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

CS411W Spring 2019 Team Silver
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Submission Date: 0/25/2019
Version: Final

Table of Contents

List of Figures

List of Tables

1. Introduction

The FBI estimated, in their 2017 crime analysis report, that an estimated 1 in 50 individuals living in the United States will fall victim to 1 or more forms of violent crime in any given year. Crime will occur regardless of whether one is prepared. People find ways to try and mitigate the chances of encountering crime or outright avoiding potential/high-risk areas for crime all together. There are tools one can use; one such tool comes in the form of crime-mapping software. Crime mapping depicts areas where crimes have occurred, and in some cases both the type and details of the crime. Crime maps are quite common and are already in use by the police, U.S. citizens, and cities alike. However, the majority of modern crime maps overwhelm users with the sheer amount of information presented and subsequent clutter. The appears of one's user interface, as shown in *Figure 1*. In other cases, there is too little information to help the average American.

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

To address the issues of the commonly used icon crimemaps along with other previously mentioned shortfalls with team Silver of CS 411W offers various solutions as seen in *Table 1.* In addition, there is a significant difference between crimes which have occurred and the risk of the individual crime which could potentially impact the user that is, in many cases, misrepresented in modern icon-based crime maps. There are often cases where the amount of crimes that are shown can misrepresent the safety of an area. For example, if one were to look at crime reports they may notice that during election years, urban homes with front lawns will have a spike in crimes relating to trespassing, property damage, theft, and vandalism. These all sound like crimes that could most definitely affect one's safety and show that the area in question is dangerous. In reality the reoccurring spike in crimes during elections is, in many cases involving relatively safe neighborhoods, all related to political yard signs which can have multiple offences for the removal, tampering, or placement of all in the same location, as shown in *Figure 3*, where

in which any of the aforementioned crimes would not show any great potential harm to passerby's or the residents of this yard-sign infested home.

The solution to a majority of the issues such as misrepresentation of an area along with scenery overloads due to the amount of clutter on an average crime-map can be solved, in part, with a heat-based crime mapping approach as seen in *Figure 2*.

Figure 2. Theft of political campaign signs is a minor offense but can be over-represented in an area during campaign season and make the area appear unsafe "Campaign Signs." Minnesota Brown, minnesotabrown.com/wp-content/uploads/2018/07/campaign-signs.png.

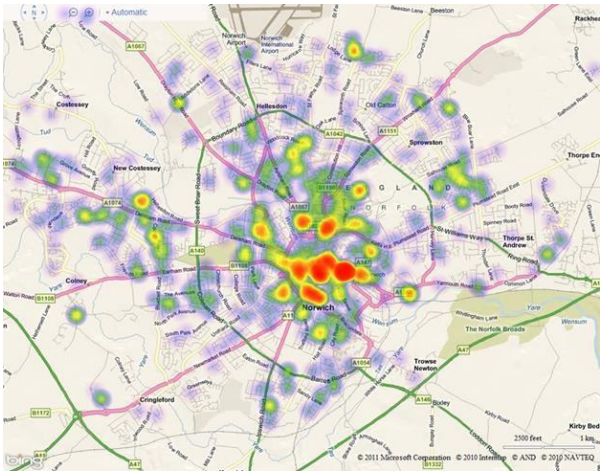

Figure 3. Example of a heatmap, with the red areas depicting a hotspot which where there is higher density of crimes. Reprinted from "Heatmap" by Microsoft, 2011, Retrieved from alastaira.files.wordpress.com/2011/02/image24.png.

This heatmap allows users to easily spot where the majority of crimes occur in a given area in comparison to *Figure 1*. The weight each crime will be determined in regards to the potential threat it has to an individual based off of our own SafetyScore system.

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

Table 1 *Competition Vs. HeatMap*
https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

2 Product Description

The crime mapping application, named Crime HotSpot, will assist users in making well informed decisions in regards to an areas safety based on facts. The use of a heatmap will be the basis of Crime HotSpots crime mapping platform. This course of action was chosen due to the reduced amount of clutter it produces in comparison to an Icon based crime map, shown in *Figure 1 & Figure 4*, along with its ability to eb easily viewed and understood by the vast majority of users. The heatmap itself will be overlaid on the Google Maps platform while using predetermined color schemes to represent crimes along with the calculated danger in a given area. The algorithms that has been create for Crime HotSpot will calculate an areas safety and store this information in an overlay which will be shown in the website as hotter and cooler areas of the heatmap. In addition to the web-based heatmap there will be a mobile app developing in order to notify users, with their permission, if they have entered an area that poses a significant risk to their well-being.

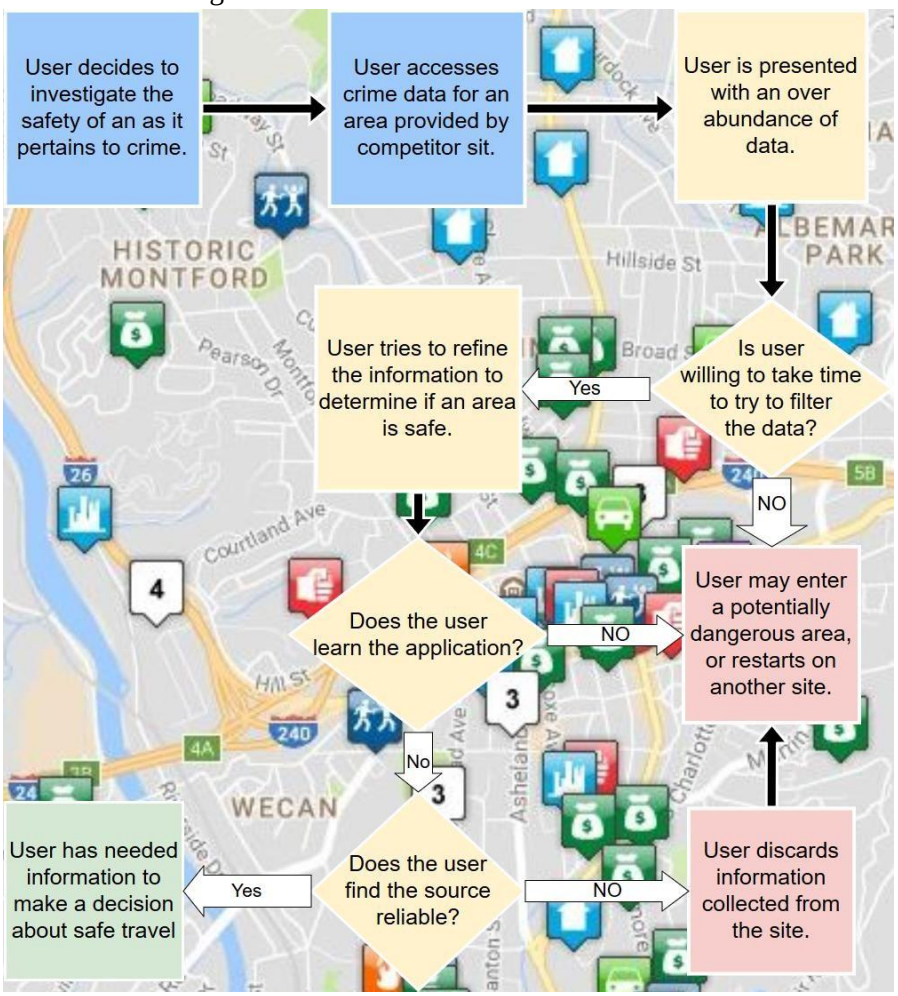

Figure 4. Cluttered Current Process Flow. This flow is hard to follow and may lead to inaccurate information. https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

2.1 Key Product Features

Crime HotSpot will be a primarily web-based application capable of running on all mainstream webbrowsers such as Google Chrome, Firefox, and Microsoft Edge. The major components in regards to the interactions of all working components are shown in *Figure 9*, which also shows our intention of developing a phone-based companion application that users can use to view and use the websites heatmap. The website will provide users with the latest up to date information, from our servers based on the most recent analysis of data acquired from our data providers such as local police departments, in regards to an areas safety and the occurrence of various crimes. The data itself is already available to the public, though not always easily accessible, so there is little to no risk of accidentally jeopardizing an ongoing, or sensitive, investigation due to information of the crime being uploaded to our database. Users are capable of looking for specific types of crimes such as violent, vandalism, theft, or property related crimes. The phone app will in turn work hand in hand with the website by notifying users with updates in regards to their current location if they have entered a dangerous area.

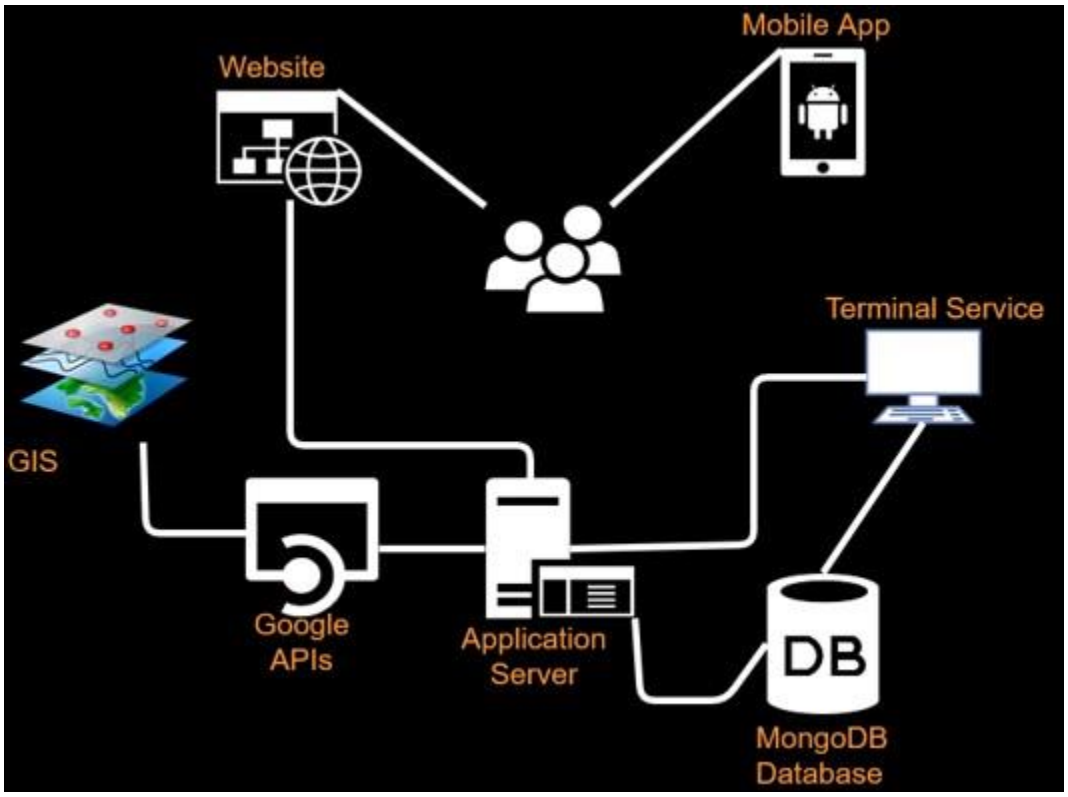

Figure 5. Major Functional Components. This diagram illustrates the relationships between the main application components. Reprinted from "Presentations" by Crime HotSpot, 2018, Retrieved from https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

Both the mobile and web-based applications will provide users with a means of informing our database of new crimes which will in turn, once the crime is verified, update our database and our SafetyScore algorithm will update the areas safety based on the crime and its threat potential.

2.1.1. Crime Statistics

Crime HotSpot does not only categorize by types of crimes but also by the level of effect they have to the general public along with its level of severity and area of effect based on our SafetyScore which can be found in section 2.1.4. of this report.

2.1.2. Geographical Crime References

Thanks to the implementation, and use, of Google APIs Crime HotSpot is able to display where each crime has occurred along with tracking the user's location or planning routs in a predetermined area by the users. However, we will not be displaying the exact location of a crime or any information which could jeopardize an individual('s) safety and/or privacy. For this reason, we will be showing the area of effect rather than the exact location as many other icon-based crime maps choose to do.

2.1.3. Crime Heatmap

The heatmap will implement color scaling in order to display the affected areas based on our accumulated crime related data. The colors primarily used to discern the safety of an area will be based on the visible ultraviolet spectrum where low frequency colors will indicate the highest level of danger to higher frequency colors such as blue to indicate the safest areas on the map, as seen in *Figure 2*. At the base of the device, or browser if used to view our website, there will be a key to actively remind users the meaning behind each color that will only expand when hovered over by a mouse or clicked on. The heatmap will be available to both users of the web-based application as well as the mobile version. In addition, there will be an option to view our heatmap in grayscale for those who are afflicted by partial colorblindness. Currently we have no feasible way to assist those who are completely colorblind or blind all together from using our heatmap due to the complexity of the code needed to work with electro mechanically based brail devices, such as the eBrailleNote Apex, for the blind.

2.1.4. SafetyScore

The SafetyScore is determined by a number of variables. It takes into account the number of crimes committed in a specific area, the time lapse from the time the crime occurred to present day, the density of the population in the surrounding area, additional crimes committed near the area being viewed/scored, user's multipliers on all listed crimes, as well as the safety score based on the type of crime and its area of effect. For this to work, each crime will be given its own impact radios depending on the type of crime as well as other crimes committed in relation, such as how a burglary can lead to murder in which case both crimes are linked. Each crime will impact a general area while allowing for the area affected by said crime('s) to overlap. The population density will also affect the safety of an are due to the fact that if an area is highly populated then crimes committed within said area could affect more people.

For a more detailed description of our SafetyScore please refer to our *Safety Score Algorithm* which can be found on our website at www.cs.odu.edu/~411silver/downloads.html under *Design Presentation Handout Pg. 11*.

2.1.5 Analytics

We also offer an analytics window that pops up when users are viewing crimes on our web-based application. It details the number of crimes committed, types of crimes, along with other related data, to a given area. This will help users discern the types of crimes occurring based on their search parameters when crimes overlap one another.

2.2 Major Components

In regards to location, for the mobile application, users will need to give permission to our app in order for us to accurately determine one's location as well as give them active updates for when they enter a dangerous area. This may also require the use of mobile data if Wi-Fi is not available. The GPS tracking itself is the same one used for our web-based application which will be handled, in a large part, by google API's in order to help pinpoint locations of both the user as well as the crime data stored on our application servers.

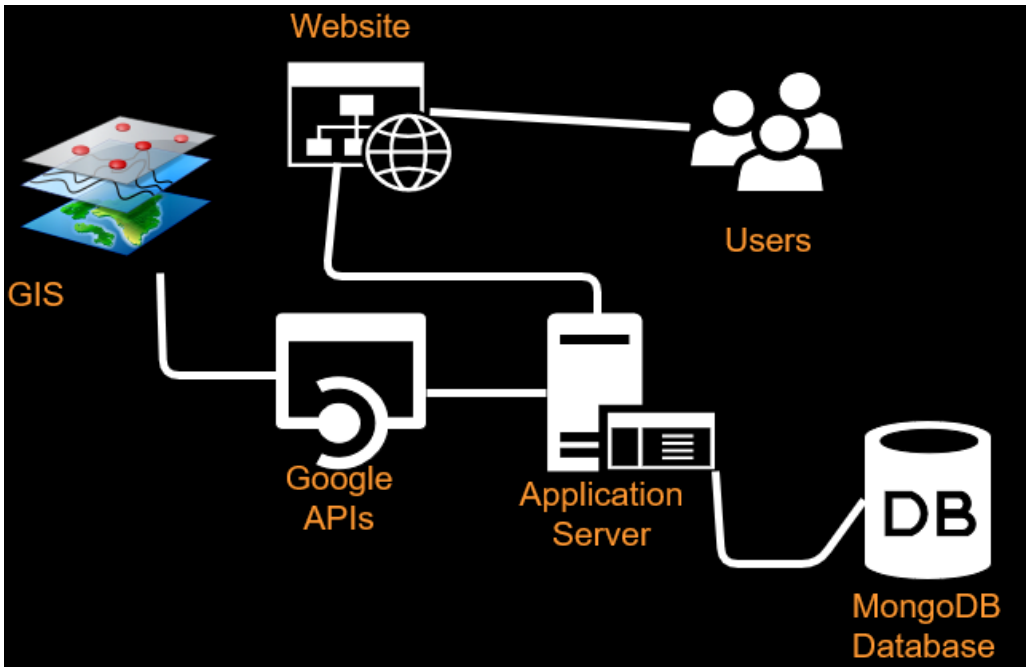

Figure 6. Major Functional Components Prototype Diagram
www.cs.odu.edu/~411silver/presentation.html

2.2.1. Crime HotSpot Website

The web-based application will be accessible on any mainstream browsers such as Google Chrome, Mozzarella Firefox, or Microsoft Edge. It is a graphics-based user interface web application which allows users to interact with our heatmap and analytics page('s). The website will be created primarily through the combined use of HTML, CSS3, JavaScript, Bootstrap, and Angular.js files while in compliance with MEAN Stack templates/outlines. The website will interact with the MongoDB database to gather information as well as Google API's in order to properly display information on the heatmap as well as show user locations in correlation to dangerous areas through the mobile application.

2.2.2. Google Maps API

Our team looked at various options in order to find the right interface for our prototype. Out of all the options we found, Google Maps API was the one we chose due to its low cost, large history of proven reliability, flexibility, and lack of a drastic learning curve. Though it has a free option, we decided against and went with the paid version in order to gain more features as well as support, more tools, and greater flexibility.

2.2.3. Crimes Database

The Database will primarily use Mongo DB and Node.js as the basis. The database will house, and organize, data relating to the radius, GPS coordinates, type, time, location, area of affect, SafetyScore, and analytics of the crimes stored inside our database. The full structure of the database, including the handling of stored data, can be seen in *Figure 7.*

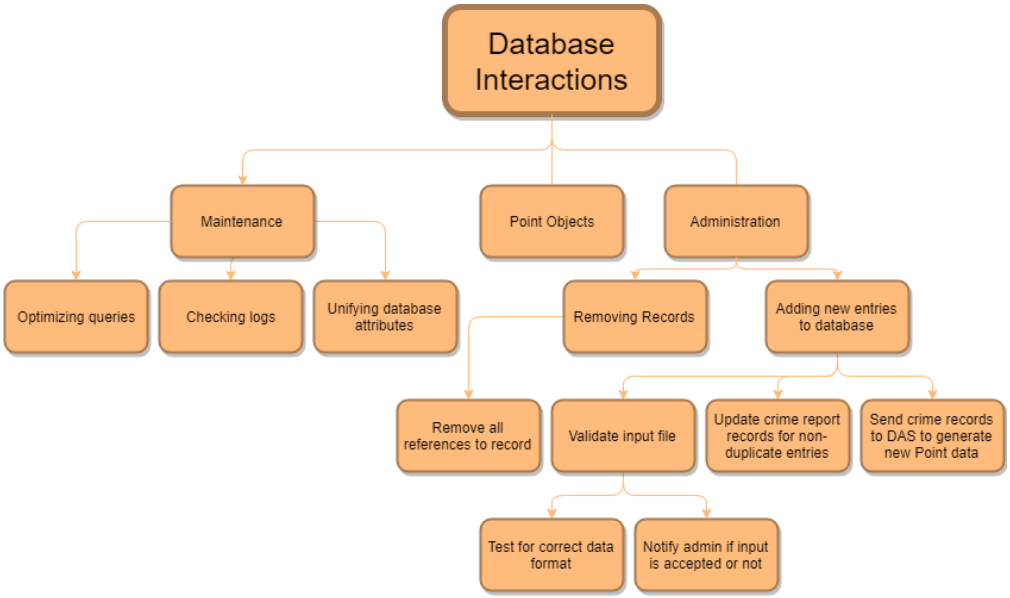

Figure 7. WBS: Database Prototype Diagram www.cs.odu.edu/~411silver/presentation.html

In addition to the storing of data the MongoDB database will be receiving raw crime data, uploaded by admins, which will then be sent to our Dynamic Application Server to be converted into point data. The newly converted data is then sent back to the database for later use. This database will primarily be handling .CSV based files in regards to accepted format for crime related data.

2.2.4. Application Server

"The Dynamic Application server will also interact with the GIS system to perform actions which are related to geographical positioning, but not necessarily mapping, such as alerting a user who is using the mobile app that they are entering a dangerous area in real time.", (Crime HotSpot 2018 Feasibility Presentation).

2.2.5. Mobile Application

The mobile based application, much like the web-based application, will also communicate with the application server in order to function properly. It will have many of the same features as the web-based application, but with one additional noteworthy inclusion. The mobile app will, with the user's express permission, be able to trac and warn users when and if they travel into dangerous areas based on our databases crime data. In addition, when such an event occurs it will notify users of the potential risks to their safety.

3 Identification of Case Study

This product was made with the general populace in mind, with the exception for those without internet and/or computer access. This product has the potential to assist cities with providing information for the safety of those who live within its borders as well as tourists and those who seek to live there. This will in turn assist the police, government agencies, realtors and local businesses when selling and buying properties based on our provided data. In addition, individuals who want to view locations they intend to visit, those who wish to move in to a new location, or one who was overcome by the curiosity of their surroundings can gain valuable information form the application. The targeted sectors, as can be seen in *Figure 8*, will be able to view the types and frequency of crimes within a given location. This will be a great boon to those who are concerned for their, or another's, safety.

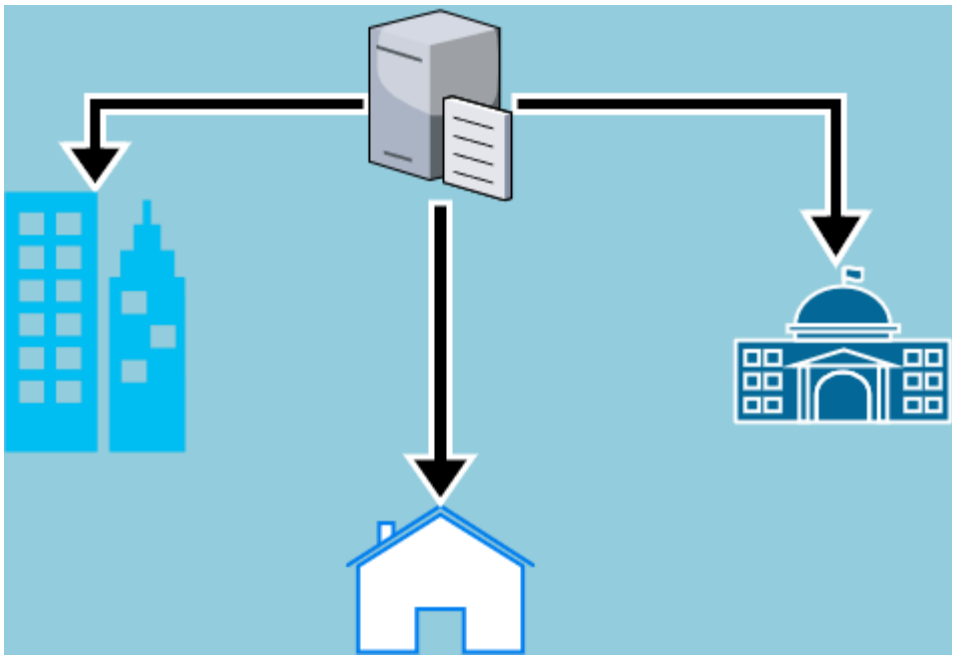

Figure 8. Target Market Prototype Diagram
www.cs.odu.edu/~411silver/presentation.html

Realtors could provide their customers with accurate data in regards to the safety of a location in order to close a deal. Businesses' could see which area would have the least break-ins for a new branch. Families can see where they should avoid on trips or vacations. The police and other government/law agencies can use the data we provide to analyze crime patterns and improve their coordinated efforts in reducing, or mitigating, crime. They can even use it as a learning tool for new recruits or crime analysts. In short, this product has a wide array of potential users and customers alike, and in comparison, to rival crime maps it is much easier to understand and see the bigger picture in regards to crime and one's safety. The full scope of what we offer can be seen in *Table 1*.

4 Product Prototype Description

The prototype itself will consist of a website, MongoDB database, heatmap, analytics page, and possibly a mobile application, provided there is enough time. Tis prototype will have the SafetyScore implemented in the heatmap and analytics page data. In addition, both versions of the ultraviolet spectrum and grayscale heatmaps will be implemented within the prototype. *Table 1*.

4.1 Prototype Architecture

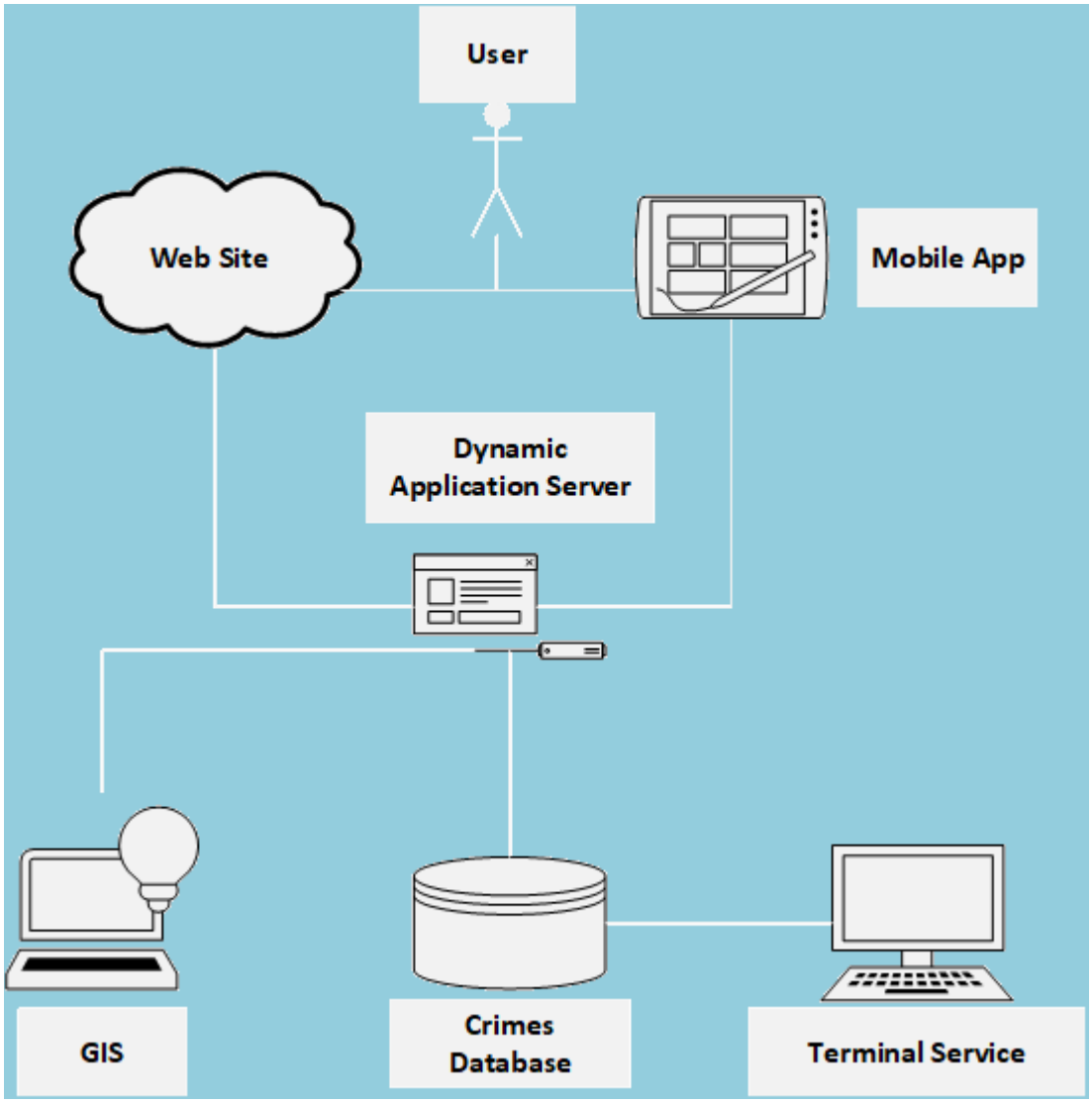

Figure 9. Major Functional Components Prototype Diagram
https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

Ass seen above in *Figure 9*, the prototype will have a mobile application as well as its primary web-based application which will both be linked to our Dynamic Applications Server. The application server will receive data from the MongoDB Database in its raw form and then convert it into our own standard .CSV file type before returning the converted data to the Crime Database. The information will be made with pointers and nods in mind for the use of the Google Maps APIs in order to show crime data on the heatmap itself.

4.1.1 Crimes Database

The crime database itself will still be MongoDB and node.js based. I refer readers to *Figure 7* for more detailed visual information.

4.1.2 Web Page

The webpage itself will still be HTML, CSS3, JavaScript, Bootstrap, and Angular.js file based while in compliance with MEAN Stack templates/outlines. It will contain the heatmap and analytics page along with our team's lab reports, downloadable, presentations, and other project related information.

4.1.3 Google Maps API

This prototype will be using the paid version of Google Maps API in order to affectively display the crime data, based off of provided data from the ODU police, on the heatmap. This will also assist in tracking users through the mobile application, but only with their express permission.

4.2 Prototype Features and Capabilities

The scope of the prototype's features will be very similar to the original design concept. The only difference would be in the number of crime categories active upon the completion of the prototype, as well as the quality of the overall look of the application.

4.2.1 Crime Categories

For this prototype we will be focusing on violent crimes as a whole. Due to the lack of severe crime types such as murder, there will be an additional set of 2-5 fictional murder crimes added to the database in order to have data for all categories. In addition to violent crimes, another category will be property damage. Finally, there will be a minimum of 1 non-violent crime category for demoing purposes for the prototype. All of the above is the minimum scheduled for completion as a team for this prototype. If able, the implementation of all original categories for the heatmap will be fully functional.

4.2.2 Location

The exact location of the crimes themselves will not be visible in the heatmap, nor will they be accessible in the analytics portion of the website. This is to ensure the safety of those involved in the crime.

4.2.3 Static Database

The creation of a static database is necessary in order to upload and retrieve information for the prototype. This database will be housed on an ODU CS server in order to reduce overall costs.

4.2.4 Crime Heatmap

The heatmap will be implemented in the prototype. It will have only one color scale systems implemented and show crime locations as described in section 2.1.3. of this report.

4.3 Prototype Development Challenges

Due to the allotted time and amount of resources provided for the completion of this prototype there will be some complications along the way.

4.3.1 JavaScript MEAN Stack

We will be using the MEAN Stack for the backend of the prototype. This will also be needed for the database due to the use of Angular, Express, and Node.js for an ensured, relatively, easy integration between the front end, backend, database, and Google Maps API.

4.3.2 Cross-browser Compatibility

As previously stated in section *2.2.1*, this application will be compatible with multiple browsers in order to reach the broadest range of users as well as be more readily available. It will be compatible with most, if not all, mainstream browsers.

4.3.3 Location is ODU, fixed location, size, etc.

For the prototype, due to various factors, such as time and amount of crime related data, we will be setting a fixed location for the heatmap to represent our data. It will be a fixed location around ODU main campus based off of ODU campus police crime data.

4.3.4 HeatMap Multi spectrum color options. – This will not be in the prototype.

Due to the amount of time and workload to complete this prototype we have opted to not implement multiple color options for the prototype, unless all other goals for the prototype are met and we are left with additional time. This will make it easier to implement on the website since we do not have to worry about multiple color pallet swaps, or overlaps, occurring on accident

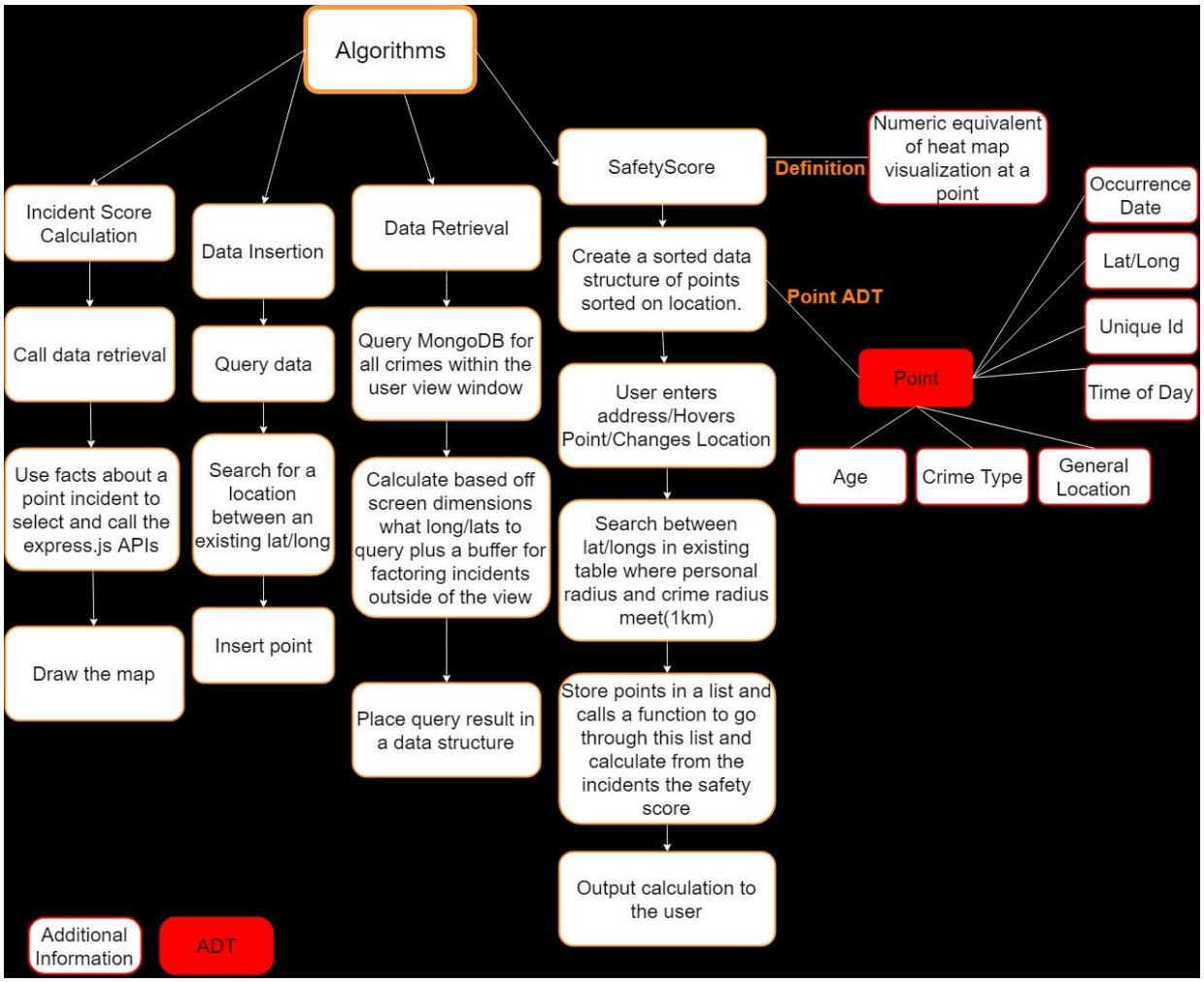

Figure 10. Algorithms Work Breakdown Structure. This diagram presents the algorithmic approaches used in Crime HotSpot. Reprinted from "Presentations" by Crime HotSpot, 2018, Retrieved from https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

5.0. Glossary

5.1. 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.

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

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

5.4. 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.

5.5. 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

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

6.0. References

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