

Project Title

Interim Report

DTXXX

BSc in XXX XXX

**Student Name**

**Student Number**

**Supervisor**

School of Computer Science

Technological University, Dublin

**Date**

Abstract

Declaration

I hereby declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university.

Signed:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Student Name

Date

Acknowledgements

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# 1. Introduction

**As least 2 pages, but as many as you like**

## Project Background

Some background and literature, start with an interesting fact or a newspaper item

In todays word of constant data sharing and large open source datasets, data exploration and exploration tools are extremly useful tools used to help organization understand their data. Most data is stored in databases and usually exported out as CSV files. As you can imagine reading hundeds of thousands of lines of text is not the best way to go about anaylizing data. For one, humans are prone to make little mistakes and would struggle to keep track of all the data. This is where data visualization can become very useful. Data visualization is taking massive amounts of data and displaying in them in a format that is easy to visualize and understand like maps and graphs.

Data visualization can help us better understand trends and allows us to explorer the data more easily to find causes of certain trends. This is a huge advantage for criminal data. There is an anubundance of datasets on criminal activity from around the world online and free to the public. Visualizing this data can help us better understand the data and explortation tools will help us find potienal causes to crime spikes and where and when they might happen.

## Project Description

An overview of the project

Include a diagram

## Project Aims and Objectives

Overall aim and some milestones along the way to achieve the aim

* Project setup (django, webpack, npm, bootstrap, babel, database)
* collect data (weather, deprevation index, census boundries, population per boundries, crime data)
* normalization of data
* Dataset validation, clean up and migrate to database
* Adding in census borders
* Create REST API to query crime dataset in database
* Create filters for data and display them on map
* add Extra details when a crime marker is clicked on
* create clusters for performance
* Create graphs visulizations
* Create Filters for graphs
* Create functionality to comapre two filter options and visualize them with graphs

## Project Scope

Project scope, what the project isn’t about

## Thesis Roadmap

One sentence explaining what each of the following chapters is about.

# 2. Literature Review

## 2.1. Introduction

In todays digital world there is a vast amount of data being captured and stored in databases. Alot of this data is released to the public as open source software. Most of the data is stored in tables and it can be difficult to explore the data. This is where data visualization can be a very use stategy for businesses. Taking large datasets and creating visualizations with them can help organisations better understand their data. Data exploration also allows businesses to anaylis their data and find trends and view how different data features effect their business. Research has been done on crime and possible causes of crimes and what factors contribute to crime. These factors range from the population of an area the education of the people in the area or lack of employment. With a web based data anylitacal tool that allows users to explore what areas have higher crimes than others and compare them with areas with low crime to see if there is a potienal spike in crimes when one area has a high percentage of a data feature than the other. E.g. comparing an two areas one with people with a lower edecution percentage to a area that has a higher percentage of education can help authorties potieally reduce crime by adding easily accesibly centers that provide education to areas that are lacking in the hopes to reduce crime.

There are a few web applications that provide data visualization for crimes in certain coutries while these application help visualize crime very few have tools to filter and explore the data which can be very useful for finding potienal causes of crime.

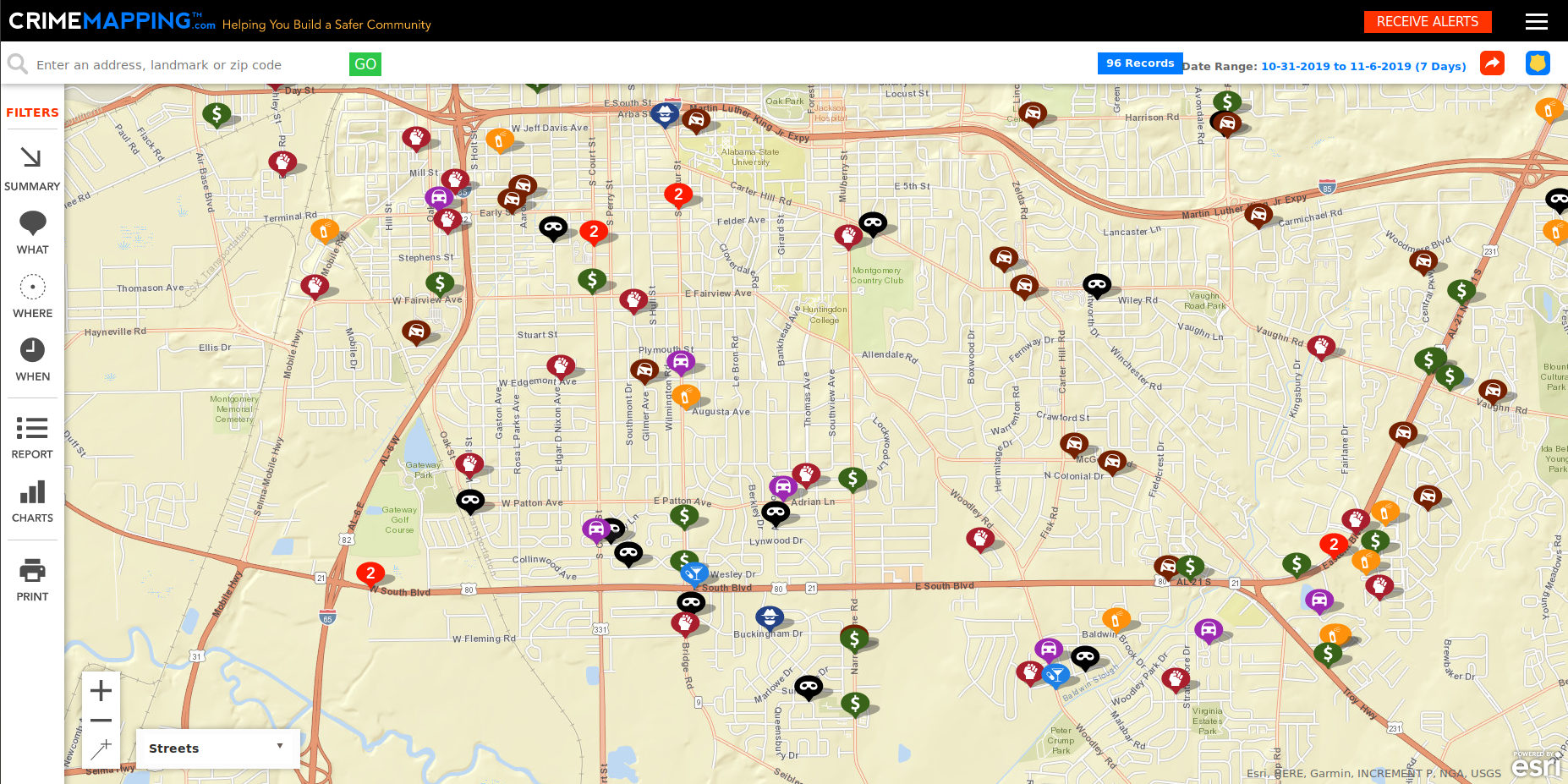
Building this application will require a lot of research to create an application that is accurate easy to use and scalable. As data can frequently change it is important to create a logical data model that can map and validate data so it fits the web applications requirements. The logical data model will consist of a few predefined filter options that will require a comprehensive proccess of mapping and validating the data to ensure the data is accurate and up to date.

This this section I will go through the different datasets, technologys and exsisting applications and review them to see what works and what can be improved on.

## 2.2. Alternative Existing Solutions to Your Problem

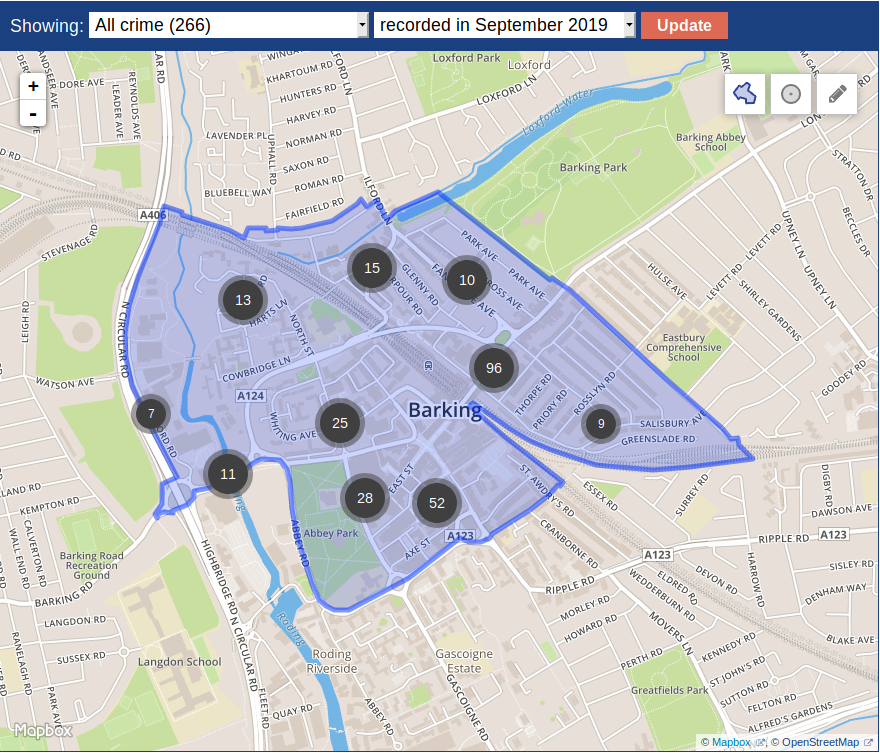
### 2.2.1 Crime Mapping

Crime mapping is a web application that visulaizes all crimes in america. It also provides the user with options to filter for specifc crimes in specific locations [13]. Crime mapping has great visualizations, each crime type has its own map marker and there are options to view the selected crimes in the form of a chart or report. The web application is somewhat scalable. It works well with tablets if they are in landscape mode but some of the filter options are not within the viewport of phone screen. The map performes well on mobile devices and computers. I think is is largerly to do with how it displays crimes. You can only view one thousand crimes at a time on a map. While this will mostly likely increse performance it also restricts the user. This is something to consider when developing my application and might be a comprise I will have to make since the dataset I have chosen has over five million rows of data. Crime Mapping provides the uses with lots of filter options to search for crimes in in your area by a certain date. This is perfect for providing criminal information to the public but it doesn’t have any filters to explore the data. I think it would be usedul to add filters for weather or population in a area to see if these factors have an impact on crime. Below is an image of crimemapping.



### 2.2.2 Police.uk Crime Map

Police.uk. Crime map is another great crime visualization web application. The web application displays all crimes in a spefic month in a niegbourhood. One great feature I noticed from this web application straight away is how it clusters crimes together. This is a huge improvement to the previous crime mapping web applications we looked at (Crime Mapping). This allows the web appliction to display potionally thousnds of crimes on a map without sacraficing performance. However the map doesn’t proved any filter options besides month and nighbourhood since it is mainly used for public information and not data exploration. The neighbour hood zones are a nice feature which allow users to view crimes in a certain area [14]. Below is an image of the web application.



## 2.3. Technologies you’ve researched

### 2.3.1 Web Frameworks

The project will be deployed as a web application and to avoid developing commonaly used features like database abstration models, user autherization and routing I have decided to use a webframe work. There are many webframe works available. Below I will discuss the different types and their advantages and disadvantages.

The first webframe work I am going to look at is Django. Django is a high level web framework built with python. It has a alot of built in features that it comes with out of the box. These features are bundled into componets called apps. Apps can be added to your django project and they can automate a lot of common tasks involved in web development. Tasks such as user authorization and authetencation and much more. Django claims to be extremly fast, scalable and secure1. Companies like instagram, youtube, spotify and bitbucket use django1.

**Pros**

* **Models**: Django has an inbuilt feature where you can define models in a python class. Each field in the model can be converted to a database table. This allows you to define your relational database as a class. You can migrate your models and django will setup a database with models you defined with a database of your choosing. The most powerful and useful feature about django models are once you migrate your models django will provide you with API to query your database through python. This is particually useful when combined with views which are discuesed below 2.
* **Urls**: Another useful feature of django is its url dispatcher. Django alows you to define your own custom urls and map them to a view which will handle the request 3..
* **Views**: Views are how djangos handles requests from the user. When a user goes to a certian url you defined in your url dispatcher it will be mapped to a view. The view will process the request and return a respone e.g. a html page. Views are a big selling point for my project when combined with django model API it will allow me to make request to my database to retrieve data to be visualized 4.
* **Uses Python**: Django uses python which I am very familuar with and has a lot of great libraries.
* **Security**: Django includes a securty layer that helps prevent Cross-site request forgery and sql ingections 5.
* **Admin page**: Django provides you with a built in admin page that allows you to manage your models, users and groups.
* **GeoDjango**: Geodjango is a feature that comes with django that help you make spacial queries to a database. You can define spacial datatypes like multi-polygons and provides you with a model API to make spacial queries e.g. return the country the point(x,y) is in.

**Cons**

* **Everything include**: Django has a lot of features include by default which depending on your application might be overkill and proved unnessarcy overhead and bloat ware.

Flask is a web framework built with python. It is commonly called a micro framework because unlike django it doesn’t come with user autherization or a database abstraction model. However these features can be added to flask using extension. Extension are components at automate alot of common task in web development like user autherization. This way you can build a web application with just the functionality and not have any unwanted modules and bloatware 6.

**Pros**

* **Extensions**: Extension allow you to create a minimal app with just the components you need.
* **Python**: Uses python which has a lot of great libriaries

**Cons**

* **Documentation**: Flasks documention isnt to the same standard as djangos’
* **Project Structure**: While flask is a great and compact webframe work it doesn’t provide you with the same structure as django. Django provides you with a clean structured folder structure when you create a new project.

Ruby on rails is a web framework like flask and django. It automates a lot of the common task in web development and is built on the model view controller MVC philosophy. It uses ruby has its main programming language. It is classifified as an optinionated framework meaning you are encourged to develop your application in way they want to7.

**Pros**

* **Clean code**: Ruby enforces the MVC design pattern and forces you to write cleaner more maintainable code.
* **Community**: Ruby on rails has a great community behind it with lots of posts on stackoverflow.

**Cons**

* **Not flexible**: Ruby on rails is not as flexibale as Flask you can’t easily add extensions to it and it doesn’t have a inbuilt spacial component for dealing with spacial data like django does with geodjango.

After a lot of consideration I have decided django would be the best fit for this project. It provides a lot of commonly need tasks built in and an database abstraction model to easly perform queries to a database and the main reason I have chosen django is because of its geodjango extension app which will allow me to and geo spatial data.

### 2.3.2 Databases

For this application I will be dealing with a lot of large data sets. The criminal records data set just the city of chicago is 2GB. Will this isn’t too much if I were to added in more cities and towns this dataset could be large very quickly. One of the solutions to dealing with the larges datasets is normalizating the data (only if using a relational database). Another big aspect of my application is going to be performace. I want the user to be able to filter crimes and display them on a map as quickly as possible. Taking this into consideration I would need a database with fast read speeds. Another big part of this application will be spatial data like border polygons. I will need a database that can handle these datatypes. In summary the main attributes I am looking for in a database is read speed, scalibilty and can handle spatial data. I have to consider two types of databases SQL and no-SQL. The advantages of a no-SQL database is that it is more flexiable and you can dont have to spend too much time creating relational schemes. Although someone people may see this as a disadvantage depending on the project. No sql also can store data as a json object making it easier to parse and send out in a reqiest response. SQL on the other hand scales better than no-SQL because common values can be stored ina table and referenced with a key. SQL databases generally provide more flexablity for querying data. However this deponds on how you design your scheme. I am leaning towards towards a SQL database because it will provide a more flexible querys, scales well and as a added bonus I am more familar with SQL database. However below I will explore possible options.

The first database I looked at was postgres. Postgresql is a retional open source database it has been ACID complient since 2011. Postgresql is highly extensionable and has a big communtity behind it and a lot of documentation 8. Postgresql caught my eye because of its PostGIS extension. This extension alows you to make spatial querys, for example is point(x,y) in ireland. This could be very useful for my project if I only want to display crimes in a certain county for town. Another big advantage of postgis is that it has spatial datatypes like polygon and multipolygon which can be used to store information about borders which can then be visualized on a map.

MongoDB is also a possible option for this project. It is a no-SQL database and is used by many large companies such as facebook, ebay, google, sap and many more 9. The advantages of mongodb is that it is scalable, what this mean in my situation is that data can be stored in documents that are simular to json. When I want to add a new information that might have a new column for two I can just added it to the database with little to no hassle on the other hand in a SQL database I would have to alter the database table and possibily perform normalization to make sure the database is up to industry standard. This would cost extra development time. Another advantage of mongdo is that because it doesn’t have relations there is no need to developed a relational database model that I would most likely have to reference every no and then to make sure I am querying the right data and depending on how I design it I may need to re-design the model if I want to remove or add new columns. This is not a huge issue but something to consider as it could save me development time. In terms of query performance mongdb would be faster than a SQL database the downside is that if you want to perform more complex queries that need very specific data then noSQL might not be the best option.

In this project I am leaning towards mongodb because it is easy to set up and scales well with newly added data it is also not restricted to a relation schema. The one downside to mongodb is that it doesn’t have any fully featured extensions for handling geo spatial data like multipolygons for borders. While this data can still easily be stored in mongodb, postgresql comes with an extension called postgis which provides custom datatypes another benifit to postgres is that it works well withs geodjangos model api. This means I can easly perform geo spatial queries from django to a postgres database with the postgis extension. For this reason I have decided to choose postgresql for this project.

## 2.4. Other Research you’ve done

### 2.4.2 Datasets

A major factor in this project is going to be what datasets I choose. The datasets need to span span over a decent peroid of time be accutarate and have a lot of information. One of the first places I looked was the UK. The UK has a good dataset with lost of inforamation as well as longitude and latitude positions and a small description of the crime. The UK also has census data which can be used to filter crimes in areas that have a low deprevation index. A deprevation index is a measurement from one to ten of how aflunent or disadvanteged an area is. This is based of census data which includes poverty, population, type of employment/skill and a few others. This can be used to better visualize criminal data in certain areas.

Another possible candinate for datasets is the city of Chicago in America. The reason I am considering this city as a possiblilty is because it has a detailed dataset on crimes going back to 2001 census data that calculates deprevation index of areas and chicago as lot of dataset relation to public facities like transport, education, enviroment and many more 10. In terms of datasets relating to crimes and census data Chicago and the UK are that different, however Chicago as a lot of other useful datasets that could become useful for visualizing criminal data after more research about what causes crime, which will be discussed below.

Orginally I conisdered ireland and a possiblity however while ireland has excellent census data its dataset on crimes is not very accurate and reports crime by garda divions which isn’t very useful for visualizations. It is also marked as “under reservation” by the cental statistics office, due to the data not beign accurate 11.

I have chosen to use Chicago as the focus point for this application

After a quick anyalsis of the data I found there was very little missing values except for the comunity areas, where 8% of the values are missing. Community areas are areas in chicago that are used for gathering census data. Luckily using geodjango I can query the database of comunity area borders and using the longitude an latitude of the crimes and update the missing values.

### 2.4.3 Filter Options

A big part of this web application is going to be the the filter options. There are a lot of factors that could potienally cause crime. I will go through all the filter options I have chosen and why I have chosen them.

**city**

In current version of the application the only the chicago dataset will be used but in future, however the application will be designed with more cities being added on in the future. To achieve this a logical data model will be used and datasets from different cities will be mapped to this logical data model.

**Deprevation Index**

Deprevation index is a rating of how advataged or disdavataged an area is. The deprevation index rating is based on census data and include factors like population in the area, crime rate, education rate and work class i.e. labouror, retail etc. The deprevation index is devided into

SHOW MAP OF SMALL AREAS AND COMM AREAS

**Districts**

Most cities are divided up into large areas these might be called districts, community areas or something else. Allowing the user to filter by one of these large areas will give the user the option to compare to districts in a city.

**Population**

Studies have shown that population can have an impact on crime therefore it will be a usefull feature to explore the data with.

**Weather Type (advanced)**

The weather types will be retrieved from weatherstack. Weather stack provides historical data as far back as 2008. There are many weather types defined by weatherstack ranging from drizzle, hail to volcanic dust clouds. This filter option will be marked as advanced and can used if need but by default it will select all weather types for the query.

**Weather Degrees**

Weather can impact crimes in multple ways. Car thefts are unlikely to be commited in freezing tempratures. This feature can be used to see if there is an increase in crimes when there when weahter is mild or it can be used to disprove that weather has a major impact on crime rates.

**precipitation**

There were a lot of weather types related to rain and snow which included

* Moderate or heavy snow in area with thunder
* Patchy light snow in area with thunder
* Moderate or heavy rain in area with thunder
* Patchy light rain in area with thunder
* Moderate or heavy showers of ice pellets,
* Light showers of ice pellets
* Moderate or heavy snow showers
* Light snow showers
* Moderate or heavy sleet showers
* Light sleet showers
* Torrential rain shower
* Moderate or heavy rain shower
* Light rain shower
* Ice pellets
* Heavy snow
* Patchy heavy snow,
* Moderate snow
* Patchy moderate snow
* Light snow,
* Patchy light snow
* Moderate or heavy sleet
* Light sleet
* Moderate or Heavy freezing rain
* Light freezing rain
* Heavy rain
* Heavy rain at times
* Moderate rain
* Moderate rain at times
* Light rain
* Patchy light rain
* Heavy freezing drizzle
* Freezing drizzle
* Light drizzle
* Patchy light drizzle

While this is very specific data types it doesn’t allow an easy to use system that allows the user to just just for crimes commited in mild to heavy rain. That is why I have added in the precipitation feature which allows user to use a slide bar to select the precipitation in mm. Further more users can also filter for crimes in snow by setting the weather degreas option to be below 0 degrees celesuis which is the temperature where rain generally turns into now. This is a much more user friendly way of selecting crimes that occured in the rain. I have kept the more advance weather types as an option if they are needed.

**cloud cover**

Cloud cover will be a slidable bar from 0% to 100%, 0% meaning there is a clear sky and 100% would be a fully cloudy sky. I added this feature because again the weather types for cloud were to varied. This is a much more user friendly approach.

**moon cycle**

People being affect by different moon cycles is often debated. I have added in this extra filter option as an expermentation so it can be used to see if there are trends during certain moon cycles.

**crime type**

There are many different types of crimes allowing the user to filter by crime type will be useful for narrowing down the data and analysing specific crimes.

**time**

This can be used to compare crimes during the day and night and see if there are spikes during the night for certain crimes.

**date**

The date field is self explanetory. The user can use it to search for crime during a certain date period.

## 2.5. Existing Final Year Projects

### 2.5.1. Deividas Savickas - Crime Explorer

Crime explorer is a very simular in concept to my idea. He created a web application that visualizes criminal data on map and on graphs. The application displays crimes on a map with options to filter the crimes. The options are limited to date (by month), area and crime type. This is perfect for just displaying information to the public. Deividas Savickas gave me a lot of insight on all the possible challenges I could potienally face in the development of this project. One of the issues he faced was the performance of the map when loading too many crime markers. He solved this by using marker clusters. Marker clusters are markers that are close together and grouped into clusters, so 5000 crime markers could potienally be reduced around to 10 clusters. The closer you zoon in the clusters will split and break up until evenually there is just a crime marker left which will be displayed. I am going to be using this technique in my web application because it will provided a sigificant performace boost. Another issue Deividas encoutered was performance issues with loading boundries onto the map. Boundries are polygons that are stored as an array of points. Some boundiers can have up 5000+ points and when you combine that with over 100 different types of bounders all those polygons can have a huge affect on performance. He solved this problem by removing some of the points in each boundrie. This increased performance but decreased the accuracy of the bounderies.

Crime explorer is an excellent web mapping and visualization tool. The main takeaways I got from his project was that when dealing with large datasets performace is going to be challenge and some comprises will have to be made to increase performance and decrease the acuracy of the map.

### 2.5.2. Max Curtis – Crimeviz

Crimeviz is a web application that visualizes criminal data in Ireland. One of the challenges in his project was merging data from different data sources. Since my project will be using lots of external data sources it will be something I will have to focus on and make sure the database design is solid. Crimeviz has a data visualization feature where it shows crime hot spots of a area with the use of heat maps. This looked like a very useful type of data visualization for this tye of project and is something I will be incorerating into my project.

Max used simular technologies that I plan to use and they seemed to work well for him. The major on being using GEO Django to django the spacial data.

In conclusion Mac had a great project with very to understand visualizations which I will take into consideration for my project.

## 2.6. Conclusions

There is a lot of technologies out there for building a web application and it can be quite confusing trying to decide which on to use since they all claim to be easy use, fast and scalable. After doing a lot of research I was able to find the technologies that would best fit my idea for a web application. I was able to find frameworks that suit my design idea and work well together. GEO Django provides a lot of inbuilt features to help make spacial queries and grouped with POST GIS (a postgres addon for spacial data) will make development a lot easier. Their was a lot of frameworks for building frontend components and most of them would be used in my project but I decided on AngularJS.

The are a lot of web applications that specialize in data visualization for crime. Researching them all I was able to see what worked and didn’t work and some compremises that some applications made for performance. I did’t find a web application that had a data exploration feature like the one I have planned to developed. The closest I came to find one was Crime Mapping [13] which only had three options “what”, “why”, “when”. There was no filter options for population and deprevation index which I believe would be very useful.

In conclusion there are a lot of data visualization applications out there and they all aim to help people and orginasations better understand data and can be very useful to organisations. Using the right technologies and datasets crime datasets can be merged with other data sources like weather, deprevation index, population etc. To help people better understand crime and potienal causes of crime.

# 3. Prototype Design

## 3.1 Introduction

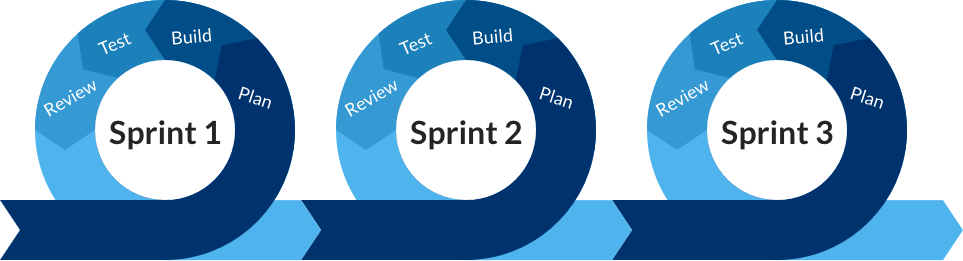
The prototype will showcase a bit of the main features of the project. The first feature and potienally the most time consuming is the collecting, validating and loading of the data. I am using a lot of different datasets and merging them into one system. A lot of consideration has to be taken into validating the data because the visualization of the data is a big part of the project. If the data is not accurate or up to date the web application will not be useful. I have decided to have two users for this application a general user and admin user. The admin user will be responsible for uploading new crimal data. A validation workflow will ensure the dataset is accurate and if there are any errors they can beview in the logs.

TOOLS

## 3.2. Software Methodology

Agile

For this project I will be using the Scrum software methodology. Scrum is a agile proccess that focuses on small incremental development cycles called sprints. A sprint is a short development cylce that can range from one to three weeks but is generally kept short at one week. During a sprint the team will complete a task and have daily standups and at the end of each sprint the sprint is reviewed and changes are made if nessesary. This allows the developer to recieve feedback and easily adapt as the requirements change.

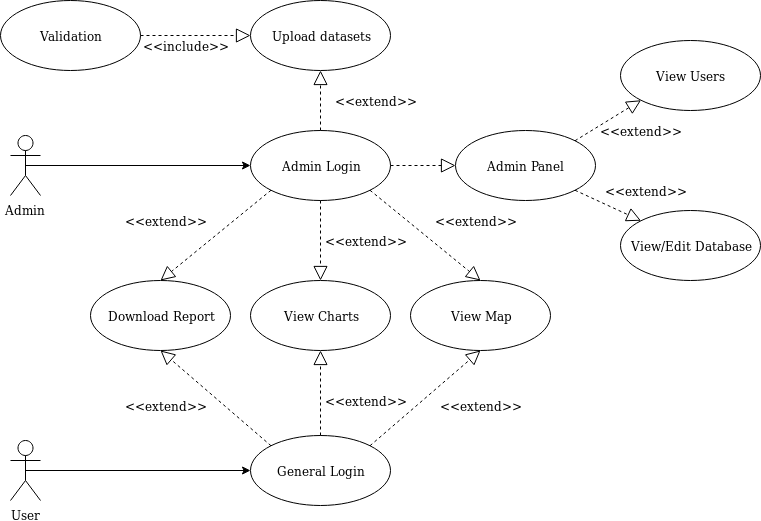


## 3.3. Overview of System

The web application will be built with the web framework Django. Djangos ORM (object relational model) abstract the postgres querys. Django will also handle all requests sent to the web application. The database will be postgres with the POSTGIS extension which is used to make spacial queries. The database will be hosted on

## 3.4. Front-End

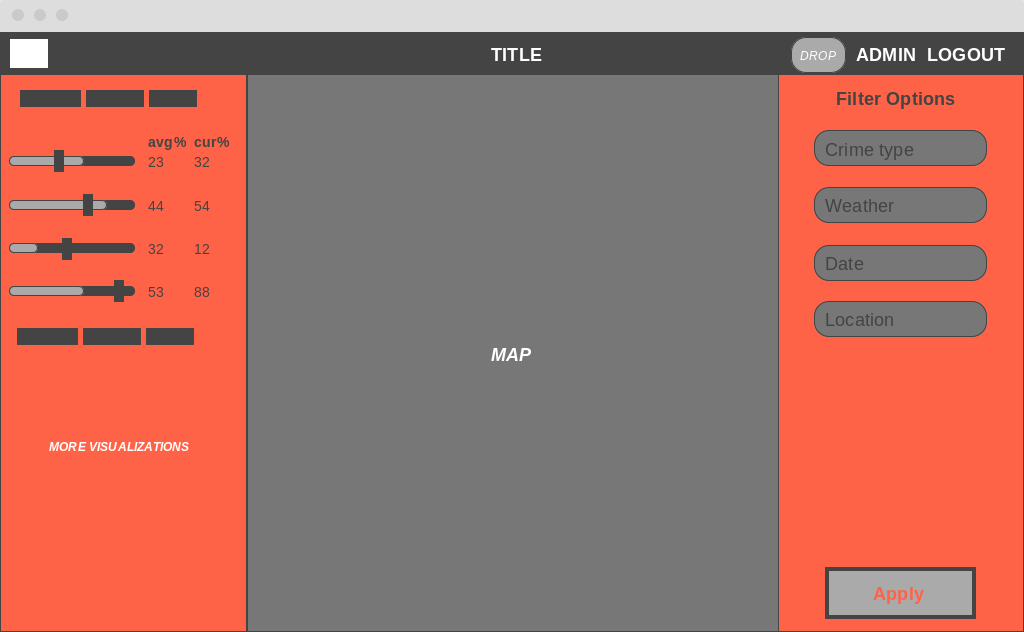
The frontend is going to be an intergral part in the application. There will be two types of users that can use the web application; admin user and general user. The admin user can upload data, edit data, remove data and view logs for the data validation process when a file is uploaded. A general user can view the map and graph data visualizations. Bellow is a use case diagram of the system.



An admin can upload new data to the database. This will allow a none techinical person TO upload new crimes to the database.

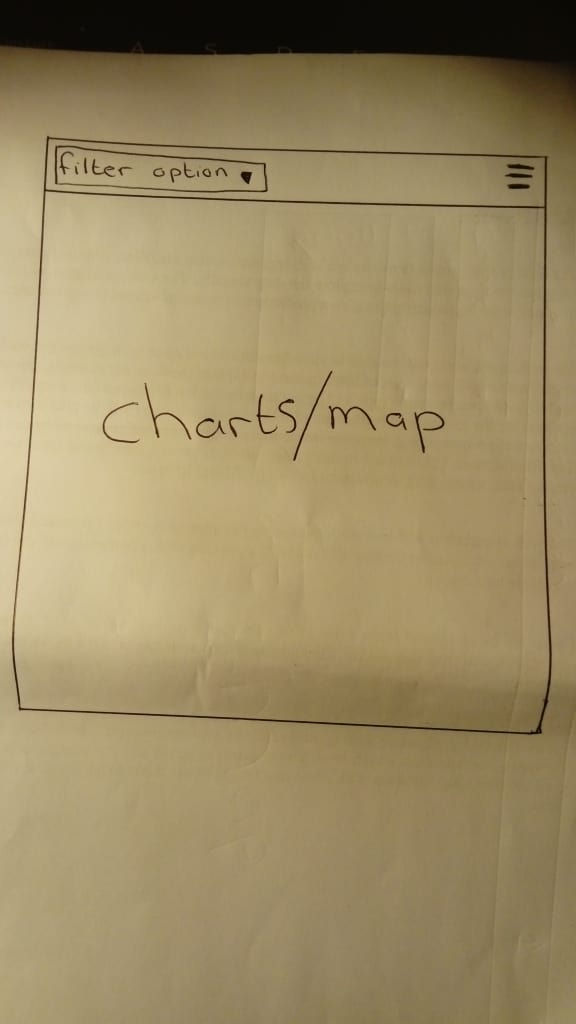
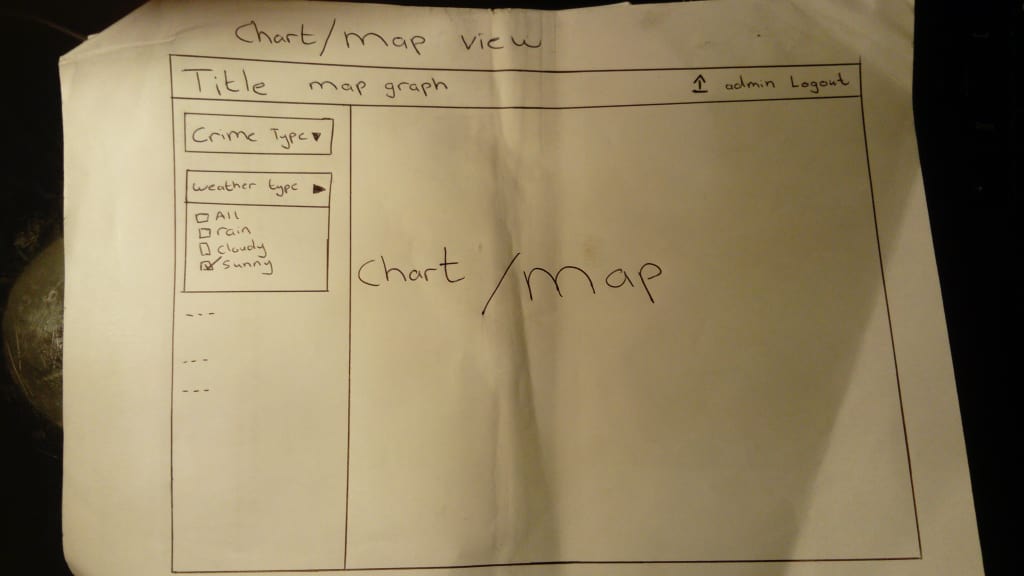
Developing the frontend is going to be another major part of this project. Decideing on a frontend design layout for the application I looked at a few web mapping web applications online until I found a design that I liked and that was user friendly and easy to navigate through. When designing the color scheme I took into consideration of the colors would affect the user. Color pychology is a field of science that is has conflicting reports on its creditablity. A few insteresting studies have been done over the years that give conviencing evidence that colors can effect peoples moods and behaviours. One study on color pychology found that changing the color of the street lights to blue decressed crime [17]. Another study had findings where colors can be used to alter a users mood [18]. This can be seen in our day to day lives. Fast food restraunts that claim to have healthy food will often use a lot of green for their food wrappings. This is because most people associate the color green with health and plant based foods. Anothering interesting example of companies using color for marketing is McDonalds logo color change. McDonalds logo used to be a yellow “M” on a red background but was changed to a yellow “M” on a green background. This was done to give the impression that McDonalds is enviromentally friendly [19]. From this information it seems that people associate colors with types of emotions, enviroments or products. With all this in mind I decided to have a dark color scheme with a minimal layout for my web application. I have decided on a dark color scheme because it seems a lot of data anylitical web application templates i have seen have a dark color scheme.

I went few a few iterations for the layout of the web application. Originally I decided to have everything on a single page.

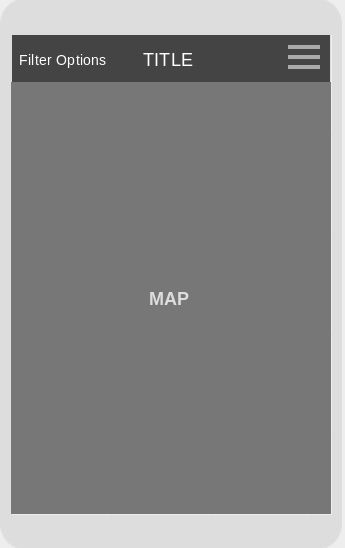
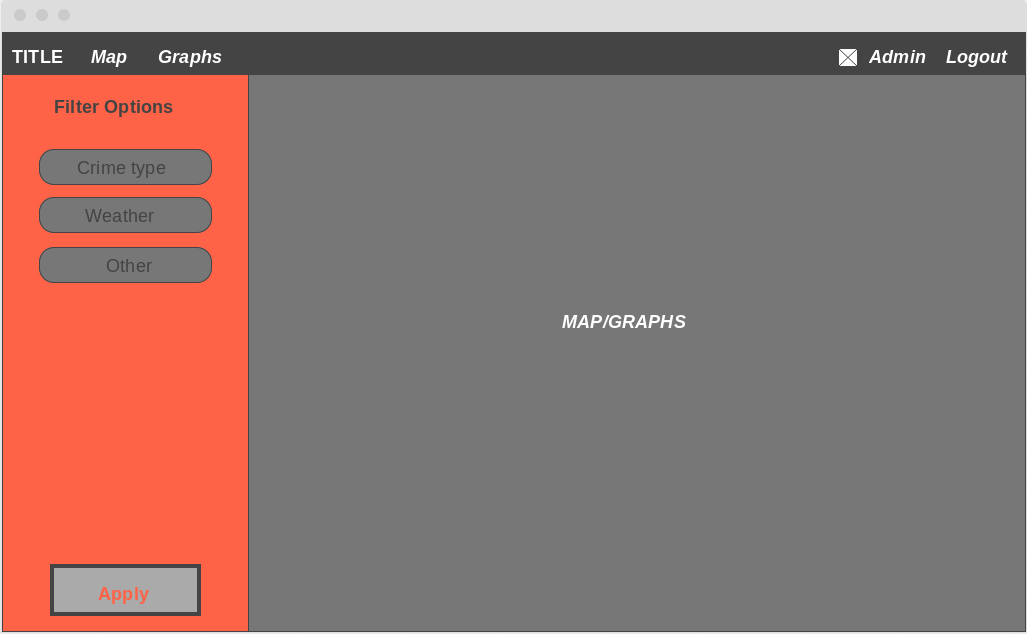


The filter options would be on the right hand side with the map in the middle and some simple staticts of the current filter options versus the average with some basic graph visualizations. While I liked this design I was limited in that I couldn’t fit more complex graphs into the panel on the left side.

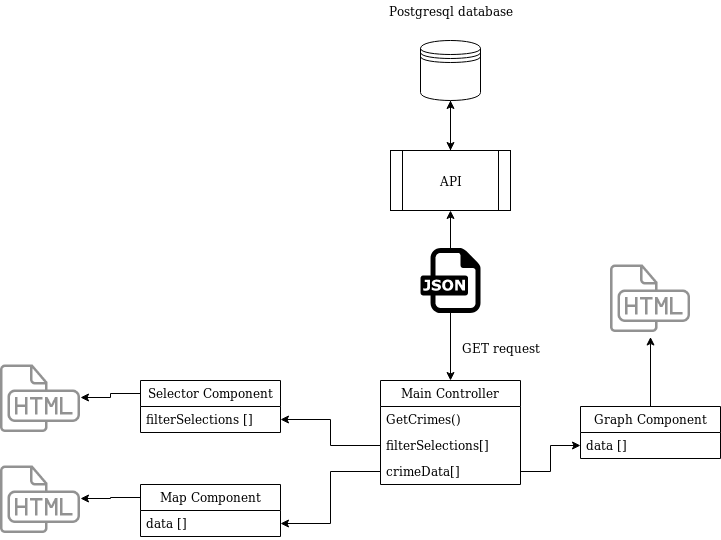
I redesigned the wireframe with pen an paper so that it had a seperate page for the map and graph visualizations. Since the map and charts are the main aspect of the web application I wanted to give them the most space on the page.



I then recreated the pen and paper wireframes with a online tool.



I will be using AngularJS to create the filters. Each filter option will be a component that will have a two way binding to the main controller. A two binding just means any changes made to a variable in the component that is binded to the controller will also change the variable in the controller. This means I can create indepent componts that are controlled by a single controller. When the user clicks the “Apply” button the controller will build a URL query based on the selected filter options and send a GET request to the django API using the query URL. Below is a diagram of how the componts and the controller will interact.

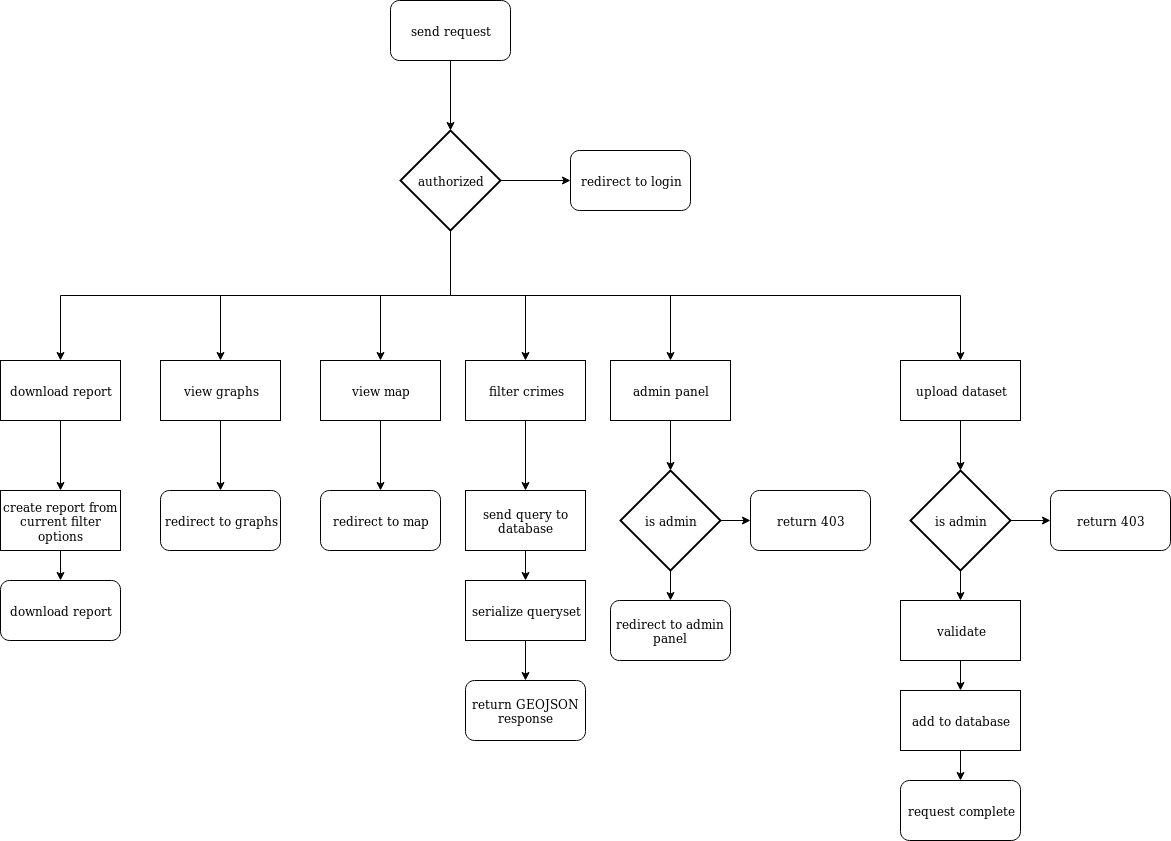


The getCrime() function will be called when the user clicks on the “Apply” button which will return a GEO-JSON object that will be used by the graph and map component to visualize the data. The getCrimes() function uses the filterSelection data to build the URL query.

## 3.5. Middle-Tier

The middle tier will consist of an API that can be used to query the database for crimes and returned as a JSON or GEO-JSON object and a file upload handler that validates the file and creates logs of errors. All this can be done using the django framework.

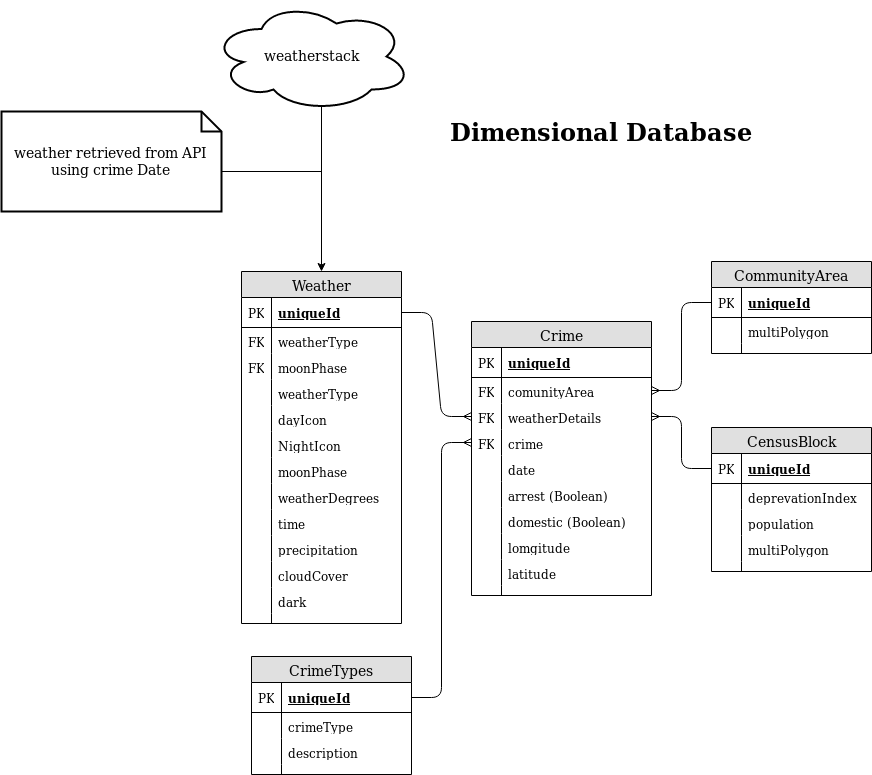
Django has an inbuilt feature that allows you to handle requests. Below is a simple glow chart of how the system will handle requests.



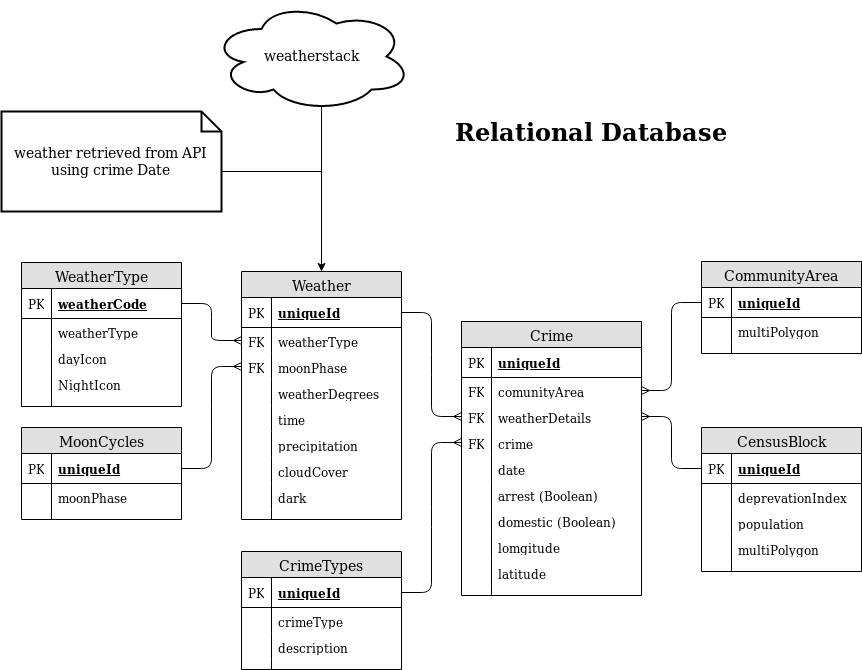
## 3.6. Back-End

Including ERDs, and maybe ISDs

When creating the database, the first step I took was collecting all the data and creating a ERD diagram for the data. First I decided to create a dimensional model for the database scheme. A dimensional model also known as a star shema is a database design used for data warehousing. A central table known as the fact table is used as the main data source and dimensions are added on to it. This makes adding new data easy, all you have to do is create a new dimension and add it to the fact table in constrast to heavy relational designs you might have to redesign the database to add in new data. [16] This is very appealing for my project because based on use feedback I might need to add in new data. Below is a ERD diagram of my first iteration of the database schema.



The dimension model was nearly in the 3rd normal form with the weather table being the exception. In my second iteration I decided to split the weather table up into moonCycles and weather types. While this would impact performance because there will be an extra two tables to query. I decied to do it because it made the shema more readable. Below is my relation design of the database.



This this version of the diagram has an extra two tables. The reason I am choosing this shema as my final design is because the table that defines the weather type and moon cycle ensures all rows in the weather table have predefined weather types and moon cycles. This will make filtering the data easier because all the possible weather types are in the WeatherType table. I can then extract that data and use it in the front end and list all the possible weather types the user can select in the query. This can also be done if I was using the star shema but I would have to check and validate each row and check that it has the correct weather type and stores all the valid weather types somewhere and use them to update the front end filter options. Putting all weather types and moon cycles in their own table makes the development a little easier.

## 3.7. Conclusions

# 4. Prototype Development

**As least 2 pages, but as many as you like (but lots of code samples).**

## 4.1. Introduction

## 4.2. Prototype Development

## 4.3. Front-End

## 4.4. Middle-Tier

## 4.5. Back-End

## 4.6. Conclusions

# 5. Testing and Evaluation

**As least 2 pages, but as many as you like**

## 5.1. Introduction

## 5.2. Plan for Testing

## 5.3. Plan for Evaluation

## 5.4. Conclusions

# 6. Issues and Future Work

**As least 5 pages, but as many as you like**

## 6.1. Introduction

## 6.2. Issues and Risks

## 6.3. Plans and Future Work

### 6.3.1. GANTT Chart

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