

# CSC110 Project: **Effect of COVID-19 on Crime in Canada**

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## 1 Problem Description and Research Question

During the beginning of the COVID-19 pandemic, a newfound fear of catching the virus caused many people to become increasingly conservative regarding their usual activities. Going to public places only increased the risk of acquiring COVID-19. As a result, the general population was advised to stay indoors as much as possible and not to go to public gatherings and events where the virus may spread. In addition, during this period of time, public health measures by the Canadian government caused many businesses and organizations to begin implementing stricter social distancing and general operating procedures to manage the spread of COVID-19 across the population. For instance, restaurants began limiting the number of people able to eat indoors, and face masks have become a necessity to enter almost any public building. The provincial government even went as far as shutting down non-essential businesses and putting the whole province into lockdown to ensure that the virus was contained as much as possible.

Similarly, measures such as the requirement for proof of vaccinations for many indoor facilities and event spaces became prevalent strictly as a result of the COVID-19 pandemic. For this project, our group aims to investigate how the COVID-19 pandemic and the public health measures initiated by the government have impacted crime and calls for service (calling the police, EMS, etc.) in Canada. We are particularly interested in exploring the effect of the pandemic on crime because this topic is one that does not seem to be super prevalent in the media. Typically, we tend to only hear about radical cases of crime from the news (terrorism, extreme violence, abuse, etc), but this does not really give us a sense of the trend in the amount of crime in general, which we believe is important to analyze. Therefore, our research question is “**How has COVID-19 and the Canadian governments response to the pandemic changed the amount of (reported) crime in Canada?**” Our group hypothesizes that as a result of this trend of decreasing activity outdoors and in public spaces, organized-crime activities during the COVID-19 pandemic will have decreased, which may be reflected by the computations that we plan to perform on our data in order to analyze this trend.

## 2 Dataset Description

Both of our datasets on crime and COVID are from **Statistics Canada** and are in **CSV** format. In the dataset on selected police-reported crime and calls for service during the COVID-19 pandemic[1], we are provided with information about the number of 911 calls for each type of service required, for each month from March 2019 to August 2020. This includes calls for enforcing physical crimes and requests for help with mental health and suicide prevention. For this project, we will only be focusing on the 911 calls that relate to crimes. Moreover, we only used the `REF_DATE`, `GEO`, `Violations and calls for service`, and `Value` columns. The `REF_DATE` column provided the date of the call, the `GEO` column told us the location of the call down to a region of Canada, the `Violations and calls for service` column gave us the type of incident that provoked the call, and the `Value` column gave us the number of calls for the same emergency type in the month of the call. This data was stored for every observation listed in the dataset as `EmergencyCall` instances, which contained attributes corresponding to these values. There was sufficient data in the dataset before the pandemic to compare the change in crime before and during the pandemic, which we were able to analyze through statistical models.

The second data set[2] that we will use provides us with a daily update about the number of COVID-19 cases in each province and in Canada as a whole. This daily update starts on January 31, 2021 and is still continuously being updated. It is important to note that in the beginning of the dataset, there is no update on the number of COVID-19 cases everyday, probably because there were not new cases every day at the start of the pandemic. For this dataset, we only used the `prname`, `date`, `num_conf`, and `num_deaths` columns. The `prname` column gave us the province for which the data corresponds to, the `date` column gave us the date for which the data was collected, the `num_conf` column gave us the total number of active cases in the particular province, and the `num_deaths` column told us the number of new deaths recorded in the particular province on the given day. As with the emergency call data, this information was stored in a list of instances of the `CovidData` class, with attributes corresponding to each value.

Filtering the list of all `EmergencyCases` instances to get just the calls induced by crimes, we were able to analyze this data in conjunction with the list of `CovidData` instances using statistical models to answer our research question.

## 3 Computational Description

The data in `police_data.csv` is read and put into a list of `EmergencyCall` dataset instances. We have a helper function that uses keyword filtering to sort the `GEO` column into a province or territory, or Canada (if its a total). We have neglected the `Royal Canadian Mounted Police [99C01]` rows because this row does not provide us with the exact location of the crime. All these rows tell us is that these crimes happened in Canada. However, the crimes under these rows would already be included in the `Total`, `Selected police services` rows so we can safely omit this data. We also have a helper function that rewrites the `REF_DATE` column to assume that each crime occurs on the last day of each month. This is to ensure that the date formats are parallel across the 2 datasets and so it can be converted into a `datetime.date` object. We have many helper functions that help perform computations on the list of `EmergencyCalls`. We have a function to return a new list that contains only crimes, with other types of emergencies omitted. The function, `filter_crimes_by_type`, returns a tuple of 2 new lists. The 2 lists are either a list of public crimes and a list of private crimes or a list of physical crimes and a list of non physical crimes.

We have another function called `filter_crimes_by_location` that returns a new list of `EmergencyCall` with only crimes that occurred in a certain year for a certain location. Finally, `emergency_call_to_dict` returns a dictionary mapping relevant attributes of `EmergencyCall` to the list of instance attributes for all the `EmergencyCall` instances in the input list. The purpose of `get_police_data_totals()` is to add up the number of crimes in a certain category per month for a year. There are 2 keys; the first key is the date and maps to a list of 12 `datetime.date` objects that refer to the last day of each month for a certain year. The second key is the total crimes in a certain category for a certain location for the year. This key maps to a list of integers. The integer at index `i` represents the total number of crimes, in the category that is passed in as a parameter, for the `datetime.date.month` object at the same index in the previous list.

We organized the data from the `covid_data.csv` dataset into a list of `CovidData` instances. A helper function is used to convert the `date` column into a `datetime.date` object. The function, `get_monthly_cases`, returns a list of `CovidData` with only the data for the last day of each month for a particular year for a particular location. A helper function, `check_if_monthly_case`, is called in the `get_monthly_cases` function. This helper function checks to see whether the `CovidData` instance is data for the last day of the month. Lastly, `covid_data_to_dict` returns a dictionary mapping relevant attributes of `CovidData` to the list of instance attributes for all the `CovidData` instances in the input list. Although the `_num_deaths` attribute is defined in the `CovidData` class, it is unused because we decided to focus on cases rather than deaths. We still decided to read and save this column of data for potential future analysis of the pandemic.

Since the relationship between COVID cases and crime rate in each province/territory is different, we separated out data for each province/territory for both crime and COVID data sets as described above, and put them into separate Pandas Data Frames (in the `pandas` library) to be processed separately. We also compiled a result from the dataset for Canada as a whole as described above. We also categorized the specific crimes into different categories (*physical-public*, *non-physical-public*, *physical-private*, *non-physical-private*) with keyword filtering, and processed each type of crime separately as well in order to provide more detailed conclusions and insight.

After trimming our data as stated, we plotted our data with `matplotlib`, to show the amount of a certain type of crime committed in a certain province/territory over time, combined with current active covid cases over time, and make one graph for each province/territory, as well as for Canada as a whole. We used `matplotlib` for its robust graph customizability (including the ability to create subplots, customize axes, labels, colors, etc.) for a clearer and cleaner visual representation of our data.

Then in order to find a correlation (or lack thereof) between crime and COVID cases, we tried to fit different statistical models to both datasets as bivariate data to figure out the relationship between the two for each province. In order to accomplish this we used the library `statsmodels`, which can fit different statistical models such as linear, logarithmic, and more, using functions such as `statsmodels.api.OLS.from_formula`, onto our data, returning correlation coefficients, sum of squared residuals, and other important values to help us find the best fit. And in order to show our different attempts and models visually, we again used `matplotlib`.

In addition, because our crime data covers months before the pandemic, we also compared crime before and after the pandemic hit, calculated regressions for both to see how the pandemic itself made an impact on crime rates.

Finally, in order to present our findings visually in a GUI, we used `matplotlib.pyplot` and `Tkinter`, which allows us to present our graphs both visually and interactively.

## 4 Dataset Instructions

In order to download the two necessary datasets used in this project, navigate to the first two links listed in the references below. The first link should yield the crimes dataset, where the `csv` file can be downloaded. The second link should yield the COVID-19 dataset at the very bottom left of the page. The file name should be `covid19-download.csv` for the second dataset. The crime dataset file should be renamed to `police_data.csv` and the COVID dataset file should be renamed to `covid_data.csv`. If this doesn't work, navigate to this Github repository to download the files:

<https://github.com/rsrinivasan1/Datasets-for-CSC110-Project>

After downloading both files, they should be placed in a directory titled `data_sets` so that they can be accessed by our project. You can run our project by running the `main.py` file.

## 5 Changes since Proposal

For the most part, we stuck to the project plan outlined in the proposal for the final submission. However, we did encounter some issues with graphing the data once we aggregated it into `pandas` DataFrames. We wanted the graphs to be more interactive and as a result had to use `Tkinter` in combination with `matplotlib` to show our visual representations and compare the crime data with the COVID data.

## 6 Discussion

### References

- [1] Selected Police-Reported Crime and Calls for Service during the COVID-19 Pandemic, Government of Canada, Statistics Canada, 22 Oct. 2021,  
<https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3510016901&pickMembers%5B0%5D=1.20&cubeTimeFrame.startMonth=01&cubeTimeFrame.startYear=2019&cubeTimeFrame.endMonth=10&cubeTimeFrame.endYear=2021&referencePeriods=20190101%2C20211001>
- [2] Public Health Agency of Canada. "Covid-19 Daily Epidemiology Update." Canada.ca, 28 May 2021,  
<https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html#tiles>
- [3] Global Affairs Canada. "Covid-19 Travel: Checklists for Requirements and Exemptions." Travel Restrictions in Canada, Travel.gc.ca, 25 Oct. 2021,  
<https://travel.gc.ca/travel-covid/travel-restrictions/exemptions>
- [4] Public Health Agency of Canada. "Government of Canada." Canada.ca, / Gouvernement Du Canada, 5 Nov. 2021,  
<https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19/epidemiological-economic-research-data/mathematical-modelling.html>
- [5] "Public Health Infobase - Data on COVID-19 in Canada." Open Government Portal, Public Health Agency of Canada,  
<https://open.canada.ca/data/en/dataset/261c32ab-4cfd-4f81-9dea-7b64065690dc>

- [6] “Covid-19 Intervention Timeline in Canada.” CIHI, Canadian Institute for Health Information,  
<https://www.cihi.ca/en/covid-19-intervention-timeline-in-canada>