Lab1: Descriptive Paper of ODU Spring 2019 CS411 Team Silver Project

Crime HotSpot

CS411W Spring 2019 Team Silver
Professor: Thomas Kennedy
Author: Thom Loftin
Submission Date: 3/7/2019
Version Number: 2.0

Table of Contents

Table of Tables

Table of Figures

****

This area is intentionally left blank.

****

1. Introduction

According to the FBI (2017), approximately 1 in 50 individuals will be a victim of violent crime in any given year. Due to factors such as an increase in population, particularly in metropolitan areas, the number of crimes committed on a daily basis remains a clear and present danger to the public at large. Because of this fact, individuals concerned with personal safety seek out tools that will provide them with the needed information to remain safe. There are many tools on the market today, but while these tools provide needed information that could be used to help keep an individual safe, most provide such an overwhelming onslaught of information, as shown in Figure 1, that the information provided becomes meaningless. To address the shortfalls identified in solutions currently available, as shown in Table 1, ODU CS411 Spring 2019 Team Silver offers a new solution aptly named Crime HotSpot.

Figure 1 Screen shot of crimes for the city of Norfolk, Virginia. Reprinted from Helping You Build a Safer Community in CrimeMapping.com., 2018, Retrieved from CrimeMapping.com

****

This area is intentionally left blank.

****

Characteristics / Programs	Crime Hot Spot	LexisNexis Community Crime Map	SpotCrime	CrimeMapping	AreaVibes	Trulia
Generalized crime data	✓	✓			✓	✓
Crime types differentiated	✓	✓	✓	✓		
Filter options: date, crime type	✓	✓		✓		
Weighted to user relevance (SafetyScore ™ Heat Map)	✓					
Supplemental analytics	✓	✓	✓	✓	✓	
Companion app	✓					
Distributes data evenly across area of concern	✓					
Cluttered icon graph presentation		✓	✓	✓	✓	✓

Table 1 Competition Matrix Crime HotSpot. (2018, December 15). Presentations. From Crime HotSpot: https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

****

This area is intentionally left blank.

****

One of the most noticeable items that Crime HotSpot has improved over current solutions is the reduction of visual clutter. Most tools available today operate on an icon-based topography, shown in Figure 1,which is avoided in the development of the Crime Hotspot solution. The idea behind an icon-based crime map is that each crime represents a point on a map. Each of these points will then be categorized according to the type of offense committed. Due to a large number of crimes in a given metropolitan area the icons tend to drown out the underlying map to the point that most cities soon appear to be havens of crime best left alone. With the Crime HotSpot solution, the map will not pinpoint individual crime but instead show an aggregate heatmap similar to Figure 2 that will represent the calculated danger of an area according to the types of crimes committed. This use of heatmaps, according to the NIJ (n.d.), better communicates vital information.

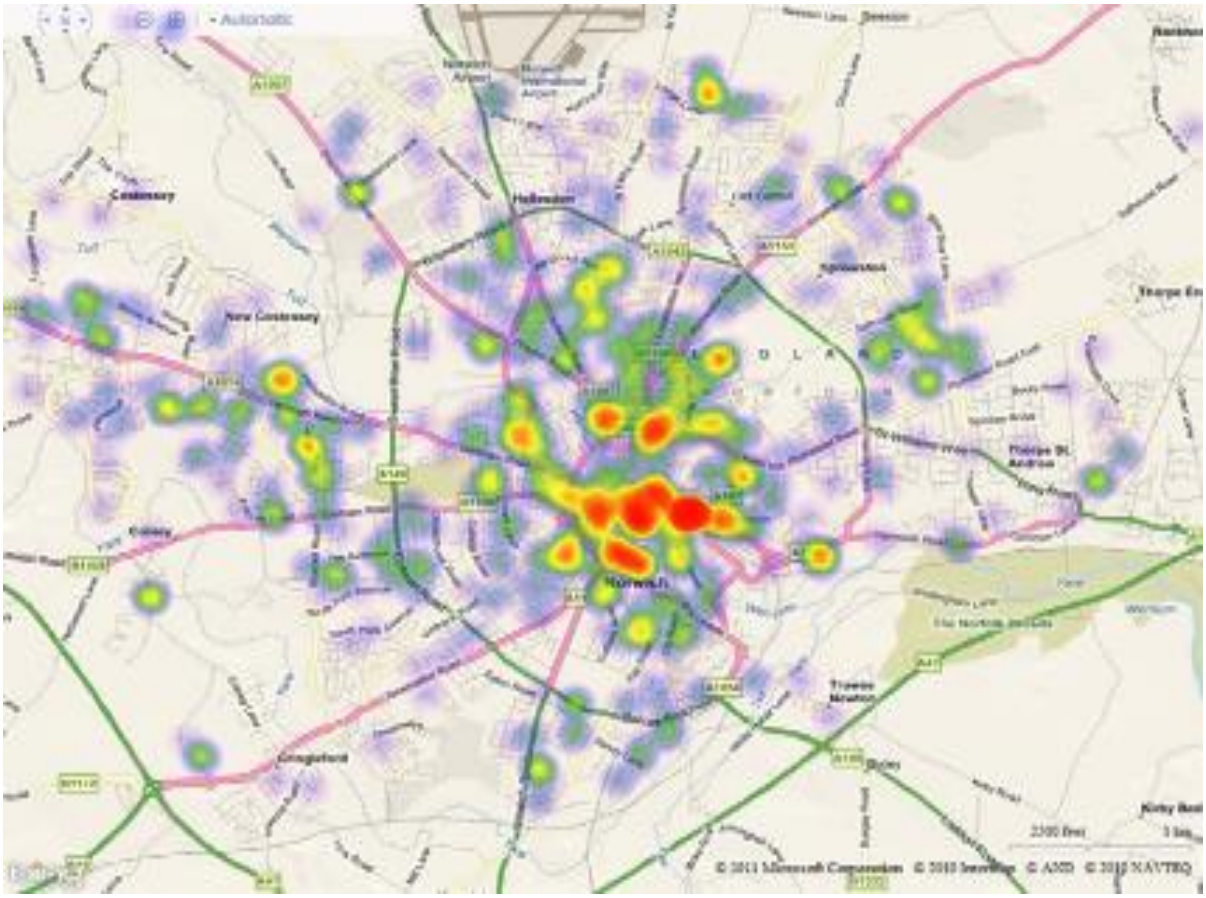

Figure 2 Example of a heatmap, with the red areas depicting a hotspot which where there is higher density of crimes. Reprinted from "Heat Map" by Microsoft, 2011, Retrieved from alastaira.files.wordpress.com/2011/02/image24.png.

****

This area is intentionally left blank.

****

Not all crimes are created equal. Some crimes are more violent and pose a greater threat to the community than others. That is not to say that there are good crimes and bad crimes, only that some crimes have little to do with the safety concerns of an individual. While all of the available tools categorize crimes by types, the differentiation is a change of icons that are layered one atop another leading to confusion and exasperation. The Crime HotSpot solution will weight a crime by type with more violent crimes leading to a heavier preset which is then aged and placed on the map as the center of an area of influence. As more crimes overlap in the areas of influence, the area becomes hotter indicating that an area is less safe and yielding a lower SafetyScore. With functions such as hover statistics, the user will still be able to identify the prevalent crimes in an area while in a glance be capable of identifying areas that may not be safe enough to meet the user's personal preferences.

Crime HotSpot provides a much-needed improvement to the current offering of tools. By using a heatmap as opposed to the icon-based maps, the information is more easily for absorbed. By weighing crimes according to safety, erroneous assumptions such as deeming a shopping mall unsafe due to a large number of shoplifting events or deciding a neighborhood dangerous because of a high level of political vandalism as shown in figure 3 are prevented. With the use of Crime HotSpot individuals will not only have but also be able to understand the information needed to make effective and informed decisions about the safety of a geographical area.

Figure 3"Campaign Signs." Minnesota Brown, minnesotabrown.com/wp-content/uploads/2018/07/campaign-signs.png.

2. Product Description

Crime HotSpot will provide the information needed to make effective and informed decisions about the safety of an area as it relates to an individual's safety concerns. The basis of the informational display will be a heatmap overlay of the Google Maps platform that will represent by color the calculated danger of an area. As the weighting algorithm calculates the danger of an area, the information will be inserted into the overlay with safer areas represented as cooler colors and more dangerous areas as hotter. This website will work on major web browsers. In final production, the website will have a companion mobile app that will alert a user as an area of increased danger is entered or exited.

2.1. Key Product Features

Crime HotSpot will be a web application built to run on all major web browsers. It will be developed according to the Major Functional Component Diagram shown in Figure 4.

The user interface will be comprised of a set of web pages and a mobile application. The web pages will provide a heatmap representation of the crime in a given area as well as provided advanced analytics, and a means for contributors to send crime updates. The mobile application will provide added security to the user on the go by monitoring the user's location and issuing alerts as dangerous areas are entered and exited.

The database will store the crime statistics that will be used by the application server to calculate and plot the Safety Score of an area on a geographical map using the Google Maps API as a GIS.

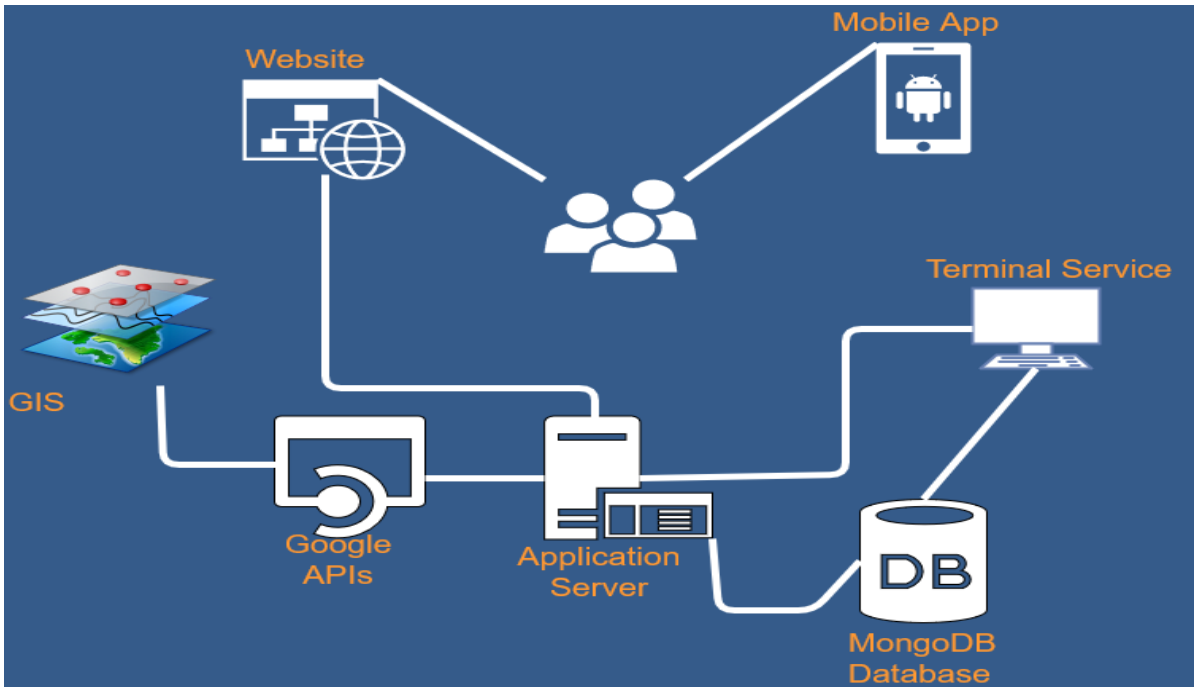

Figure 4 MFCD Crime HotSpot. (2018, December 15). Presentations. From Crime HotSpot: https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

2.1.1. Crime Statistics

The fundamental aspect of any crime mapping tool is crime statistics. These statistics contain such information as the location, date and time, and type of crime committed. These are essential details for plotting valid crime data over a geographical area.

2.1.2. Geographical Crime References

The basic premise of crime mapping is to plot crime data over a geological area display. Most tools do this by placing icons for each crime on a map which leads to a cluttered view with crimes one atop another which can lead to misinformation. Crime HotSpot will provide statistical data as a hover function informing the user of what crimes contribute to the crime level indicated on a heatmap overlay that plots the location of the crime with a related area of influence.

2.1.3. Crime Heatmap

A heatmap is an overlay of data represented by a range of colors. As more data and/or data with heavier weight will be plotted to an area, the intensity of the heatmap moves from a cooler spectrum to one of a higher heat level. Crime Hotspot, unlike any other tool currently available, will assign each crime a weight that will reflect the violence of a crime. This weight, while initially preset, will be adjustable by the user to reflect the individual's feelings as to how different types of crime will affect the safety of an area. The weight will then be reduced as the time elapses from the instance of the crime. This aging will cause crimes to age out eventually. Each of the recorded crimes will affect an area of a given radius from the offense. As more crimes happen near one another, the overlapping regions of the crime influence areas will aggregate scores causing a higher level of heat.

2.1.4. SafetyScore

The unique aspect of the Crime HotSpot idea is the SafetyScore. The SafetyScore will be a numerical value that represents the information of the Crime Heatmap. As crime data accumulates in an area, that area becomes less safe just as when the violence of the crimes in an area increases. This perceived safety, or lack thereof, will then be given a score with lower values indicating an area that is more dangerous and higher scores indicating an area that is safer. This score can act as a quick reference or in the case of those of whom are unable to see the entirety of the visual color spectrum as a means of integrating this service for use.

2.2. Major Components

As shown in Figure 4, Crime HotSpot will consist of multiple identifiable parts. Many of the units shown, while important individual units that require specific developer attention, could be considered as sub-units. This section will discuss such items under the headings of the major components to which they are subordinate.

****

This area is intentionally left blank.

****

2.2.1. Crime HotSpot Website

Crime HotSpot will be a web-based application. The interface, or user experience portion, of the application will be a series of web pages built on Angular.js as part of the JavaScript MEAN stack.

On initially loading the page, the user will be asked to allow location services which will enable the page to center the map on the user's location. The user will have the option to enter a different location on which to center the map.

A heatmap overlay will be placed over the map indicating the levels of crime data in the given area. By hovering the mouse over an area of the displayed map crime statistics that affect the displayed crime level will be displayed.

The crime statistics will be cached to be used in providing information on the contributing crimes to the SafetyScore of the area using a text display when hovering over an area.

The initial webpage will be sparse to provide minimal clutter and thereby focus the user on the information provided by the crime map. More information such as crime analytics over a given time frame such as a day, week, month or year will be provided on a linked advanced analytics page.

A mobile application version of this page will provide alerts to the user as they enter or leave areas of increased danger by using the GPS of the mobile device to determine the location and thereby the Safety Score of the individual's current position.

A site for contributors will be linked to the main site to allow for submission of new crime data to the crimes database.

2.2.2. Google Maps API

The premise of this application is mapping. Any mapping program requires a GIS to plot the data over a geographical location. The GIS used will be the Google Maps API. This API works well with the MEAN stack as it was developed specifically as a JavaScript API.

A basic map centered on the area prescribed will be provided by making a function call containing a latitude, longitude and zoom level to the Google Maps API.

A heatmap overlay will be provided to the webpage by sending crime statistical data collected from the crimes database along with severity scores calculated for each crime to the Google Maps API. The heatmap returned by the call will then be overlaid on a base geographical map of an area providing crime data.

By using the geotag markers provided in the map, the webpage will be able to determine what crimes are in a prescribed radius and thereby determine what crimes contribute to the SafetyScore.

****

This area is intentionally left blank.

****

2.2.3. Crimes Database

Crime HotSpot will operate on crimes statistical data provided by law enforcement contributors such as local police forces, state university police forces and possibly the FBI or other federal agencies. These contributing organizations will be able to submit a CSV file to a website which will then be parsed for correctness and entered into the Crimes Database. Any entries that fail conformance testing will be flagged for review. By providing a standardized input method, the application will allow asynchronous updating of the database as opposed to requiring submissions by a given date.

The MongoDB platform will host the crimes database. MongoDB is the “M” of the JavaScript MEAN stack. Queries and data can be passed back and forth using JSON. This platform is quite versatile and allows for simple queries that will return results within a given geospatial radius. These results will then be further filtered to fit within a period of time selected by the webpage user.

The crimes database will store the latitude, longitude, date/time, and classification of reported crimes. The GIS will use this information for plotting crimes. The application server will use this information to calculate weights for each crime to be displayed.

2.2.4. Application Server

The application server will collect information from the crimes database, make calculations to provide an adjusted weight for plotting by the GIS and provide the maps and overlays to the webpage. The application server will be built on Node.js and utilize the Express.js framework for communication to the webpage.

The application will take the center location provided by the webpage and use it to collect crimes in a given radius from the crimes database. Those crimes will then be aged by applying a multiple representing the distance from the time of occurrence to the current date and time causing an offense to be less relevant to the safety of an area the older it becomes. By using the location and date as filters, the application server will receive a map of the geological location of concern and a weighted heatmap overlay from the GIS according to the calculated scores of the crimes. The map and overlay will then be provided to the webpage for display.

****

This area is intentionally left blank.

****

3. Identification of the Case Study

Crime HotSpot will take individual instances of crime and create a mosaic picture, or heatmap, of the calculated safety of an area. As the number and or severity of crimes increases over an area, the heatmap will show those areas as being of increasing danger making Crime HotSpot an invaluable tool to anyone with an interest in the crime levels of a geographical location.

The general public will be able to access the website to research the criminal activity of a geological area of interest. As such this tool will improve the safety of the general public by providing a means of informing the public of areas of increased danger.

Businesses will be able to make better decisions by using Crime HotSpot. By using the heatmap, businesses will be able to locate offices and storefronts in areas of safety for employees and customers. By using statistical data, businesses will be able to protect valuable assets by locating them in areas of low rates of theft or vandalism.

Government agencies will find Crime HotSpot useful as a tool for resource management. By being able to identify areas of greater concern policing forces can be distributed in a manner to reduce crime. By focusing efforts on areas of increased criminal activity agencies will be able to reduce crime and thereby increase the safety of the public.

4. Product Prototype Description

This section covers the planned development of a prototype for the Crime HotSpot web application. As the prototype is a small-scale version of the production model, the primary operations of the web application will be present in the prototype design. This section will focus on the differences between the design models.

4.1. Prototype Architecture

A prototype is by definition a trial product. The idea being that small-scale productions of a program are created and used to refine designs for further development of the product. As the saying goes plans only last until the first engagement with the enemy. By developing a prototype, ideas that appear sound on paper can be tested to create a better understanding of what is needed and thereby provided a better resulting product. The Crime HotSpot Prototype will be a small-scale version of the production plan, as shown in Figure 5. In the prototype, the mobile application is removed as well as some of the ancillary webpages. There will be other small changes to the algorithm and database schemas that will be needed to support the prototype development. Most changes made for the development of the prototype will be a matter of scale and only need to be expanded for a production model.

****

This area is intentionally left blank.

****

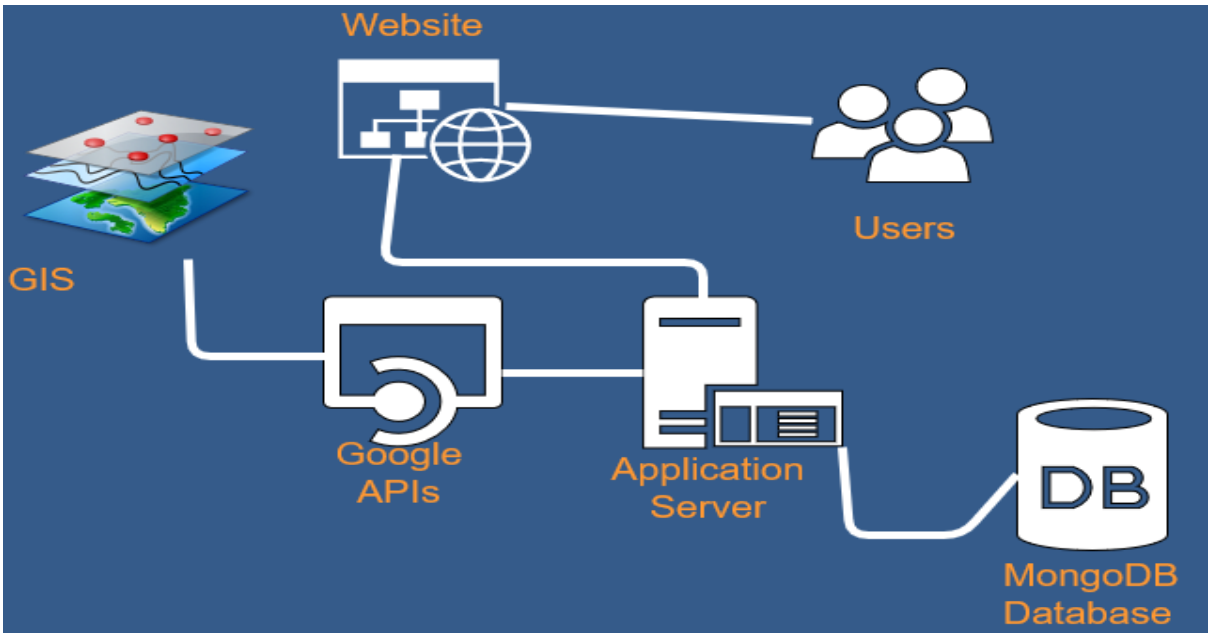

Figure 5 Prototype MFCD Crime HotSpot. (2018, December 15). Presentations. From Crime HotSpot: https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

4.1.1. Crimes Database

The database for the Crime HotSpot will provide crime data that was provided by the ODU Campus Police to the webpage and application server. The overall concept of the database will have only minor changes between production and prototype models in that it will be static and the data it contains will be slightly altered to provide simplicity.

4.1.2. Web Page

The base web page in the prototype will be very near to what is envisioned in the production model. It will display a map of an area of concern and a heatmap overlay indicating the safety, or lack thereof, of an area. The page will have sliders so that the user can manipulate the data to reflect the user's personal views as to the severity of individual crime types. Where the prototype will differ from the production model is that it will not have the advanced analytics or contributor pages. These pages provide improved functionality to a user but are not needed as a part of the prototype. The mobile companion application will also not be developed as a part of the prototype and will remain as an add-on function for the production model.

****

This area is intentionally left blank.

****

4.1.3. Application Server

The application server will operate for the most part, in the same manner, as envisioned for use in the production model. The application server will query the database for crime data in the geographical area and time frame of concern. The results will be applied to an algorithm for Safety Score calculations and the aging of the data. Once the data is processed, it will be used to compile a heatmap layer to be displayed over the geographical map by the webpage. The geographical map and heatmap layer will be provided by the Google Maps API in the same manner as in the production model. Minor changes to the algorithms for Safety Score to support the data storage schema used in the prototype will not be in the production model.

4.2. Prototype Features and Capabilities

As the Crime HotSpot prototype will be but a small-scale version of the production model, many of the features will be scaled back, altered slightly or removed altogether. This shrinking of the scale of the project is necessary to meet the delivery schedule for the prototype. The modifications to the features will not inhibit the prototype from functioning as a proof of concept for Crime HotSpot, and while this may, in the end, be a throwaway version of the web application, it will be a crucial part of the development process. A heatmap representing the data available under these limiting factors will be displayed over a map of the geographical area and time constraints of data under consideration.

4.2.1. Location

In a final production model, the Crime HotSpot application is envisioned to expand across large areas and encompass multiple jurisdictions. The law enforcement agencies of these jurisdictions would provide relevant crime statistics covering the areas providing a sizeable usable footprint for the application; this would lead to a requirement to be able to view all areas in which contributors have submitted data. In the prototype of Crime Hotspot, the ODU campus police will be the sole contributor. As such the footprint for the prototype will be reduced to the ODU campus. Due to this fact, there will be no need to provide location services other than that centered on the ODU campus. The Crime HotSpot prototype will not ask for or accept user location preferences but will center the focus on the ODU campus to encompass the breadth of the crime data provided.

4.2.2. Static Database

An application of crime mapping such as is envisioned for the Crime HotSpot application is highly dependent on contributed data provided by law enforcement entities. Those brave men and women work tirelessly and with little recognition to keep the public safe. While Crime HotSpot is planned to act as a tool for individuals to take a personal interest in safety by arming themselves with information, it is entirely dependent upon the buy-in of law enforcement agencies. If it is too cumbersome a task to submit data to the project, law enforcement members may choose to stop contributing and thus make Crime HotSpot a defunct application. In the production model, there is a plan to have a means for law enforcement to submit records via CSV files to the crimes database upon which Crime HotSpot will operate. As the prototype will be working on a fixed set of data, the database will be static and will not be programmed to collect new contributor crime data.

4.2.3. Restricted Time Frame

Context is important to any data set. Crime HotSpot is planned to display the crime statistical data stored in the crimes database on a heatmap according to the users desired time frame allowing the user to understand the ebb and flow of criminal activity over a period of time be it a day, week, month or year. This will allow for planning of events such as visits for vacation or perhaps to understand that more muggings occur in an area after known pay dates. Crime HotSpot also ages the Safety score of a crime according to how far the event is removed from the present. As the prototype will be built on a static database with crime continually becoming older, it is important that the prototype focuses on the period in which data is available. Due to this, the prototype will not offer the user selectable time frames so as to provide enough relevant data for proof of concept.

4.2.4. Crime Categories

The campus policing force for ODU has provided a file comprising a year's worth of crime statistical data. As a part of this data, the crimes are categorized by the types of crimes committed. In this list, more than 50 separate categories have been identified and cataloged. While several crime categories will be collapsed into single categories in the production model, this would still result in more categories than planned for the prototype version of this application. Due to this fact, the crimes will be compressed to only four distinct categories, as shown in Table 2. This will ease the burden of prototype development while making adaptation to a production model a matter of scaling.

****

This area is intentionally left blank.

****

Severe crimes against the person S=8	Crimes against the person S=4	Crimes against property S=2	Crimes against the public S=1	Uncategorized
Assault, Aggravated Abduction Motor Vehicle Crash, Hit and Run	Assault Dating Violence Harassment Animal Bite Intimidation/Threats Reckless Endangerment Sexual Assault	Auto Theft Burglary, Residence Destruction of Property Larceny Larceny from Auto Larceny, Electronics Motor Vehicle Crash, Property Damage Robbery Trespassing	Criminal Mischief Curfew Violation DUI Disorderly Conduct Disturbance Fire Alarm Liquor Law, Public Intoxication Liquor Law, Underage Minor in Possession – Alcohol Narcotics Violation Narcotics Violation, Distribution/Sale Narcotics Violation, Marijuana Odor Of Marijuana Poss of Controlled Substance Poss of Marijuana Public Indecency Public Intoxication Suspicious Person Suspicious Vehicle	Identity Theft Resisting Arrest Credit Card Fraud Fraud Evading False Report Forgery Obstructing Protective Order Traffic Arrest Uniform Notice of Violation

Table 2 Crime Categorization Prototype

4.3. Prototype Development Challenges

All change leads to challenges, and the development process is by definition change. As the process moves along an idea becomes a plan, that becomes an algorithm, that becomes an application. Along each of the steps comes new challenges for a team to overcome. Team Silver of the CS411W Spring 2019 class is a diverse group of professionals and students ready to accept the challenges afforded in the effort of creating the prototype of the Crime Hotspot application as it will lead to new learning opportunities.

4.3.1. JavaScript MEAN Stack

The programming platform has been identified as a large concern to the members of Team Silver. As a whole, the majority of programming efforts accomplished by team members has been stand-alone applications. Crime HotSpot is a web application that spans several parts and as such appears as a daunting task for the team. The JavaScript MEAN stack spans areas from front end web development to a back-end server completing commutations to a NoSQL database. All of this is perhaps a bit much to expect any one person to learn in a few weeks.

To combat and conquer this challenge, Team Silver has divided itself into three subgroups each with its own area of focus. One of the teams will focus on web development and the use of the Angular.js programming style. This team will create the user interface that is the principal benefit of the application.

Another team is prepared to program the back-end server for the application. This Node.js server will make computations of the weighted scores for individual crimes that it has queried from the crimes database. It will provide the needed information to the front-end webpage via an Express.js framework.

The final group will configure and load the database. This group will be the team's primary knowledge source for MongoDB. This group will also configure the web-hosting server to support operations in an administrative role.

Each group is free to contribute to the other groups but have a primary focus in a particular field. This minimizes the amount of information needed and shrinks the task to smaller and more attainable goals.

4.3.2. Cross-browser Compatibility

A stand-alone application can be programmed to work only on a particular OS with little repercussion. The user and the programmer will know in advance the OS and will develop, or purchase, the application to meet requirements. Web applications are a different animal altogether. A web application can be accessed from any number of different browsers. A user will quickly lose interest in an application that only works in Chrome if the user's preferred browser is Firefox or vice versa.

Making a program compatible with all major platforms is a challenge. The main test for many web applications is, "Does the application work in Internet Explorer?", as this is most often the browser that an application will fail on. This is one of the major benefits of using the JavaScript MEAN stack as the build platform. All programming will be done in JavaScript meaning that any browser that recognizes the syntax will be capable of running the application. That said this application will be rigorously tested on Chrome, Firefox and Internet Explorer browsers.

5. Glossary

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.

Crime Map - A map that has crime statistical data overlaid on it to provide information on the criminal activity of an area.

Comma-Separated Values (CSV) file - a delimited text file that uses a comma to separate values.

Geographic Information System (GIS) - a framework for gathering, managing and analyzing data in respect to spatial location.

Heatmap - a representation of data in the form of a map or diagram in which data values are represented as colors.

JavaScript MEAN Stack - MEAN is a free and open-source JavaScript software stack for building dynamic websites and web applications. The MEAN stack is MongoDB, Express.js, AngularJS (or Angular), and Node.js.

JavaScript Object Notation (JSON) - a lightweight data-interchange format that is easy for humans to read and write as well as easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language

SafetyScore - A number, proprietary to Crime HotSpot, that represents the relative safety of an area.

****

This area is intentionally left blank.

****

6. References

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

CrimeMapping.com. (2018, December 5). *Helping You Build a Safer Community* . From TriTech Software Systems: CrimeMapping.com

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

Neighborhood Scout. (2018, October 8). *VA Crime Rates and Statistic.* From NeighborhoodScout: https://www.neighborhoodscout.com/va/norfolk/crime

NIJ. (n.d.). *Mapping Crime: Understanding Hotspots.* Retrieved September 5, 2018 from NCJRS: www.ncjrs.gov/pdffiles1/nij/209393.pdf

Old Dominion University. (2017, August 24). *Old Dominion University.* Retrieved September 1, 2018 from Old Dominion University: media.wric.com/nxs-wrictv-media-us-east1/photo/2017/08/24/odu_37569108_ver1.0_1280_720.jpg

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