Data Science to tackle Urban Mobility Challenges

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1- Big data to improve Urban Mobility?

2- Big data to improve Urban Policy?

3- Do this require new business models?
How do we govern cities related to Mobility?

Founded in 1978 has 16 Companies around the World

- Bogota
- Bologna
- Boston
- Leeds
- London
- Los Angeles
- Madrid
- Mexico City
- New Delhi
- New York
- Rome
- San Juan
- Santiago
- Sao Paulo
- Toronto
- Vancouver
**Algorithm 1: Estimating OD Matrices from CDRs**

\[ N_{\text{users}} \leftarrow 0 \text{ for each location } o \]
\[ OD_{o,d} \leftarrow 0 \text{ for all location pairs } o,d \]

for all users \( u \mid n_{\text{min}} < u.\text{numCalls} < n_{\text{max}} \) do

\[ u.\text{calls} \leftarrow \text{vector of calls of } u, \text{sorted by time} \]
\[ u.\text{home} \leftarrow \text{most visited location between 9pm and 7am} \]
\[ N_{u.\text{home}} \leftarrow N_{u.\text{home}} + 1 \]
\[ o \leftarrow \text{inPolygon}(u.\text{calls}[0].\text{location}) \]
\[ t_o \leftarrow u.\text{calls}[0].\text{time} \]

for \( i = 1 \) to \( i = u.\text{calls}.\text{length()} \) do

\[ d \leftarrow \text{inPolygon}(u.\text{calls}[i].\text{location}) \]
\[ t_d \leftarrow u.\text{calls}[i].\text{time} \]

if \( t_o - t_d < t_{\text{diff}} \text{ and } t_{\text{start}} < t_o, t_d < t_{\text{end}} \) then

\[ OD_{o,d} \leftarrow OD_{o,d} + 1 \]

end if

\[ o \leftarrow d; t_o \leftarrow t_d \]

end for

end for

\[ \text{totalTrips} \leftarrow \sum_{o,d} OD_{o,d} \]
\[ VUR_o, \text{POP}_o \text{ loaded from database} \]
\[ W \leftarrow \sum_{o} \text{POP}_o \cdot 4 \cdot 1/24, \text{total hourly trips} \]

for \( o,d \text{ in OD} \) do

\[ OD_{o,d} \leftarrow W \cdot VUR_o \cdot \frac{\text{POP}_o}{N_{\text{users}}} \cdot \frac{OD_{o,d}}{\text{totalTrips}} \]

end for

* \text{inPolygon(b)} returns the census tract from which the call was made.

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The path most traveled: Travel demand estimation using big data resources JL Toole, ..., MC González
Transportation Research Part C: Emerging (2015)

Origin-destination trips by purpose and time of day inferred from mobile phone data
L Alexander, S Jiang, M Murga, MC González
Validated Travel Demand
Demand Management for Large Events

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(a) Data Integrated
(b) Number of audiences arrive venues and when? (used data: Olympics schedule, capacity of venues)
Traffic Model
Smart-app (routing)

Modifications on the level of altruism:

\[ c_e^\lambda (x_e) = (1 - \lambda) t_e(x_e) + \lambda \frac{d [x_e t_e(x_e)]}{dx_e} \]

\[ \lambda = [0..1] \]

- User Equilibrium component
- Social Optimun component
Smart-app (routing)

(a) Map showing routes from Origin to Destination:
- SO Route: λ = 1, 25 mins
- UE Route: λ = 0, 20 mins
- Optional Route: λ = 0.2, 22 mins

(b) Graph showing the number of vehicle trips for different λ values in Rio and Bay:
- λ = 1.0
- λ = 0.1

(c) Graph showing net benefit in commuting travel time for different social good weights (λ) and percentage decrease in congestion.
Recommendations of Car reduction per Origin and Destination

Vehicle demand decrease: ~1.3%
Total travel time decrease: ~10.5%
Adoption of Financial Services for Low Income Groups

Credit Card Users 251,000  Population 8.9 millions
Debit Card Users 855,000  Area 1,485 km²
#Transactions 23 millions

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Sequitur's algorithm

User Transactions Sequence

Transaction Words

User Words Similarity

Life Style of a group

Louvain algorithm
\[ D_i = \frac{-\sum_{j=1}^{k} p_{ij} \log(p_{ij})}{\log k_i} \]

\[ R_g^2 \overset{\text{def}}{=} \frac{1}{N} \sum_{k=1}^{N} (r_k - r_{\text{mean}})^2 \]

\( p_{ij} \) is the fraction of \( k_i \) events between nodes \( i \) and \( j \)

Events are trips or Phone contacts
Commuters:
High expenditure, Living far from the city center, High radius of gyration, Low social diversity.
Tech-users:
High Expenditure, younger and larger mobility diversity
Current Project: Urban Mobility and the Wealth Divide
Current Project: Accessibility to Facilities in Diverse Cities
Conclusions

- Today we can measure behavior from communication technologies and can plan cities with them.
- Real time incentives is the next frontier.
- Integration of Data from companies, governments and online
- Urban applications are the next frontier