Data Visualization Project

COVID-19 Melbourne City Movement Tracker

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Introduction

The novel Coronavirus or COVID-19 is a respiratory disease that has been declared as a pandemic by the World Health Organization (WHO) (Mayo Foundation for Medical Education and Research (MFMER), 2020). This pandemic has spread fast and wide throughout the globe, forcing countries to lockdown their economies and employ several methods like social distancing to keep it's citizens safe from the virus (Wikimedia Foundation, 2020). This project, The COVID-19 Melbourne City Movement Tracker (MMTC in short), aims to track the effects of COVID-19 in the City of Melbourne using the pedestrian counting sensors placed all over the city by the government since 2009 (City of Melbourne Open Data Team, 2020) and the Parking Sensors placed in parking bays all over Melbourne by the government since 2011 (City of Melbourne Open Data Team, 2020).

The Questions Addressed

(Broad) How has COVID-19 in Australia affected Melbourne City Activity?

Motivation

To realize how much the pandemic has affected the access to work in the city, the pedestrian counting system and on-street car parking system proved to be a good proxy of the liveliness of the city itself. Combining that with the case counts from Victoria helps visualize the severity of this pandemic.

Intended Audience

This project is for both the general public and for city services that might want to recognize the change in activity because of COVID-19 (like transport and waste collection).

Design

This section of the report provides a detailed explanation of the design process undergone during the ideation and creation of the visualisation.

Ideation

The Melbourne City COVID-19 Tracker (MCCT) uses 3 data sources namely,

1. *2019 Novel Coronavirus COVID-19 (2019-nCoV) Data Repository by Johns Hopkins CSSE* (John Hopins University Center for Systems Science and Engineering, 2020) with numeric data corresponding to the confirmed case counts and date data.
2. *Pedestrian Counting System by City of Melbourne* (City of Melbourne Open Data Team, 2020) with numeric data corresponding to the number of pedestrians detected by each sensor at a particular place (location data given) with a character name and date of recording (sensor data from *Pedestrian Counting System Sensor Locations* (City of Melbourne Open Data Team, 2020))
3. *On-Street Car Parking Sensor Data* (City of Melbourne Open Data Team, 2020) with dates corresponding to start and end time of a car parking above a parking sensor (location from *On-Street Parking Bay Sensors* (City of Melbourne Data Team, 2020))

The ideation represented in sheet 1 of the design sheets is based on the restrictions placed by these sources. The idea is to use the data to track the city activity. This can be done by visualizing the case counts, pedestrian counts. There can be two views – days and months – providing different perspectives essentially trying to find after which day / month the effects have started and how they are in the present. The pedestrian and parking counts have location data which can be used to make maps and display a more visually understandable graph for city services on which places were affected more within the city. The ideation takes all this into account, filters, categorizes and

refines the ideas to arrive at a few possible visualizations for each of these aspects. These mainly include choropleth maps and proportional symbol maps for the location based data and bar graphs for the count only data like COVID-19 data.

Alternative Designs

The sheets 2,3 and 4 of the design sheets describe the alternative designs that were thought of during the design process. They go from naïve designs to elaborate to compact design. These three designs and the reasons for choosing them have been explained in detailed below.

Naïve Design

The naïve design consists of 2 date selectors and 4 visualizations – 2 each corresponding to the case counts on each date and maps of pedestrian, parking counts on each date. This view was chosen as it is the simplest way of comparing the details on any 2 days.

Elaborate Design

The elaborate design heavily emphasizes on the narrative to guide the understanding of the viewer about each aspect (COVID-19, Movement – Parking and Pedestrian Counts). Different tabs explaining different aspect in both views – monthly and daily giving the viewer and overall thorough understanding of the different aspects. This seems like a pretty good choice for a final design, except it is heavy, elaborate, expensive and misses the point of conveying the comparison in a very clear way.

Compact Design

The compact design combines some of the ideas from both the naïve and elaborate approach and tries to provide a simpler yet clearly communicating the message of change in situation. It uses a slider to change the date and as the date changes the COVID-19 plot and the Movement map change reactively to providing a simpler tool for the user to visualize the change. As the date

changes, it changes the case count plots to highlight the day selected and the movement map to show the proportionally circular symbols representing the pedestrian and parking counts on that day. This design also seems quite good to be a final design but it doesn't provide different aspects nor does it provide a way to automatically trigger a day by day change. This is mutated into the final design to account for these disadvantages.

Final Design

The final design uses the components of the compact design and in addition has a view selector to indicate a daily or monthly view. It also includes an animation play button for the user to easily go through the dates without dragging the slider themselves. The map provides a way to use the legend to filter out pedestrian or parking data. It also provides labels to recognize the place. The final touch to the compact design is the simple narrative of a modal dialog box at the start to explain the tool and the situation been explored.

Implementation

This section of the report covers the implementation aspects of the visualisation. The main components of implementation include

1. Programming Language and IDE
2. Data Processing and Visualisation Libraries

The programming language chosen for this project is R. R provides a sophisticated and simpler environment for this project in particular because it provides a easily usable existing modules unlike Javascript (D3) which is more building from scratch or Tableau which doesn't provide as much flexibility with its functionality.

The Data Processing library chosen for this project are

1. RSocrata and read.csv for collecting data from the city of Melbourne api's and from JHU's Github repository respectively, since they are readily available. Rsocrata also provides querying features. This provides an easier approach to retrieve only the necessary data from millions of data entries.
2. R's built-in functions like aggregate is enough to otherwise process the data.

The Visualisation tools and libraries used include

1. R's Shiny application for UI components and server functionalities. Shiny provides the exact components required for the project like the slider with animation play button plot components and map components
2. Leaflet and ggplot were used for the map and plot visualisations as they provide easier and compatible ways to design proportional symbol maps, plot daily and monthly views for case counts combined with Shiny's reactive components processing.

User Design

This section of the report describes the interfaces the user sees in the order they see and how they can interact with it in different ways.

Introduction

The introduction is given by a model dialog box providing a message of how the tool works and what the purpose of the tool is. A picture of it is provided below in Figure 1.

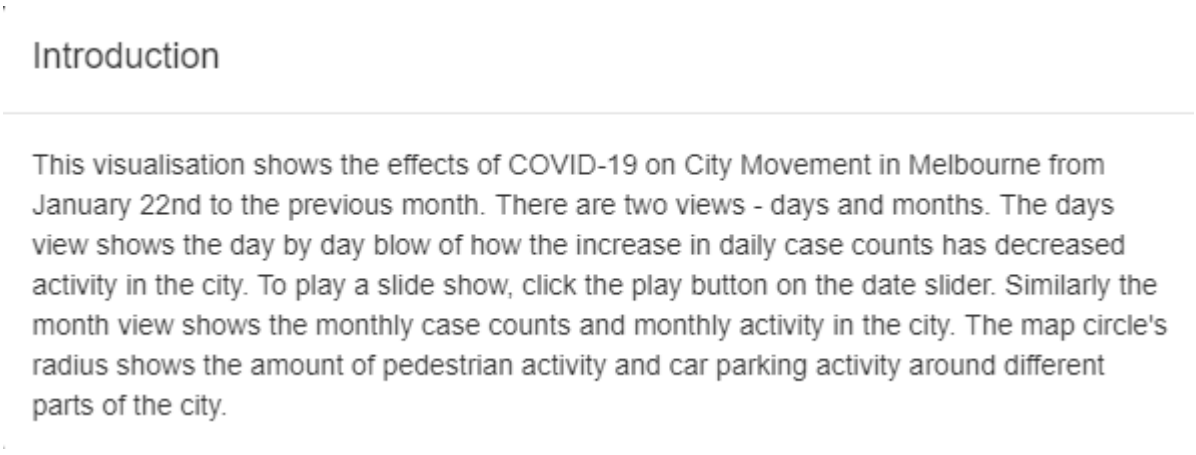

Figure 1. Modal Dialog Box describing the tool and purpose of the tool

This sets the best compact narrative to start with for this visualisation because of its compact nature.

View Selection

After the modal dialog box, it might take a minute or two for the data to load in case the user is running it for the first time with no data.csv (collected data) in the background or if the data is being uploaded after a new month. With this, the user is then exposed to the whole visualisation. The first tool for the user to manipulate is the view selection tool. This provides the user with a method to select whether they want to view the daily day (day by day) or monthly data (month by month). A picture of the selection UI is provided in Figure 2.

Figure 2. Time View Selector. Days (Daily) / Months (Monthly) view selection.

Date Slider

After selecting the view, based on the view, the next selection tools is the date slider providing the a choice of days to choose from using a slider and it also has an animation button to

automatically go through the dates. A picture of the slider for both view is given below in Figure 3a and 3b below.

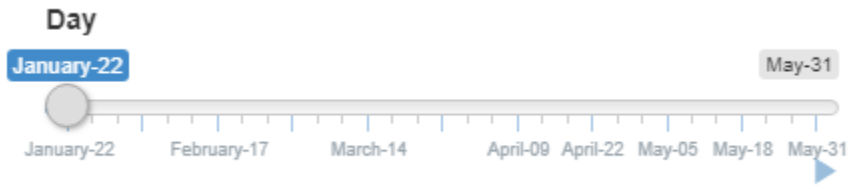

Figure 3a. Date Slider for Days (Daily) View

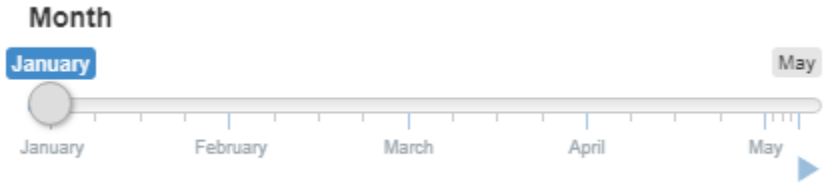

Figure 3b. Date for Months (Monthly) View

COVID-19 Case Count Plot

After selection of view and day/month from date slider, the next visual section for the user is the COVID-19 Case Count plot providing a bar chart of the counts for each day in the month of the day selected for the days view and the counts for each month in the year with the month selected highlighted for the months view. Both of these are shown below in Figure 4a and 4b.

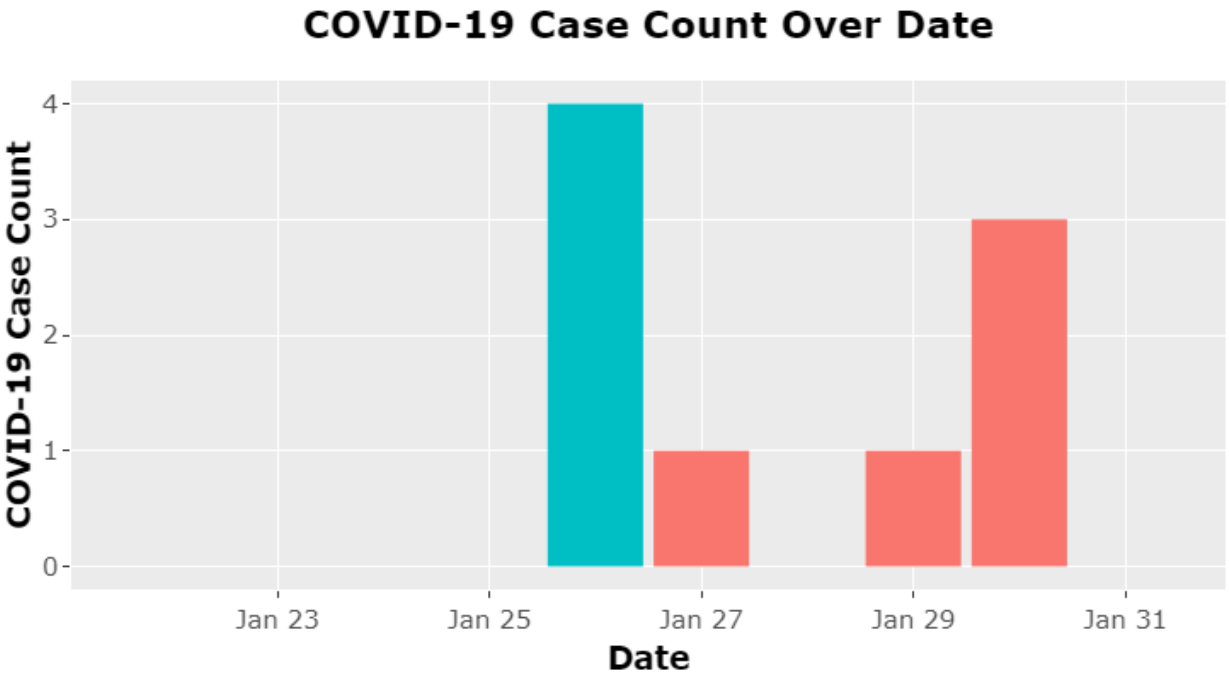

Figure 4a. The COVID-19 Case Counts for the Days of the Month. Highlights the day selected. Also provides tooltip with the count and date for each bar.

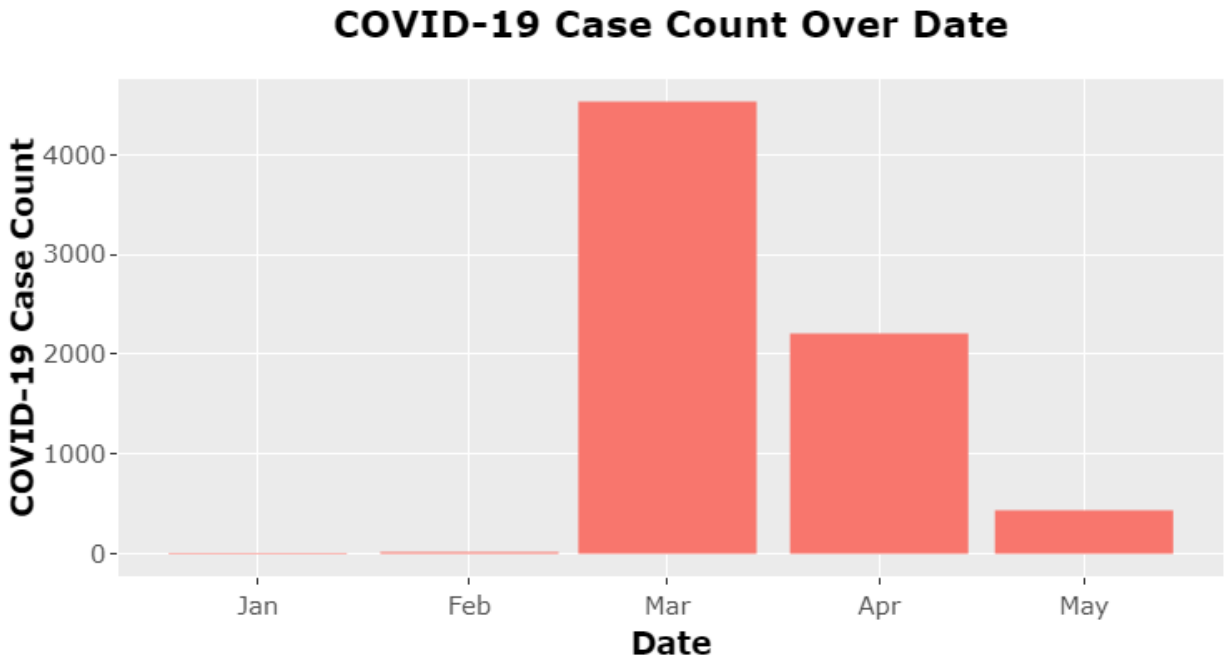

Figure 4b. Monthly view of COVID-19 Case Counts. Highlights month selected and provides count value on tool tip when hover on bar.

Movement Map

Finally, the user sees the proportional symbol map at the end of the page in the application providing the pedestrian counts and the parking counts at different locations across Melbourne. An image of this has been provided below in Figure 5a and 5b for days and months view respectively.

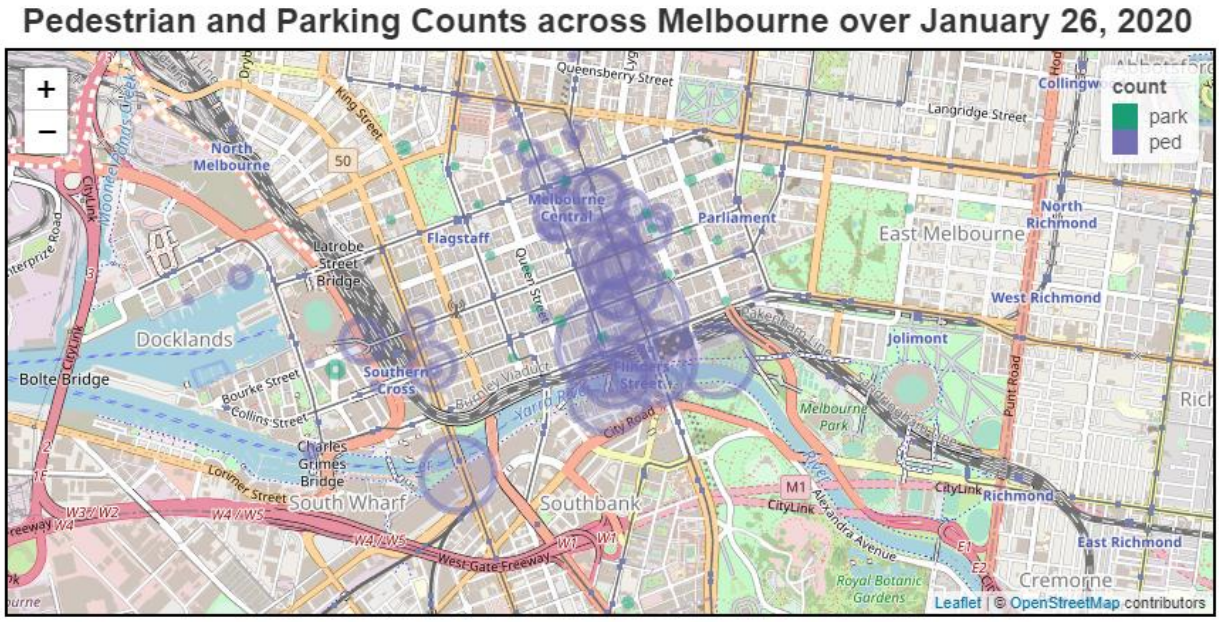

Figure 5a. Movement Map for days view. Proportional symbol map of Pedestrian counts in purple and Parking counts of green.

These maps can be zoomed in and out using touchpads or keyboard. It also provides a filtering of pedestrian count data or parking data from the legends.

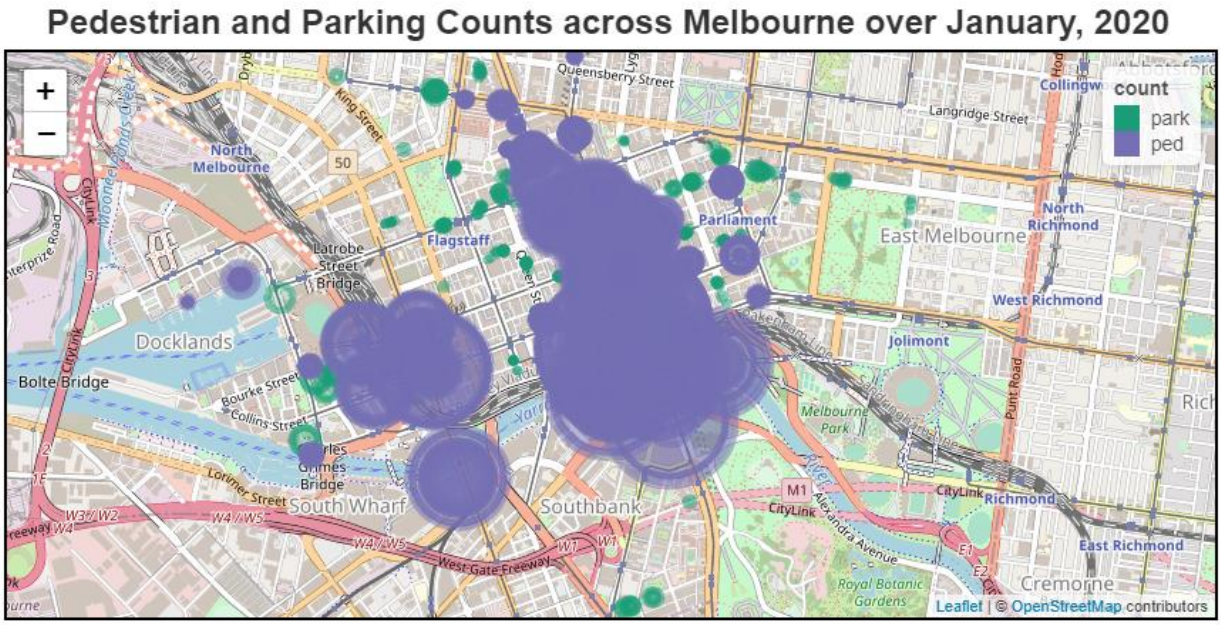

Figure 5b. Movement Map. Proportional symbol map of pedestrian counts in purple and parking counts in green.

Conclusion and Reflection

COVID-19 has affected the world severely and this project was aimed at answering whether it has affected Melbourne City pedestrians. After playing a slideshow of the days view and the months view, it will be clearly evident that the city's activity has lowered immensely and if anything changes the city services will have to become active again fast. For the public this indicates the law being enforced and safety procedures being followed by their fellow citizens and also the immensity of the effects of COVID-19 in their lives.

On hindsight, many more visualizations with more narration could have been performed. A better focus on the narration and improving the seamlessness of the visualization would have been a better choice.

Bibliography

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Appendix

This section contains the design sheets describing the design process. The images of these sheets have been attached from the next page onwards.