Lab 1: Crime HotSpot Descriptive Paper

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1 Introduction

It is generally accepted that people do not desire to be victims of crime. The popularity of car alarms, home security systems, and self-defense classes attests to this. Despite people taking these defensive measures, the FBI estimates that 9.9 million crimes occurred in 2017 (FBI: UCR, 2017). Rather than defending from crime, the average person may find it more useful to avoid areas where crime is likely to occur. People tend to do this instinctually, but what if their perception of safety is incorrect? Safety assessments based on hearsay and physical observations are easy to make, but they can be drastically influenced by recent, isolated events. Analyzing factual sources such as police records may offer a better perspective, but drawing conclusions from these sources can be too time-consuming or challenging for the average person. People need a reliable source of crime information that remains as easily interpretable as hearsay.

Several public web sites exist which aim to fulfill this need. While the web sites often supplement with graphs, charts, and one-off statistics, the most popular approach to conveying this data is through crime maps. A crime map visually denotes the geographic occurrences of crimes. These maps have been used by police departments for decades to analyze crime trends and determine hot spot areas which may require additional police resources. Crime maps can be an incredibly useful method for conveying data, but public web implementations do not feel intended for the public. As seen in Figure 1, the maps present every crime occurrence as an icon on the map.

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

Searches regularly return a similarly cluttered visual that requires extensive filtering and search adjustment to achieve meaningful results. This may be reasonable for a crime analyst, but can be daunting, confusing, and even misleading to the average person.

Current crime maps do not distinguish between isolated crime reports and multiple crime reports related to a single incident. They provide no inherent distinction between crimes that endanger a person and those which cause minor inconvenience. This can be especially deceptive when the crime targets are of similar nature to the yard of campaign signs pictured in Figure 2. For every campaign sign that is damaged, stolen, or moved, crime icons for a combination of vandalism, theft, and trespassing appear on the map.

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

Even though these crimes pose little threat to safety, the average user will only see the overwhelming number of crime occurrences in that area and mistakenly believe the area is dangerous. From these examples, it is apparent that current crime maps do not display data in a way that allows the user to make effective and informed decisions about their safety.

A better approach to crime mapping for the public keeps the audience in mind. People visit crime mapping web sites because they are concerned about safety, be it theirs or their property's. Crime occurrences are therefore only as important as their impact on that safety. An ideal crime map displays crimes relevant to the user's concerns and in a manner that reflects the threat of those crimes. Dangerous crimes should be weighted to impact the crime map more, while less threatening crimes should draw less attention. To minimize user confusion, the map display should appear uncluttered regardless of the number of crimes displayed. The core map data must remain verifiable despite these transformations. Statistics may be used to focus on specific crime trends but should not overwhelm the crime map. Most importantly, users must be provided a standard method by which they can reliably assess the safety of the area. These aspects will combine to form the ideal solution to public crime mapping: Crime HotSpot.

2 Crime HotSpot Description

Crime HotSpot will be a crime mapping tool with a design focused on conveying safety information to everyday people. Users will be able to visit the Crime HotSpot website, search for a location on the crime map, and understand the general level of safety at that location. As shown in Figure 3, using search filters and additional analytics tools may enhance the user's experience, but meaningful safety information will be conveyable through viewing the results of a simple search.

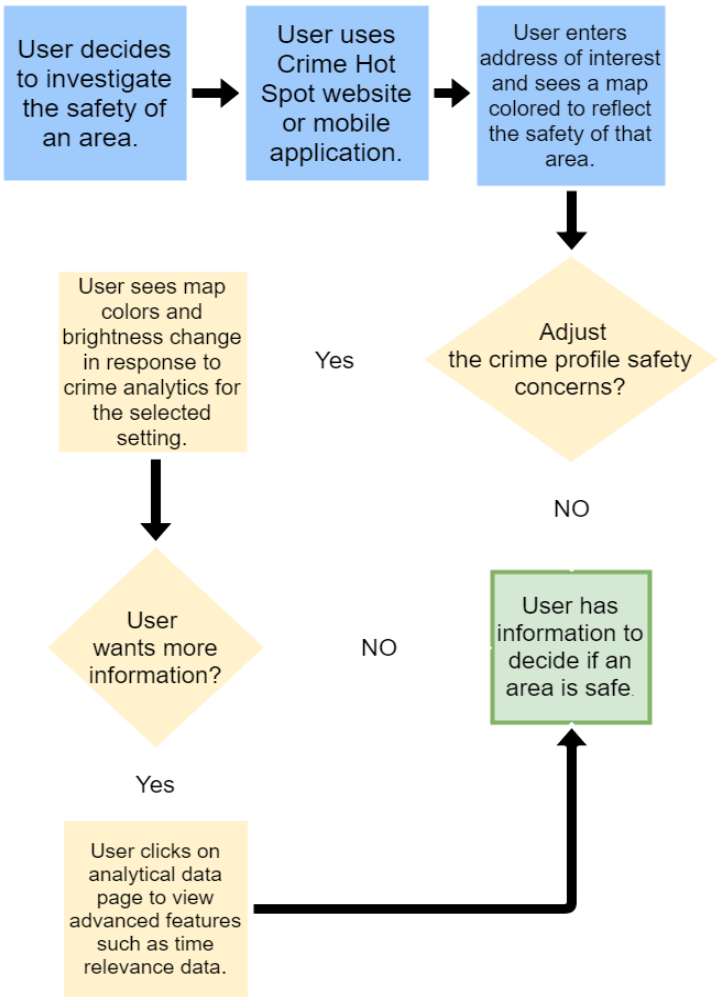

Figure 3: Process flow for Crime HotSpot. Reprinted from "Presentations" by Crime HotSpot, 2018, Retrieved from https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation.

2.1 Key Product Features

Crime HotSpot will have two major distinguishing features: the visualization method of crime threat and the calculations to determine that threat. Geographical crime references will be visualized as a heatmap denoting crime threat. Crime statistics will be used to weight calculations of crime threat, resulting in a SafetyScore safety estimate for any searched area.

2.1.1 Geographical Crime References

Crime data must be anonymized enough to preserve privacy while remaining specific enough to remain useful. If data is too specific, it may endanger the families of those involved or point out security weaknesses that encourage further exploitation. If data is too generalized people cannot use it to make decisions to better their safety. Because of these concerns, many police departments generalize their data to the nearest block. Crime HotSpot will preserve this level of generalization.

2.1.2 Crime Heatmap

Crime HotSpot will use a heatmap to visually represent crime threat on the map. Areas where crime is clustered will display as “hotter” than their surroundings. Crimes of higher threat to the user will produce more individual heat than crimes that are not within the user's concerns. Users will be able to adjust their search and the resulting heatmap by selecting a premade “crime concern” profile, then finetuning the weights of specific crime types. For example, a user looking to buy a house to rent for extra income may select a “Property Safety” profile and reduce the weights of automotive crimes.

2.1.3 Crime Statistics

Crime HotSpot is intended to display the threat of crime at a location, not to display specific crime occurrences. Since multiple crime occurrences recorded at the same time and location are likely related, their effect on calculations will be treated as a single, high-impact crime incident. Different crime incident types will carry a default weight based on their severity and likelihood to impact a person in the area. Various statistics, such as a crime type's distribution over time, will be provided to supplement the heatmap.

2.1.4 SafetyScore

The heat levels on the Crime HotSpot map will directly translate to a numerical SafetyScore denoting the crime threat of the area. The SafetyScore thus serves as a safety rating for a specific location based on the frequency and severity of nearby crimes as well as their distance. Once a user sets their desired search filters, viewing the SafetyScore can serve as a quick and consistent method of comparing areas.

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2.2 Major Components

The major components of Crime HotSpot will be implemented using the MEAN Stack framework complemented by Google Maps API. The connections between these components are shown in Figure 4.Crime HotSpot will be available to users both as a website and a mobile application. The website will use Angular.js to provide a dynamic web page to communicate user location and search preferences to the Node application server. The server will query the collection of crime records stored as JSON documents in MongoDB Atlas, perform calculations to determine the weights for the data points, and return data ready to be drawn by Google Maps API. Administrators will update and maintain the database through use of a terminal service.

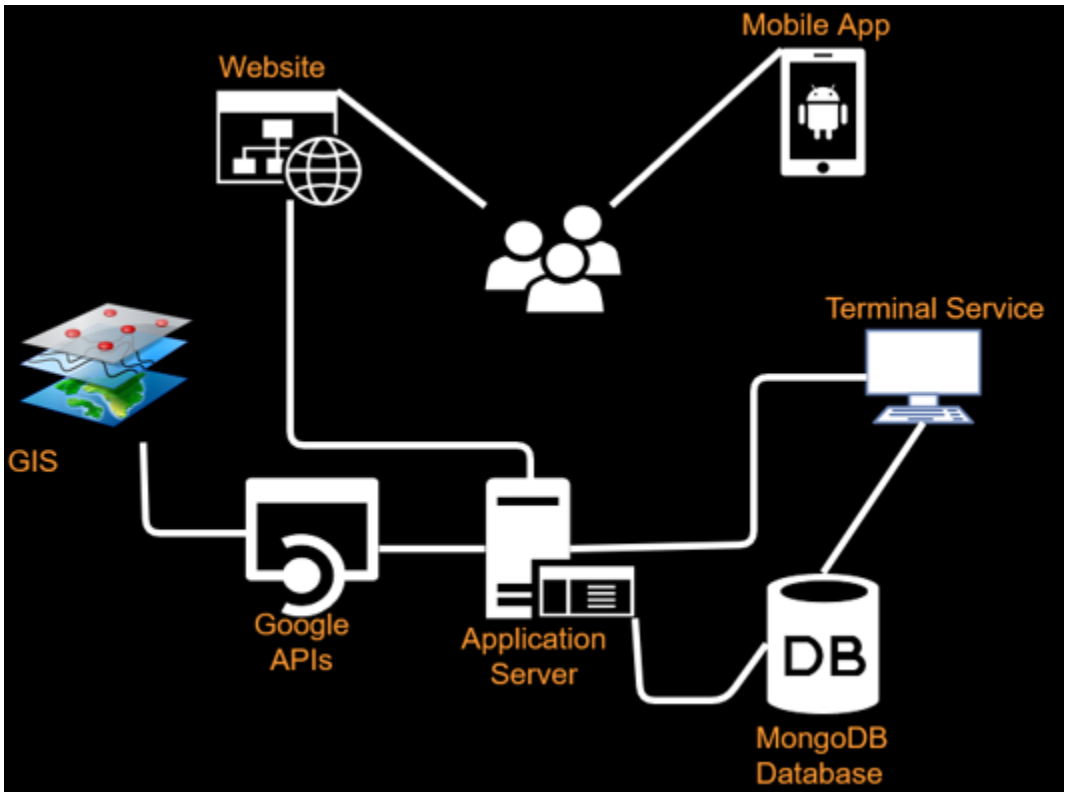

Figure 4: Major functional components of Crime HotSpot. Reprinted from "Presentations" by Crime HotSpot, 2018, Retrieved from https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation.

3 Identification of Case Study

Crime HotSpot will focus on conveying safety information, not pure crime data. This will cater to an audience composed of people untrained in crime analysis. The Old Dominion University Police Department has shared their data with the Crime HotSpot team, so initial users will consist of those interested in safety around the ODU campus. These people, and future general public users, will use Crime HotSpot to check the safety of areas when making decisions. People may check areas they intend to visit for their personal safety, research locations before purchasing a property, or check their location's safety level when considering buying security systems. Businesses may use Crime HotSpot for similar purposes. Some specific businesses, such as small real estate agencies or companies marketing security measures, may use Crime HotSpot to target locations or persuade customer purchases.

4 Product Prototype Description

4.1 Prototype Architecture

The Crime HotSpot prototype will be structured similarly to the description in Section 2.2 but with two key differences. The first is that the mobile application will not be developed in favor of focusing effort on the website. Second, the database will not be updated during use, so a terminal service will not be used.

4.2 Prototype Features and Capabilities

The Crime HotSpot prototype will behave similarly to the full product but with fewer options provided. The crime map location will be centered around Old Dominion University, as that data has been provided to the Crime HotSpot team. Instead of updating the crimes database as reports become available, the database will be preloaded with crime data from 2017. Rather than distinguish between all crime types, crimes will be placed into one of four categories indicating the severity of crime relative to personal safety. These categories will each have an inherent weight which may be adjusted by user search preferences. The resulting heatmap will be drawn and allow the same interactions as the full product.

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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 provided information on the criminal activity of an area.

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 web sites 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. 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.

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

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