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ABSTRACTS
OF
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Best Research Gold Award

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Transport à Haut Niveau Service

STOCHASTIC DRIVER MODEL BASED CONTROLLER FOR HUMAN-LEAD VEHICLE PLATOONING

Shuhan Wang, Jia Hu, Yiming Zhang
College of Transportation Engineering, Tongji University

Key Words： CACC, Vehicle Platooning, Human-Lead Platooning, Stochastic Model Predictive Control

Abstract： Human-Lead Cooperative Adaptive Cruise Control (HL-CACC) stands out as a promising technology for vehicle platooning in practical applications. By employing a Human-driven Vehicle (HV) as the platoon leader, HL-CACC effectively reduces costs and enhances the reliability of perception and decision-making. However, current HL-CACC technologies face significant challenges in ensuring driving safety due to the leading human driver's uncertain behavior. This study introduces a Cooperative Adaptive Cruise Control (CACC) controller for maneuvering a human-lead platoon. The controller addresses the uncertainty associated with the human-driven leader by predicting their future driving intentions. Key to its design is the integration of stochastic prediction models for the leading vehicle's state and scenario-based stochastic model predictive control (scenario-based SMPC). The proposed controller has the following features: i) comfortable cruising in traffic with fluctuating speed; ii) safe cruising with string stability guaranteed; iii) fast computation for real-time implementation. The proposed controller is evaluated on a PreScan&Simulink simulation platform. Results reveal that the proposed controller: i) ensures comfort cruising by maintaining a stable speed and acceleration when the human platoon leader introduces oscillation; ii) enables the followers to anticipate the speed change of the leader vehicle and take action in advance to guarantee safety; iii) is confirmed with string stability; iv) is verified to be ready for real-time implementation.

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A NON-COOPERATIVE GAME FOR ANALYSING HIGH-SPEED RAIL AND AIR COMPETITION

Tahseen Bashir[1],Francesca Pagliara[2], Lina Mallozzi[3],Guglielmo De Lulio[4]
[1,2,4]Department of Civil, Architectural and Environmental Engineering, Univeristy of Naples Federico II
[3]Department of Mathematics and Applications, Univeristy of Naples Federico II

Key Words： High-Speed Rail, Air Transport, Competition, Game Theoretical Approach, Value of Time

Abstract： In the literature, many contributions have been published on the direct and indirect impacts of the High-Speed Rail (HSR) system and its competition with the Air transport mode. In this contribution, the case study linked to the construction of a new HSR with a strategic hub in the city of Bucharest (Romania) has been analyzed using a Game Theoretical Approach. Specifically, the line consists of 2 main corridors. The first one called the Northern Balkans Corridor, aiming at connecting the capital of Romania, Bucharest, with the capital Hungary, Budapest, with stops in the stations of the cities of Brasov, Cluj- Napoca, and Debrecen. The second one named the Southern Balkans Corridor, connecting the capital Bucharest to the Greek capital Athens passing through the Bulgarian capital Sofia, which makes intermediate stops in the stations of Thessaloniki (Greece) and Pleven (Bulgaria). The HSR-Air competition issue has been studied with reference to the Bucharest-Budapest corridor (the Northern Balkans Corridor) and the Bucharest-Sofia corridor (first section of the Southern Balkans Corridor). The introduction of HSR into a market where Air transport is currently the only fast travel option between cities could significantly influence the market equilibrium. It is anticipated that HSR will attract part of the demand that previously chose Air travel between the same cities, especially among those with a higher Value of Time (VOT), while also generating new induced demand. Moreover, the entry of a competitor as HSR would lead to a reduction in air fares compared to the previous situation, where the air market had the monopoly. The introduction of HSR offers significant environmental advantages, such as the reduction of greenhouse gas emissions and lower consumption of non-renewable resources compared to Air transport. From a social perspective, HSR improves accessibility and inclusion, making travel between cities more accessible to a broader range of users. This not only enhances users' mobility but also promotes regional integration and sustainable tourism. The analysis shows how HSR can become a catalyst for economic growth

and sustainable development in the regions served by the new corridors, providing an environmentally friendly and socially inclusive alternative to Air transport.

Best Research Silver Award

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EVALUATING TEMPORAL VARIATIONS IN ACCESS TO MULTI-TIER HOSPITALS USING PERSONAL VEHICLES AND PUBLIC TRANSIT: IMPLICATIONS FOR HEALTHCARE EQUITY

Ziqi Yang, Yuntao Guo, Xinghua Li
Urban Mobility Institute,Tongji University

Key Words： Healthcare Accessibility, Equity, Public Transit, Personal Vehicle, Temporal Variations

Abstract： Understanding healthcare accessibility, or the ability to access healthcare services, has significant implications for both individual well-being and community equity. However, existing studies seldom account for temporally varying factors such as traffic conditions and hospital schedules, resulting in miscalculation of accessibility. This study addresses this gap by introducing a framework that evaluates accessibility to multi-tier hospitals, factoring in both spatial and temporal aspects, using public transit (PT) and personal vehicles (PVs), and assesses its impact on horizontal and vertical equity. Implemented in Shanghai, China, we employ the Gaussian two-step floating catchment area method for accessibility quantification and utilize map APIs for dynamic travel time data. Our analysis reveals: (i) notable temporal fluctuations in healthcare accessibility, especially for PT, and their significant impact on both horizontal and vertical equity due to varying travel times and hospital schedules; (ii) larger disparities in higher-tier hospital accessibility compared to lower-tier ones; (iii) greater horizontal equity using PV-based accessibility and higher vertical equity using PT-based accessibility. These findings highlight the need to offer customized transit to healthcare facilities, expand telehealth services, incorporate equity in healthcare resource allocation, incentivize healthcare professionals to work in underserved areas, and develop outreach programs to improve accessibility and equity.

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STRATEGIZING SUSTAINABILITY AND PROFITABILITY IN ELECTRIC MOBILITY-AS-A-SERVICE (E-MAAS) ECOSYSTEMS WITH CARBON INCENTIVES

Haoning Xi
The University of Newcastle

Key Words： Electric Mobility as a Service (E-MaaS) Ecosystem, Multi-Leader Multi-Follower Game (MLMFG), Mobility Resource Allocation, Alternating Direction Method of Multipliers (ADMM)

Abstract： Electric Mobility-as-a-Service (E-MaaS) emerges as a promising solution for environmentally- friendly mobility in the future, yet MaaS operators have been struggling to achieve profitability. We introduce a novel E-MaaS ecosystem where platforms can leverage carbon credits revenue from the government's emissions reduction fund (ERF) by incentivizing travelers to choose more E-MaaS services, thereby reducing carbon emissions. In such an E MaaS ecosystem, travelers can select either electric (E)-MaaS or traditional (T)-MaaS services and submit heterogeneous service requests, such as distance, service time, tolerance for inconvenience, and travel delay budget, which are modeled as inputs. We propose a multi-leader multi-follower game (MLMFG) model where each leader (MaaS platform) competes to maximize its profits by making operational decisions such as pricing, EV acquisition ratio, and E(T)-MaaS bundle allocation while anticipating travelers' participation levels. In response to the platforms' decisions, each follower (traveler) aims to minimize her travel costs by determining the participation levels for E(T)-MaaS services via multiple MaaS platforms. We develop a customized alternating direction method of multipliers (ADMM) algorithm to solve the proposed MLMFG efficiently. Comprehensive numerical experiments based on real-life data in Australia demonstrate the convergence and robustness of the proposed ADMM algorithm. Further, experimental results reveal how factors such as market size, travel demand, ERF budget, subsidy rate, and unit price boundaries impact the profits and operational strategies of different MaaS platforms. Overall, the proposed MLMFG model for the E-MaaS ecosystem provides valuable insights for MaaS operators aiming to balance profitability with environmental responsibility, navigating a future where sustainability and profitability goals could converge.

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SIMULATING THE IMPACT OF CLIMATE CHANGE ON TRANSPORT INFRASTRUCTURE IN THE MEDITERRANEAN CITY OF THESSALONIKI

Apostolos Papagiannakis
School of Spatial Planning and Development, Aristotle University of Thessaloniki

Key Words: Climate Change Impact, Environmental Simulation, Sea Level Rise, Urban Heat Island, Transport Resilience

Abstract: Long-term planning and operation of transport systems must increasingly consider climate change and extreme weather conditions. Multiple risks, such as coastal and urban flooding, sea level rise, extreme temperatures, drought, and wind, are relevant. This research project aims to achieve two objectives through two case studies: first, to assess the impacts of sea level rise to identify vulnerabilities of transport infrastructure in the Greater Thessaloniki area; second, to investigate the Urban Heat Island (UHI) effect in a typology of streets in the city's central area. The first case study covers a coastal zone 60 km long and 2 km wide across five municipalities. Using cartographic data from Climate Central's Surging Seas Risk Zone Map, land use data from Corine Land Cover, and population data from the Hellenic Statistical Authority, two scenarios of sea level rise (0.5 and 1 meter) were simulated with GIS. Under the most likely scenario of a 0.5 meter rise by 2100, 1.87% of the coastal road network will be submerged, rising to 3.07% under the worst-case scenario of 1 meter. At the same time, the disruption of the road access to the airport in both scenarios, the vulnerability of some parts of the port, and their potential inability to operate are highlighted. The second case study focuses on the simulation of microclimatic conditions and the impact of environmental street design strategies on thermal comfort in a typology of streets using the ENVI-met 5.1 software. The streets were selected using criteria such as road functional classification and orientation, land use, building height/street width ratio, the sky view factor, and the continuity/discontinuity of buildings. The results showed that a middle-aged person experiences extreme heat burden when exposed to the sun, which is the case at pedestrian crossings. The heat stress is significant even in shaded areas in the existing situation, but the improvement is significant when environmental urban design measures are applied. The perceived air temperature (Physiological Equivalent Temperature - PET index) can be reduced by up to 10 °C in well-shaded locations and near building corners. The combined results of the two case studies point to the need to plan and build resilient transport systems, as well as to coordinate and implement specific climate change adaptation measures for transport infrastructure in Mediterranean cities such as Thessaloniki, which already face high climate risks.

Best Research Bronze Award

TRUSTED PERCEPTION METHOD FOR TRAFFIC SIGNS THAT ARE PHYSICALLY ATTACKED

Qunyao Tan, Shize Huang, Zhaoxin Zhang
College of Transportation Engineering, Tongji University

Key Words： Automatic Vehicle Detection and Identification Systems, Safety, Traffic Signal, Vehicle–Highway Automation, Hazard Perception

Abstract： Traffic sign recognition is a crucial method by which autonomous driving systems acquire road information, and is predominantly based on deep neural networks (DNNs). However, the recognition results of DNNs are not always trustworthy for traffic signs subject to abnormal disturbance. Recently, the phenomenon of adversarial examples successfully deceiving DNNs has garnered considerable attention. Because DNN-based computer vision techniques are becoming increasingly prevalent in traffic scenarios, the misclassification of attacked traffic signs by DNN classifiers poses serious safety hazards. Although numerous methods have been proposed for crafting physical adversarial examples that are robust in the real world, most existing defense approaches focus on digital attacks, which necessitate the adversary infiltrating the embedded system; thus, it becomes challenging to obtain results. A reliable approach for defending against physical adversarial traffic signs enables autonomous vehicles to achieve trusted perception of traffic signs. In this paper, we present a deep image prior-based pipeline to defend against robust adversarial traffic signs in the real world, an approach that circumvents the need for prior data sets during training. Our approach protects the safety of autonomous vehicles by performing image reconstruction of captured traffic sign images. The genuine traffic sign class can be inferred by leveraging the consistency of the victim classifier's decision results for reconstructed images at different stages. Additionally, we evaluate the efficacy of our defense pipeline for detecting other potential types of physical adversarial traffic signs that may exist in the real world, thus demonstrating the generalizability of our approach.

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ACCESS TO BASIC AMENITIES VIA PUBLIC TRANSPORT IN RURAL AREAS IN THE MEDITERRANEAN. IS IT FEASIBLE AND EQUITABLE? WHAT ABOUT FUTURE PERSPECTIVES?

Stefanos Tsigdinos
National Technical University of Athens

Key Words： Accessibility, Rural Areas, Equity, Public Transport, Scenarios

Abstract ： Using public transport to access essential facilities such as public services/administration, healthcare, post offices, grocery stores, supermarkets, etc. should be truly embraced in the sake of sustainability and inclusivity. Urban areas are undergoing significant transformations in this direction. However, what about rural areas? Inefficient public transport services often encountered in those areas, hinder equitable access, thus cultivating “a car-dependent transport realm” for their residents. Which should be the key solutions for enhancing accessibility and equity? In this context, this research investigates the levels of public transport accessibility to basic amenities in rural areas of the Mediterranean, assessing both current conditions and future potentials through scenario testing. Additionally, the study explores the equity implications for households lacking personal motorised vehicles. The study area is the municipality of Amari in Crete, Greece, characterized by a prevalent reliance on cars in daily life. Four distinct scenarios are examined; the first assesses the existing condition, the second proposes a redistribution of basic amenities, the third explores the expansion of the public transport network, and the final one suggests both new amenities and new public transport routes. Employing spatial analysis techniques and welfare economics, helps measure accessibility and equity conditions in the study area. The findings show that implementing combined solutions could significantly enhance both accessibility and equity, potentially reducing car usage to a certain extent. However, an intriguing finding is that when implementing standalone solutions, extending public transport lines lead to more favourable conditions for households without access to personal vehicles compared to the redistribution of amenities. The study's contribution lies in its quest for key solutions tailored to rural areas, exemplified by the challenging case of Amari municipality. By identifying pathways towards improved accessibility and equity, this research intends to contribute to the development of more inclusive and sustainable rural transport systems.

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THE INTEGRATION OF HIGH-CAPACITY TRANSPORT MODES INTO LOCAL DEVELOPMENT IN THE AGGLOMERATION OF ABIDJAN: A CASE STUDY OF BUS RAPID TRANSIT (BRT) AND THE METRO

DIABATE LANCINE
Institut National Polytechnique Félix Houphouët Boigny (INP-HB)

Key Words： High-Capacity Transport Modes, Integration, Master Plan SDUGA, SOTRA, Gbaka, BRT and Metro

Abstract： The integration of high-capacity transport modes into local development in the Agglomeration of Abidjan: a case study of Bus Rapid Transit (BRT) and the Metro. DIABATE Lanciné, Institut National Polytechnique Félix Houphouët Boigny — BP 1083 — Yamoussoukro lancine.diabate@inphb.ci Summary: This study aims to demonstrate the local development of the Abidjan agglomeration through the integration of high-capacity transport modes. The study area is the Abidjan agglomeration, which has been delineated by the urban master plan designated as SDUGA (Schéma Directeur du Grand Abidjan). In this zone, capacity transport is currently provided by small-scale transport and SOTRA buses. The fares of artisanal transport services vary according to the journey, the commuting patterns of the passengers, and the duration of the journey. The difficulties associated with small-scale transport can be broadly categorised into two main areas: firstly, the malfunctions that occur in the provision of the service itself, and secondly, the malfunctions that occur in the interactions between the service provider and the user. One challenge with SOTRA is that it does not extend to the first and last kilometres. Furthermore, there are events that present a threat to the continued operation of SOTRA. During periods of civil unrest, SOTRA buses are frequently vandalised and even burned. The new modes of transport are the BRT and the Métro, which are currently under construction. The analysis indicates that the average delay is 1 hour and 13 minutes. In order to facilitate local development in the Abidjan agglomeration, it is recommended that capacity transport (BRT and metro) be integrated, that small-scale transport (Gbaka) be professionalised, and that capacity transport systems be made interoperable. The project will primarily benefit artisanal transport operators, who will enjoy increased revenue, the elimination of illicit practices, and ultimately, enhanced customer satisfaction. Key words: high-capacity transport modes, integration, master plan SDUGA, SOTRA, Gbaka, BRT and metro.

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WHAT SPATIAL MESHES TO CONTAIN AND ORGANISE MOBILITY ? SITUATION OF THE FRENCH METROPOLITAN TERRITORY IN 2020

Anne Guillemot, Fabien Leurent
Ecole nationale des ponts et chaussées (ENPC); International Research Center for Development and Environment (CIRED)

Key Words： Cities and Crowns, Metropolitan Influence, Rank-Size rule, Spatial Meshes, Spatial Configuration

Abstract： The geographical space of metropolitan France is unevenly populated. Cities have a range of orders of magnitude. The most important of them polarize a space around them which constitutes a “crown” based on home-work mobility. The city and its surroundings together form a City Attraction Area (AAV) which contains most of the daily mobility of people. Besides, public passenger transport is organized locally by a Mobility Organizing Authority (AOM), whose territorial jurisdiction encompasses a population within a designated area. The article questions the capacity of the three types of entities (agglomerations, AAV and AOM) to contain everyday mobility, and their relationships with the network of municipalities and Departments across the national territory. We statistically characterize the distribution of each type of entity in terms of population and spatial extent, and we identify a typology of orders of magnitude (following the rank-size rule). We match the three types of spatial entities, by order of magnitude class, by measuring amplification factors of the population and the space covered. There are two contrasting categories of AOM, respectively urban versus rural. The urban AOM closely surround their agglomeration, but only capture 10% of their crown. Rural AOMs form larger spatial groups and are therefore more populated than AAVs of similar rank (from 200 to 700). The 50 largest metropolises, and the next 50, are overwhelmingly departmental capitals. Thus the Departments contain the metropolises and their rings, apart from the ten at the top of the ranking, and their spatial network determines a regular spatial configuration of the metropolises in France.

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ENGINEERING-ADAPTIVE PAVEMENT MAINTENANCE DECISION-MAKING MODEL: A REINFORCEMENT LEARNING APPROACH FROM EXPERT FEEDBACK

Wenyuan Cai, Yuchuan Du, Chenglong Liu
College of Transportation Engineering, Tongji University

Key Words：Pavement Maintenance Decision-Making, Reinforcement Learning from Expert Feedback, Fine-Grained Reward Model, Data-Knowledge Driven

Abstract：Rising highway mileage and lifespan are heightening road maintenance demands. With most research focusing on major and special maintenance, daily maintenance optimization is understudied, despite its prominence in work orders. Due to the complex and variable road scenes and fuzzy maintenance decision rules, the daily maintenance strategy generated by the pure data-driven model is easy to deviate from the engineering reality, and the decision-making method with optimization as the core is difficult to fully consider the regional characteristics, and the generalization of the scene is limited. This paper addresses this gap by developing a detailed maintenance decision model that combines data and expert feedback via reinforcement learning. The research uses a pavement performance prediction model based on actual data as the environment to learn the coupled influences of the climate, road, traffic, and maintenance conditions and employ reinforcement learning to optimize strategies. Furthermore, in reinforcement learning, the model incorporates expert ratings as a reward function to learn the ambiguous decision rules and scenario characteristics in practical engineering, enhancing the adaptability of the data-driven decision model to different scenarios. Real-world data validation demonstrates that the RLEF model can rapidly learn expert knowledge, adapt to different scenario-specific decision rules and objectives, and achieve superior cost-effectiveness.