurisdictions might result in misapplied investment and misunderstandings of the prioritisation of resources for advancing railway safety. Potential solutions include standardised cross-jurisdictional analysis and the establishment of central authorities for railway safety-related knowledge sharing. The primary contributions of this research are to identify the potential deterioration of railway safety, reveal difficulties and propose critical insights for overcoming barriers. Future research could incorporate quantitative data for evaluating the negative impacts of railway safety deterioration.

Pre-disaster Self-evacuation Transport Network Design under Uncertain Demand and Connectivity Reliability: A Novel Bi-level Programming Model

Junxiang Xu, *University of New South Wales (UNSW)*

This research proposes a novel bi-level nonlinear programming model for the pre-disaster self- evacuation transport network design. The model takes into account both uncertainties of demand and connectivity reliability, an approach to quantify network connectivity reliability is proposed based on percolation theory, and an upper-level model is developed with the minimum evacuation time and maximum connectivity reliability, while the lower-level is a traffic assignment model that describes people's evacuation route choice behaviour, with the objective of total utility maximization, and the regret-risk utility function is proposed as the lower-level model objective function, and an equilibrium condition to improve the Logit model based on the regret-risk utility function is also proposed. For the uncertain demand in the bi-level programming model, the Robust Optimization (RO) approach is used for its solvable transformation, and an Improved Genetic Algorithm combined with Non-dominated Sorting Genetic Algorithm II(IGA-NSGA-II) is designed to solve this model. The Nguyen-Dupuis network is used as a test network to demonstrate that the approach developed in this paper can be used to solve a multi-objective bi-level nonlinear programming model and to obtain a satisfactory design solution for self-evacuating transportation networks. Not only that, the risk aversion parameter and regret aversion parameter in the regret-risk utility function can be observed to have significant effects on the model solution through parameter sensitivity analysis. The Central Coast region of New South Wales, Australia is used as a case study, and the research output will help government authorities to plan and design a pre-disaster self- evacuation transport network.

Beyond Machine Learning: The Power of Large Language Models in Traffic Accident Management

Artur Grigorev, *University of Technology Sydney (UTS)*

Traffic accident duration prediction and severity classification are critical components in intelligent transportation systems, aiming for efficient traffic management and emergency response. Traditional machine learning models have exhibited reasonable performance in these tasks, but they often lack the ability to capture the complex linguistic features found in accident reports and textual accident descriptions. To address this gap, this study deploys eight different large language models, including BERT, MT5, XLNet, GPT-2, RoBERTa and large versions of these models, across three diverse accident datasets from the USA, UK, and Australia. Our comprehensive evaluation reveals that these language models can significantly outperform traditional machine learning approaches in some cases, while we observe nuanced differences that suggest a one-size-fits-all approach by moving to all NLP approach may not be optimal. The findings of this study hold significant implications for the integration of natural language processing techniques in intelligent transportation systems, promising more accurate and globally adaptable solutions for traffic management and public safety.

Resilient Tracks on Trash: Polymers to Enhance Safety and Stability of Railways on Landfills

Marwa Mohsen, *University of Technology Sydney (UTS)*

Ensuring safety and stability in railway construction, especially when built atop landfill waste material, hinges on the dynamic response of its substructure components. This paper delves into the performance of polymeric geosynthetic-reinforced closed landfill subgrades under the cyclic loading from trains. Using a cyclic triaxial apparatus, series of consolidated undrained tests were conducted. We incorporated non-woven geogrids, recognised for enhancing track stability in transportation due to their exemplary tensile strength and stiffness. Various geogrid layouts were assessed to gauge the impact of geogrid reinforcement on the mechanical behaviour of the landfill subgrade. Notably, the inclusion of geogrids led to marked reductions in permanent axial deformation. The findings further underscore the potential advantages of integrating geogrid layers into the subgrade. The findings equip practicing engineers with actionable insights for optimal material selection and design in railway constructions atop landfill waste. Emphasising reduced deformation, the results hint at longer-lasting railways with potential cost savings in maintenance. Such knowledge paves the way for resilient and efficient railway infrastructure.

Session 2.2 Active Transport and Placemaking

Movement Patterns of Pedestrians and Cyclists at Signalized Segregated Crosswalks

Cheng Zhang, *University of Wollongong (UOW)*

Interactions and conflicts between vulnerable road users, mainly pedestrians and cyclists, are frequently observed on crosswalks, especially in urban areas with relatively high traffic volume. To alleviate the potential safety risks, one possible measure is to adopt the segregated crosswalk to provide separate crossing space for pedestrians and cyclists. However, the crossing behaviours of pedestrians and cyclists at segregated crosswalks have rarely been investigated. To fill the gap, this study aims to investigate the movement patterns of pedestrians and cyclists at signalized segregated crosswalks. Field observations and data collection are conducted at a typical intersection with segregated crosswalks in Nanjing CBD, China. In total, trajectory data of 659 pedestrians and 1,212 (e-)cyclists is collected and analysed. The route choice and crossing speed of pedestrians and cyclists are explored, and multiple influencing factors are analysed. The research findings indicate that road users, especially cyclists, in the minor direction violate the segregation rule more frequently compared to road users in the major direction. It is recommended to adopt the segregated crosswalks mainly for unidirectional pedestrian and cyclist flow.

On the transferability of pedestrian demand models: Empirical insights from Sydney, Melbourne and Brisbane

Fatemeh Nourmohammadi, *University of New South Wales (UNSW)*

In this study, we present an approach to pedestrian demand estimation using household travel survey data from Brisbane, Sydney, and Melbourne. The study develops and compares classical statistical modelling approaches with more advanced machine learning models to compare the intricate relationships between socio-economic factors, land use patterns, and pedestrian demand. To assess the transferability of the models, we cross-validate each city-specific model using data from the other two cities. Findings reveal both the strengths and limitations of developed pedestrian demand models and their transferability. The research highlights the factors that contribute to successful model transferability and identifies key differences in pedestrian demand characteristics across the three study locations.

Incorporating ethics in the active network design and development

Mehrdad Memarpour, *University of New South Wales (UNSW)*

With a growing population, the demand for transport is also increasing which in turn contributes to more problems; from congestions and disparities in access to the jobs, to environmental and safety risks to the people. Regarding these issues, the policymakers need to address sustainability in their planning to properly control urban traffic flow to ensure the accessibility and smooth mobility of the network users.

In development of the active transport networks, the planners must decide on what design could serve both group of network users best while simultaneously is regarded as an ethical design. The challenge becomes more stark considering various financial and non-financial constraints they face in their decision-making processes. Hence, in their network development plans, the planners must not only define the ethical characteristics of a network and how to measure them, but also, they should address the tacit competition among the users for the limited resources in the network.

In this study we aim to develop ethical measures for different aspects of active transport network design including the street space allocation for both motorised and non-motorised users as well as the financing of the network. In doing so, we first draw on developing active links in a car-oriented road network through reallocation of the street spaces among all users. We also try to capture the flow interactions between users in case of shared lanes through modelling the problem as a non-linear bi-modal user-equilibrium optimisation model. In a separate attempt, we address the active network finance issue through designing a mechanism in which the stakeholders benefit from the network development are incentivised in an equitable manner to provide the financial resources required for the developments. The mechanism is modelled as a mixed-integer linear programming optimisation model and analysed under different scenarios for development and stakeholders' contributions.

Sharing Road Space: Modelling Shared Spaces with Agents with Diverse and Conflicting Goals

Delilah Slack-Smith, *University of Technology Sydney (UTS)*

Sydney's transport system accommodates a variety of transport options beyond automobiles. Ensuring the functionality and optimisation of a system with such a diverse traffic mix requires unique road infrastructure designs and traffic management solutions. To evaluate these solutions, intricate and robust models are necessary to comprehend its complexity. To improve upon the fidelity of available modelling tools, the research presented in this study enhances conflict avoidance and trajectory prediction within a microscopic simulation model.

The research has focused on shared spaces as a case study in multimodal street design. Shared spaces aim to provide equal priority to different modes of transportation, minimise physical separation and distractions, and incorporate elements like furniture, artwork, and nature to define the space. Shared space designs face difficulties however, such as: ensuring the safety of pedestrians, cyclists, and other vulnerable road users; and a lack of established guidelines, standards, and tools for their design and assessment.

To improve the efficiency, safety, and comfort of shared spaces, this project is focused on developing an enhanced shared space model. The model enhancements will include complex behaviours, including support for stationary pedestrians, modelling signal-controlled crossings, and activity areas like cafes and kiosks. The model will also include zones with specific states to enable signal-controlled crossings, and agent states to capture more realistic human behaviour in the presence of conflicting objectives.

Session 2.3 Freight and Logistics

Redefining EMS Efficiency: Beyond Response Time to Enhanced Survival Rate

Changle Song, *University of Sydney (USYD)*

Emergency Medical Services (EMS) play a crucial role in patient survival, especially in critical, time-sensitive situations. The allocation of overarching medical resources, from their classification to spatial distribution, down to the real-time dispatch of ambulances, is of paramount importance.

We initially introduced the concept of survival rate as a direct metric to evaluate the performance of the EMS system. This is a shift from traditional studies that primarily focus on optimizing the response time of EMS. Furthermore, innovative logistical methods are employed, moving beyond path selection and algorithms, to enhance patient survival rates.

From an operational standpoint, we compared various ambulance dispatch and reassignment strategies. We explored whether these methods could improve the outcomes of emergency incidents without unduly prolonging the waiting time for general patients. Simultaneously, we considered the current varieties of ambulances and their unique capabilities in handling different types of incidents. An effective dispatch policy can fully leverage the strengths of each resource.

In summary, when viewing EMS from the perspective of a transportation engineer, it can be understood as a specialized form of logistics. Building upon existing logistical frameworks, tailored solutions can make EMS more efficient.

Multi-hop on-demand courier-parcel delivery through spatial division of labor

Yue Yang, *University of Sydney (USYD)*

On-demand logistics services enable customers to place parcel orders online within a prescribed delivery time window. The surge in parcel volume poses significant challenges to meeting service expectations and uncertain demands. To optimize delivery efficiency, a common practice is to use a single-hop delivery approach, where no intermediate parcel transfer is allowed. This approach may result in under-utilization of supply capacities and hamper the ability to service parcels effectively. Multi-hop delivery, on the other hand, allows parcels to transfer between couriers in a single trip, making greater use of existing capacities and creating service opportunities that were previously unattainable. Under the assumption that couriers prefer to operate within smaller geographic areas to enhance their efficiency for local pickups and drop-offs, this paper addresses the real-time multi-hop delivery problem. The service area is divided into smaller courier regions, and each courier is assigned to a specific region, performing delivery tasks exclusively within their designated region. A set of accessible lockers is assumed to be placed on the edges of these regions, serving as transfer nodes. We propose two-phase heuristic algorithms, Dynamic Programming and Earliest-Completion-Time (ECT) algorithms, to tackle the multi-hop delivery problem. Experimental results for realistic settings demonstrate the advantages of multi-hop delivery services with pre-assigned courier operating regions. Our proposed methods outperform the single-hop delivery benchmark significantly, achieving more courier-parcel matchings, reducing total travel distance, and simultaneously enhancing customer satisfaction.

Uncovering the Determinants of Shippers' Willingness to Shift from Road to Rail Freight Transport

Kesewa Agyemang, *University of New South Wales (UNSW)*

Traditionally, shippers have preferred road transport to move their commodities from the point of production to the point of consumption. However, road transport's environmental and economic impact have become increasingly apparent, especially following the just-ended COVID pandemic. As such, a growing interest in inducing a modal shift in the freight movement from road to rail freight has increased exponentially. This shift can potentially influence the existing modal split, as rail transport offers lower carbon emissions, reduced road congestion, and lower transportation costs. Various factors influence the mode choice decisions of freight shippers, and modellers consider these factors within the perceived utility these shippers are assumed to maximise. However, this perceived utility varies for different shippers, even for the same commodity type, resulting in shippers choosing different modes for different freight trips. In this study, we look at revealed modal shift choice behaviours by estimating a discrete choice model to understand the key factors that induce modal choice. The estimated mode choice model applies a revealed preference data of import and export movement to and from one of the major Australian ports. The model estimation results show that shipments' weight, distance, rail mode accessibility and monetary value are highly relevant to modal shift choices. Specifically, the higher the monetary value of commodities such as agricultural and livestock products, the less likely shippers will use rail. Moreover, distance, weight, and mode availability play a crucial role in the mode choice behaviour of shippers. For example, longer distance increases the likelihood of using rail compared to road, and heavier commodities such as coal products are more likely to be shipped by rail than by road.

Enhancing Last-Mile Delivery Planning: Understanding Drivers' Preferences with Machine Learning

Zahra Nourmohammadi, *University of New South Wales (UNSW)*

In last-mile delivery logistics, drivers often choose routes based on personal preferences, favouring familiar roads over the shortest distance. This study proposes an innovative approach to learning drivers' routing preferences by integrating Adaptive Large Neighbourhood Search (ALNS) with a sampling technique and a Machine Learning (ML)-based optimization technique. While ALNS aids in finding the optimal solutions, the sampling and ML-powered optimization adapt and learn from historical data to align with the preferences of drivers and route planners. This process not only humanizes the delivery process but also infuses it with intelligent, data-driven decision-making. The study, validated with real-world data, showcases that this approach yields superior solutions, reflecting the preferences of drivers and planners more accurately. The findings represent a significant step forward in machine learning-powered last-mile delivery planning.

Anchored in sustainability: A system dynamics model for ship recycling in the Port of Newcastle

Veronica Schulz, *University of Sydney (USYD)*

While the maritime transport industry plays a pivotal role in the global economy, it faces the challenge of effectively recycling ships, which typically reach the end of their operational life in 25-35 years. The principal output of ship recycling is scrap steel, a valuable resource. Presently, this industry is concentrated in South Asia, particularly Bangladesh, India, and Pakistan, where roughly 90% of end-of-life ships, in terms of gross tonnage, are recycled. However, the extant industry is environmentally, economically and socially unsustainable, typically failing to meet the standards set by various regulations, including the International Maritime Organisation's Hong Kong Convention for the safe and environmentally sound recycling of ships. Moreover, the anticipated surge in end-of-life ships, driven by the impending transition of ships towards carbon-neutral fuels, necessitates an expansion of global ship recycling capacity. Simultaneously, for coal ports, diversification away from fossil fuels in the run-up to 2050 is paramount. To analyse the economic viability of a sustainable ship recycling industry at the Port of Newcastle, currently the world's largest coal port, a system dynamics model has been built. The pivotal role of the Port of Newcastle in the economy of the Hunter region, and Australia as a whole, emphasises the need for a successful transition from fossil fuels. A ship recycling industry within the Port of Newcastle not only has the potential to safeguard its future but also to position Australia as a leader in the future circular economy.

Stream 3 - Transport Modelling

Session 3.1 Public Transport

Modelling public transport disruptions and impact by smart-card data

Dong Zhao, *University of Technology Sydney (UTS)*

Evaluating disruptions in public transport (PT) utilisation is challenging due to often stochastic traveller behaviour and missing data information on affected services. This research proposes a new approach for modelling PT patronage and disruption impact using integrated data-driven modelling and the Fourier transform technique. Firstly, using tap-on and off information of smart-card data, we estimate in-vehicle passenger numbers to integrate as well as trips passing through the incident area. Secondly, considering the PT patronage pattern as a periodic function, we employ the Fourier transform to convert it into a sum of simpler trigonometric functions to filter out the one representing common data noise successfully and generate an accurate profile for a typical day. Thirdly, we introduce an enhanced sensitivity test to improve the model's ability to identify the impact of the disruption. Finally, multiple impact measurement methods are compared to capture the disruption impact. The findings demonstrate the effectiveness of leveraging in-vehicle count to maximise data volume and enhance impact identification. The PT patronage pattern can be effectively modelled using the Fourier transform. The utilisation of the enhanced sensitivity test can effectively filter out unnecessary trigonometric components, resulting in a refined model capable of accurately identifying the impact of disruption.

Adaptive Behaviour of Intelligent Agents under Schedule Disturbances in Rail Systems

Kevin Malysiak, *University of Wollongong (UOW)*

This research focuses on the application of intelligent, agent-based, adaptive approaches to address delays in transport services in the presence of multiple, overlapping service disturbances. The objective is to develop efficient, effective and cooperative approaches to adaptive rescheduling in a decentralised context in which agents representing transport entities take actions to reduce the impact of disturbances.

An agent model and its accompanying simulation environment is described. Intelligent agents in this model have been designed using the Belief-Desire-Intention (BDI) paradigm which supports proactive and reactive behaviour initiated by agent objectives and external stimuli from the agent environment.

Agents are modelled to represent train and station entities that act as a consequence of objectives so train agents can travel from origin to destination while making the best use of rail resources. Train agents travel through the network according to a predefined schedule while station agents manage entry to and departure from stations to prevent collisions. Station agents may prevent train agents from entering a station if platforms are fully utilised or from departing a station if tracks required are in use.

Schedule disturbances are introduced into the model as delays at given times and locations. Such schedule disturbances necessarily require trains to alter their speed and travel times. Train and station agents cooperate to deal with resource contention to facilitate the completion of journeys.

Experimental work has focused on passenger travel on segments of the Sydney rail network. An initial agent model has been established in which simulation of scheduled services has been validated. The introduction of simple disturbances has been established and agent behaviours defined to enable train and station agent cooperation.

Unveiling the Underlying Mechanics: Principal Stress Rotation's Impact on Railway Track Subgrade Behaviour

Lakshmi Nair, *University of Technology Sydney (UTS)*

Transportation is a vital element in the economic growth of any country in the world. Among all the transportation modes, railways are pivotal in catering to the ever-growing population's increasing demands. The most recurring challenge in the field of railways is track failure. The subgrade is the most vulnerable of all the track layers. Therefore, it becomes necessary to study the performance of the railway track subgrade in detail. The present study specifically addresses the issue of mud pumping on railway tracks. The laboratory experiments to study subgrade instability are primarily conducted on cyclic triaxial equipment. However, the Principal Stress Rotation (PSR) phenomenon affects the actual field condition. PSR is the rotation of principal stresses due to cyclic vertical and shear stresses resulting from a moving load. The axisymmetric loading condition applied in the cyclic triaxial apparatus fails to capture the true stress path in the soil underneath railway tracks and pavements. Therefore, it is imperative to study the effect of PSR to understand soil deformation behaviour when subjected to moving traffic.

A comprehensive investigation of subgrade soil behaviour collected from mud-pumping-prone site is imperative. Previous laboratory experiments on mud pumping primarily focused on cyclic triaxial tests but often overlooked the analysis of Principal Stress Rotation and its detrimental impact on subgrade health. This presentation aims to highlight the influence of Principal Stress Rotation on soil behaviour. The Hollow cylinder test's basic principle and application in transportation geotechnics is explained and compared with the conventional cyclic triaxial test to achieve this aim. Such a comparison highlights the significance of parameters overlooked when simulating traffic loading conditions solely through cyclic triaxial tests. The ultimate goal of the presentation is to emphasize the importance of studying stress rotation under actual traffic loading conditions.

The Role of Right Turns in Bus Operation

Tingsen(Tim) Xian, *University of Sydney (USYD)*

The higher traffic volumes, traffic signals, and right turns all significantly contribute to bus unreliability during operation. This highlights the importance of implementing additional bus priority measures, which reduce bus delay and improve reliability at intersections. Right turns (left turns in places that drive on the right side of the road) have historically been avoided in bus route design because of their contribution to unreliability.

Utilizing GTFS-Realtime Trip Updates and Vehicle Position data, we conduct a microscopic analysis of the effect of right turns on bus operation. First, we establish the statistical significance of right turns in increasing both mean and standard deviation of delay. Then, we analyze vehicle speeds and trajectories in the local environment of the right turn to understand the delay cause. Finally, we analyze two intersections for implementing bus right turn priority measures: a queue jump lane in the first intersection with three right turn lanes, and a novel bus right turn priority box in the second intersection with limited space.

We find that right turns during bus operation not only lead to delays relative to the schedule but also contribute to service unreliability. Based on speed map estimates with a spatial resolution of 5 meters along the bus trajectory, we prove that both the bus queue jump lane and the bus right turn priority box can effectively reduce bus right turn delay. For mitigating bus right turn delays, bus right turn priority measures should be considered in addition to routes that avoid right turns.

Session 3.2 Advancements in Transport Modelling

Bridging Decisions and Destinations: Advanced Computational Models for Household Decision-Making in Land Use and Transportation

Maryam Bostanara, *University of New South Wales (UNSW)*

The complexity of urban living demands multifaceted research to address converging issues of land-use, transport networks, and sustainability. Developed over an exhaustive PhD journey, this presentation outlines four innovative projects that collectively model household decision-making. These models account for socio-demographic variables, life-course events, and environmental factors, all aimed at fostering both affordability and sustainability in urban planning.

The first project utilizes a Bayesian time-varying hazard-based model to examine residential relocation behavior in Sydney and Chicago. This study underscores the crucial role of residential choices in land-use planning. It compares household behavior between Sydney and Chicago residents and explores the full benefits of Bayesian statistical modeling. The second project deploys a copula-based hazard model within a Bayesian framework to investigate the mutual dependencies between home and job relocations. This work significantly informs our understanding of how these two decisions are interrelated. The paper evaluates multiple copula formulations and includes data from both Sydney and Chicago. In the third project, machine-learning algorithms refine hazard-based models for residential relocation. Multiple algorithms and feature selection methods are evaluated, offering a benchmark comparison to traditional hazard-based models. The study further explores how home accessibility influences household decisions to relocate. The fourth project introduces a Dynamic Discrete Choice Modeling (DDCM) approach that offers a comprehensive understanding of human decision-making by seamlessly incorporating past and present data with future expectations into a unified model. This tool serves as an invaluable resource for time-sensitive policy interventions. The study incorporates affordability metrics, addressing a current and high-value concern in Sydney.

Collectively, these projects offer an intricate view of household decision-making mechanics and their subsequent impact on land-use and transport planning. They furnish empirical evidence and methodological insights that can inform policy strategies aimed at creating sustainable, affordable, and efficient urban ecosystems, thereby promoting both environmental sustainability and human well-being.

A Fuzzy Logic based Home based Work Trip Generation Approach using High-Frequency Data

Thivya Amalan, *University of Wollongong (UOW)*

Estimating trips generated from each traffic zone is one of the essential steps in the classic four-step transport planning model. Multiple linear regression, which is one of the most commonly used methods of trip generation, relies heavily on independent variables associated with the region. Updating these independent variables requires significant time and resources to conduct relevant types of surveys, such as Household Travel Survey (HTS). To address this issue, this paper proposes a fuzzy logic model to estimate home-based work and school related trip generation. Instead of relying on survey data, high-frequency data is adopted by the proposed model for the home based working trips. Among the different variables related to the trip generation model, the monthly electricity consumption and the floor area of households are considered valuable variables since they can be derived from several sources and updated frequently for working trips. Study also uses the pre trained deep learning algorithm to extract the building footprint to calculate the area of the households from the satellite imagery. The proposed fuzzy logic model was validated using HTS data in 2013 and predicted trip generation for 2019 in the Thimbirigasyaya Divisional Secretariat Division in Western Province, Sri Lanka. Results of numerical experiments showed a nonlinear relationship between the high-frequency data and the dependent variable, as well as good performance for the proposed approach.

Investigating the Value of Travel Time of Sydney Residents by Developing Time-use Models

Maliheh Tabasi, *University of New South Wales (UNSW)*

Willingness to pay (WTP) for improving different travel attributes, specifically travel time, is a crucial concept in transport infrastructure investment analysis. It has major implications in cost-benefit analysis and provides transport planners with insights on how to price transport services. This research will focus on investigating this fundamental concept for Sydney residents from various perspectives using different methodologies.

The utility maximization framework serves as the basis for the employed models. We began with a simple discrete choice modelling approach called the Multinomial Logit (MNL) model to investigate the value of time, as well as how incorporating a complementary SP data set in our MNL development on the RP dataset can help us reach statistically significant estimates for WTP. Next, we investigated the distribution of WTP using Mixed Multinomial Logit (MMNL) models, while incorporating the correlation among parameters. Following that, the Logit Mixed Logit model, introduced by Train, 2016, is employed to study the non-parametric distribution of WTP. This method reveals the underlying WTP distribution without imposing any restrictions. The findings can be incorporated into transport policy analysis. For instance, the multi-modality of WTP distribution.

The Value of Travel Time Saving (VTTS) comprises two components: the (dis)utility of travel time itself and the utility of activities that would have otherwise been undertaken. Therefore, VTTS is defined based on the value of working time, leisure time, and time-use patterns. As our next step, we will investigate individuals' time-use patterns by developing Multiple Discrete Continuous Extreme Value models (MDCEV) using time-use data. Then, we will implement Jara-Diaz et al.'s expanded microeconomic consumer theory model to estimate the different components of the value of time using time-use data, providing a holistic overview of VTTS for Sydney residents.

Incorporation of Non-Persistent Delays in Macroscopic Network Modelling

Xiaolin Gong, *University of Sydney (USYD)*

In a macroscopic assignment model, traffic flows are allocated to a transport network by means of a network loading model. The main output of network loading are travel times. The network loading not only disseminates flows across links, facilitated by a link model, but also governs flow transitions through intersections, represented by a node model. Notably, in urban settings, most travel time delays arise due to queue formations at intersections. Therefore, the efficiency and accuracy of node model is vital to be able to capture delays and corresponding flows. These intersection delays can be categorized into persistent and non-persistent delays. Contemporary flow-based models, such as the Cell Transmission Model and Link Transmission Model, do capture persistent delays through their embedded node models. However, they have limitations regarding modelling non-persistent delays, leading to potential discrepancies in travel delay predictions. In this work, we propose a novel methodology to integrate non-persistent delays into the link model without contravening the First-In-First-Out principle. To achieve this, a virtual link is implicitly incorporated into the link model representation, on which Webster's delay is reformulated in terms of its fundamental diagram representation, ensuring the inclusion of non-persistent delays in an elegant fashion. The proposed methodology offers a macroscopic resolution, meaning constructing average flow rates for each time instance considering the entire traffic signal control cycle. Finally, a generic solution algorithm is presented accompanied by a numerical example demonstrating how the proposed method works in a practical setting.

A Multi-stage Spatial Queueing Model with Logistic Arrivals and Departures Consistent with the Microscopic Fundamental Diagram and Hysteresis

Yang Gao, *University of Sydney (USYD)*

This paper establishes a spatial queueing model with a single bottleneck during the morning peak period. Firstly, based on the logistic function, we describe the arrival and departure flows in continuous and differentiable forms after calibrating the arrival flow and considering scenarios with constant or varying capacity. The model captures fundamental features of the morning peak flow, including the phenomenon of hysteresis loops appearing in fundamental diagrams (FDs) of density and flow. The multi-stage queueing model takes into account three different states in the link, that is, freeflow segment, transition segment, and queued segment, ensuring spatial continuity of flow and density. We consider the expansion of the queued segment and vehicle spillback under different bottleneck severities. The resulting FDs of speed and density also exhibit hysteresis loops. We calibrate model parameters using time-series traffic flow and density space-time maps based on real data. The obtained space-time maps of density and speed align with real-world scenarios and replicate the counterclockwise hysteresis loops of density and density heterogeneity. Furthermore, based on the model, we provide three-dimensional FDs at different locations in the link, all of which correspond to real-world scenarios.

Session 3.3 Transport Infrastructure Design and Construction

Decentralized intersection control: enhancing autonomous vehicle navigation and traffic efficiency

Alireza Soltani, *University of Sydney (USYD)*

In this research, we present a new, decentralized intersection control method that helps autonomous vehicles move through intersections without needing a central controller or a conventional traffic signal system. The proposed method tackles the intersection control issue by only requiring each vehicle to have sensors that detect nearby vehicles and assess their ability to safely cross the intersection, without explicit communication among all vehicles.

We propose a decentralized intersection control approach that uses distance-based and priority-based rules to manage autonomous vehicle movement at intersections effectively. Our simulation results show that this method reduces delays and improves intersection throughput compared to traditional signalized intersections. The proposed method can handle arrival flows of up to 6,300 vehicles per hour, with an average delay time of 10.3 seconds per vehicle. In contrast, traditional signalized intersections can have delays between 20 and 40 seconds per vehicle with arrival flows of 3,600 vehicles per hour.

Moreover, our simulations that the decentralized intersection control algorithm is at preventing deadlocks, a common problem in autonomous intersection management. This is done using distance based rules that identify vehicles within a specific range and closeness to the intersection.

The decentralized intersection control method offers more flexibility in handling different traffic demands and patterns. With its ability to adapt to changing traffic conditions in real-time, this new approach is well-suited for managing traffic fluctuations and unexpected events.

Towards a Capability Improvement Framework for Information Requirements Management on Rail Infrastructure Projects

Yu Chen, *University of Technology Sydney (UTS)*

Linear rail infrastructure networks are made up of interconnected cyber-physical systems. As the transport sector embraces digital twinning in support of more strategic approaches to asset lifecycle management, traditional approaches to requirements management (RM) during delivery are increasingly challenged due to the increasing complexity of requirements interfaces. Across the planning, design and construction stages, RM must now handle the technical requirements and specifications of the physical and digital assets, their respective software applications and the convergence of the physical and digital lifecycles with their corresponding software application lifecycle. With the introduction of digital twin creation processes during project delivery, RM must account for information requirements specifying the asset information model of the physical asset. This complexity is partially managed using project level data governance standards, which underpin the implementation of digital engineering processes and how data and information is expected to flow over the complete asset lifecycle. However, current RM practices are lacking a consistent and robust interface with new digital engineering process and data requirements. Such complexity presents significant challenges for RM practices when handling the myriad of requirement types across temporary project supply chains. This is a particular challenge during the planning and create/ acquisition stages of the asset lifecycle. Consequently, the RM effort needs to continuously account for a complex of requirements describing cyber, physical and digital systems. Adopting a design science research methodology, this research developed a capability improvement framework for data and information requirements management on rail infrastructure projects delivered using digital engineering. This framework defines four maturity levels, describing requirements processes, protocols and toolsets. This framework provides a checklist of activities, and a strategic RM guide to support both client-side and contractor organisations throughout project delivery.

Achieving greater circularity in the construction and demolition industry: A greater Sydney case study

Ze Wang, *University of Sydney (USYD)*

Facing urgent global challenges like climate change, the circular economy has become a key paradigm for sustainable development. However, the construction industry, a major environmental impactor, has been slow to adapt. As of 2022, only 9% of global materials were recycled. In Australia, particularly in New South Wales, construction waste is a major issue, with concrete being a significant contributor. The recycling of concrete into Recycled Aggregate Concrete (RAC) offers a sustainable path but faces logistical and carbon challenges. This study aims to fill this gap by focusing on concrete recycling in the Sydney area. Employing a system dynamics model, the research explores the complex interplay between recycling cost, landfill cost, logistics cost, recycling rate, and landfill rate. The study aims to provide actionable insights for policymakers and stakeholders, identifying critical factors that can optimize recycling processes, reduce associated costs, and enhance waste management efficiency. Our findings have direct implications for Sydney's waste management strategies, contributing to the achievement of recycling targets efficiently and fostering sustainable construction. Moreover, the study offers a valuable framework that can be applied globally, aligning the construction industry with the principles of the circular economy. This research thus serves as a timely and critical examination of the challenges and opportunities inherent in the transition towards a more sustainable construction industry.

Putting People First: Human Factors-Driven Infrastructure Design for Empowering Active Travel

Sara Haider, *University of Sydney (USYD)*

The necessity of active transport to be a prominent mode of travel stems from its ability to mitigate environmental impact, promote public health, boost economic vitality, and foster equitable and liveable urban environments. Recognizing these benefits, substantial investments continue to be made on improving active transport infrastructure in cities like Sydney, however, the adoption of active modes has remained below its potential. The presentation delves into the key decision-making factors that affect human mode choice, particularly the influence of travel demand, current human needs and long-term human goals on decision-making. We will explore the possibility of aligning infrastructure design and investments strategically towards facilities that maximize the adoption of active travel. Can we pave the way for a transformative shift in urban mobility towards active travel by integrating the complex web human drivers of choice at the core of transport infrastructure design where active travel becomes the more intuitive mode of travel for most?

POSTER PRESENTATION

P1. On-demand meal delivery: A Markov Model for Circulating Couriers

Dat Le, *University of Sydney (USYD)*

On-demand meal delivery has become widespread in cities worldwide, driven by meal delivery platforms. Accelerated by the pandemic, it had temporarily shut down restaurants. Couriers, typically on bikes, e-bikes, or scooters, pick up meals from kitchens, or multiple kitchens before delivering them to customers. This study introduces a Markov model with parameters to represent circulating couriers. Each kitchen and customer correspond to a parameter reflecting courier demand, and there is one parameter representing delivery urgency. The study demonstrates how to calculate the mean and variance of delivery time once these parameters are known. Two procedures for parameter calibration are presented: one that aligns courier visit probabilities precisely with known order probabilities and another that matches a known mean delivery time while closely approximating courier visit and order probabilities. Model calibration is demonstrated using a publicly available dataset from Grubhub dataset of meal orders, and an example illustrates how changing a kitchen's location can estimate the resulting shift in meal demand. Additionally, the Markov model, given the order data's origin-destination matrix for meal couriers, could be employed for courier trip assignment within a street network.

P2. Empirical evidence of habits and patterns in public transport use

Durba Kundu, *University of Sydney (USYD)*

People tend to change their travel behaviour around disruptive events. We hypothesise that a substantial fraction of public transport users has detectable regularised travel patterns and for some travellers, those patterns change in response to a disruption. This research tries to identify how travel behaviour patterns change in response to the disruptions like home relocation, the introduction of a new mode and weather conditions employing evidence from transit smartcard data of 5.5 years from Canberra.

This research uses a long baseline of transit smartcard data to identify patterns in traveller behaviour and analysis those to understand how those patterns can identify or respond to the disruptions. This study proposes to infer home locations using the Spatio-temporal boardings and alightings from smartcard data. The approach builds on spatial patterns where stops nearby the home are used more frequently and reinforced with temporal habits where days begin and end at home. The inference of a home location is a necessary foundation for examining patterns in home-based travel and the behavioural impact of home relocation.

In contrast, the opening of Canberra's light rail transit system is a disruption experienced by the entire network, and the timescale of new habit formation can be directly compared across card IDs. Building upon the earlier work inferring home location, the spatial proximity of the cardholder to the light rail transit system is used to understand variation in the impact. The outcome of the study can be used to understand better how public transport users might be susceptible to change their travel behaviours in response to disruptive events. It is essential that the ACT government should monitor travel behaviour changes during key moments relevant to disruption. Our findings will inform network design, service design, and enable public transit providers to improve how information is conveyed to users.

P3. The impact of the built environment on active travel mode choices among school students in NSW, Australia

Laya Hossein Rashidid, *University of Sydney (USYD)*

Over the past three decades, active transport to school (ATS) has declined, despite its manifold health, economic, environmental, and social benefits. Although the built environment resembles that of 30 years ago, spatial variations in active travel suggest that built environment attributes are important in supporting decisions to walk or bike. A better understanding of the built environment correlates of active travel to school will enable interventions that reverse this trend.

My PhD program focuses on the “6Ds” framework of the built environment: design, density, diversity, distance, destination accessibility, and demand management. It aims to gauge how the built environment influences student mode choice, with a focus on promoting active modes. To accomplish this, I've employed data from the 2015 School Physical Activity and Nutrition Survey (SPANS), encompassing a demographically representative sample of K-10 students in New South Wales. I've enriched this dataset with additional built environment data surrounding schools.

In the initial phase, I used a logistic regression model to assess active travel patterns among 7,555 students. I also determined the distribution of elasticity of active mode choice with respect to distance, factoring in demographics and geography. Results revealed that this elasticity varies among age groups, genders, school sectors, distance ranges, and land-use types. These findings suggest that increases to the typical 1-2km catchment sizes will deter ATS, as students are highly responsive to even minor distance increases in this travel distance range.

In the ongoing phase, this work has been further developed with a nested logistic regression model assessing how the “6Ds” affect students' choice of car, public transit, or active modes. Preliminary results indicate that incorporating built environment factors into this model improves the fit and alters the sign and significance of socio-economic coefficients.

P4. Analysis of Alcohol- and Drug-Related Crashes in South Australia and Victoria

Amin Shaer, *University of Sydney (USYD)*

Driving under the influence (DUI) of alcohol and drugs is a major contributor to road crash injuries and fatalities. In Australia, for example, this issue accounts for more than 20% of fatal road crashes every year. The context of alcohol- and drug-related casualties (ARC and DRC, respectively) has been extensively studied worldwide, contributing to a rich body of literature. Despite the considerable attention given to the broader topic, there seems to be a lack of effort in the investigation of DUI-related crashes by considering road factors and environmental characteristics in the states of South Australia (SA) and Victoria (VIC). To fill this gap, we aim to study influencing factors on injured and fatal ARC and DRC in SA and VIC. We applied an ordered logit model to road crash datasets of SA and VIC. Our results reveal that driving on country roads significantly influences the number of DUI-related casualties per link in both SA and VIC. Furthermore, driving on undivided segments and local roads increases the number of ARC per link in VIC. Additionally, undivided roads, curved segments, and hills positively affect the number of DUI-related casualties in SA. Further findings showed that high- and medium-speed limit segments negatively affect the number of ARC per link in SA. By shedding light on the specific characteristics of DUI-related casualties in SA and VIC, policymakers can devise strategies that address the distinct issues faced by each state. Ultimately, the findings of this study have the potential to enhance the effectiveness of law enforcement, educational campaigns, and rehabilitation programs targeted at reducing the prevalence of DUI-related casualties.

P5. Tracing the Behavioral Performance of Drivers in a Car-Following Simulator Experiment: A Multi Mental Workloads and Traffic Flow Conditions Study

Mobina Faqani, *University of Sydney (USYD)*

In an era where driving under distractions is a significant threat to road safety, understanding driving style under various mental workloads is paramount. This study presents a comprehensive investigation into driver behavior through a car-following experiment. Three mental workloads - normal driving, hands-free Bluetooth mobile phone call, and sending a text message - were implemented, each subjected to four steady conditions (free flow, coherent-moving flow, synchronized flow, and jam) and two complementary conditions (recovery from traffic jam and collision avoidance). A K-means clustering algorithm was used to unravel driving style. Through this methodology, we clustered drivers into two distinct clusters assigning them labels based on their driving styles. By comparing the resulting driver labels across all three experiments, we gain valuable insights into how distractions and traffic conditions influence driver behavior. This research contributes to the development of intelligent transportation systems and driver assistance technologies aimed at enhancing road safety. The insights gained from this study can inform the design of interventions and driver training programs tailored to mitigate the adverse effects of distractions and improve driver awareness and decision-making in various traffic conditions.

P6. Resilience Assessment of Urban Rail Transit Stations

Xiaowei Liu, *University of Wollongong (UOW)*

Evaluating and improving the ability of urban rail transit (URT) stations to cope with operational disturbances is of great significance for improving the operational service level in an increasingly complex transportation environment. Based on queuing theory and stochastic user equilibrium assignment, a calculation method of passenger travel time in the station is proposed, incorporating with the topology network of the station facilities and equipment. The applicability of the proposed method is verified by simulation. Based on the service level without disruption, a time-varying performance indicator is constructed from the perspective of passenger travel efficiency. On this basis, station resilience under four types of daily disturbances can be evaluated, including passenger flow disturbance, facility and equipment disturbance, walking path disturbance, and train operation disturbance. A case study on Simaqiao station of Chengdu Metro is carried out. The results show that the station can effectively deal with the adverse effects of most daily disturbances on its operations. However, it has poor resilience under disturbances such as passenger flow outbursts or transfer ladder failure. Finally, according to the resilience assessment results, relevant suggestions are put forward for the key factors affecting the station resilience to improve the operational service level of the station.

P7. Enhancing Safety Analysis Through Microscopic Traffic Modelling

Seyedehsan Seyedabrishami, *University of Sydney (USYD)*

Microscopic traffic models, specifically the Car Following Model (CFM) and Lane Changing Model (LCM), are fundamental components for analysing and optimising traffic operations. However, an equally critical aspect is the ability to predict potential crashes effectively. In this research, we present CFM and LCM models specifically designed to meticulously simulate vehicle movements at a microscopic level, ensuring that the distances between adjacent vehicles closely mirror real-world conditions. These models excel in recreating the distribution of distances between adjacent vehicles in various lanes, facilitating the assessment of crash likelihood. To achieve this objective, we adopt a two-step calibration approach involving linear regression models. The first step, referred to as "fast calibration," entails estimating all coefficients through ordinary least squares based on observations to predict vehicle longitudinal and lateral acceleration. Subsequently, in the second calibration phase, our aim is to minimize errors in distance estimation between adjacent vehicles by fine-tuning the coefficients derived from the previous calibration step. The resulting histograms of simulated distances between vehicles demonstrate a striking resemblance to real-world observations, particularly for distances less than 10 meters. The coefficient of determination between observed and estimated distances between adjacent vehicles consistently ranges from 0.77 to 0.99, except for distances from the right preceding vehicle, where limited real-world data is available. Furthermore, our proposed model successfully replicates the distribution of vehicle speeds observed in actual traffic flow, ensuring a comprehensive representation of real-world scenarios. The significance of this research extends to its potential applications in predicting crashes in transport infrastructure settings where crash data is scarce or unavailable. Moreover, the model proves invaluable in newly implemented traffic systems, where a proactive approach to crash prediction and management is paramount. The CFM and LCM models put forward in this study contribute significantly to the advancement of traffic safety.

P8. Development of Activity-Based Modelling Leveraging Novel Deep Learning Methods

Yuanchen Ma, *University of New South Wales (UNSW)*

The rapid evolution of urban agglomerations has propelled urban transportation systems towards greater dynamism, comprehensiveness, and complexity. Consequently, there is an increasing need for more effective transportation policies and nuanced urban planning. To address this demand, transportation modellers are turning to activity-based modelling (ABM) as an alternative to traditional four-step models. ABM, unlike its predecessor, requires granular individual-level travel activity data that is derived from various survey data to serve the discrete choice models at the individual level for activity and trip assignment. Despite its promise, ABM struggles to accurately interpret fundamental travel behaviour patterns and the complexities between travel choices and activities. Our research seeks to bridge this gap by introducing a deep learning-based approach to enhance ABM. Deep learning models excel in identifying underlying patterns and relationships within datasets, highlighting a promising future for capturing fundamental travel behaviour patterns. Our focus extends beyond precision in predicting transportation activities, we also aim to gain profound insights into the impact of various factors on travel demand and decisions. To achieve this, our work involves applying deep learning techniques leveraging Victorian Integrated Survey of Travel and Activity (VISTA) data to model travellers' choices, including but not limited to destination choices, travel mode choices, and departure time preferences. By evaluating multiple models for each choice, we aim to identify the most effective ones. Ultimately, our goal is to supplant the discrete choice models of ABM with our deep learning models. We will also leverage SHapley Additive exPlanations (SHAP) as an explainer to unveil the contributions of individual features. In doing so, our research aims to provide a comprehensive understanding of individual behaviour patterns and the underlying reasons for each travel decision, contributing to more informed policy-making and urban planning.

P9. Household Relocation and Cost of Travelling: a CGE Framework for Strategic Transport Appraisal

Jason Wang, *University of New South Wales (UNSW)*

Transport appraisal is a key aspect of determining the suitability of a transport policy or infrastructure project, most often done via a cost-benefit analysis (CBA). Urban computable general equilibrium (CGE) models have been used as an alternative for appraisal, with the goal of capturing wider economic benefits (WEIs) that are not typically captured in traditional CBAs. Their complexity however means that urban CGE models often lack features critical to the appraisal process. The poster presents a novel integration of residential relocation and complex travel behavior in a CGE model framework. Individual models with each of the two exist, where sequential, iterative application of the two may be used by an analyst in a cost benefit analysis; to the best of our knowledge, no framework however has combined both for transport appraisal purposes, despite plentiful literature on the importance of both in the development of an economy. A CGE model framework that integrates both endogenous residential relocation and complex travel behavior is proposed. A case study of Sydney, Australia, is presented to illustrate the importance of this integration. We find that without relocation, the benefits of projects can be greatly underestimated, leading to the possibility of incorrect negative feasibility evaluations.

P10. A New Measure of Similarity between Routes

Haotian Wang, *University of Sydney (USYD)*

Route choice prediction can be seen as a discrete choice problem. However, the alternative routes in the choice set are not fully independent of each other, which differs from many other choice problems. The chosen route and other alternative routes in the choice set can share some links, have almost the same attributes, or be located adjacently. These similarities increase the difficulty of modelling but also make the incorrect route choice prediction still useful. However, the common evaluation criteria from the confusion matrix, like sensitivity, specificity, and precision, cannot measure the similarity between routes. The overlap rate for evaluating the choice set cannot distinguish the similarities of the non-overlapped parts of routes. Therefore, this study proposed a new measure of similarity that includes overlap rate, attribute similarity, and spatial similarity. One case study with a simple grid network and four predicted routes is designed to show the calculation process and some special cases. A real-world GPS data set from the 2010 Travel Behavior Inventory (TBI) is applied in a second case study. Random Forest is applied in the second case study to predict people's route choices. The proposed overall similarity measurement is applied to evaluate the model performance. Finally, with a 98% threshold, the predicted routes of the 6% of routes that are not correctly identified in the testing set are found to be highly similar to the chosen routes, and two examples from these predicted routes are presented.

P11. Battery Attack Detection in Unmanned Aerial Vehicle using Artificial Intelligence

Arupa Sarkar, *University of Wollongong (UOW)*

Unmanned Aerial Vehicles (UAVs), known as drones, attracted research and development fields due to their potentiality in sectors like emergency services, healthcare, agriculture, media coverage, atmospheric mentoring, object detection, surveillance, vehicle tracking, and data collection. However, UAV-based systems are facing many vulnerabilities and security issues, such as GPS jamming and hacking. Despite many anticipated features, the UAV deals with some constraints, such as limited battery life and battery weight. Hence, it is very important to complete the UAV operations in energy efficient way without losing data integrity and confidentiality. Further, it is crucial to maintain battery health and functionality as the battery is the primary source of energy. The Depletion of battery attack (DoB) causes the operation failure and drone crashes. In this kind of security attack, the energy of a device is depleted to process unexpected activities. The purpose of the attackers is to force sensors to waste computing time on energy-consumption tasks, e.g., processing garbage data, and thus vastly deplete the power of victim nodes without authorised permission. Moreover, battery depletion attacks could lower the system performances that causes reducing flight duration and crushing the drones. Developing an artificial intelligence (AI) techniques-based battery depletion attack detection is in demand, which has not been well addressed in previous research studies. This research will use a data-driven energy consumption model to train the UAV that can detect unusual battery depletion to identify the attacks. To do this, the first step is to develop an AI-based energy consumption model to identify the abnormality. The proposed model will receive a sequence of input data and predict the corresponding energy consumption as output. Then, this study will use deep learning algorithms and a fuzzy logic approach to detect the attack and then apply performance analysis to select the best approach in attack detection.

P12. Long short-term memory neural network modelling of bottleneck pedestrian evacuation based on transfer learning

Qiuyun Luan, *University of Wollongong (UOW)*

In order to improve the robustness and reliability of the microscopic simulation model in bottleneck areas for pedestrians' evacuation movement, considering that existing evacuation simulation models based on neural networks lack the ability of generalization, a new modelling approach using Long Short-Term Memory neural network with transfer learning is proposed to simulate the crowd evacuation at bottleneck areas. Using the pedestrian trajectory data from a bottleneck pedestrian flow experiment considering three different sizes of bottleneck structure. The proposed LSTM model is trained with the parameters representing the interactions between the pedestrian, building structure and other pedestrians as independent variables and the coordinates of the pedestrian in the next step of movement as the dependent variables. The data of S1 is used to train the LSTM microscopic simulation model, and three evaluation indicators are used to evaluate the results of the model simulation by comparing the three types of data as model input and the number of different LSTM hidden layers. The results show that the best performance of the model can be obtained by using the input data of one backward time step and two hidden layers, and using transfer learning can greatly increase the generalizing ability of the model. The model using transfer learning can adapt to different modeling scenarios and performs best with the training strategy of freezing the LSTM layer and tuning the three fully connected layers.

P13. Optimizing Transit Planning for the Evacuation of Vulnerable People During Natural Hazards

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The consequences of natural hazards are becoming increasingly severe, significantly impacting Australia's built environment. These devastating events challenge community resilience and infrastructure stability, highlighting the urgent need for adaptive strategies and disaster preparedness. Disasters affect individuals differently, with certain social groups being more vulnerable and at greater risk. The Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) introduced the concept of people-centred disaster risk reduction policies, emphasizing the challenges faced by vulnerable populations during disasters. One significant concern during natural hazards is the evacuation of people from affected areas, particularly those who are transit-dependent, such as vulnerable residents. Evacuating vulnerable individuals is a complex operation due to their limited mobility and potential health issues, along with transportation planning challenges like road closures, time constraints, and shelter availability. Various transportation systems, including emergency buses, taxis, ambulances, and aeroplanes, are utilized to transfer people from disaster-stricken areas to safe shelters. In this study, we address the problem of efficiently scheduling and routing these vehicles to transport vulnerable individuals from affected areas to secure shelter locations using the safest routes within specified timeframes. This is formulated as a vehicle routing problem with the objective of minimizing the total evacuation time. Our computational findings are illustrated through a case study in New South Wales.

P14. Optimizing signal control at continuous-flow intersections considering traffic progress

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Continuous-Flow Intersections (CFI), also known as Displaced Left-Turn (DLT) intersections, aim to improve the efficiency and safety of traffic junctions. A CFI introduces additional sub-intersections upstream of the main intersection to split the left-turn flow from the through movement before it arrives at the main intersection, which decreases the number of conflict points between left-turn and through movements. This study develops a two-step optimisation model for CFI traffic signal control design and demonstrates its performance across 18 different travel demand scenarios. The model is also compared with a state-of-practice CFI signal control model as a benchmark. Simulation results suggest that the proposed model reduces average delay by 30% and average queue length by 21% compared with the benchmark for a full CFI across a variety of demand patterns.

P15. Enhancing public transport accessibility: Should we use feeder bus or shared-bike system?

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Both feeder buses and shared bikes could be used to address the first-and-last-mile issues associated with public transport use. Budget constraints and geographical conditions mean that practitioners typically have to make a choice between the two systems. Which system is more suitable given customer's preferences and the geographical setting? This study investigates factors that determine public transport user's choices of feeder services using a discrete choice modelling approach and revealed preference data. Specifically, smart card data of bus and bike sharing in Taiwan are processed, and trips that can be served by both modes are used to develop a behaviour model for policy analysis and future planning. Modelling results provide evidence-based implications for policy and planning practice that aims to use feeder buses and/or micro-mobility services to supplement the existing transport network.

P16. Implication of AVs operational models on accessibility and transport-related social exclusion

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Transport-related social exclusion (TRSE) occurs when individuals are prevented from participating in societal activities due to limited accessibility to these opportunities, particularly in societies structured around the assumption of high mobility. As we transition into the era of autonomous vehicles (AVs), there is a growing concern that social exclusion may exacerbate. Different factors such as the digital divide, changes in preference for residence locations, changes to transport services, among others, could further exclude certain groups from reaping the benefits of AV technology. Addressing transport-related social exclusion necessitates a comprehensive examination of various dimensions of accessibility. These dimensions encompass aspects related to land use, transportation systems, individual capabilities, and temporal factors. Different AVs operational models will impact these dimensions of accessibility in diverse ways. Previous research has explored the impact of operational models with varying assumptions, leading to inconsistent findings - some contradicting while others supporting findings of other research. While these studies have predominantly focused on assessing the influence of these models on dimensions of accessibility, there is still a dearth of knowledge on the effect of TRSE. To address this gap, our research seeks to investigate how different AVs operational models affect accessibility components, and consequently, how the cumulative impact on these dimensions influences the occurrence of TRSE. By addressing this issue, we aim to provide insights that can inform policies and strategies to mitigate TRSE in the evolving transportation landscape of autonomous vehicles.