Objective
The STEPS report “Three Revolutions in Urban Transportation,” is a scenario analysis of global economic and environmental impacts of market penetration of electrification, automation, and shared-use mobility in replacing single-occupant vehicle trips.

This research examines patterns in taxi trip cost per mile, network attributes, and driving travel times relative to alternative modes to draw high-level conclusions on how an autonomous vehicle rideshare network, as outlined in the “Three Revolutions” scenario of the STEPS report, could impact mode split and affordability of vehicle trips.

Dataset
- 2015 NYC Yellow Cab: 146 million trips (took 12.5 million samples for Google Maps API queries)
- 2015 NYC Green Taxi: 19.2 million trips (took 1.68 million samples for Google Maps API queries)
- Chicago 2013 – 2016 (all cab companies): Over 100 million trips
- Variables: trip origins & destinations, passenger count, trip distance, fare, fees, tip, and total costs

Travel Times by Mode
2015 New York City Yellow Cab and Green Taxi trips were sampled and queried through the Google Maps Distance Matrix API to obtain trip travel times of driving, transit, cycling, and walking. These times were used to draw a scenario where a taxi or autonomous rideshare vehicle offers point-to-point transportation.

- Driving times are moderately better than transit on average, most commonly by about ten minutes or less
- In roughly half of the taxi trips, cycling would have been faster
- For both cycling and transit, there is a right skew in travel times where cycling does substantially better, indicating that for those trips, driving was the optimal approach
- For the portion of trips where alternative modes were faster, either imperfect information or a preference for car travel led to the consumer decision to use a taxi

Network Attributes
Number of Trips by Node, Weekday, and Hour (Right)
Trip coordinates were rounded to 3 decimal places to form nodes. By summing trips at each node, we get a sense of the most popular origins and destinations of yellow cab trips, and can separate these by hour and weekday.

PageRank Algorithm (Below)
PageRank was originally designed to rank web pages by the sum of PageRanks of web sites pointing to the given web page, normalized by the total number of outbound links from that web page. This gives both the number of links to a given website and the quality of each link.

Future Work
- Taxi and rideshare trip-level data is needed for cities with a more average population density, like Sacramento, CA
- Data is needed on rideshare trips to understand 1) induced demand for vehicle trips caused by lower-cost and more convenient rideshare services, and 2) the degree to which pooled rides are chosen
- A better understanding is needed of the social dynamic of pooled autonomous vehicle rideshare. It is an ideal concept mathematically, but this service must be viable in absence of an authority figure (the driver) when sharing rides with “strangers”

Conclusions
- Better information available to consumers on mode choices and travel times at the trip decision point could shift at least some taxi trips to transit or cycling in cases where driving was not the fastest mode
- Sharing rides mitigates user cost and traffic congestion and expand access to point-to-point transportation to lower-income groups
- ~70% of 2015 NYC Yellow Cab trips had one passenger
- ~66% and ~84% of NYC and Chicago taxis, respectively, have hybrid powertrains. Autonomous vehicle rideshare fleets should aim to achieve comparable or better fuel economy
- Shared zero-emissions taxis are the next step for reducing emissions

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