CS591 Data Mechanics

How many people are at intersections in Boston?

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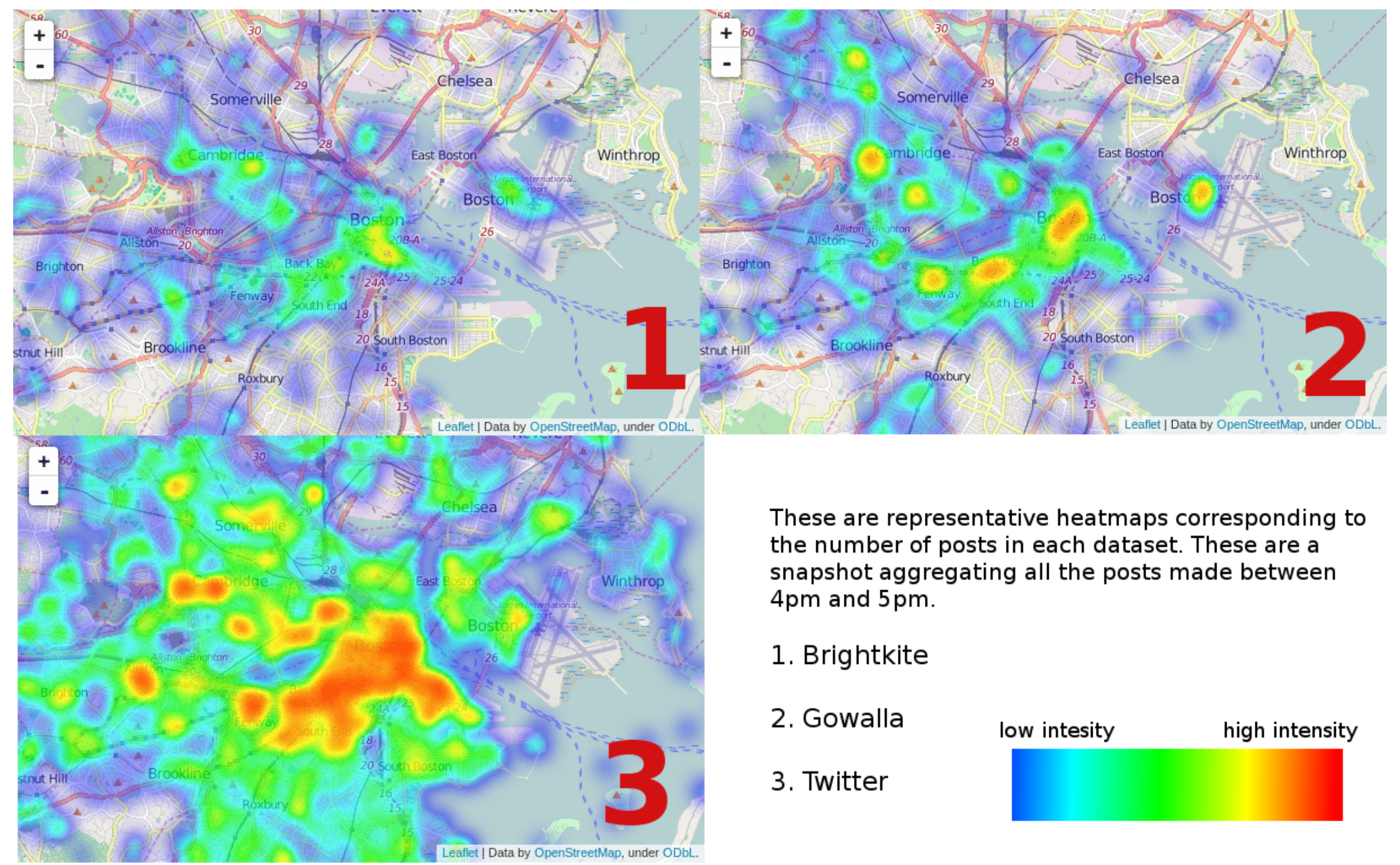
Introduction

In this project, we attempt to develop an understanding of human movement within the city of Boston. Using social media data from three companies, Brightkite and Gowalla, both of which are no longer active, and Twitter. To generate higher granular information, we used OpenStreetMap data to associate social media user's posts to specific intersections. Since not all people use social media, and thus are not represented in the datasets presented here, we must infer the actual amount of people that are present at these intersections in real life. Future work will attempt to cross-validate these methods with different types of observations, such as census population data and population counts at intersections derived from street cams and computer vision. Future work will also include using this data to solve classic problems, like max flow, in the pedestrian setting.

Datasets

Brightkite This is a social media networking service that was acquired by a mobile social network, Limbo, in 2009. The dataset contains posts with a user id, geocoordinates, and a timestamp between 14 April 2008 and 18 October 2010. **Gowalla** This is a social media networking service that went out of business. Each post in the dataset has a user id, geocoordinates, and a timestamp, dating between 23 April 2009 and 22 October 2010. These two datasets are publicly available and have been filtered for posts only with Boston's geocoordinates for this project. **Twitter** This is a micro blogging service that collects geological information about users's posts. This is still an active service and this data set was collected from 11 May 2015 until 2 April 2016. This data was collected via Twitter's streaming API.

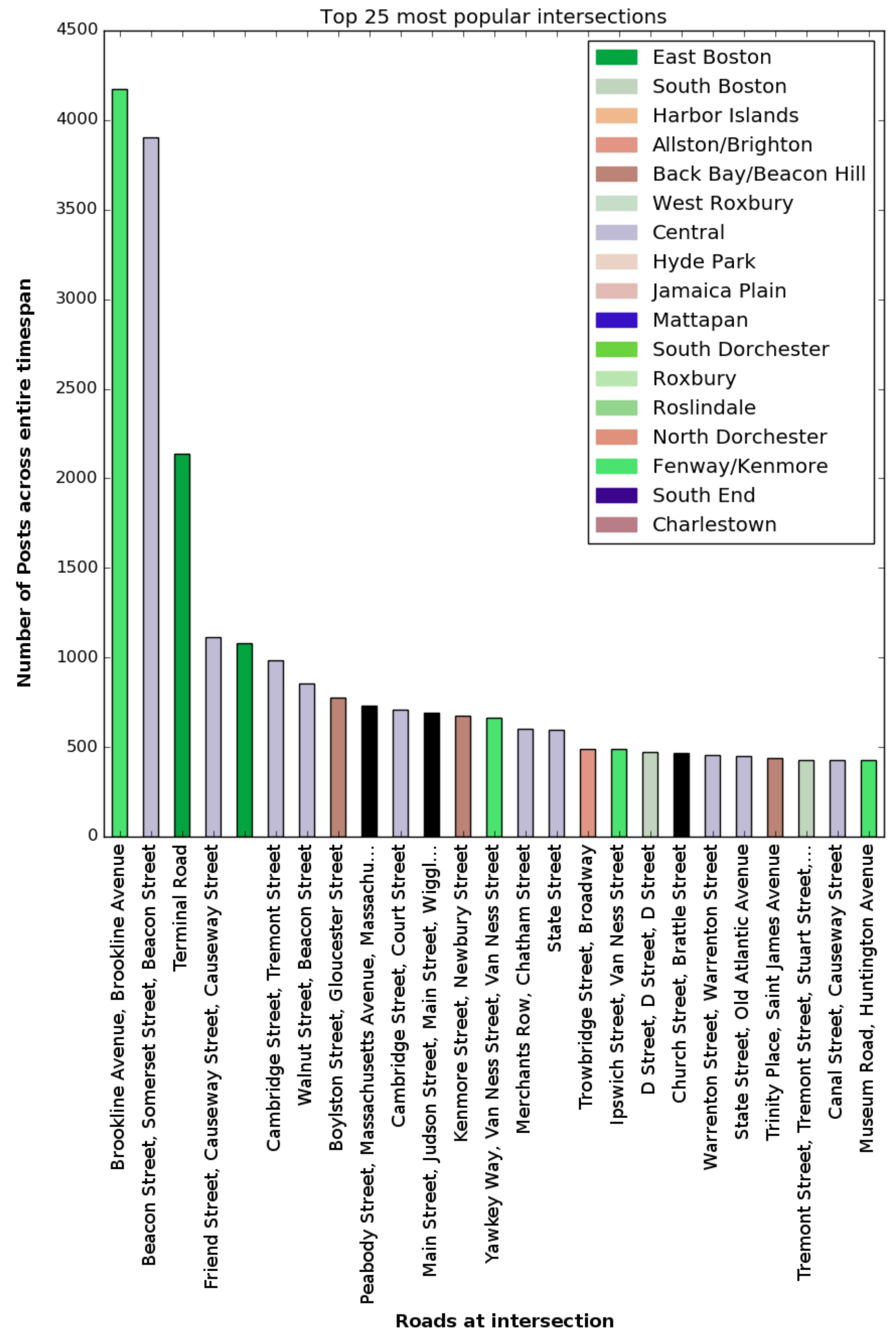


These are representative heatmaps corresponding to the number of posts in each dataset. These are a snapshot aggregating all the posts made between 4pm and 5pm.

1. Brightkite
2. Gowalla
3. Twitter

Service	# of users	# of posts	$\frac{posts}{users}$	duration
Brightkite	1,383	31,928	23	917 days
Gowalla	2,395	39,398	16	547 days
Twitter	39,540	632,990	16	291 days

Segmentation



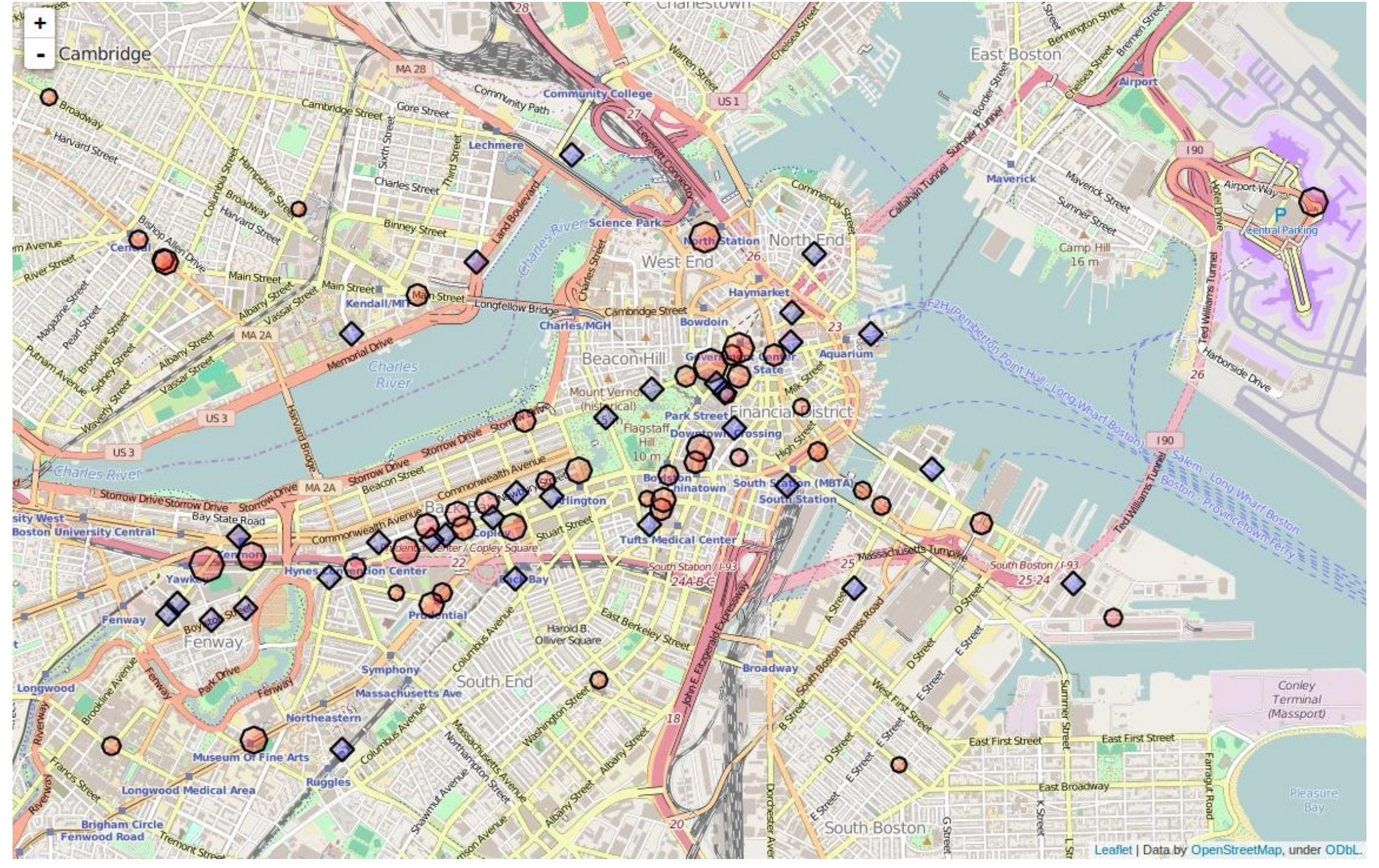
Using the OpenStreetMap data, each Twitter post was associated with the closest intersection. The chart shows the most popular twenty-five intersections.

Intersection Estimation

Capture & Recapture. This type of sampling was first used when measuring animals in traps. Trappers would mark animals and then count how many of these animals returned to derive an estimate of the total population. This is represented in the following formulation:

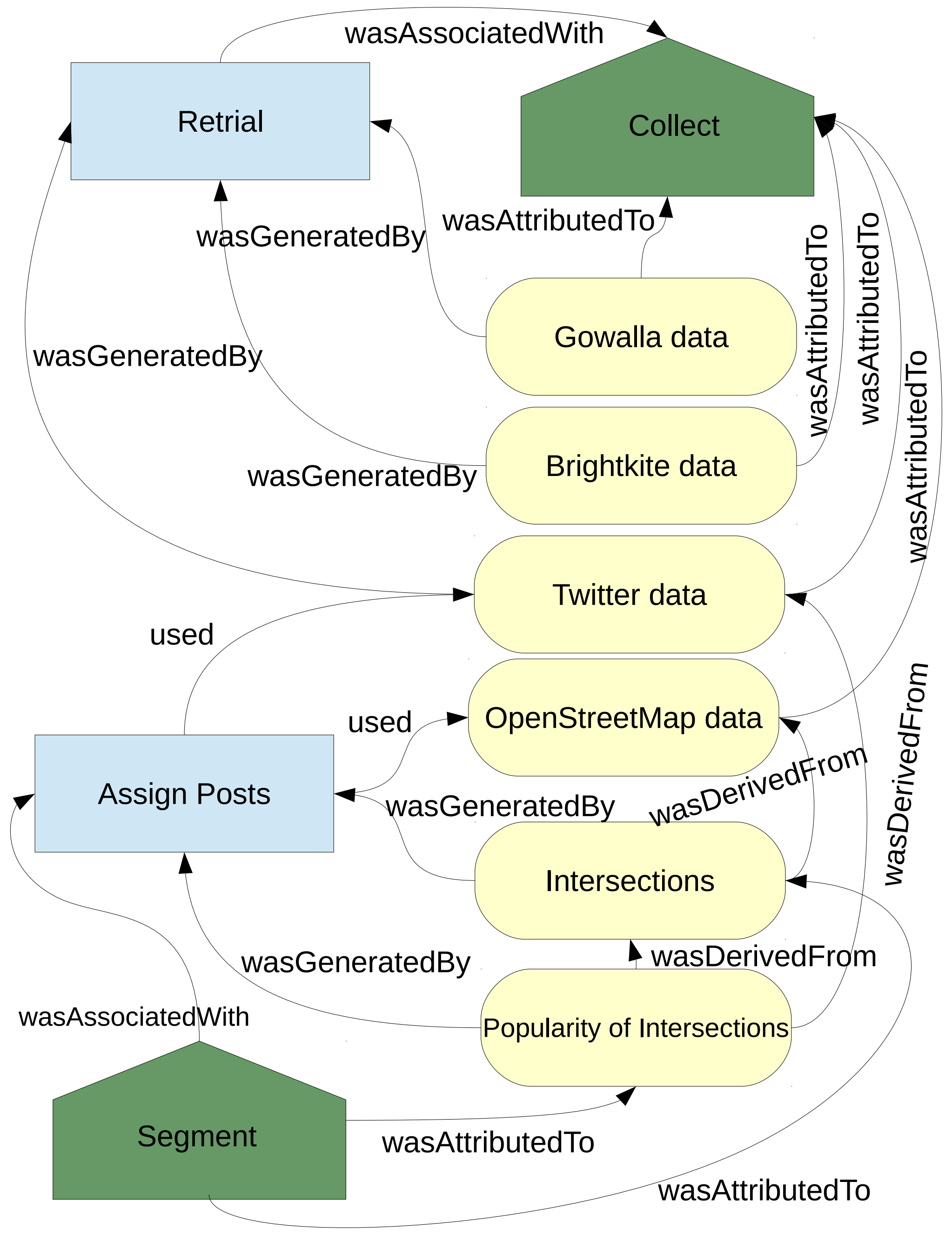
$$\hat{N} = \frac{Kn}{k}$$

where $\hat{N}$ is the estimation of the total population, n is the number of users during the first month, K is the number of users during the second month, and k is the number of users from the first month that are observed during the second month. With this formulation, we can derive estimations for the number of social media users that post near an intersection per month.



We discovered only 94 intersections, of the almost 25,000, had five or more visitors each month. Only 57 of these intersections had visitors that returned during the capture/recapture period. The red markers show the intersections that estimates could be computed, scaled with the $\log_2$ function. The blue markers show the intersections that did not have returning users. Fenway park had that max estimate with approximately 12,000 visitors per month.

Data Provenance



We use six (two of them derived) datasets denoted in yellow, two agents in green, and two activities in blue. Excluded from this chart is the provenance information for the scripts that generate the visualizations and some other statistics.

Conclusions

Although the social media data consisted of many posts, only a fraction of the intersections had data spanning the entire collection period. Of these intersections, only a fraction had entire data to compete the estimate via the capture & recapture method. Future work will be to include the Brightkite and Gowalla datasets in the estimation of intersection occupancy and analyzing flow problems associated with pedestrian traffic.

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