



Spatial Crime Patterns vs Safety Perception: Mixed Experiments

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NCS⁴ NATIONAL CENTER FOR
SPECTATOR SPORTS
SAFETY AND SECURITY
SOUTHERN MISS

About me



-> Bachelor in Geography and Cartography;

-> Master in Geographic Information Systems (GIS), Department of Geography, University of Bucharest, Romania

-> PhD in Applied Geoinformatics, University of Salzburg, Austria: ***Integration and evaluation of social media in crime prediction models***

-> Postdoc at Boston Area Research Initiative, CSSH, Northeastern University

Interests: spatial crime analysis, social media mining, predictive analytics, safety perception, neighborhood analysis, GIScience, urban informatics

Outline



PART 1: Social media in crime prediction models

- Background
- Scope (research gaps and objectives);
- Results
 - Research Objective 1;
 - Research Objective 2.
- Discussion;
- Scientific contribution;
- Future directions of research;

PART 2: Applying Geospatial Technology to Explore Urban Blight and Perceived Safety

- Background
- Scope
- Data and Geospatial Technologies;
- Results;
- Relevance;
- Future work.

Thesis Context

Predictive policing -> goal of preventing crime, solving past crimes, and identifying potential offenders and victims. (Perry et al. 2013)

Social media mining -> process to extract **patterns**, form conclusions about users, and act upon the information, often for the purpose of advertising to users or conducting **research**. (Zafarani et al. 2014)

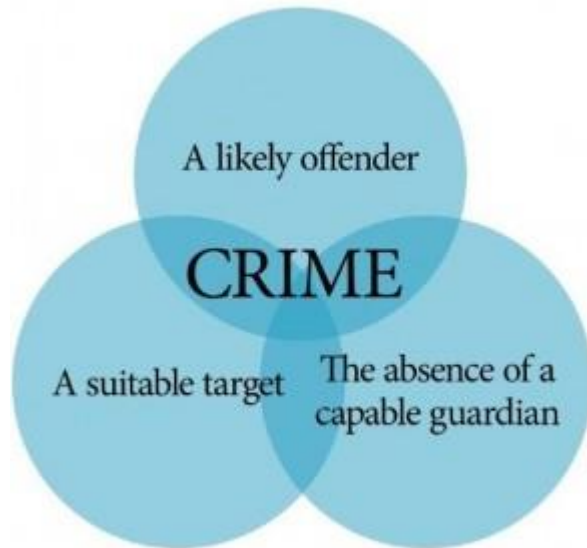
Space and time!



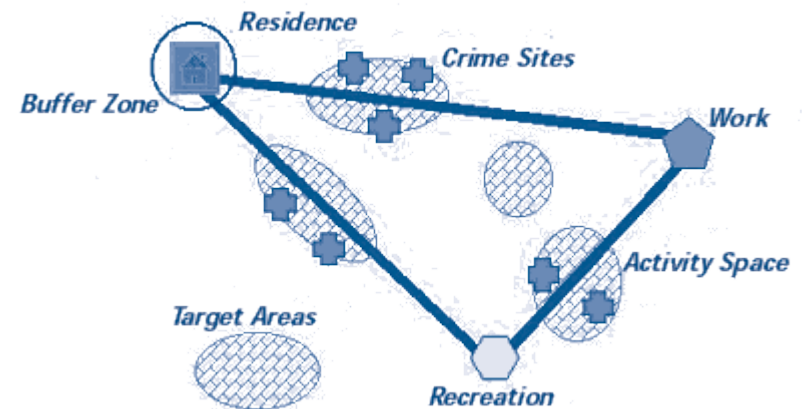
Environmental criminology

important theoretical foundation for exploring spatial crime distribution (Bruinsma and Johnson, 2018).

Routine Activity Theory 1979



Crime Pattern Theory 1981



Key concepts: crime attractors, generators and detractors

Research gap

RO 1. Space and time relationships

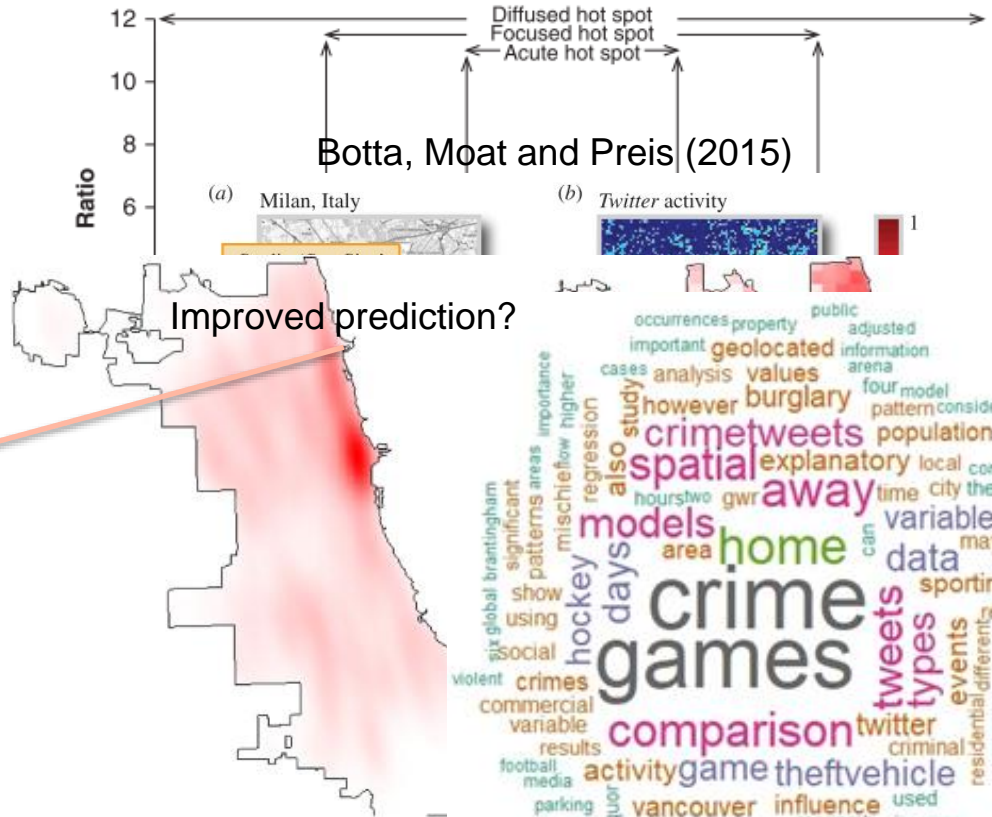
Sporting events

Crime occurrences

Social media data

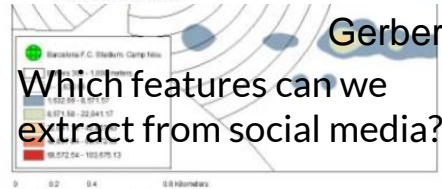
RO 2. Space and time crime prediction

Kurland, Tilley and Johnson (2014)

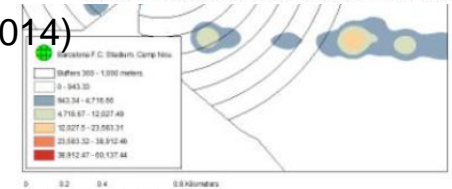


Botta, Moat and Preis (2015)

(a) Predicted threat surface using KDE feature.



KDE feature and the Twitter features.



Gerber (2014)
Which features can we extract from social media?

Struse and Montolio (2014)

Objectives



Research Objective (RO) 1: Uncover relationships between crime patterns and social media posts

RQ1: Does social media activity (i.e., tweets) correlate in space and time with crime occurrences?

RQ2: Do different crime types show distinct relationships with tweet-related features?

RQ3: Does the distribution of social media posts follow the changes in urban crime patterns when a sporting event occurs?

Objectives



Research Objective (RO) 2: Improve methods for integrating social media data into crime prediction models

RQ4: Do geo-located tweets improve crime prediction models and enrich the information coming from historical crime data and additional explanatory variables?

RQ5: Can tweets be a factor for determining at-risk populations?

RQ6: Does the use of social media as a dynamic feature have a higher relevance in prediction models related to non-routine activities, rather than ordinary ones?

Case studies



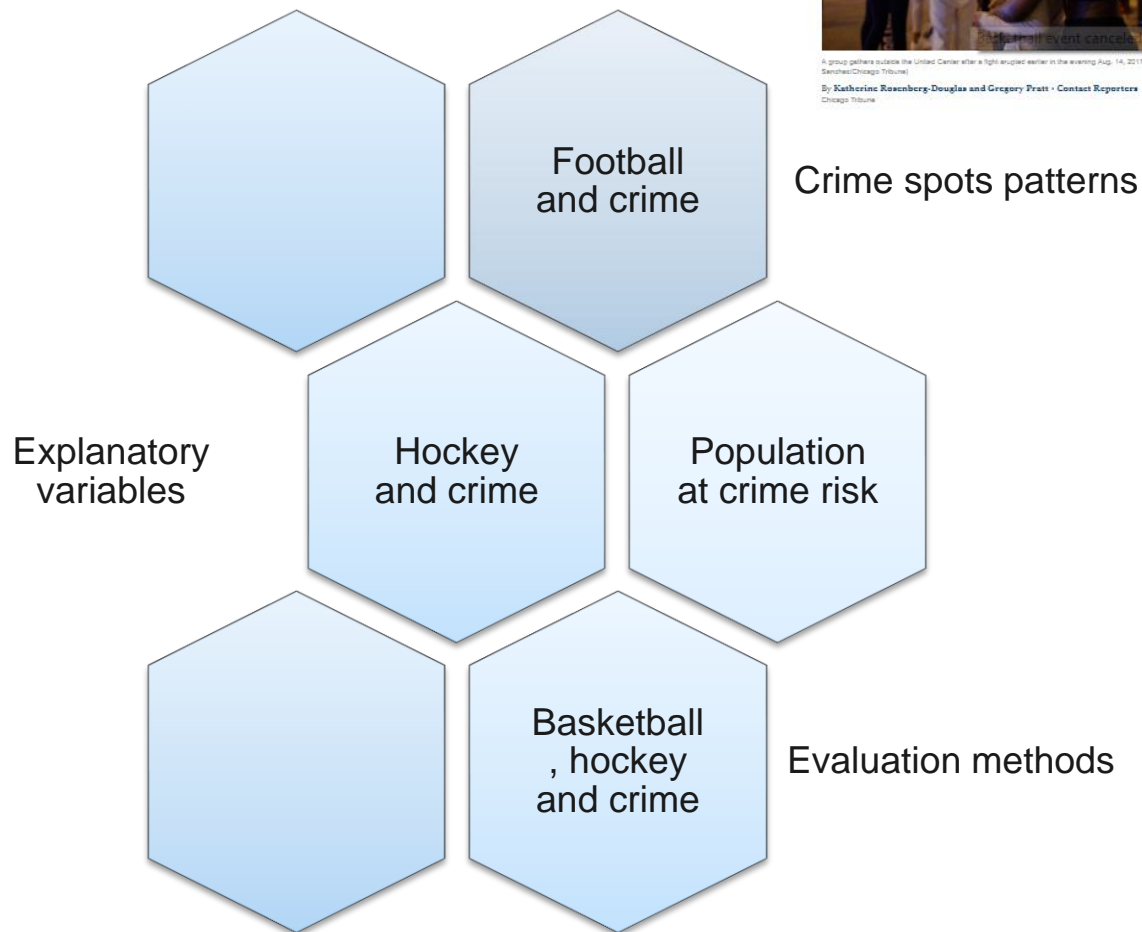
News / Local news / Breaking News

United Center cleared after reports of fighting during basketball tournament

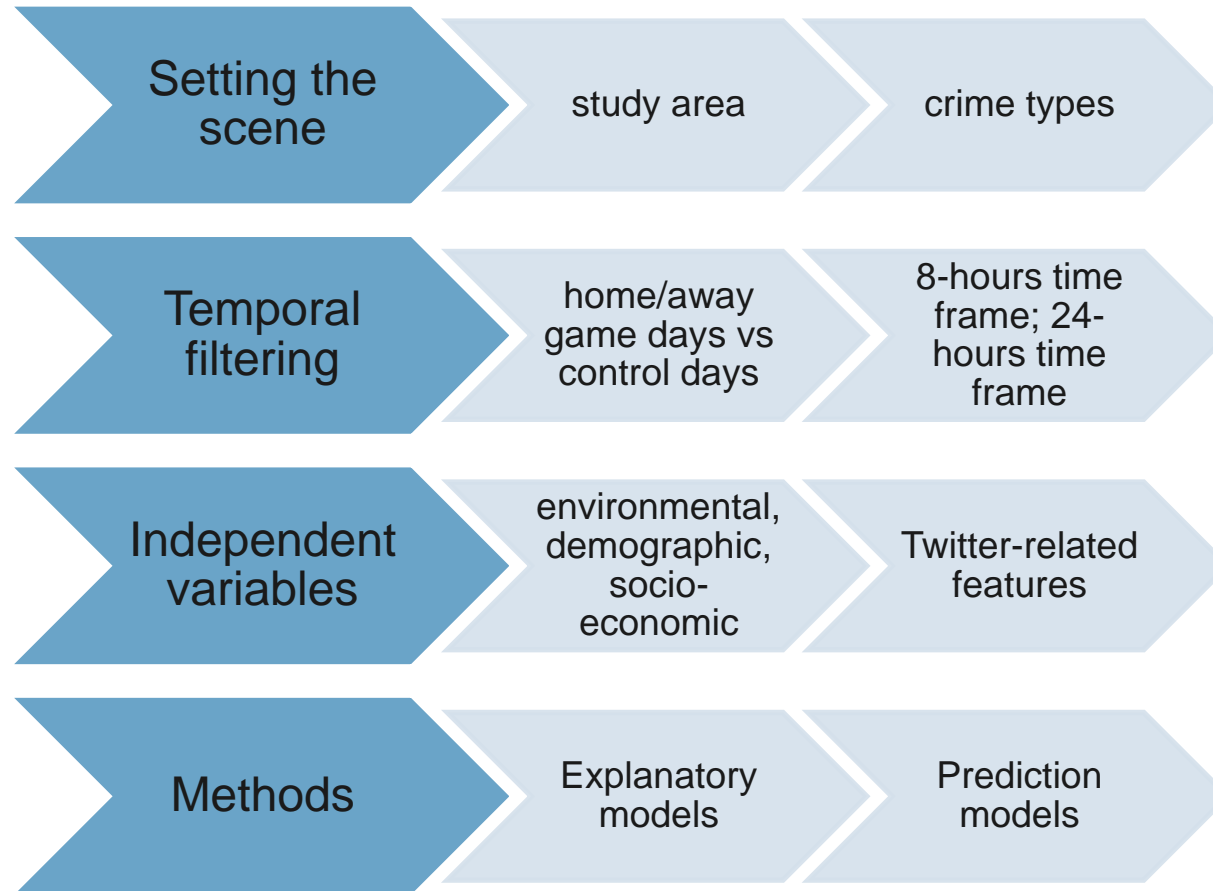


A group gathers outside the United Center after a fight erupted earlier in the evening Aug. 14, 2017, in Chicago. (Armando L. Sanchez/Chicago Tribune)

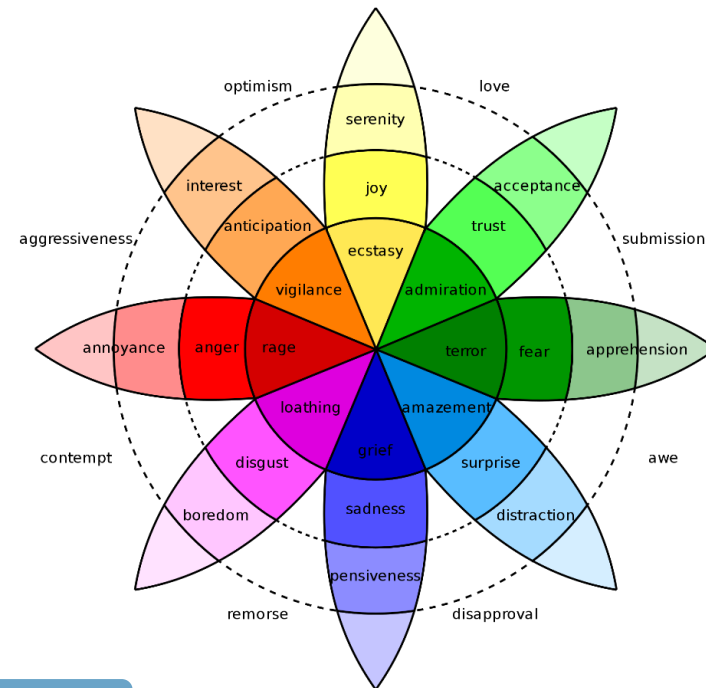
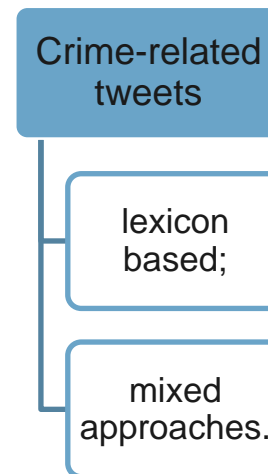
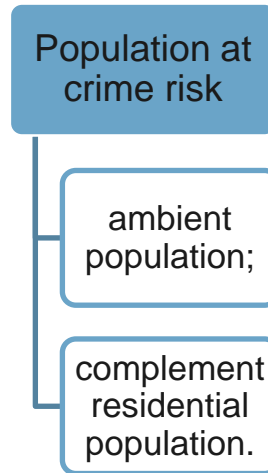
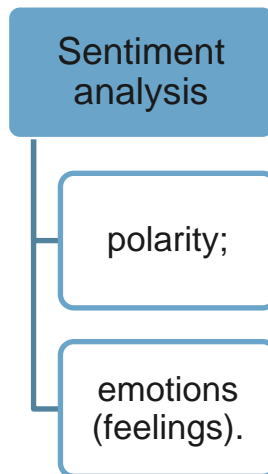
By Katherine Rosenberg-Douglas and Gregory Pratt - Contact Reporters
Chicago Tribune



Data (pre) processing flow



Tweet-related features



Plutchick's wheel of emotions

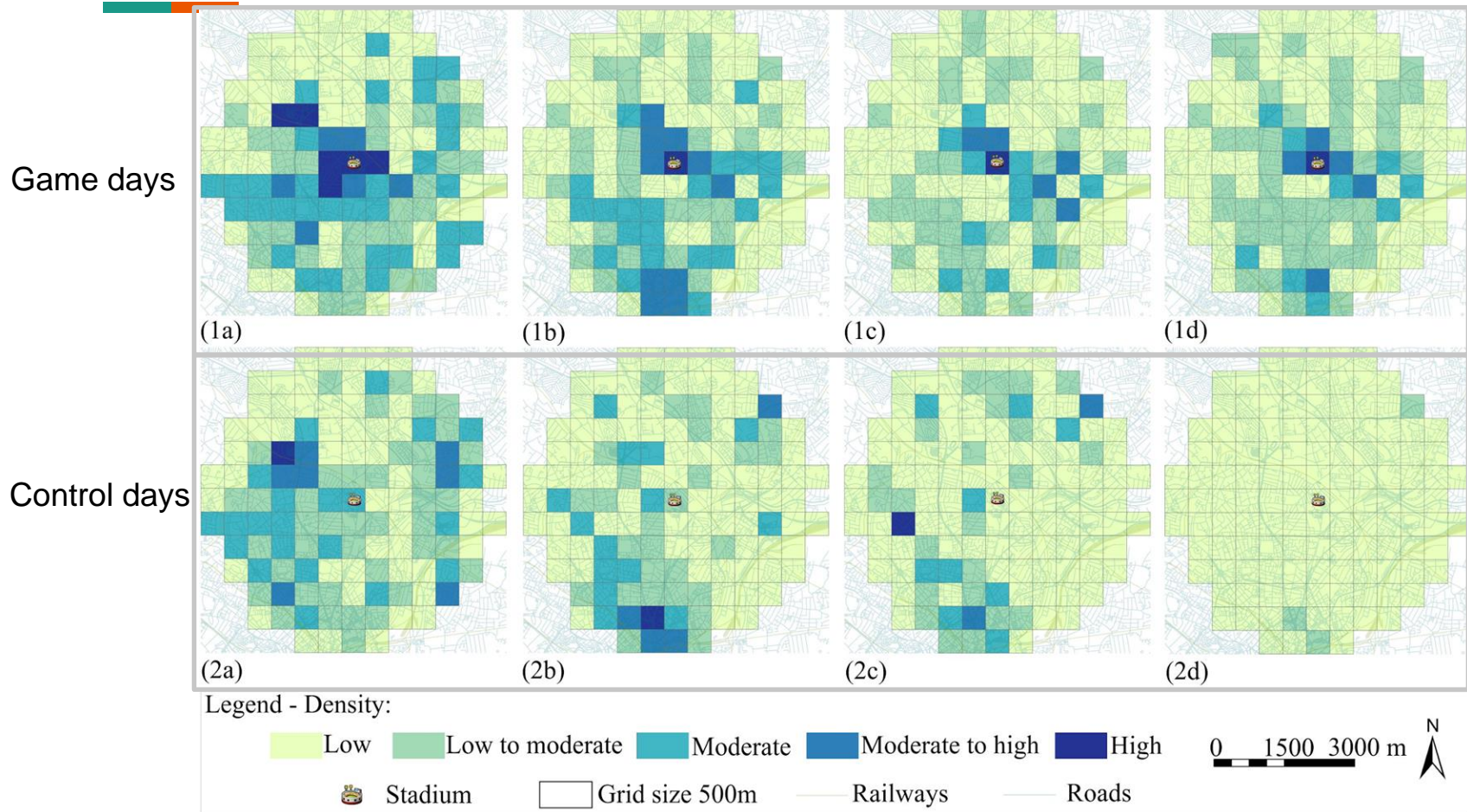
Plutchik
(2001)



RO 1: Uncover relationships between crime patterns and social media posts

Methods: spatial autocorrelation Moran's I, bivariate autocorrelation, Pearson correlation, density mapping, comparison between game days and control days, sentiment analysis, topic modeling, crime-related text extraction.

RO 1 -> RQ1

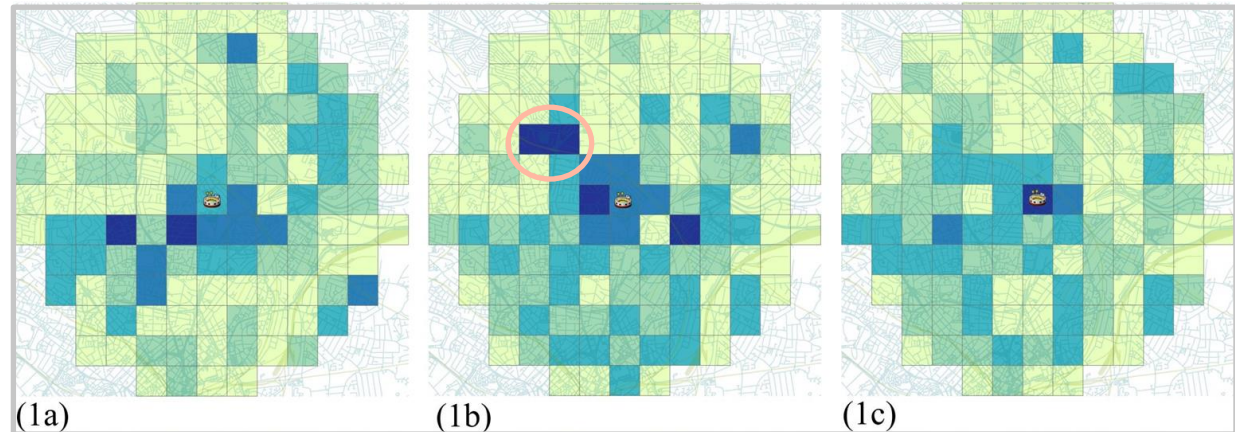


Density maps Aston Villa stadium (a) amalgamated crimes, (b) geotagged tweets, (c) violent tweets, and (d) football-related tweets

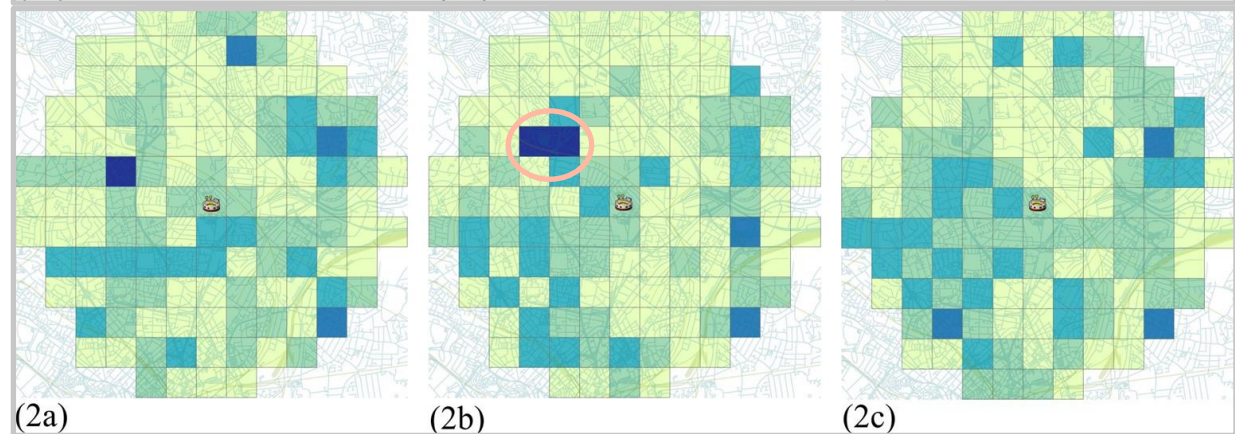
RO 1 -> RQ2



Game days



Control days



Legend - Density:

Low
 Low to moderate
 Moderate
 Moderate to high
 High

Stadium

Railways

Grid size 500m

Roads

0 1500 3000 m



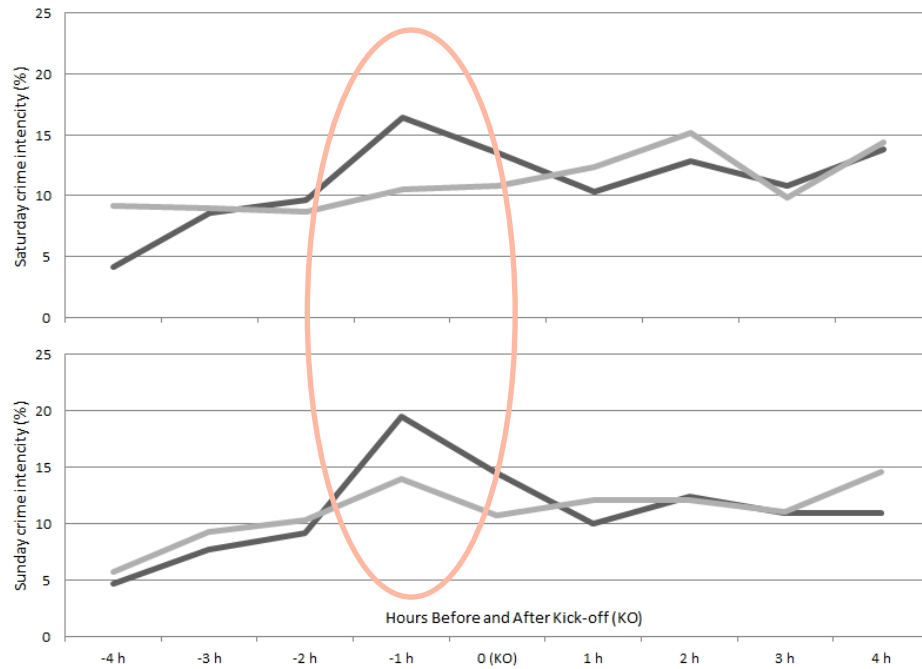
P2

Density (a) criminal damage,
(b) theft and handling, and (c)
violence against the person

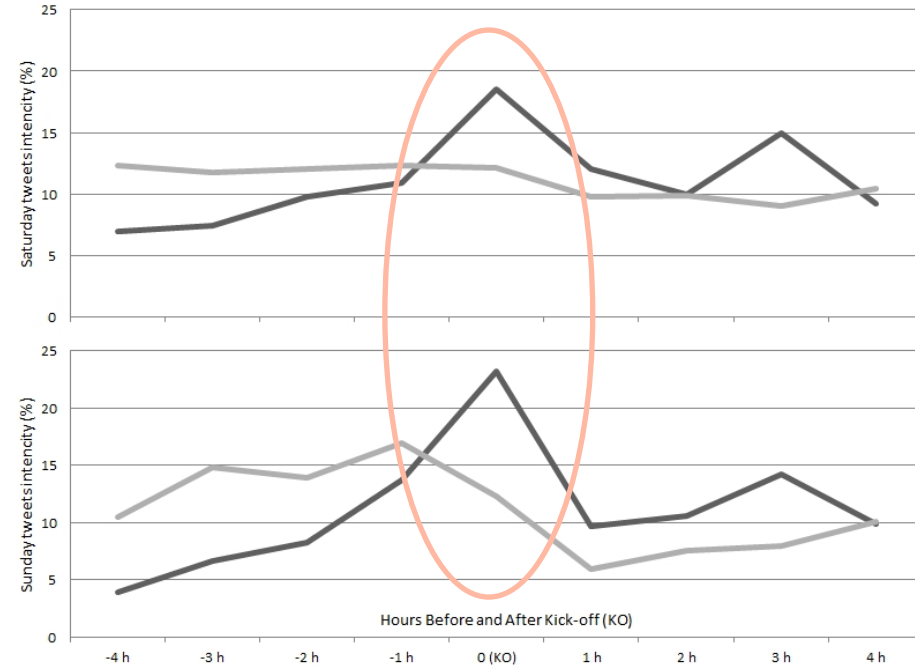
RO 1 -> RQ3

P2

Crime occurrences



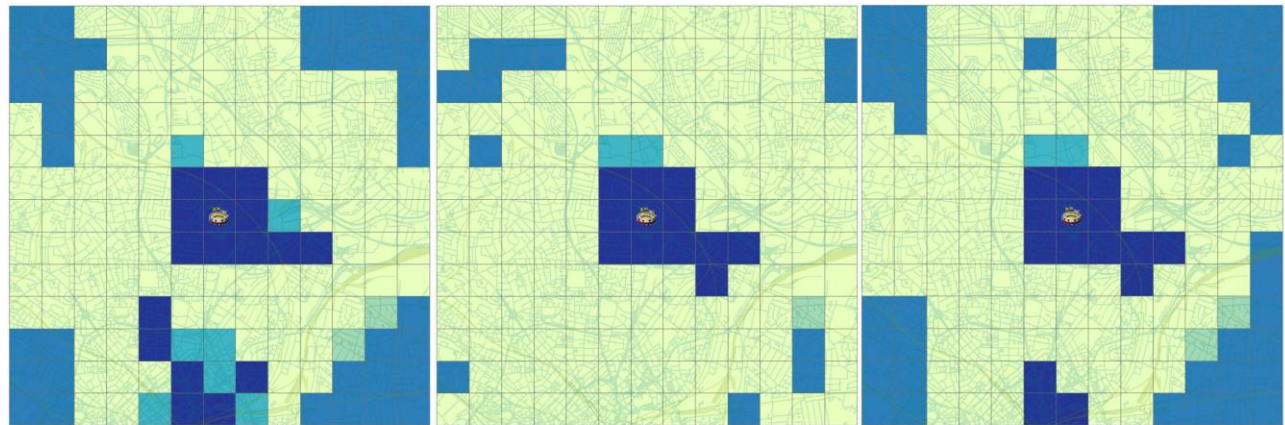
Twitter posts



RO1 -> RQ1

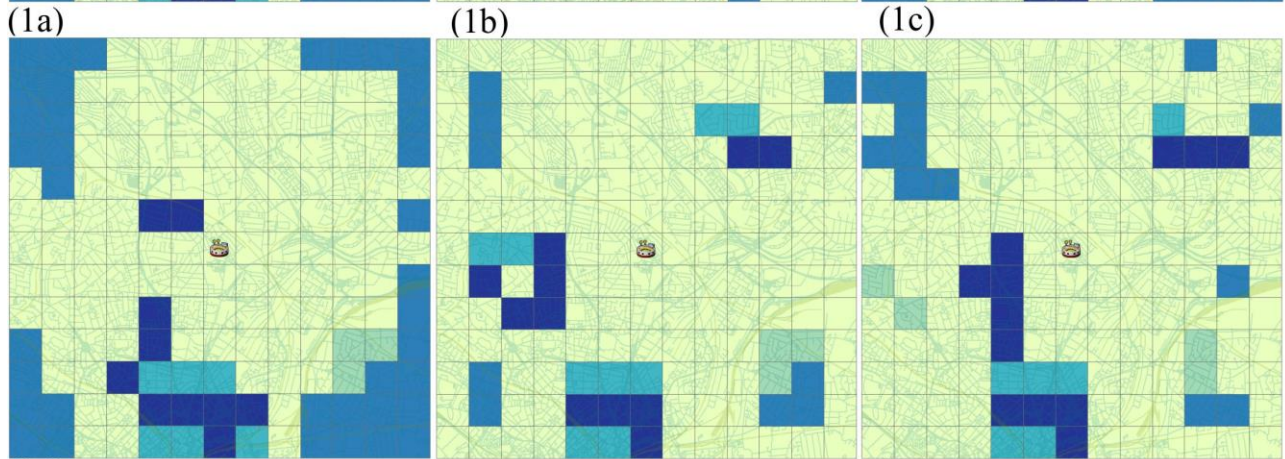


Game days



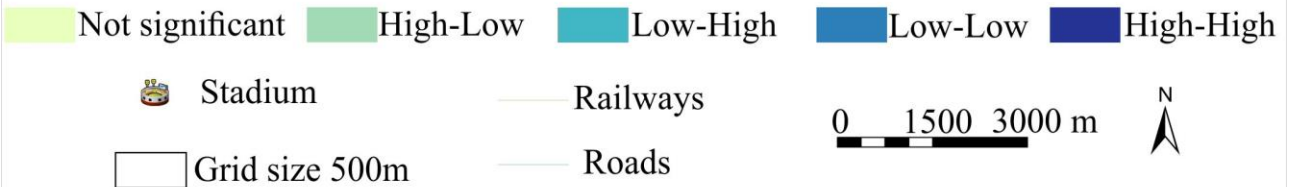
P2

Control days



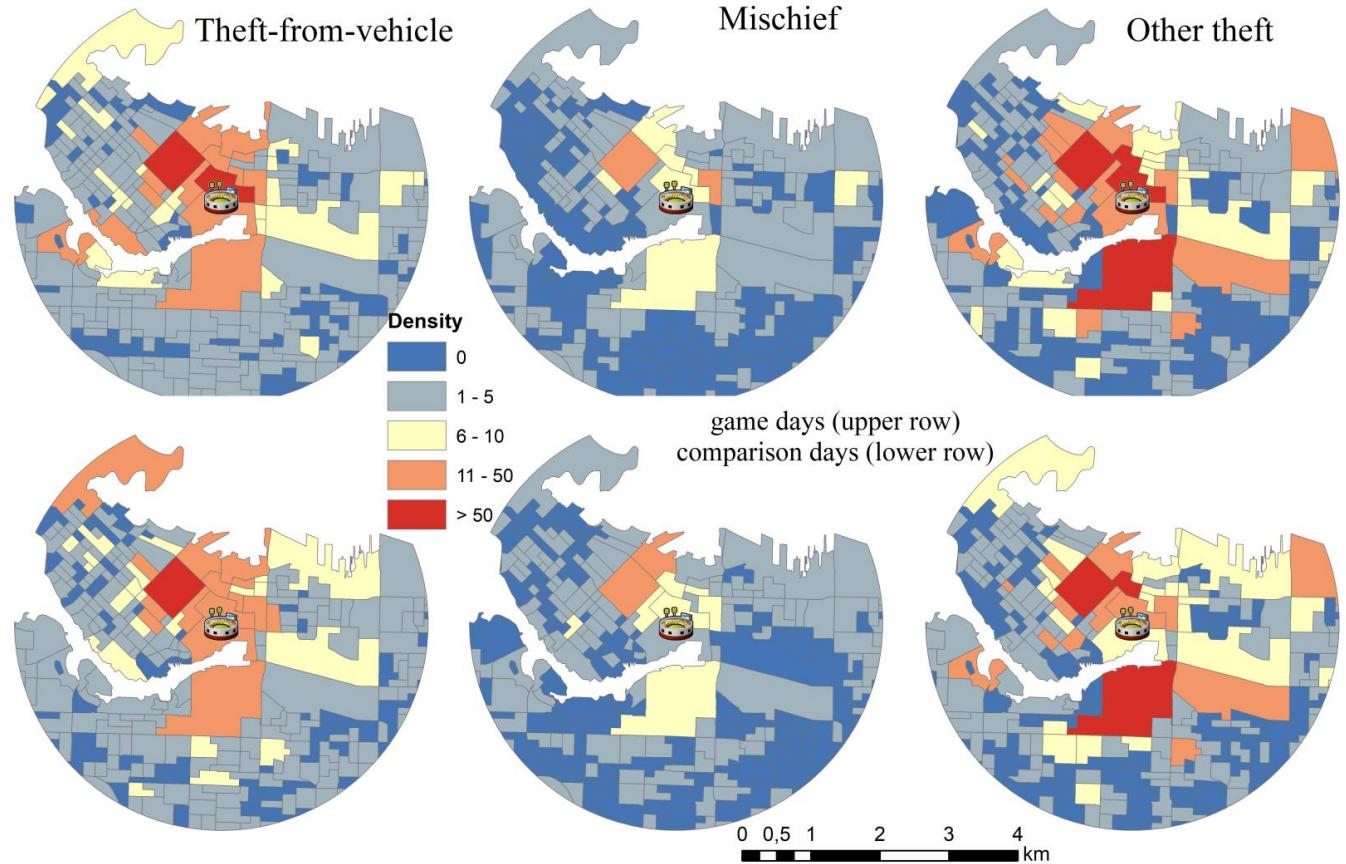
Bivariate LISA clusters between crime density and (a) tweets density, (b) violent tweets density, and (c) football topic tweets density

Legend - Cluster Map:



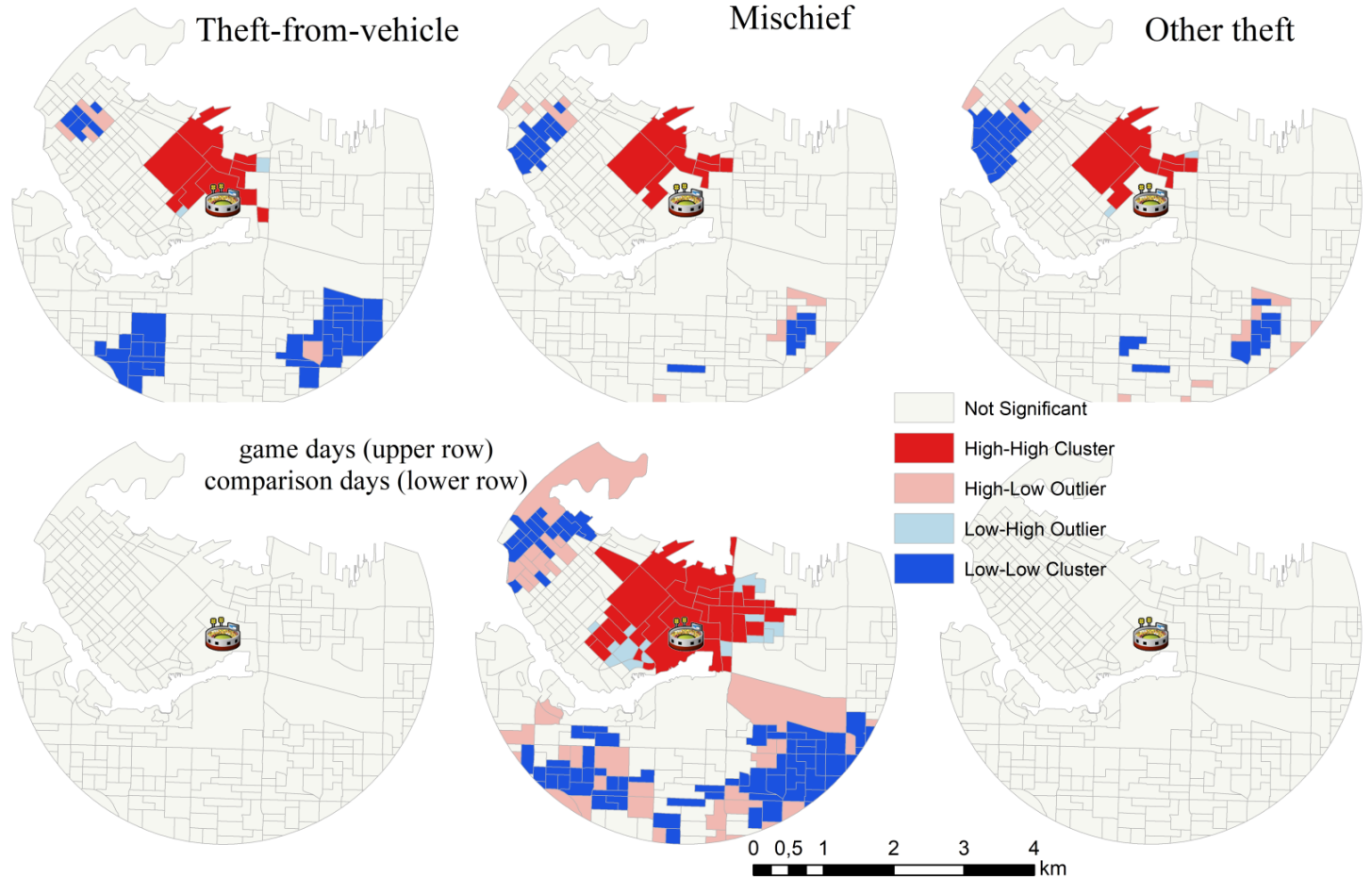
RO 1 -> RQ2

P4

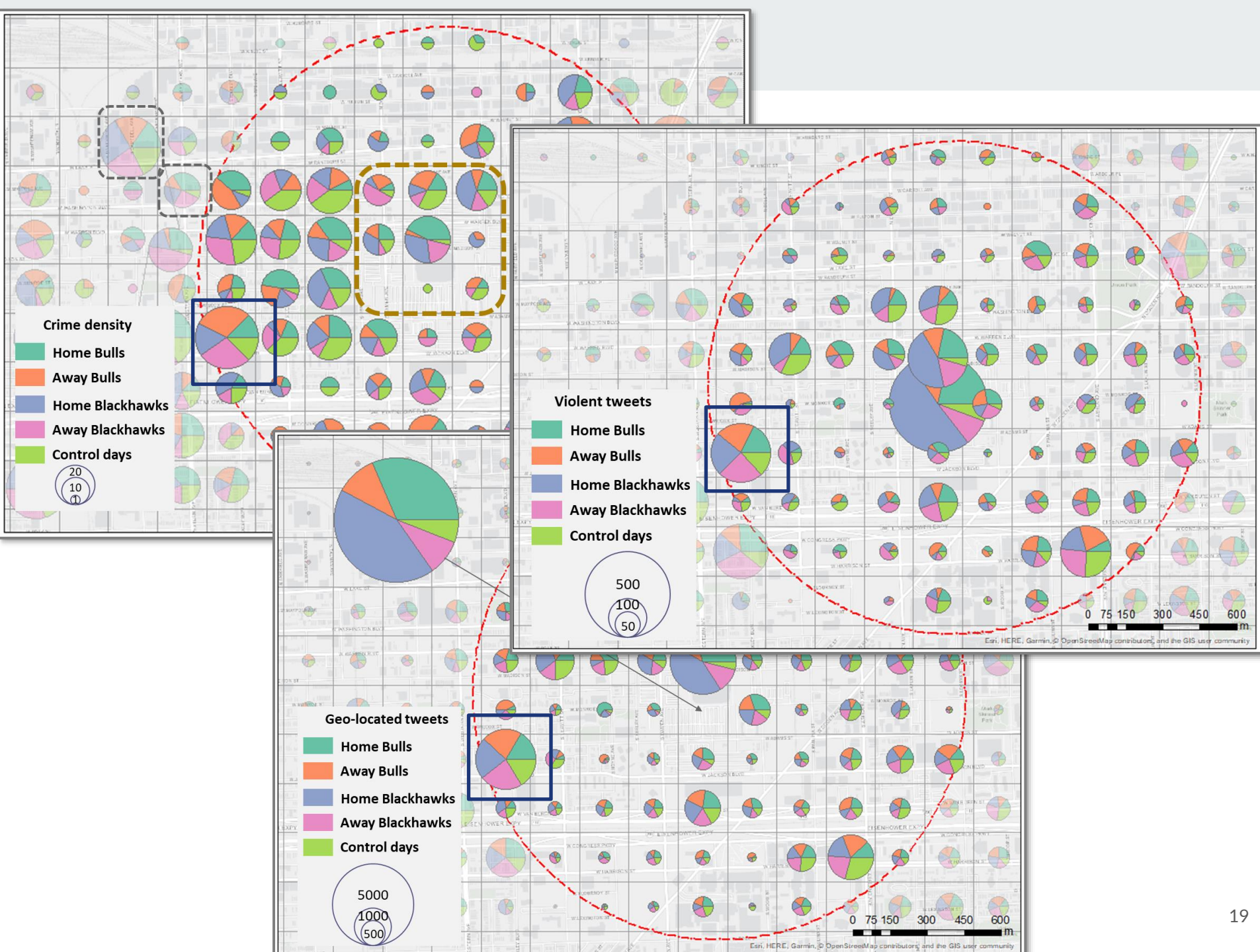


Crime density 3km area around Rogers Arena, Canucks team (hockey), Vancouver, Canada

RO 1 -> RQ2



Crime density 3km area around Rogers Arena, Canucks team (hockey), Vancouver, Canada





RO 2: Improve methods for integrating social media data into crime prediction models

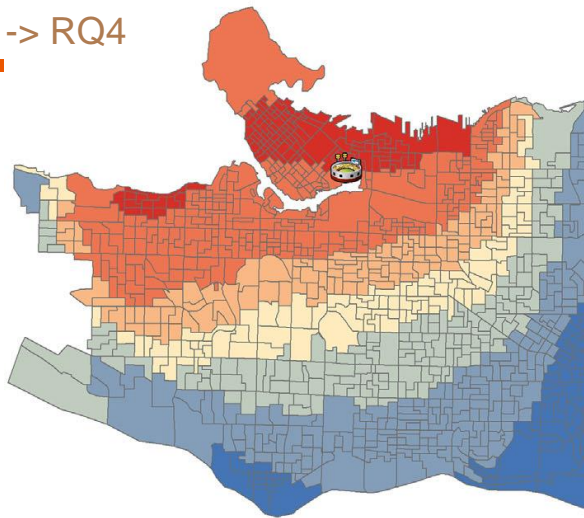
Methods: Geographically Weighted Regression (GWR), Negative Binomial Regression (NBLR), Logistic Regression, Random Forest, (Local) Kernel Density Estimation (LKDE and KDE), density weighted areal interpolation.

RO 2 -> RQ4



Crime-tweets influence on theft-from-vehicle spatial distribution

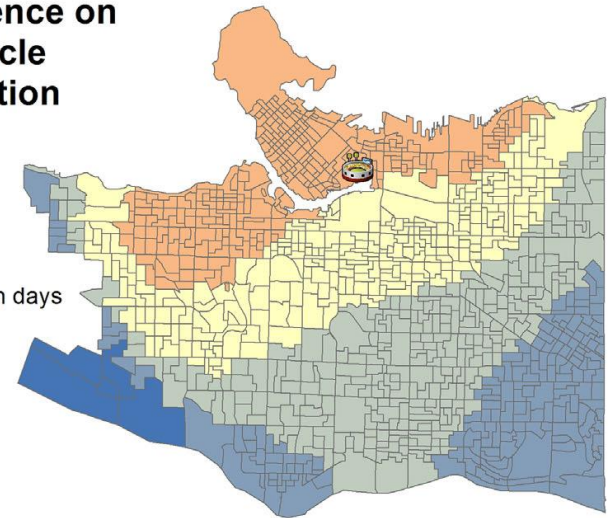
P3



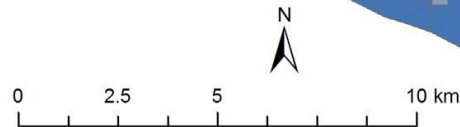
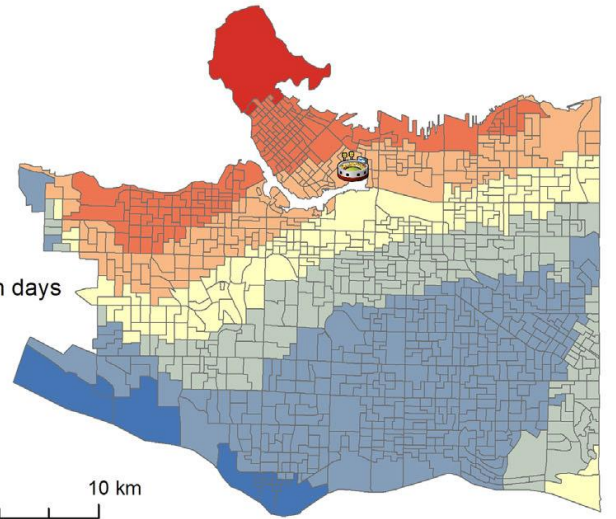
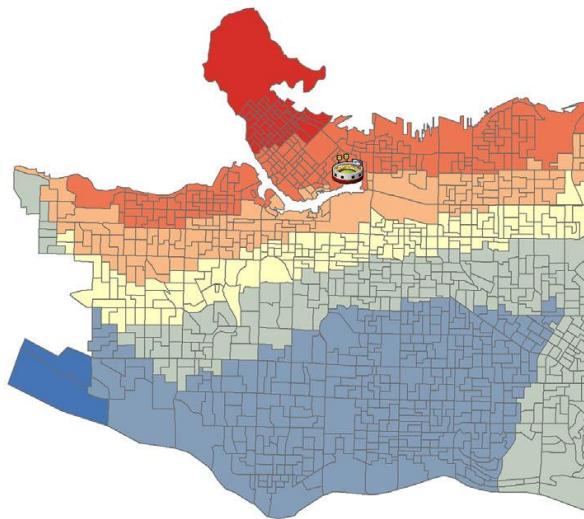
Home games and comparison days

Legend

- Stadium-Rogers Arena
- Coefficient crime-tweets**
- ≤ 0
- 0.001 - 0.050
- 0.051 - 0.100
- 0.101 - 0.150
- 0.151 - 0.200
- 0.201 - 0.250
- > 0.250
- Dissemination areas (DA)



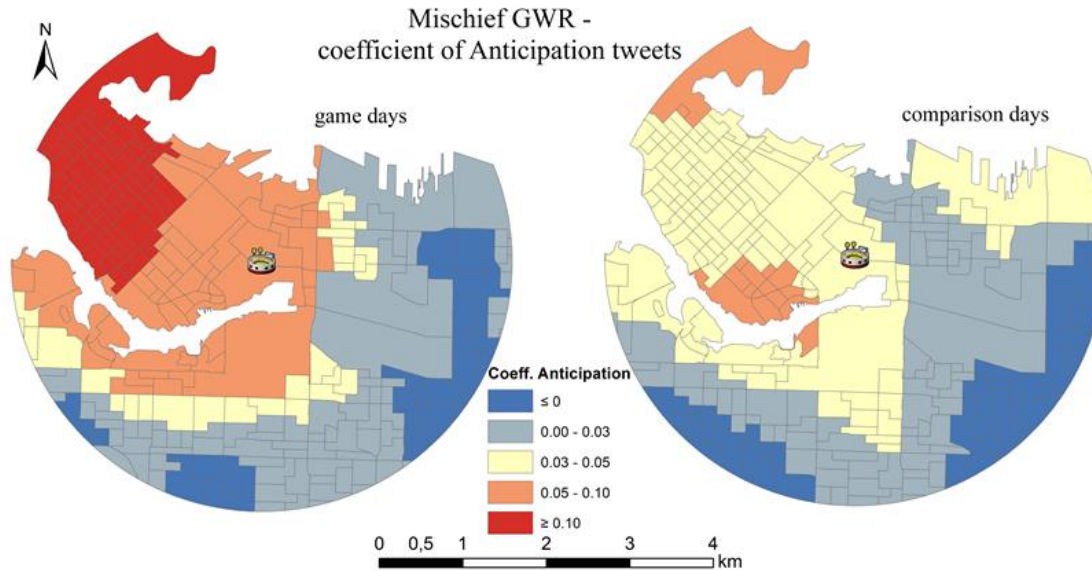
Away games and comparison days



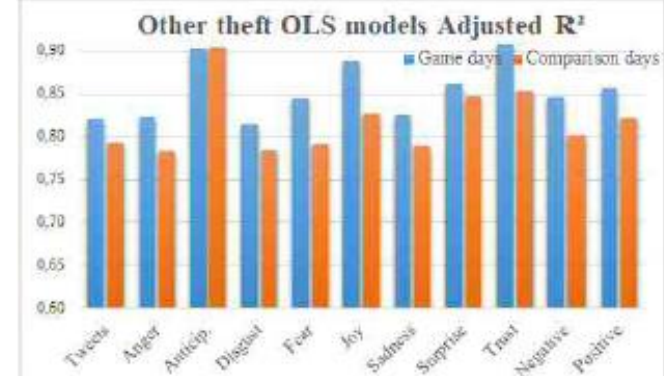
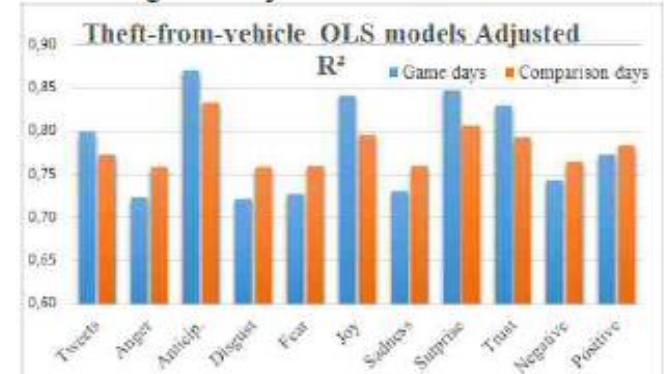
GWR models

RO 2 -> RQ4

GWR models



Mischief Adj. R ²	Game days GWR	Comparison days GWR
Tweets	0,83	0,78
Anticip.	0,85	0,79
Surprise	0,82	0,78
Trust	0,85	0,78
Positive	0,84	0,79

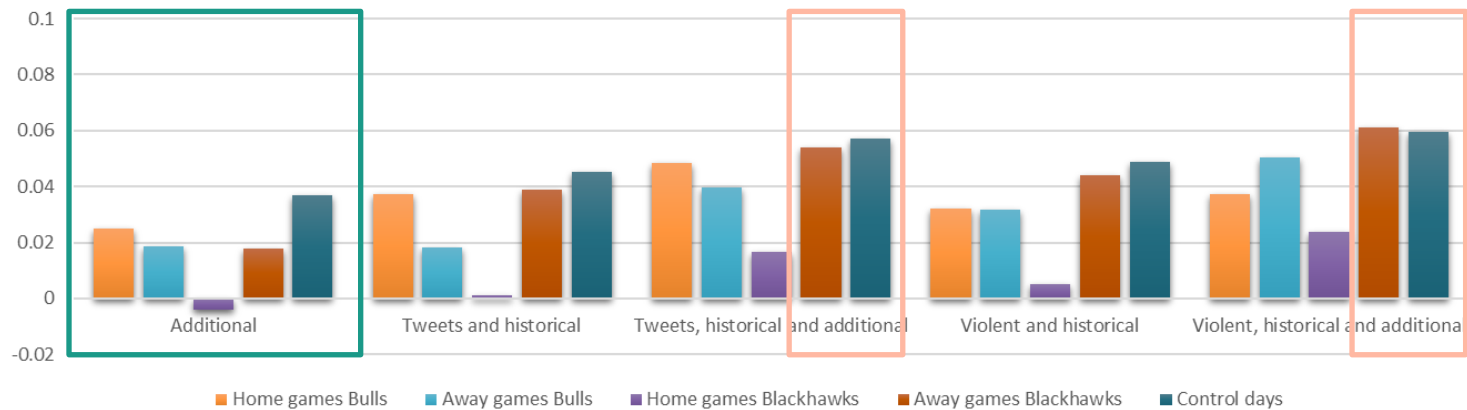


Predicting crime types

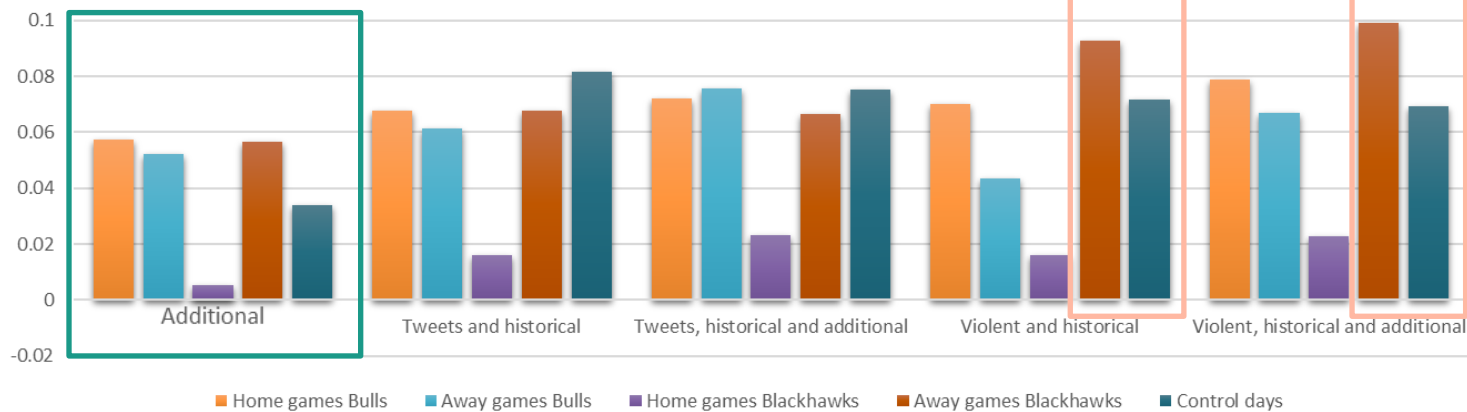
RO 2 -> RQ6

P7

Assault - AUC improvement



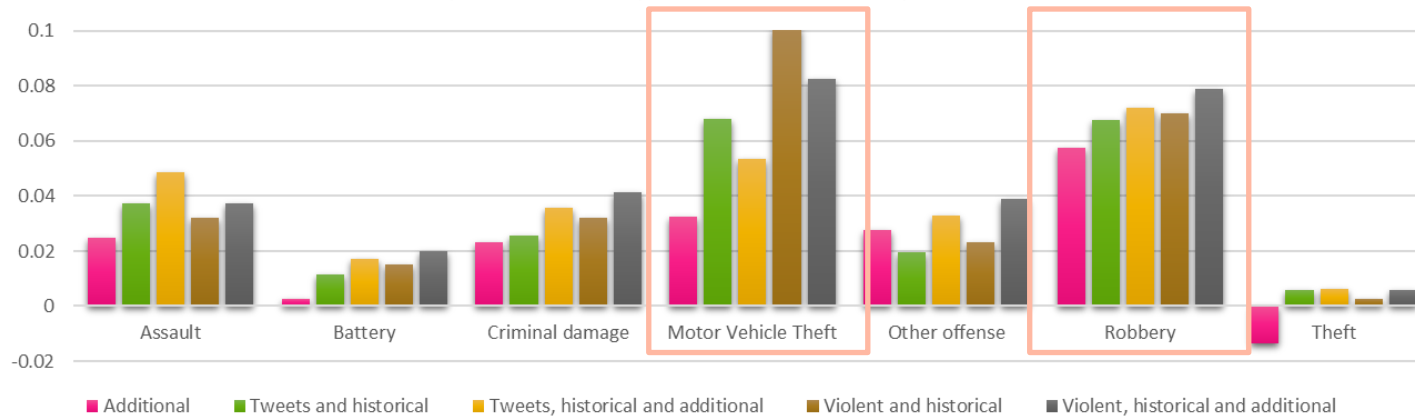
Robbery - improvement AUC



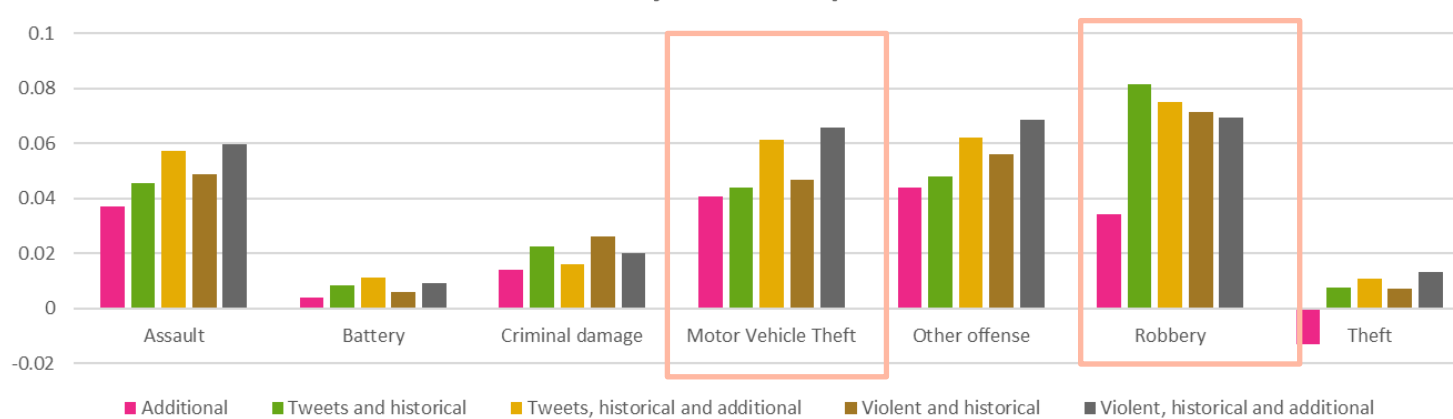
Game days vs control days prediction

RO 2 -> RQ6

Home games Chicago Bulls – AUC improvement



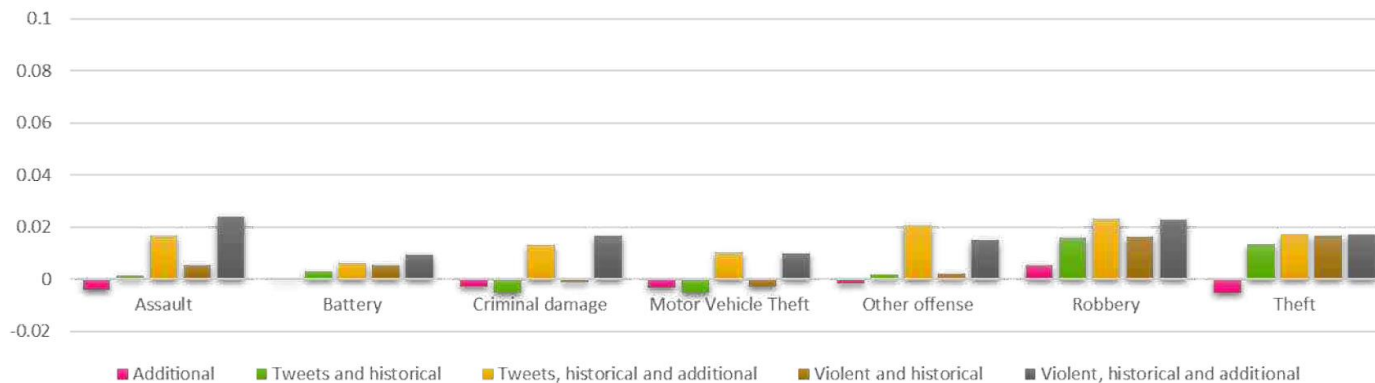
Control days – AUC improvement



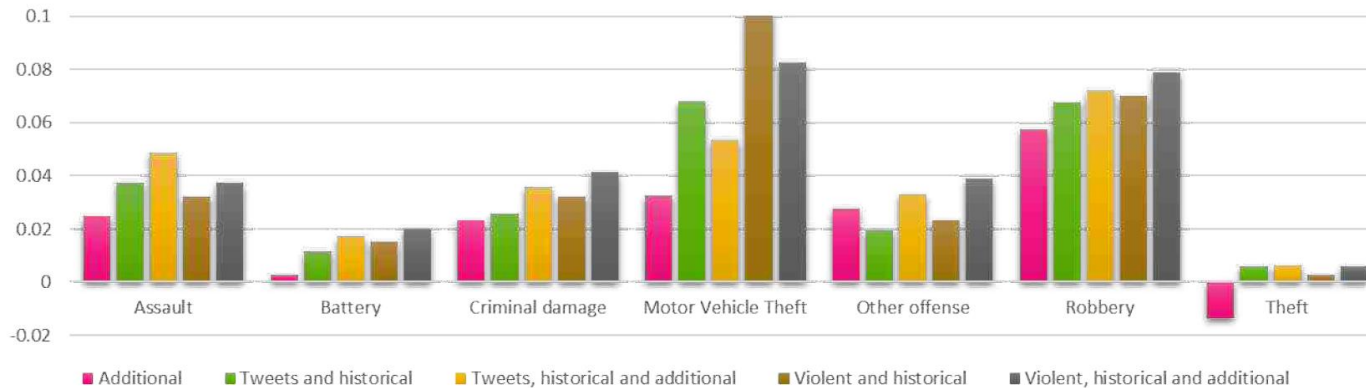
Controversial result

RO 2 -> RQ6

Home games Chicago Blackhawks – AUC improvement



Home games Chicago Bulls – AUC improvement

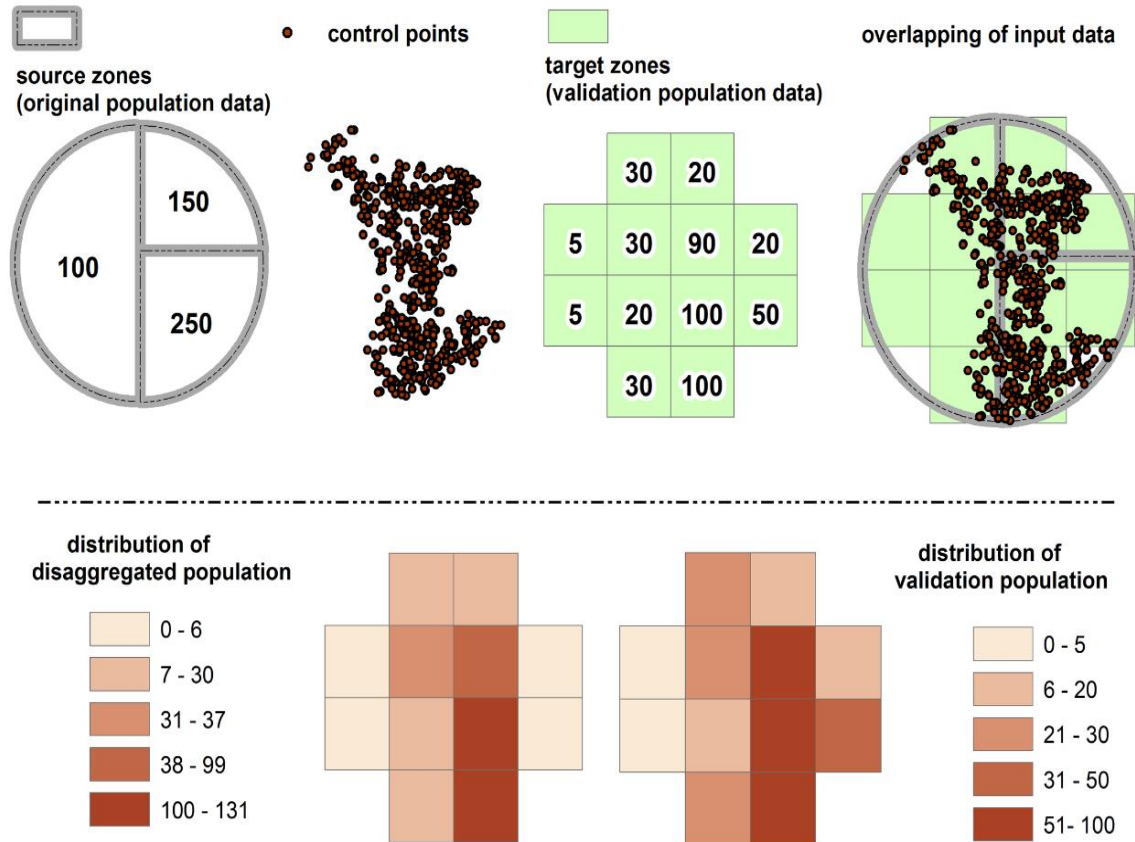


Density weighted areal interpolation technique

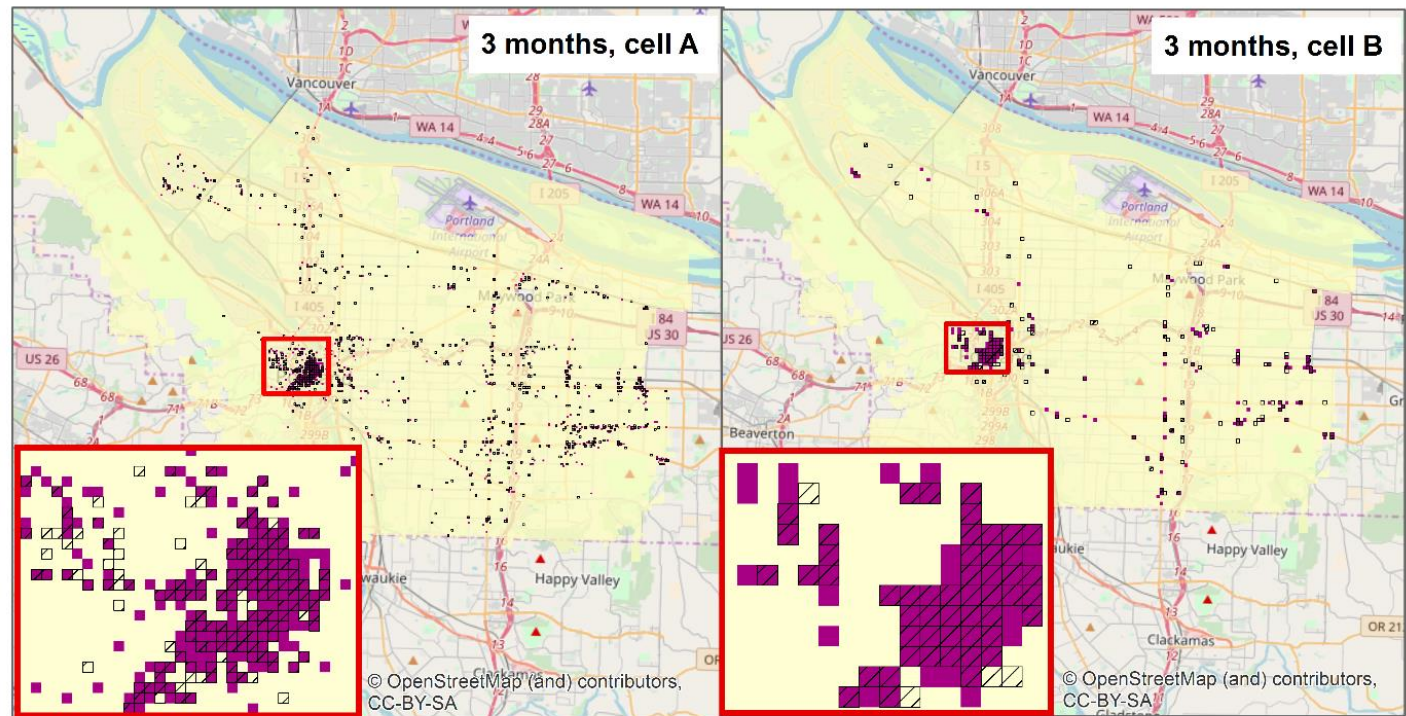
RO 2 -> RQ5

Residential population = consists on residents who permanently stay in an area for a considerable amount of time and are part of the official population count;




Ambient population = refers to the actual number of persons who are present within a particular area at any given time.



RO 2 -> RQ5



Legend

-  prediction area, baseline
-  prediction area, GWR
-  extent of study area

N



1 centimeter = 0.5 kilometers



zoom in into the city centre

Mean values of Hit Rate

cell size	cell A*	24.9
	cell B	20.0
length of prediction period	1 week	18.7
	2 months	23.0
	3 months*	25.7
method	GWR*	25.2
	Baseline	19.7 ²⁷

Discussion



Explaining relationships

Event routine activity

Need of control variables

Fan behavior

Significant crime-crime tweets relationship

Population at crime risk

Prediction day vs training data

Data characteristics

Data quality: social media bias and geo-location

Geo-privacy for crime data

MAUP and temporal unit selection

Data sparsity: negative-positive ratio

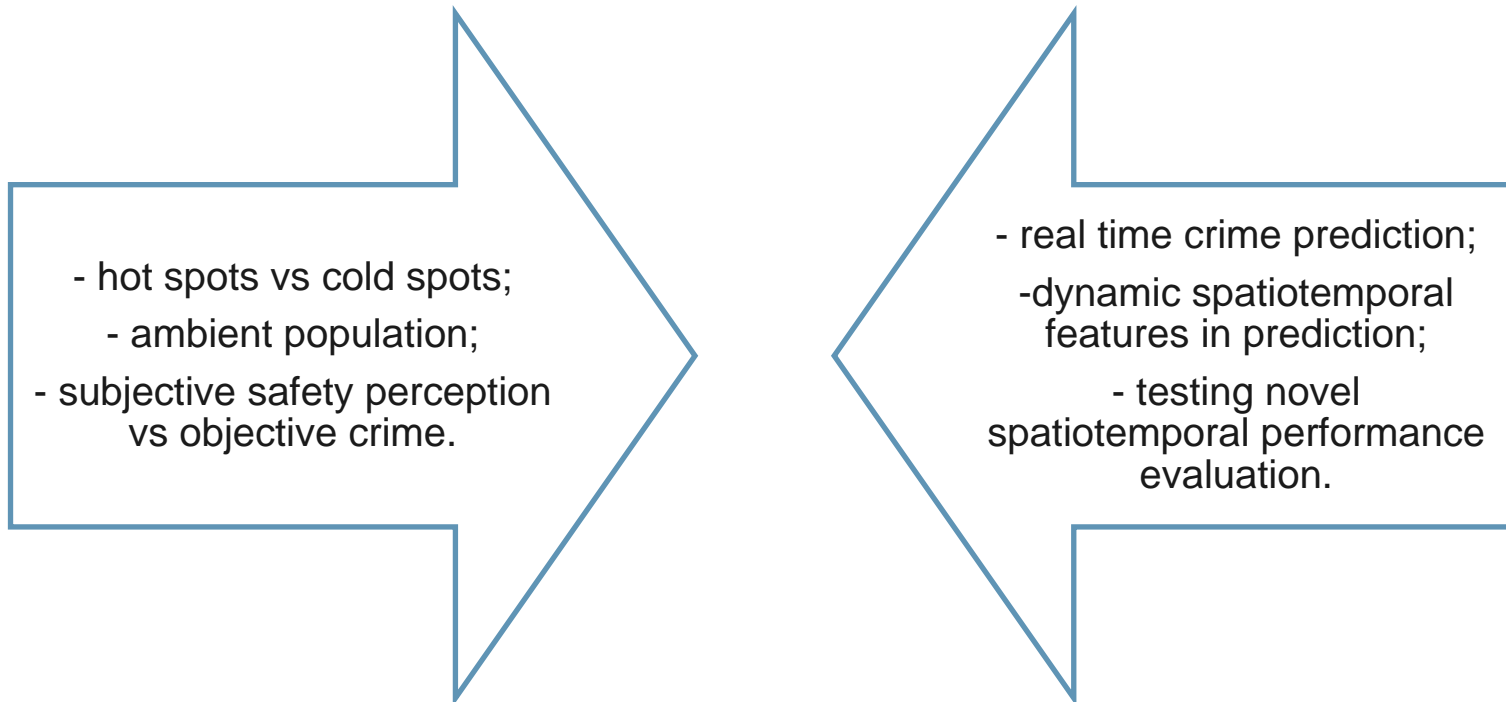
Transferability

Differences per crime types/culture/country

Scientific contribution

- emerging field of **predictive analytics**;
- **geography of crime** for sporting events;
- collaboration based - highly **interdisciplinary outcomes**;
- evaluating **significance of social media** features in prediction models;
- spatial **hot spots and cold spots** analysis;
- **text** analysis in the **space-time** view.

Future directions of research



Applications: crime prevention strategies and law enforcement, policy makers, law enforcement, urban design for events, crime safety regulations, sports analytics.

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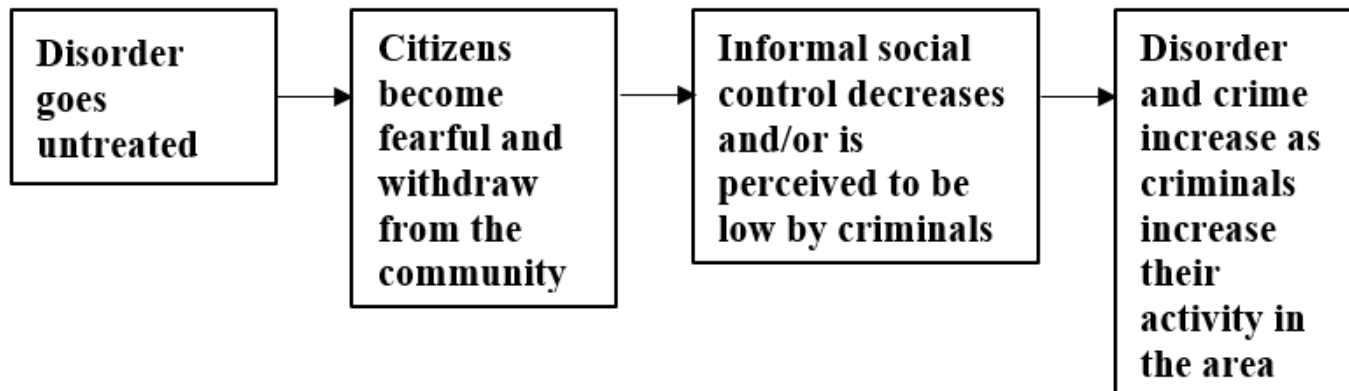
Collaborators: Michael Leitner, Judith Stratman, Bernd Resch, Kalliopi Kyriakou

Broken Windows Theory

Kelling and Wilson (1982)



It states that “visible signs of crime, anti-social behavior, and civil disorder create an urban environment that encourages further crime and disorder, including serious crimes”
 → great debate in criminology and not only!!!



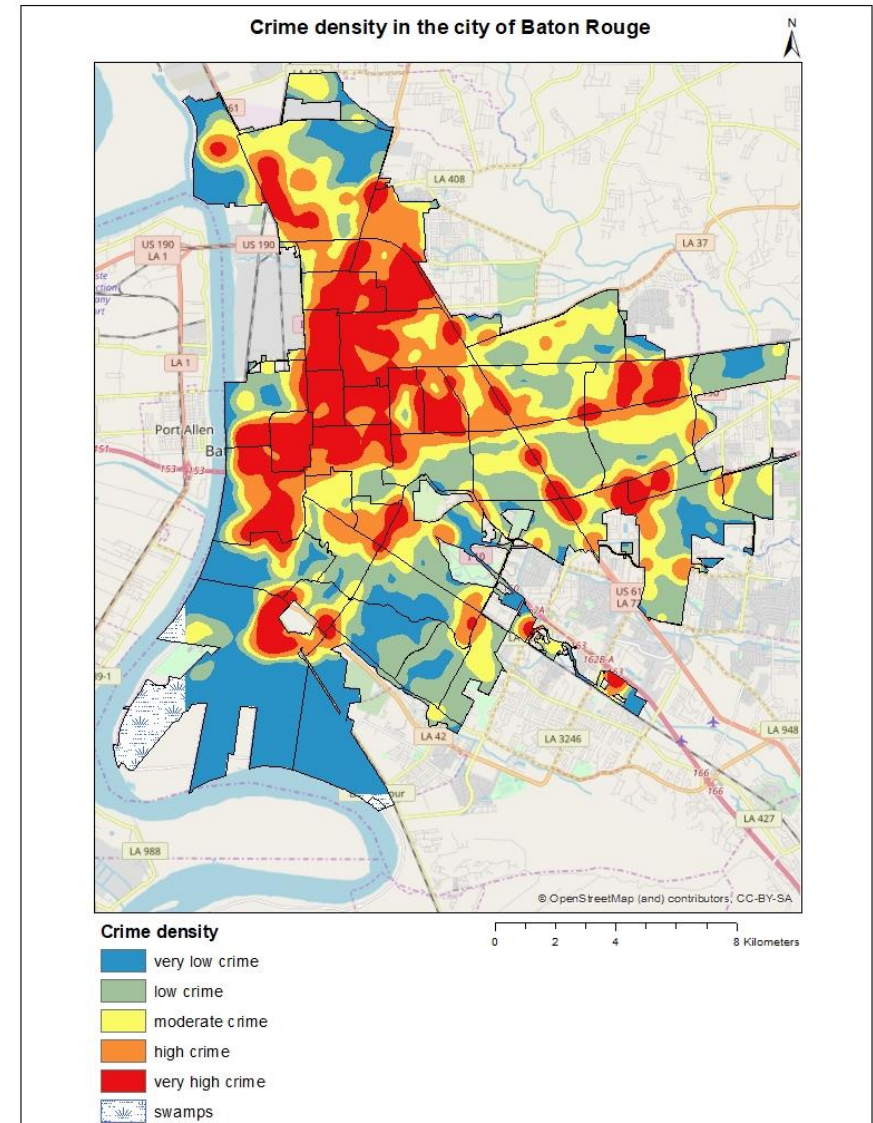
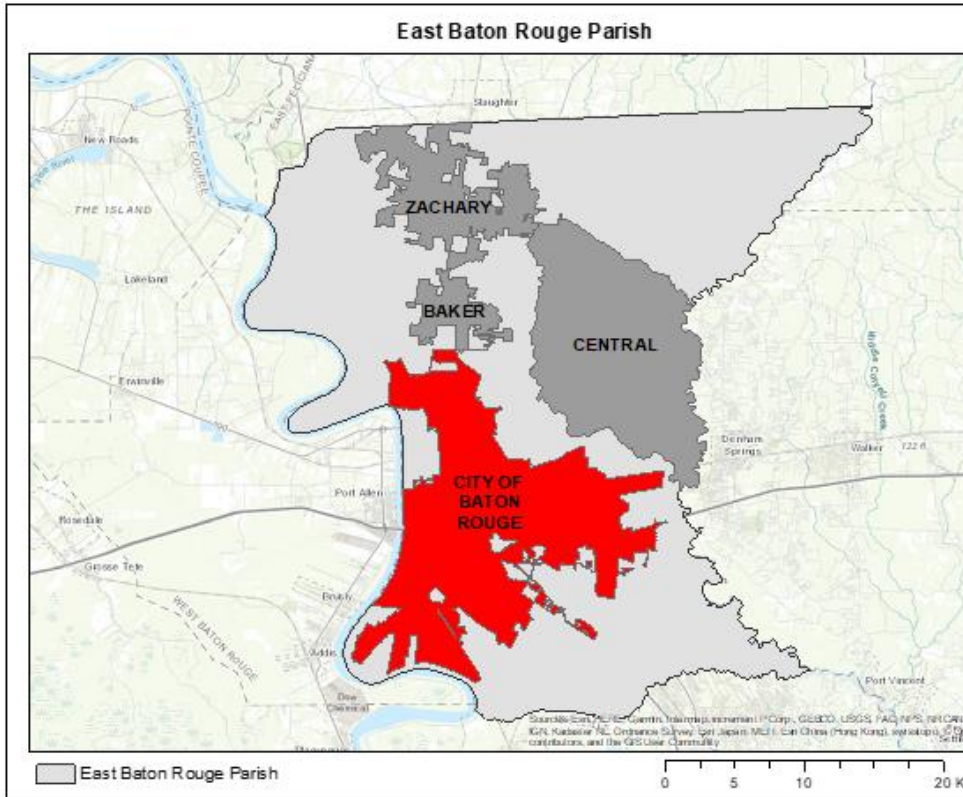
Broken windows effect (Hinkle and Weisburd 2008)

Motivation and goals

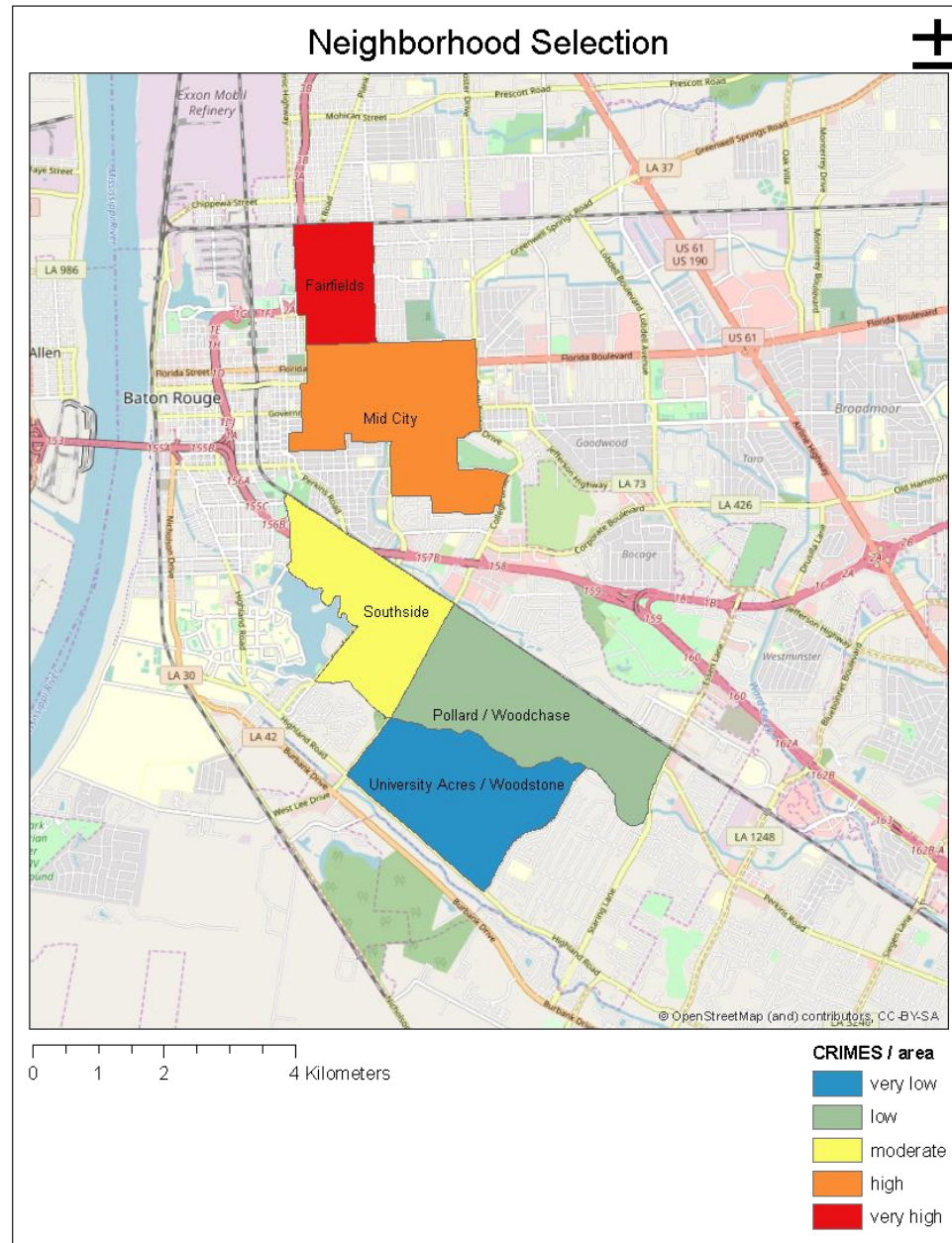
- Identifying physical **urban blight indicators** and find correlations with **crime** data;
- Applying new methods to observe **urban neighborhood characteristics** and to include qualitative data into a GIS;
- Extracting **safety information** from the data acquired using mixed methods and to implement it in a **GIS**.

As a long-term outcome, we would like to contribute to improving citizen's cooperation with official stakeholders and help to design crime prevention strategies

Study area

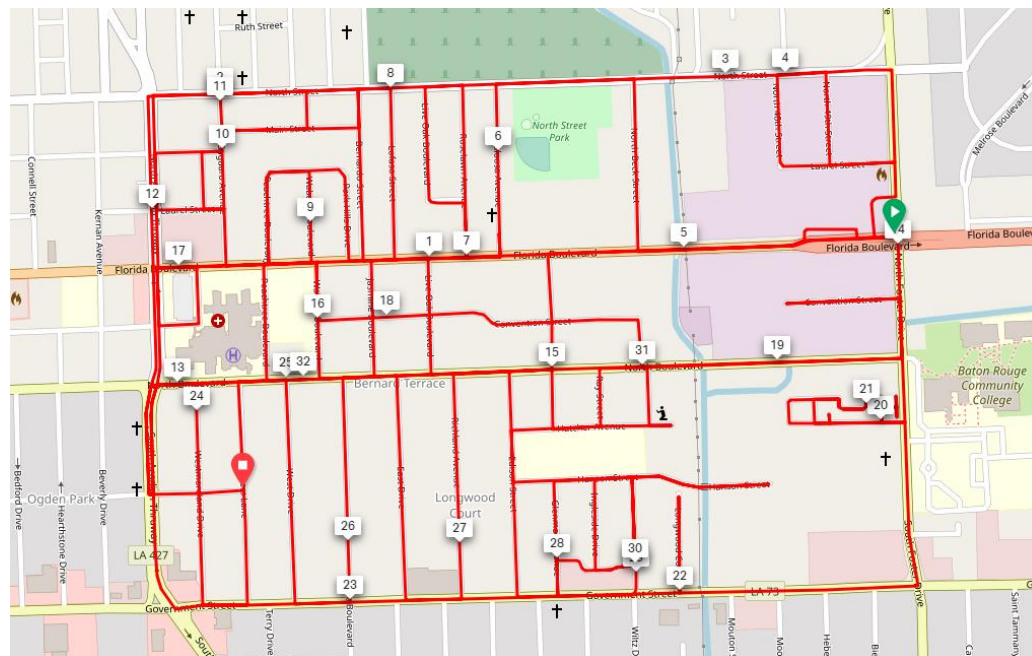


Study area



Methodology. Pre-analysis for field work

- **Spatial unit selection:** neighborhood for field selection, Census blocks for interpretation;
- **Defining categories:** very high, high, moderate, low, very low crime rates;
- **Selection criteria:** no highway; no lakes; connectivity; similar length of street network
- Determining the shortest path for driving in the neighborhood;



Methodology. Data acquisition



Primary data collection:

- Survey: background questionnaire and on-screen mapping;
- Spatial video acquisition system (SVAS);
- Geonarratives;
- Physiological measurements using wristbands;

Secondary data collection:

- Crime data;
- Additional: socio-demographic and environmental data.

(1) Spatial video acquisition system (SVAS)

- additional technique to GIS to improve the documentation and analysis;
- unlike Google Street View, SVAS data collection is in the control of the researcher;
- spatial video can be collected using a variety of modes (car, motorbike, bicycle, boat and by foot);



a.



b.



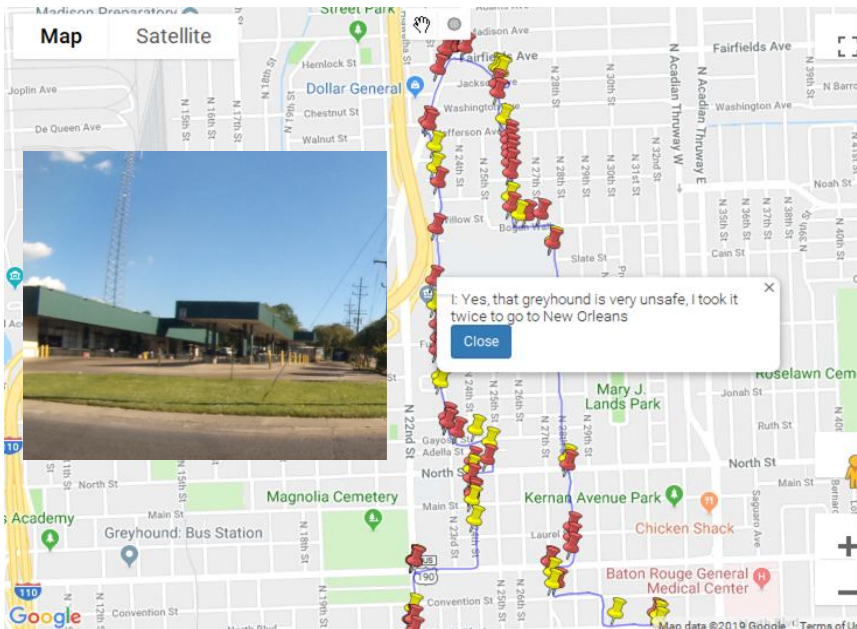
c.



d.

(2) Geonarratives

- gives contextual details and enriches typical hotspot approaches with more on-the-ground context;
- audio recording of this narrative is linked to the video via timestamp;
- multiple perspectives for the same geographic area;
- mental map from behavioral geography.



Example of geo-narrative output

(3) Physiological measurements - wristbands

- tool for capturing people's subconscious reactions to environmental stimuli;
- add contextualizing information to observed phenomena;
- can complement videos and narratives;



Source: www.empatica.com

(4) Crime, socio-economic, demographic data



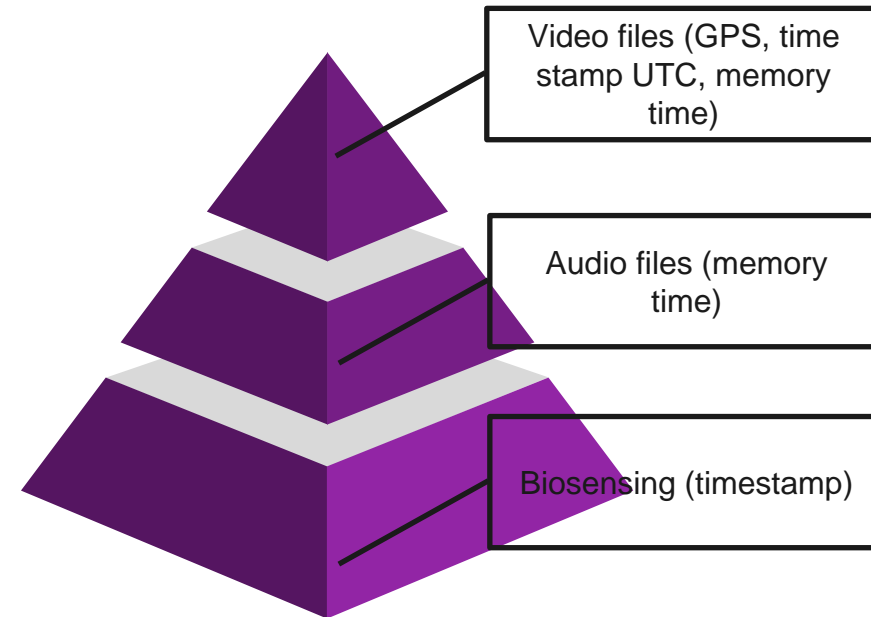
- Baton Rouge Police Department (BRPD) including coordinates and time stamps of crime occurrences;
- Census data: residential population, ethnicity, education, household types, foreign born, unemployment, poverty rate;
- Environmental data: street network, buildings footprint, public buildings, neighborhoods, etc.

Methodology. Data processing



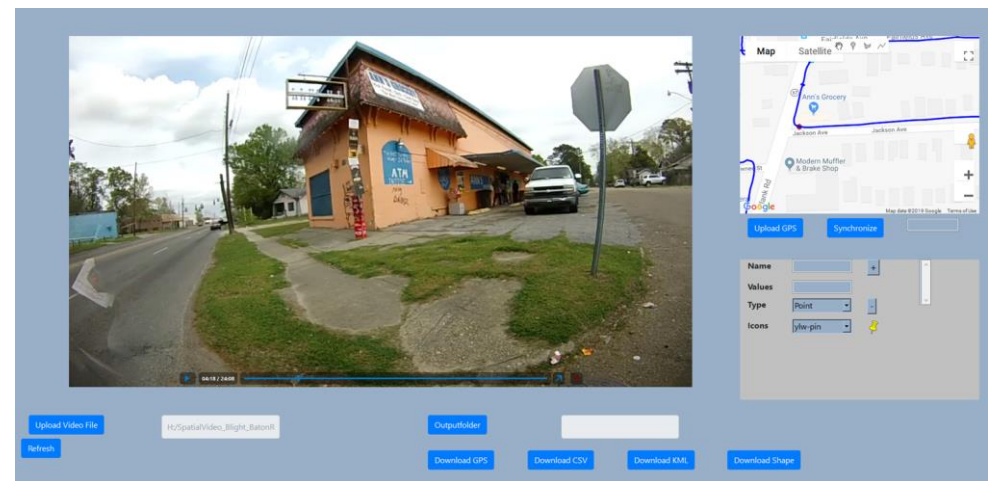
Processing tools:

- Videoplayer with integrated GPS track and
- WordMapper (developed by Prof. Andrew Curtis and his team)

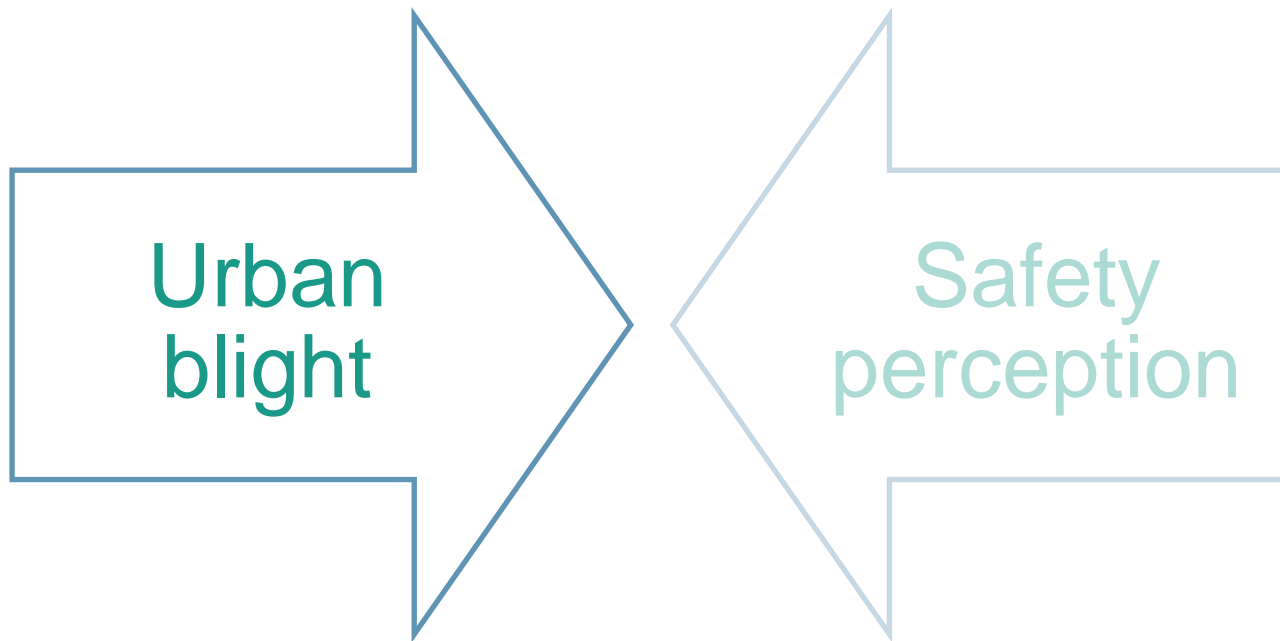


Analysis tools:

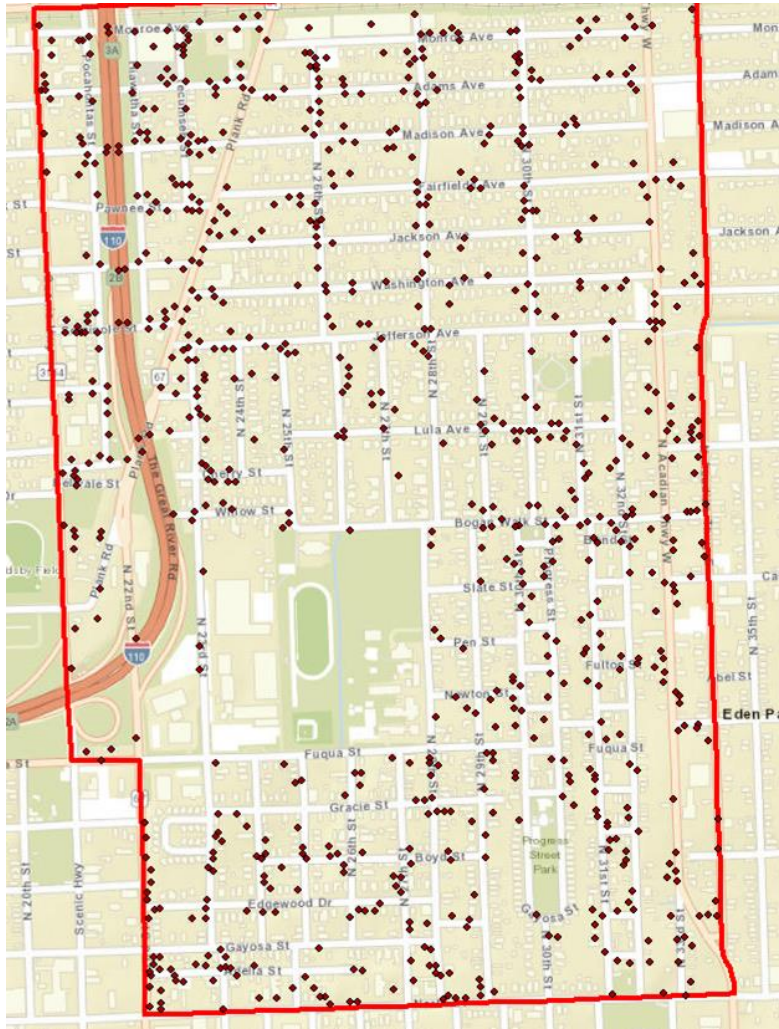
- R programming for statistical analysis
- GIS software for mapping



Results

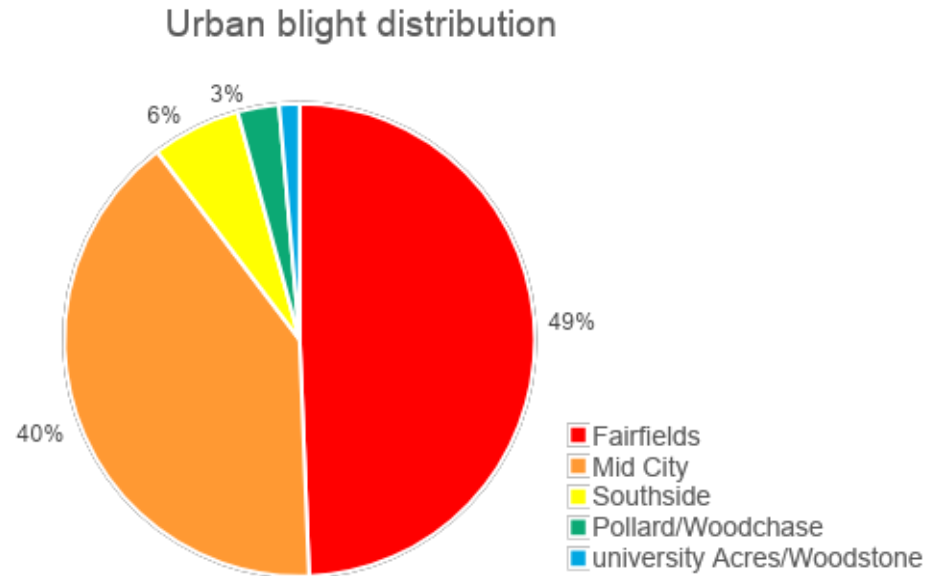
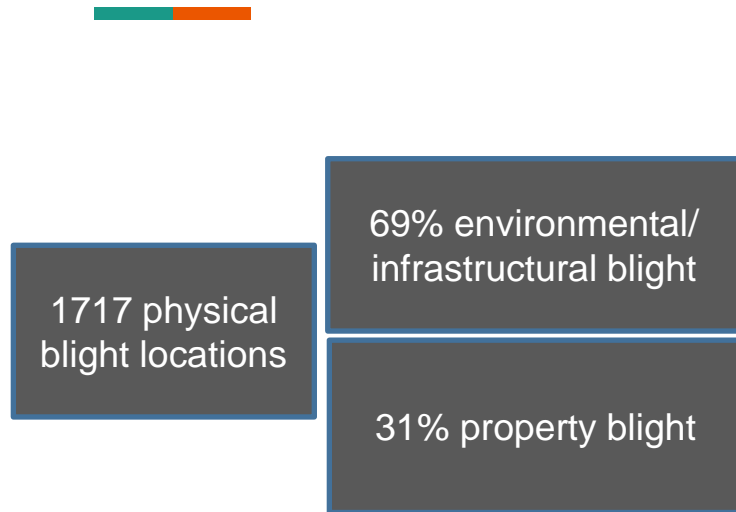


Physical Blight – data extraction

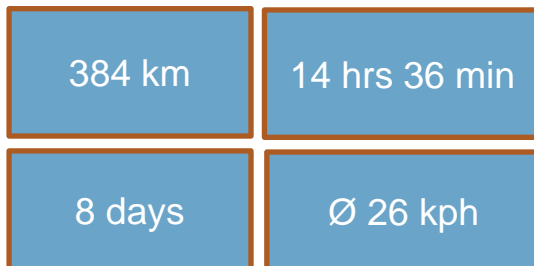


Building	
B1	Abandoned or boarded up properties
B2	Broken window
B3	Blocked window
B4	No window
B5	Building graffiti
B6	Structural integrity
B7	Broken roof
B8	Other
Environment/ Infrastructure	
E1	Damaged sidewalk
E2	Damaged roads
E3	Overgrown vegetation
E4	Litter
E5	Illegal dumping
E6	Unkempt vacant areas
E7	Illegal parking
E8	Abandoned vehicle
E9	Graffiti (environment)
E10	Other

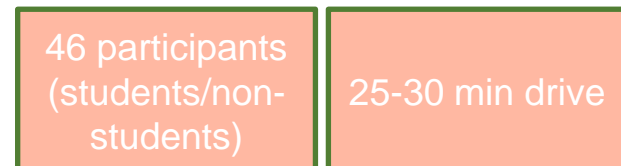
Some numbers...



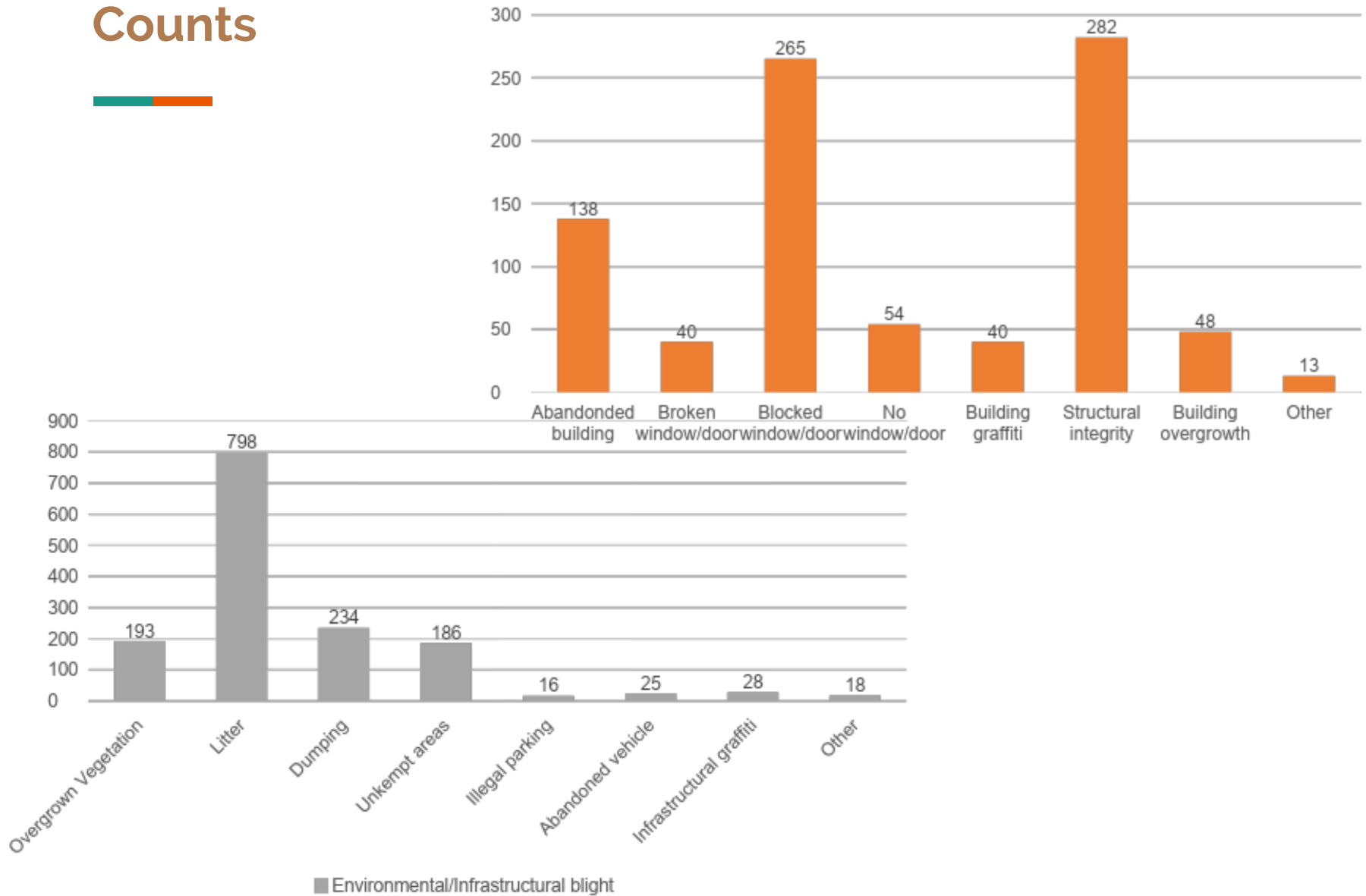
Spatial video



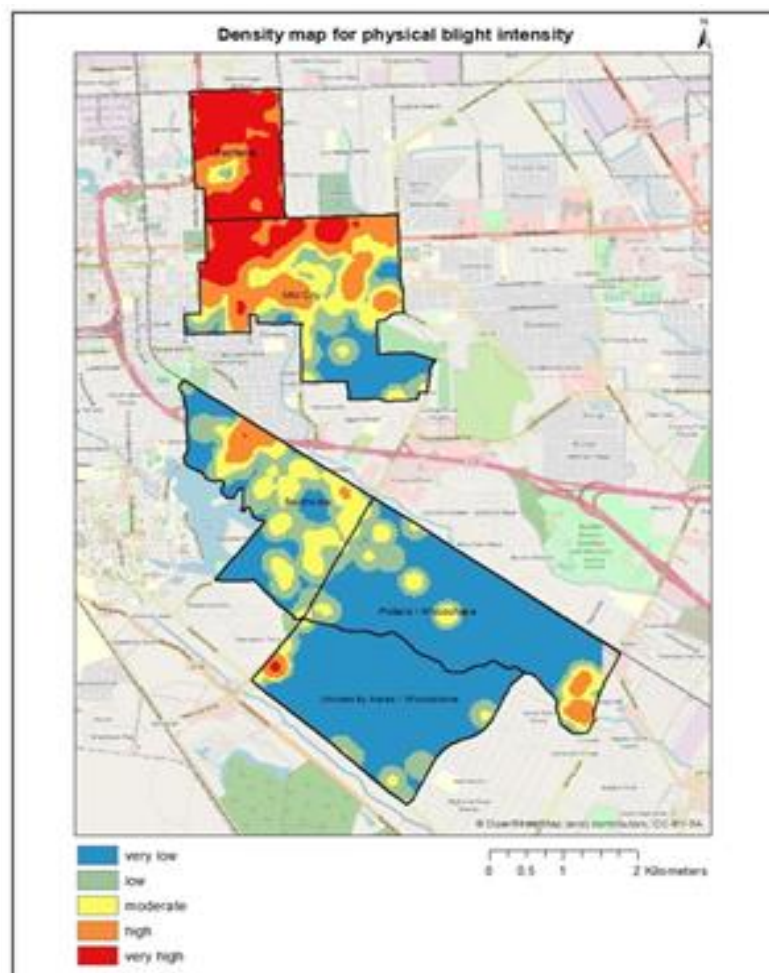
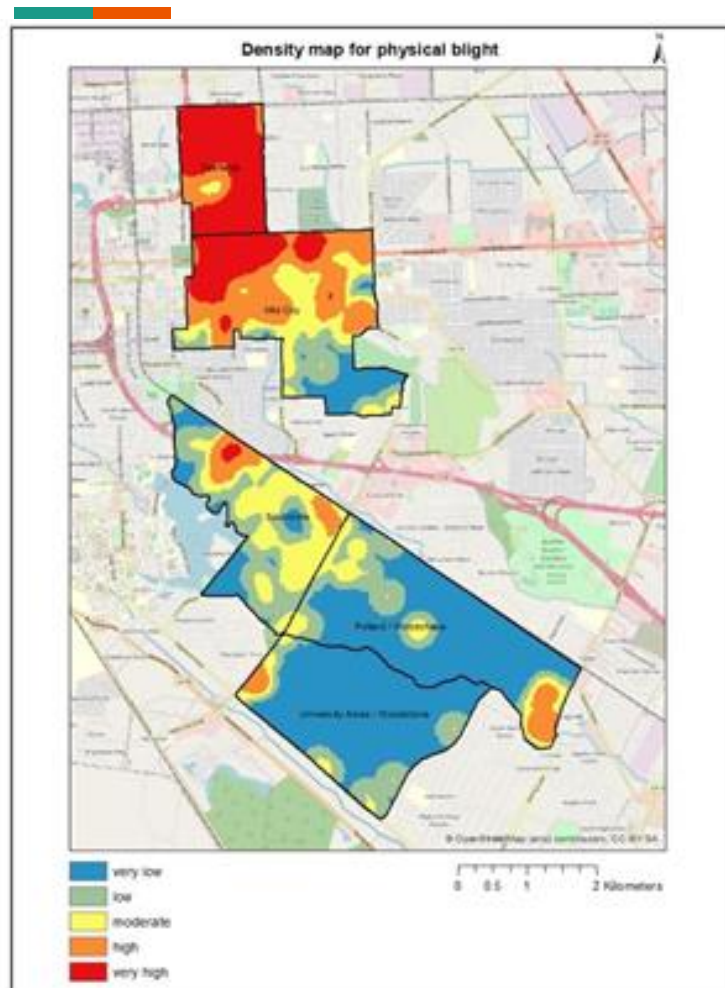
Geo-narratives



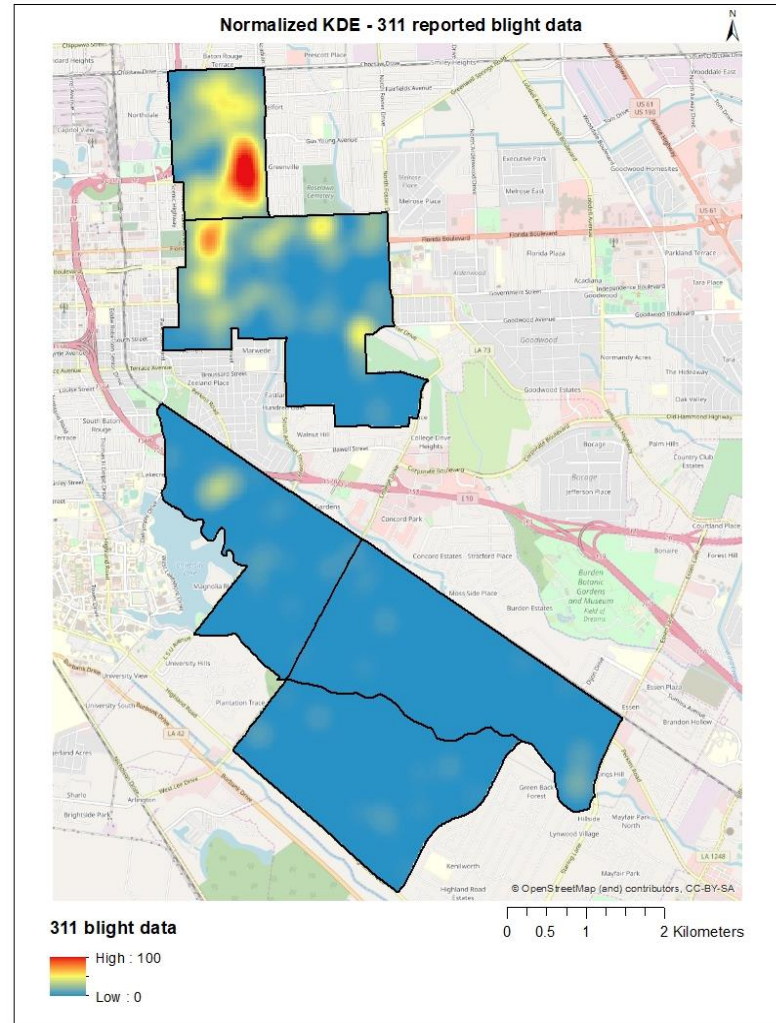
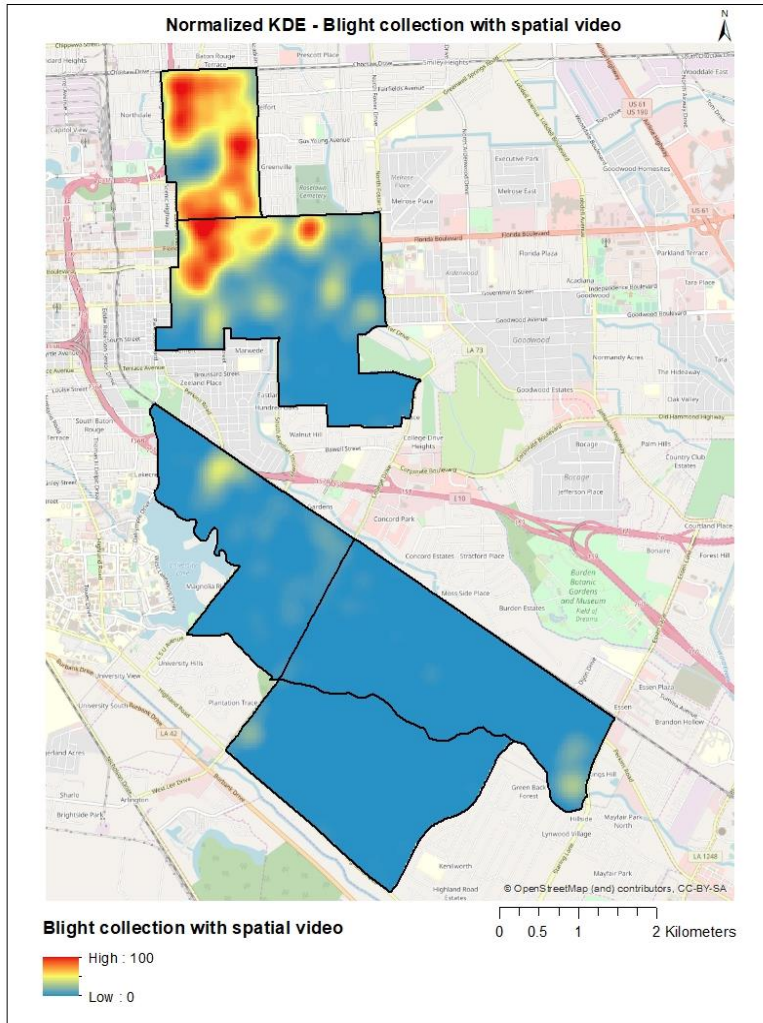
Counts



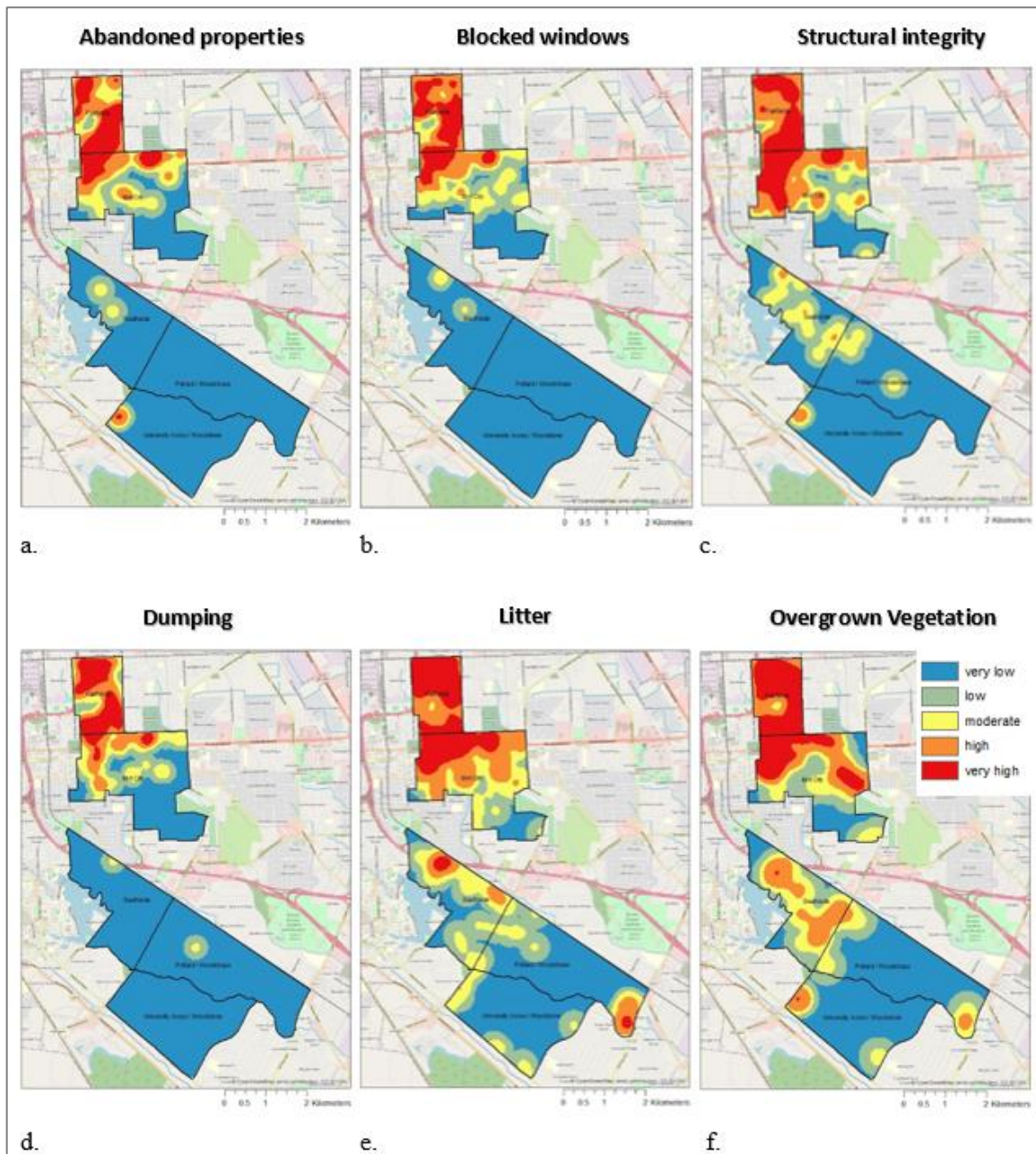
Density maps



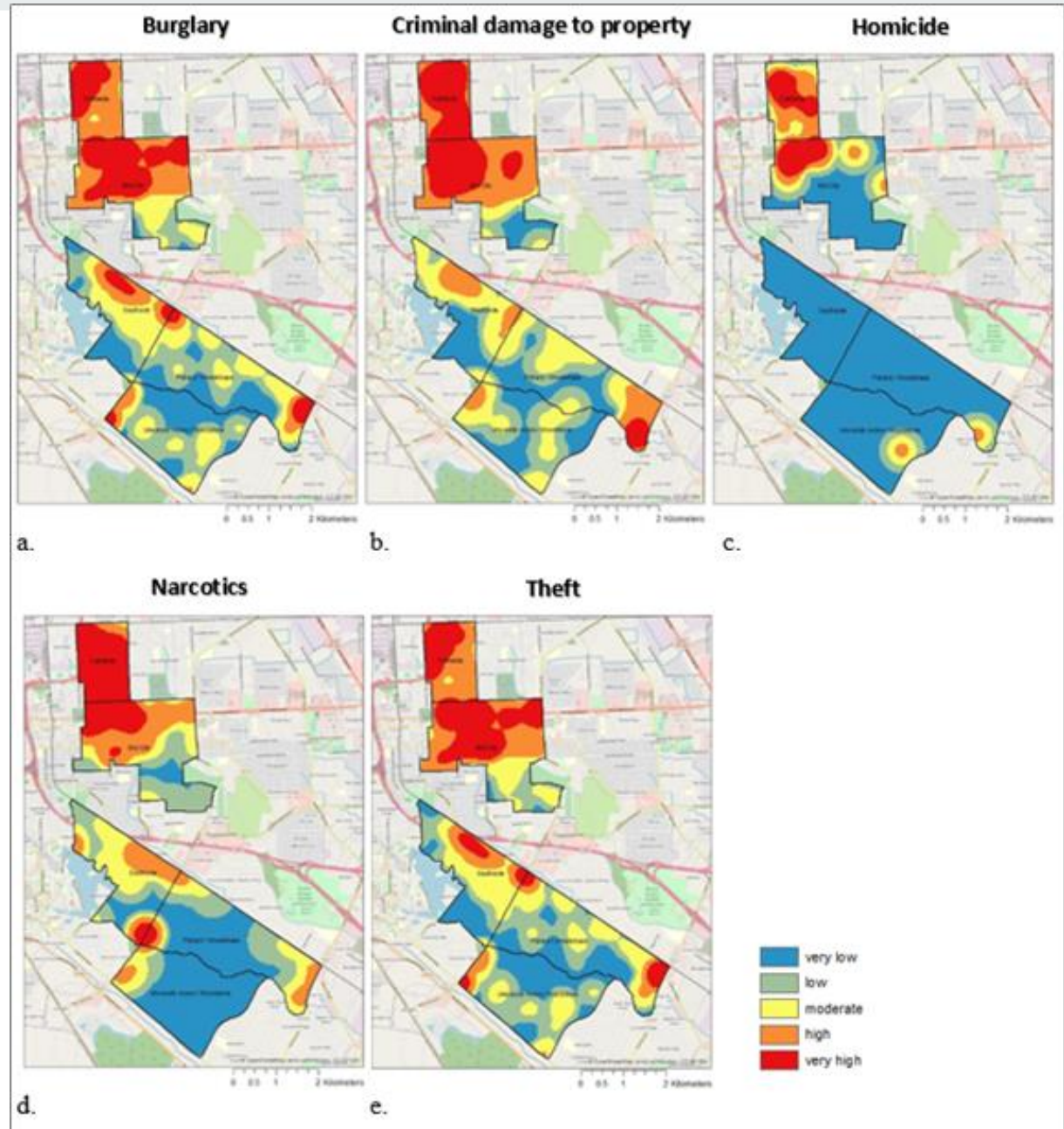
Density maps



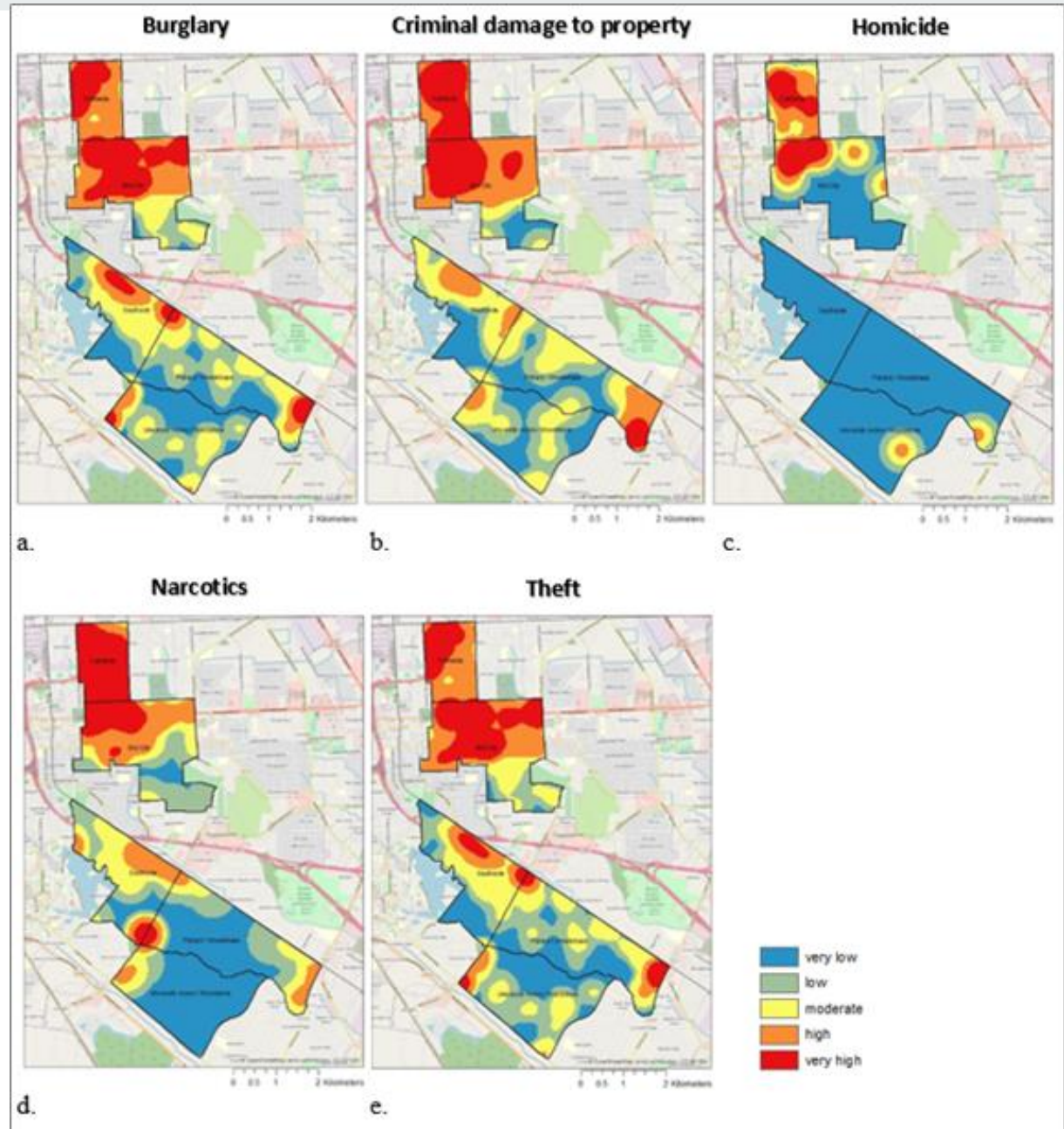
Density maps



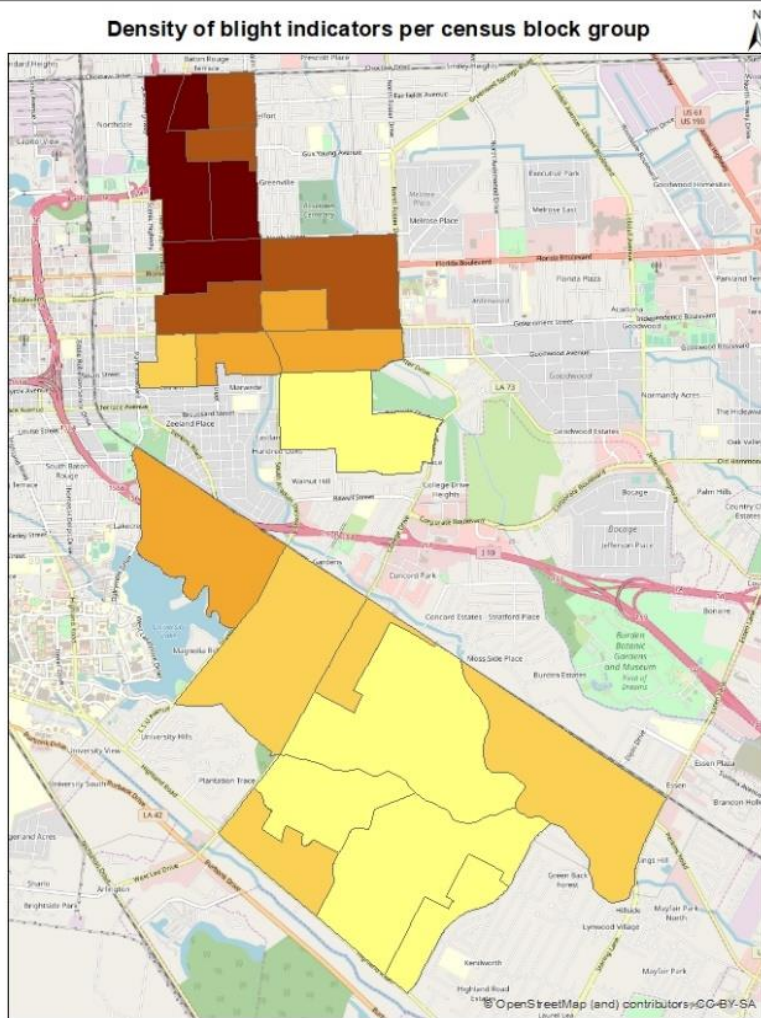
Density maps



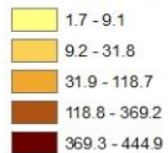
Density maps



Density of blight indicators per census block group

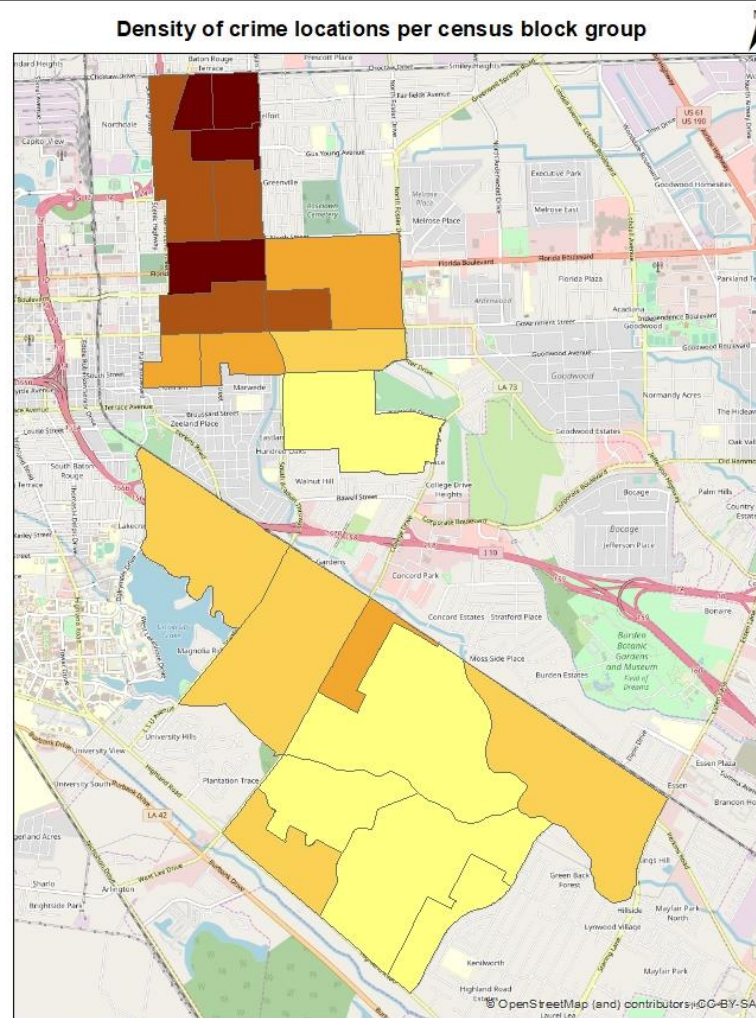


Density of blight indicators

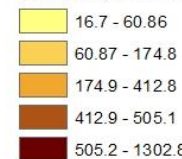
blight / area km²

0 0.5 1 2 Kilometers

Density of crime locations per census block group

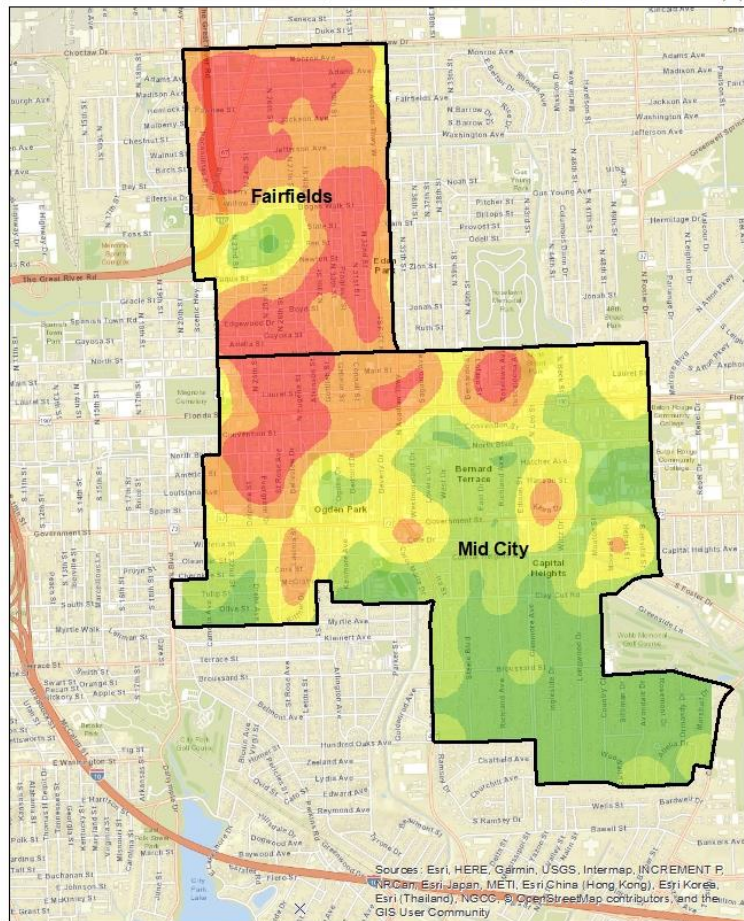


Crime density

crimes / area km²

0 0.5 1 2 Kilometers

Kernel density estimation urban blight



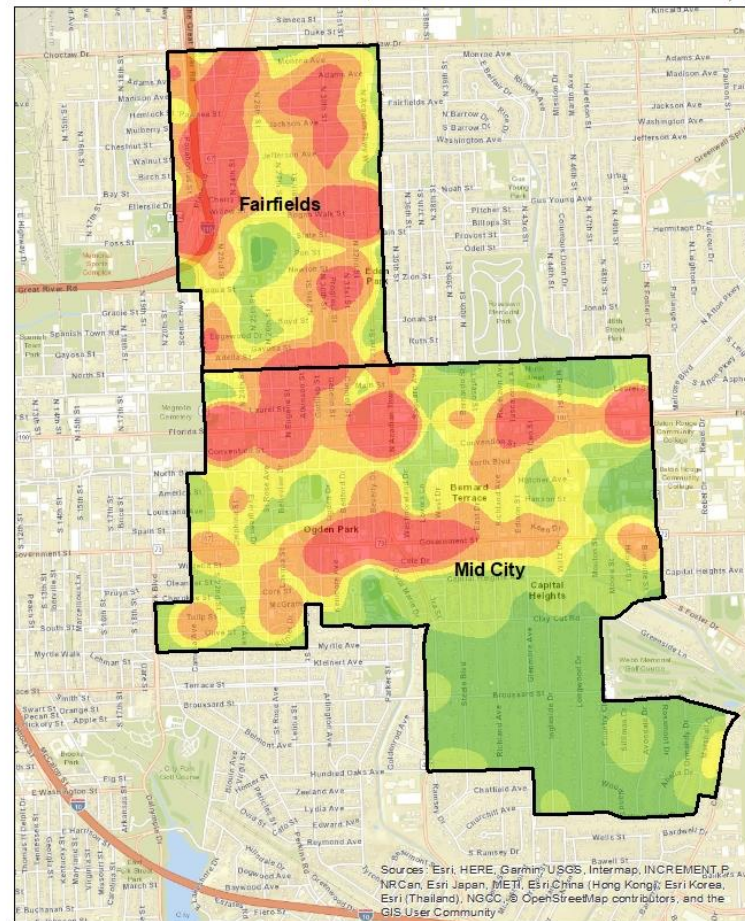
Urban blight indicators



0 0.5 1 Kilometers

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Kernel density estimation crime



Crime



0 0.5 1 Kilometers

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

Some insights

Overlay Blight and
Crime
Fairfields
Neighborhood



THE
ADVOCATE

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Researchers: Battling blight in Baton Rouge can play a key role in fighting crime

BY LEA SKENE | LSKENE@THEADVOCATE.COM FEB 23, 2019 - 5:44 PM



Two boarded up houses sit on N. 23rd Street just a stone's throw from B's Seafood & Deli, located at 1760 Plank Road at Jefferson Ave., seen Friday, Feb. 22, 2019. A study by LSU and the DA's office found homicides are more likely to occur in neighborhoods with a high concentration of blighted properties in close proximity to a convenience store. ADVOCATE STAFF PHOTO BY TRAVIS SPRADLING

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“Her grandson was shot and killed in a 2015 triple homicide outside the B's Seafood convenience store about a block from her house — the same place her nephew was gunned down less than two years later.”



LSU study shows link between blighted property and homicide in Baton Rouge



The Blight Strike Team demolishing an abandoned property in East Baton Rouge Parish

By [Danae Leake](#) | February 11, 2019 at 10:44 AM CST - Updated February 11 at 10:44 AM

BATON ROUGE, LA (WAFB) - A new LSU study shows a link between homicide, blighted property and convenience stores in Baton Rouge.



Latest LSU study ties Blight to Homicides

18th February 2019 · 0 Comments

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By **Fritz Esker**
Contributing Writer

A new study led by LSU Department of Sociology Assistant Professor Matthew Valasik showed a statistical connection between homicide and blighted buildings and convenience stores in Baton Rouge.

The study began as a group project in Valasik's crime mapping class. Stephen Martinez, Valasik's student and co-author of the study, was interested in searching for data on whether or not murders were clustered near certain types of buildings. The project looked at homicides in Baton Rouge occurring in 2016.

LSU Media Center

Contacts

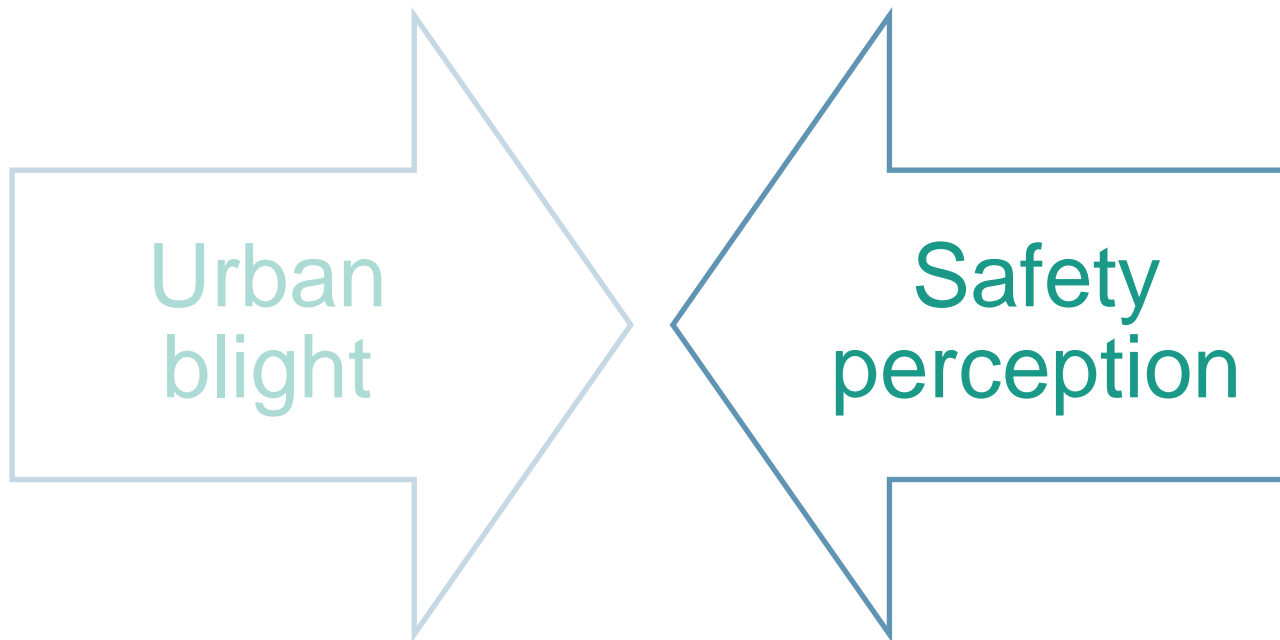
News Releases

New Study Linking Blight and Homicide May Help Predict Where Murder May Occur

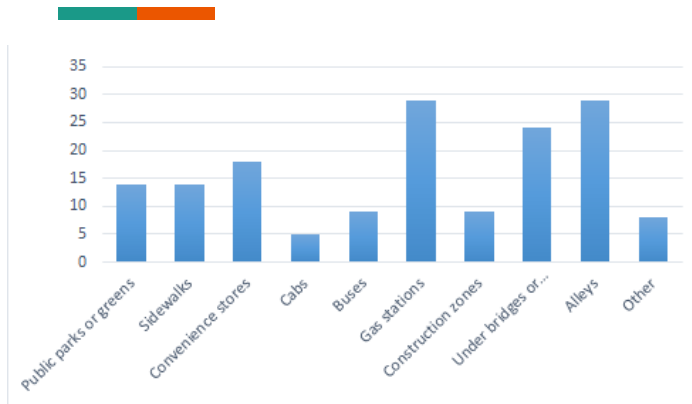
02/08/2019

BATON ROUGE – A new study led by LSU Department of Sociology Assistant Professor Matthew Valasik is the first to show a statistical connection between homicide, blighted buildings and convenience stores in Baton Rouge. Valasik, doctoral candidate in sociology Elizabeth Brault and his former student Stephen Martinez, who is now an investigator in the East Baton Rouge District Attorney's office looked at where homicides occurred in the city in 2016. They found that nearly 25 percent of homicides in Baton Rouge take place within the same areas that comprise about 3 percent of the city.

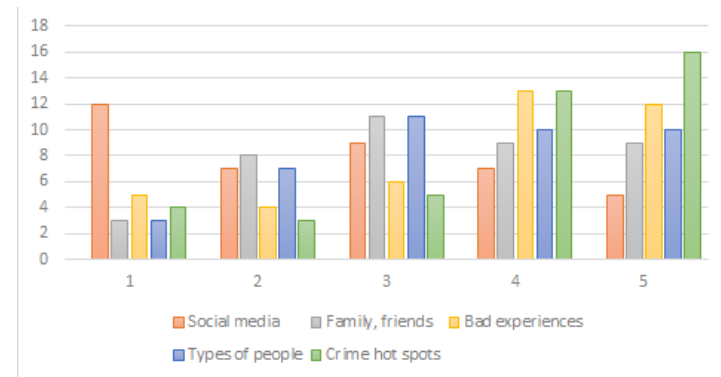
Results



Survey

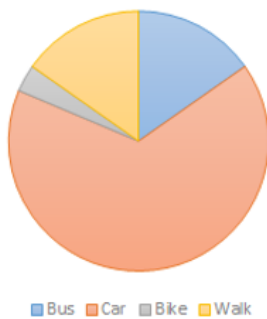


Places where test participants felt less safe

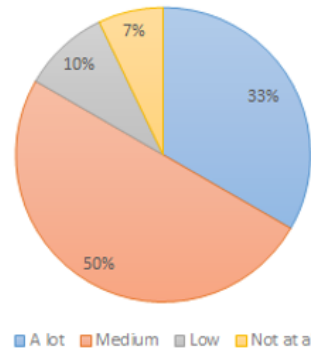


Categories influencing test participants' crime perception from 1 (not at all) to 5 (most)

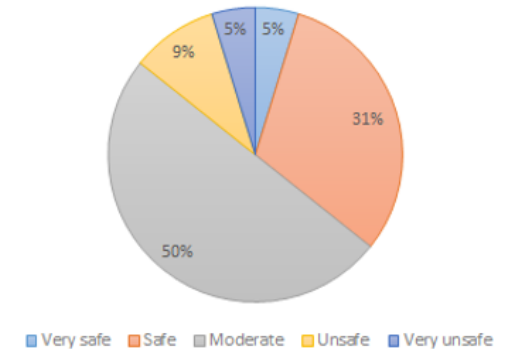
How do you generally travel within the city of Baton Rouge?



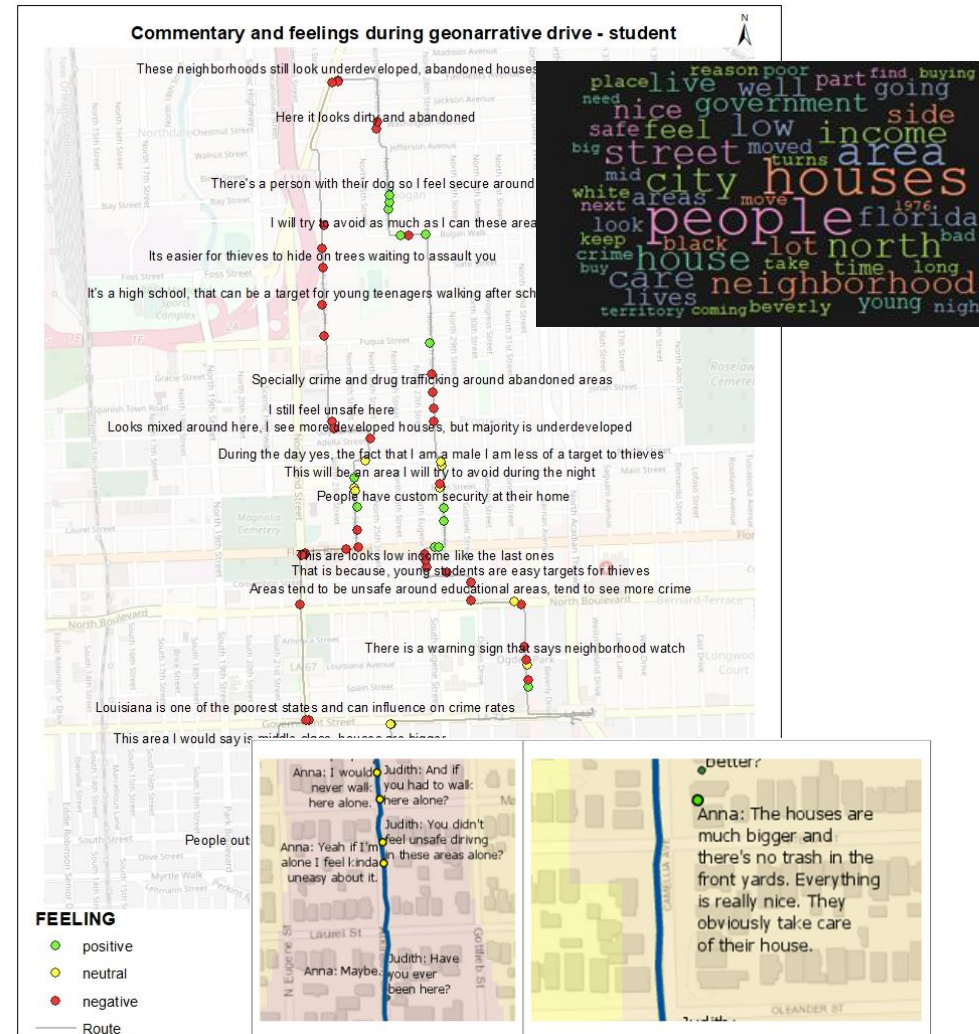
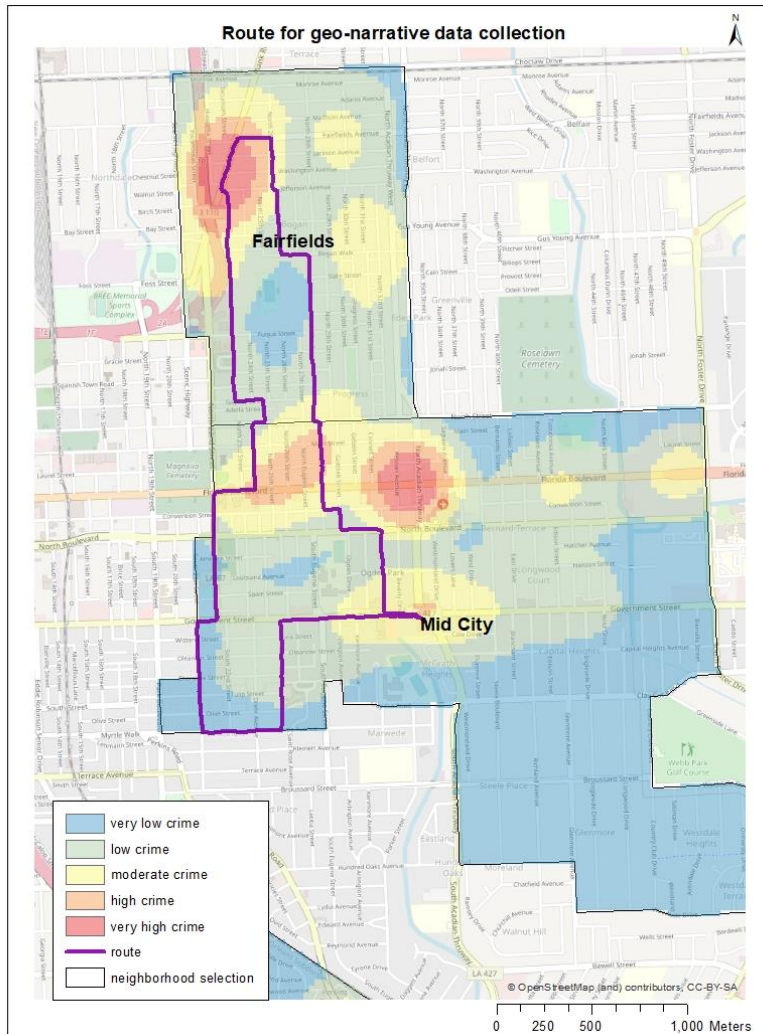
Urban blight influence in safety perception



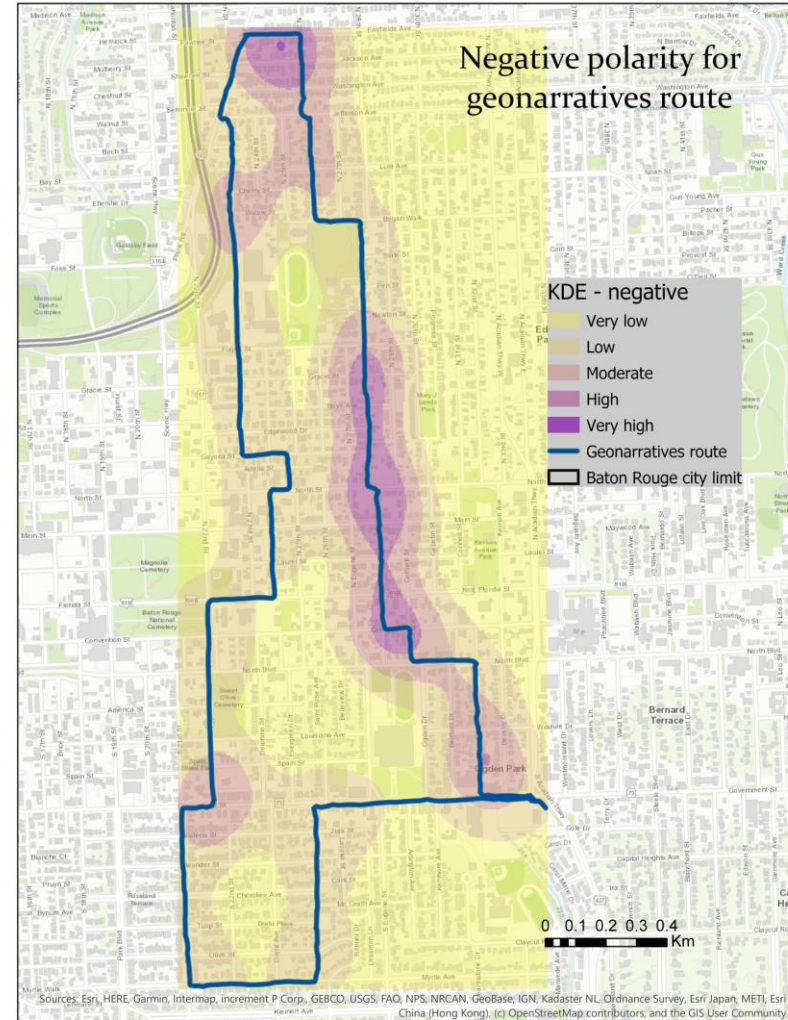
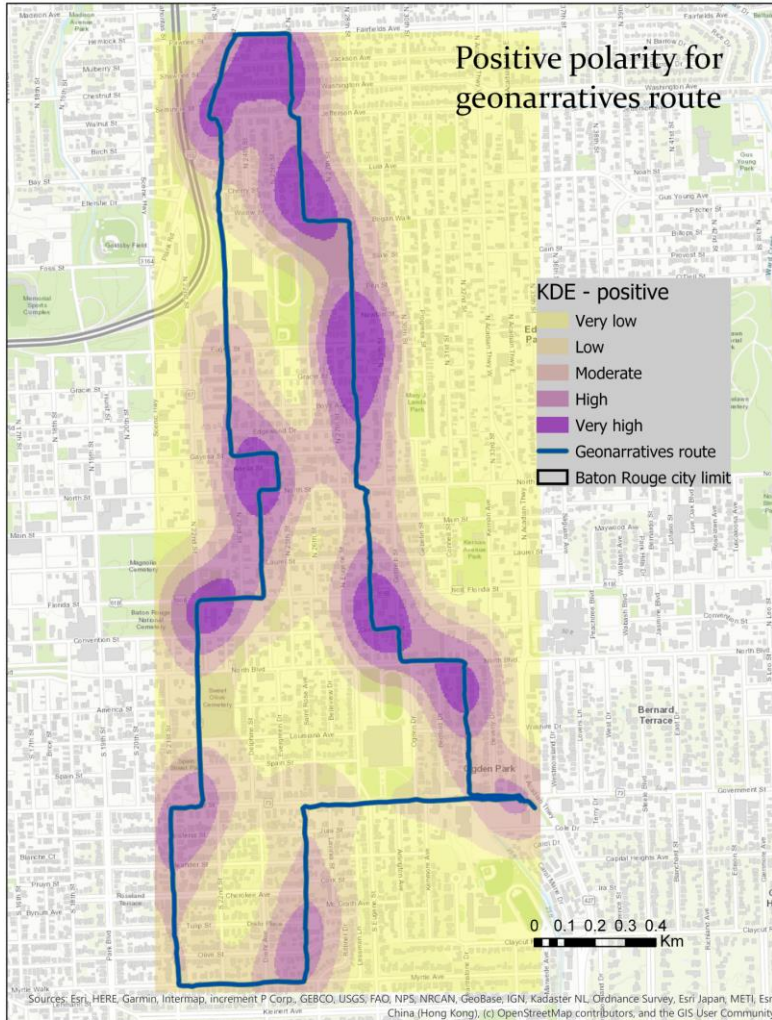
How safe do you feel in Baton Rouge?



Geonarratives route



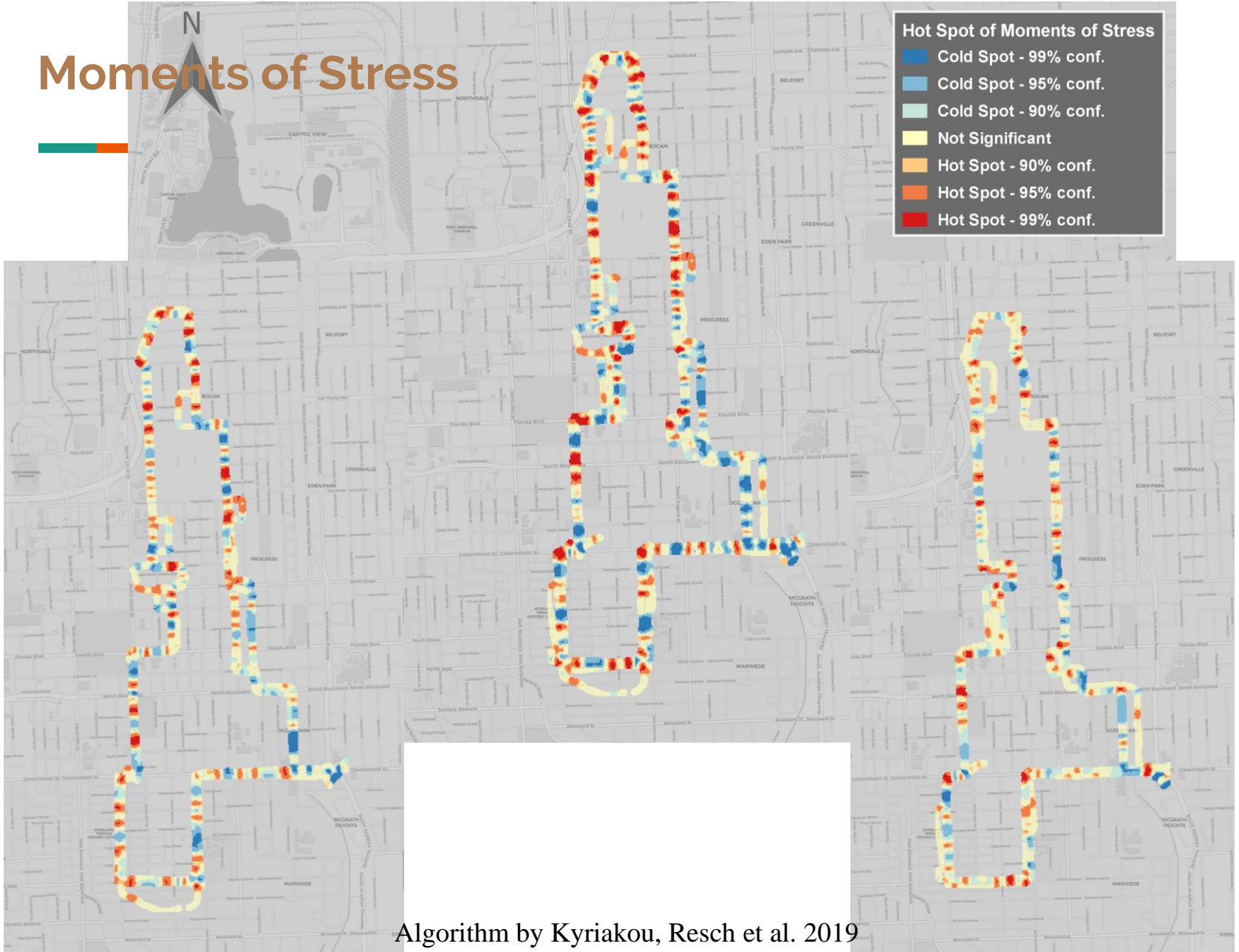
Sentiment analysis



Moments of Stress

Hot Spot of Moments of Stress

- Cold Spot - 99% conf.
- Cold Spot - 95% conf.
- Cold Spot - 90% conf.
- Not Significant
- Hot Spot - 90% conf.
- Hot Spot - 95% conf.
- Hot Spot - 99% conf.



Relevance



- New geospatial technology as a methodology to improve the identification of **crime-related variables** and to **explore urban safety**;
- Identify physical urban blight indicators on a **micro-scale**;
- Collect **contextual information** in a standardized way and in a format that can be archived, so that they can be used in long term and comparative studies;
- Security improvements and **enhancement of quality of life** in Baton Rouge.

Future work



- Machine learning algorithms for image recognition;
- Automation of transcripts;
- Integration of UAV's to record multiple facades of the property;
- Crime prediction models by including newly extracted information;
- Social media text analysis based on crime perception;

Let's imagine



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