Temporal and Spatial Analysis of Hate Crimes in Toronto*

Uncovering Neighborhood Disparities and Bias Trends Across the City

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This paper analyzes the temporal and spatial patterns of hate crimes in Toronto focusing on trends over time and neighborhood disparities. Toronto Open Data hate crime is used to explore variations in crime frequency and the prevalence of biases such as race, religion and sexual orientation. The results highlight distinct trends and reveal neighborhoods with higher concentrations of bias-motivated incidents; these findings offer insights for addressing hate crimes in the city.

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*Code and data are available at: https://github.com/YichengFu/hate_crimes.git

1 Introduction

Hate crimes are a significant incident reflecting deep-rooted prejudice and discrimination within communities. Hate-crime victimization against racially visible people is of growing concern (Chongatera 2013). These crimes not only impact individuals but also harm the society often leaving individuals feeling unsafe. Social violence omit both the daily violence suffered by certain social categories and its many impacts on the victims (Dalphond 2021). In Toronto, understanding the patterns and dynamics of hate crimes is crucial for addressing their causes and mitigating their effects. While racial and cultural diversity initiatives are central in hate crime policy, combating racially motivated hate crime is often obscured by matters considered more significant by police (Bryan 2019). This paper aims to fill that gap by providing an in-depth analysis of hate crimes in Toronto over time and across different neighborhoods.

This study focuses exploring two primary questions: how hate crimes in Toronto have evolved over time and whether certain neighborhoods experience a disproportionate concentration of bias-motivated incidents. Using Toronto open Data hate crime from 2018 to 2023 I analyzes temporal trends to identify peaks and patterns in the frequency of reported incidents. Additionally, the research examines whether specific biases (such as race, religion, or sexual orientation) are more prevalent in particular areas contributing to an understanding of neighborhood-level disparities. The results provide insight into both the temporal and spatial aspects of hate crimes, shedding light on how bias manifests in different contexts within the city.

The data section will introduced the detail of the data set used in this research in Section 2 – Data. The variables as well as the cleaning process will be discussed in this section. Section 3 will focus on the findings and the visualization of the analysis. Section 4 talks about the limitation of this research and potential error caused by research design or the natural form of data. lastly, the conclusion part raps up the discovers and summarizes all the findings into a short paragraph.

2 Data

2.1 Measurement and packages

The Data set used in the analysis is gathered from Open Data Toronto through the Open Data Toronto (Gelfand 2022) and used the statistical software R (R Core Team 2023) for importing data, data cleaning and testing data. The data source "Crime Data" is collected from Toronto Police starting from 2018 to the end of 2023. It includes both temporal and spatial attributes. Other packages were used for analyzing the data such as ggplot (Wickham 2016), knitr(Xie 2023), tidyverse (Wickham et al. 2019), lubridate (Grolemund and Wickham 2011), tinytex(Xie 2024), dplyr (Wickham et al. 2023).

Data contains around 1400 observations and contains the occurrence date and specific time where the incident happened and the date reported to the police. The reason for the hate crime is categorized as race bias, religion bias and sexual orientation bias etc. The motive for committing a crime, the illegal activity and the neighborhood where the crime occurred are documented by the police throughout the years. Furthermore, the type of location such as park, apartment and school are documented to form the detailed data set and is named "Hate Crime".

2.2 Data cleaning

After observing the data, some observations were dropped due to missing values in location type meaning the recorder had a hard time describing the location characteristics. Therefore, these observations were dropped out of the cleaned data set and will not be included in further data analysis. Date is critical in our data investigation, observations where the reported time is before occurrence time is dropped to assure data validity. Since the data set is from Open Data Toronto the quality of the data is decent. Further cleaning process is unnecessary due to origin high quality of data set .

2.3 Observation

```
# A tibble: 150 x 2
   NEIGHBOURHOOD_158              Crime_Count
   <chr>                               <int>
 1 Yonge-Bay Corridor (170)               49
 2 Church-Wellesley (167)                 46
 3 York University Heights (27)           39
 4 Annex (95)                             38
 5 Downtown Yonge East (168)              37
 6 Moss Park (73)                         32
 7 NSA                                    28
 8 Kensington-Chinatown (78)              25
 9 Wellington Place (164)                 25
10 Oakdale-Beverley Heights (154)         23
# i 140 more rows
```

3 Results

Our results are summarized in Table 1.

Table 1: Explanatory models of flight time based on wing width and wing length

	First model
(Intercept)	1.12
	(1.70)
length	0.01
	(0.01)
width	−0.01
	(0.02)
Num.Obs.	19
R2	0.320
R2 Adj.	0.019
Log.Lik.	−18.128
ELPD	−21.6
ELPD s.e.	2.1
LOOIC	43.2
LOOIC s.e.	4.3
WAIC	42.7
RMSE	0.60

4 Discussion

4.1 First discussion point

4.2 Second discussion point

4.3 Third discussion point

4.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

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