## The 1st ISTRC Annual Conference (21/06/2021) Abstracts

**TRACK A1**

***Alon Bloch*** *& Mor Kaspi (TAU). Shuttle routing in automated parking-lot systems.*

In recent years, lack of parking spaces has become a major concern in dense cities. To overcome this issue, several companies are offering Automated Parking-lot Systems (APS), which enable higher land resources utilization then in conventional parking-lots. In APS, users park their cars in designated entry/exit rooms and later on pick them up from these rooms. The movement of the cars to/from parking spots is performed automatically by robots. This study focuses on a particular APS design in which cars are carried by shuttles, moving on a single horizontal rail in each floor and moving vertically using two elevators located at both ends of the rails. We refer to this type of system as Double Elevator Shuttle-based APS (DES-APS). This setting introduces several operational challenges, including, parking spot allocation, task allocation to shuttles, and shuttle routing, which should consider shuttle conflicts to avoid system deadlocks. To reduce potential conflicts, several companies apply a circular routing policy. Namely, one elevator is used to take the shuttles up, while the other takes them down. However, under this policy the elevators become the bottleneck as their utilization rate is bounded up to 50%. We approximate the system by a Markovian model, and use it to demonstrate that less conservative policies may enable the system to serve up to twice as many users. To operate the DES-APS under these policies, we develop heuristic routing algorithms which are tailored for its specific characteristic. A collaboration with an APS company has enabled testing the performance of these policies and routing heuristics over real-world scenarios.

***Gal Neria*** *& Michal Tzur (TAU). Dynamic routing to achieve efficient and fair allocation.*

A well-known optimization problem arises when a central decision maker needs to determine how to allocate a resource of limited supply to several agents in order to maximize the system's objective. In some more challenging settings, the sequence of visited sites (agents) affects the system performance, in which case the routing aspect needs to be considered as well. Finally, information may be uncertain and arrive gradually over time, and on top of the effectiveness considerations, fair distribution may be critical. The ability to make fast routing and allocation decisions in an uncertain environment has a great importance for numerous urban logistic and smart transportation applications that are becoming increasingly prevalent. For example: food banks' activities that collect an (unknown in advance) supply of food from suppliers and distribute it to welfare agencies. In general, we consider the problem that arises when information about supply quantities arrives gradually over time. We model this problem as a stochastic-dynamic routing - resource allocation problem, with the aim of delivering as much goods as possible while obtaining equitable allocations to the agents. We present a formulation to the problem, however it does not lead to exact solution methods in a reasonable amount of time. Therefore, we develop a heuristic approach that uses a novel implementation of approximate dynamic programming, using a lookup table that approximates the future value given any initial information and decision. Finally, we develop upper bounds and benchmark solutions, which were used to test our method. In a preliminary numerical experiment that we performed over 40 and 60 sites instances, in which the information arrived in two points of times, the heuristic solutions achieved values which on average were about 20% better than the benchmark solutions.

***Ido Orenstein** (1), Yedidya Levi (1), Israel Feldman (2) & Bat Hen Nahmias-Biran (1). Discovering Commuting Patterns in Israel using Multiple Big Data Sources. (1. Ariel, 2. Mobility Insight)*

Commuting is commonly defined as the traveling activity that people perform daily from home to workplace or school. Increased commuting is often related to road congestion, noise, air pollution and loss of time. Transportation planners hypothesize that commuting trips are the main cause for traffic congestions inside and on the roads that lead to cities. However, as we rarely collect travel data that unfolds over several days, it is possible that many of the trips are not repeated nearly daily and therefore are not defined as commuting trips. It is possible that such a hypothesis is fundamentally wrong, or was correct in the past and no longer holds due to the technological developments, which changed economic markets and might cause variance in the commuting patterns of individuals. In this paper, we examine commuting patterns using big data from multiple sources collected recently in Israel. Our data collection is based on three methods: cellular data that follows the driver location; Bluetooth sensors on the road segments that interact with the Bluetooth component of the car; and ALPR cameras on the road segments that capture the license plate number of the car. Our analysis shows that individuals' daily travel behavior changes frequently, commuting is not performed nearly every day by most individuals, and that there are many random rides on the roads that are not repeated often. Our findings suggest that transportation planning models should consider the travel behavior of individuals over a significant period, rather than on average day. Moreover, by using big data analysis, transportation models used by planners and researchers can include an up-to-date and accurate behavior of the commuting patterns, and thus help to reach a better transportation planning policy.

***Yana Barsky** (Technion) & Ayelet Gal-Tzur (Ruppin). Identifying commuters' travel patterns based on Bluetooth data.*

Understanding commuters' travel patterns, and particularly private-car users, is a key element for planning new shared mobility solutions. High resolution analysis of commuters' travel patterns enables, beyond identifying prominent destinations, to unveil specific route choice and short detours from the main path (typically for drop-offs and pickups of passengers), thus providing valuable insight regarding the diversity of individual mobility needs. GPS-based data, that provide high spatiotemporal resolution, is not typically at the disposal of transport authorities and consequently cannot provide mobility profiles for sufficiently large sample of population for long time periods. Point-to-point data sources, and particularly to Bluetooth (BT) detectors, have become a popular information source for deriving travel times along road links. The raw data such detectors provide can also be used for extracting individual trips. However, the partial detection rate of BT detectors (typically about 25%) and incomplete network coverage pose challenges to the process of trajectory mining. The proposed methodology focuses on high resolution analysis of BT-based trajectories for identifying commuters' travel patterns and its contribution is fourfold: 1) It provides a set of rules for classifying individual trips into trajectory clusters, each representing a specific route from origin to destination; 2) It addresses detours from the main route representing a specific trajectory cluster; 3) It specifically addresses round trips; 4) By using a two-step methodology, it demonstrates the use commuters' travel patterns and information regarding return trips for overcoming incomplete data and improving trips' classification into trajectory clusters. The proposed methodology was applied to field data from a sub-network of Haifa, and the case study provide a basis for discussing the transferability of the methodology to other networks.

***Rui Yao** & Shlomo Bekhor (Technion). A ridesharing simulation platform that considers dynamic supply-demand interactions.*

This paper presents a new ridesharing simulation platform that accounts for dynamic driver supply and passenger demand, and complex interactions between drivers and passengers. The proposed simulation platform explicitly considers driver and passenger acceptance/rejection on the matching options, and cancellation before/after being matched. New simulation events, procedures and modules have been developed to handle these realistic interactions. The capabilities of the simulation platform are illustrated using numerical experiments. The experiments confirm the importance of considering supply and demand interactions and provide new insights to ridesharing operations. Results show that increase of driver supply does not always increase matching option accept rate, and larger matching window could have negative impacts on overall ridesharing success rate. These results emphasize the importance of a careful planning of a ridesharing system.

**TRACK A2**

***Eliel Blum**, Amir Brudner & Nicole Adler (HUJI). The likely impact of autonomous vehicles on public transport service in the 300 to 700 km medium-haul market.*

In recent years there has been significant progress in the development of autonomous vehicles. However, much of the research revolves around safety impacts and their effect on traffic conditions in an urban environment. In this research, we examine the likely impact of autonomous vehicles on public transport service in the 300 to 700 km medium-haul market, which was assigned by the EU in 2010 as one of the targets for vehicle trip reductions through investments in transport infrastructure. Current data reveals that the private car remains a significant player in the medium-haul due to flexibility and door-to-door accessibility despite the additional time required and fatigue involved. However, the autonomous vehicle reduces these disadvantages, creating a robust alternative to the private car and increasing competition in the public transport market. To investigate the possible impact of the autonomous vehicle in the medium-haul market, we develop an applied game theoretic formulation that analyses the potential transport equilibria outcome accounting for four profit-maximizing competitors, including high-speed railway, airlines and autonomous vehicle companies, offering single passenger or ride-sharing options. The supply-side decision variables for a high-speed railway company and airline include fares and frequencies, whilst the autonomous car company's decision variables are fares and fleet size. We model the demand-side using a logit market share function that accounts for the transport providers' decisions, the passengers' value of time characteristics and origin-destination paths. We apply the formulation to a case study of the Madrid-Barcelona corridor in Spain, using anonymized mobile phone records which are combined with data from the Google Maps API in order to calibrate the model. Preliminary results suggest that autonomous vehicles will directly impact high-speed railway fares and airfares, potentially undoing any gains achieved since the publication of the 2010 EU White Paper.

***Golan Ben-Dor** (1), Ido Klein (1), Aleksey Ogulenko (1), Eitan Bluer (3), Issa Zananiri (3), Eran Ben-Elia (2) & Itzhak Benenson (1). Simulating shared (autonomous) demand-responsive transport: A case study of Jerusalem. (1. TAU, 2. BGU, 3. Jerusalem Transport Master Plan)*

Future MaaS systems should optimally integrate between traditional - taxi, buses, light rail - and new demand-responsive transport. The latter includes various ride-sharing modes that can be served by automated vehicles, which despite their popularity among scholars and planners, remain a major unknown.

We employ a calibrated and validated MATSim multi-modal transportation model of the Jerusalem Metropolitan Area (JMA) in order to assess the introduction of Shared Autonomous Vehicles (SAV). We investigate whether the SAV would continue the line of Transportation Network Companies (TNC) that have become a likely rival of traditional public transport (PT), or would it be able to reduce private car usage and bring the transportation system to a new stable equilibrium. Our model confirms existing empirical observations that new ride-sharing modes mostly attract PT users, while their impact on private car use is quite limited. We further investigate an optimization problem of preserving travelers' flows to areas of high demand while reducing private car use. In order to control the equilibrium, we consider adjusting parking prices and/or congestion charges while varying SAV operational parameters, like the size and shape of the service area, fleet size, and requests prioritization. Our goal is to propose a balanced set of carrot-and-stick measures to bring a sustainable modal shift in JMA.

***Shir Tavor*** *& Tal Raviv (TAU). Balancing autonomous vehicle car-sharing systems.*

In a vehicle-sharing system, users can rent a car from a fleet of vehicles scattered throughout the service area of the system, use it for a short trip and return it anywhere in the system's service area. The rental and return process is carried out independently by the passengers using technological means (usually a mobile app). In a traditional car-sharing system based on human-driven vehicles (HDV), the users need to locate a nearby car and walk to it before starting their journeys. In a futuristic car-sharing system based on driverless automated vehicles (AV), the requested cars can travel to the passengers. In that sense, the AV based system resembles a ride-hailing (taxi) service. Both types of car-sharing systems tend to go off balance, and cars are likely to accumulate at locations where they are less needed while shortages occur at the high demand areas. This phenomenon may decrease cars' availability to passengers, prolong the walking distances (in HDV systems) and waiting times (in AV system). In the case of AV based car-sharing systems, the operator may locate cars in advance, where and when they are expected to be requested. In this study, we devise an algorithm for rebalancing an AV based car-sharing system. Moreover, we demonstrate the merits of relocating cars in advance in terms of the system's quality of service and the fleet's effective utilization.

***Oksana Sabinik** (BGU), Tal Raviv (TAU) & Hillel Bar-Gera (BGU). Partially Flexible Demand Responsive Transit services.*

This study focuses on a partially flexible demand responsive transit (DRT) service for passengers who share one of their trip ends. We mathematically formulate the operational challenge of a DRT service of this type as the one-to-many DRT problem (DRT 1-M). Preliminary results on modest size problems indicated the potential of this approach. The current study improves the formulations and the solution methods to enable addressing realistic size problems. Based on these new methods, we conduct additional numerical experiments and analyze the results statistically. The solution of the optimization model is done in three stages:

1. Generate an appropriate set of vehicle routes using a dynamic programming algorithm.
2. Select routes to meet the specific demand by solving a set covering problem.
3. Assign passengers to trips.

A comparison between alternative dynamic programming algorithms is conducted in terms of efficiency and suitability for several variants of the original formulation. We consider the possibility of pre-planning a large set of routes for the entire service area instead of generating the routes only once the demand is known. From a computational point of view, pre-planned routes may allow faster response in real-time. From an operational point of view, pre-planned potential drop-off points may be desirable due to safety considerations. The contribution of the current study is in the methodological aspects as well as the operational aspect. The methodological aspects include mathematical formulations of relevant optimization problems, examining solution methods (algorithms and heuristics) and analyzing computational complexity. The operational aspects deal with testing the potential effectiveness and feasibility of this type of service, using a series of numeric experiments and statistical analyses, as well as analyzing the factors that affect the characteristics of the level of service.

***Omer Karny** & Mor Kaspi (TAU). Autonomous On-Demand Transit Services Over Existing Guideways.*

Technological advances in vehicle autonomy, vehicle connectivity and vehicle electrification are expected to revolutionize urban mobility. However, due to many barriers, a significant adoption of fully autonomous vehicles is only projected to occur in two to three decades. Large scale deployments of novel mobility services provided using autonomous vehicles could potentially be implemented in the near future in controlled environments. This study examines the potential of transforming existing guideway based public transportation systems (tram, light-rail, BRT) to on-demand point to point services by utilizing current technological capabilities. In particular, the objective it to reveal the characteristics of existing systems that have high potential to be successfully transformed to flexible on-demand services. For this purpose, an approximate model and a simulation model that represent the dynamics of the service are developed. The approximate model is based on the Israeli Queue model which allows accurately measuring the waiting times of the passengers under ridesharing policies. The simulation model replicates in more details the operations of the proposed service while relaxing several simplifying assumptions made in the approximate model. Numerical results obtained for case studies derived from several public transit systems around the world, confirm that the proposed service can reduce by up to 50% the average waiting time, as compared to existing services.

**TRACK A3**

***Ido Klein** (1), Aleksey Ogulenko (1), Avner Saadon (2), Golan Ben-Dor (1) & Itzhak Benenson (1). Multi-Agent Transportation Simulation as a framework for modeling COVID-19 dynamics in Jerusalem Metropolitan area. (1. TAU, 2. Jerusalem Municipality)*

Traditionally, epidemic dynamics are modeled by the macroscopic compartmental models that account for the different stages of the disease and population partition into the age- and other groups. Recent availability of high-resolution data on human spatial activities has accelerated the development of the agent-based models (ABM) of epidemics that explicitly describe human behavior in space and time. ABM models enable direct representation of human contacts when traveling, at home, at work, during commercial and leisure activities at the level of resolution that is dictated by the available data. The basic component of every applied epidemic ABM is a model of human mobility that defines the spread of the epidemic in space. The Multi-Agent Transportation Simulation (MATSim) framework, a commonly accepted leader in transportation ABMs, accounts for the travelers' adaptation to the transportation conditions that may vary during an epidemic. MATSim was recently extended to describe the COVID-19 virus transition. The resulting modeling platform, called Episim, is already applied in Berlin, Montreal, and Cape Town. In Episim, the epidemic dynamics is modeled based on the detailed description of individual agents' everyday activities at home, workplaces, commercial facilities, or in transit. The model's level of detail enables assessment of both general and fine-grained interventions, such as closing specific public transit lines, defining quarantine for specific areas, and vaccination schemes for specific population groups. We employ Episim based on the calibrated MATSim model that we have recently established for the Jerusalem metropolitan area. The epidemic model is validated and calibrated based on the data supplied by the Jerusalem municipality and employed for assessing the role of the different population groups in the city in the COVID-19 pandemic dynamics.

*Yves Molenbruch (VUB), Kris Braekers (Hasselt), **Ohad Eisenhändler** (Afeka) & Mor Kaspi (TAU). The Electric Dial-a-Ride Problem on a Fixed Circuit.*

Innovative shared mobility services involving electric autonomous shuttles have increasingly been implemented in recent years. Due to various restrictions, these services are currently offered on fixed circuits and operated on fixed schedules. This study introduces a service variant in which the shuttles' stopping patterns and schedules are determined in a flexible way. Specifically, in the Electric Dial-a-Ride Problem on a Fixed Circuit (eDARP-FC), a fleet of capacitated electric shuttles operates on a given circuit, consisting of a recharging depot and a sequence of stations where users can be picked-up/dropped-off. The shuttles may perform multiple laps between which they may need to recharge. The goal of the problem is to determine the vehicles' stopping sequences and schedules, including recharging plans, so as to minimize a weighted sum of the total user journey time and the total number of performed laps. The eDARP-FC is formulated as a non-standard lap-based MILP and is shown to belong to the class of NP-Hard problems. Efficient polynomial time algorithms are devised for two special scheduling sub-problems. These algorithms and several faster heuristics are then applied as sub-routines within a Large Neighborhood Search metaheuristic tailored to the eDARP-FC's structure. Experiments on various instance sizes ranging between 25 to 300 requests per instance, demonstrate the capability of the proposed approach to obtain high quality solution within short running times. A case study derived from a real-life service in Renmark, Australia, also demonstrates that the flexible service allows system operators to reduce costs and improve service quality at the same time.

***Idan Meshulami** & Mor Kaspi (TAU). The Dial-a-Ride Problem with Transfers and Walking.*

The Dial-a-Ride Problem (DARP) consists of defining routes and schedules for a fleet of vehicles serving multiple transportation requests within a service area. In this work, we define and study a new variant of the DARP which considers both transfers and walking, namely, the DARP with Transfers and Walking (DARPTW). In particular, passengers are allowed to transfer multiple times and their itineraries may include several walking segments. The goal of the DARPTW is to minimize a multi-objective function consisting of the total distance covered by the vehicles, the number of transfers, the total walking distance and the total excess time of the passengers. Introducing transfers and walking presents several opportunities. Multiple transfers may allow balancing the vehicle loads and reducing the service area covered by each vehicle, by decomposing itineraries to separate service segments that would be served by different vehicles. Walking may assist in reducing unnecessary vehicle detours to extreme regions of the service area. Additionally, walking may facilitate significant shortcuts that cannot be fulfilled by the vehicles due to travel directions imposed by the road network. Nevertheless, these opportunities generate a challenging problem to solve. Specifically, the DARPTW generalizes the DARP and therefore is also NP-Hard. We devise an efficient algorithm for the scheduling sub-problem, which minimizes the total travel time of the passengers. The algorithm determines the feasibility of given routing plans and applies fast heuristics to construct good schedules. We implement the algorithm within a Large Neighborhood Search framework in search for promising solutions of the DARPTW. Numerical experiments are conducted using real-world data obtained from Bubble-Dan in Tel Aviv. Preliminary results over thousands of scheduling sub-problem instances demonstrate that our heuristic algorithm finds the optimal schedule in more than 90% of the cases.

***Ilil Blum Shem-Tov*** *& Shlomo Bekhor (Technion). Modular Multi-Dimensional Tool for Emergency Evacuation Process Including Decentralized Scenarios using Location-Based Social Network Data.*

Emergency situations caused by natural and human-made disasters are usually not predictable. When a disaster occurs in populated areas, there is an urgent need to evacuate the population present in the area to save lives. Predicting the demand, represented by the origin-destination (OD) matrix, in evacuation and rescue missions is a major challenge. The existing methods for building the OD matrix are based on statistical methods, ad-hoc surveys, or historical information. The limitations of those methods are coverage areas, outdated data and cost. One possible solution to the problem is using worldwide distributed and widely used technology of location-based online social networks (LBSN). LBSN data has not yet been studied as input for transportation models during emergency times for evacuation although this data contains users' location and relationship information. This presentation focuses on building the OD matrix using these two parameters: the friendship weight and the distance. It also considers the evacuation zone boundaries and the daily routine data. The concept of a modular personalized recommendation system has been compared to traditional evacuation models to central shelters using anonymous real LBSN data on a large transportation network using multiple evacuation scenarios. The developed system offers the users in the affected area to evacuate to their nearest best friends or family members who are outside the danger zone.

**TRACK B1**

***David Zar**, Amos Azaria & Noam Hazon (Ariel). Explaining Ridesharing: Selection of Explanations for Increasing User Satisfaction.*

Transportation services play a crucial part in the development of modern smart cities. In particular, on-demand ridesharing services, which group together passengers with similar itineraries, are already operating in several metropolitan areas. These services can be of significant social and environmental benefit, by reducing travel costs, road congestion and CO2 emissions. Unfortunately, despite their advantages, not many people opt to use these ridesharing services. We believe that increasing the user satisfaction from the service will cause more people to utilize it, which, in turn, will improve the quality of the service, such as the waiting time, cost, travel time, and service availability. One possible way for increasing user satisfaction is by providing appropriate explanations comparing the alternative modes of transportation, such as a private taxi ride and public transportation. For example, a passenger may be more satisfied from a shared ride if she is told that a private taxi ride would have cost her 50% more. Therefore, the problem is to develop an agent that provides explanations that will increase the user satisfaction. We model our environment as a signaling game and analyze the equilibria for three agents' classes. Specifically, we show that a rational honest agent, which follows the perfect Bayesian equilibrium, must reveal all the information regarding the possible alternatives to the passenger. We then develop a machine learning based agent that, when given a shared ride along with its possible alternatives, selects the explanations that are most likely to increase user satisfaction. Using feedback from humans we show that our machine learning based agent outperforms the rational honest agent and an agent that randomly chooses explanations, in terms of user satisfaction.

***Sharon Shoshany Tavory** (1), Ayelet Galtzur (1), Yoram Shiftan (1), Amnon Frenkel (1), Ofer Lerner (1) & Fabio Scheinkman Shachar (2). ShareMore - demonstrating the potential of personalized incentives for carsharing. (1. Technion, 2. Tel-aviv-Yafo Municipality)*

The EIT-mobility Share-More project, aims to optimize the added value of carsharing services and promote a portfolio of transport services that encourage sustainable urban mobility through the development of the infrastructure for personalized incentives. By understanding the needs of travelers, transport authorities, and service providers, we can potentially provide personalized incentives tailored to their needs, to increase carsharing efficient use, while contributing to its sustainable integration with the overall transportation system. The research was conducted through a partnership between municipalities, car-sharing commercial company, and Universities, in Denmark, England, Germany, and Israel and led by the Technion. This paper reports the results of the demonstration phase in Tel-Aviv-Yafo. The project results were test-trialed by incorporating incentives into Autotel carsharing application. Two kinds of flexible/dynamic incentives, each to a specific set of neighborhoods were trialed for 5 weeks during late 2020. These high ranked incentives can influence users' choice, while contributing to the sustainability of the service provider. Analyzing Autotel carsharing service statistics allowed us to select neighborhoods according to the waiting time parameter before the demonstration, and according to expected carsharing traffic. During the trial period, information regarding the generated trips (both with and without incentives) was collected, along with the available characteristics of service users. Additionally, a short users' survey was conducted at the end of the trial. The results were analyzed for descriptive statistics and preliminary signs of potential personalization, addressing age, gender, and target neighborhoods attributes. We have demonstrated that: (1) carsharing policy-oriented incentives should be tailored to address specific needs; (2) Context tailoring is needed as cities and neighborhoods differ by their baseline situation and by the local use culture; (3) Existing carsharing apps can be adapted to supply such incentives and may change users' choice towards more sustainable results, both for the city and the operators.

***Eliya Tzarfaty**, Eran Ben Elia & Dan Vilenchik (BGU). Extracting public transportation satisfaction using Twitter: A Location-aware method.*

Traditionally public transport (PT) users' opinions were examined in surveys which require expensive resources of manpower and money. Recent improvements in Big-Data analytics to retrieve and analyze textual information from location-based social networks, have opened new possibilities for user opinion mining. In comparison to traditional methods, data extraction from a social network is based on voluntary information, which is not biased in answering specific topics, or lack of time or weather conditions that may affect answers. This allows wide spatial coverage and a large data set for further analysis. However, new challenges have been raised in dealing with this data source. First, in extracting relevant information it is critical, to make sure that the raw textual data set, does not contain noises caused by spelling errors, ambiguous words, and the unique idiom of social media. Second, is extracting geotags. Most recent studies do not use geographic information due to user privacy settings (less than 1% from overall posts reveal location). Therefore, in this study we apply two machine-learning tools in parallel followed by NLP (TextBlob) technic for sentiment analysis. First, for extracting relevant tweets, we streamed and classify over 20,000 tweets to train a Bidirectional LSTM Algorithm which significantly (score f1 factor = 85) cleared irrelevant data. Second, GeoTag tweets, were extracted with textual data mining, using unique lexicon for PT users. The case study is the opinions of PT users in the county of San Francisco Data from Twitter was streamed over 6 months (March – June 2020). Using TextBlob Algorithm, tweets received a sentimental score from a polar sequence ((-1)– 1). In the last stage, tweets were classified into 9 topics, 8 according to the formal measuring of PT passenger satisfaction, the additional topic related to COVID-19. The findings will be presented at the conference.

***Svetlana Daichman*** *(SCE), Eran Ben-Elia (BGU) & Hillel Bar-Gera (BGU). Public transportation literacy of the elderly.*

Public transportation (PT) is a key component of modern society and it should be comprehensive, efficient, sustainable and accessible to the entire population. Current technology trends require from a PT user some minimal acquaintance with modern digital tools for the efficient use of PT. Unfortunately, the majority of these tools are not adapted to the needs of the elderly population. Recently, the payment PT payment in Israel has been changed dramatically to become fully digital (with the “Rav-Kav” card or mobile apps). However, a big part of the PT users, in particular the elderly, have difficulties in the usage of the” Rav-Kav” or the apps. The first objective of this study was to establish a new term: "Transportation Literacy”. We based the definition of the term on the experience from various analog and digital tools in public transportation in Israel. The second objective of the study was defining criteria and creating a prototype for evaluation of transportation literacy in the elderly. We used mixed methods by integrating quantitative and qualitative data collection from expert interviews, in-depth interviews and questionnaires. 318 people (61% females 39% males) participated in the internet survey. 53 participants (17%) where 65 or older. 52% of the elderly participants do not use the “RavKav”, 87% of the entire group considered that cash payments should be allowed for the elderly and 35% of the entire group would keep the cash payment for all PT users. The data from our study suggests that the level of transportation literacy among elderly population in Israel is low. The implications can be a significant obstacle for the efficient use of PT and more generally Mobility-as-a-Service by the elderly.

*Lior Zalmanson &* ***Yaara Welcman*** *(TAU). Vital Skills and Competencies for Drivers Working Under Algorithmic Management: Findings from Bubble Dan.*

Current smart transportation schemes commonly require a degree of collaboration between algorithmic systems and human drivers. In shared transport services, such as Uber Pool and Bubble, drivers work under specialized apps that dictate passengers' assignments, routes, stop sequences, and work breaks. This new working model is known as “algorithmic management,” where algorithms fulfill managerial roles (Möhlmann, Zalmanson, Henfridsson, and Gregory, 2020). For many drivers, this is a major change from traditional work on buses and taxis as it challenges their previous experiences of routines, control, and agency. This study aims to define are drivers’ needed skills (Stasz, 2001) and competencies (Jarrahi & Sutherland, 2019) to achieve a successful and sustainable operation of these services. Our case study is “Bubble Dan,” a ride-sharing service. Bubble Dan incorporates machine learning algorithms through a specialized app created by Via. Based on ethnographic work, including observations at drivers training and apprenticeships, and informal conversations with former and current drivers during and after work, we identified three capabilities in our “workers’ competency & skills under algorithmic management” model. We find three different sets of skills and competencies. The first regards drivers’ need to perform actions of “plan ahead and memorization” and is the result of dynamic changes in the information flow between the app and the driver side, including the possibility of tech and GPS malfunctions. The second is “cognitive load balancing and alertness,” which seeks to balance the attention and cognitive load between the road, passengers, and the app's updates. The third set of skills and competencies relates to the drivers’ confidence and ability to exercise their own judgment and perform a “bypass and circumference” when the app’s request is against traffic rules, company protocols or may jeopardize passengers' safety. We plan to utilize our findings to improve the training and apprenticeship programs of new drivers.

**TRACK B2**

***Eldar Lev-Ran*** *(Technion), Valentino Servizi (DTU), Miroslawa Lukawska (DTU) & Sagi Dalyot (Technion). GNSS-based Classification Including Emerging Two-wheels Electric and Shared Transport Modes, with Semi-supervised Artificial Neural Networks.*

Enhancing the transport infrastructure and reducing travel time and carbon footprint while increasing users' safety requires a deep understanding of transport behavior. Advanced transport pattern analysis depends on the correct classification of (often unlabeled) GNSS trajectories that document trips users generate in their everyday mobility. In this work, we focus on the classification of users' transport mode – a crucial task underpinning proper transport investigation and analysis of the contributed trajectories. Most transport modes can show similar patterns (signal) from the GNSS sensor perspective in the urban context. This is mainly because mobility characteristics, such as speed patterns, are similar due to the urban form. Evident GNSS data noise and accuracy limitations contribute to the difficulty of the classification task. Furthermore, new disruptive transportation trends, such as e-bike, e-scooter, and car-sharing services, generate new feature patterns within the trajectories, which are not well studied yet. This new challenge presents itself while standardization problems are still emerging due to the fast penetration of machine learning methods, which promise to substitute traditional statistical and rule-based approaches. Our contribution is manifold. To improve methods' generalization power, we formulate a uniquely large dataset composed of all transport types, focusing on bikes, e-bikes, and e-scooters, including shared and owned vehicles across three continents. To improve classification methods' efficiency, we apply semi-supervised artificial neural networks (ANN), and we reduce the need for both pre-processing steps and labeled data. Compared to multiple baseline methods, such as random forests, our results show that although the classification task remains very challenging, our method outperforms the baseline methods in most of the key performance indexes that measure the efficiency and suitability within the context of Big-Data, including emerging transport types.

***Ilya Finkelberg*** *(1), Tibor Petrov (2), Ayelet Gal-Tzur (1), Nina Zarkhin (1), Peter Počta (2), Tatiana Kováčiková (2), Ľuboš Buzna (2), Milan Dado (2) & Tomer Toledo (1). The Effects of Vehicle-to-Infrastructure Communication Distortions on Performance of Signalized Intersections.*
*(1. Technion, 2. UNIZA)*

The introduction of connected vehicle serves as a rich source of real-time information about the state of the traffic system, that may be used to enhance the efficiency of traffic management and control, most notably intersection signal control. Recently, the design of traffic signal control algorithms incorporating the new information provided by vehicle-to-infrastructure communication, such as location and speed of connected vehicles, evoked a lot of research. A common assumption in these studies is that communication messages are received precisely without any loss or delay. This assumption is rarely realistic. Communication performance is affected by a variety of factors, such as vehicle speed, the number of vehicles within the communication range, physical obstacles (e.g. buildings, trees), presence of interference sources and weather conditions. In this study, we explore possible effects of a temporal decrease in the reliability of the communication channel on the performance of a signalized intersection. By integrating well-established simulation tools, i.e., VISSIM (traffic flow microsimulation) and OMNeT++ (communication simulation), we build an evaluation framework that combines a traffic flow and control model with DSRC-VANET communication network. Comparisons of a perfect communication scenario with challenging, yet realistic, scenarios of communication distortions show substantial deterioration in vehicle-delay performance indicators due to communication failures. An increase in vehicle delays occurs when the communication distortions affect all intersection approaches or only a single one. The negative impact of communication distortion can be substantially reduced by incorporating even a relatively simple compensation mechanism

into the signal control logic to account for communications failures, i.e. by making straight forward assumptions about the vehicle movements based on data received in the previous time intervals. The study demonstrates that both the negative impact of communication distortion and the benefits from the compensation mechanism non-linearly increase as volumes approach capacity.

***Shuki Wolfus**, Sahar Bareli, Lidor Geri & Yosef Yeshurun (BIU). Optimization of Coil Configuration for Dynamic Wireless Charging of Electric Vehicles.*

Dynamic Wireless Power Transfer (DWPT) technology enables the process of charging the on board battery of an Electric (EV) while on the move and along its travel path. Charger coils under the road transmit electromagnetic energy to receiver coils mounted under the car chassis. Since the process of charging the EV accompanies the car along its travel path, it allows the on-board battery to be minimized in dimensions, capacity and weight. The reduced battery carried by the EV leads to dramatic energy savings due to the reduced vehicle weight, as well as significant environmental advantages caused by minimizing CO_2 emissions and other hazardous waste and contaminants. In designing DWPT systems, one must consider receiver and transmitter coil dimensions, shapes, and alignments. In this paper, we explore the effects of various receiver coil dimensions and configurations on power transfer efficiency using advanced simulation tools. We demonstrate that the spatial distribution of the magnetic field leads to non-monotonic dependent of the coupling coefficient on coil size. Thus, an optimal coil size, where the coupling coefficient peaks, should be regarded a crucial design parameter which affects the entire system performances.

***Mali Sher** (Israel Police). Smart transportation and traffic police?*

Traffic policing is part of the transportation system. Nowadays, the traffic officer's tasks are mainly: (1) preventing traffic offenses by presence and conspicuousness, education and enforcement; (2) assisting road users, and (3) investigating road accidents. Will it also be in the future of smart transportation? The current estimated annual costs of the transportation system in Israel include: 22 billion NIS as a result of traffic jams, 9 billion NIS as a result of road accidents, and 2.7 billion NIS as a result of pollution. Presumably, a smart transportation system will reduce some of these costs. The current state of affairs, however, is that: (1) road congestion is increasing and (2) about 54% of the fatalities in road accidents are vulnerable road users: pedestrians, motorcyclists, and cyclists. The assumption is that even in the future with Connected, Autonomous, Sharing and Electrification cars (CASE) these problems will remain. Therefore, the traffic officer is one of the effective solutions for reducing congestion and preventing road accidents involving vulnerable road users. Meanwhile, in order to prepare for CASE a lot of data is now being collected using various sensors, advanced technologies, and models. These technologies, data, and models assist the traffic officer's operations by: (1) forecasting road accident locations, (2) identifying the best routes for traffic police vehicle patrols, (3) data mining, text mining, geographic layers and image processing models that analyze our databases for insight and business intelligence, etc. All these research studies and developments help us to increase the level of service for road users.

***Yaakov Shnerb*** *(Ariel). A Model for Public Regulation of Ethics and Morality.*

In Israel, on average, every day a citizen is killed in an accident involving vehicles. 94% of critical accidents are the fault of the driver. In the coming decades, a gradual process takes place, where autonomous vehicles (without a driver), electric, collaborative and connected – are expected to enter the Israeli economy, in parallel with similar processes that will take place in the world. The accelerated development throughout the last decade, of research and development in the field of smart vehicles, and the expected changes in public roads, are causing a growing gap between the existing and required regulation, especially in terms of ethical dilemmas. The uniqueness of autonomous vehicles is that their design requires decisions on ethical issues already at the planning stage, and requires the regulator to make decisions in advance and to guide the market accordingly. These decisions constitute a milestone in enabling the realization of capabilities presented by the developing companies. The lack of regulation leads to a delay in the technologies that may lead to a reduction in road accident damage. The creation and implementation of Positive Regulation will enable further development and will constitute a social moral compass, which will lead to a change in the negative public perception towards the autonomous vehicle, and the possible dangers from its entry into our lives. The purpose of this study is to develop an ethical model of Positive Regulation, which will enable decision makers to create suitable government regulations for autonomous vehicles. The research will be conducted in two main parts: In the first part, the basic principles will be determined by experts and decision makers in the relevant fields. The second part will examine the attitudes of the population in Israel in relation to the evolving principles, using focus groups with different sectoral characteristics, representing the heterogeneous population in Israel. At the end of this section, an attempt will be made to present an agreed model, which will be able to serve as a tool for policymakers to create a proper regulation.

**TRACK B3**

***Géza Dévényi** (Óbuda). Functional Safety of In-Vehicle-Infotainment systems of autonomous road vehicles.*

This paper investigates the challenges arise due to the increasing performance and complexity of In-Vehicle-Infotainment (IVI) systems of autonomous road vehicles. Series production road vehicles install increasingly more highly automated driving functions. The IVI-systems are interconnected with these functions as well as are in close interaction with the driver. Therefore, the IVI-systems are becoming considered as safety-critical. The proper interaction with the driver plays a significant role in the controllability of hazardous situations. Also, the requirements on providing valid information, e.g., geolocation, to other critical functions make the IVI-systems safety-critical. IVI-system malfunctions of self-driving vehicles can have the potential to lead to hazardous driving situation as well as to lead to the violation of critical transportation infrastructure. Also, the compromise of critical IT-infrastructures, e.g., cloud-based navigation, can have the potential to lead to the malfunction of the IVI-system of self-driving road vehicles. The development of such safety-critical and information-security-critical IVI-systems of future autonomous road vehicles is a very complex and multi-disciplinary process. In the other hand, the higher the level of driving automation the higher the safety criticality of the IVI systems is. To handle such technical complexity and to manage the consistency of the system of systems (e.g., a smart city) the functional safety and the information security risk will have to be analyzed in a parallel manner from the concept phase of vehicle as well as smart city lifecycles.

***Gergo Igneczi**, Erno Horvath & Daniel Pup (SZE). Implementation of a self-developed model predictive control scheme for vehicle parking maneuvres.*

In this paper a self-developed controller algorithm is presented with the goal of handling a basic parking maneuver. One of the biggest challenges of autonomous vehicle control is the right calibration and finding the right vehicle models for the given conditions. As a result of many other research, model predictive control (MPC) structures have started to become the most promising control technique. During our work we implemented an MPC function from white paper. Considering the low-speed conditions of a parking maneuver we use a kinematic bicycle model as the basis of the controller. The algorithm has two main inputs: a planned trajectory and the vehicle state feedback signals. The controller is realized as a Simulink model, and it is integrated into a complete autonomous control system using ROS framework. The results are validated through multiple steps: using Simulink only with a pure kinematic bicycle plant model; using LGSVL simulation framework containing a real vehicle model and the entire software chain; the controller is prepared for real vehicle tests.

***Mátyás Szántó** & László Vajta (BME). Enhanced motion-based segmentation of vision sensed environment of moving vehicles.*

A key component for the feasibility of a vision-based, distributed, low-latency mapping solution is the ability to reduce the amount of unnecessary data supplied by image acquisition sources. There are numerous techniques for the segmentation of useful information from images and masking the visual data flow accordingly. This presentation introduces a novel approach that uses Deep Learning (DL) for the segmentation and selection of objects that belong to the static and quasi-static regions of the sensed / depicted environment – and therefore useful for low-latency mapping tasks. The method presented here is an extension of our recently published solution – that was developed as part of our combined evaluation setup, which we call “CrowdMapping”. In this presentation, followed by a short outlook to other solutions published in the literature, we will introduce a comparison of our two methods using images and ground truth data provided by the KITTI benchmark suite.

***Thomas Y. Chen** (AMSE). Social media imagery as a source of data for training deep learning models for computer vision-based autonomous vehicles.*

The rise of autonomous vehicles yields many opportunities in terms of transportation safety and efficiency. Many autonomous vehicles are now driven by computer vision-based technology. Computer vision, the study of how computers gain high-level insights from imagery and video, has largely been conducted using deep learning (multi-layered machine learning) techniques in the last decade. In this introductory work, we discuss the use of social media data for the training of convolutional neural networks for scene and object identification, with the goal of implementing them in self-driving cars such that navigation mechanisms will allow for the avoidance of obstacles and the saving of lives in difficult situations. Social media platforms have become increasingly popular in recent years, as they are utilized by people around the world to post images and text during times of relaxation as well as times of crisis. Social media data (the user-created content itself) is analyzed using machine learning in two primary ways: natural language processing (NLP) and computer vision. Computer vision-enhanced approaches can be useful in a variety of fields, from humanitarian assistance and natural disaster response, to wildlife conservation. In regards to autonomous driving, we first acknowledge that social media networks such as Twitter and Instagram contain various sets of imagery depicting situations on the road from the perspectives of individuals in vehicles. Collecting this data through web scraping and subsequently crowdsourcing labels for object segmentation is conducted through platforms such as Amazon Mechanical Turk. Further, we train a convolutional neural network of the AlexNet architecture on this data. Finally, we compare the results to other works in the literature utilizing other sources of data for deep neural network training in this scope. We seek to determine whether transfer learning from social media-based vehicle-level scene data is effective when deployed.

Afeka - Afeka College of Engineering

AMSE - The Academy for Mathematics, Science, and Engineering

Ariel - Ariel University

BGU - Ben-Gurion University of the Negev

BIU - Bar-Ilan University

BME - Budapest University of Technology and Economics

DTU - Technical University of Denmark

Hasselt - Hasselt University

HUJI - the Hebrew University of Jerusalem

Óbuda - Óbuda University

Ruppin - Ruppin Academic Center

SCE - Shamoon College of Engineering

SZE - Szechenyi Istvan University

TAU - Tel-Aviv University

Technion - Technion, Israel Institute of Technology

UNIZA - University of Žilina

VUB - Vrije Universiteit Brussel