ComputerScience

BOSTON UNIVERSITY

BOSTON BIKES

Expanding Select Bicycle Lanes to Improve Bike Safety in Boston

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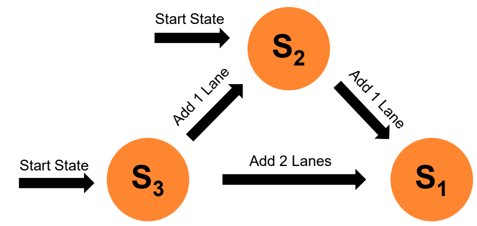

Figure 3. States Transformation≈

INTRODUCTION

- **2007** – *Boston Bicycle Program* launched: doubled ridership.
- **2012** – 5 fatal bicycle incidents.
- **2013** – *Boston Bike Network Plan* : decreasing bicycle crashes by 50 percent by 2020.
- This project: *identifying a comprehensive network of bicycle routes* through the city of Boston based on the Bikes Crash Data.

DATA

- **Bikes Crash Data Sets** (2009 – 2012):
  - Boston Bikes Crash Data (by BPD)
  - EMS Crash Data (by City of Boston)
  - Bike Collision Database (by Harvard Dataverse)
- **Existing Bike Network** (by BostonGIS)
- **Boston OpenStreetMap** (by Metro Extracts)
  - to get groups of connected streets
  - to acquire the length of each street

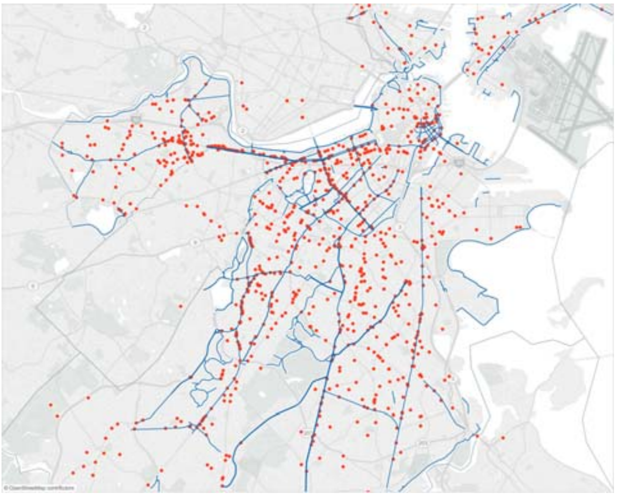

Figure 1. Existing Bike Lane & Bikes Collisions in Boston

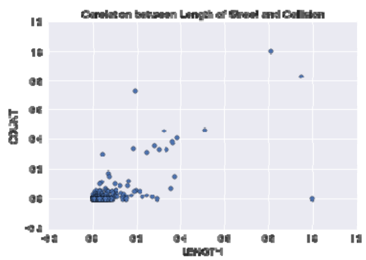

Figure 2a.

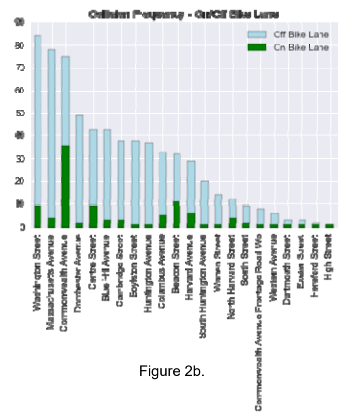

Figure 2b.

DATA VISUALIZATION

- **Figure 2a**: no strong evidence suggests the covariance between the length of the street versus the amount of bike collisions.
- **Figure 2b**: there are significantly less collisions occurred in the bike lane, compared to the streets without bike lane.

DATA ANALYSIS

- **Goal:**
  - To build a better *connected* bike lane network
    - What are the main streets that need a bike lane (if it hasn't) in order to achieve connective routes?
- **Modeling:**
  - 3 states for each pair of streets (x_i,x_j) that connect/intersect:
    - S_1 = both streets have bike lanes.
    - S_2 = only 1 of the 2 streets has a bike lane.
    - S_3 = neither of the streets have bike lanes.
  - Binary representation:
    - S_1 = (1, 1)
    - S_2 = (1, 0) or (0, 1)
    - S_3 = (0, 0)
  - State Transformation (Figure 3.)

Optimization:

- *Maximize* S_1 where most bike lanes are connected.
- non-linear model:
- $argmax_{i\ j\ \in\ N} \sum(-1)^{x_i+x_j}$
  - *constraint set*: $x_{i\ j} \in \{0,1\}$ where 0 represents no bike lane, 1 means there is a bike lane.
  - Solver: **dReal**
- *Minimize* S_2 where single bike lanes are left alone.
- linear model:
- $argmin_{i\ j\ \in\ N} \sum|xi - xj|$
  - *constraint set*: $x_{i\ j} \in \{0,1\}$ where 0 represents no bike lane, 1 means there is a bike lane.
  - Solver: **Z3Opt**
- Both models need constraint on how many bike lanes *K* would like to be added:
  - $x_1 + x_2 + \cdots + xN \leq K$

FUTURE WORK

- Linear Programming vs. Integer Programming
- Statistical analysis on the impact of adding bike lanes.
- Updated Bike Collision Data.
- More information on when (date) each bike lane was installed in order to match with the bike collision on bike lane.

REFERENCES

- Boston Bikes, http://www.cityofboston.gov/bikes
- Figure 1., https://public.tableau.com/profile/asross#!/
- http://www.cs.bu.edu/faculty/kfoury/UNI-Teaching/CS512-Spring16
- http://cs-people.bu.edu/lapets/591/