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Comparative Analysis of Simulation Tools Used for Shared Mobility Modeling

F. S. Salman, Dr. V. P. Sisiopiku, and Dr. O. E. Ramadan

UAB **Tr**ansportation **En**gineering and **D**evelopment **Lab**oratory

Introduction

There are many assertions about the likely benefits of shared mobility and e-hailing services, yet the full impacts of such services on transportation network performance are not fully understood. Thus, there is a need to assess the impacts of car/ridesharing platforms (e.g., Uber and Lyft) on operational performance of transportation facilities at the local and regional levels. Field data availability is limited, thus simulation modeling can be employed to quantify such impacts for various market penetration levels of car/ride sharing modes. Traditional traffic simulation models lack the capability to simulate shared modes in detail, however, some new simulation platforms have emerged to allow shared mobility simulations.

Given the limited experience in this area, an extensive review of the literature and research case studies took place to identify available platforms for shared mobility simulation modeling. This presentation documents the findings from a comparative study of such simulation platforms.

Methodology

The study first identified simulation models that allowed simulation of shared modes. Then attributes of each simulation platform were reviewed and documented. A comparison of the models took place to assist transportation professionals in selecting the tool that best meets their modeling needs and priorities.

Results

Attributes	MATSim	Mobility Simulator for InfraWorks 360	D-RIDE-AMS	ICON Carpooling
Simulated modes	Car, bike, train, taxi, truck, car/ride share	Car, taxi, bicycle, walking, bus, train	Car-pooling, ride-sharing, vanpooling	Ridesharing
Simulation architecture	Multi-agent simulation	Multi-agent/ agent-based model	Activity based model	Data Mining/Machine Learning
Pre-requisite skills	Java Prog., XML structures, agent-based	OS, MS Office	OS, MS Office, GIS	PostGRESql, PostGIS, Python
System requirements	4 GB RAM and 200 GB free disk space	8 GB RAM,10 GB free disk space, Core i7	MS Windows 7, Visual Studio Libraries	MS Windows 7 or newer, 2 GB RAM
Model development time	Extensive	Low	Low	Moderate
User-friendliness	Basic GUI without online help	Fully developed GUI, well organized	Good GUI interface, easy to locate tools	Basic GUI, counter intuitive
Input requirements	**Configuration**: Connects other input files, configuration parameters, controller, etc. **Network**: Nodes & links, coordinates, modes using link, link capacity, speed **Demand**: Travel demand and daily plans (tours) for every agent	**Parameters**: Defines agents' behaviors **Network**: Shows roadways and paths **Control**: Traffic signals, ped. crossings **Demand**: Trips, origin, destination **Trips**: List of trips, agent, origin, destination, and departure time **Validation**: Validate model performance	**Agent data**: Demand, origin, dest., depart. time, arr. time, capacity **Configuration data**: Iterations, shortest path, vehicle cost/hour **Link data**: Id, start/end node, type, direct., leng., lanes, speed limit, capacity **Node data**: Node id, coordinates	GPS trajectories. The study is anchored to a large mobility dataset, consisting of the complete one-month-long GPS trajectories of approx. 10% circulating cars in Tuscany, Italy.
Modeling fidelity	**Mesoscopic**: Medium/high fidelity	**Microscopic**; High fidelity	**Macroscopic**; Low fidelity	**Macroscopic**; Low fidelity
Outputs	• Score Statistics (.png): show the avg. best, worst, executed and overall avg. of all agents' plans for every iteration. • Leg Travel Distance Statistics (.png): plot travel distance • Events (XML): activity start or change, important base for post-analyses • Plans(XML): the current state of the population with their plans • Leg Histogram (.png): agents arriving, departing or en-route, per time unit • Trip Durations (.txt): listing number of trips and their durations • Link and Network Stats (.txt): count values, travel times, emissions • Accessibility measures	• Summaries for People/ Cyclists/ Public Transport/ Private Vehicles/ Freight: • Distance (m), time (sec.), stops for each mode (number of stops) • Modes includes walking, passenger, driving, waiting • Lane changes • Loop activations • Emissions (CO_2 (kg/ton), NO (g/ton), PM10 (g/ton)) • Detailed Public Transport Information • Economic Evaluation (detailed costs for each trip) • Level of Service Reports	• AgentPlus: suggests each vehicle's pickup, delivery sequence, and corresponding paths to satisfy all passengers' needs while minimizing the overall cost. • DTALite: determines the best dynamic pricing strategy for vehicles, to have a sustainable development of D-RIDE applications. • Agent routing • Agent scheduling: a path containing a sequence of time stamps • Assignment of vehicles to passengers • Updated agent serving value ($) • Upper bound, Lower bound, and the gap percentage between these two	• GPS trajectories and networks in PostGRES tables
Dynamic events modeled	Weather conditions, incidents	No	No	No
Cost	Open-source + €1000 /yr. for Via	$1575 /yr.	Open-source	Open-source

Discussion and Conclusions

Based on an extensive literature review and market survey, four simulation platforms that showed promise toward simulating shared mobility in transportation were identified and evaluated. These were: MATSim (version 0.8.1), Auto Desk Mobility Simulator, the Dynamic Ridesharing (D-Ride) (version 1.0), and ICON Carpooling Demo software. These simulation platforms implement agent/activity based modeling, data mining and machine learning, and have various advantages and shortcomings for implementation. The comparison of model capabilities performed in this study showed that the most promising and well-established platform/model is MATSim. It incorporates time choice, mode choice, and/or destination choice into an iterative loop, leading to a stochastic user equilibrium. Through its computationally efficient-queue based approach, MATSim promises accurate modelling of technology-based car/ridesharing modes. The findings of this study are expected to be of great interest to researchers and practitioners that are in search of reliable simulation tools to model shared mobility modes.