Spatio-temporal crime data analysis in Cardiff city.

A dissertation submitted in partial fulfilment of the requirements for the degree of Bachelor of Science (Honours) in Software Engineering

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Declaration

I hereby declare that this dissertation entitled *Spatio-temporal crime data analysis in Cardiff city* is entirely my own work, and it has never been submitted nor is it currently being submitted for any other degree.

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Abstract

This project aims to analyse and understand the spatio-temporal crime data by exploring the spatial and temporal behaviour patterns that contribute to the presence or absence of criminal offences. The crime data will be downloaded from data.police.uk which contains open data about crime and policing the United Kingdom. But, this project will only use a sample data-set in Cardiff city for evaluation. Next, the data-set will be imported into a SQL database, and a java application will be created to query and analyse the data. Moreover, Google Maps API will be used for spatial visualisations. Specifically, this work will analyse the effect specific seasons/events on the drop or increase of the number and types of incidences. Also, it will discover the unsafe geographic hot spots that witness an increase in the number or types of crime incidences.
Acknowledgements

In the Name of Allah, the Beneficent, the Merciful First praise is to Allah, the Almighty, on whom ultimately we depend for sustenance and guidance. Second, I would like to thank my precious wife Haya. Her support, encouragement, quiet patience and unwavering love were undeniable. She gave me support and help, devotion and love. Further, I would like to thank my parents and my old sister, Dr Khalid and Fawiziah and Soha, for their faith in me and allowing me to be as ambitious as I wanted my sincere appreciation goes to my supervisor Dr Chaminda Hewage, whose guidance, careful reading and constructive comments was valuable. Her timely and efficient contribution helped me shape this into its final form and I express my sincerest appreciation for his assistance in any way that I may have asked.
Contents

Abstract i

Acknowledgements ii

Contents iii

List of Figures vi

List of Tables viii

1 Introduction 1

2 Literature Review 4

2.1 Background Information 4

2.2 Introduction 5

2.3 Association of Crime with Specific Behavior 6

2.4 Crime and Location 7

2.5 Effect of Police Action on Crime 9

2.6 Conclusion 10
3 Specification and Design

3.1 Overview

3.2 Data Source

3.3 Crime Types

3.4 Temporal and Spatial behaviour patterns

3.4.1 Spatial Patterns

3.4.2 Temporal Patterns

4 Implementation

4.1 Software Design

4.1.1 DB Browser for SQLite

4.1.2 NetBeans IDE 8

4.1.3 Google Maps API

4.1.4 Excel

4.1.5 Dropbox

4.2 Framework

4.3 Project implementation and source code

4.3.1 Crime Data Analysis

4.3.2 Crime Search in Locations

4.4 Geospatial Distribution of Crime Data

5 Results

5.1 Nature of Crime and Their Incident Count

5.2 Nature and Distribution of Crime in Cardiff
5.3 Distribution of Different Form of Crime in the year 2016..........................31
5.4 Different types of Crime and their Prevalent Locations .........................32
5.5 The Trend of Shoplifting in Cardiff.................................................................34
5.6 Trend Showing Violence and Sexual Offense .............................................35
5.7 The Trend of Public Order Crime .................................................................36
5.8 The Trend of Drug Offence in the Year 2016 .............................................38
5.9 Burglary in Cardiff.........................................................................................39
5.10 Bicycle Theft Pattern in Cardiff.................................................................39
5.11 Theft from a person in Cardiff.................................................................40
5.12 Robbery locations in Cardiff......................................................................42

6 Conclusion ........................................................................................................44

Bibliography ........................................................................................................46
List of Figures

3.1 View of Cardiff Records .............................................. 12
3.2 Illustration the Geospatial Distributions of Crimes on Google Maps 15
3.3 Robbery Query ...................................................... 15
3.4 The Query of Temporal Distribution of Crimes in Locations .... 16
4.1 Crime Analysis Framework ........................................... 21
4.2 Database Connection Code .......................................... 21
4.3 Database Connection Code .......................................... 22
4.4 Execute Query Java Code ............................................. 22
4.5 Create View Code .................................................... 23
4.6 Temporal Search Java Code .......................................... 23
4.7 Temporal Search Example 1, Location: City Road ............... 24
4.8 Temporal Search Example, Location: Newport .................... 25
4.9 Non-Temporal Search Example 1, Location Newport Road ...... 26
4.10 Non-Temporal Example 2, Location: Queen Street ............. 27
4.11 Extracting Longitudes and Latitudes Query ....................... 27
4.12 Geospatial Distribution of Robbery Crimes in Cardiff ........................................ 28

5.1 The Distribution of Different Crime Category incidents in Cardiff .................. 31
5.2 Crime Rate in the whole of 2016 from January to December ...................... 33
5.3 Different types of Crime and their Prevalent Locations ................................. 34
5.4 Line Graph Showing Shoplifting Crimes in Cardiff in the Year 2016 ............. 35
5.5 Line Graph Showing the Trend of Violence and Sexual Offense ................. 36
5.6 Linear Graph Showing the Drug Crime Count in Cardiff ............................ 37
5.7 Drug Offence in the Year 2016 ........................................................................ 38
5.8 The Spatial Distribution burglary in Cardiff .................................................. 40
5.9 Distribution of Bicycle theft in Cardiff ......................................................... 41
5.10 Spatio Pattern of Theft from Person in Cardiff ............................................. 42
5.11 Robbery Spatio Pattern in Cardiff ............................................................... 43
# List of Tables

3.1 Downloaded South Wales Police Data .............................................................. 11

3.2 Cardiff Crime Data Set .................................................................................... 12

3.3 Locations Example in Cardiff Data Set .............................................................. 14

3.4 Temporal Distribution of Robberies in Cardiff City ............................................ 16

3.5 My caption ........................................................................................................ 17

5.1 Showing The Crime Type a Number of Incidences That Occurred in Cardiff ................................................................. 30
Chapter 1

Introduction

This project aims to analyse spatio-temporal crime data that is available on-line. Crime is one of the high risk problems that faces all countries all over the world, an being safe is the dream of every person in the whole world. With the availability of crime data on the internet, it is really important to analysis crimes and understand the effect of spatial and temporal patterns on the occurrence of crime incidents. Moreover, identifying safe locations and being able to know the frequency of crimes that occurs in a specific location in different times of the year is one of the objectives of this project.

The key aims of this project is as follows:

1. Understand the different dimensions of crime data
2. Understand the effect of spatial and temporal patterns on the occurrence of crimes
3. Identify safe and unsafe locations
4. Identify the change of crime occurrence in given location
5. Visualize the geospatial distribution of crimes on maps
6. Evaluate the system on a real dataset in Cardiff City

In order to fulfil these aims, we identified the main requirements, then an eight week research plan was followed to develop, evaluate and document the project. The main tasks identified in the research plan is as follows:
Week1:

- Download a dataset from data.police.uk within south wales area during year 2016 and clustered into months.
- Select Cardiff City for evaluation and group the data into one file and import the data into an SQL database, each city in a separate table.
- Gather papers for literature review and read them.

Week2:

- Write a Java program that reads and query the SQL database.
- Gather some statistics about the data.
- Analyse the data according to the following research questions:
  - Q1: Are there any relationship between specific months of the year and crime incidents?
  - Q2: Do more crime incidents happen in certain geographic areas?
- Write the Background Chapter.

Week3:

- Study the various visualization tool techniques that can help to visualize the data.
- Use google maps API to visualize the two research questions Q1 and Q2.
- Write a draft from Specifications and design Chapter.

Week4:

- Implement a search function that search crimes in specific locations.
• Extend the search function to display the temporal change of crimes in specific locations.

• Write a draft of the Implementation Chapter.

Week5:

• Test the program on the dataset from Cardiff.

• Compile the results, and complete the figures needed.

Week6:

• Write the Results and Evaluation Chapters.

Week7:

• Write the Future Work Chapter and finish the final report.

Week8

• Combine the chapters and produce the final document.
Literature Review

2.1 Background Information

It cannot be overemphasized that crime-related offenses are on the priority list of many countries due to its effect on the economy and the safety of the people. It is, therefore, imperative that measures be taken to mitigate the crime from all fronts including but not limited to empirical research. With research, several aspects of crime can be established which in turn will aid in coming up with the strategies to combat them in a more directed and purposeful way. It has been shown that through empirical research on crime, crimes assume certain trends or patterns. Understanding such trends can help to reduce the incidents of crime and its prevalence in a given area. The objective of this review is to analyze and understand the Spatio-temporal crime data by exploring the spatial and temporal behavior patterns that contribute to the presence or absence of criminal offenses.

The behavior pattern that is core to this review is the seasonality of crime where there is increment and reduction of crime basing on when a crime is analyzed regarding months. The nature of the crime can also be associated with a season which is an important perspective for the analysis. The review will also examine the tendencies of crime to be associated with certain geographical areas that later become the hotspots experiencing higher crime rates. The review, also, examines research findings on the effect of the police investigation on the crime occurrence. It has been observed that
before crime investigations are launched, there are higher incidences of crime than after the investigations are initiated. These aspects form the types knowledge that can be derived from the Spatio-temporal pattern analysis.

2.2 Introduction

Spatio-temporal pattern analysis is an important aspect especially on the analysis of crime. Kelvin & Anna (2015) define spatiotemporal pattern analysis as a process that gets its information and knowledge from given localities and within a well-defined time frame (p.2). This dimensions of crime provide a good basis for analyzing crime. Kelvin & Anna (2015) further looks into the knowledge that can be obtained using the parameters such as time and place about crime. There is some knowledge that can be obtained including the behavioral aspect of the offense (p.5). Such knowledge can only be obtained, according to Kelvin & Anna (2015) through different kinds of spatial-temporal patterns of breakdown (p.4).

The only limitation is the absence of related systematic review that can provide a lead on how to get similar or related knowledge from different trends of crimes. There are a fivefold spatiotemporal crime trends that determine the knowledge obtained about crime. They are of significance in getting a different kind of knowledge from crimes incidents. There is the spatial pattern which is a significant aspect of analysis. In this pattern, crime does not occur evenly a given area. Some experiences higher rates of crimes while others experience remote kind of crimes. It is through this pattern that some areas are defined to be hotspots which are defined by Kelvin & Anna (2015) as an area with higher than normal rates of crime (p.6).

The second aspect of the trend in crime is known as the temporal pattern where crime occurs on the transient manner in that certain conditions have to be met for it to occur. Such conditions include an inspired offender, suitability of target and absence of surveillance. In this pattern of crime, the cost-benefit analysis is done by the offender
before executing the crime. Then the other pattern is the frequent Spatio-temporal pattern which according to Kelvin & Anna (2015), it determines the confluence existing between the space, time and event. With this pattern, there are areas that are designated as Spatio-temporal hotspot. The characteristic of Spatio-temporal hotspot is the aoristic nature of the crime with the almost even distribution of crime in an area over time.

The fourth trend is known as unusual Spatio-temporal is where crime is believed to happen on arbitrary cases and in a random manner that cannot be easily localized. Crime in an area is dispersed with no aoristic characteristics when crime mapping is done (Caluwe & Bordogna, 2004, p.8). Finally, it is Spatio-temporal pattern can be explained by the intervention that is being taken by the local authorities. It is a pattern that is well explained by displacement theory posited by Kelvin & Anna (2015) in their research. The theory has it that some of the police investigation and anti-crime activities do not, in essence, prevent crime but shift the hotspot of crime in the nearby theory. To that effect, the action of the police should be well organized and strategize if the crime is mitigated instead of being shifted. The five aspects of the Spatio-temporal pattern analysis can be related in some of the crime-related research articles.

### 2.3 Association of Crime with Specific Behavior

One of the temporal patterns is seen in a research that was conducted in India with women being the victim. It is temporal because of nature is seen in them such as a target, motivated offender, and suitability of the environment. In this research, it has been shown that assault of women takes specific dimension of behavior. It such behaviors that need to be analyzed so as to come up with mitigation strategies. Ruchita and Heiser (2012) observed in research that was conducted in Indian population that crime had gender dimensions with high cases incidences occurring because of the suitability of the conditions such as culture and environment (p.43). Most of the crime were
2.4 Crime and Location

directed towards young girls to a stage of capturing a global attention. The crimes involved rape, assault of women and even madder. The trend could clearly show that the country was turning into a brutal place for women to live. Compared with other crimes, the spikes of women suffering dominated most of the analysis done. It made assault and crime against women to be a national priority.

However, the analysis of the crime against women had its underlying causes that needed to be addressed if they were to have a comprehensive solution to the problem (Weisburd & Bruinsma, 2009, p.32). Through empirical research, Ruchita and Heiser (2012) came up with the behavioral reason as to why the crime in India led to the victimization of women (p.29). Some of the reason included lack of awareness of the populace, inadequate infrastructure and program for the safety and protection of women. Besides, some cultural reasons in India made crime on women to be higher than any other demographics. The culture of Sati and Dowry also had a causative element on the brutalization of women. Through Spatio-temporal crime data analysis, the association of crime with behavior can easily be established, and solution meted (Weisburd & Bruinsma, 2009, p.77). It is better that a data set is examined in relation to gender base crimes in Cardiff for the analysis since they have shown some of the association.

2.4 Crime and Location

Another intriguing aspect of crime is its relationship with location or region. Findings of many pieces of research have indicated that crime incidents are higher in some areas compared with other. Ruchita and Heiser (2012) it indicated that crime against women was more pronounced in the rural area compared to the Urban area (p.89). The tendency of crime being restricted to certain area is becoming evident in most of the research done. Evidence shown by a survey done by Todd-Bennett (2015) using social media big data such as Twitter has shown that there is a significant relationship between
crime and certain location (p.38). It is due to this predisposition that some areas are known to be the hotspots of crime while other are considered to be safe (p.3). The understanding of the Spatio-temporal crime data and the behavior pattern be important in localizing where the crimes are likely to be high. Tableau and Safei (2012) indicated that the modern time world has an established many software to locate areas that are most vulnerable to crime (p.67).

The additional resources that can aid in the precise location of crime id Police Application Program Interface (API) which provide better visualization of and comparison of crime in the relationship with the crime occurrences. Todd-Bennett (2015) goes ahead and provide a systematic approach that proves the importance of analyzing social media data in connection with a crime (p.4). The analysis, Pearson chi-squared statistical test been used and reveal the capacity to show the correlation that exists a crime incidence on Twitter and its actual spatial area. The research done by was in larger London, and it was shown through spatial analysis that most of the crimes occurred within the Metropolitan area London. More important to the analysis of the data obtained from Twitter is the other application that was used including the JavaScript programming language, CSS, and HTML coupled up with Google Maps and API as a mapping device (Caluwe & Bordogna, 2004). It is evidenced that location has more relevance when analyzing the crime incidences (Geradts & Veenman, 2009, p.34). The establishment of this relationship is dependent on the technique that is put in place.

Core to this software that is keen on locating the crimes in their exact areas is the gravity and the nature of the crime that is attached to the locality. Different areas experience a different type of crimes. Ruchita and Heiser (2012) indicated that rural areas experience crimes that are culturally and less advanced than those that are in the urbanized areas (p.48). The locality of a place can also determine the technique that will be used in gathering the data and information from people. The cases of rape and assault of women shown by Ruchita and Heiser (2012) indicated that they cannot be easily be availed when compared to the crimes that are in highly digitized areas like

2.4 Crime and Location
Metropolitan areas within London (p.12). Consequently, for a successful analysis and acknowledgment of Spatio-temporal crime data by exploring the spatial and temporal behavior patterns, the digitization of the population and how urbanized they are is necessary.

### 2.5 Effect of Police Action on Crime

Various research has shown that police action has an influence on the area that crime is endemic. It does not necessarily prevent the crime from happening but only causes a shift on the crime scene. In research done by Ruchita and Heiser (2012) in India established that rape cases kept shifting from within the rural area with every police intervention that was done (p.22). It is a finding that is in agreement with the principles of the Spatio-temporal pattern which is based on the theory of displacement where police of any investigation done in an effort of deterring the crime will end up maintaining the crime level area but the prevalence is maintained at the same state. The level of crime incidence may remain the same in the area but the locality is displaced. It is the same scenario that was found by Tableau and Safei (2012) that where a crackdown on criminal activity led to higher crime incidents in the area neighboring Cardiff. It is a finding that needs more of research to invoke the reasons that could be leading to this displacement effect of crime. However, an interesting relationship in this displacement phenomena is that area with the even hotspot of crime activity is usually vulnerable to the displacement effect. In the event of isolated hotspots of crime in an area, then there is the likelihood that the displacement effect will not be felt. It is, therefore, necessary that a Spatio-temporal pattern analysis is done to find such effect of police intervention on the crime incidences since they provide a clue on a strategy to be used and prevent crime in entirety.
2.6 Conclusion

In summation, it can be seen that crime has a number of patterns that are associated with human behavior. Spatio-temporal pattern analysis is significant in associating the relationship that exists between crime, time and location of the areas. Other factors that have an important relationship with crime include the intervention of the authorities. It is through Spatio-temporal pattern analysis technique that aspects such as hotspot of the offense, displacement effect of crime and clustering of crime areas can be identified. To that effect, for better strategies to combat crime, such relationships should be factored in and solution based on those factors be made if the crime is to be dealt with in a conclusive fashion.
Chapter 3

Specification and Design

3.1 Overview

This goal of this chapter is to provide knowledge on how the crime data was gathered and analysed. The chapter includes the discussion of data, statistics and applications used.

3.2 Data Source

The data set used in this project were downloaded from data.police.uk which contains open data about crime and policing in the United Kingdom. The website lets you download a *.csv file that provides street level crime, outcome, and stop and search information broken down by police force. Also, it allows you to download the data within a specific time range. South wales police was chosen as the desired data source and the date range was chosen to be during 2016. Table 3.1 shows an example of the data downloaded. This data is imported to a SQLite database. SQLite is different from

<table>
<thead>
<tr>
<th>Crime ID</th>
<th>Month</th>
<th>Reported to</th>
<th>Falls within</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Location</th>
<th>LSOA code</th>
<th>LSOA name</th>
<th>Crime type</th>
<th>Last outcome category</th>
</tr>
</thead>
<tbody>
<tr>
<td>44df4e66</td>
<td>2016-01</td>
<td>South Wales Police</td>
<td>South Wales Police</td>
<td>3.131859</td>
<td>51.700286</td>
<td>On or near Parking Area</td>
<td>W01001466</td>
<td>Blaenau Gwent 009C</td>
<td>Violence and sexual offences</td>
<td>Unable to prosecute suspect</td>
</tr>
<tr>
<td>3e0208261</td>
<td>2016-01</td>
<td>South Wales Police</td>
<td>South Wales Police</td>
<td>51.634723</td>
<td>3.658828</td>
<td>On or near Tudor Estate</td>
<td>W01000991</td>
<td>Bridgend 001A</td>
<td>Anti-social behaviour</td>
<td></td>
</tr>
<tr>
<td>db7407c8</td>
<td>2016-01</td>
<td>South Wales Police</td>
<td>South Wales Police</td>
<td>51.639072</td>
<td>3.65968</td>
<td>On or near Heol Ceulanydd</td>
<td>W01000991</td>
<td>Bridgend 001A</td>
<td>Criminal damage and arson</td>
<td>Investigation complete; no suspect identified</td>
</tr>
<tr>
<td>6905860</td>
<td>2016-01</td>
<td>South Wales Police</td>
<td>South Wales Police</td>
<td>51.630072</td>
<td>3.659008</td>
<td>On or near Heol Ceulanydd</td>
<td>W01000991</td>
<td>Bridgend 001A</td>
<td>Criminal damage and arson</td>
<td>Unable to prosecute suspect</td>
</tr>
</tbody>
</table>
3.3 Crime Types

### Table 3.2: Cardiff Crime Data Set

<table>
<thead>
<tr>
<th>CrimeID</th>
<th>Month</th>
<th>Reported by</th>
<th>Fall within</th>
<th>Longitude</th>
<th>Latitude</th>
<th>Location</th>
<th>LSOAcode</th>
<th>LSOAname</th>
<th>Crime type</th>
<th>Last outcome category</th>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>39209a9</td>
<td>2016-01</td>
<td>South Wales Police</td>
<td>South Wales Police</td>
<td>3.180078</td>
<td>51.545667</td>
<td>On or near Lodge Close</td>
<td>W01001778</td>
<td>Cardiff0101B</td>
<td>Anti-social behaviour</td>
<td>Investigative complete; no suspect identified</td>
<td></td>
</tr>
<tr>
<td>40555af2</td>
<td>2016-01</td>
<td>South Wales Police</td>
<td>South Wales Police</td>
<td>3.179502</td>
<td>51.541797</td>
<td>On or near Millfield</td>
<td>W01001778</td>
<td>Cardiff0101B</td>
<td>Burglary</td>
<td>Investigation complete; no suspect identified</td>
<td></td>
</tr>
</tbody>
</table>

many other sql database engines because it is serveless and cross platform database. With SQLite, the process that wants to access the database reads and writes directly from the database files on disk. The data downloaded is aggregated over months. This means that each month has a separate file. To analyse all the data in 2016, we combined the tables of the twelve months into a single table, then we used the following query to create a view of all the records within Cardiff city as shown in Figure 3.1.

```
CREATE VIEW `Cardiff_2016` AS
  select * from southwales2016
  where southwales2016.LSOAname like 'Cardiff%'
```

**Figure 3.1: View of Cardiff Records**

The following table shows an example of the data after concatenation and selection of the data in Cardiff city. The data set contains 45,925 records. Each record represents a crime identified by a CrimeID. The crimes cover about 2884 locations in Cardiff with 14 different crime type.

#### 3.3 Crime Types

As mentioned above, the dataset downloaded contains 11 different types of crime as listed below.

1. **Anti-social behaviour:** It is defined as behaviour by a person that causes stress to one or more persons.
2. **Burglary**: It is an illegal entry of a building with intent to commit a crime, especially theft.

3. **Vehicle crime**: It is a criminal act of stealing or attempting to steal a car.

4. **Criminal damage and arson**: A person who destroys or damages any property belonging to another.

5. **Drugs**: It is the crime of having one or more illegal drugs in one’s possession, either for personal use, distribution, sale or otherwise.

6. **Robbery**: It is person accused of robbing another person or place.

7. **Theft from the person**: It covers theft (including attempts) of item or items (e.g. cash, phone) directly from the victim, but without the use or threat of physical force.

8. **Shoplifting**: It generally refers to the theft of merchandise from a store or place of business.

9. **Possession of weapons**: It is the unlawful possession of a weapon by an individual.

10. **Public Order**: It is the crime which involves acts that interfere with the operations of society is the ability of people to function efficiently.

11. **Bicycle theft**: It is the crime of stealing a bicycle.

### 3.4 Temporal and Spatial behaviour patterns.

This project aims to analyse and understand the spatio-temporal crime data by exploring the spatial and temporal behaviour patterns that contribute to the presence or absence of criminal offences. Crime opportunities are neither uniformly nor randomly organized in space and time. As a result, unlocking these spatial and temporal patterns
3.4 Temporal and Spatial behaviour patterns.

<table>
<thead>
<tr>
<th>Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>On or near Ty-Gwyn Avenue</td>
</tr>
<tr>
<td>On or near Greenlawns</td>
</tr>
<tr>
<td>On or near Queenwood</td>
</tr>
<tr>
<td>On or near Clarendon Road</td>
</tr>
<tr>
<td>On or near Llanedeyrn Road</td>
</tr>
<tr>
<td>On or near Birchwood Road</td>
</tr>
<tr>
<td>On or near Ennerdale Close</td>
</tr>
<tr>
<td>On or near Pant Yr Wyn</td>
</tr>
<tr>
<td>On or near Pine Wood Crescent</td>
</tr>
</tbody>
</table>

Table 3.3: Locations Example in Cardiff Data Set

can help in understanding of the role of geography and opportunity, as well as enabling practical crime prevention solutions that are tailored to specific places or specific periods of times. The following subsections explains how did we address these the spatial and temporal patterns in our analysis.

3.4.1 Spatial Patterns

The spatial patterns in the data are represented by three columns: the location, the longitude and the latitude. The location column contains the streets and areas in Cardiff. Examples of the locations in the dataset is shown in Table 3.3.

The longitude and latitude are used to plot locations on Google maps. The Google Maps API is used to map the longitudes and latitudes to visually locate the locations of concentration of crimes in different areas of Cardiff city. We construct a *.csv file that contains a set of longitudes and latitudes as layer into google maps that is displayed as locations on the map. Figure 3.2 shows an example.
3.4 Temporal and Spatial behaviour patterns.

3.4.2 Temporal Patterns

It is important to study the temporal patterns in Crime analysis. For example, regarding burglary, repeated crimes burglary may occur in a specific place. Discovering these repeating crimes can help in crime prevention. The temporal pattern in our dataset is present by the month of the year. Our dataset time range is from January 2016 and up till December 2016. For example, if we want to find the temporal distribution of Robberies in each month in Cardiff city, we use the query in Figure 3.3. The results of the robbery query is displayed in Table 3.4.

```sql
select month, count(crimeid) as RobberyCount
from Cardiff2016
where crimetype like 'Robbery'
group by month
```

Figure 3.2: Illustration the Geospatial Distributions of Crimes on Google Maps

Figure 3.3: Robbery Query
Table 3.4: Temporal Distribution of Robberies in Cardiff City

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Robberies</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-01</td>
<td>11</td>
</tr>
<tr>
<td>2016-02</td>
<td>12</td>
</tr>
<tr>
<td>2016-03</td>
<td>12</td>
</tr>
<tr>
<td>2016-04</td>
<td>12</td>
</tr>
<tr>
<td>2016-05</td>
<td>16</td>
</tr>
<tr>
<td>2016-06</td>
<td>12</td>
</tr>
<tr>
<td>2016-07</td>
<td>12</td>
</tr>
<tr>
<td>2016-08</td>
<td>20</td>
</tr>
<tr>
<td>2016-09</td>
<td>15</td>
</tr>
<tr>
<td>2016-10</td>
<td>12</td>
</tr>
<tr>
<td>2016-11</td>
<td>12</td>
</tr>
<tr>
<td>2016-12</td>
<td>19</td>
</tr>
</tbody>
</table>

Also, if we want to discover the crime types in each location and its change in during the year, the following query groups and counts the crime types in each month using the query in Figure 3.4 Table ?? shows the output of the query. The table only show

```
select location, crimetype, month, count(crimeid) as crimecount
from Cardiff2016
group by location, crimetype, month
group by month
```

Figure 3.4: The Query of Temporal Distribution of Crimes in Locations

a subset of the results which contains the location City Road only. As shown in the table, the temporal distribution of the crime types are displayed for each location. For example, two Criminal damage crimes were convicted in City Road, one in September and one in November.
### Table 3.5: My caption

<table>
<thead>
<tr>
<th>Location</th>
<th>Crimetype</th>
<th>Month</th>
<th>crimecount</th>
</tr>
</thead>
<tbody>
<tr>
<td>On or near City Road</td>
<td>Anti-social behaviour</td>
<td>2016-08</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Anti-social behaviour</td>
<td>2016-09</td>
<td>2</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Bicycle theft</td>
<td>2016-04</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Burglary</td>
<td>2016-02</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Criminal damage and arson</td>
<td>2016-09</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Criminal damage and arson</td>
<td>2016-11</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Drugs</td>
<td>2016-06</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Other crime</td>
<td>2016-08</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Other theft</td>
<td>2016-07</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Other theft</td>
<td>2016-09</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Public order</td>
<td>2016-07</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Public order</td>
<td>2016-08</td>
<td>2</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Public order</td>
<td>2016-09</td>
<td>2</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Robbery</td>
<td>2016-06</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Vehicle crime</td>
<td>2016-01</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Vehicle crime</td>
<td>2016-02</td>
<td>2</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Vehicle crime</td>
<td>2016-03</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Vehicle crime</td>
<td>2016-05</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Vehicle crime</td>
<td>2016-08</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Vehicle crime</td>
<td>2016-09</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Vehicle crime</td>
<td>2016-11</td>
<td>2</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Violence and sexual offences</td>
<td>2016-01</td>
<td>1</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Violence and sexual offences</td>
<td>2016-06</td>
<td>3</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Violence and sexual offences</td>
<td>2016-07</td>
<td>3</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Violence and sexual offences</td>
<td>2016-08</td>
<td>2</td>
</tr>
<tr>
<td>On or near City Road</td>
<td>Violence and sexual offences</td>
<td>2016-09</td>
<td>1</td>
</tr>
</tbody>
</table>
Implementation

This chapter introduces the implementation of the system. It provides the technical information about the system including the system structure the software technology used.

4.1 Software Design

During the development of the project program, several software technologies were used. These are listed in the following subsections.

4.1.1 DB Browser for SQLite

SQLite is a sql database engine that is serveless and public, so it is free to use. We used SQLite to construct the database and import the tables of the crime data. It is also used to analyse the data by using the appropriate queries and storing the result of these queries in tables. The stored tables are then retrieved to produce graphs for the results.

4.1.2 NetBeans IDE 8

NetBeans IDE is an open-source integrated development environment. NetBeans IDE supports development of all Java application types (Java SE (including JavaFX), Java
ME, web, EJB and mobile applications). We use it for handling and querying the crime data. We also use it to build the program interface using the Java Swing library.

### 4.1.3 Google Maps API

Google Maps API is a software that allow developers to integrate Google Maps into their websites. It was essential to use google maps for geospatial distribution of crime locations. Using longitudes and latitudes, google maps is able plot the locations on the map. All visualizations and mappings of this project is done using the Google Maps API.

### 4.1.4 Excel

Microsoft excel was used to produce graphs of crime data analysis for this project. Results of queries are saved as tables or views in the database, then they are exported as CSV files. Using Excel, CSV files are used to produce graphs for this project.

### 4.1.5 Dropbox

In this project, we used the Dropbox as a primary backup for the project data files, sources code and documentation. The Dropbox tool is free and the folders can be accessed on multiple devices.

### 4.2 Framework

This project introduces a framework for spatio-temporal crime analysis. The proposed framework has three main function: 1) Crime data analysis, 2) Crime Location search, 3) Geospatial Distribution of Crime data. An outline of the framework is shown in
4.2 Framework

Figure 4.1. The crime analysis has different stages. The first step is to collect the data from the data.police.uk and store it in a CSV file. The data.police.uk provides CSV files that contain street level crime, outcome, and stop and search information, broken down by police force. We chose South Wales police force as our data source. We’ve also chosen 2016 to be the data time range. The CSV files downloaded is clustered into months. This means that we have a CSV file for each month that contains the crime data. To process the data altogether we had to concatenate these files to form one file CSV file only. This file is then imported in the SQLite database, each file in a separate table. We then use java to query the database to do our crime analysis. The results of the queries are also stored in the database either in a separate table or a view.

One of the important functionalities in our framework is the location search. In the crime data, there is a location field that has street names. The search functionality allows the user to input a name of the street and then search query is triggered and a list crimes are retrieved based on the name of the street that the user inputs. We also implemented a temporal search query that retrieves the crimes done in each month in this specific street so that the user can be aware of how safe is the street in the present and in the past.

The third functionality of the framework is to be able to provide a geospatial distribution of crimes in our dataset. This is done using Google Map API. The first step towards this is to retrieve the longitudes and latitudes of the crimes that we want to analyse and export it as a CSV file. Then, the CSV file is imported to Google Maps API which then displays locations represented by the longitude and the latitudes. Each crime locations can be displayed separately as layer, and multiple layer can be imported.

The three function are not separate because they all deal with the same data. With these functions, a user living in Cardiff can answer questions like what crimes are done in a specific area, how many? And when? Are the crimes committed all over the year? Do crimes increase or decrease in a specific period of time? What areas in Cardiff are safe?
4.3 Project implementation and source code

4.3.1 Crime Data Analysis

The first step to implement the crime data analysis functionality is to connect to the database. We need to establish a connection with the SQLite data source we use. The

```java
void sqlite_database_connection(){
    conn = null;
    try {
        Class.forName("org.sqlite.JDBC");
        conn = DriverManager.getConnection("jdbc:sqlite:CrimeData.db");
    } catch (Exception e) {
        System.err.println(e.getClass().getName() + ": "+ e.getMessage());
        System.exit(0);
    }
    System.out.println("Opened database successfully");
}
```
void sqlite_database_connection(){
    conn = null;
    try {
        Class.forName("org.sqlite.JDBC");
        conn = DriverManager.getConnection("jdbc:sqlite:CrimeData.db");
    }
    catch ( Exception e ) {
        System.err.println( e.getClassName() + ": " + e.getMessage() );
        System.exit(0);
    }
    System.out.println("Opened database successfully");
}

Figure 4.3: Database Connection Code

```java
stmt=conn.createStatement();
stmt.executeUpdate("select Month, CrimeType, count(CrimeType) as crimecount from Cardiff2016
    group by Month, CrimeType");
rs=stmt.getResultSet();
    while (rs.next()) {
        month=rs.getString("Month");
        crimetype=rs.getString("CrimeType");
        crimecount=rs.getString("crimecount");
        System.out.println(month + "..." + crimetype + "..." + crimecount);
    }
```

Figure 4.4: Execute Query Java Code

DriverManager is an implemented class that connects the application to the data source, which is specified with a URL. The class then attempts to establish a connection by loading the JDBC drivers found within the class path. Figure 4.3 shows the code for the database connection in Java.

When the database is opened successfully, the next step is to create a statement to execute a query. Figure 4.4 shows the steps for executing a query. In the figure, we execute a query that count the number of crime categories in each month. The output of the query is then stored in a variable of type result set. The result set contains the selected fields. To extract the desired information, we loop on the result set and extract the selected fields based on its data type. After executing all the queries needed, we want to store the results back in the database. There are two options for storing the data in the database. The first one is to create a new table and insert the selected data into it. The second option is to create a view from the selected Figure 4.5 shows the code for creating a view in the database.
4.3 Project implementation and source code

4.3.2 Crime Search in Locations

The crime search is implemented using a simple user interface that takes an input from the user from a text box, then executing a query that counts the number of crimes in the specified location. The search query is a conditional query, and the condition depends on the location that the user inputs in the text box. When the user press on the search button, we get the text in the text box and store it in a string. Then we execute the query and pass the text to the query as a 'where' condition. The result set is then retrieved and the output is displayed in a scroll list. Figure 4.6 shows the code of the temporal search function that is implemented when the button is pressed. Two search processes were implemented. A temporal and a non-temporal search process. The temporal process displays the search results clustered by months. So, for each month, the crime category is displayed and the number of crimes committed for this category. The non-temporal search process displays each crime type and the number of crimes calculated all over year 2016. Figures 4.7, 4.8, 4.9 and 4.10 shows four examples of searching locations.

```java
try{
    String query = "CREATE VIEW " + ViewName + " AS SELECT Location, CrimeType, COUNT(*) FROM CrimeTable 
    WHERE Location = ? ORDER BY Location, CrimeType;"
    PreparedStatement stmt = conn.prepareStatement(query);
    int i = 1;
    for (String location : locations) {
        stmt.setString(i++, location);
        rs = stmt.executeQuery();
        while (rs.next()) {
            String location = rs.getString("Location");
            String crimeType = rs.getString("CrimeType");
            int count = rs.getInt("Count");
            // Process the data
        }
    }
}
```
4.3 Project implementation and source code

Figures 4.7, 4.8 are examples of the temporal search. Figures 4.9 and 4.10 are examples of the non-temporal search. As you see in figures 4.8 and 4.9, the same location was used to do the search: ‘Newport Road’, but the results are calculated differently. One calculates the number of crimes in each month and the other counts the overall number of crimes in the whole year.

We validated the search process so that if the user inputs a street that is not in the database, an error message is displayed saying ‘no such location in our database’.
4.4 Geospatial Distribution of Crime Data

The third functionality of this project is the ability to display a geospatial distribution of crime data that can aid the user to visually spot the areas that have high or low density of crimes. This is done using Google Maps API. The longitudes and latitudes of crimes are extracted and exported as a separate CSV file. For example, the query displayed in Figure 4.11 is used to create a view for all the longitude and latitudes of Robbery crimes in Cardiff. The exported CSV file is then imported to Google Maps API to display the locations. Figure 4.12 shows the map resulted from the above query.
### Figure 4.9: Non-Temporal Search Example 1, Location Newport Road

<table>
<thead>
<tr>
<th>Location</th>
<th>Crime Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>On or near Newport Road</td>
<td>Violence and sexual offences</td>
<td>512</td>
</tr>
<tr>
<td>On or near Old Newport Road</td>
<td>Shoplifting</td>
<td>0</td>
</tr>
</tbody>
</table>
4.4 Geospatial Distribution of Crime Data

Figure 4.10: Non-Temporal Example 2, Location: Queen Street

<table>
<thead>
<tr>
<th>Location</th>
<th>CrimeType</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>On or near Queen Street</td>
<td>Violence and sexual offences</td>
<td>263</td>
</tr>
</tbody>
</table>

CREATE VIEW `Robbery` AS
SELECT Cardiff2016.Longitude, Cardiff2016.Latitude
FROM Cardiff2016
WHERE Crimetype='Robbery'

Figure 4.11: Extracting Longitudes and Latitudes Query
Figure 4.12: Geospatial Distribution of Robbery Crimes in Cardiff
Chapter 5

Results

5.1 Nature of Crime and Their Incident Count

When the nature and type of crime in Cardiff was analysed, several categories were noted. The least of all crime that was noted was illegal possession of weapon where 160 cases were identified while the majority of the cases was anti-social behaviour with 11394 cases representing 25.83 percent of all reported crimes that were committed in Cardiff. The anti-social behavior has several set of conduct in the public that are classified as anti-social. The most visible crime that caused public outcry of all the cases is sexual offenses such as rape. Petty crime recoded huge number of cases where some could go unreported while significant crime that threaten the security of the entire Cardiff such as arson and vehicle crime had averagely lower cases but visible to the society. The total count of crime in Cardiff from the analysis of the reported cases summed up to 44097 which is high and on gradual increase compared with the previous years. This is as shown in Table 5.1 where some crimes could fit in more than one slot.

5.2 Nature and Distribution of Crime in Cardiff

The most distributed nature of crime in Cardiff is violence and sexual offence. It has incidence rate 21 percent second after antisocial behavior but most distributed as shown with green areas on Figure 5.1 below. The antisocial behavior which is the leading
crime incident in Cardiff, is unevenly distributed as shown with color yellow overlay markers with most of the recoded incidents happening on the in the central area of Cardiff while some randomly distributed in other areas. The other form of crime the vehicle crime is mainly on the main roads in Cardiff and distributed all most in every part of Cardiff because of the road networks. The central area of Cardiff experienced almost every type of crime from burglary, the sexual offence, shoplifting and possession of weapon and drugs that are prohibited. It was estimated that 65 percent of all incidents crime happened in the Central Cardiff while the rest sporadically distributed on the outskirt of the central business district of Cardiff. The coastal areas with frontage of Celtic Sea experienced no incidents of crime while the inland area recorded

<table>
<thead>
<tr>
<th>Crime Type</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antisocial behaviour</td>
<td>11394</td>
<td>25.83</td>
</tr>
<tr>
<td>Violence and sexual offences</td>
<td>9267</td>
<td>21.01</td>
</tr>
<tr>
<td>Criminal damage and arson</td>
<td>3391</td>
<td>8.01</td>
</tr>
<tr>
<td>Shoplifting</td>
<td>3835</td>
<td>8.13</td>
</tr>
<tr>
<td>Vehicle crime</td>
<td>3822</td>
<td>8.62</td>
</tr>
<tr>
<td>Other theft</td>
<td>3803</td>
<td>8.76</td>
</tr>
<tr>
<td>Public Order</td>
<td>2759</td>
<td>6.21</td>
</tr>
<tr>
<td>Burglary</td>
<td>2692</td>
<td>6.14</td>
</tr>
<tr>
<td>Bicycle theft</td>
<td>1436</td>
<td>3.26</td>
</tr>
<tr>
<td>Theft from person</td>
<td>691</td>
<td>1.52</td>
</tr>
<tr>
<td>Other crime</td>
<td>682</td>
<td>1.51</td>
</tr>
<tr>
<td>Robbery</td>
<td>165</td>
<td>0.37</td>
</tr>
<tr>
<td>Possession of weapon</td>
<td>160</td>
<td>0.36</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44,097</strong></td>
<td></td>
</tr>
</tbody>
</table>
Figure 5.1: The Distribution of Different Crime Category incidents in Cardiff

most type of crimes and at different digress as illustrated on the Figure 5.1. More so, the areas that have security details and departments experienced more types of crime than the other areas that have no security details as seen with distribution overly marker on the Cardiff map. The least committed crimes such possession of weapon drug are in areas that experienced high rates of sexual offences.

5.3 Distribution of Different Form of Crime in the year 2016

The anti-social behavior in Cardiff was 2016 all year around highest form of crime experienced in Cardiff with April having the record high crime. The second one in the order that had high rate was violence and sexual offence that record second form of crime in Cardiff. In December, violence and sexual offence recorded the highest degree of prevalence than anti-social behavior. The other observation made in the result is whenever the drug offence recorded high incident rate a cross the year, violence and sexual offences also increased in their incident rate. Public order was all time lowest form of crime in Cardiff with some of the months experiencing insignificant incident
rate like March as Shown in Figure 5.2. Most of the different crimes in Cardiff had high incident rate in the month of August than any other month followed by September while the least incident rates of the crimes happened in the month of January. More so, it was observed that there was a constancy and pattern that could be drawn from the incidents in every month. High spikes of the different crimes in every moth were followed by suppressions. Crimes were kept alternating between highs and lows a cross the year 2016. This can be seen from the comparative bar graph in Figure 5.2 below.

5.4 Different types of Crime and their Prevalent Locations

The crime incidents differed in intensity depending with location. Some of the location experienced higher cases of crime incidents while others experienced less cases compared with the others. The diagram in Figure 5.3 shows the incidents of different crimes on different location using horizontal comparative bar graph. Queens Street for example had higher cases of violence and sexual offences compared with any other street. It recorded a record number of 56 incidents despite experiencing other form of crimes such as shop lifting and antisocial behavior. It is the single most street with many form of crime since some of the areas have one or two form of crimes. Fanny street experience the least incidences of a single form of crime compared with the other streets that had higher incidences of either one or more form of crimes in their locations. Shoplifting is the commonest form of crime that is committed across the streets and towns. The only location that experienced zero cases of shoplifting includes Comrose Road and Heol Solva. New Port Road recorded the highest incidents of shoplifting behaviors of 85 cases and is the leading crime in cases a cross Cardiff. Antisocial behavior and Violence & sexual offences seems to be twin crimes which occurs together as seen in Caroline Street and Queen Street. Public order and Vehicle crime are the
5.4 Different types of Crime and their Prevalent Locations

Figure 5.2: Crime Rate in the whole of 2016 from January to December

least of the cases in the entire of Cardiff where they had only incidences in Newport Road. All this are represented in the comparative bar graph below in Figure 5.3.
Shoplifting in Cardiff is one of the crimes that is leading in almost every street. It is a crime that seems to be constant all year around with a common figure that runs down from January to December. In the year 2016, Cardiff experienced a high of 366 incident counts of shoplifting. It is a figure from which the other month recorded close to that with a constancy that could be traced. The shoplifting is not only constant in terms of the count but also in terms of the location that they are done. Almost all locations have an average of 23 counts of shoplifting which in average they added up to a range of between 264-366. It has an appearance of endemicity in its occurrence.
Figure 5.4: Line Graph Showing Shoplifting Crimes in Cardiff in the Year 2016

where the figures remain almost the same with an addition or minus of 50 count around the average. The line graph is almost horizontal implying its constancy. The line graph in Figure 5.4 shows a line graph of shoplifting counts in Cardiff with a variance of 30 around the linear graph drawn. This suggest that the individual commuting the crime are likely to be the same within the street of Cardiff since the variance a cross the year is almost same. Newport Road in Cardiff has the highest count of shoplifting in Cardiff and could be contributing significantly to the monthly tally of the counts reported.

5.6 Trend Showing Violence and Sexual Offense

Violence and sexual offence had a huge count in Cardiff across the year 2016. It also recorded several counts in most of the streets of Cardiff such as St. Mary Street and Queens street. The trend and the pattern of the count a cross the year is indicative of endemicity and a constancy with a small variance from the mean. In the year 2016, Cardiff experienced a high of 864 incident counts of violence and Sexual offence. It is a figure from which the other month recorded close to that with a constancy that could be
5.7 The Trend of Public Order Crime

Figure 5.5: Line Graph Showing the Trend of Violence and Sexual Offense

traced. Violence and sexual offence constant in terms of the count but its distribution is uneven across Cardiff with some areas experiencing zero counts of violence and sexual offence. The locations that experiences this form of crime have a mean average of 723 counts of violence and sexual offence. It has an appearance of endemicity in its line graph in Figure 5.5 occurrence where the figures remain almost the same with an addition or minus of 100 the mean of the count around the average. The line graph is almost horizontal, with a tilt of 72 implying some level of constancy and endemicity. The line graph in Figure 5.5 shows a line graph of shoplifting counts in Cardiff with a variance of 73 around the linear graph drawn. Queen Street and St. Mary Street in Cardiff has the highest count of violence and sexual offence and contributes significantly to the monthly tally of the counts reported.

5.7 The Trend of Public Order Crime

Public order is one of the crime count with the least count in Cardiff across the year 2016. It also recorded on two locations in the entire area of Cardiff. The counts were
5.7 The Trend of Public Order Crime

Figure 5.6: Linear Graph Showing the Drug Crime Count in Cardiff

in St. Newport Road. It is one of the crime that is localized in of the area in like the rest are evenly distributed in the Cardiff. It is a crime with count of between 140- 260 in the year 2016. The trend and the pattern of the count a cross the year is indicative of a constancy with little variance. In the year 2016, Cardiff experienced a 260 as the highest incident counts of Public Order. Public Order is the least of the crime with distribution that is least unlike the other ones that are in almost every part of the Cardiff. It also indicates a constancy when plotted in the line graph as shown in Figure 5.6 with a minor variance from the mean average. The line graph is almost horizontal, with slight gradient which imply some level of similarity in terms of occurrence rate across the year. The line graph in Figure 5.6 shows a line graph of public order counts and its trend in the entire year. It seems there is no interventions being done to that effect since there is no major changes in terms of counts. The localization of crime is certain area explains the presence of port of entries and exists that are in Cardiff as a factor that offer a thriving environment for the crime.
5.8 The Trend of Drug Offence in the Year 2016

Offences pertaining drug in Cardiff registered among the least count and localized with some areas within Cardiff unlike the other form of crime that had a huge dispersion in the year 2016. It is one of the crime that need seasoned practitioners to be done hence its remoteness and less number recoded. The trend and the pattern of the count across the year is indicative of some level of low level constancy. In the year 2016, Cardiff experienced a high of 90 incident counts of possession of illegal drugs. Drug shows some constancy in terms of the locality of operation and also in terms of the counts. The line graph in Figure 5.7 shows a line graph of drug offence counts in Cardiff with a slight gradient showing reduction. It is one form of crime that influence the occurrence of the other crimes in Cardiff.
5.9 Burglary in Cardiff

Burglary is one form of crime that is concentrated and evenly distributed in most part of the Cardiff. As Figure 5.8, in Cardiff, it is densely and evenly distributed over a bigger area compared with the other form of crimes. It seems that every part of Cardiff is a hot spot of crime. The distribution takes a classic characteristic of spatio temporal crime distribution where the almost place is a hot spot of crime. The distribution is even and dense all over with no bias toward certain areas. Compared with theft from person, the spread here is solid and in many part burglary is reported in equal measure. This form of crime not be affected fully with the displacement theory because a robust establishment in Cardiff. There cannot be sporadic form of this crime in other areas that are caused by intervention of the police. The spread has aoristic characteristic where by a single area is hotspot of many crimes that it shares with the other areas. It has the same looks but denser than the bicycle theft spread. It is one form of crime that its crackdown need strategy because of its establishment. This is due to the constancy and almost equal spread. It is form of crime that happens with the other form crimes such as possession of illegal weapon and the use of drugs. Therefore, as one is being followed the other one remain clandestine. It cannot happen in solitary because of its nature.

5.10 Bicycle Theft Pattern in Cardiff

Bicycle theft also takes the same pattern as burglary in Cardiff. It is spatio-temporal pattern and seems to be the frequent pattern of most of the crimes in Cardiff. The characteristic that is visible with this spatio-temporal hotspot is the aoristic nature of the crime with the almost even distribution of crime in an area over time. There seems to be spread of the crime in growth of the crime in the area of operation. Theft of bicycle is the leading among other crimes in both dense pattern and count. With this pattern, it is almost certain that bicycle parked anywhere in Cardiff is likely to be stolen.
Figure 5.8: The Spatial Distribution burglary in Cardiff

This because there is no area within the markers that indicate a given area is hotspot while the other is safe. The is small area within the map that form the hub of all other crimes in Cardiff with the same measure of spread. The area is near the Cardiff City football club. This is area can be defined as the hotspot of multiple crime because of mutual occurrence. It is an area that host the hotspot of burglary, bicycle theft, robbery and theft from person (this can be seen in Figure 5.8, Figure 5.9, Figure 5.10, Figure 5.11). This multiple crime occurring in the same place can be risky and vicious over time.

5.11 Theft from a person in Cardiff

Theft from person is another form of crime that is common in Cardiff with biased distribution of the incidences. It takes almost the same pattern with the that of incidences of robbery in Cardiff both displaying a classic example of spatio pattern. There are some areas with higher number of theft incidences while others are experiences less counts. The theft crime is in the sea front biased where the inland areas experiences
5.11 Theft from a person in Cardiff

Figure 5.9: Distribution of Bicycle theft in Cardiff

lesser counts just like the distribution of robbery. Compared with bicycle theft, the area with higher counts is bigger than both thefts from persons and robbery. Since some of the areas have remote cases of theft crimes, it can be said that this pattern has hot spot area because of the uneven spread. More so, the uneven spread could be caused rather than happening by the design of the perpetrators. Theft from person have a hotspot that could be decentralized by the action of police on the individuals that are found culpable. This forces them to move to the areas that are least monitored making it have sporadic spots of crime on the map. It from this pattern that an impression may be concluded that it is spreading to other area from its hotspot but in real sense it is displacement due to some kind of crackdown being made on the identified hotspot. Compared to bicycle theft, theft from person shares the same hotspot but the spread on the inland is not even. The spatio pattern of theft from person can be seen on Figure 5.10.
5.12 Robbery locations in Cardiff

Robbery is one of the crimes with high incident counts in Cardiff. However, from observation, its site of occurrence it is not as dense when compared with the other kind of crimes. Bicycle theft has high incidence at the same location than robbery that is occurring in the entire of Cardiff. It is a representation that is classic example of spatial pattern which is not evenly distributed in the in a given location. It is could be due to the expertise and resource need to carry out a robbery operation in a town that makes it less spread. It because of this effect that there is a huge disproportional occurrence of this kind of crime and its count is less but its effect is palpable to the security details any location in Cardiff. A closer look on the hot spot of robbery in Cardiff is indicative that some of the places experience intense incidences with higher count than the other which form the periphery areas. The robbery is biased towards the side of sea while in the inland is patchy. This pattern of robbery has clearly defined hot spot of robbery which covers a considerably larger part but smaller with when compared with other types of crimes which have different spatio patterns, that are massive. Spatio pattern
5.12 Robbery locations in Cardiff

Figure 5.11: Robbery Spatio Pattern in Cardiff

is mostly affected by the displacement theory where when there is intervention of the police then it is probable that there will be sporadic robbery as seen in the inland parts of Cardiff in Figure 5.11.
Chapter 6

Conclusion

This project aimed to analyse the spatio temporal crime data in Cardiff city. The importance of this project is to help the Cardiff City citizens to be aware of the crime incidents that happen in the city and be aware of the safe and the unsafe places.

The first aim of this project is to understand the different dimensions of the crime data. To understand this, a real crime dataset was downloaded and imported to a database. Also, we downloaded some important papers that reviews the crime data analysis. From these two sources, we concluded that there are three main aspects that can be used in our analysis: the spatial, the temporal patterns, and crime categories. Crime categories gives us an insight of which crime types are done. The spatial pattern lets us understand how the location may be related to special types of incidents. In addition, using the spatial pattern we can identify safe and unsafe locations. By understanding the temporal pattern, one can discover crime rates at different points of time. Also, a historical crime profile of the place could be discovered.

The second aim is to understand the effect of spatial and temporal pattern on the occurrence of crimes. First, to understand the effect of the temporal pattern we did a monthly analysis on data. We counted the number of incidents in each month, also we identified and sorted the crime types that happens in certain place according to its time stamp. To understand the spatial pattern, three fields of data were used: Location, longitude, and latitude. The location provides a street location and the longitude and latitude is used for identifying the location on a map. The relationship between spatial and temporal
aspects we also studied to fully understand the data.

The third aim was to identify safe and non safe locations. This was done by implementing a temporal and non temporal search process that promotes the user to input a street location, then the output lists the crimes that happens this certain place. The temporal search lists the different crime incidents that happens in each month which gives a temporal profile of the place. On the other and, the non-temporal location search outputs all crime that happens a the whole year. This also fulfils the fourth aim, which is identifying the change of crime occurrence in a given location.

The Fifth aim was to visualize the geospatial distribution of crimes on map. This was done using the Goggle MAP API. We were able to extract the longitudes and latitudes of each crime type and display it to visually see what is the relationship between locations and crimes that happens in locations.

The sixth aim and the final aim of this project is to evaluate the system on a real data set. This was done by choosing Cardiff city as an evaluation. All data records related to Cardiff were extracted from the downloaded data and each function of the project was evaluated using this dataset.

To conclude, the project produced its outcome successfully and the aims that were set out in our plan was fulfilled.
Bibliography


Tableau, Safei, 2012, ‘Hypotheses or Questions: San Francisco Crime Incidents Dataset Data Analysis.’

Kelvin Leong & Anna Sung 2015, A review of spatio-temporal pattern analysis approaches on crime analysis: Department of Business and Management, Glyndwr University, Wrexham, Wales, U.K.

Redmond Todd-Bennett, 2015, Identifying Crime Hotspots using Twitter: School of Computer Science and Informatics Cardiff University.


Appendix: Ethics Approval Form

When undertaking a research or enterprise project, Cardiff Met staff and students are obliged to complete this form in order that the ethics implications of that project may be considered. If the project requires ethics approval from an external agency (e.g., NHS), you will not need to seek additional ethics approval from Cardiff Met. You should however complete Part One of this form and attach a copy of your ethics letter(s) of approval in order that your School has a record of the project.

The document Ethics application guidance notes will help you complete this form. It is available from the Cardiff Met website. The School or Unit in which you are based may also have produced some guidance documents, please consult your supervisor or School Ethics Coordinator.

Once you have completed the form, sign the declaration and forward to the appropriate person(s) in your School or Unit.

**PLEASE NOTE:**
Participant recruitment or data collection MUST NOT commence until ethics approval has been obtained.

**PART ONE**

<table>
<thead>
<tr>
<th>Name of applicant:</th>
<th>Meteib Khalid S Alsubaie</th>
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<tbody>
<tr>
<td>Supervisor (if student project):</td>
<td>Dr. Chaminda Hewage</td>
</tr>
<tr>
<td>School / Unit:</td>
<td>School of Management</td>
</tr>
<tr>
<td>Student number (if applicable):</td>
<td>ST20030124</td>
</tr>
<tr>
<td>Programme enrolled on (if applicable):</td>
<td>BSc (Hons) Software Engineering</td>
</tr>
<tr>
<td>Project Title:</td>
<td>Spatio-temporal crime data analysis in Cardiff city.</td>
</tr>
<tr>
<td>Expected start date of data collection:</td>
<td>01/12/2016</td>
</tr>
<tr>
<td>Approximate duration of data collection:</td>
<td>N/A</td>
</tr>
<tr>
<td>Funding Body (if applicable):</td>
<td>N/A</td>
</tr>
<tr>
<td>Other researcher(s) working on the project:</td>
<td>N/A</td>
</tr>
<tr>
<td>Will the study involve NHS patients or staff?:</td>
<td>No</td>
</tr>
<tr>
<td>Will the study involve human samples and/or human cell lines?:</td>
<td>No</td>
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<th>Does your project fall entirely within one of the following categories:</th>
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<tbody>
<tr>
<td>Paper based, involving only documents in the public domain</td>
</tr>
<tr>
<td>Laboratory based, not involving human participants or human samples</td>
</tr>
<tr>
<td>Practice based not involving human participants (eg curatorial, practice audit)</td>
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### Compulsory projects in professional practice

<table>
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<th>Description</th>
<th>Answer</th>
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<tr>
<td>(eg Initial Teacher Education)</td>
<td>No</td>
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<tr>
<td>A project for which external approval has been obtained (e.g., NHS)</td>
<td>No</td>
</tr>
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If you have answered YES to any of these questions, expand on your answer in the non-technical summary. No further information regarding your project is required.

If you have answered NO to all of these questions, you must complete Part 2 of this form.

---

**In no more than 150 words, give a non-technical summary of the project**

**Abstract:**

This project aims to analyse and understand the spatio-temporal crime data by exploring the spatial and temporal behaviour patterns that contribute to the presence or absence of criminal offences. The crime data will be downloaded from [data.police.uk](http://data.police.uk) which contains open data about crime and policing the United Kingdom. But, this project will only use a sample data-set in Cardiff city for evaluation. Next, the data-set will be imported into a SQL database, and a java application will be created to query and analyse the data. Moreover, Google Maps API will be used for spatial visualisations. Specifically, this work will analyse the effect of specific seasons/events on the drop or increase of the number and types of incidences. Also, it will discover the unsafe geographic hot spots that witness an increase in the number or types of crime incidences. Finally, the crime rates before and after police investigations outcomes will be monitored.

---

**DECLARATION:**

I confirm that this project conforms with the Cardiff Met Research Governance Framework

I confirm that I will abide by the Cardiff Met requirements regarding confidentiality and anonymity when conducting this project.

**STUDENTS:** I confirm that I will not disclose any information about this project without the prior approval of my supervisor.

<table>
<thead>
<tr>
<th>Signature of the applicant:</th>
<th>Date: 23/11/2016</th>
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<tbody>
<tr>
<td>Meteib Alsuabie</td>
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**FOR STUDENT PROJECTS ONLY**

<table>
<thead>
<tr>
<th>Name of supervisor:</th>
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<tr>
<td>Chaminda Hewage</td>
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