Lab 1 - Crime HotSpot

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1. Introduction

Most crime mapping software is designed to present crime data as it is. These applications do not come with tools to filter and display crimes based on type, age and severity. These applications do not calculate the safety of an area but leave it to the judgement of the user. Most crime mapping software calculate the safety of regions and not as a continuous measurement. Without the help of these features, users must be self-reliant when interpreting the safety of an area.

Crime HotSpot will be an integrated system that will provide a better way for people to view crime data. Crime HotSpot will present crime data to users using a heatmap and interactive interface. The interface will allow the user to distinguish crime types based on relevance to the user making the application adaptable to each individual user.

Crime HotSpot will eliminate these issues. By giving the user the ability to filter crimes and distinguish the relevance of each crime based on type, age and severity, Crime HotSpot becomes tailor made to its users. Users who are more interested in crimes of theft, such as banks and stores, can assign a higher weight to that type of crime. Users who are more interested in crimes of rape and murder, like those looking for a house, can assign a higher weight to that type of crime. Crime HotSpot will show the safety of an area with a heatmap as an alternative to an icon graph. That way users can see what locations are the safest based on their own assigned weights. And by hovering the mouse over the screen, users will be able to see an approximation of the crime safety score at any point on the map.

2. Product Description

One of the main features of Crime HotSpot is the heat map. A heat map is a representation of data in the form of a map in which data values are represented as colors. Using a heat map, the crimes committed in an area will be depicted as shades of colors that represent the density and severity of crimes committed in an area. This is an alternative to icon graphs, which show individual crimes with dots or icons. As the number of crimes increase, the map becomes more and more cluttered making it harder to read. A heat map simplifies a map, reduces data noise and visualizes crime data making it easier to understand.

2.1 Key Product Features

Crime HotSpot will have four main features: crime statistics, geographical crime references, Crime Heatmap, and SafetyScore. The crime statistics will be an analytics page that gives detailed statistics about crimes in an area. Statistics like density of crimes based on population and area will be shown. The Crime Heatmap will make the prominence of crime in an area more visual and easier to understand. The SafetyScore is an approximation of the safety of an area at each individual point. It is based on the type, age, severity and location of crimes committed in an area.

2.1.1 Crime Statistics

When people are evaluating an area based on crime, they usually want some kind of measurement that they can compare to other areas. These could be things like the density of crimes based on the population. They may also want to know things like the days when crimes are most prominent. If a new restaurant plans to serve more customers over the weekend, then the owners might plan to build the restaurant somewhere with fewer crimes over the weekend.

Some crimes are known to be committed at certain times of the year, for example during holidays.

2.1.2 Geographical Crime References

As crime data can be misunderstood, Crime HotSpot removes the ability to see individual crime reports. Some crimes may occur on someone's property. Some may interpret that as being the fault of the property owner, or resident, when in reality that property may be convenient for criminals. So that people cannot put the blame on individuals living in the midst of crimes, Crime HotSpot removes the ability for users to see individual crime reports and their locations. This is in the person's best interest so that they cannot be falsely accused of being responsible for crimes committed on their property.

2.1.3 Crime Heatmap

As the number of crimes in an area, icon graphs become harder and harder to read. Since each crime is plotted as a dot or icon on the map, the map will be overcluttered with information to the point of not being able to see the map itself. To solve this problem, Crime HotSpot uses a heatmap. A heatmap is a representation of data in the form of a map or diagram in which data values are represented as colors. Crime HotSpot will utilize the Googles heatmap API to create a heatmap overlay. The crime datapoints along with their weights will be passed to the API, which will then calculate the color of each pixel on the map. The crime data will be hidden from the user, even in debugging mode. When the map is shown, it will be very hard to distinguish individual crimes.

Figure 1. Icon graph

2.1.4 SafetyScore

The crime SafetyScore is the main selling point of Crime HotSpot. It is something that is not found in other crime mapping software. The SafetyScore is a heuristic that approximates the safety of each point in an area. It is calculated based on the nearby crimes, their age, severity and type. What is very special about the SafetyScore is the ability for users to adjust the weights and filters used in the calculation to suit their individual needs. Instead of calculated the score of a region like some software do, the SafetyScore is calculated as a continuous function and can be evaluated for any point on the map. This gives users the ability to hover their mouse over the map and see the value of the SafetyScore at any point.

2.2 Major Components

There are four major components of Crime Hotspot: the website, the Google Maps API, the database and application server. Each will serve an important role in the project.

2.2.1 Crime HotSpot Website

The website will be the main way that users use the Crime HotSpot application. User will be able to open the website and use the app. The website will also contain information about the developers.

2.2.2 Google Maps API

Crime HotSpot will use the Google Maps API to show the map in the web browser along with the heatmap overlay. The Google Maps API is a powerful tool used by many companies. But the API is not free. Instead the API uses a security key linked to a bank account. Whenever a certain number of uses is reached, the API begins charging for more uses. This will not be a

problem so long as the number of uses stays below 25,000 uses per day. If the website becomes more popular, an ad service will need to be implemented to accommodate further charges. To protect the security key, Crime HotSpot will load the corresponding map in the server and then send the map object to the client for viewing.

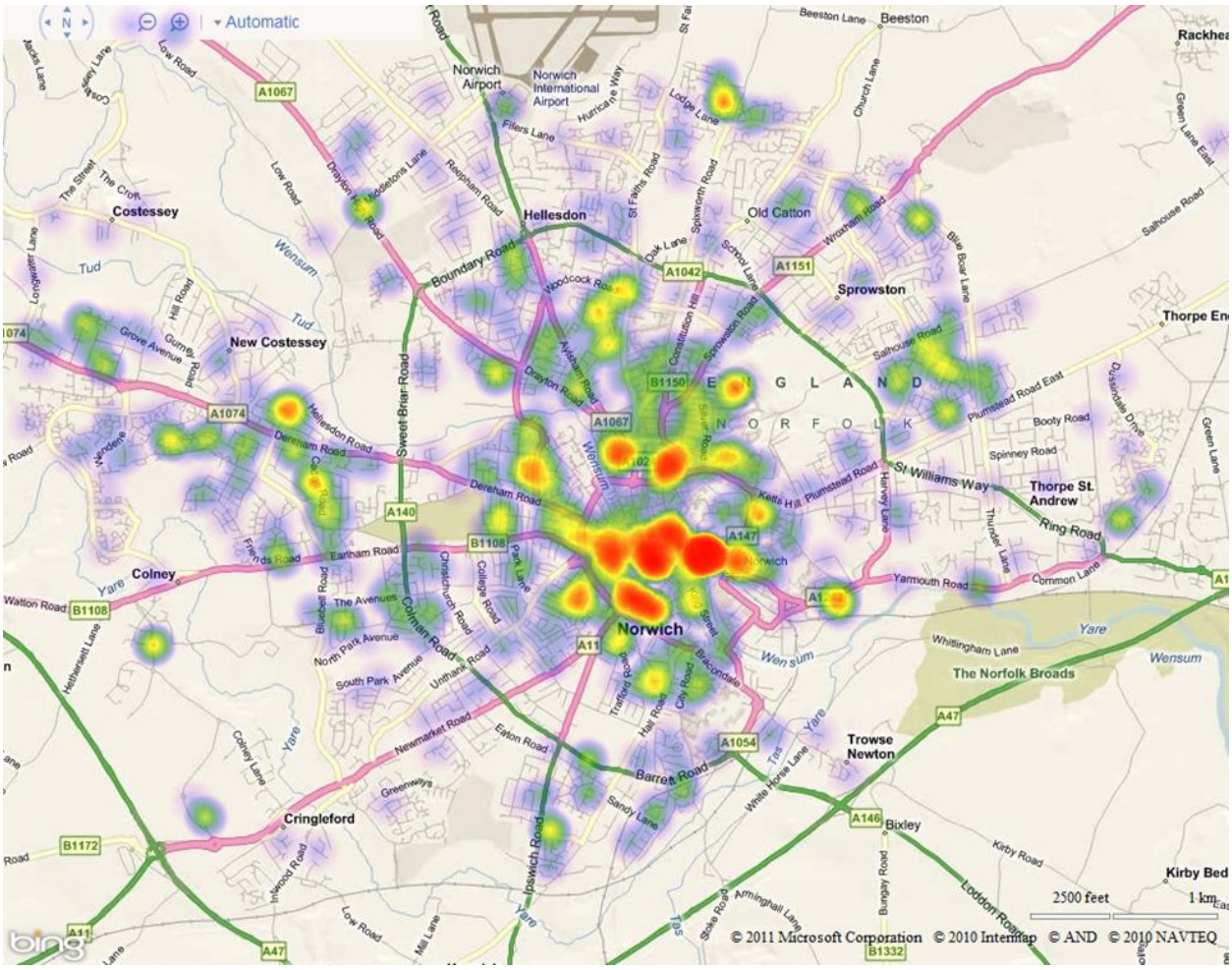

Figure 2. Google Map and Heatmap Overlay

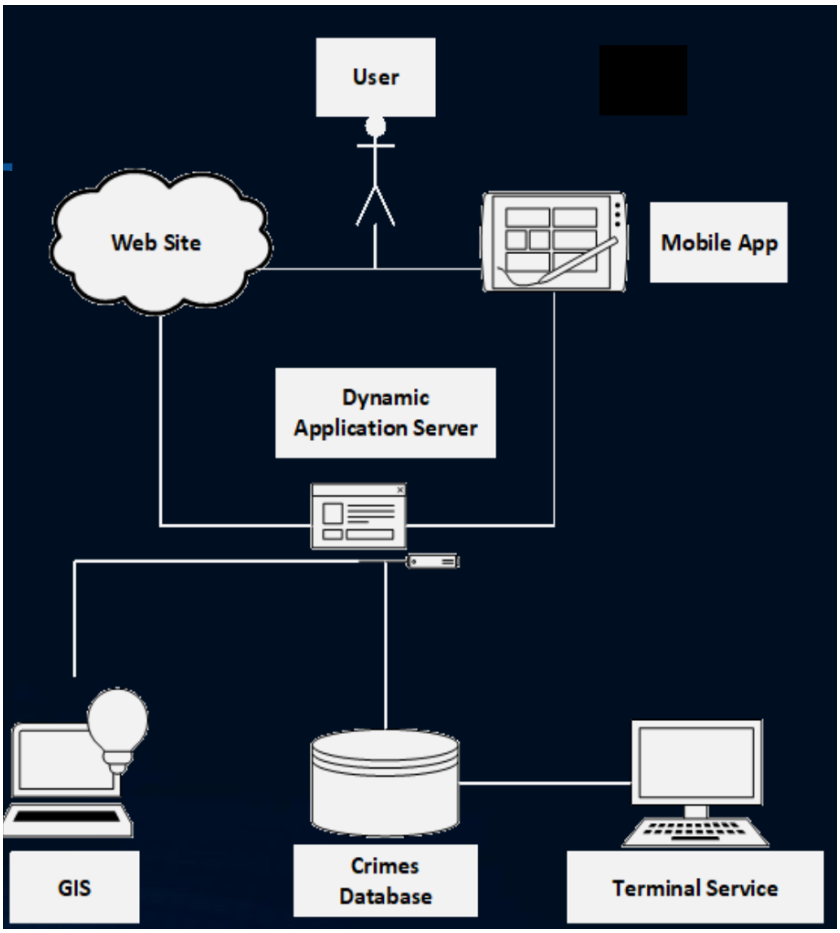

Figure 1. Crime HotSpot Prototype Architecture Design

2.2.3 Crimes Database

The crime data will be organized and stored in a database. The main challenges of the database are getting access to public crime data and formatting them so that all the data will be stored in the same way. MongoDB will be used to aid in this.

2.2.4 Application Server

The application server component will be responsible for data storage, client hosting and map generation. By making the server responsible for crime data, the data becomes more secure

and individual crime incidences become harder to steal. The server will also be responsible for managing individual client hosts where data is stored temporarily while the user is using the application.

3. Identification of Case Study

Obviously people are concerned with all types of crimes no matter the kind. But some crimes may be more or less important to certain types of pepol Assume someone is planning on opening a store. As they will probably be concerned with the crimes committed in that area, not all crimes will be relevant to them. They will be more concerned with crimes of theft and burglary and less with drugs. Women moving to college will be more concerned with rape while men may not. Someone with a really nice car or motorcycle may be very concerned about crimes of motor-vehicle theft. Whatever crimes someone is most concernec with

4. Product Prototype Description

The Crime HotSpot prototype will consist of all necessary parts except the mobile app. These components are the server, database, website and web app. The mobile app will be completed after the prototype is finished.

4.1. Prototype Architecture

The prototype will consist of the server, database, website and web app. The website will run the web app and will fetch the map and heatmap objects from the server. The server will calculate of heatmap from the crime instances stored in the database.

4.1.1. Crimes Database

The database will store crime data using MongoDB. New crime reports will be loaded to the data base periodically or when new data is made available. Most crime data are not recorded with the geographical coordinates of where the crime occurred but instead with the address. The data base will parse and format the crime data to get the longitude and latitude coordinates from the addresses listed in the crime files. When a crime map is requested from a client, crime data relevant to the area of the map is loaded into a map object along with the calculated weights of each crime. The map is created using the API key, and sent to the client.

4.1.2. Web Page

The prototype's webpage will contain all relevant information for using Crime Hotspot. It will contain the web app for viewing the crime map along with the interface

4.1.3. Application Server

The application server will be responsible for hosting individual user sessions. Each user that opens the web app will have a session on the server. The purpose of each session is to create a crime map of the users area, load crime data from the database and send the crime map to the client for viewing.

4.1.4. Google Maps API

Crime HotSpot will use the Google Maps API to show the map in the web browser along with the heatmap overlay. The Google Maps API is a powerful tool used by many companies; but the API is not free. Instead the API uses a security key linked to a bank account. Whenever a certain number of uses is reached, the API begins charging for more uses. This will not be a

problem so long as the number of uses stays below 25,000 uses per day. If the website becomes more popular, an ad service will need to be implemented to accommodate further charges. To protect the security key, Crime HotSpot will load the corresponding map in the server and then send the map object to the client for viewing. This way the API security key is not viewable by the user even in browsers that have developer modes.

4.2. Prototype Features and Capabilities

The Crime HotSpot prototype will have most of the features of the final product. The prototype will open a Google Maps interface centered on the ODU campus with the crime heatmap overlay. The user will be able to adjust the crime weights and see the heatmap overlay change to match the new weights. The prototype will also have an analytics page showing statistics pertaining to the crimes of the shown area. Because crime data is only obtained for the ODU campus, crimes committed outside the campus will not be used in the prototype. Instead, if the user pans the map to other places, the browser will show a warning that no crime data is available for that area.

4.2.1. Crime Categories

Crime HotSpot will organize crime in one of five categories. The categories are based on the severity of the crimes. From most to least severe the categories are, severe crimes against the person, crimes against the person, crimes against property, crimes against the public and uncategorized. Severe crimes against the person involve assault, aggravated abduction, motor vehicle crash and hit and run. Crimes against the person involve dating violence, harassment and sexual assault. Property crimes involve crimes that affect property. Crimes against the public are the least severe and the most common. These involve DUI, Disturbance, Fire Alarm, Public

Intoxication and underaged drinking. Uncategorized crimes involve all others. The severity of these crimes will not be factored into the crime SafetyScore by having a severity weight of one.

4.2.2. Location

At first crime data will only be taken from the ODU Police Departement. But further development will involve near by Police Departments. Each may store their data in a different format. Therefore, multiple formatting functions will be used so that each database can be read by the server.

4.2.3. Static Database

Although an app with constant update to new crimes would be useful, the prototype will instead run on a static database. When the client fetches data from the server, the data will not be updated until the client fetches data again. This will prevent the ability of seeing new crimes as they are committed but will make the system simpler to develop.

4.2.4. Crime Heatmap

The crime heatmap will show the distribution of crime in an area. The heatmap will be generated from the Google Maps API in the server and sent to the client. This is to protect the API key from being stolen by the user. The heatmap will be generated based on all the crimes committed in the desired region and according to the weights assigned to each crime. The weights will be calculated by the server based on the users specifications.

4.3. Prototype Development Challenges

The main challenges in development will be learning new programming languages. These languages are JavaScript MEAN stack and Python. Most members in the development team are

not yet familiar will the languages they will be using. These languages are intended to simplify the development process but must first be learned. Other challenges include securing the API security key and handling a higher amount of users.

4.3.1. JavaScript MEAN Stack

The database will be programmed using MongoDB.js to store and organize crime data. The website backend will be programmed with Express.js. Angular.js will be used for the front end application.

4.3.2.Cross-browser Compatibility

The Crime HotSpot prototype will be first developed to work with Google Chrome. All development and testing will be done there. Once development on the prototype is complete, development and testing will be performed on other browsers as well.

5. Glossary

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

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

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

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 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.

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