

Lab1 – Crime HotSpot Description

Lab1 – Crime HotSpot Description

Vairon Mendoza

CS411W

Professor Thomas Kennedy

15 February 2019

Version Number: 1.1

Table Of Contents

1. Introduction	3
1.1. Hearsay vs fact-based knowledge concerning crime	3
1.2. Background of the current problem	3
1.3. Characteristics of an ideal solution	5
2. Product Description	6
2.1. Key Product Features	7
2.1.1. Crime Statistics	7
2.1.2. Geographical Crime References	7
2.1.3. Crime Heatmap	7
2.1.4. SafetyScore	8
2.2. Major Components	8
2.2.1. Crime HotSpot Website	9
2.2.2. Google Maps API	9
2.2.3. Crimes Database	9
2.2.4. Application Server	9
3. Identification of Case Study	9
4. Product Prototype Description	10
4.1. Prototype Architecture	10
4.1.1. Crimes Database	10
4.1.2. Web Page	10
4.1.3. Application Server	10
4.1.4. Google Maps API	11
4.2. Prototype Features and Capabilities	11
4.2.1. Crime Categories	11
4.2.2. Location	11
4.2.3. Database	11
4.2.4. Crime Heatmap	11
4.3. Prototype Development Challenges	11
4.3.1. JavaScript MEAN Stack	11
4.3.2. Cross-browser Compatibility	12
5. Glossary	13
6. References	14

Table Of Figures

Figure 1 Theft of political campaign signs is a minor offense.....	3
Figure 2 Cluttered view of current applications.....	4
Figure 3 Current Process Flow.....	5
Figure 4 Solution Process Flow	6
Figure 5: Example of a heatmap	7
Figure 6 Major Functional Components	8

1. Introduction

Crime is something no one wants to experience but might unfortunately be affected by during their lifetime. Maybe you are visiting an unknown area, just moved to a new location, or are opening a business in an area unfamiliar to you.

The FBI estimated that for 2017, 7.7 million property crimes and 1.2 million violent crimes occurred in the United States (FBI: UCR, 2017). In 2016, U.S. residents age 12 or older experienced 5.7 million violent victimizations, or 21.1 victimizations per 1,000 persons (Bureau of Justice Statistics, 2017).

Having no knowledge of how dangerous or safe an area is, the user dreads sifting through a lengthy internet search about the crime rates for the area and wonders if there might be a simple and efficient solution. A solution that does not require looking at news articles on the internet for long periods of time. It turns out that crime mapping addresses this particular issue. Crime mapping is a discipline which attempts to reveal crime patterns by analyzing an area and its surroundings.

1.1. Hearsay vs fact-based knowledge concerning crime

Currently, many people know to avoid crime-ridden areas by listening to their social circles, the news, or past experiences. The problem in making the decision to enter or avoid an area from these sources is that they tend to be anecdotal evidence which might be inaccurate. Perhaps a gruesome crime took place in an area, but it was a rare instance; Anecdotal retellings may convey the false notion that an area is dangerous based on a small number of outlier crimes.

1.2. Background of the current problem

Shoplifting, fraud, and similar incidents are not necessarily violent crimes or crimes which will affect the public. Political campaign signs are an example of this scenario, as they may be overrepresented as a crime during elections, but rarely affect the general public's safety.



Figure 1 Theft of political campaign signs is a minor offense

On the other hand, armed robbery, driving under the influence, and car theft are all crimes that can severely impact the general public. Not only do these crimes differ by how violent they are, but their low rate of occurrence may not be a major concern to most users.

Current applications do not take these details into account, which leads to a cluttered interface where data is difficult to digest. The following image is an example of the cluttered map interface current applications display to their users.

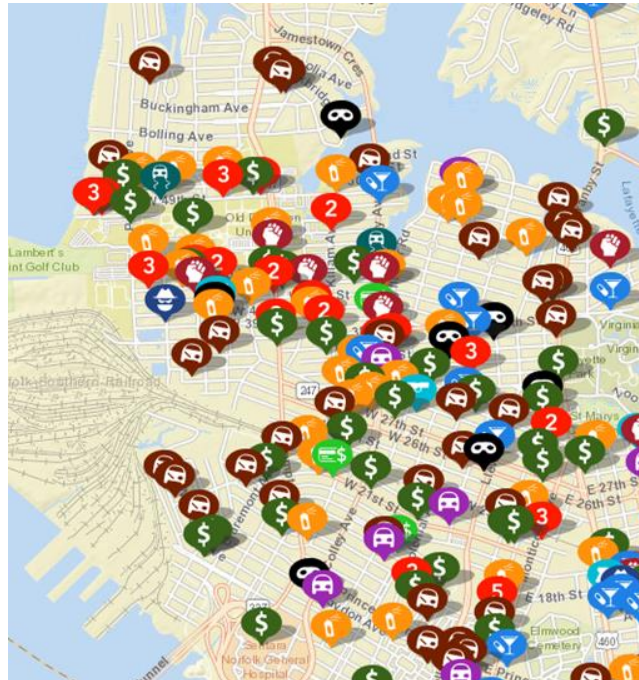


Figure 2 Cluttered view of current applications

In these applications the user may not be able differentiate one crime from another due to the amount of icons displayed in an area. The crimes may be nonviolent crimes that occur frequently, such as credit card fraud, but the density of icons on the screen could lead to the false perception that an area is unsafe. These applications may leave the user overwhelmed, frustrated, and confused leading them to risk entering an area that is potentially dangerous. The current process flow that users follow in existing crime mapping applications is outlined by the following diagram:

[this space intentionally left blank]

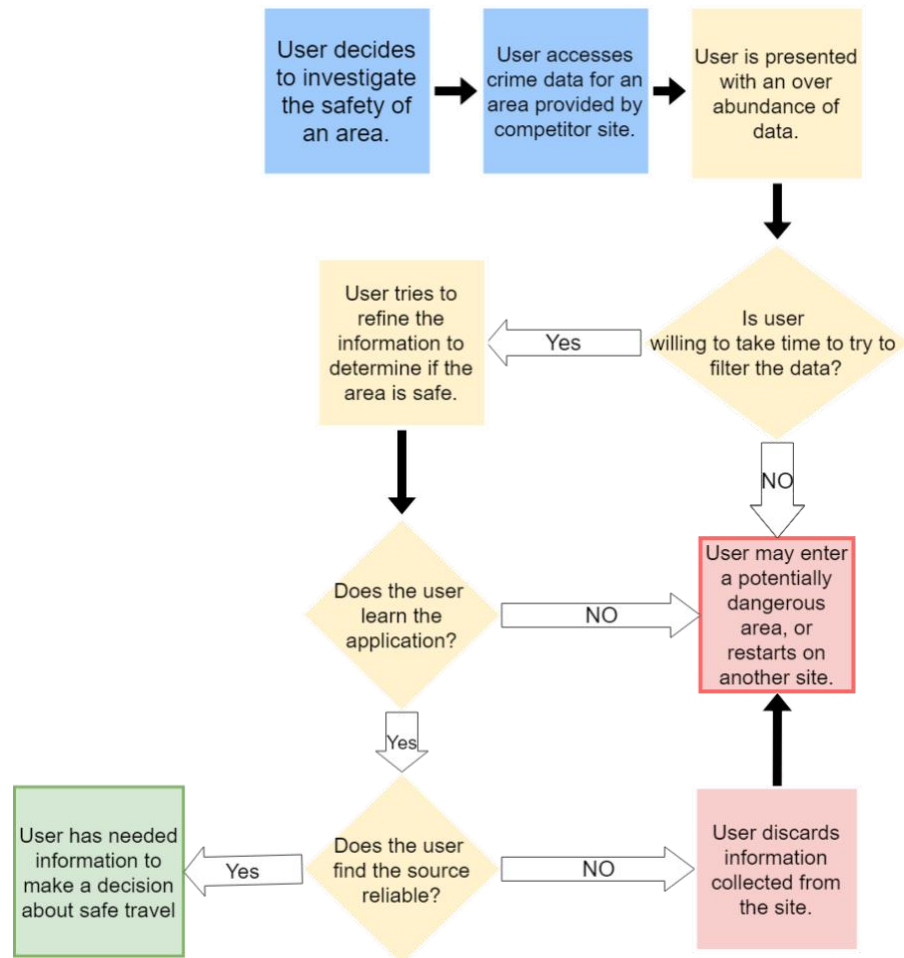


Figure 3 Current Process Flow

1.3. Characteristics of an ideal solution

After learning that most available crime mapping applications use a similar interface, Team Silver decided to devise a solution application named Crime HotSpot.

Crime HotSpot is a web application geared towards helping its users learn about the safety of an area through simple visual representation, free from the clutter that plagues current applications, while also allowing the user to conduct searches tailored to their needs.

[this space intentionally left blank]

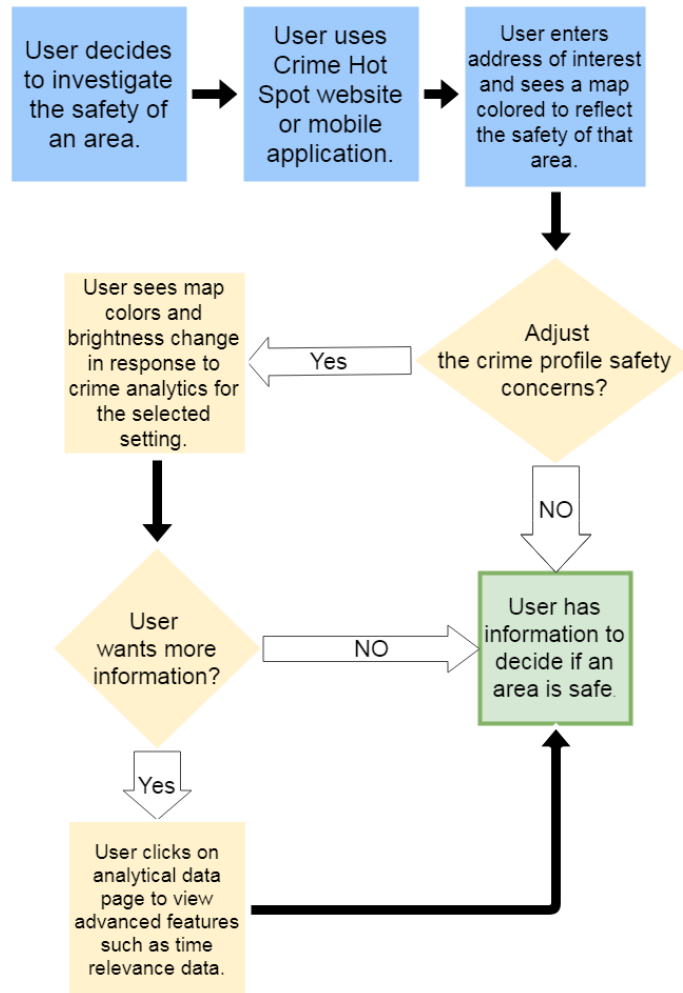


Figure 4 Solution Process Flow

We understand a one size fits all solution is impossible to achieve for crime mapping applications. Different users are concerned about different crimes depending on their situation. A homeowner is primarily interested in crimes against property, on the other hand a dealership would be more concerned about an area with high rates of car theft. To address this issue, Crime HotSpot allows each user to place a higher weight on the crimes that concern them the most.

The application will use a heatmap in lieu of icons, as it makes the data much easier to understand and digest among several other reasons discussed in later sections. Should the user be more interested in learning how the crimes surrounding an area affect it, an analytics page with statistic information will be generated on demand. These solutions lead to an updated process flow which is outlined in Figure 4 above.

2. Product Description

Should a person have the option of avoiding a crime ridden area, they would most certainly do so. To make this option a reality, Crime HotSpot will provide its users a map view with a heatmap laid on top, which allows the user to see the severity of crimes across multiple areas. A value dubbed SafetyScore will be displayed when the user clicks on an area to convey

how safe that area is. Crime statistics will also be available, however, these will not be displayed by default to avoid intimidating users who solely seek to learn about the safety of an area.

2.1. Key Product Features

2.1.1. Crime Statistics

The statistics in crime mapping applications should help to clarify information on the map, rather than become a nuisance to the user. The Crime HotSpot website will only display statistic information when the user hovers and clicks on a specific area. If the user would like to receive more detailed information of the crime statistics affecting a specific area, an analytics page may be generated on demand.

2.1.2. Geographical Crime References

When crimes are being presented to the user they are visualized through the use of a heatmap. As discussed in the previous section, clicking on a specific area will display crime statistics for the crimes influencing the SafetyScore for said area. However, Crime Hotspot will only provide a general location for the crimes being displayed to its users, rather than exact coordinate points. The decision to provide a general location is a deliberate one due to privacy concerns.

2.1.3. Crime Heatmap

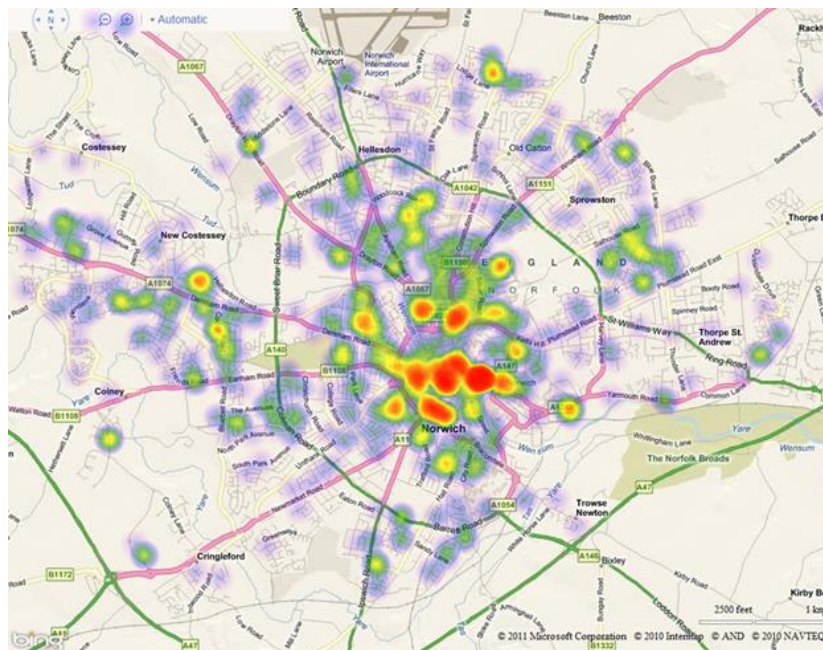


Figure 5: Example of a heatmap

Heatmaps are a form of data representation which use colors to display a particular dataset, allowing for the quick digestion of information (Search Business Analytics, 2011). The image above, which is of a heatmap with test data, quickly conveys the fact that red areas have a higher concentration of crime relative to blue areas, therefore making red areas more dangerous

and to be avoided. The heatmap is arguably the most important feature in Crime HotSpot as it quickly conveys the needed information to the user without filling the map with unneeded icons or information.

2.1.4. SafetyScore

In certain cases, a user might want to quickly learn about the safety of an area of interest. For this purpose, Crime HotSpot provides a SafetyScore; The SafetyScore takes several variables into account such as how long ago the crime was committed, the population density of an area, the time of day, the severity of the crime and then weighs all of these factors accordingly to provide a scaled value expressing how safe an area is to explore. However, upon adjusting the weight for different types of crimes that concern the user, the SafetyScore will be recalculated to provide a more accurate representation about the safety of an area relative to the crimes of interest.

2.2. Major Components

Crime HotSpot will be composed of four main components as displayed on the diagram below, which are the Website, the Google Maps Application Programming Interface (API) API, the MongoDB Atlas Database, and the Application Server. A terminal service will also be used to modify the database and application server as needed. A mobile companion application, designed to help users on the go, is also expected to be implemented for the official release of the product.

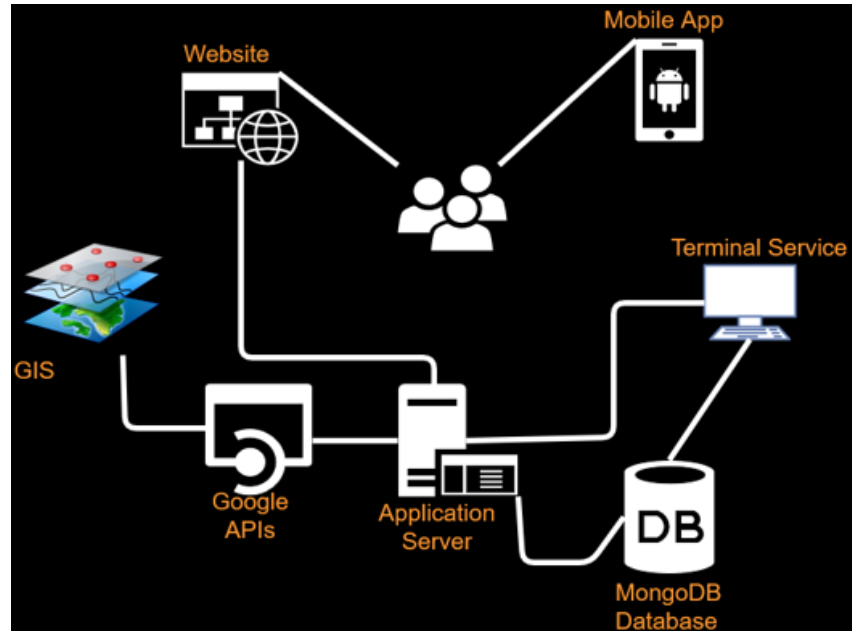


Figure 6 Major Functional Components

2.2.1. Crime HotSpot Website

The website will be the entry point to our application, it will be simple to use and easily accessible to users on a wide range web browsers. A user should be able to enter the Crime HotSpot website link in their browser, type the address of the location they are interested in learning more about, see the heatmap, SafetyScore and use these pieces of insight to evaluate whether they should avoid the area or can safely explore it.

2.2.2. Google Maps API

The location entered by the user is passed to the Google Maps API to request a map view of the area. This same API will also be used to plot the points with their appropriate weight on the heatmap. Delegating the geographic intensive tasks and functions to the API takes a huge burden off the team's shoulder as it is an additional degree expertise that would otherwise have to be managed.

2.2.3. Crimes Database

The database contains information about the crimes, their location, time of occurrence, date and it will be created and managed using MongoDB Atlas. MongoDB Atlas will make the process to store and retrieve crimes from the database simple as it provides a lot of the functionality to interact with the database.

2.2.4. Application Server

Our application server will handle the requests to view crimes in a specific area from the website and extracts crime data points from the database, as needed. It then delivers these crime data points to the frontend of the website to calculate the SafetyScore and generate a heatmap using the Google Maps API.

3. Identification of Case Study

Crime HotSpot is being developed for the general public, businesses, government offices, and non-profit organizations. As mentioned in the introduction, we would like to provide everyone with the ability to quickly look up an area of concern due to the lack of crime knowledge, or misinformation, and discern how safe or dangerous it is.

The general public is the main focus group of the Crime HotSpot application. The website should allow the user to enter the website link, provide the address of a location, and upon being shown the heatmap and SafetyScore the user should be able to make an informed decision about visiting or avoiding the area.

Businesses and government offices are another group that will greatly benefit from the Crime HotSpot application. These groups will be using the more refined and complex analytical features of our tool. Considering these users have a greater degree of expertise, they can modify crimes according to their goals and use the analytical page generated to analyze an area more in-depth.

4. Product Prototype Description

The Crime HotSpot prototype will be implementing the website which will display the map, heatmap, and crime statistics page. The Google Maps API will be providing the map view and heatmap layer. MongoDB Atlas handles the database which will consist of a fixed set of handpicked records. The application server itself will handle obtaining the data from the backend and supplying it to the frontend of the application. The mobile application will not be developed for the prototype.

4.1. Prototype Architecture

Team Silver has decided to use the MEAN stack as it is a well-documented framework for web development. Since MEAN is a very well-known and supported framework in the web development community it should lead to less time investment when it comes to development, testing, and troubleshooting the application.

4.1.1. Crimes Database

MongoDB Atlas is a cloud database solution we have decided to use for the implementation of this application. As it is fully-managed by the MongoDB team and provides a graphical user interface, it will be simple to use and allow us to scale the database past the prototype. MongoDB Atlas is prepackaged with some neat functions that make it work well with the geographical data of this application, thus it allows the team to focus on other areas of the project rather than having to dedicate a great amount of time and effort to make queries to the database.

4.1.2. Web Page

The frontend of Crime HotSpot will make use of the AngularJS framework. AngularJS will allow Team Silver to build the client-side application using plain JavaScript and it will also make the code modular and reusable through the use of modules. Modules will allow the team to only import the necessary functionality to develop the website. For the frontend the model-view-controller pattern will be used as AngularJS highly encourages it. Using this pattern our visual elements, which mainly consist of HTML and CSS code will be the views. The model will consist of the data stored in MongoDB Atlas. The controller will allow the interaction between the view and the model through the use of AngularJS.

4.1.3. Application Server

Our application server will be hosted on the ODU servers. The server itself will be running using the Linux Ubuntu operating system with Node.js and its supporting framework Express.js handling requests and responses from and to the website. As users customize which crime statistics are relevant to them, requests will be sent to the server which will then return an updated set of data points which are then handed over to the Google Maps API for generating an updated view of the map.

[this space intentionally left blank]

4.1.4. Google Maps API

When the user zooms in and out and pans around the map, AngularJS request an updated view of the map from the Google Maps API. At this point the API simply takes the new centered location, scale of the map, and weighted points calculated to provide the user with an update view.

4.2. Prototype Features and Capabilities

4.2.1. Crime Categories

The crimes will be split into several categories, these being severe crimes against the person, crimes against the person, crimes against property, crimes against the public, and uncategorized. These categories will facilitate the SafetyScore calculations and decrease the number of categories the application would have to sort through.

4.2.2. Location

The users will be able to use the HTML5 Geolocation request feature to allow the Crime HotSpot application to obtain the approximate coordinate points of their location. For the prototype of the Crime HotSpot application the data will be limited in scope to the Norfolk area around the ODU campus.

4.2.3. Database

The database for the prototype will not be receiving updated data overtime, as this will allow the team to solely focus on more demanding and complex features, such as improving performance when concurrent users are present and search result accuracy.

4.2.4. Crime Heatmap

For the prototype, the heatmap generated will be based on data that has been curated. This will allow us to make heatmaps that are limited in geospatial scope which eliminates performance related issues that could arise from requesting large amounts of datasets by various concurrent users.

4.3. Prototype Development Challenges

4.3.1. JavaScript MEAN Stack

Most members of the team have solely focused on non-web development languages throughout their academic career. Since the MEAN stack framework being used for the application is largely unknown to Team Silver, the team will have to learn a large amount of unknown material in a short amount of time and implement it in a complex project, which can often lead to hideous and unmaintainable code. To avoid this issue, finding the strengths and weaknesses of each member as well as mentoring team members who have trouble with certain topics will be a key factor.

4.3.2. Cross-browser Compatibility

Different browsers may display content such as text size, fonts, and scrollbars differently. Each browser also has multiple versions enforcing different standards depending on the version. Ensuring features are compatible across different browsers and versions of these browsers often results in additional work which increases the potential to introduce bugs in the program. To limit the amount of mistakes and additional overhead required for cross-browser compatibility, we plan on limiting browser flavors and versions.

[this space intentionally left blank]

5. Glossary

1. Application Programming Interface (API) - a set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service.
2. Crime Map - A map that has crime statistical data overlaid on it to provided information on the criminal activity of an area.
3. Heatmap - a representation of data in the form of a map or diagram in which data values are represented as colors.
4. JavaScript MEAN Stack - MEAN is a free and open-source JavaScript software stack for building dynamic web sites and web applications. The MEAN stack is MongoDB, Express.js, AngularJS (or Angular), and Node.js.
5. JavaScript Object Notation (JSON) - a lightweight data-interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language
6. SafetyScore - A number, proprietary to Crime HotSpot, that represents the relative safety of an area.

6. References

- Bureau of Justice Statistics. (2017, December). *Criminal Victimization*. Retrieved October 5, 2018 from Bureau of Justice Statistics:
https://www.bjs.gov/content/pub/pdf/cv16_sum.pdf
- Business Insider. (n.d.). *Tourist*. Retrieved October 5, 2018 from Business Insider:
amp.businessinsider.com/images/5abbaa40a54f322b2d8b4597-750-563.jpg
- Crime HotSpot. (2018, December 15). *Presentations*. From Crime HotSpot:
<https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation>
- FBI: UCR. (2017). *Offenses Known to Law Enforcement*. From FBI's Uniform Crime Reporting (UCR) : <https://ucr.fbi.gov/crime-in-the-u.s/2017/crime-in-the-u.s.-2017/topic-pages/offenses-known-to-law-enforcement>
- Lexis Nexis. (2018, December 18). *Lexis Nexis Community Crime Map*. From Lexis Nexis:
<https://communitycrimemap.com/>
- Microsoft Corporation. (2011, 2). *Heat Map*. Retrieved October 5, 2018 from
alastaira.files.wordpress.com/2011/02/image24.png
- Minnesota Brown. (2018, July 28). *Campaign Signs*. Retrieved October 5, 2018 from
minnesotabrown.com/wp-content/uploads/2018/07/campaign-signs.png
- Search Business Analytics. (2011, July). *What is a Heat Map (Heatmap)*. Retrieved September 5, 2018 from SearchBusinessAnalytics:
searchbusinessanalytics.techtarget.com/definition/heat-map
- Wikipedia. (n.d.). *Crime Mapping*. Retrieved October 5, 2018 from Wikipedia:
https://en.wikipedia.org/wiki/Crime_mapping