Impact of Dynamic Ride-sharing Software on Traffic Congestion in Metropolitan Cleveland: Multi-agent Simulation Approach

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Background

Dynamic ride-sharing matches riders on demand with available drivers for one-time carpool in real time. The use of dynamic ridesharing services for transportation have seen explosive growth in recent years due to the ease, popularity, and ubiquity of mobile apps such as Uber and Lyft. Although the commonly held intuition is that dynamic ride-sharing alleviates traffic congestion, such concept warrents further investigation.

Research Questions

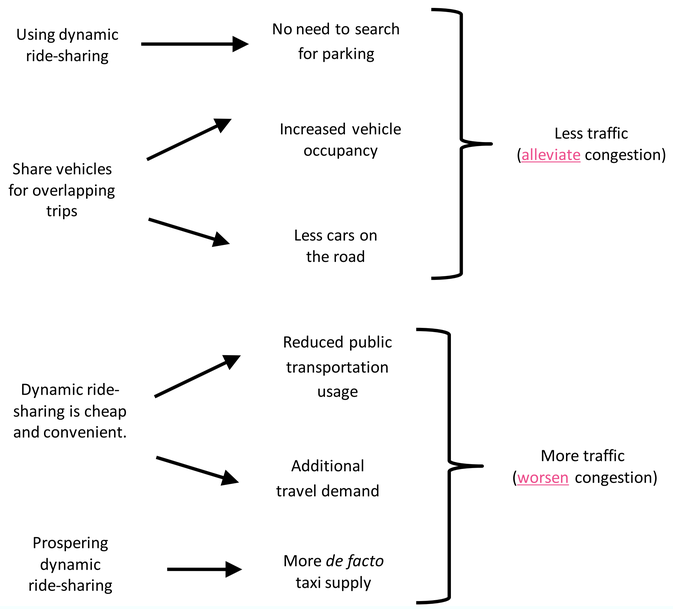
Does dynamic ride-sharing software alleviate/worsen traffic congestion?

Why does dynamic ride-sharing alleviate/worsen traffic congestion?

How might we improve traffic condition through manipulating the ride-sharing related factors and/or policies?

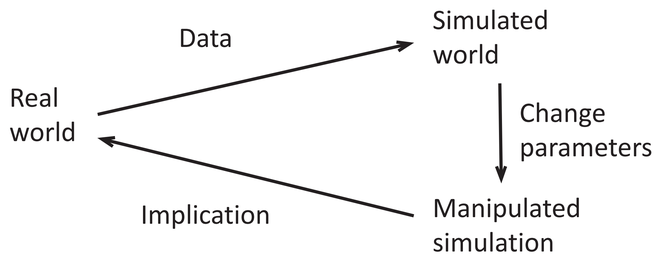
Hypothesis

My research aims to investigate the following hypothesized reasons for dynamic ride-sharing alleviate/worsen traffic congestion.



Research Method

Simulation



Multi-agent Simulation (MAS)

MAS is a kind of simulation involving multiple agents, which can be people, vehicles, or even cats. MAS can model the interaction between agents. Each agent should at least capable of:

- Making autonomous decisions
- Interacting with each other
- Interacting with the environment

Multi-agent Traffic Simulation

We made use of the state-of-the-art simulation tool MATSim[1] and the Dynamic Responsive Transit[2] extension.

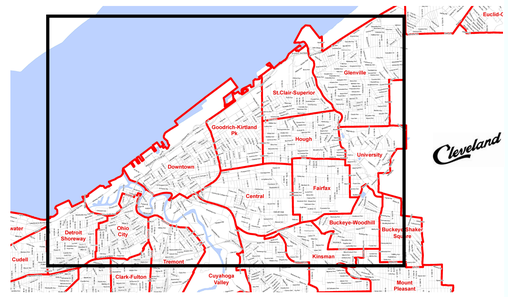
Data

The simulation is based on real-world data. I have looked at data of the following kinds:

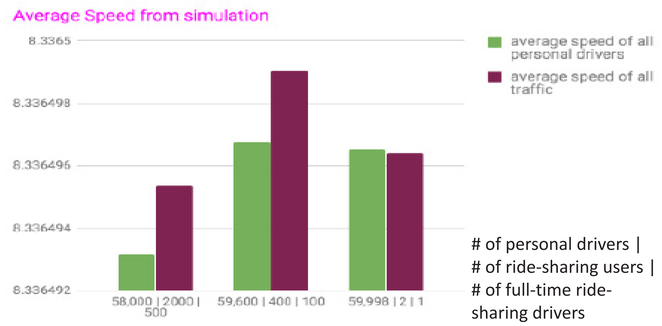
Map	OpenStreetMap[3] (downloadable)
Traffic	Traffic counts[4]
Survey	Dynamic ride-sharing[5]
	Beliefs about ride-sharing[5]
Census	General information[6]
	Travel related information[7]

Case Study

My simulation is based on Cleveland map, census and traffic data, as well as national surveys. Due to the limitation of time and resources, I created an initial study focused on a selected section of Cleveland, including traffic-heavy Downtown and University Circle.



Result and Discussion



I use the average speed of all vehilces as a measure of congestion. The preliminary conclusion we can draw from the simulation I ran is that there is no significant difference in congestion. However, this is by no means conclusive. We can make many improvements to the simulation such as:

- Larger map covering the entire Cleveland Metro
- More traffic elements and modes of transportation
- Larger and more detailed synthetic population
- Different trip purposes
- Part-time ride-sharing drivers
- Match real-world traffic data

Citation

1 http://matsim.org/
2 http://matsim.org/extension/drt
3 http://www.openstreetmap.org
4 http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/Traffic-Count-Reports-and-Maps.aspx
5 Smith, Aaron. "Shared, collaborative and on demand: The new digital economy." Washington, DC: Pew Internet & American Life Project. Retrieved May 21 (2016): 2016.
6 https://www.census.gov/quickfacts/fact/table/clevelandcityohio/PST045216
7 https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/subject_areas/national_household_travel_survey/daily_travel.html

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