Smart Bike-Sharing Systems for Smart Cities

Gus Lipkin

Introduction and Literature Review

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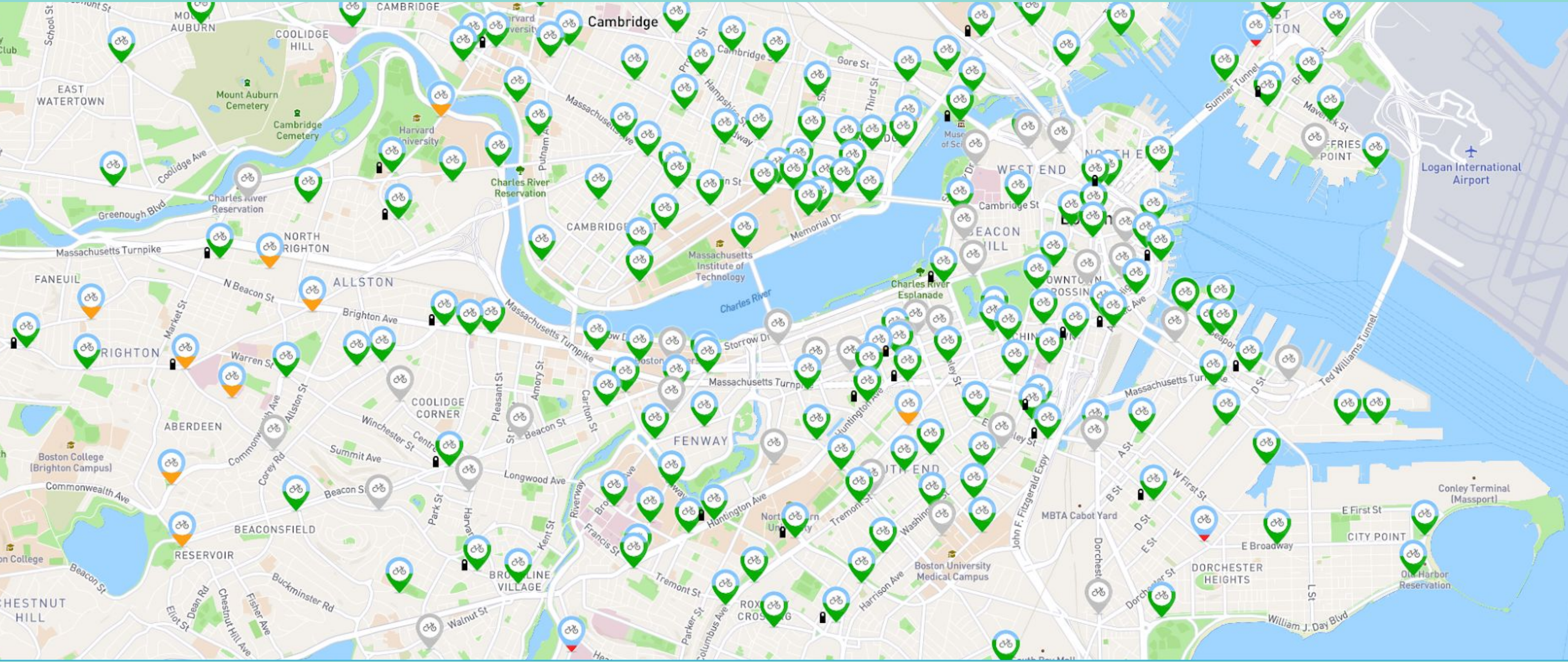
As cities grow and more people are pushed to public transit, the so-called “**last-mile problem**” needs to be solved. One solution is a **bike-share program**. Smart systems use **data analysis** to **monitor** stations, **collect** usage data, and **predict** future bike use and availability.

- Bike availability prediction
  - Tracking bicycle movement and location so that they are appropriately distributed so there are no shortages or too many bikes going unused
- Using clustering to explore data trends
  - Examining docking station usage to find desirable and undesirable travel zones
- Rebalancing
  - Moving bikes from low-demand areas to high-demand areas


CAMBRIDGE
Cambridge
COOLIDGE HILL
Mount Auburn Cemetery
Cambridge Cemetery
EAST WATERTOWN
School St
Coolidge Ave
Greenough Blvd
Charles River Reservation
Massachusetts Turnpike
FANEUIL
N Beacon St
ALLSTON
Brighton Ave
Market St
Warren St
Allston St
COOLIDGE CORNER
ABERDEEN
Boston College (Brighton Campus)
Commonwealth Ave
Corey Rd
Winchester St
Summit Ave
Beacon St
Longwood Ave
Pleasant St
Amory St
Carlton St
Park St
BEACONSFIELD
RESERVOIR
Buckminster Rd
Dean Rd
Eliot St
Chestnut Hill Ave
Fisher Ave
Walnut St
Kent St
Riverway
Francis St
Putnam Ave
Massachusetts Ave
Hampshire St
Gore St
Third St
Memorial Dr
Massachusetts Institute of Technology
Charles River
Storrow Dr
FENWAY
Huntington Ave
Tremont St
Parker St
Columbus Ave
Harrison Ave
Charles River Esplanade
WEST END
Cambridge St
Boston University Medical Campus
John F. Fitzgerald Expy
MBTA Cabot Yard
Dorchester Ave
A St
B St
D St
E St
W First St
Dorchester St
DORCHESTER HEIGHTS
E Broadway
E First St
CITY POINT
L St
William J. Day Blvd
Conley Terminal (Massport)
Ted Williams Tunnel
Sumner Tunnel
Maverick St
Logan International Airport

Data & Analysis

Dataset – Docking Station Data

- Collected between August 2013 and August 2015
- From the San Francisco Bay Area
- Data includes:
  - Station ID
  - Number of bikes and docks available
  - Date-time of recording
- Data description:
  - 70 Stations
  - Documented every 15 minutes

Analysis

Bike Prediction Models

- RF, least square boosting, and partial least squares regression ML algorithms
- RF and LSBoost for univariate prediction
- PLSR for multivariate model for each zip code

Supervised Clustering

- Aimed to answer how different bike stations were similar on different days of the week, different weather, etc

Rebalancing

- Improve the bike rebalance tour by optimizing the route for the number of bikes available
- Think of it like a game of mancala where you want to evenly distribute the stones

Proposed Algorithm

Phase I: Tour Construction

- Optimize the tour so that each “NotSpot” is included once and only once

Phase II: Improve and Select

- Use an algorithm to improve the tours constructed in Phase I and then select the optimal tour

Results

.824%

Percent difference in the proposed algorithm over the best-known solution

Next Steps

- Use existing data to analyze cyclist movement patterns to increase or decrease the number of bays available at each docking station so that tours can be better optimized
- Look into ways to incentivize travel between at capacity NotSpots and empty NotSpots to better aid in tour optimization

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