Visualizing Mobility and COVID-19

Lily Bryant, Frank Yu, James Yoo

{labryant,frankyu,yoo}@cs.ubc.ca

The University of British Columbia

1 Introduction

The COVID-19 Pandemic is without a doubt the largest event in recent memory to have disrupted the lives of billions of people on a global scale. Many across the globe have changed their daily routines as a response to this event; within our society, people have changed how they work, play, and otherwise spend their time. Advances in technology and the ubiquity of mobile devices have accelerated the collection of data on a massive scale, especially with respect to how the mobility of individuals has changed across the course of the pandemic.

Although the scale of mobility data collected throughout the pandemic is massive, it requires an expensive amount of pre-processing and domain-specific modelling that makes interpretation difficult for a layperson. In order for this data to be useful, it needs to be presented in a way that explains trends in mobility and presents the data in a way that is accessible to a layperson. Tasks such as comparing the changes in mobility across regions, or observing a change in a behaviour over time during the pandemic may be of interest to a layperson.

This work aims to create an *interactive explainer* that leverages a number of visualizations that help to present mobility data collected during the COVID-19 Pandemic in a way that makes trends easily observable. Our interactive explainer will be focused on visualizing changes in mobility across Canada, with a particular focus on the province of British Columbia.

2 Background

Mobility is defined as the study that describes how individual humans move within a network or system [7]. Various infection mitigation measures introduced throughout the pandemic have led to marked changes in the mobility of individuals in their communities. The reduction of activities in community locations that can be categorized under retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential have been the focus of efforts to mitigate community transmission of COVID-19. Our work will explore the trends in mobility across these categories.

Taking a focused approach to data from Canada, and British Columbia in particular, also affords us the option of framing our visualizations in the context of government-mandated shutdowns. A specific example could be visualizing how mobility changed with respect to the phases of British Columbia's Restart Plan [6].

3 Related Work

There have been a large number of visualizations performed with COVID-19 data. A seminal example is the COVID-19 Dashboard by the Center for Systems Science and Engineering at Johns Hopkins University [3]. We explore two visualizations that interactively display COVID-19 data in Canada (3.1), and display mobility data across a number of categories (3.2). We also review an article about the dangers of irresponsible COVID-19 visualizations and discuss how our project will avoid them (3.3).

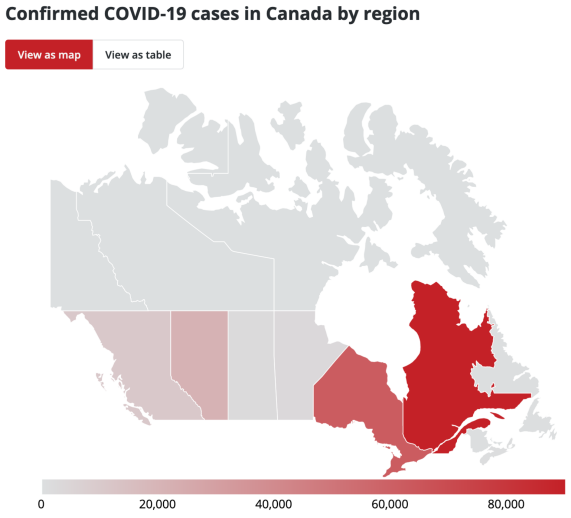

Fig. 1. A choropleth map from the CBC Coronavirus Tracker

3.1 CBC Coronavirus Tracker

Fig. 1 shows a chloropleth map from the CBC Coronavirus Tracker [1]. The tracker exists in the form of a web page that contains a number of visualizations. It enables end-users to perform tasks such as viewing the number of new cases, cumulative cases, and death tolls in Canadian provinces across a range of months. This style of presentation applied to mobility data could be something we explore in our project.

3.2 Google COVID-19 Mobility Reports

Fig. 2 is an example of a sample PDF that users can generate from the Google COVID-19 Mobility Reports [2]. It shows a matrix of line charts that visualize the changes from baseline mobility levels across a number of activity categories.

Although the data provided is rich, there are a number of pitfalls. These visualizations do not enable a pairwise or one-to-many comparison between regions for which data was collected. There is also the added complexity of users needing to explicitly download these PDF visualizations on per-region basis. Our project plans to remedy this by providing visualizations for which regional data is displayed on-demand, enabling pairwise and one-to-many comparisons without the user needing to collate an ensemble of downloaded visualizations themselves.

3.3 Responsible COVID-19 Visualizations

Misinformation about COVID-19 is incredibly widespread. Visualizations are widely used to disseminate information that may be incorrect or even harmful. For example, data scientists and statisticians have been producing their own models and and visualizations that attempt to draw conclusions about the spread of the virus [8]. There has also been a marked focus on visualizing case numbers without providing additional context.

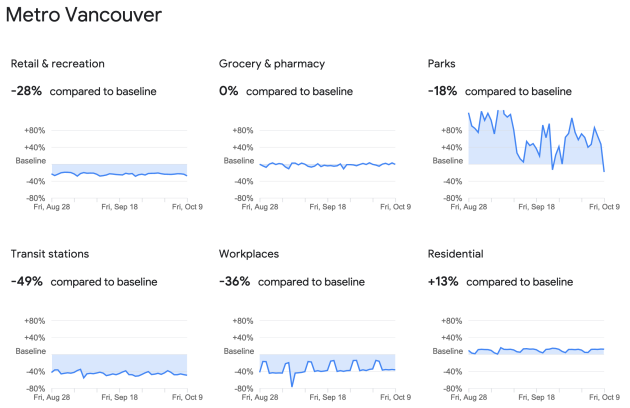

Fig. 2. A matrix of changes in mobility for activity categories in Metro Vancouver

In creating responsible visualizations, we will not be visualizing or generating any models of how COVID-19 progresses in a region. We do not have the necessary background in epidemiology to do so, and proceeding without further domain knowledge in this space would be unethical. We will also not be focusing on the visualization of case numbers for our visualizations. Instead, our visualizations will be centered around data relating to the mobility of individuals in a regional basis.

4 Data and Task

For our project, we plan to create an article that can be viewed by a layperson. We do not assume that our intended audience has specialized knowledge in epidemiology or are intimately familiar with interpreting complex visualizations. We expect our audience to participate in tasks which resemble some form of exploratory data analysis (EDA). Some tasks may include locating which months had the greatest change in mobility in provinces across Canada, or observing how the mobility associated with an activity changed over time.

To support these types of tasks, we expect our article to take the form of a Distill [4] article, which can be categorized as a type of interactive explainer. This format is particularly well-suited for our audience for a number of reasons. They enable the presentation of data with explicit explanations that may guide and help the audience in understanding it, even if they are not domain-experts. Additionally, they enable the inclusion of interactive diagrams which allow the audience to explore the data in the context of the explanations provided in the article.

We plan to use the COVID-19 Community Mobility Reports dataset that is provided by Google. The data in these reports has been collected from users of Google's services that have the *Location History* setting in their accounts turned on. Although Google provides the option to download data for a number of countries, we plan to limit our scope to data that has been collected in Canada to define a more precise storyline. Google limits publicized data when there is an insufficient amount of samples to ensure anonymity, so we will need to take care to remedy gaps in the dataset. We will use all the mobility categories provided by this dataset which include: retail & recreation, grocery & pharmacy, parks, transit stations, workplaces, and residential. We plan to show how the mobility of Canadians, specifically those in British Columbia, have been affected thus far. Given the time-series nature of the data we also hope to identify and show trends within each category as well.

In addition to the Google dataset, we plan to include information about the timing of COVID-19-related governmental restrictions put in place to help reduce disease spread as well as provincial and federal holidays, so the user may reflect on their possible impact on mobility.

5 Proposed Solution

We plan to curate an article on the changes in mobility trends due to the COVID-19 Pandemic across Canada using Observable [5], a platform

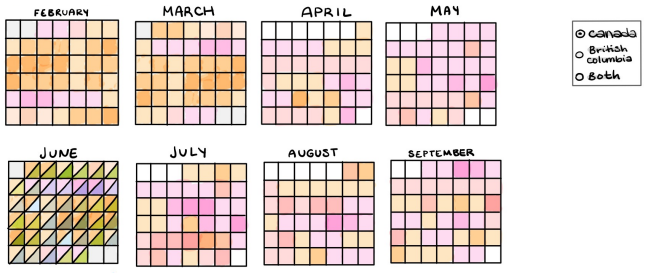

Fig. 3. A calendar heatmap visualization representing changes in mobility for an arbitrary attribute in BC and Canada

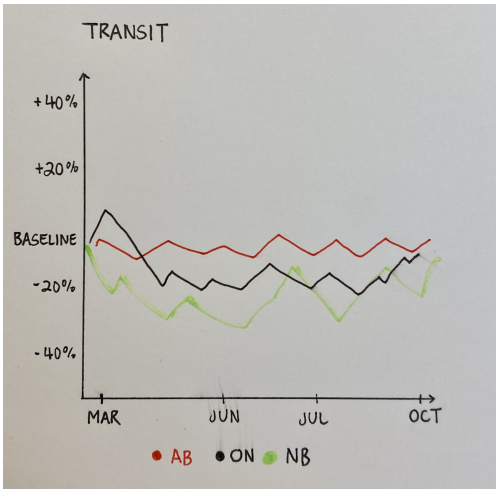

Fig. 4. A line chart for changes in mobility in the Transit category for AB, ON, and NB

which enables the interleaving of rich D3.js visualizations within a text document. Details about the visualizations we provide are listed in the following subsections.

5.1 Choropleth Map of Canada

This visualization focuses on showing an overview of how mobility is currently being affected in each province and territory in Canada. *Fig. 1* shows a rough idea of what this visualization will look like using a similar dataset; however, our design will also include a slider so the user can see how mobility changes over time. Because this figure is designed to be an overview, we limit the scope of the data that will be visualized in two ways. First, we will only be showing the average mobility of all categories as opposed to individual ones. Second, we also limit the time frame to only the current month. We reserve more detailed information for visualizations that come later in the article.

5.2 Provincial/National Comparison Calendar Heatmap

Fig. 3 displays a calendar visualization mock-up with heatmap-style colour coding. For a given mobility attribute, we will encode the daily average difference from pre-pandemic levels according to a pre-defined shade range. Users will have the ability to display values for both British Columbia and Canada, either independently or simultaneously. If the latter option is selected, the visualization will switch to two contrasting colour palettes as shown in the bottom-left corner of *Fig. 3*. We plan to include three iterations of this calendar design within our article to highlight changes in individual mobility attributes. In particular, they will focus on each of retail & recreation, grocery & pharmacy, and parks.

In addition to the basic calendar layout, we plan to overlay information about relevant provincial and federal holidays as well as government-imposed lockdown measures. After preliminary review

of the data, these external factors notably affected mobility values and thus should be presented to the user.

5.3 Provincial Mobility Matrix

This visualization specifically addresses one of the shortcomings we found in the Google Community Mobility Report PDFs. We plan to create a matrix of line charts that visualizes changes in mobility for the categories of Transit, Workplaces, and Residential. *Fig. 4* shows a mock-up of one of the line charts that could be embedded in the matrix.

This visualization would enable the user to compare the mobility trends of numerous provinces, as opposed to just being limited to one region, and without the need to re-download a PDF each time.

6 Milestones and Schedule

Table 1 outlines a tentative schedule for the implementation of our project from initial implementation to final paper submission. Estimating person-hours on tasks is an incredibly error-prone process. We plan to revisit this allocation of hours by November 17 with a more precise understanding of how long the implementation of each task will take in practice.

References

[1] CBC coronavirus tracker. https://newsinteractives.cbc.ca/coronavirustracker/. Accessed 10.15.2020.

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[7] N. Keyfitz. Individual mobility in a stationary population. *Population Studies*, 27(2):335, July 1973. doi: 10.2307/2173401

[8] A. Makulec. Ten considerations before you create another chart about COVID-19. https://medium.com/nightingale/ten-considerations-before-you-create-another-chart-about\-covid-19-27d3bd691be8, Apr 2020.

Expected Completion	Task	Hours (Total/Person)
October 21	Write project proposal and divide tasks	18 / 6
November 10	Implement first draft of article visualizations	15 / 5
	Write first draft of interactive explainer article content	9 / 3
November 17	Update paper to include new changes	9 / 3
December 3	Implement final draft of article visualizations	15 / 5
	Write final draft of interactive explainer article content	9 / 3
December 10	Create content for final presentation and prepare talking points	9 / 3
December 14	Update paper to include final designs and conclusions	12 / 4

Table 1. Proposed project timeline