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Title:	Transportation Model in the Boston Metropolitan Area from Origin	**Title:**	
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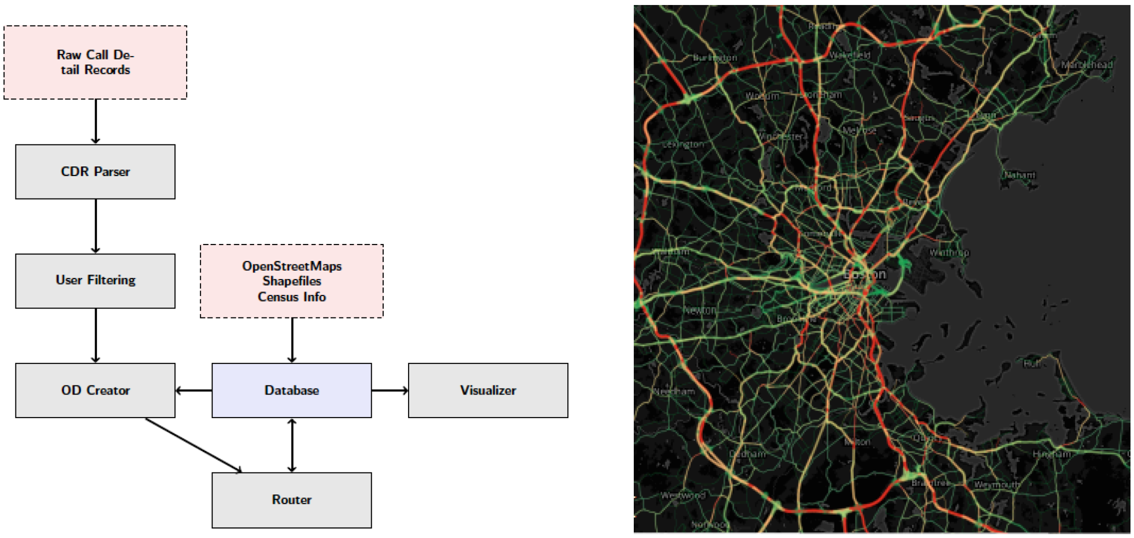

Figure: flowshart of the system architecture and car demand results assigned in the Bostn road network.

As millions of people migrate cities each year, it is critical that we put new data sources to work improving them. The density of cities brings economic productivity, provides cultural amenities, and facilitates sustainability, but is also the root of problems related to congestion, health, and safety. This project has presented new perspectives and applications of massive, passively collected data sources to understand human mobility and its relation to these outcomes. It has detailed a number of new methods and applications for extracting meaningful insights from this data to make cities better places to live. Above all, though, this work highlights the need for interdisciplinary approaches. We have seen combinations of methods from data mining and machine learning, network theory, and spatial statistics, with deep domain knowledge from urban planning, economics, and transportation. For decades, planners and sociologists such as Jane Jacobs have recognized cities as systems of organized complexity where the interactions between millions of residents combine to produce emergent phenomena. The promise of "big data" is to measure these interactions and enable us to study their consequences at a massive scale.

Understanding demand for and operation of city infrastructure is crucial for civil engineers, planner, and policy makers. Passively collected data from new mobile devices have generated a wealth of insights about human movement. Metrics and methods from statistical physics have been applied to data on millions of individuals to show that we are generally slow to explore new places, highly predictable, but also unique. This data has been used in conjunction with traditional survey and census sources to produce and validate estimates of aggregate flows of people or vehicles from origins and destinations around the city. Papers [1-5] and Masters thesis [6] developed and exhaustive method to mapping these mobility insights and measurements onto transportation infrastructure and zoning information in order to evaluate system performance and to validate the obtained results with existing travel demand models on cities.

Figure 1 describes a software system that uses call detail records from millions of mobile phones to estimate travel demand and road usage patterns in multiple cities around the world. The system takes as an input billions of rows of data on where mobile phone users make calls or send messages from and estimates the flow of people between origins and destinations in a city at different times and for different purposes.

These origin-destination matrices are then used to assign trips to transportation infrastructure. For example, we leverage crowd-sourced road networks from repositories such as OpenStreetMap and routes vehicle trips through road networks. The result is a rich map of traffic and congestion which contains estimated usage data for nearly every road in the city. Because the system tracks the origins and destinations of every vehicle routed, we are also able to perform a detailed analysis of which areas contribute traffic to a particular congested area or which streets serve local traffic versus traffic from all over a city. Finally, we have seen an interactive, online visualization platform that allows researchers and policy makers to explore travel and congestion patterns of cities.

This system was built with generalizability as a requirement. It has currently processed more multiple cities around the world and new cities can be added easily provided input data. We have gone to great lengths to validate this work against traditional methods that use survey and census data and compare with the state of the art in the transportation and urban planning communities. This platform has great potential to produce estimates of travel demand more accurately, faster, and at lower cost than traditional survey based methods. The relative uniformity of mobile phone data across the world presents a great opportunity to conduct comparative studies of congestion patterns in cities and explore the relationship between network topology, system performance, and travel demand. Still more can be done to include multiple modes of transportation such as busses, rail, and even bicycles. Finally, there is ability to connect this work with that from the previous chapters in this thesis to understand how social and economic behaviors are correlated with transportation network usage. This work is critical into leveraging the massive scale of new mobility data to understand and improve the transportation systems we use every day.

Related Publications

1. Colak S., Lima A., Gonzalez MC, Understanding congested travel in urban areas, Nature Communications (forthcoming 2016)

2. Toole JL, Colak S., Sturt B., Alexander LP, Evsukoff A., González MC, ,The path most traveled: Travel demand estimation using big data resources Transportation Research Part C: Emerging Technologies, 58, Part B, September 2015, 162–177, (2015)

3. L Alexander, S Jiang, M Murga, MC González, Origin–destination trips by purpose and time of day inferred from mobile phone data, Transportation Research Part C: Emerging Technologies, 58, 240–250 (2015)

4. P Widhalm, Y Yang, M Ulm, S Athavale, MC González. Discovering urban activity patterns in cell phone data,Transportation, July 2015, Volume 42, Issue 4, pp 597-623 (2015)

5. S Çolak, LP Alexander, BG Alvim, SR Mehndiretta, MC González, Analyzing Cell Phone Location Data for Urban Travel: Current Methods, Limitations and Opportunities, Transportation Research Board 94th Annual Meeting (2014).

6. Lauren Alexander M.Sc in Transp. 2015 “Cell phone location data for travel behavioranalysis" Manager, Now: Product Analytics at Zipcar.