Lab 2 - Product Specification Outline

CS 411W Lab II

Crime HotSpot Product Specification

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1 April 2019

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1 Introduction

Crime HotSpot is a web-based crime mapping application. In the context of existing products and the proposed product, a crime map is any geographical map that presents statistical data regarding criminal activity. Application of crime mapping techniques have usually stayed within the bounds of law enforcement agencies, who produce and analyze them in the hopes of locating problem areas and efficiently allocating resources (NIJ, n.d.). Computer technology has made maintenance of crime records fast and secure. It has also allowed detailed visualizations of crime data to be created in relatively short amounts of time. With these benefits in mind, opening these tools up to the public could make people more aware of their surroundings and promote public safety. As humans, intuition and keen observation help indicate what areas might be safe and what areas should be avoided due to crime or other potential dangers. However, intuition and instincts do not provide the same level of certainty as fact-based data and statistics. Fortunately, public crime mapping applications have already started appearing online, but there are issues that may limit their effectiveness at communicating crime information. The primary concerns are lack of distinction between different crime types and the presence of cluttered interfaces, both of which Crime HotSpot will address.

1.1 Purpose

Crime HotSpot is an attempt to provide an ideal solution to the issues presented in the introduction. It seeks to eliminate ambiguity in terms of the types of crimes being presented and to present them in such a way as to keep clutter in the interface to a minimum. To accomplish this, Crime HotSpot will provide an interactive and customizable heatmap display to users. Traditionally, heatmaps work by color coding data points and overlaying these points across a geographical map. From the user's perspective, the brightness or shade of each color conveys how concentrated a particular area is with regard to the data, as shown in **Figure 1**. This is a boon to crime mapping. Without the clutter of dozens of icons, colored "heat" will instead serve the purpose of showing how high the crime level is in an area and how risky it is according to user preferences. This is in contrast to **Figure 2**, where the sheer number of icons can make it hard to distinguish crime types and to interact with the icons themselves. The focus of attention then becomes the overall crime count, ignoring the possibility that violent crimes may only make up a small percentage of visible icons. Users would have to compensate by aggressively applying filters, to the point where the loss of detail would prevent the user from receiving information useful to their original query. With heatmaps this is unnecessary. Users should not have to sacrifice fidelity for the sake of a cleaner interface.

With a heatmap being the primary interface, users should know in an instant what areas are safe and what areas should generally be avoided. By default, a red area would indicate that a region has had a higher concentration of violent type crimes, whereas cooler colored areas might indicate less crime or less severe crime. Accessibility is another important aspect to the heat map interface, and having options supporting color-blind persons is planned. This would manifest itself as including different color combinations for the heatmap drawing.

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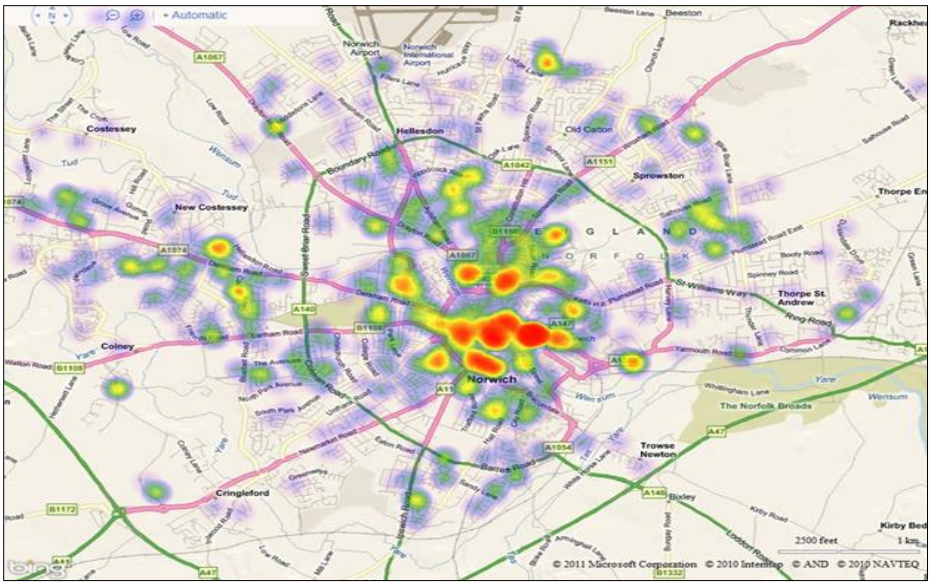

Figure 1. Example of a heatmap, with the red areas depicting a hotspot which where there is higher density of crimes. Reprinted from "Heat Map" by Microsoft, 2011, Retrieved from alastaira.files.wordpress.com/2011/02/image24.png.

Figure 2. 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 supplement the heatmap display, the application will also provide a numerical score for the general safety level of an area, on a scale of one to ten. This is called SafetyScore and is actually the design for how the heatmap is calculated "under the hood." A key difference that separates Crime HotSpot from similar products is that this calculation, and its factors, is displayed to the user. A value of ten means an area is extremely safe whereas a value of one would mean an area is extremely unsafe. For users curious about how the score was calculated, they would hover their pointer over the area and get some quick information about it. Such information would include breakdowns on the number of crimes of each type, their weights when being calculated, and the relative population density of the area. These factors are also heavily tied to the filtering options available to the user to control the SafetyScore calculations and the resulting heatmap. Since each user might have unique priorities when it comes to crime (e.g. violent crime vs property crime), filters would allow control over what types of crimes have higher weights assigned to them, date ranges for crimes, and time of day to name a few. Ideally, filtering functionality would be implemented with buttons and sliders, and would be flexible enough to handle a multitude of crime types.

The last primary feature of the application will be an analytics section dedicated to providing users with charts, graphs, and statistics based off the same data the heatmap uses. This is meant to augment user understanding of the data, and the feature is planned to be interactive as well for the final product.

As planned from the beginning, Crime HotSpot is to be a free web application open to the public. It is meant to be a full crime mapping solution geared towards public use. Its functionality might not fulfill the many needs of law enforcement, but it should be usable by organizations such as schools and businesses. These entities put time and money into choosing an ideal location that is also free of crime, relative to other sites. For individuals, user-friendly filtering options provide a way to tailor the application and to display information that is most important to them, whether that be violent crime, property crime, or other types of crime.

1.2 Scope

Time and other constraints limit what the team can realistically accomplish in a semester. The most limiting factor besides time is the team's access to crime data, which requires the cooperation of various police departments. This restricts both the locations accessible to the heatmap as well as the period of time that the records date back. These constraints, along with the completion of further research by the team resulted in slight changes to the design of Crime HotSpot.

The team has chosen four distinct categories of crime for the prototype, each in order of decreasing severity. These are (1) severe crimes against the person, (2) crimes against the person, (3) crimes against property, and (4) crimes against the public. Examples of each include aggravated assault, harassment, destruction of property, and disorderly conduct, respectively. These four categories incorporate the majority of common crimes, as supported by sample data received from law enforcement. There is a fifth category for crimes that do not fit into the four previous ones. An example of this would be identity theft. Restricting the number of categories to a reasonable amount was deemed necessary to allow for a clean looking interface. Having a dozen or more UI elements dedicated to filtering crime categories might not clutter the actual map, but it would encroach upon the screen space dedicated to it.

The location functionality for the Crime HotSpot prototype will also be limited in scope. There will be no specific search feature for users. The location will be fixed to the area surrounding ODU, limited by the jurisdiction of the ODU police department.

Due to the finite amount of data accessible to the team, there is no plan on implementing any date filtering functionality to the heatmap interface. Current data is limited to 60 days' worth of crime incidents. Artificially creating dummy data is a possibility if time permits but is tedious and will only be created if the current data is not sufficient for drawing a standard heatmap. The prospects for acquiring more data is not certain, so it is also planned to load the database only once by csv, without any updating functionality. In essence, there will only be a single dataset for use with the prototype.

1.3 Definitions, Acronyms, and Abbreviations

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.

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

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

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 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

RGB - Red, Green, Blue colors.

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

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1.5 Overview

Section 2 of this specification will further detail the major hardware and software components of the prototype and explain their relationships. Core functionality within each component will be briefly explained. Hardware and software interfaces necessary for the development and functioning of the product will be listed. Section 3 will see the functional and nonfunctional requirements for the product listed, with functional requirements being organized by feature.

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2 General Description

Figure 3 introduces the main functional components of the Crime HotSpot application and their relationships. The focus is on the primary Crime HotSpot website, Google Maps API, dynamic application server, and the database. GIS technology is abstracted away by the Google Maps API.

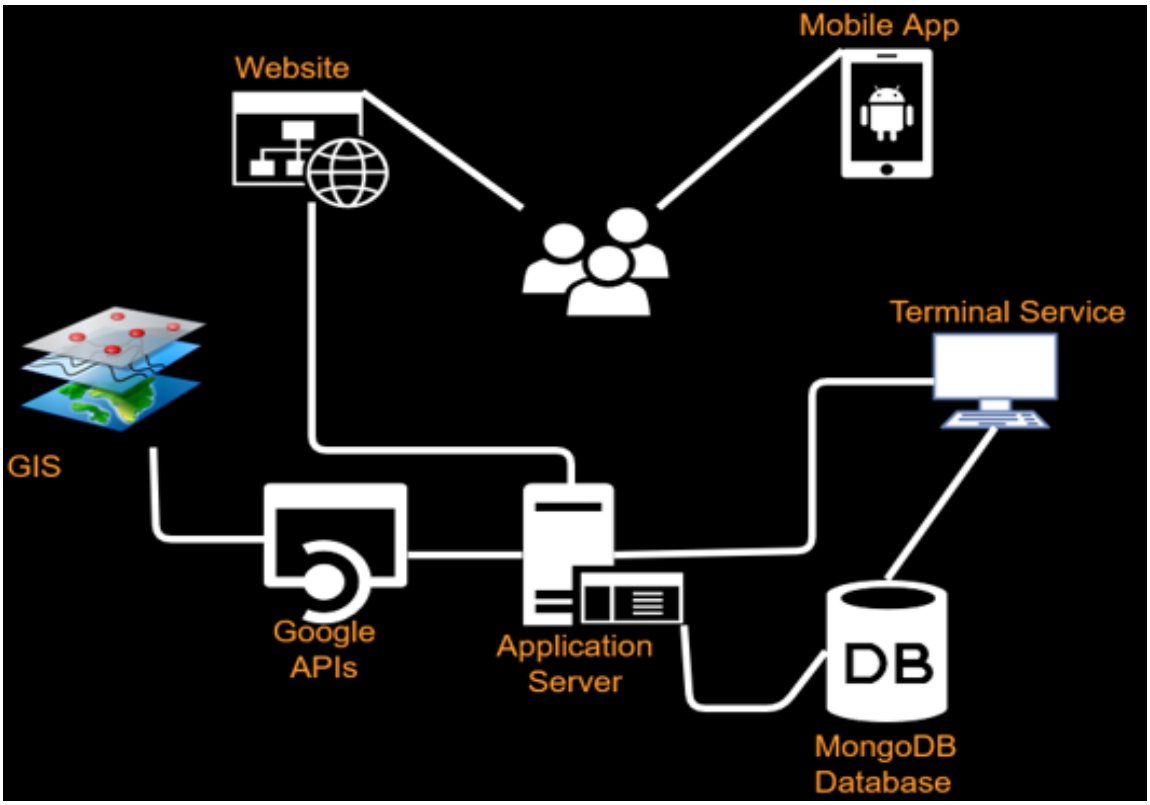

Figure 3. Major Functional Components. This diagram illustrates the relationships between the main application components. Reprinted from "Presentations" by Crime HotSpot, 2018, Retrieved from https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

2.1 Prototype Architecture Description

Since the application will be solely web based, the team will develop the infrastructure in the standard web development languages of HTML, CSS, and JavaScript. Since the product is a full stack application, requiring a robust front and back end, Team Silver chose to use the popular MEAN stack collection of frameworks for development.

- **Webpage**: Crime HotSpot will be a web application. As mentioned, the heatmap is the primary focus of the application and will provide users with options to filter results based on their preferences. Most of the interactive functionality will be implemented in AngularJS and Google Maps. In addition to interfacing with users, the website will also interface with the dynamic application server. The object sent back to the website is the heatmap rendering provided by Google Maps, but returned by the application server.

- **Google Maps API**: This software API facilitates the rendering of the GIS map and heatmap layer in Crime HotSpot. The code calls to Google Maps would be made from the application server and the resulting heatmap would be relayed back to the website.

- **MongoDB**: This is a database management system that will store the crime data in both raw form and a form usable by Google Maps API. Raw data is uploaded from any terminal that can access the database. The raw crime data provided by law enforcement would likely be processed before being stored however. For prototype purposes, the database will be hosted by MongoDB themselves, using their MongoDB Atlas service.

- **Application Server**: The purpose of the application server is to be the main point of intersection between the other components. These components do not speak directly to each other. Instead, they communicate with the application server and the application server serves as a proxy to get the necessary information. This is where most of the logic and processing is done for the application. For prototype purposes, this will exist on the same machine as the web server hosting the front end.

2.2 Prototype Functional Description

Behavior and subcomponents important to proper functioning include:

- **Webpage**:
    - Divided into the main page view and analytics view
        - Main page contains the heatmap and filtering options, implemented as buttons and sliders, as well as a tooltip popup that opens when the map is clicked
        - Analytics contains charts, graphs, and statistics
    - View preference information will be sent to the server as a GET request, along with information about the current selected location (ODU).
- **Google Maps API**
    - Heatmap is considered a layer, separate from other map rendering and it takes *LatLng* or *WeightedLocation* objects. For Crime Hotspot purposes, *WeightedLocation* is used, which stores a latitude, longitude, and a set weight value. The weight value affect how intensely the location influences
    - Point is a container data type that represents a *WeightedLocation* plus information from the raw crime report

SafetyScore calculation

The approach Crime HotSpot is taking with the SafetyScore calculation is detailed in **Figure 4**.

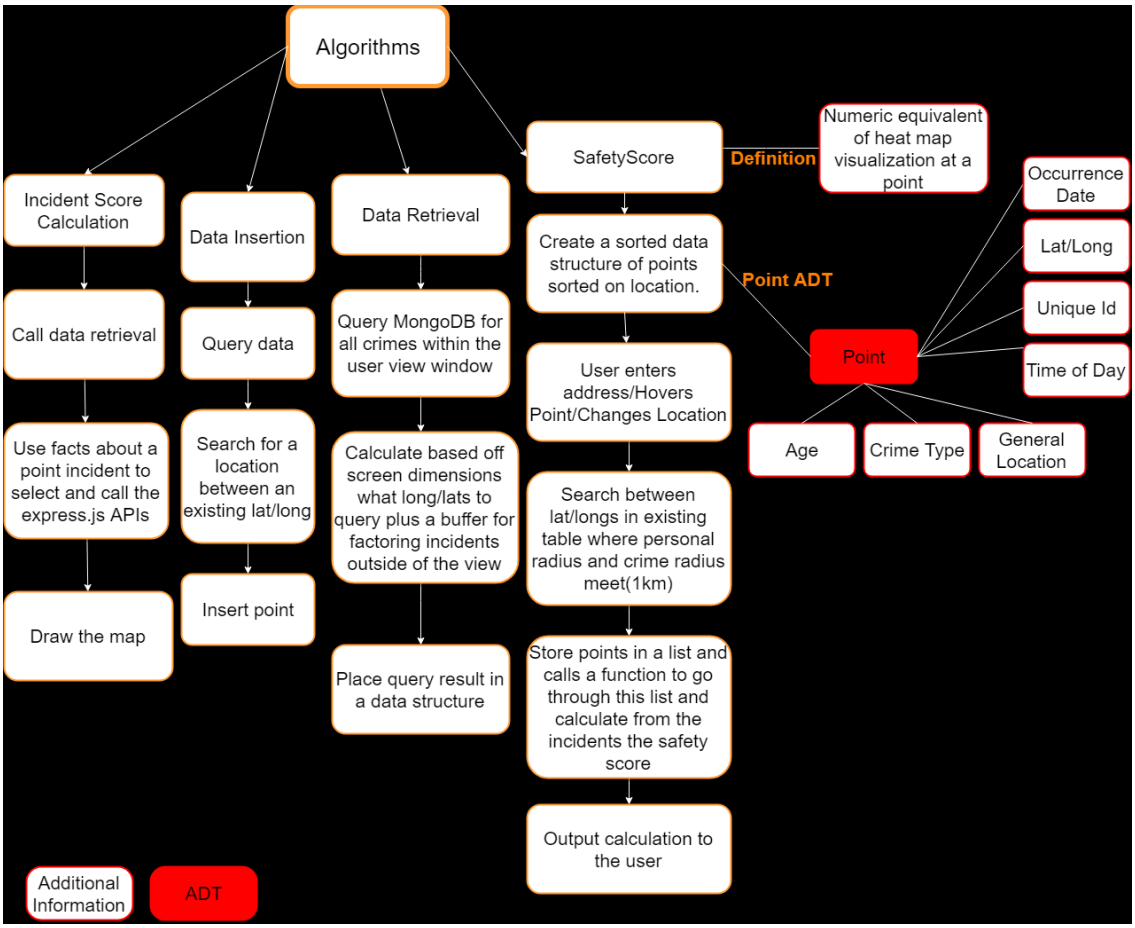

Figure 4. Algorithms Work Breakdown Structure. This diagram presents the algorithmic approaches used in Crime HotSpot. Reprinted from "Presentations" by Crime HotSpot, 2018, Retrieved from https://www.cs.odu.edu/~cpi/old/410/silverf18/presentation

2.3 External Interfaces

Interfaces necessary for proper development and functioning of the application are listed in following sections.

2.3.1 Hardware Interfaces

The primary hardware interface is the Ubuntu Linux VM, acting as the web server and application server.

2.3.2 Software Interfaces

Software interfaces include the Google Maps API and the MEAN stack collection of frameworks (MongoDB, Express.js, AngularJS, Node.js). The MEAN stack allows the team to work in a tightly coupled ecosystem of JavaScript constructs, permitting more time to learn the concepts of full stack development.

2.3.3 User Interfaces

The Crime HotSpot heatmap interface acts as the home point for users to interact with the application.

2.3.4 Communications Protocols and Interfaces

N/A