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 remainder of this paper is structured as follows: Section 2 will discuss the data for this paper, Section 3 will discuss the model that has been obtained, Section 4 will present the results obtained from the analysis of the dataset, and finally Section 5 will discuss the strengths and weaknesses of the paper.

2 Data

2.1 Obtaining the covid_cases dataset

```
## # A tibble: 32,000 x 18
```

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

```
##    `_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']))
```

```r
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
```

```
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

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

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.