Crime Hotspots in Toronto*

Exploring the Patterns of Violent and Non-Violent Crimes in Local Communities

Yuanyi (Leo) Liu

September 27, 2024

In this paper, we analyzed crime trends in Toronto from 2014 to 2023, focusing on selected neighborhoods with the highest recorded crime rates. By transforming and visualizing crime data over the years, we identified clear patterns of increasing or decreasing crime across various neighborhoods. The findings highlight specific areas, like Moss Park and Yonge-Bay Corridor, where crime rates have significantly fluctuated, providing critical insights for community safety and resource allocation. Understanding these trends is essential for developing targeted interventions and improving public safety in Toronto's most affected areas.

Table of contents

---

*Code and data are available at: https://github.com/leoyliu/Crime-in-Toronto.

1 Introduction

Crime rates in major cities are a central concern for policymakers, law enforcement, and communities alike. Understanding how crime fluctuates over time and identifying areas most affected by criminal activity are essential for ensuring public safety and optimizing the allocation of resources. In a city as diverse as Toronto, crime does not affect all neighborhoods equally, making it crucial to examine specific trends across different areas to inform targeted interventions. This paper explores crime trends in Toronto from 2014 to 2023, focusing on selected neighborhoods with notable crime patterns. The study seeks to provide insights into how crime has evolved over time and which neighborhoods require greater attention for crime prevention efforts.

Although overall crime trends in Toronto have been explored in previous studies, less attention has been given to how these trends differ at the neighborhood level over extended periods. This paper addresses that gap by analyzing crime data from specific neighborhoods across ten years, offering a detailed view of local crime dynamics. Using data from multiple sources, we identify key patterns in how crime has fluctuated, with particular emphasis on neighborhoods such as Moss Park and Yonge-Bay Corridor, which have shown significant changes over time.

To conduct this analysis, we transformed raw crime data into a summarized format and visualized trends across each year from 2014 to 2023. The findings indicate that certain neighborhoods have experienced sharp increases in crime, while others have remained relatively stable or shown improvements. These insights are crucial for informing public safety strategies and ensuring that resources are directed to areas where they are most needed. By identifying which neighborhoods have the highest crime rates and how those rates have changed, policymakers can develop more targeted interventions to improve community safety.

The structure of the paper is organized as follows: Following Section 1, Section 2 outlines how the data was collected, cleaned, and analyzed. Section 3 presents the main findings, including detailed crime trends for each neighborhood and year. Finally, Section 4 provides an in-depth discussion of these findings, exploring potential factors influencing these trends, drawing connections to broader urban issues, and providing suggestions for future research in this area.

2 Data

This section aims to provide a clear understanding of the dataset used in our analysis, focusing on its content, source, and the methods applied for organizing, aggregating, and visualizing crime data. The dataset serves as the foundation for our exploration of crime trends in Toronto's neighborhoods, particularly examining the top 10 areas with the highest reported crime rates between 2014 and 2023.

2.1 Source and Methodology

The dataset comprises crime statistics in Toronto, spanning from 2014 to 2023. The dataset analyzed in this report was obtained in csv format from the City of Toronto Open Data Portal(Toronto Police Services 2014) using the R package `opendatatoronto`(Gelfand 2020). It includes the Crime Data by Neighbourhood. Counts are available for Assault, Auto Theft, Break and Enter, Robbery, Theft Over, Homicide and Shooting & Firearm Discharges. Data also includes the crime rate per 100,000 population calculated using the population estimates provided by Environics Analytics. For the purpose of this study, we focus solely on the number of reported incidents. The data, which is updated as of January 11th, 2024, is a well-regarded resource for scholarly and policy-making endeavors, valued for its thoroughness and dependability.

Although alternative datasets were considered, this specific dataset was selected for its detailed year-wise breakdown and the diversity of crime types it encompasses. Other datasets either lacked the temporal detail or the variety of crime categories present in our chosen dataset. The data was processed and cleaned using R(R Core Team 2020), a powerful statistical programming language. For key operations, please refer to the Section 6.

2.2 Variables

The dataset includes several variables representing different types of crimes reported across Toronto's neighborhoods from 2014 to 2023. Given the extensive dataset, which covers 150 neighborhoods, we have chosen to focus on the top ten neighborhoods with the highest total crime counts. This allows for a more focused and manageable analysis while still capturing significant crime trends across the city.

To simplify the analysis, we aggregated the data to produce a `Total Crimes` variable by summing the various crime types for each year. Figure 1 shows a bar chart of the top ten neighborhoods with the highest overall crimes, emphasizing the variation in crime levels across these areas. Notably, West Humber-Clairville reports the highest total crimes over the period, followed by Moss Park and Downtown Yonge East. The graph clearly shows a gradient of total crimes from the highest in **West Humber-Clairville** to relatively lower totals in **South Riverdale** and **West Hill**. This ranking allows for an easier comparison across neighborhoods and provides insight into which areas may require more focused crime prevention efforts.
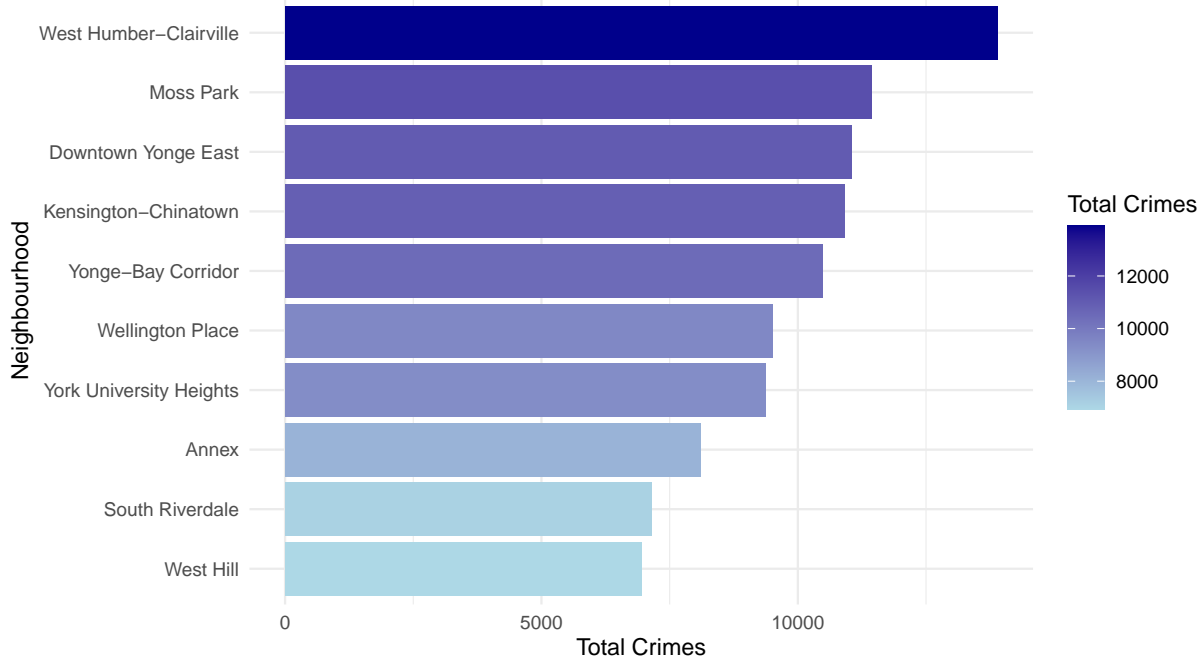
Figure 1: Top 10 Neighborhoods with the Most Crimes

Transitioning from the visualization to a more detailed breakdown, Table 1 presents the total crime numbers for each neighborhood across the ten years from 2014 to 2023. This table provides a year-by-year view of how crime rates have fluctuated in each of the top ten neighborhoods.

Table 1: Yearly Crime Counts in the Top 10 Toronto Neighborhoods (2014-2023)

Neighbourhood	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
West Humber-Clairville	1,247	1,119	1,135	1,177	1,553	1,393	1,286	1,341	1,785	1,856
Moss Park	956	948	1,016	1,044	1,335	1,415	1,430	1,171	1,011	1,113
Downtown Yonge East	922	904	853	1,131	1,211	1,410	1,086	1,217	1,052	1,259
Kensington-Chinatown	1,186	1,208	1,239	1,258	1,241	1,258	991	757	775	999
Yonge-Bay Corridor	931	1,005	950	1,172	1,220	1,339	946	763	1,040	1,117
Wellington Place	930	919	1,016	1,052	1,080	957	854	838	964	898
York University Heights	735	815	844	861	910	932	1,042	928	1,065	1,236
Annex	665	692	753	795	862	915	870	780	841	933
South Riverdale	683	624	769	712	800	717	709	686	684	768
West Hill	604	635	689	720	697	718	641	684	736	828

Table 1 reveals how crime rates in these neighborhoods have fluctuated over time. Some areas, such as West Humber-Clairville, have seen consistent increases, while others, like Kensington-

Chinatown, have experienced more volatility, with crime rates dropping in recent years. This breakdown is essential for understanding not just the overall crime totals but also the year-to-year shifts that could reflect the impact of local policies, demographic changes, or external factors influencing crime trends.

We further differentiated the crime data by classifying crimes into two categories: Violent and Non-Violent. Violent crimes include offenses such as Assault, Homicide, Break-and-Enter, Robbery, and Shooting Incidents, while non-violent crimes encompass acts like Theft. The stacked bar chart in Figure 2 visualizes this distinction, showing the proportion of violent and non-violent crimes for each of the top 10 neighborhoods.
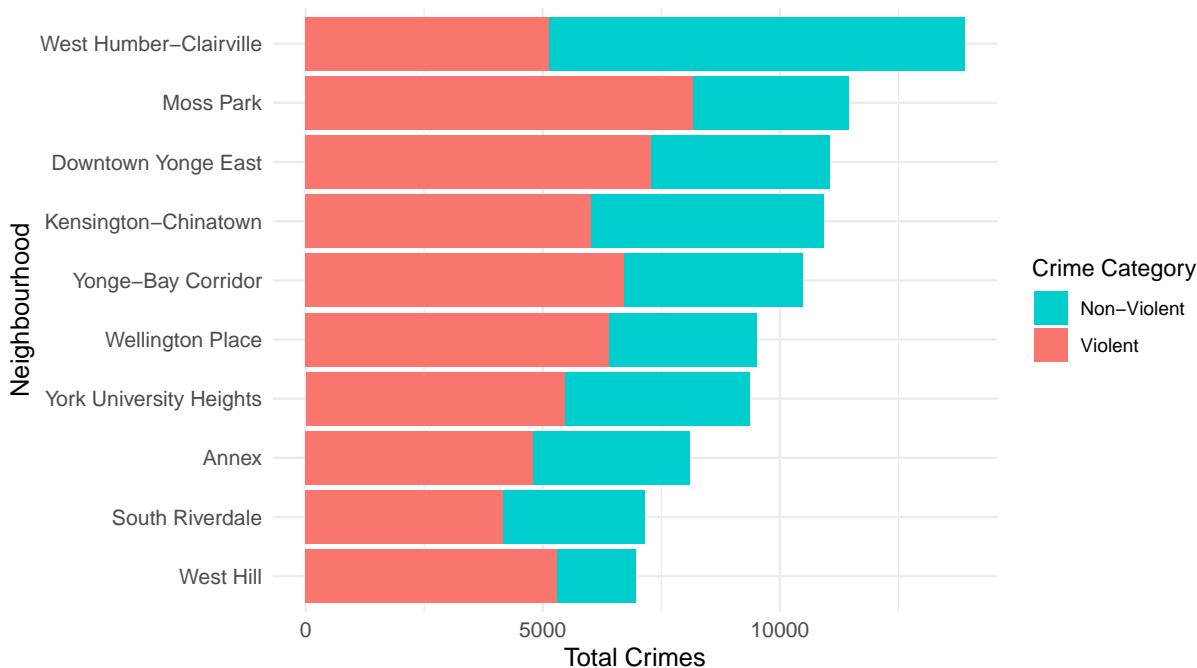

Figure 2: Distribution of Violent and Non-Violent Crimes in the Top 10 Neighborhoods

Figure 2 highlights the relative proportions of violent and non-violent crimes in each neighborhood. In some neighborhoods, like **West Humber-Clairville**, non-violent crimes make up a significant portion of the total, while others, like **Moss Park** and **York University Heights**, violent crimes (such as assault and robbery) constitute a significant proportion of the total, highlighting the need for targeted interventions. **Downtown Yonge East** and **Kensington-Chinatown** show a slightly higher prevalence of non-violent crimes, likely due to high population density and economic activity. Overall, the chart indicates that different neighborhoods experience varying proportions of violent and non-violent crimes, suggesting that crime prevention strategies need to be tailored to the specific needs of each area to effectively address both categories of crime.

2.3 Measurements

The data used in this study was measured based on official crime reports collected by law enforcement agencies and the City of Toronto. Each crime type, such as assault, auto theft, and break-and-enter, was measured as the total number of reported incidents per neighborhood, recorded annually from 2014 to 2023. These incidents were classified based on standard legal definitions and recorded by police officers responding to each reported crime.

The measurement of crime data is straightforward, as each crime variable represents the count of incidents reported within a calendar year for each neighborhood. The dataset ensures consistency in measurement across neighborhoods and years, enabling accurate time-series analysis of crime trends. While reporting practices may vary slightly due to local policing efforts or societal factors, the dataset's reliance on official records ensures a high degree of validity and reliability in how crime is measured and represented.

A Total Crimes variable was constructed by aggregating all individual crime types for each year and neighborhood. This aggregate measurement helps provide an overall view of criminal activity while still allowing for the examination of individual crime types when needed. The consistency and structure of the dataset ensure that the measurements used provide an accurate representation of crime patterns across Toronto neighborhoods.

3 Results

In this section, we delve into the core findings of our study, shedding light on the intricate patterns and trends of crime in Toronto from 2014 to 2023. Our analysis dissects both violent and non-violent crime statistics, revealing insightful correlations and variations over the decade.

The results of this study provide a detailed analysis of crime trends across Toronto's neighborhoods from 2014 to 2023, with a focus on the ten neighborhoods reporting the highest total crime rates. This section presents both aggregated crime data and year-by-year fluctuations for each neighborhood, offering insights into how crime patterns have evolved over time. Through visualizations and summary statistics, we can identify key neighborhoods with consistently high or fluctuating crime rates, as well as trends that may inform future crime prevention strategies. The following subsections break down these findings, starting with an overview of total crimes across all selected neighborhoods and moving into more detailed discussions of specific crime trends.

```
Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
i Please use `linewidth` instead.
```

```
Warning in RColorBrewer::brewer.pal(n, pal): n too large, allowed maximum for palette Set2 i
Returning the palette you asked for with that many colors
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_line()`).
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_point()`).
```
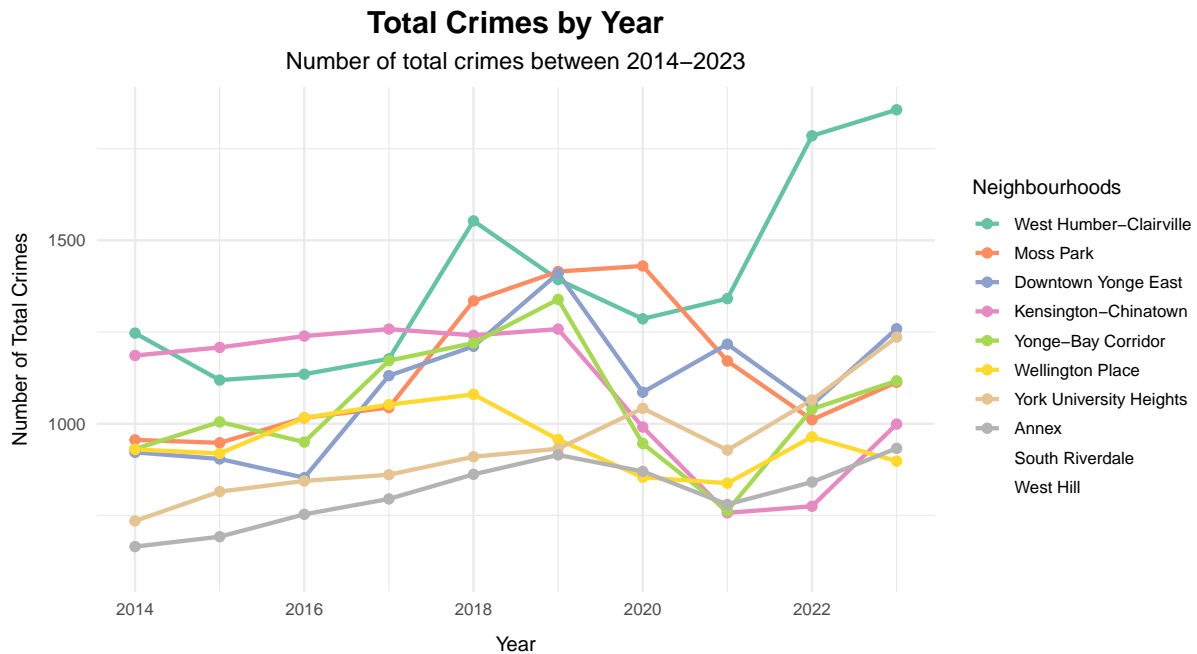

Figure 3: Trends in Crime Cases in Toronto

Figure 3 reveals distinct trends for various crime types in Toronto over the years. We notice that assault crimes have been on the rise in recent years. This could signal a growing concern in public safety and might prompt law enforcement to investigate the underlying causes, such as increased urbanization, changes in population density, or other socio-economic factors. Conversely, there is a noticeable decline in theft-related crimes, which could reflect the success of recent crime prevention initiatives, improved security measures, or increased public awareness.

There has been an overall increasing trend in the number of violent crime cases over the years (Figure 4). There are some fluctuations, with a noticeable dip occurring in one of the years, but the general direction is upwards, especially towards the end of the period, indicating a rise in violent crimes or an increase in reporting. The trend in non-violent crime cases shows some variability but does not have as clear an increasing pattern as violent crimes. There are years where the rate has increased or decreased, but the last year shows a notable increase, suggesting a possible upward trend at the end of the period.
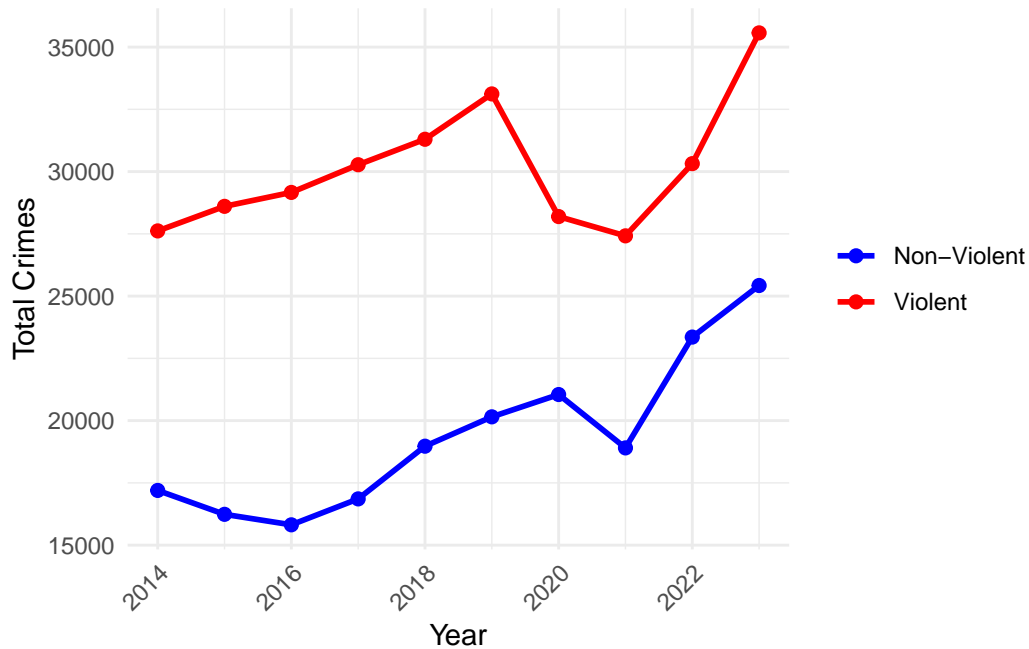
Figure 4: Trends in Violent and Non-Violent Crimes in Toronto (2014-2023)

Overall, the graph indicates that while both violent and non-violent crimes have seen rises and falls, the increase in violent crimes towards the later years is more pronounced. This could reflect changes in societal conditions, law enforcement practices, or reporting mechanisms.

A difference following the pandemic is also especially noticable (Figure 4). Add another sentence or two.

There has been a clear overall increasing trend in violent crime cases over the years, as shown in Figure 4. While there are fluctuations, with a noticeable dip in one particular year, the general direction is upward, particularly towards the end of the period, suggesting an increase in violent crime or heightened reporting. In contrast, non-violent crime cases display more variability, without a consistent increasing pattern. Some years saw rises or declines, but the final year shows a significant increase, possibly indicating an emerging upward trend.

Overall, the graph shows that while both violent and non-violent crimes have experienced fluctuations, the surge in violent crimes in the later years is more pronounced. This may reflect changes in societal factors, law enforcement policies, or crime reporting practices. Notably, the post-pandemic period also appears to coincide with an increase in both categories of crime.

4 Discussion

The analysis of Toronto's crime trends from 2014 to 2023 reveals a complex and evolving landscape of public safety. The pronounced increase in assault cases in recent years is alarming, suggesting that the city may be facing emerging challenges in maintaining public order. This rise in violent crime needs a closer investigation of possible causative factors, such as the effects of increased urbanization, economic disparity, and shifts in population density.

4.1 Variation in Crime Trends

Simultaneously, the decline in theft-related crimes offers a more hopeful narrative. This trend may reflect the successful implementation of preventative measures by law enforcement agencies, such as community policing efforts and the integration of advanced surveillance technology. The use of crime prevention techniques, potentially aided by increased public awareness and education, appears to be bearing fruit.

The contrast between the trajectories of violent and non-violent crime rates underscores the need for a differentiated approach to policy-making and law enforcement. While we appreciate our gains in decreasing property crimes, the data motivates us to pursue more effective interventions for preventing and reacting to violent crimes. This might include extending social services, improving community engagement, and investing in data-driven police strategies.

4.2 Weaknesses and Next Steps

While the visualization provides a high-level overview of crime trends in Toronto, it's essential to conduct a more detailed analysis to understand the underlying causes of these trends. This includes examining subcategories of crimes, focusing on specific geographic areas within the city, and considering other relevant data sources.

Furthermore, this study emphasises the need for ongoing monitoring and analysis of crime data to comprehend the ever-changing dynamics of urban crime. In light of these findings, future studies should focus on understanding the influence of specific policies and social changes on crime rates. Only by doing such a comprehensive analysis can we hope to develop strategies that will ensure the safety and well-being of all Toronto residents.

5 References

Gelfand, Sharla. 2020. *Opendatatoronto: Access the City of Toronto Open Data Portal.* https://CRAN.R-project.org/package=opendatatoronto.

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

Toronto Police Services. 2014. *About Neighbourhood Crime Rates.* https://open.toronto.ca/dataset/neighbourhood-crime-rates/.

Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis.* Springer-Verlag New York. https://ggplot2.tidyverse.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.

Wickham, Hadley, Romain François, Lionel Henry, Kirill Müller, and Davis Vaughan. 2023. *Dplyr: A Grammar of Data Manipulation.* https://dplyr.tidyverse.org.

Wickham, Hadley, Jim Hester, and Jennifer Bryan. 2024. *Readr: Read Rectangular Text Data.* https://readr.tidyverse.org.

Wickham, Hadley, Davis Vaughan, and Maximilian Girlich. 2023. *Tidyr: Tidy Messy Data.* https://tidyr.tidyverse.org.

Xie, Yihui. 2021. *Knitr: A General-Purpose Package for Dynamic Report Generation in r.* https://yihui.org/knitr/.

6 Appendix

6.1 Data Manipulation and Cleaning

- **Data Cleaning:** The initial phase of cleaning the Toronto crime rates dataset involved importing the raw data using the `read_csv` function from the `readr`(Wickham, Hester, and Bryan 2024) package. Following the import, the dataset was streamlined using the `select` function from `dplyr`(Wickham et al. 2023), a tidyverse(Wickham et al. 2019) package, to remove irrelevant columns such as `X_id`, `HOOD_ID`, `POPULATION_2023`, and `geometry`. This step was crucial to focus the analysis on relevant variables. Additionally, the `na.omit` function was employed to discard any rows with missing values (NA), ensuring the dataset's completeness and reliability. The final step in the cleaning process was the exportation of the cleaned data into a new CSV file using the `write_csv`function from `readr`(Wickham, Hester, and Bryan 2024), thereby preserving the cleaned and refined dataset for subsequent analysis.

- **Data Transformation:** The dataset was transformed from a wide format to a long format using the `gather` function from the `tidyr`(Wickham, Vaughan, and Girlich 2023) package. This transformation is crucial for simplifying the data structure and making it more amenable to analysis. Also, the separate function, again from `tidyr`(Wickham, Vaughan, and Girlich 2023), was instrumental in dividing the 'Crime_Year' column into two distinct parts: 'Crime_Type' and 'Year'. This enhances the granularity of the dataset, allowing for more detailed analysis.

- **Aggregation:** The `group_by` and `summarise` functions from `dplyr`(Wickham et al. 2023) were employed to aggregate the data by year and crime type.

- **Data Visualization:** For visual representation, `ggplot2`(Wickham 2016), a versatile package in R for data visualization, was employed. It was used to create comprehensive line plots depicting the trends of various crime categories over the years.

- **Paper Generation:** The packages `knitr`(Xie 2021) is used in generating R Markdown reports.