Predicting Human Flows

Using massive passive data to predict regions attraction

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Introduction

Riyadh:

-Population: 6M.

-Undergoing significant transportation infrastructure changes (one of the largest metro projects in the world).

-Using data for 300k users in Riyadh, we extract the flows between regions in the city.*

-Problem statement:

How do we estimate inflows of population to regions?

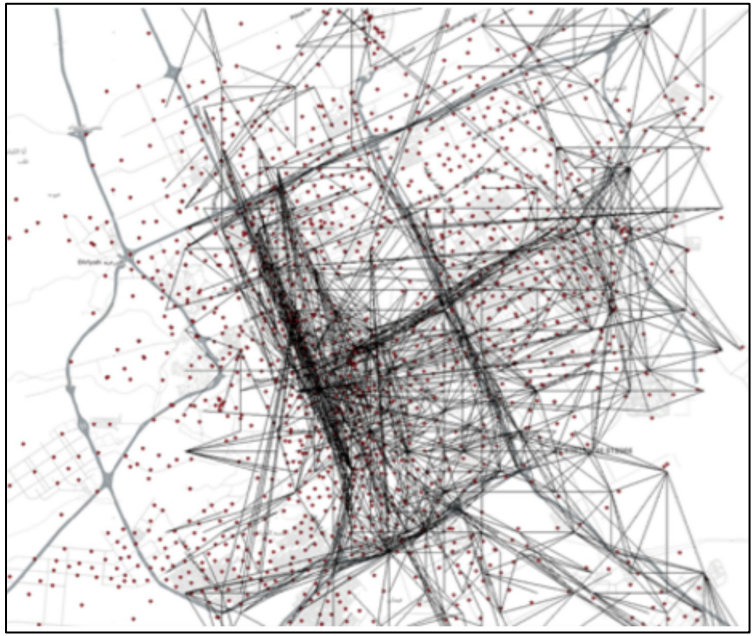


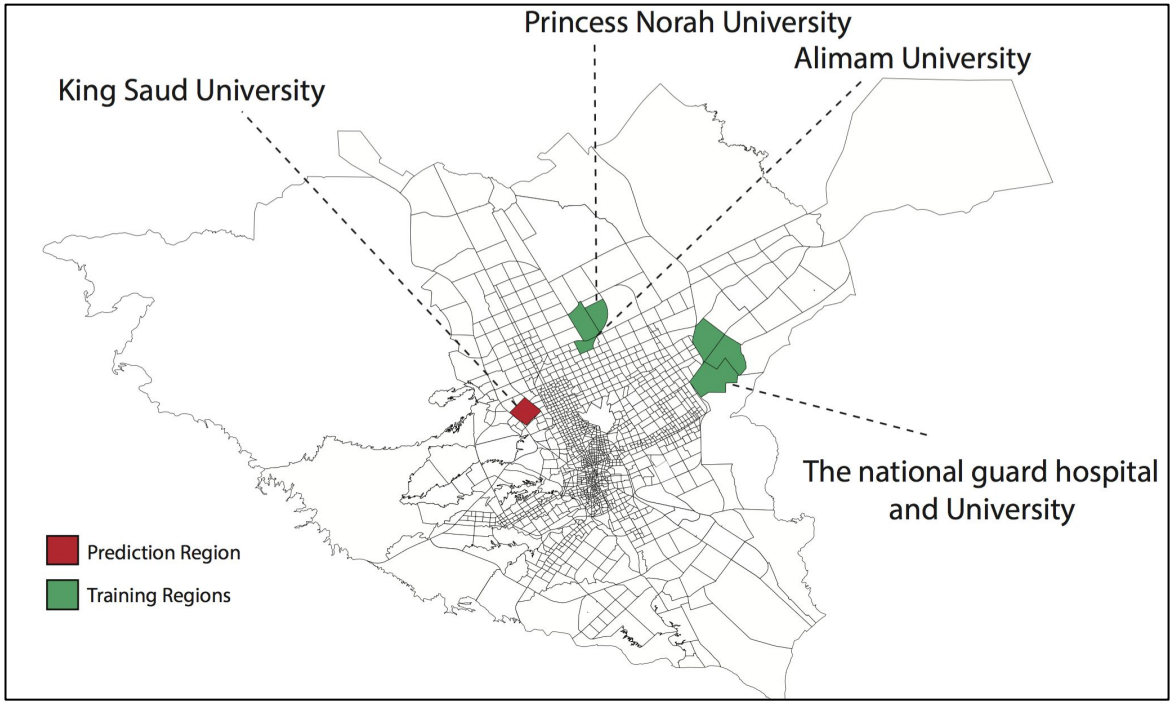
Figure. Trips in the City of Riyadh during the morning period

* Toole, Jameson L., et al. "The path most traveled: Travel demand estimation using big data resources." *Transportation Research Part C: Emerging Technologies* 58 (2015): 162-177.

Example Problem

-Similar places attract inflows from same location.*

-Can we predict KSU inflow given the other universities in Riyadh?



* Alhazzani, M., Alhasoun, F., Alawad, Z., and Gonzalez, M. Urban attractors: Discovering patterns of regions attraction in cities. Submitted to UbiComp: Ubiquitous Computing (2016).

Gaussian Process Model

$$f(x) \sim \mathcal{GP}(m(x), k(x, x'))$$

Where mean function and kernel function are given by

$$m(x) = 0, \qquad k(x, x') = \sigma^2 \exp\left(-\frac{(x - x')^2}{2l}\right)$$

Sample of the data (~2000 data points):

i	lon_i	lat_i	l_{ik}
1	46.5766	24.7173	45
2	46.5194	24.7461	68
3	46.5920	24.7166	6

sample of inflow data for regions set k from region i

Gaussian Process Prediction

Residential areas are major inflow contributors to universities.

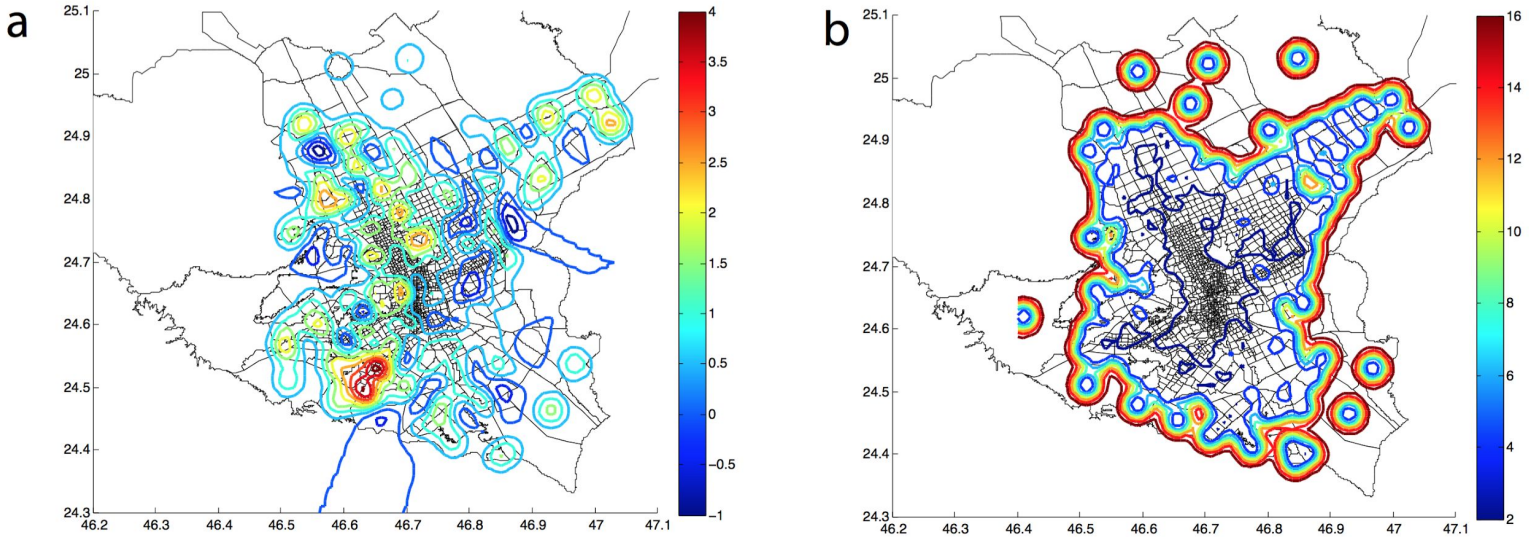


Figure. The figure shows (a) log of predictive mean and (b) predictive variance for the inflow to regions in the set k

Evaluation

-Gravity model (baseline)*:

$$L_{ij} = \frac{O_i \, T_j}{d_{ij}^{\alpha}}$$

T_j Region j inflow.

O_i Region i outflow.

d_{ij} Distance between region i and region j.

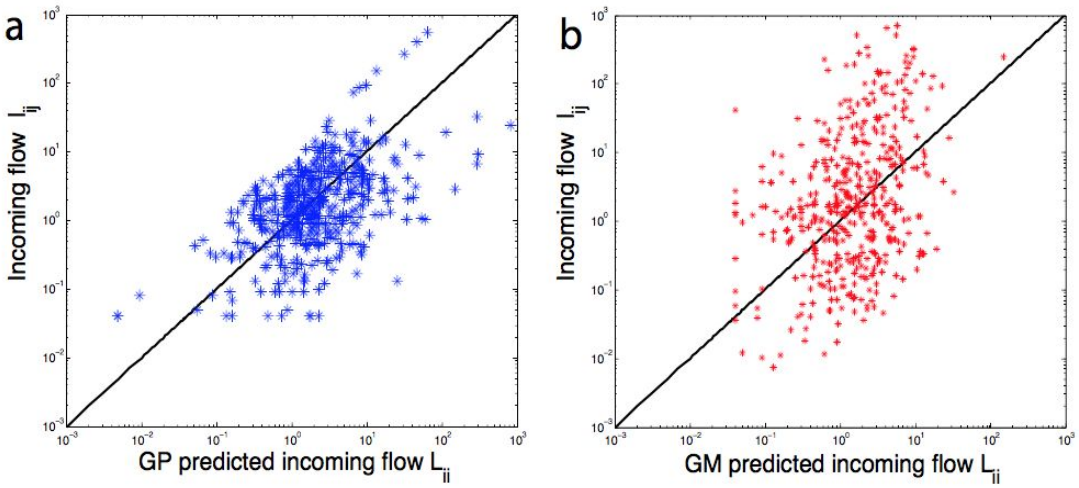


Figure Performance of (a) Gaussian process (GP) versus (b) gravity model (GM) for predicting the inflow to King Saud University

* Erlander, S., and Stewart, N. F. The gravity model in transportation analysis: theory and extensions. 18–19.

Evaluation

-Root Mean Squared Error (RMSE) and Mean Error (ME):

$$\mathrm{RMSE}_j = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(L_{ij} - l_{ij})^2} \quad , \qquad \mathrm{ME}_j = \frac{1}{n}\sum_{i=1}^{n}|L_{ij} - l_{ij}|$$

method	ME	RMSE
Gravity model	212.05	900.52
Gaussian process	10.5	54.58

ME and RMSE for GP and gravity model in predicting inflows to King Saudi University

* Erlander, S., and Stewart, N. F. The gravity model in transportation analysis: theory and extensions. 18–19.

Questions?