

Detecting Traffic Crash Patterns and Identifying the most Risky Hotspots by Street Sections for Vision Zero Boston using Spatial Statistical Methods

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VISION ZERO BOSTON

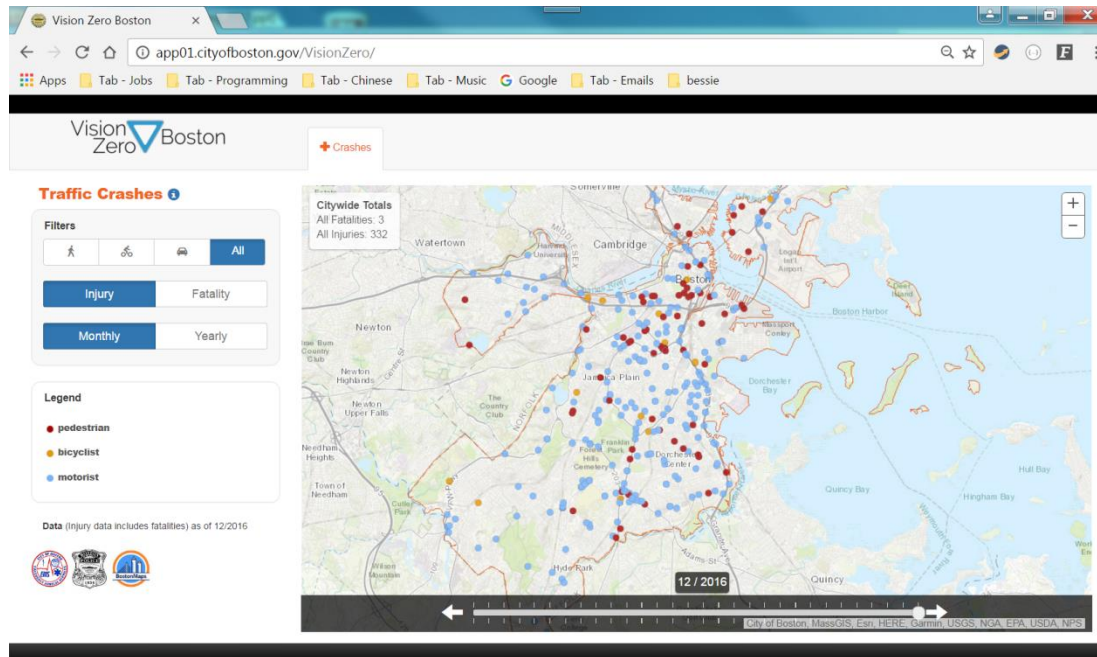
- Vision Zero is an international road traffic safety initiative that aims to achieve a road traffic system with no fatalities or serious injuries. It started in Sweden and was approved by their parliament in October 1997.
- The City of Boston joined New York, Washington DC and other cities worldwide in adopting Vision Zero and issuing similar plans to prioritize transportation safety in December 2015.
- Vision Zero Boston is our commitment to focus the city's resources on proven strategies to eliminate fatal and serious traffic crashes.
- See <http://www.visionzeroboston.org> for more details.

VISION ZERO BOSTON – THE MOST RISKY HOTSPOTS BY STREET SECTIONS

- Objectives:
To detect traffic crash patterns and identify the most risky clusters / hotspots by street sections.
- Methodologies:
Two spatial statistical methods:
 - 1, Kernel Density Estimation (Planar and Network KDE).
 - 2, Local Indicator (Getis-Ord G_i^*) of Network-Constrained Clusters (GLINCS).
- Website: <http://app01.cityofboston.gov/proxy/vzanalysispart2>

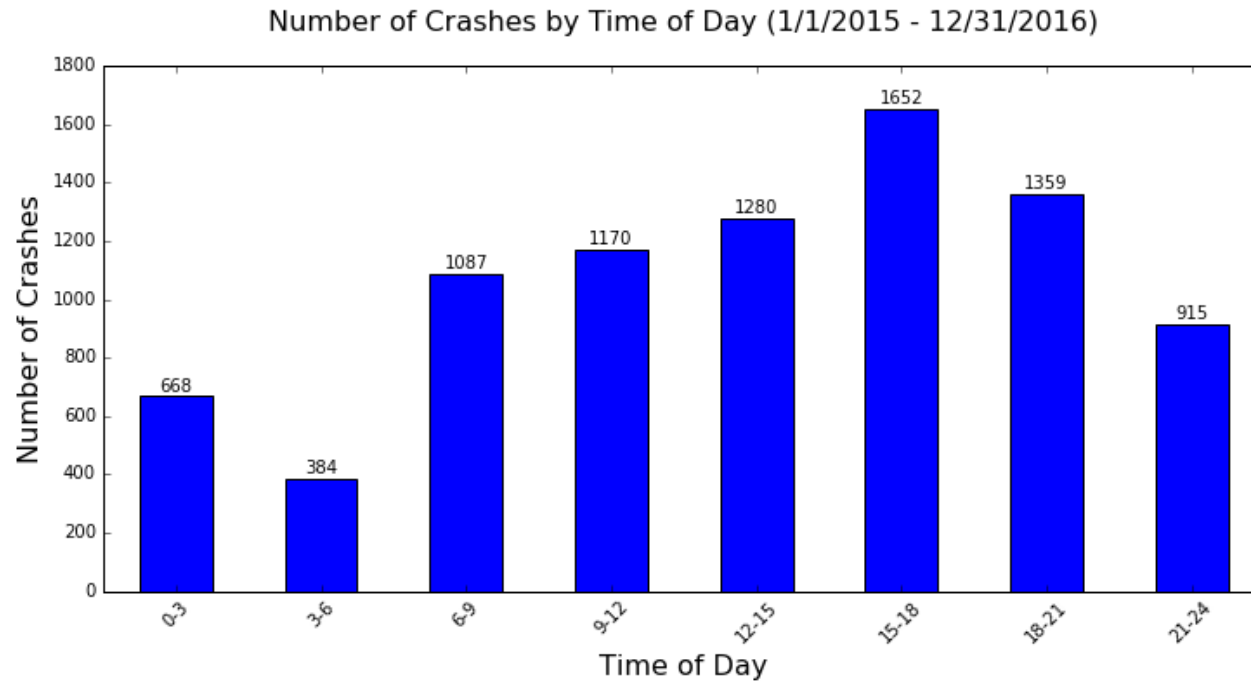
TRAFFIC CRASH DATA

- <http://app01.cityofboston.gov/VisionZero>

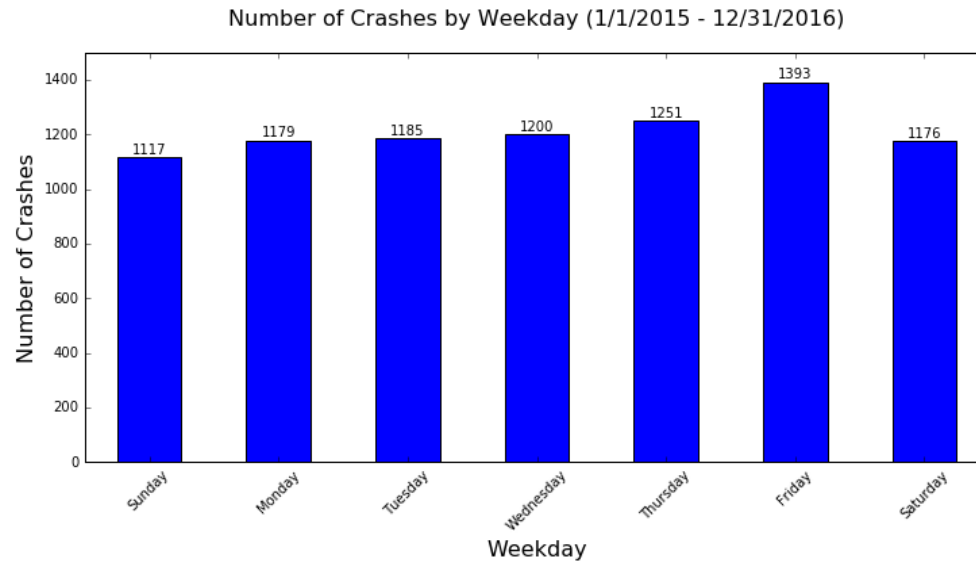


- Traffic Crash Data Used in Analysis
Totalled 10,752 Crashes from 7/1/2014 - 12/31/2016.

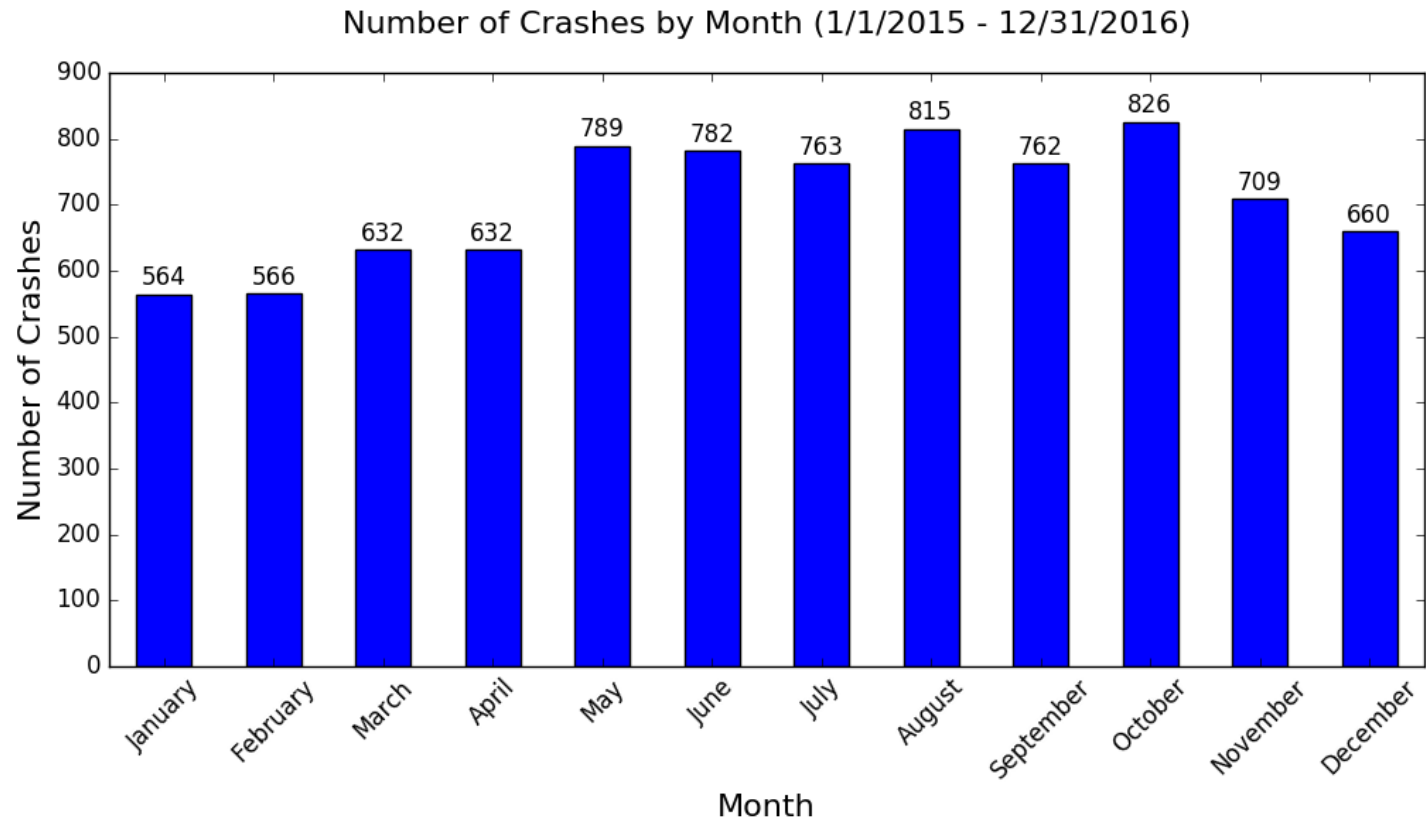
TRAFFIC CRASH DATA



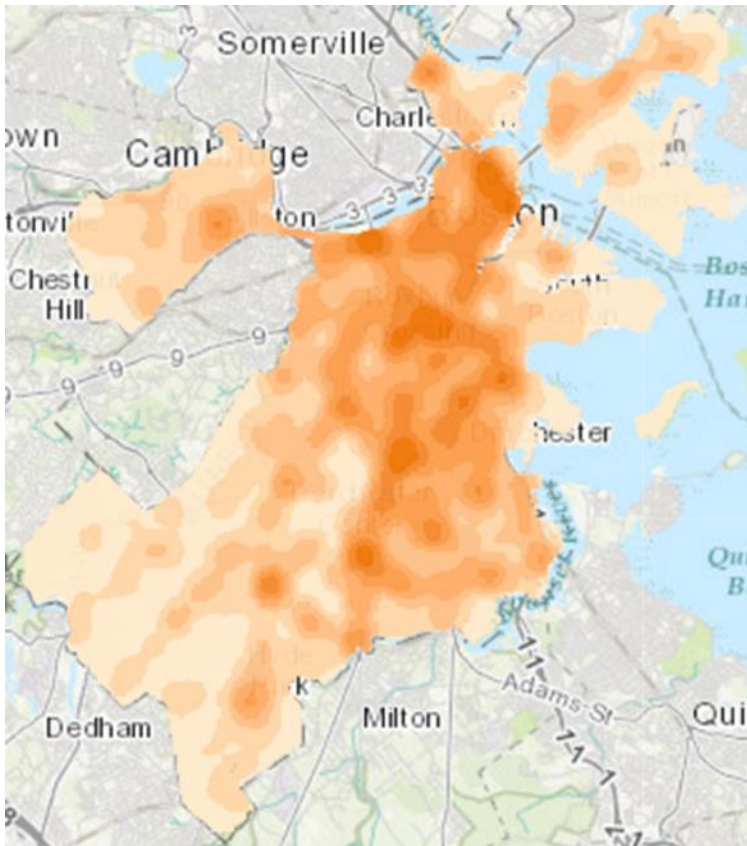
TRAFFIC CRASH DATA



TRAFFIC CRASH DATA

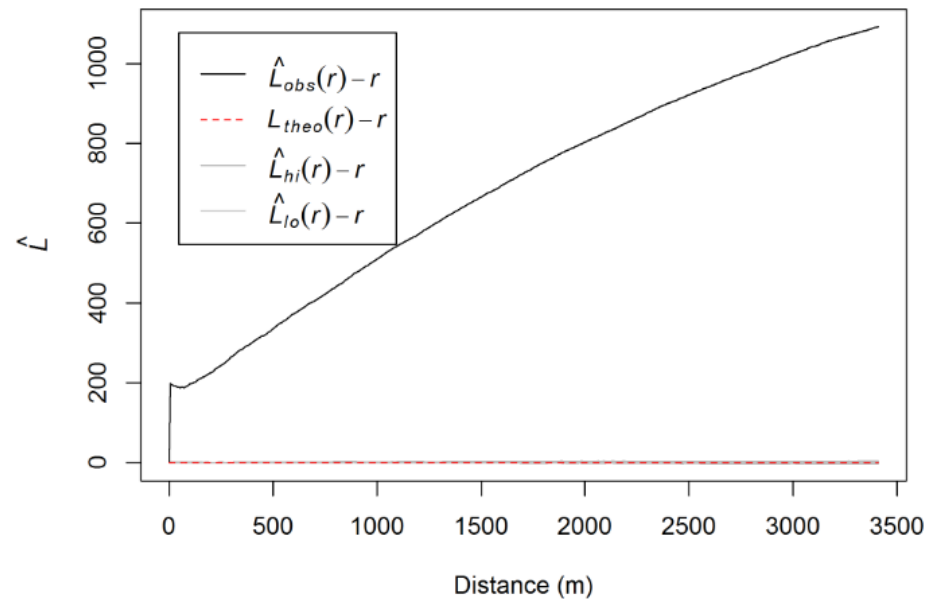


SPATIAL PATTERN OF TRAFFIC CRASHES BY PLANAR DISTANCE

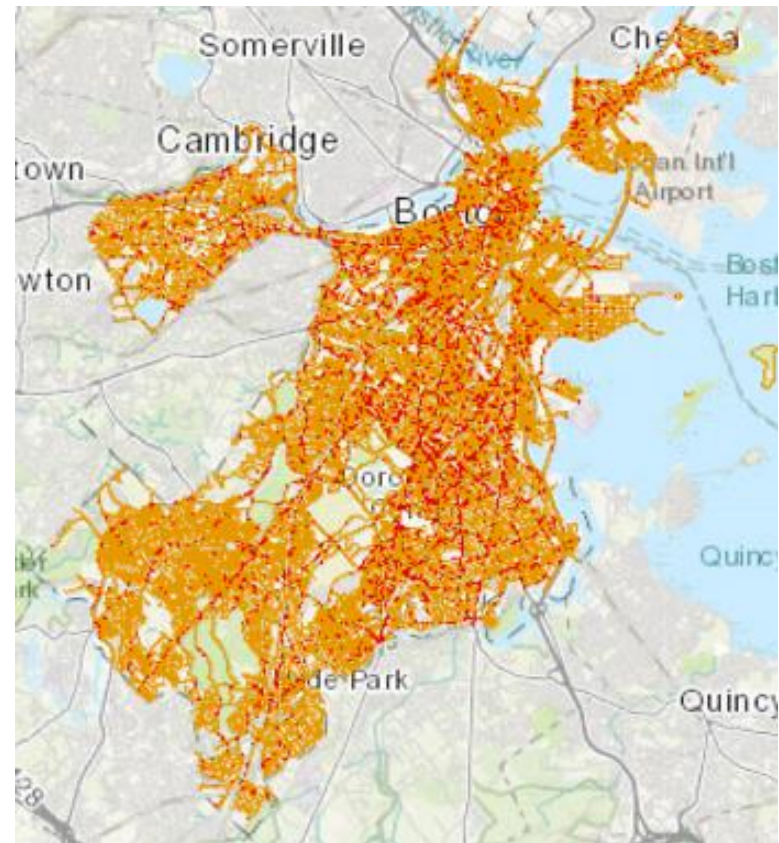
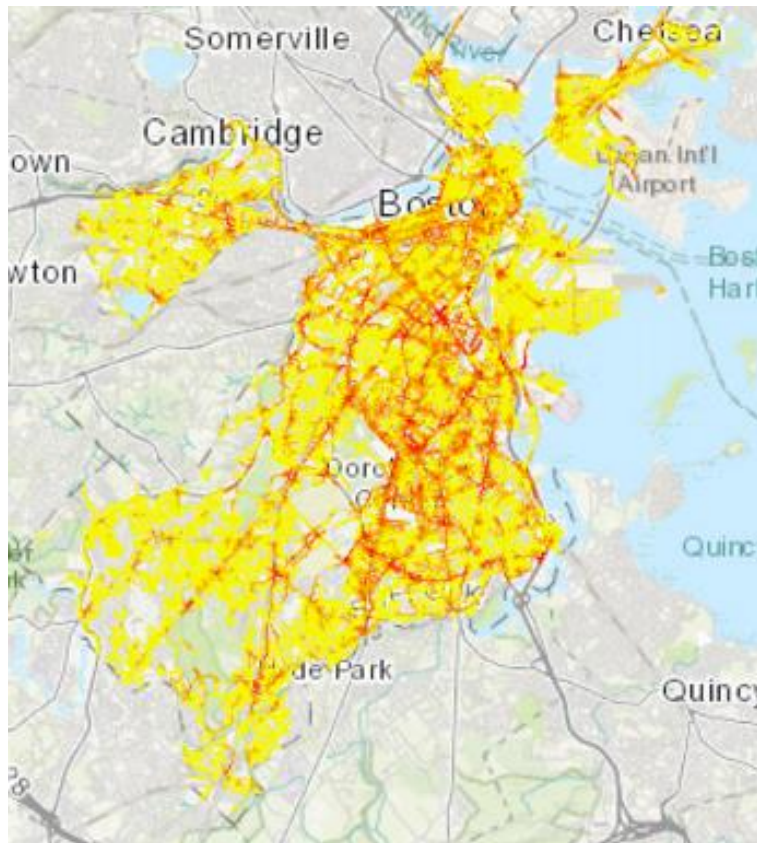


Univariate Ripley's L Function for All crashes

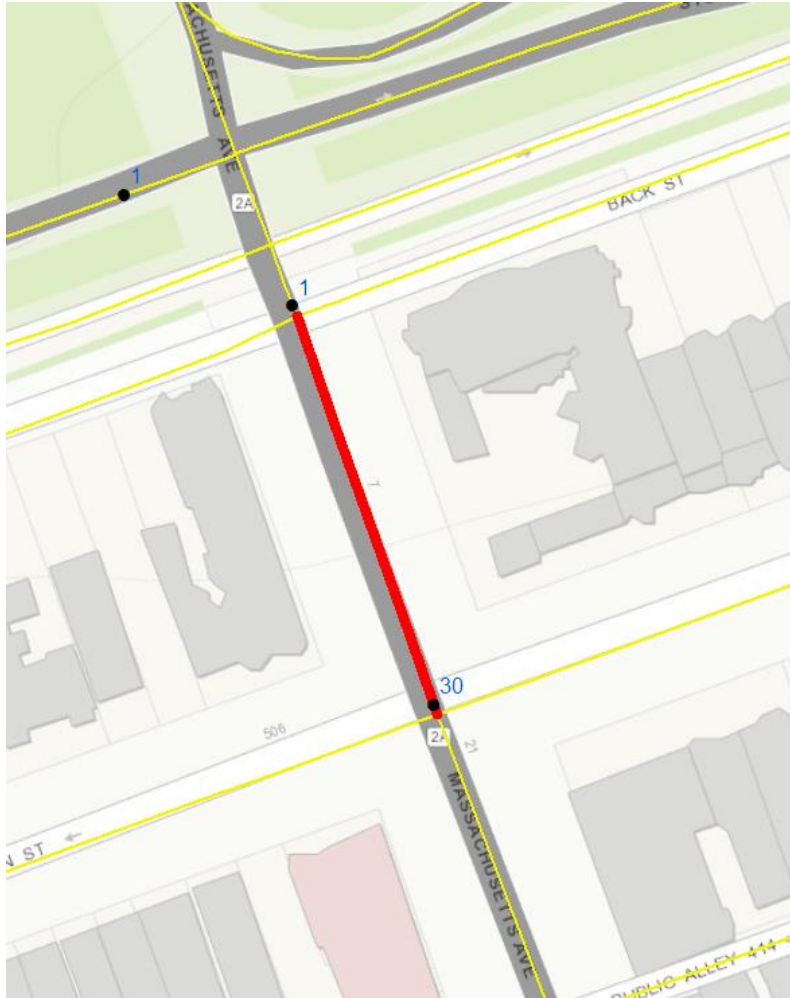
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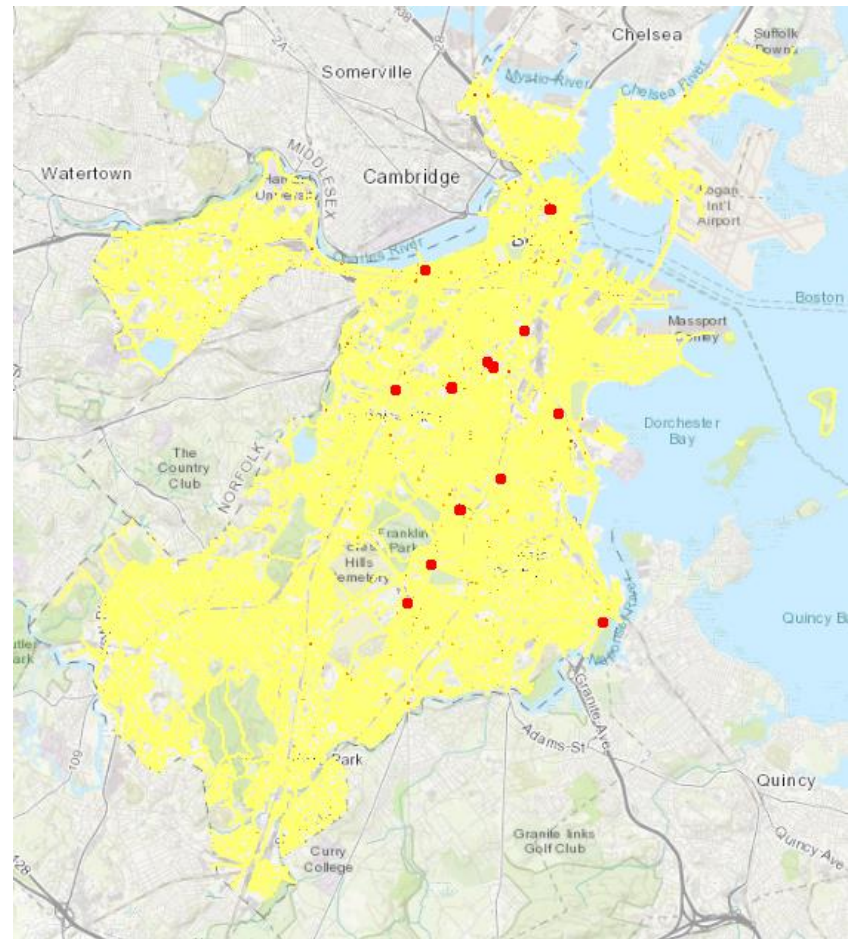
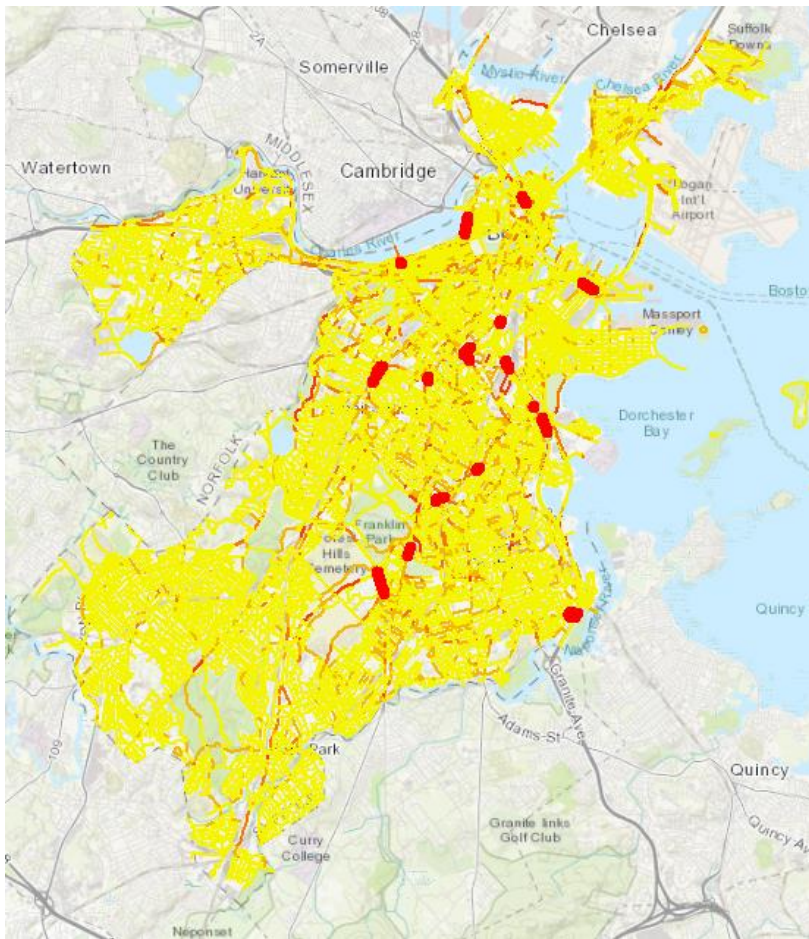
SPATIAL PATTERN OF TRAFFIC CRASHES BY NETWORK DISTANCE



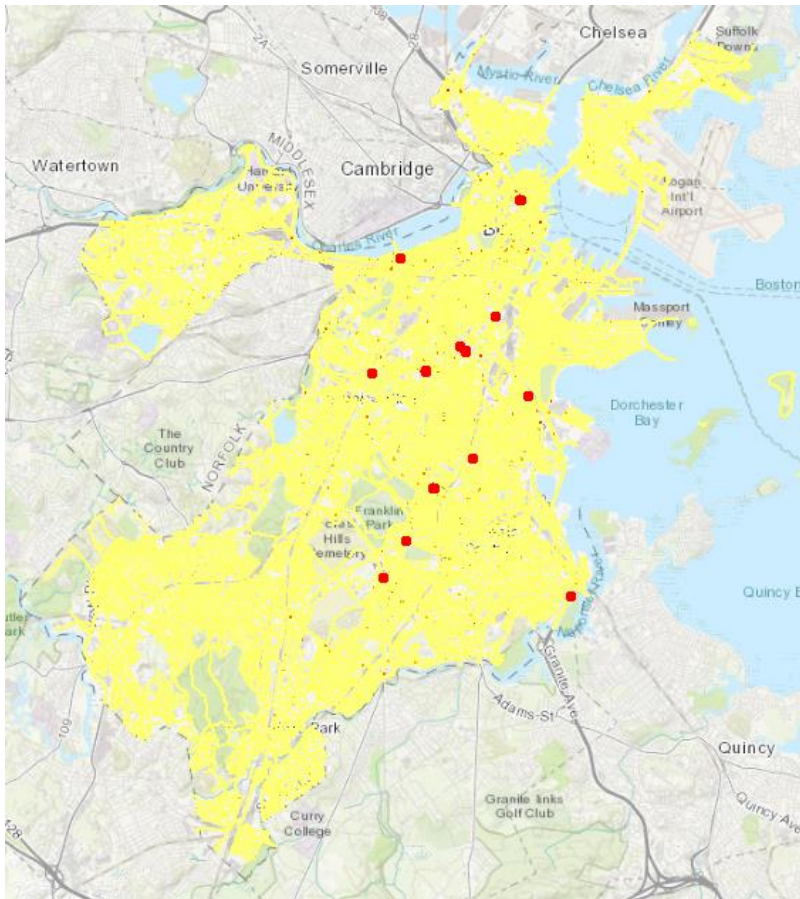
STREET SEGMENTS VS STREET SECTIONS



THE MOST RISKY STREET SEGMENTS AND SECTIONS

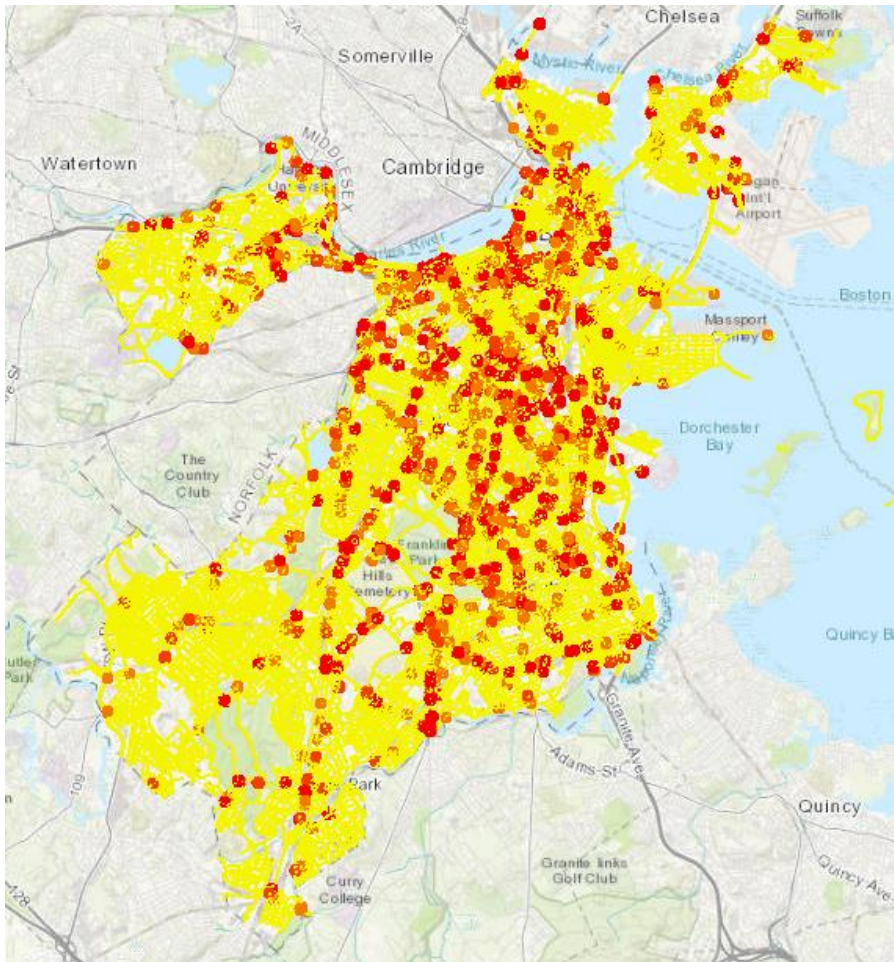


THE RISKY HOTSPOTS BY STREET SECTIONS



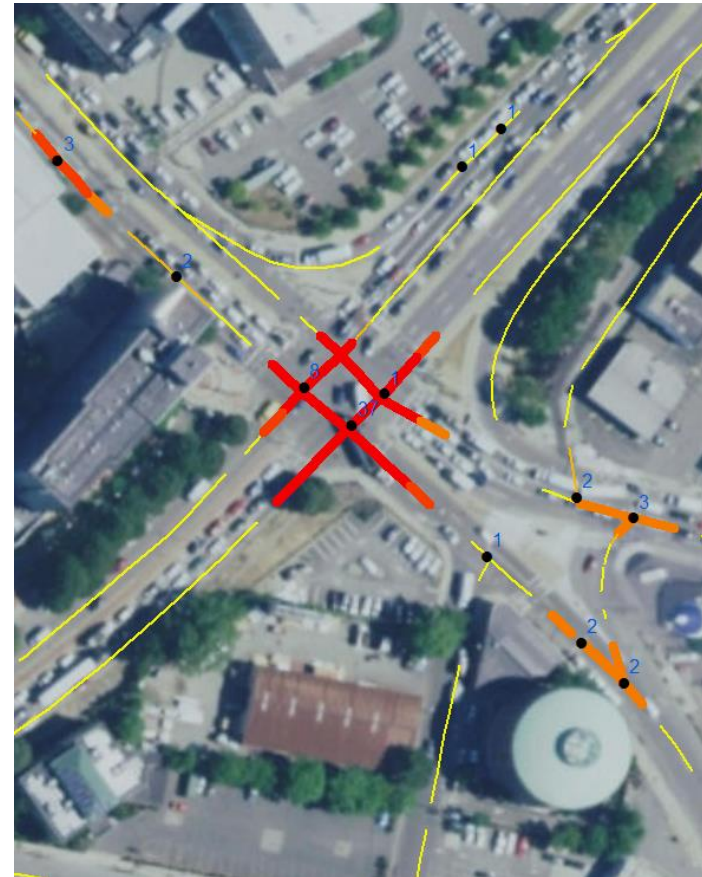
- Create a density map using Network Kernel Density Estimation (NKDE).
- Identify hotspots from the density map using Local Indicator (Getis-Ord G_i^*) of Network-Constrained Clusters (GLINCS).

THE RISKY HOTSPOTS BY STREET SECTIONS



- 1038 hotspots identified.
- The hotspots sorted by total number of crashes for each hotspot in descending order.
- Screenshots taken for top 17 most risky hotspots.

The Most Risky Hotspots (#1)



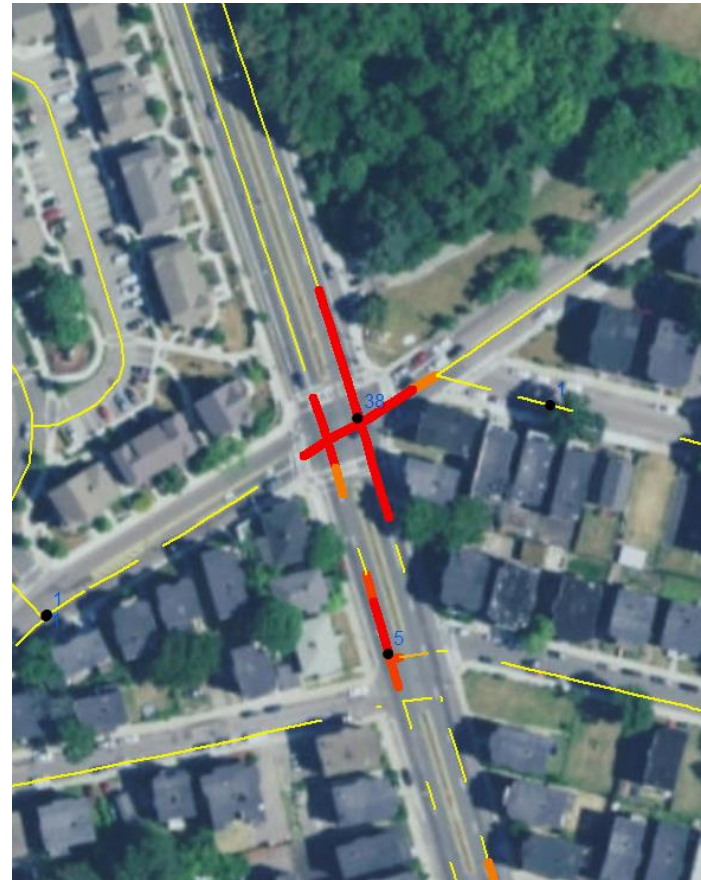
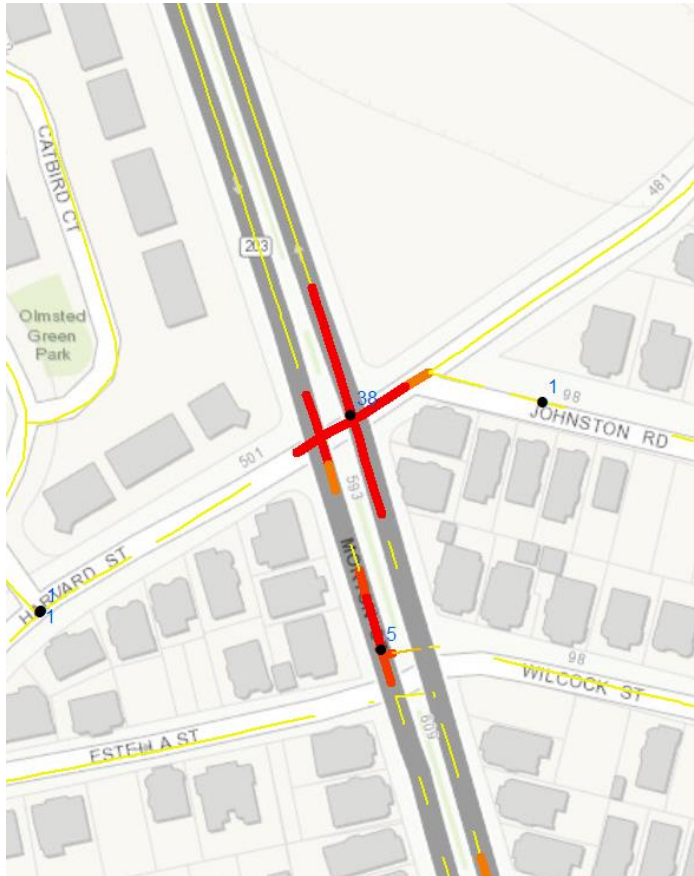
An intersection between Massachusetts Ave, Mass Ave Conn and Melnea Cass Blvd with **46** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#2)



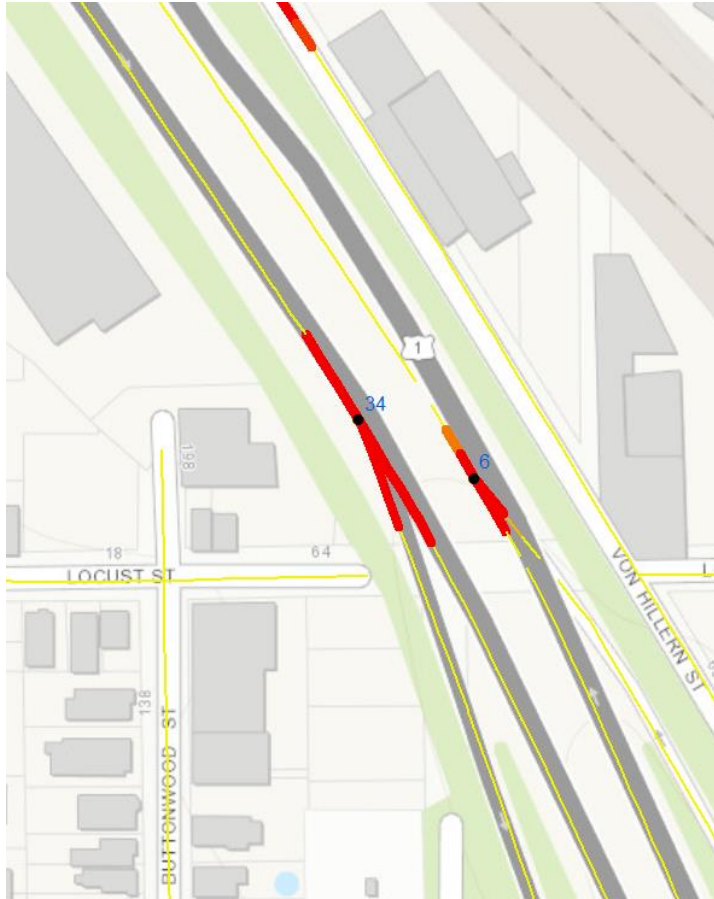
An Interstate 93 Exit towards Mass Ave Conn with 40 Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#3)



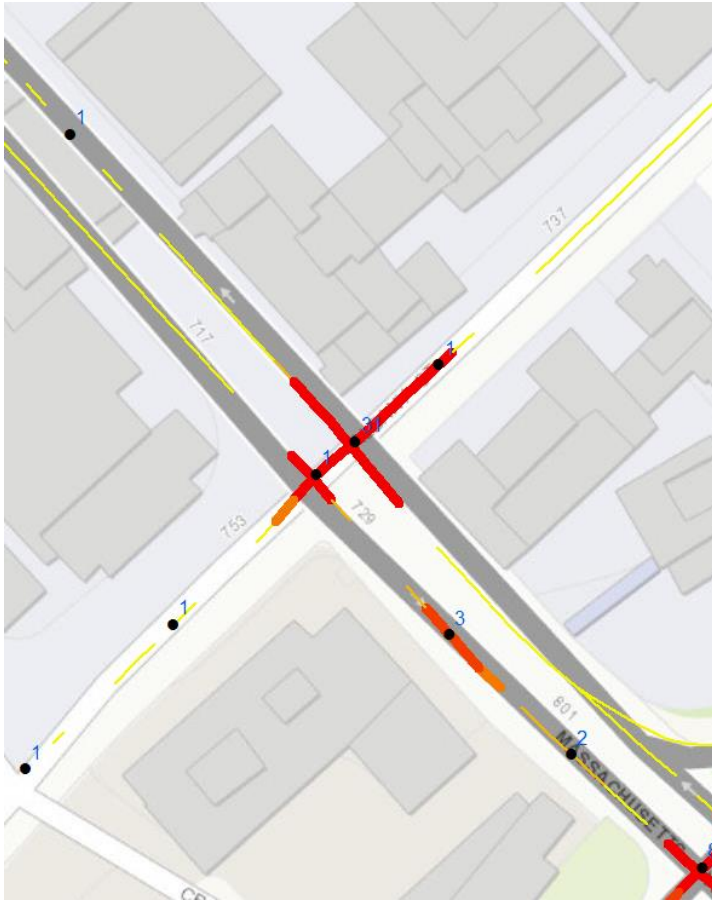
An intersection between Morton St and Harvard St with 38 Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#4)



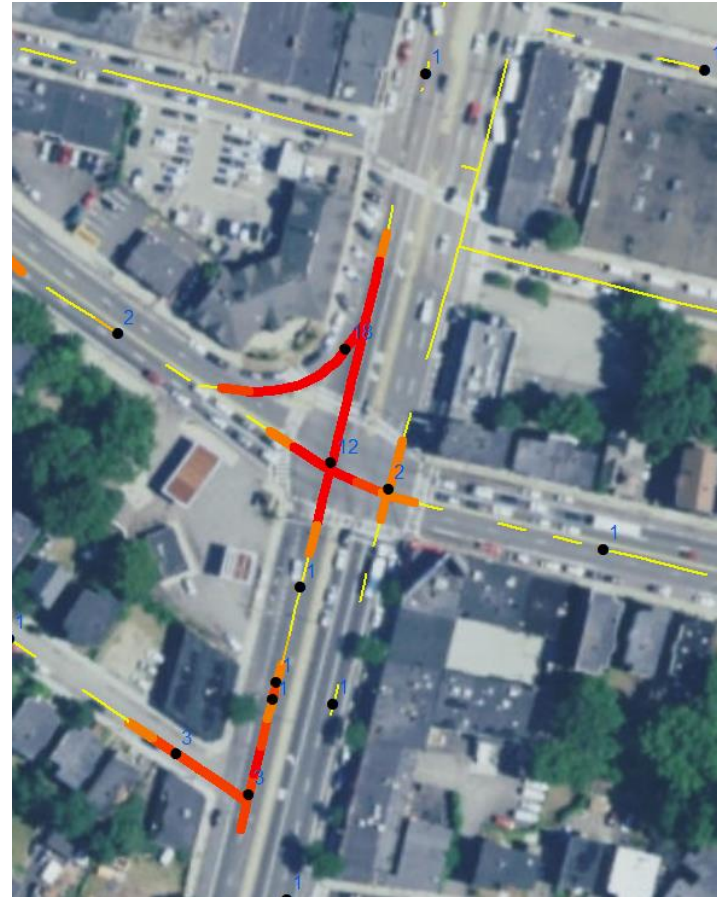
An Interstate 93 Exit towards Columbia Rd with **34** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#5)



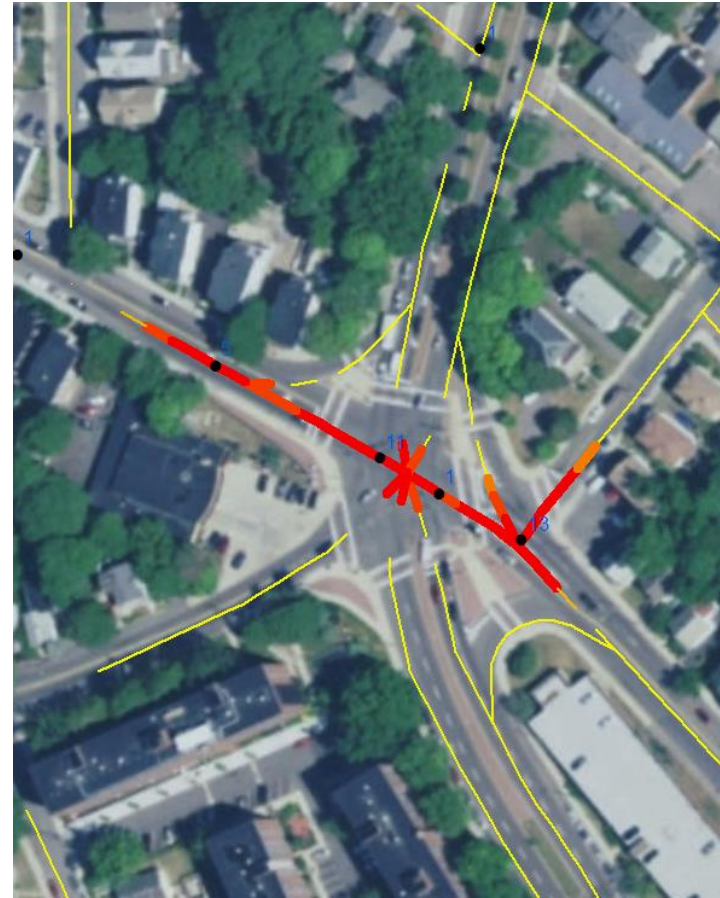
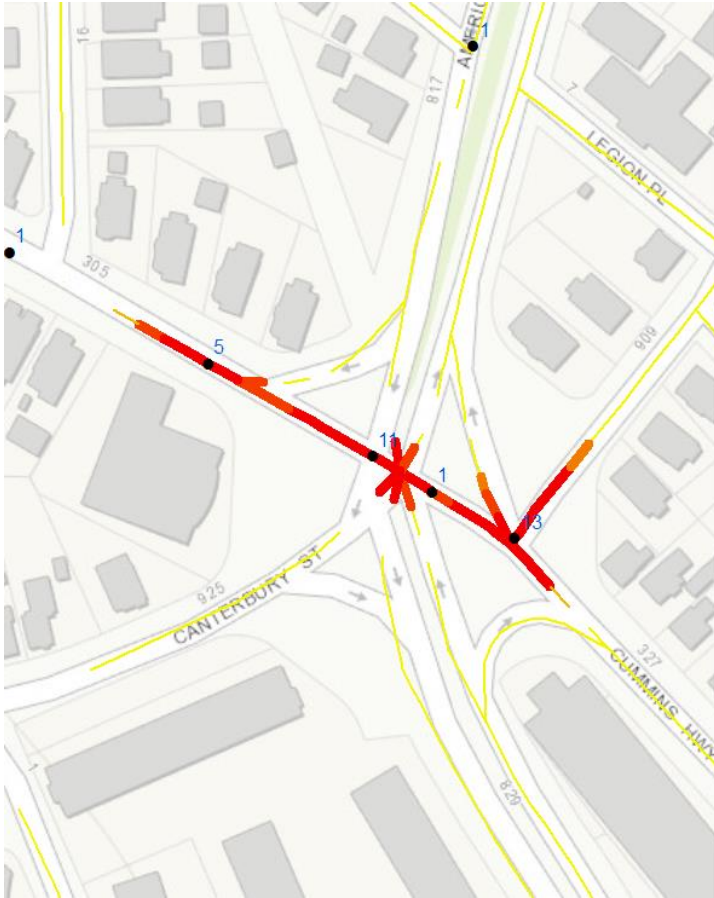
An Intersection between Massachusetts Ave and Albany St with **33** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#6)



An Intersection between Blue Hill Ave Ave and Morton St with **32** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#7)



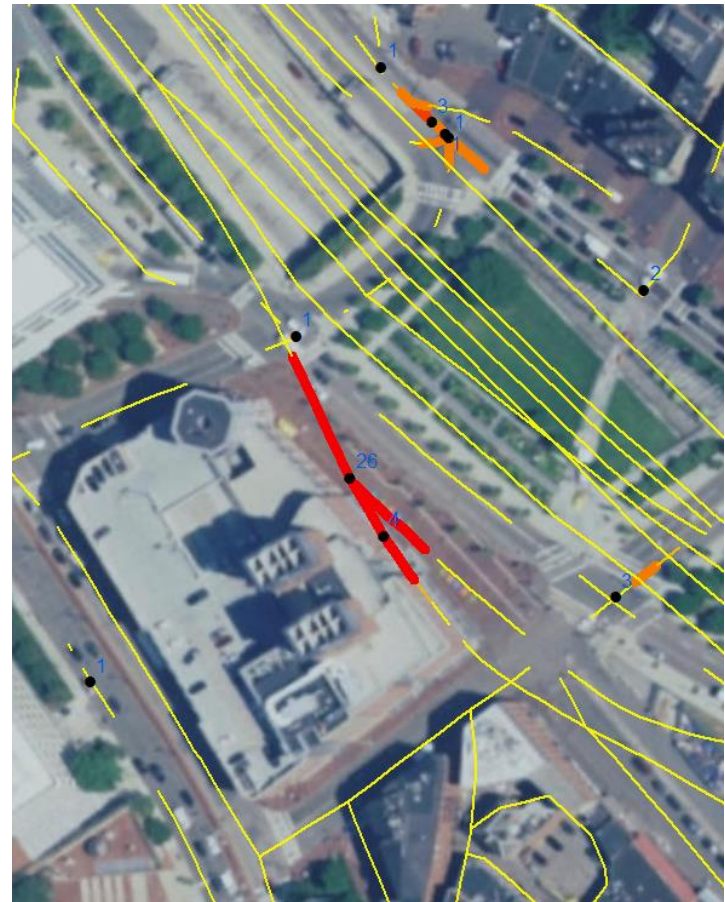
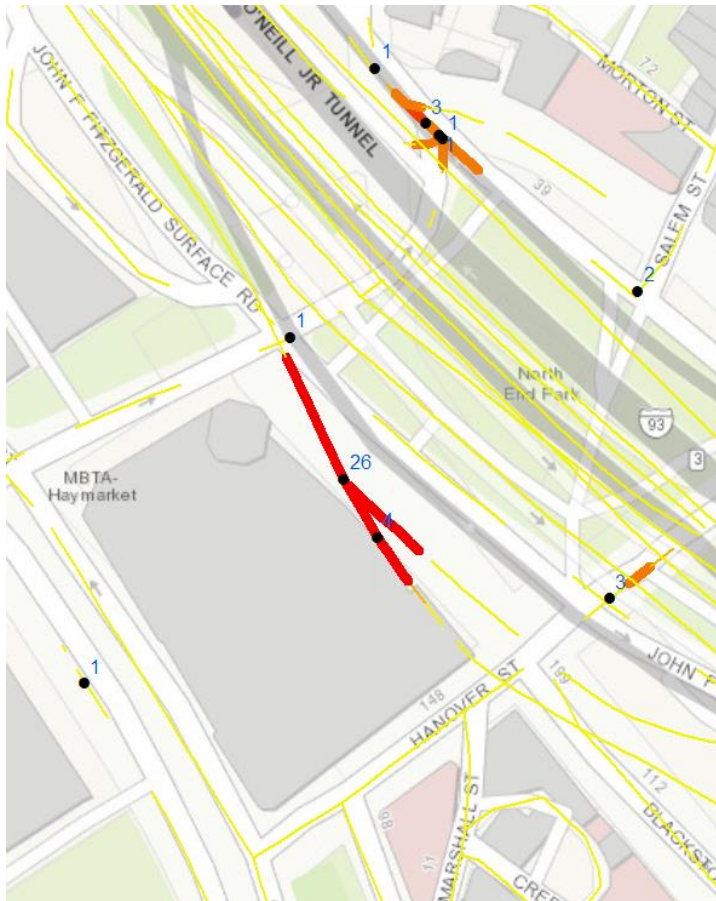
An Intersection between American Legion Hwy, Cummins Hwy and Canterbury St with **30** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#8)



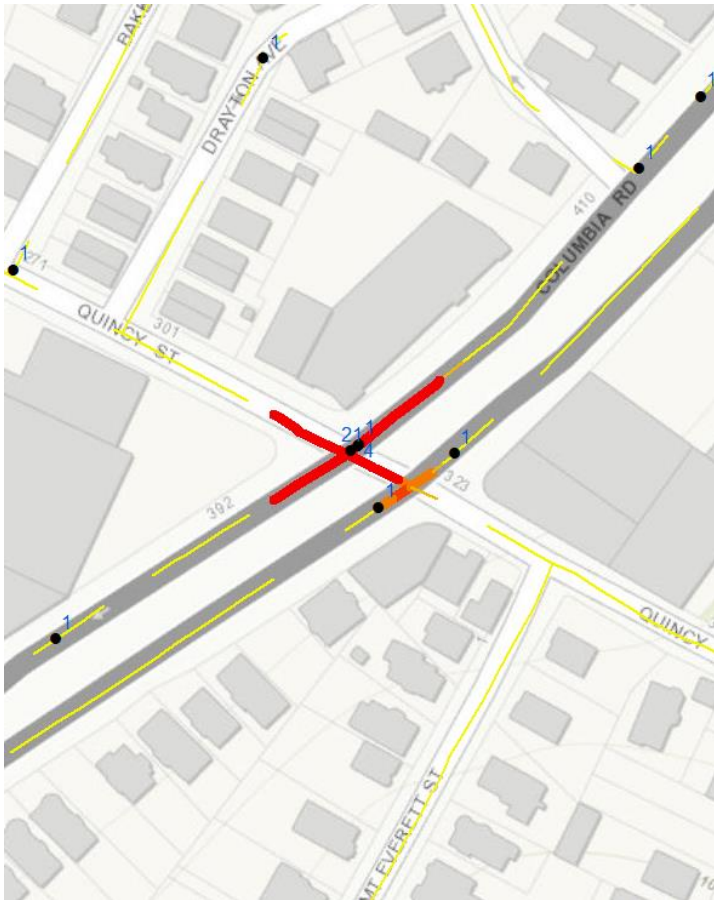
An Intersection between Massachusetts Ave and Beacon St with **30** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#9)



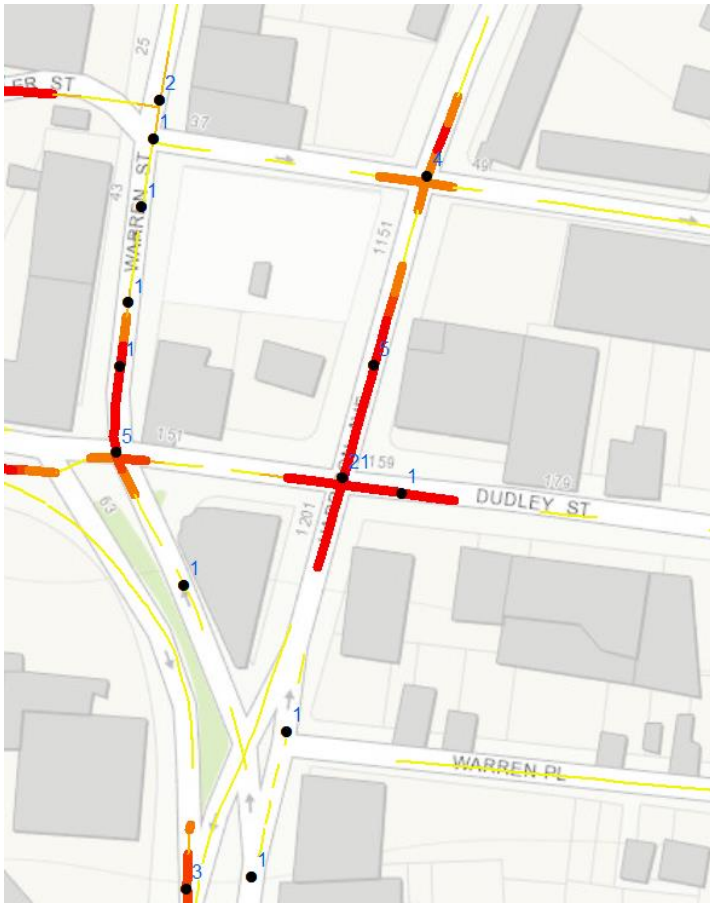
An Interstate 93 Ramp towards Clinton St with 30 Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#10)



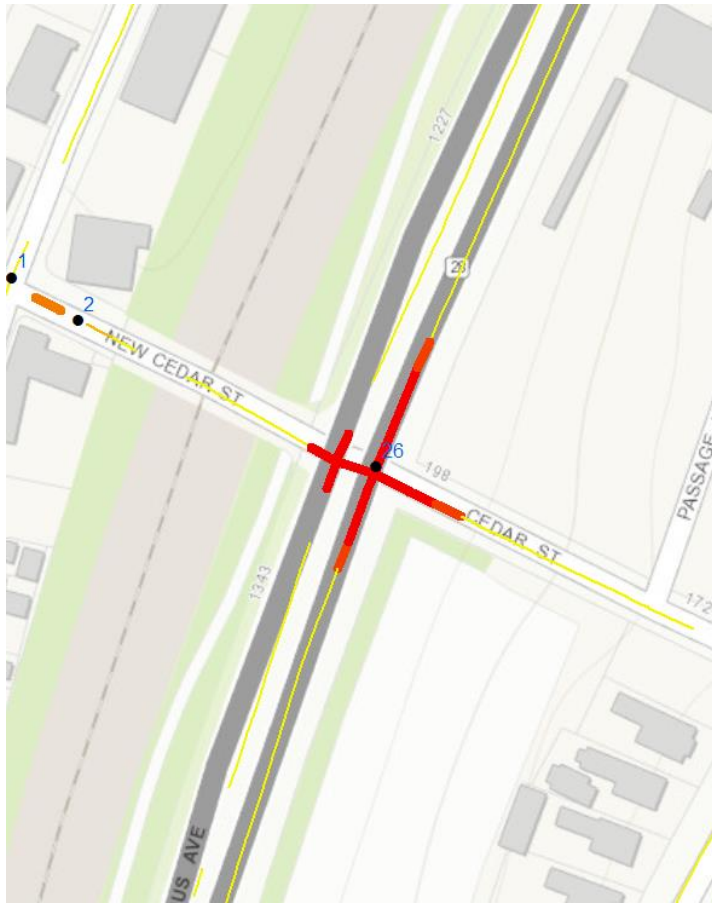
An Intersection between Columbia Rd and Quincy St with **27** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#11)



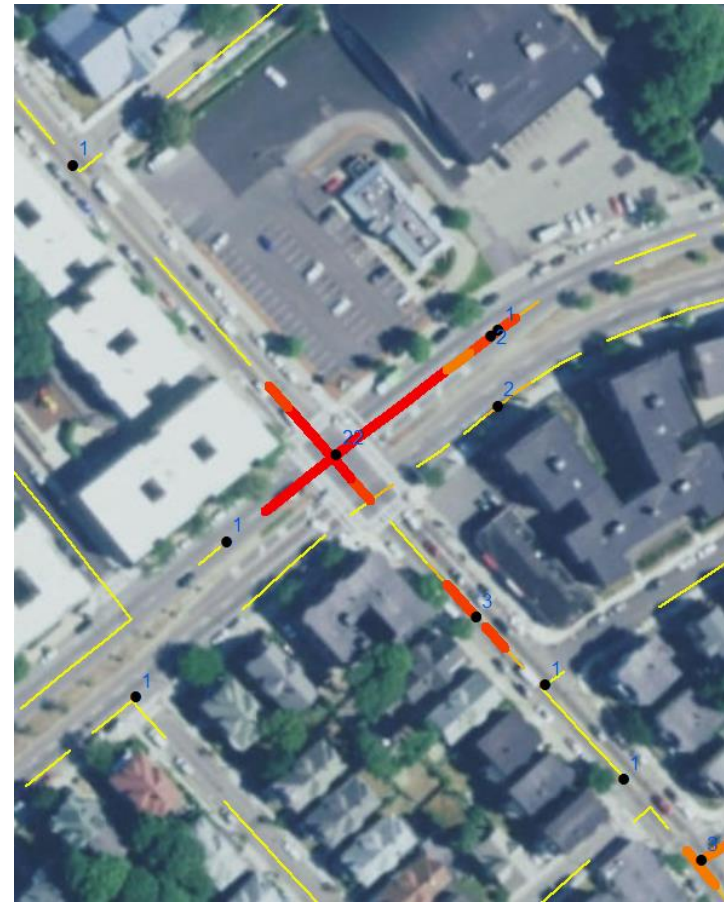
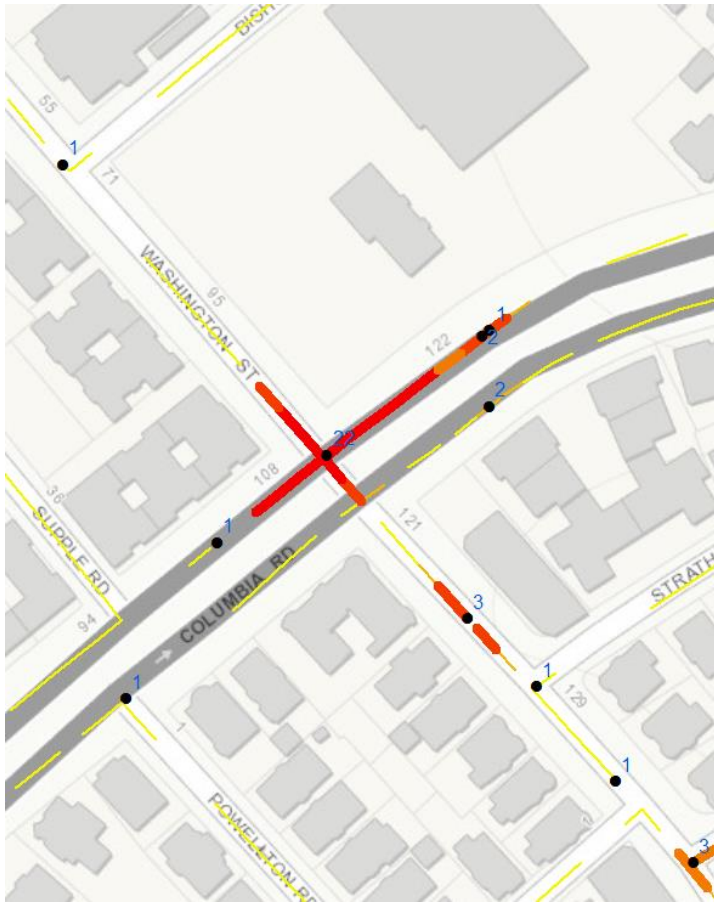
An Intersection between Harrison Ave and Dudley St with **27** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#12)



An Intersection between Columbus Ave, Cedar St and New Cedar St with 26 Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#13)



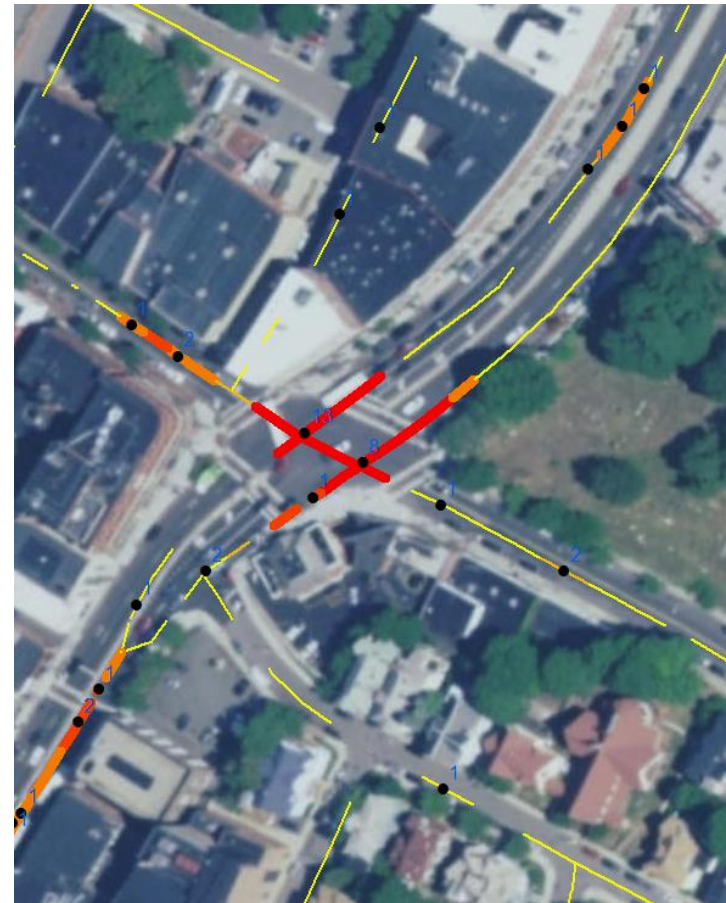
An Intersection between Columbia Rd and Washington St with **25** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#14)



An Interstate 93 Exit towards Gallivan Blvd with **23** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#15)



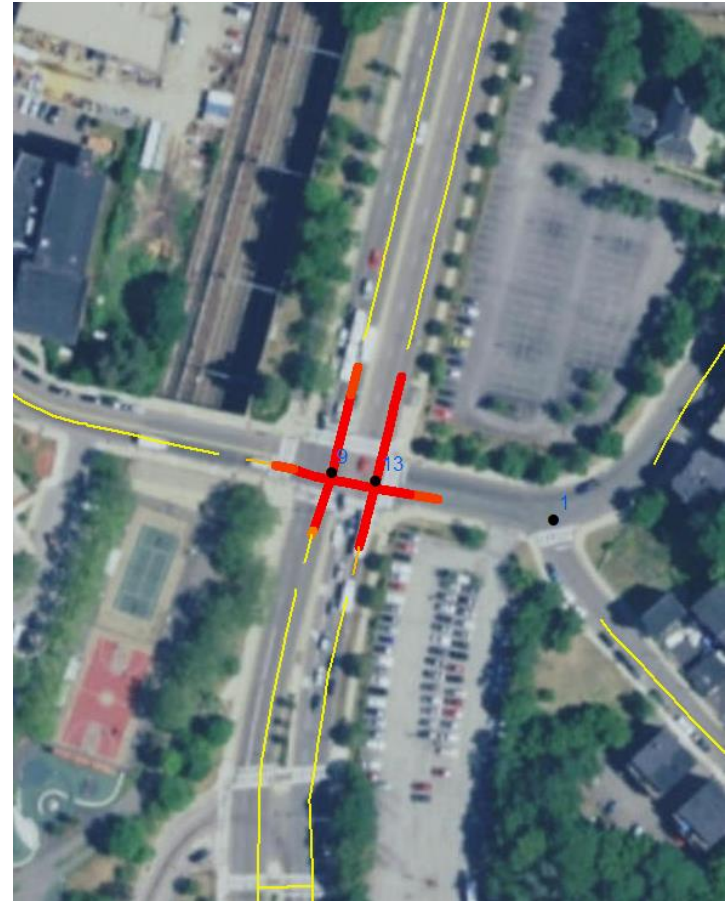
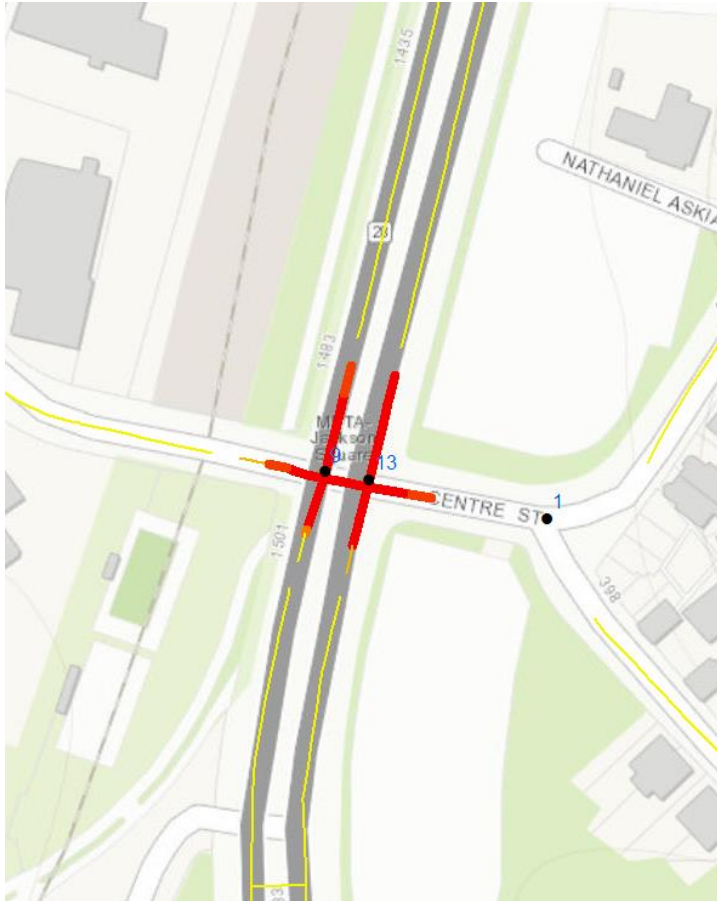
An Intersection between Columbia Rd and Dudley St with **22** Traffic crashes during 7/1/2014 – 12/31/2016.

The Most Risky Hotspots (#16)



An Intersection between Harvard St, Walk Hill St and Hazelton St with **22** Traffic crashes during 7/1/2014 – 12/31/2016.

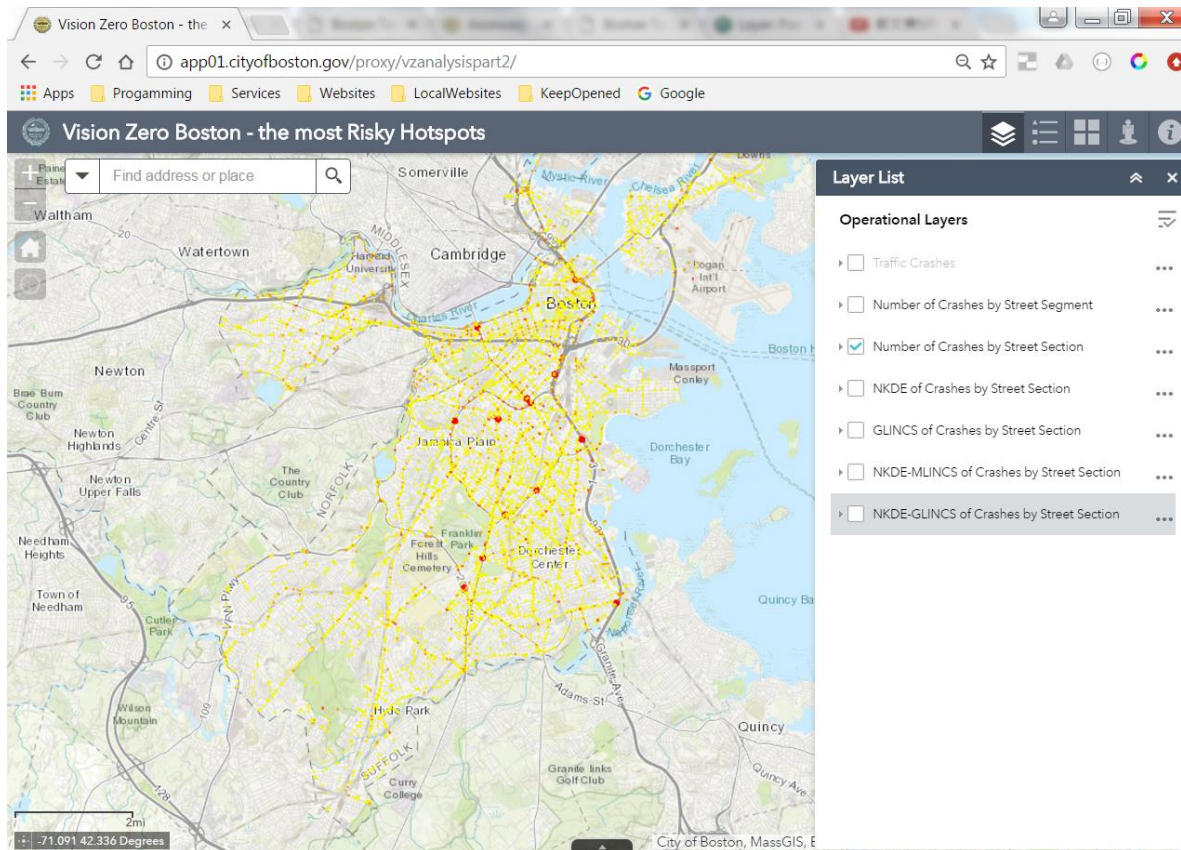
The Most Risky Hotspots (#17)



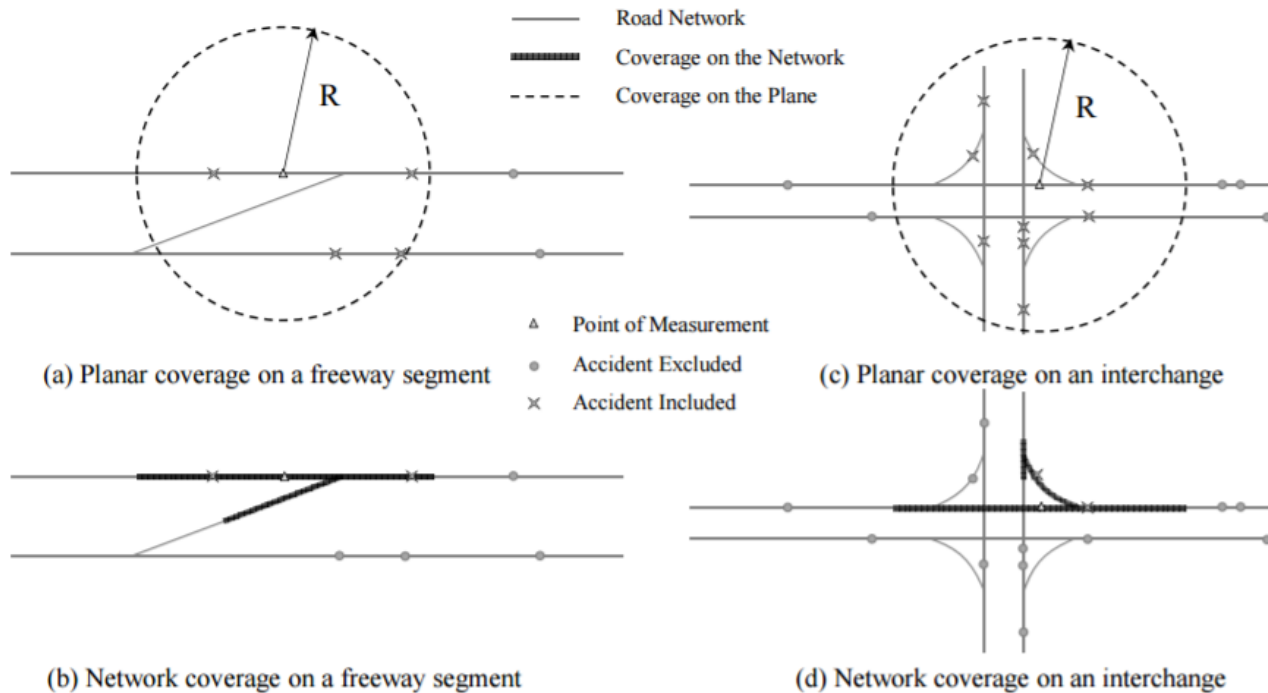
An Intersection between Columbus Ave, Heath St and Centre St with **22** Traffic crashes during 7/1/2014 – 12/31/2016.

WEBSITE FOR THIS ANALYSIS

- <http://app01.cityofboston.gov/proxy/vzanalysispart2>



Examples of Differences using Planar and Network Distances



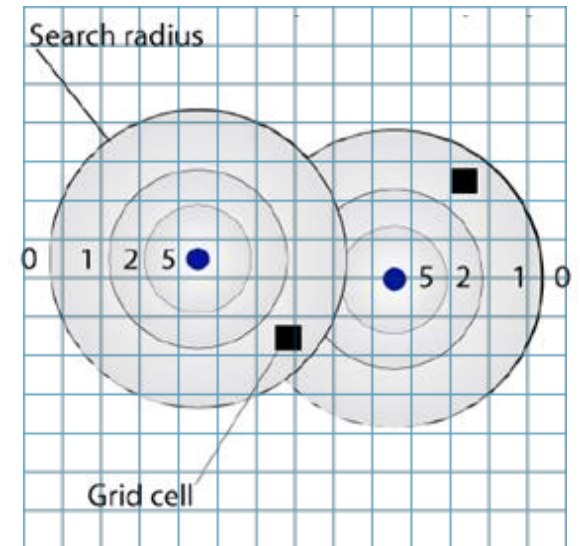
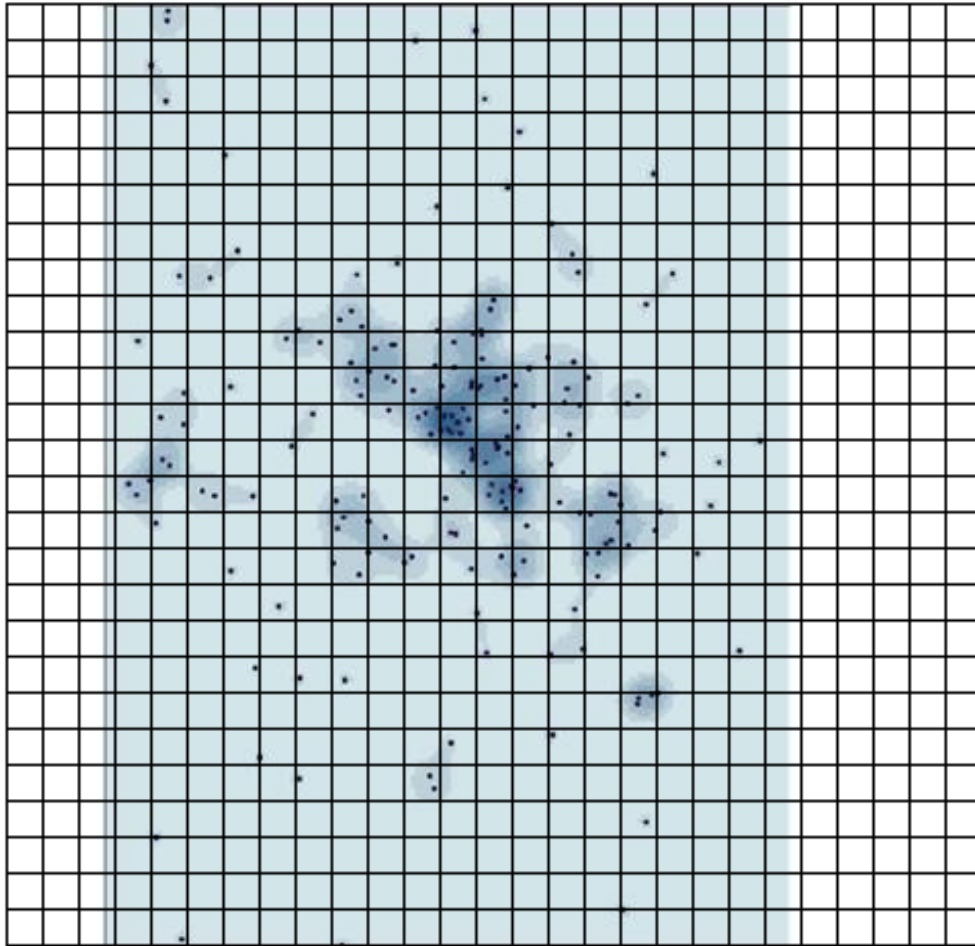
KERNEL DENSITY ESTIMATION (PLANAR KDE)

- In statistics, kernel density estimation (KDE) is a non-parametric way to estimate the probability density function of a random variable.
- Let (x_1, x_2, \dots, x_n) be an independent and identically distributed sample drawn from some distribution with an unknown density f . We are interested in estimating the shape of this function f . Its kernel density estimator is

$$\hat{f}_h(x) = \frac{1}{n} \sum_{i=1}^n K_h(x - x_i) = \frac{1}{nh} \sum_{i=1}^n K\left(\frac{x - x_i}{h}\right),$$

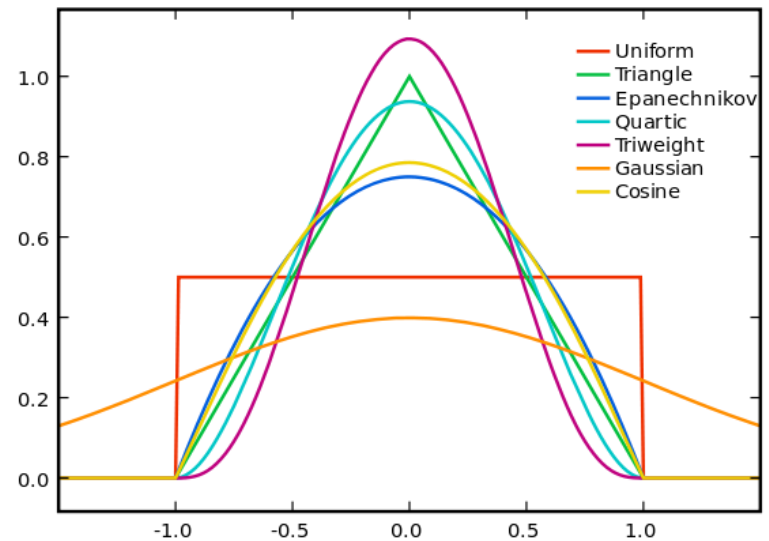
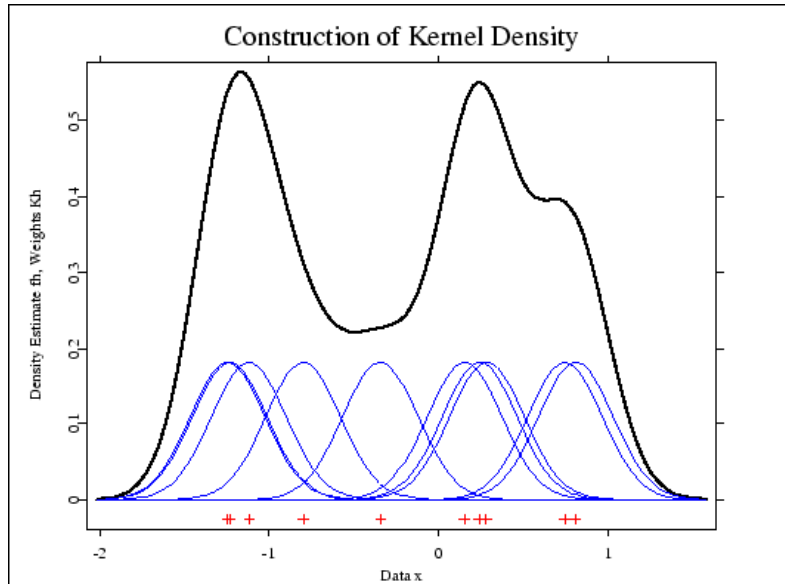
where $K(\bullet)$ is the kernel — a non-negative function that integrates to one and has mean zero — and $h > 0$ is a smoothing parameter called the bandwidth.

KERNEL DENSITY ESTIMATION (PLANAR KDE)

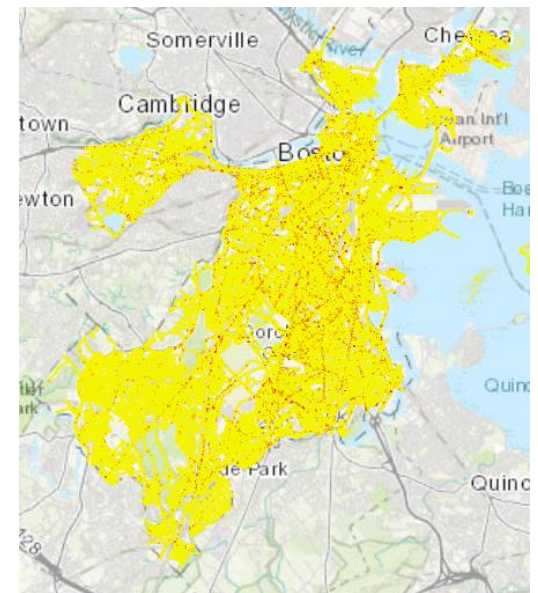
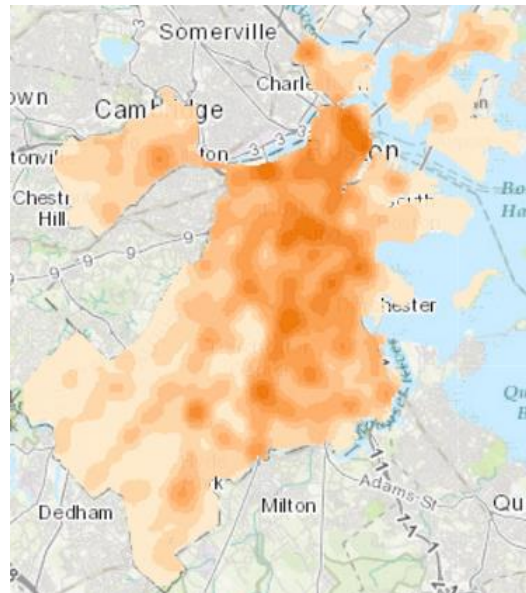
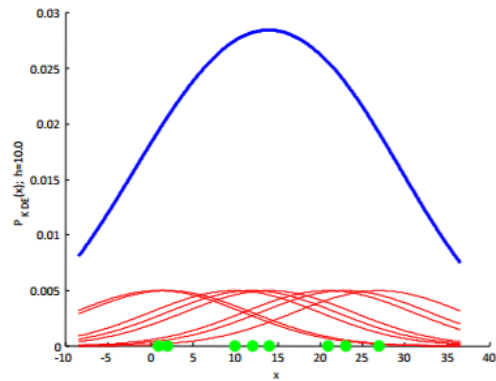
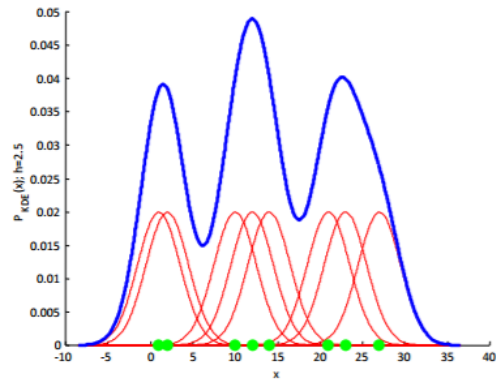


KERNEL DENSITY ESTIMATION

- Kernel Function
- Bandwidth



KERNEL DENSITY ESTIMATION



GETIS-ORD G_i^* STATISTICS

- G_i^* sums the values of the neighbors and divides by the sums of the values of all the features in the study area.

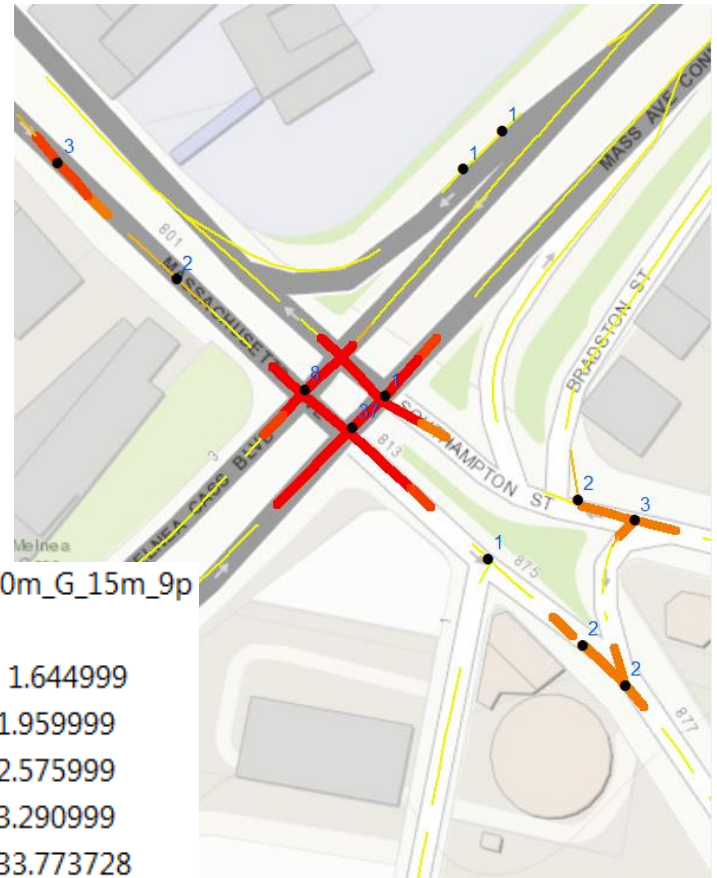
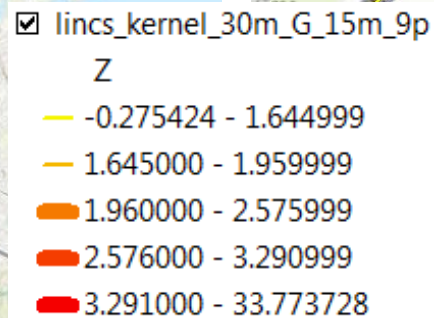
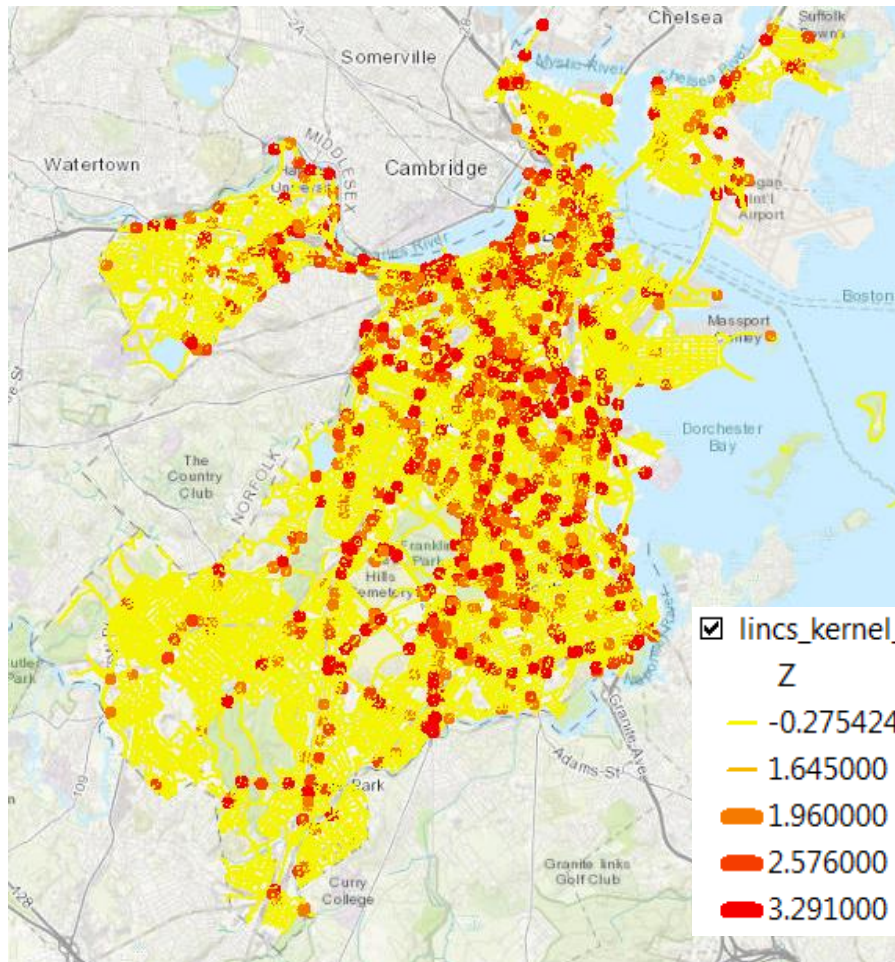
$$G_i^* = \frac{\sum_{j=1}^n w_{ij} x_j}{\sum_{j=1}^n x_j}$$

- The standardized G_i^* is essentially a Z-value and can be associated with statistical significance.

$$Z(G_i^*) = \frac{\sum_{j=1}^n w_{ij} x_j - \bar{x} \sum_{j=1}^n w_{ij}}{s \sqrt{\frac{n \sum_{j=1}^n w_{ij}^2 - (\sum_{j=1}^n w_{ij})^2}{n-1}}}$$

- A group of features with high Z scores indicates a cluster or concentration of features with high attribute values. Conversely, a group of features with low Z scores indicates a cold spot. A Z score near 0 indicates there is no concentration of either high or low values surrounding the target feature.

LOCAL INDICATOR (GETIS-ORD GI*) OF NETWORK-CONSTRAINT CLUSTERS (GLINCS)



ABSTRACT

Detecting Traffic Crash Patterns and Identifying the most Risky hotspots by Street Sections for Vision Zero Boston using Spatial Statistical Methods

Youshe Li

Department of Innovation and Technology, City of Boston

The purpose of Vision Zero Boston (<http://www.visionzeroboston.org/>) is to focus the City's resources on proven strategies to eliminate fatal and serious traffic crashes.

This study analyzed the traffic crashes data (<http://app01.cityofboston.gov/VisionZero/>) provided by Boston Emergency Medical Services (EMS) using two spatial statistical methods available from GeoDaNet: Network Kernel Density Estimation (NKDE) and Local Indicator (Getis-Ord G_i^*) of Network-Constrained Clusters (GLINCS).

The spatial statistical methods revealed visually and statistically the traffic crash patterns and the most risky clusters / hot spots by street sections (a segment is a part of a road between two closest intersections and every segment is split into 10 meter long sections). See <http://app01.cityofboston.gov/proxy/vzanalysispart2> for more details.

This study would quantitatively provide helps to remedial engineering efforts of Vision Zero Boston and make efficient use of the City's resources. Further study would address the factors causing these crashes for crash modeling.

Thank you!

Questions?