Covid-19's effect on crime in Toronto neighbourhoods*

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Abstract

This paper presents an analysis on the effect of Covid-19 on crime rates in Toronto neighborhoods in 2020. The paper uses datasets obtained from opendatatoronto to show how covid-19 had a negative effect on crime rates. The analysis consists of using the statistical programming language R to model the data using regression and constructing various plots and graphs to visually represent the data. The results obtained show us how pandemics like covid-19 can affect a person's mindset, enabling us to better predict their actions during such situations.

Keywords: Covid-19, Crime. Toronto neighborhoods, residents, open data toronto

1 Introduction

After the first reported outbreak of covid-19 in December 2019, the entire world changed. Covid-19 was quickly declared to be a health emergency of global concern by the World health organization in March of 2020. Governments took measures to restrict the spread of the disease such as imposing lockdowns, travel bans, restrictions on public gatherings, closing down businesses and advising people to isolate at home. Citizens of countries were essentially restricted to their homes and rarely left. Covid-19 had a huge impact on the global economy and had restricted people's actions and movements. The question this paper seeks to answer is how the covid pandemic had affected crime in various neighborhoods in Toronto in 2020.

In this paper, we use data on covid cases and crime rates in Toronto for the year 2020 to see how the number of covid cases in a neighborhood had affected crime in Toronto neighborhoods. We construct a model using R in order to see how the number of covid cases can affect the crime rate in a neighborhood. We also use the dataset to construct various histograms, bar plots and summary statistics about the dataset to improve the quality of our analysis. The results obtained seem to imply that the covid pandemic had a negative effect on crime in 2020 as crime rates went down in most Toronto neighborhoods. The results obtained contribute to our understanding of how the presence of a common threat that affects everyone such as a pandemic in this case can discourage people from criminal actions. It will allow us to improve our predictions of a person's behavior during such situations.

The paper first presents an overview of the datasets and the variables we will be using for this study in the data section. The model section presents the regression steps taken to generate the model that shows how covid affects crime. The results section discusses the various conclusions we can draw from the data and the model and finally the discussion section discusses the strenghts and weaknesses of the paper. Any additional details are included in the appendix.

*Code and data are available at: https://github.com/Varun1005473462/final_folder-main.git.

2 Data

2.1 Obtaining the covid_cases dataset

```
## # A tibble: 32,000 x 18
##    `_id` Assigned_ID `Outbreak Associated` `Age Group`    `Neighbourhood~` FSA
##    <dbl>       <dbl> <chr>                 <chr>          <chr>            <chr>
##  1 53531       55685 Sporadic              20 to 29 Years Dovercourt-Wall~ M6P
##  2 53532       55686 Outbreak Associated   19 and younger Don Valley Vill~ M2J
##  3 53533       55687 Sporadic              60 to 69 Years Brookhaven-Ames~ M6M
##  4 53534       55688 Sporadic              20 to 29 Years Cliffcrest       M1M
##  5 53535       55689 Sporadic              20 to 29 Years Flemingdon Park  M3C
##  6 53536       55690 Outbreak Associated   19 and younger Mount Olive-Sil~ M9V
##  7 53537       55691 Outbreak Associated   50 to 59 Years Roncesvalles     M6R
##  8 53538       55692 Sporadic              30 to 39 Years Willowridge-Mar~ M9R
##  9 53539       55693 Sporadic              60 to 69 Years Keelesdale-Egli~ M6M
## 10 53540       55694 Sporadic              60 to 69 Years Flemingdon Park  M3C
## # ... with 31,990 more rows, and 12 more variables:
## #   `Source of Infection` <chr>, Classification <chr>, `Episode Date` <date>,
## #   `Reported Date` <date>, `Client Gender` <chr>, Outcome <chr>,
## #   `Currently Hospitalized` <chr>, `Currently in ICU` <chr>,
## #   `Currently Intubated` <chr>, `Ever Hospitalized` <chr>,
## #   `Ever in ICU` <chr>, `Ever Intubated` <chr>
```

2.2 Obtaining the neighborhood crime cases dataset

```
## # A tibble: 140 x 104
##    `_id` OBJECTID Neighbourhood           Hood_ID F2020_Populatio~ Assault_2014
##    <dbl>    <dbl> <chr>                   <chr>              <dbl>        <dbl>
##  1     1        1 Yonge-St.Clair          097                14083           16
##  2     2        2 York University Heights 027                30277          273
##  3     3        3 Lansing-Westgate        038                18146           42
##  4     4        4 Yorkdale-Glen Park      031                17560          106
##  5     5        5 Stonegate-Queensway     016                27410           91
##  6     6        6 Tam O'Shanter-Sullivan  118                29970          103
##  7     7        7 The Beaches             063                23364           88
##  8     8        8 Thistletown-Beaumond He~ 003               10948           61
##  9     9        9 Thorncliffe Park        055                23518           86
## 10    10       10 Danforth East York      059                18427           68
## # ... with 130 more rows, and 98 more variables: Assault_2015 <dbl>,
## #   Assault_2016 <dbl>, Assault_2017 <dbl>, Assault_2018 <dbl>,
## #   Assault_2019 <dbl>, Assault_2020 <dbl>, Assault_Rate2014 <dbl>,
## #   Assault_Rate2015 <dbl>, Assault_Rate2016 <dbl>, Assault_Rate2017 <dbl>,
## #   Assault_Rate2018 <dbl>, Assault_Rate2019 <dbl>, Assault_Rate2020 <dbl>,
## #   AutoTheft_2014 <dbl>, AutoTheft_2015 <dbl>, AutoTheft_2016 <dbl>,
## #   AutoTheft_2017 <dbl>, AutoTheft_2018 <dbl>, AutoTheft_2019 <dbl>, ...
```

2.3 Finding the number of covid cases for each neighborhood for the year 2020

```
covid_cases<-
  covid_cases |>
```

```
  mutate(year=format(covid_cases$`Episode Date`,"%Y"))
covid_cases2020<-
  covid_cases |>
  filter(year == 2020)
covid_cases_neighbourhood<-data.frame(table(covid_cases2020['Neighbourhood Name']))
colnames(covid_cases_neighbourhood)[1]<-"Neighbourhood"
colnames(covid_cases_neighbourhood)[2]<-"Number of Covid cases"
covid_cases_neighbourhood
```

```
##                          Neighbourhood Number of Covid cases
## 1                       Agincourt North                   136
## 2          Agincourt South-Malvern West                   115
## 3                             Alderwood                    38
## 4                                 Annex                   152
## 5                     Banbury-Don Mills                    98
## 6                        Bathurst Manor                   124
## 7                    Bay Street Corridor                    52
## 8                        Bayview Village                    52
## 9                  Bayview Woods-Steeles                    43
## 10                 Bedford Park-Nortown                   126
## 11               Beechborough-Greenbrook                    51
## 12                               Bendale                   121
## 13                Birchcliffe-Cliffside                    73
## 14                           Black Creek                   204
## 15                           Blake-Jones                    23
## 16                Briar Hill - Belgravia                    87
## 17    Bridle Path-Sunnybrook-York Mills                    16
## 18                       Broadview North                    32
## 19                  Brookhaven-Amesbury                   116
## 20     Cabbagetown-South St. James Town                     9
## 21                   Caledonia-Fairbank                    75
## 22                              Casa Loma                    19
## 23                Centennial Scarborough                    57
## 24                 Church-Yonge Corridor                    82
## 25                   Clairlea-Birchmount                   140
## 26                          Clanton Park                    97
## 27                            Cliffcrest                    73
## 28                Corso Italia-Davenport                    86
## 29                               Danforth                    18
## 30                   Danforth-East York                    42
## 31                   Don Valley Village                   144
## 32                           Dorset Park                   174
## 33  Dovercourt-Wallace Emerson-Junction                   138
## 34                  Downsview-Roding-CFB                   339
## 35                       Dufferin Grove                    26
## 36                    East End-Danforth                    42
## 37              Edenbridge-Humber Valley                    80
## 38                          Eglinton East                   152
## 39                     Elms-Old Rexdale                    81
## 40                  Englemount-Lawrence                   230
## 41       Eringate-Centennial-West Deane                    57
## 42                  Etobicoke West Mall                    63
## 43                      Flemingdon Park                   122
```

```
## 44                    Forest Hill North                  65
## 45                    Forest Hill South                   8
## 46               Glenfield-Jane Heights                 263
## 47                    Greenwood-Coxwell                  31
## 48                            Guildwood                  28
## 49                           Henry Farm                  59
## 50                    High Park-Swansea                  96
## 51                      High Park North                  42
## 52                      Highland Creek                   72
## 53                    Hillcrest Village                  31
## 54              Humber Heights-Westmount                 48
## 55                          Humber Summit                157
## 56                             Humbermede                173
## 57                   Humewood-Cedarvale                  53
## 58                                Ionview                45
## 59            Islington-City Centre West                199
## 60                          Junction Area                38
## 61              Keelesdale-Eglinton West                 55
## 62                          Kennedy Park                100
## 63                  Kensington-Chinatown                 41
## 64         Kingsview Village-The Westway                119
## 65                        Kingsway South                 18
## 66                             L'Amoreaux                198
## 67                    Lambton Baby Point                 21
## 68                      Lansing-Westgate                 45
## 69                    Lawrence Park North                24
## 70                    Lawrence Park South                37
## 71                     Leaside-Bennington                36
## 72                        Little Portugal                47
## 73                             Long Branch                26
## 74                                 Malvern               291
## 75                              Maple Leaf                89
## 76                            Markland Wood               25
## 77                                 Milliken              151
## 78  Mimico (includes Humber Bay Shores)                  128
## 79                             Morningside                81
## 80                               Moss Park                61
## 81                            Mount Dennis                84
## 82    Mount Olive-Silverstone-Jamestown                  305
## 83                    Mount Pleasant East                32
## 84                    Mount Pleasant West                85
## 85                             New Toronto               39
## 86                       Newtonbrook East                31
## 87                       Newtonbrook West               171
## 88                                Niagara                60
## 89                       North Riverdale                 19
## 90                   North St. James Town                66
## 91                      O'Connor-Parkview                47
## 92                                Oakridge               57
## 93                       Oakwood Village                 94
## 94                         Old East York                 21
## 95                Palmerston-Little Italy                22
## 96                      Parkwoods-Donalda               115
## 97                   Pelmo Park-Humberlea                89
```

```
## 98             Playter Estates-Danforth                  17
## 99                         Pleasant View                 55
## 100                  Princess-Rosethorn                  29
## 101                         Regent Park                  19
## 102                       Rexdale-Kipling                57
## 103                    Rockcliffe-Smythe                143
## 104                         Roncesvalles                42
## 105                  Rosedale-Moore Park                24
## 106                                Rouge               307
## 107        Runnymede-Bloor West Village                  8
## 108                               Rustic                41
## 109                  Scarborough Village                130
## 110                       South Parkdale                77
## 111                     South Riverdale                 75
## 112                 St.Andrew-Windfields                35
## 113                              Steeles               215
## 114                  Stonegate-Queensway                67
## 115              Tam O'Shanter-Sullivan                 94
## 116                       Taylor-Massey                 73
## 117                         The Beaches                 23
## 118        Thistletown-Beaumond Heights                 94
## 119                     Thorncliffe Park               102
## 120                    Trinity-Bellwoods                41
## 121                           University                32
## 122                     Victoria Village               125
## 123   Waterfront Communities-The Island                134
## 124                            West Hill                104
## 125              West Humber-Clairville                297
## 126                 Westminster-Branson                290
## 127                              Weston                122
## 128                  Weston-Pellam Park                 96
## 129                    Wexford/Maryvale                142
## 130                     Willowdale East                101
## 131                     Willowdale West                 37
## 132    Willowridge-Martingrove-Richview                106
## 133                              Woburn                327
## 134                    Woodbine-Lumsden                 11
## 135                   Woodbine Corridor                 15
## 136                             Wychwood                37
## 137                       Yonge-Eglinton                26
## 138                       Yonge-St.Clair                23
## 139              York University Heights                181
## 140                   Yorkdale-Glen Park                167
```

2.4 Arranging the neighborhoods in the neighborhodd_crime_rates and covid_cases_neighborhood dataset alphabetically.

```
neighbourhood_crime_rates |>
  arrange(Neighbourhood)
```

```
## # A tibble: 140 x 104
##    `_id` OBJECTID Neighbourhood           Hood_ID F2020_Populatio~ Assault_2014
```

```
##    <dbl>    <dbl> <chr>                    <chr>              <dbl>        <dbl>
##  1    80       80 Agincourt North          129                31618           67
##  2    81       81 Agincourt South-Malvern~ 128                27406          104
##  3    87       87 Alderwood                020                13242           45
##  4    57       57 Annex                    095                34680          242
##  5    85       85 Banbury-Don Mills        042                31186           60
##  6    86       86 Bathurst Manor           034                17628           47
##  7    94       94 Bay Street Corridor      076                32790          522
##  8   114      114 Bayview Village          052                24799           83
##  9    46       46 Bayview Woods-Steeles    049                14020           36
## 10   115      115 Bedford Park-Nortown     039                26015           59
## # ... with 130 more rows, and 98 more variables: Assault_2015 <dbl>,
## #   Assault_2016 <dbl>, Assault_2017 <dbl>, Assault_2018 <dbl>,
## #   Assault_2019 <dbl>, Assault_2020 <dbl>, Assault_Rate2014 <dbl>,
## #   Assault_Rate2015 <dbl>, Assault_Rate2016 <dbl>, Assault_Rate2017 <dbl>,
## #   Assault_Rate2018 <dbl>, Assault_Rate2019 <dbl>, Assault_Rate2020 <dbl>,
## #   AutoTheft_2014 <dbl>, AutoTheft_2015 <dbl>, AutoTheft_2016 <dbl>,
## #   AutoTheft_2017 <dbl>, AutoTheft_2018 <dbl>, AutoTheft_2019 <dbl>, ...
```

```
covid_cases_neighbourhood |>
  arrange(Neighbourhood)
```

```
##                          Neighbourhood Number of Covid cases
## 1                       Agincourt North                  136
## 2          Agincourt South-Malvern West                  115
## 3                             Alderwood                   38
## 4                                 Annex                  152
## 5                     Banbury-Don Mills                   98
## 6                        Bathurst Manor                  124
## 7                   Bay Street Corridor                   52
## 8                       Bayview Village                   52
## 9                 Bayview Woods-Steeles                   43
## 10                 Bedford Park-Nortown                  126
## 11              Beechborough-Greenbrook                   51
## 12                              Bendale                  121
## 13               Birchcliffe-Cliffside                   73
## 14                          Black Creek                  204
## 15                          Blake-Jones                   23
## 16              Briar Hill - Belgravia                   87
## 17   Bridle Path-Sunnybrook-York Mills                   16
## 18                     Broadview North                   32
## 19                  Brookhaven-Amesbury                  116
## 20    Cabbagetown-South St. James Town                    9
## 21                  Caledonia-Fairbank                   75
## 22                             Casa Loma                   19
## 23              Centennial Scarborough                   57
## 24               Church-Yonge Corridor                   82
## 25                 Clairlea-Birchmount                  140
## 26                        Clanton Park                   97
## 27                          Cliffcrest                   73
## 28              Corso Italia-Davenport                   86
## 29                            Danforth                   18
## 30                Danforth-East York                   42
## 31                Don Valley Village                  144
```

```
## 32                          Dorset Park                174
## 33  Dovercourt-Wallace Emerson-Junction                138
## 34                 Downsview-Roding-CFB                339
## 35                       Dufferin Grove                 26
## 36                    East End-Danforth                 42
## 37             Edenbridge-Humber Valley                 80
## 38                       Eglinton East                152
## 39                     Elms-Old Rexdale                 81
## 40                  Englemount-Lawrence                230
## 41       Eringate-Centennial-West Deane                 57
## 42                  Etobicoke West Mall                 63
## 43                      Flemingdon Park                122
## 44                    Forest Hill North                 65
## 45                    Forest Hill South                  8
## 46                Glenfield-Jane Heights                263
## 47                     Greenwood-Coxwell                 31
## 48                             Guildwood                 28
## 49                            Henry Farm                 59
## 50                    High Park-Swansea                 96
## 51                      High Park North                 42
## 52                       Highland Creek                 72
## 53                    Hillcrest Village                 31
## 54             Humber Heights-Westmount                 48
## 55                         Humber Summit                157
## 56                             Humbermede               173
## 57                   Humewood-Cedarvale                 53
## 58                                Ionview                 45
## 59           Islington-City Centre West                199
## 60                         Junction Area                 38
## 61              Keelesdale-Eglinton West                 55
## 62                         Kennedy Park                100
## 63                 Kensington-Chinatown                 41
## 64        Kingsview Village-The Westway                119
## 65                       Kingsway South                 18
## 66                            L'Amoreaux                198
## 67                   Lambton Baby Point                 21
## 68                     Lansing-Westgate                 45
## 69                  Lawrence Park North                 24
## 70                  Lawrence Park South                 37
## 71                   Leaside-Bennington                 36
## 72                      Little Portugal                 47
## 73                           Long Branch                 26
## 74                               Malvern                291
## 75                            Maple Leaf                 89
## 76                          Markland Wood                 25
## 77                               Milliken                151
## 78  Mimico (includes Humber Bay Shores)                128
## 79                           Morningside                 81
## 80                             Moss Park                 61
## 81                          Mount Dennis                 84
## 82    Mount Olive-Silverstone-Jamestown                305
## 83                  Mount Pleasant East                 32
## 84                  Mount Pleasant West                 85
## 85                           New Toronto                 39
```

```
## 86                     Newtonbrook East                  31
## 87                     Newtonbrook West                 171
## 88                              Niagara                  60
## 89                       North Riverdale                 19
## 90                  North St. James Town                 66
## 91                     O'Connor-Parkview                 47
## 92                              Oakridge                 57
## 93                       Oakwood Village                 94
## 94                        Old East York                  21
## 95               Palmerston-Little Italy                 22
## 96                     Parkwoods-Donalda                115
## 97                  Pelmo Park-Humberlea                 89
## 98               Playter Estates-Danforth                17
## 99                           Pleasant View                55
## 100                   Princess-Rosethorn                 29
## 101                          Regent Park                 19
## 102                       Rexdale-Kipling                57
## 103                    Rockcliffe-Smythe                143
## 104                         Roncesvalles                 42
## 105                  Rosedale-Moore Park                 24
## 106                                Rouge                307
## 107         Runnymede-Bloor West Village                  8
## 108                                Rustic                41
## 109                  Scarborough Village                130
## 110                       South Parkdale                 77
## 111                       South Riverdale                75
## 112                  St.Andrew-Windfields                35
## 113                               Steeles                215
## 114                  Stonegate-Queensway                 67
## 115               Tam O'Shanter-Sullivan                 94
## 116                        Taylor-Massey                 73
## 117                          The Beaches                 23
## 118         Thistletown-Beaumond Heights                 94
## 119                      Thorncliffe Park                102
## 120                    Trinity-Bellwoods                 41
## 121                              University                32
## 122                      Victoria Village                125
## 123   Waterfront Communities-The Island                  134
## 124                             West Hill                104
## 125               West Humber-Clairville                 297
## 126                  Westminster-Branson                 290
## 127                               Weston                 122
## 128                   Weston-Pellam Park                 96
## 129                     Wexford/Maryvale                 142
## 130                      Willowdale East                 101
## 131                      Willowdale West                  37
## 132    Willowridge-Martingrove-Richview                  106
## 133                               Woburn                 327
## 134                    Woodbine-Lumsden                  11
## 135                    Woodbine Corridor                 15
## 136                              Wychwood                 37
## 137                      Yonge-Eglinton                  26
## 138                      Yonge-St.Clair                  23
## 139               York University Heights                181
```

```
## 140                Yorkdale-Glen Park                167
```

3 Model

Model to be updated later.

$$Pr(\theta|y) = \frac{Pr(y|\theta)Pr(\theta)}{Pr(y)} \tag{1}$$

Equation (1) seems useful, eh?

Here's a dumb example of how to use some references: In paper we run our analysis in `R` (R Core Team 2020). We also use the `tidyverse` which was written by Wickham et al. (2019) If we were interested in baseball data then Friendly et al. (2020) could be useful.

We can use maths by including latex between dollar signs, for instance θ.

4 Results

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A Additional details

References

Friendly, Michael, Chris Dalzell, Martin Monkman, and Dennis Murphy. 2020. *Lahman: Sean 'Lahman' Baseball Database*. https://CRAN.R-project.org/package=Lahman.

R Core Team. 2020. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the tidyverse." *Journal of Open Source Software* 4 (43): 1686. https://doi.org/10.21105/joss.01686.