

Did the crime rate in 2021 increase compared to 2020 in Toronto?

Created by : Seongjin Hong
Presented by : Seongjin Hong

Table of content

- Title
- Background/Problem
- Research Questions/Objectives
- Data
- Methods
- Results
- Discussion
- Conclusion
- References (APA Style) + Acknowledgements

Background / Problems

- Van Attack (2018)
 - April 23, 2018
 - North York, Toronto
 - 10 dead, 16 injured
- Auto-vehicle theft
 - November 3 to November 9, 2022
 - Old Toronto district

Research Question / Objectives

Did the crime rate in 2021 have increased compared to 2020 in Toronto?

-> **If there is**, which area is at high risk of crime?

-> what are the causes?

-> what type of crime is showing increase / decrease?

Data

Toronto Police has been *collecting* and *releasing* the crime data publicly since 2014, and 2004

Data:

- Neighbourhood_Crime_Rates (2014 - 2021)
- Homicide ASR RC TBL-002 (2004 ~)

Methods

- **Temporal differences** in crime rate between 2020 and 2021 on neighborhood crime rate data
- **Local and Global Moran's I** on neighborhood crime rate data
- **Hotspot analysis** on neighborhood crime rate data
- **Aggregation clustering** on homicide crime data

Methods

- **Temporal differences** in crime rate from 2020 to 2021 on neighborhood crime rate data
 - -> to see the **crime rate changes** (increase, decrease)
- **Local and Global Moran's I** on neighborhood crime rate data
 - -> see **clusterings of crime and distribution**
- **Hotspot analysis** on neighborhood crime rate data
 - -> to see the hotspot area where there are **high risk of crime**
- **Aggregation clustering** on homicide crime data
 - -> to see **specifically at homicide crime occurrence in Toronto**

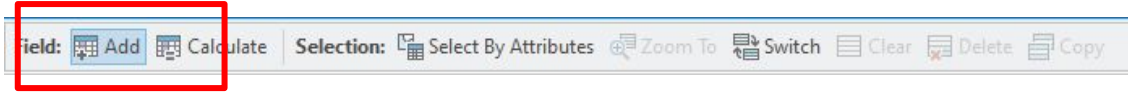
Temporal difference

- Table of showing the process of making a new column

diff_2120	diff_1421	diff_1421h	diff_2021h	dif_1421as	dif_1420as	dif_2021as	dif_1421be	dif_2021be	dif_1420be	df_1421bec	diff_1420	dif_2021at	dif_1421at	dif_1420at
-0.68971	3.0605	0	0	255.941	36.3031	219.637	-84.8361	17.1641	-102	-7	3.75021	33.5726	0	48.03
-28.073	-71.4867	16.0876	16.2666	155.118	198.83	-43.712	-0.9631	28.2836	-29.2467	7	-43.4137	-56.6391	0	238.104
9.35958	-4.62003	0	0	261.055	289.989	-28.9345	-125.236	-128.795	3.5595	-18	-13.9796	69.4806	0	141.601
-133.868	-57.423	-1.05538	-0.169899	219.621	196.571	23.0496	29.0483	-96.6347	125.683	15	76.4447	7.1484	0	60.2624
-8.30625	-1.65318	3.59221	3.59221	-78.3693	28.1023	-106.472	-173.089	-19.9242	-153.164	-42	6.65307	72.744	0	26.8896
-17.2617	-52.8276	0	-3.33667	26.9741	72.3083	-45.3342	-124.161	-130.797	6.6367	-34	-35.5659	60.9053	0	41.9976
37.7471	-18.2458	0	0	-10.2694	-22.6444	12.375	-39.2717	-109.014	69.7422	-6	-55.9929	32.6418	0	62.1428
-27.5719	-124.915	0	0	-49.3462	-93.2917	43.9455	-135.054	-27.6285	-107.425	-14	-97.3434	7.8898	0	298.266
37.5336	-17.3966	-14.2857	-8.50412	81.8251	2.9262	78.8989	-14.9201	-27.3498	12.4297	1	-54.9302	-17.8482	0	27.8984
-21.9104	15.5213	0	-5.42682	-64.7572	-78.5999	13.8427	-52.9674	-55.2026	2.2352	-8	37.4317	-6.03626	0	52.6001
-19.1863	-35.4828	0	0	68.4417	28.5069	39.9348	-84.858	-190.896	106.038	-11	-16.2965	41.3408	0	83.2439
-26.4737	-49.0566	-2.75764	1.88693	-142.079	-103.279	-38.8001	-35.1156	30.3543	-65.4699	7	-22.583	29.3538	0	81.984

Procedure of making Temporal difference (2020 -2021)

1.



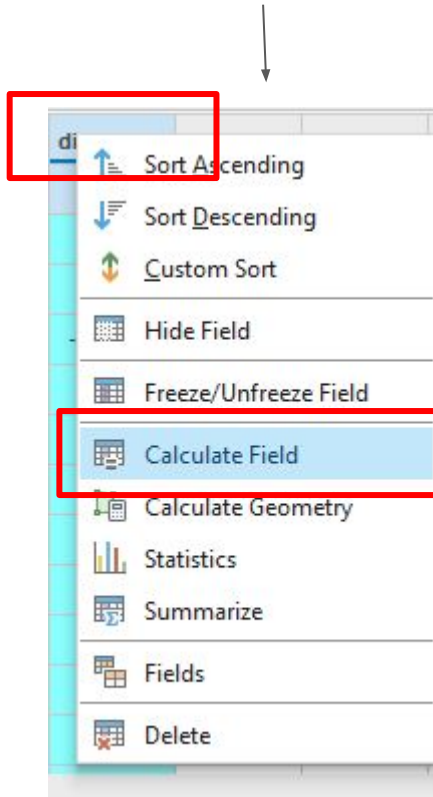
2.

A screenshot of the QGIS attribute table. A red rectangular box highlights the first row of data, which contains the field 'diff_2021h' with a value of 0. An arrow points from the '2.' label to this row. The table has columns for 'Visible', 'Read Only', 'Field Name', 'Alias', 'Data Type', 'Allow NULL', 'Highlight', 'Number Format', 'Default', 'Precision', 'Scale', and 'Length'.

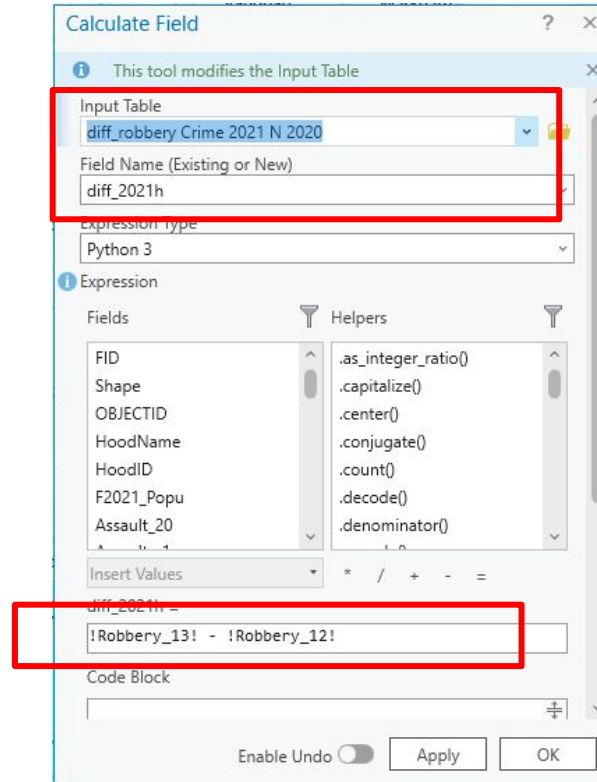
Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Default	Precision	Scale	Length
<input checked="" type="checkbox"/>	<input type="checkbox"/>	diff_2021h	diff_2021h	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	diff_1421bs	diff_1421bs	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_1420as	dif_1420as	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_2021as	dif_2021as	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_1421be	dif_1421be	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_1420be	dif_1420be	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_2021be	dif_2021be	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	df_1421bec	df_1421bec	Long	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		5	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	diff_1420	diff_1420	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_2021at	dif_2021at	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_1421at	dif_1421at	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	
<input checked="" type="checkbox"/>	<input type="checkbox"/>	dif_1420at	dif_1420at	Float	<input type="checkbox"/>	<input type="checkbox"/>	Numeric		0	0	

Procedure of making Temporal difference (2020 -2021) (2)

3.



4.



Local Moran's I & Global Moran's I

- Eg) Homicide
- Do the same for:
 - Break and enter
 - Auto-theft
 - Robbery
 - Assault

Geoprocessing

Spatial Autocorrelation (Global Moran's I)

Parameters Environments

Input Feature Class
Neighbourhood_Crime_Rates

Input Field
Homicide15

☒ Generate Report

Conceptualization of Spatial Relationships
Inverse distance

Distance Method
Euclidean

Standardization
Row

Distance Band or Threshold
Distance

Geoprocessing

Cluster and Outlier Analysis (Anselin Local Moran's I)

Parameters Environments

Input Feature Class
Neighbourhood_Crime_Rates

Input Field
Homicide15

Output Feature Class
Neighbourhood_Crime_Rates_ClustersOutliers

Conceptualization of Spatial Relationships
Inverse distance

Distance Method
Euclidean

Standardization
Row

Distance Band or Threshold
Distance

☐ Apply False Discovery Rate (FDR) Correction

Number of Permutations
499

Hotspot analysis

- Eg) 2021 Homicide
- Do the same for:
 - Break and enter
 - Auto-theft
 - Robbery
 - Assault

Geoprocessing

Hot Spot Analysis (Getis-Ord Gi*)

Parameters Environments

Input Feature Class
Neighbourhood_Crime_Rates

Input Field
Homicide15

Output Feature Class
Neighbourhood_Crime_Rates_HotSpots

Conceptualization of Spatial Relationships
Fixed distance band

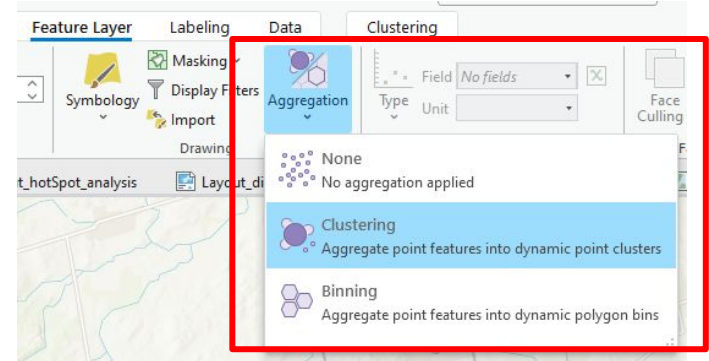
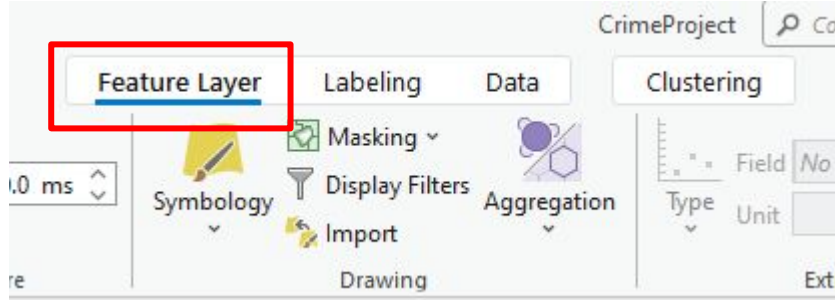
Distance Method
Euclidean

Distance Band or Threshold
Distance

Self Potential Field

☐ Apply False Discovery Rate (FDR) Correction

Aggregation Clustering



Results

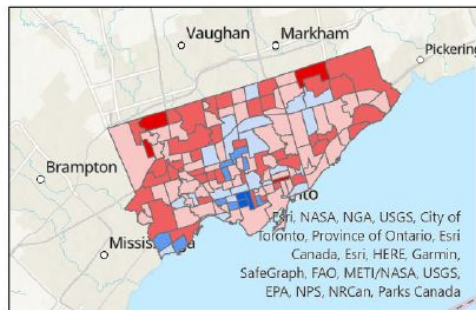
Result : Temporal differences in Crime Rate (2020 - 2021)

- Break and enter
 - 2021 crime rate - 2020 crime rate
- Auto theft
 - 2021 crime rate - 2020 crime rate
- Robbery
 - 2021 crime rate - 2020 crime rate
- Assault
 - 2021 crime rate - 2020 crime rate
- Homicide
 - 2021 crime rate - 2020 crime rate

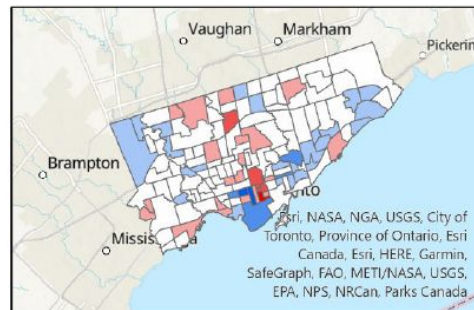
Difference in Crime Rate (2021 rate - 2020 rate)



break and enter



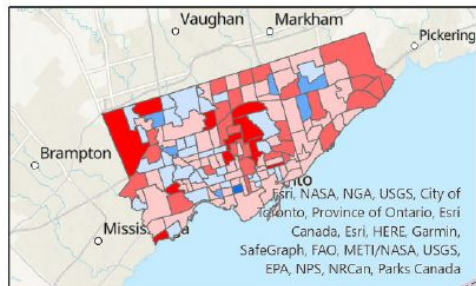
assault



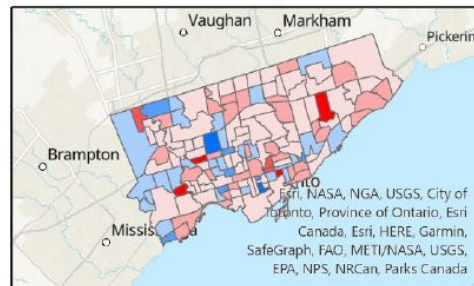
Crime rate
differences between
2020 and 2021 in
Toronto

Made by
Seongjin

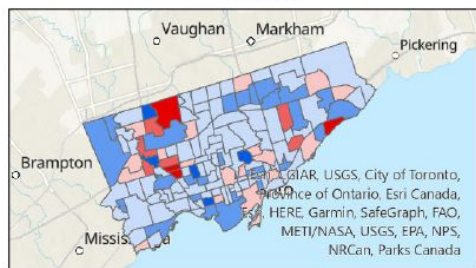
auto-theft



robbery



homicide



Difference in Crime Rate (2021 rate - 2020 rate)



Data reference:
"Neighbourhood Crime
Rates" from Toronto
Police

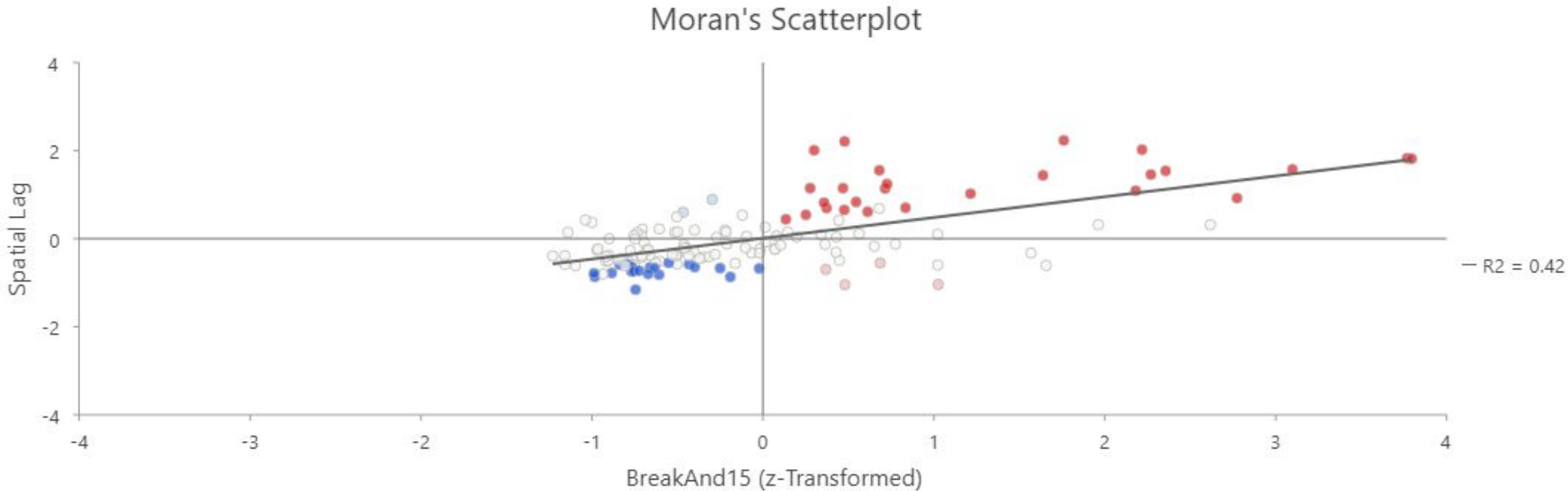
Local Moran's I

- Purpose: To see the high and low clustering of crime in Toronto
 - There are **two variables**: clusterings of the **neighborhood itself**, clusterings of the **surroundings**
 - High-high = **high** clustered itself + **high** clustered surroundings
 - High-low = **high** clustered itself + **low** clustered surroundings
 - Low-high = **low** clustered itself + **high** clustered surroundings
 - Low-low = **low** clustered itself + **low** clustered surroundings
- Property crime
 - Break and enter
 - Auto theft
- Violent Crime
 - Robbery
 - Assault
 - homicide

Local Moran's I index of Crime (High : Many, Low : Few)



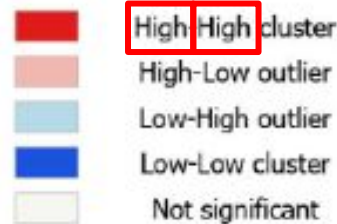
Break and Enter Moran's Scatterplot



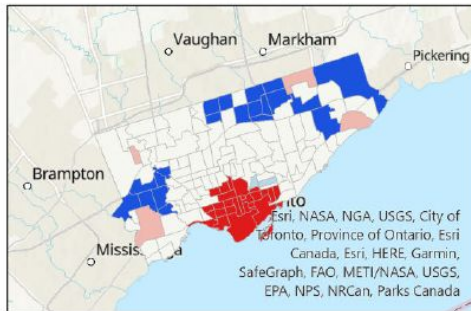
Local Moran's I

- Purpose: To see the high and low clustering of crime in Toronto
 - It is representing high vs low clustering of crime in one neighbor but also surrounding.
 - High-high = **high** clustering of crime rate itself + **high** clustering of crime rate surroundings
 - High-low = **high** clustering of crime rate itself + **low** clustering of crime rate surroundings
 - Low-high = **low** clustering of crime rate itself + **high** clustering of crime rate surroundings
 - Low-low = **low** clustering of crime rate itself + **low** clustering of crime rate surroundings
- Property crime
 - Break and enter
 - Auto theft
- Violent Crime
 - Robbery
 - Assault
 - homicide

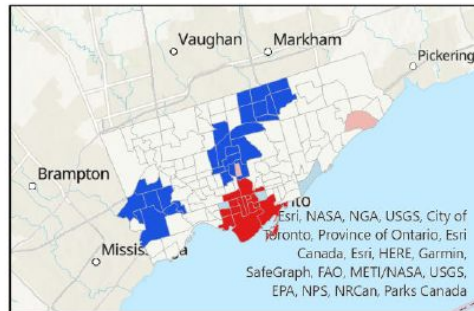
Local Moran's I index of Crime (High : Many, Low : Few)



break and enter



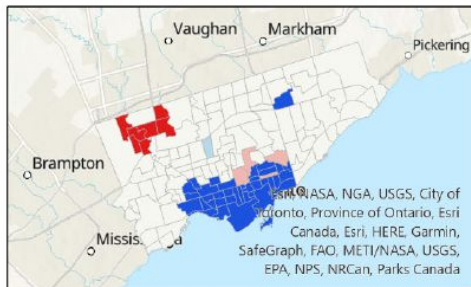
assault



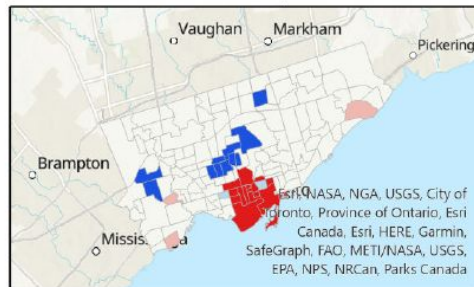
Local Moran's I of
Crime Rate in 2021
in Toronto

Made by
Seongjin

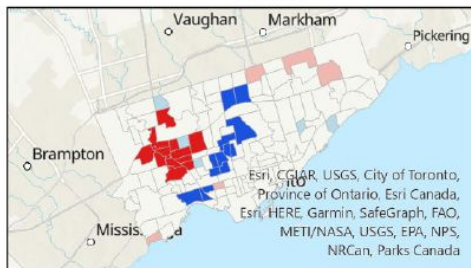
auto-theft



robbery



homicide



**Local Moran's I index of Crime
(High : Many, Low : Few)**

- High-High cluster
- High-Low outlier
- Low-High outlier
- Low-Low cluster
- Not significant

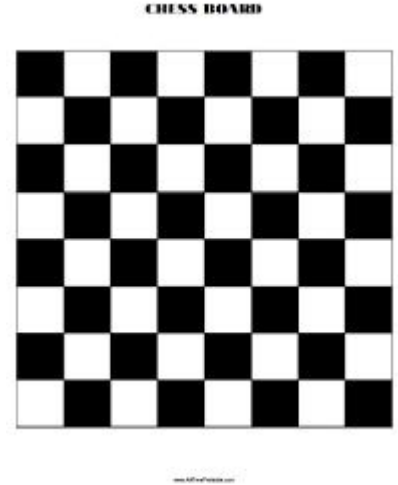
0 5 10 20 30 40
Kilometers



Data reference:
"Neighbourhood Crime
Rates" from Toronto
Police

Global Moran's I

- Z-score
 - Positive = clustered
 - Negative = dispersed
- P-value = 0.000051 = the chance of the randomness
 - High == more random == not significant
 - Near to 0 == less random == significant
 - P-value < 0.05 == 95 % confidence
 - P-value < 0.01 == 99 % confidence
- Moran's I index = 0.185126
 - Close to negative meaning less random and dispersed
 - Close to 0 meaning very random
 - Close to positive meaning less random and clustered



Spatial Autocorrelation Report

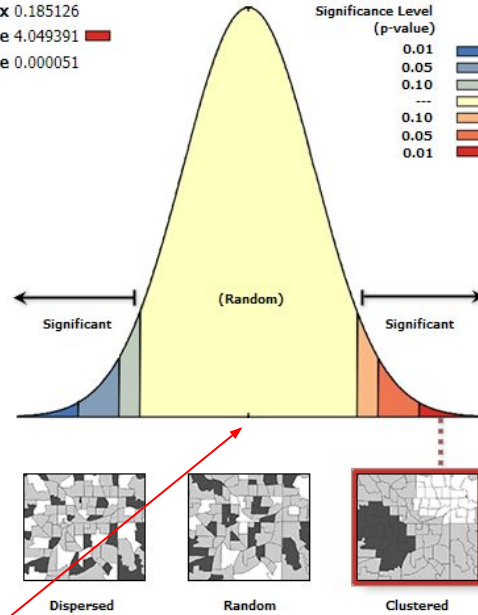
Made by
Seongjin

Moran's Index 0.185126
z-score 4.049391
p-value 0.000051

Significance Level
(p-value)

0.01	< -2.58
0.05	-2.58 - -1.96
0.10	-1.96 - -1.65
---	-1.65 - 1.65
0.10	1.65 - 1.96
0.05	1.96 - 2.58
0.01	> 2.58

Critical Value
(z-score)



Dispersed:
z-score < 0;
P-value < 0.01

Clustered:
z-score > 0;
P-value < 0.01

Completely Spatial
Random
Z-score close to 0;
P-value > 0.10

Given the z-score of 4.049391, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Global Moran's I Summary

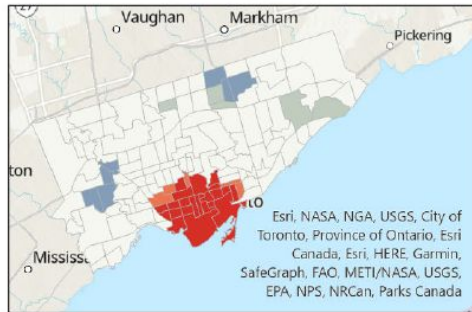
Moran's Index	0.185126
Expected Index	-0.007194
Variance	0.002256
z-score	4.049391
p-value	0.000051

Moran's Index:
Positive = clustered
Negative = dispersed

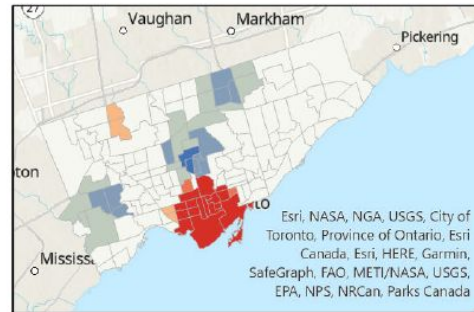
Hot spot analysis

- Purpose: To see the high and low *crime riskiness / hotspot* of regions in Toronto
 - Cold region == low risk of crime with 99% confidence
 - Hot region == high risk of crime with 99% confidence
- Property crime
 - Break and enter
 - Auto theft
- Violent Crime
 - Robbery
 - Assault

break and enter



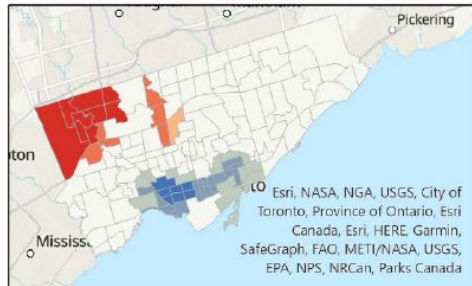
assault



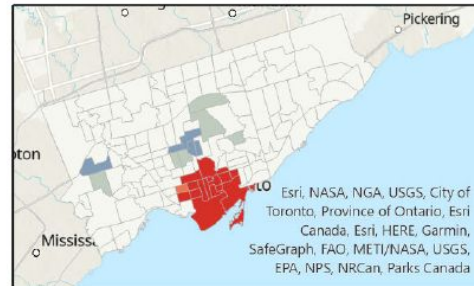
Hotspot analysis of
crimes in 2021 in
Toronto

Made by
Seongjin

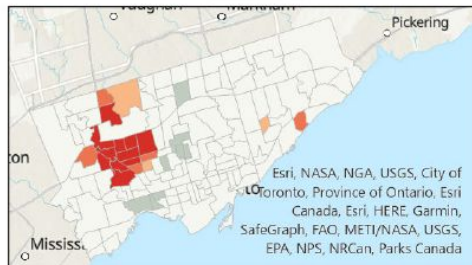
auto-theft



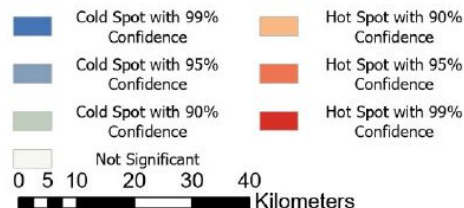
robbery



homicide

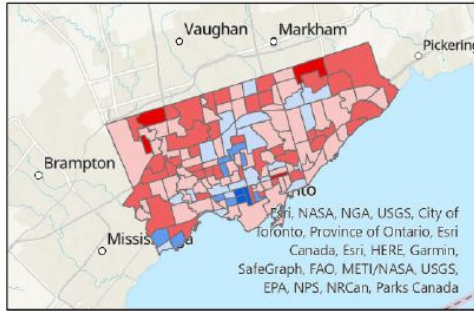


hotspot of crime
(cold : blue, hot : red)

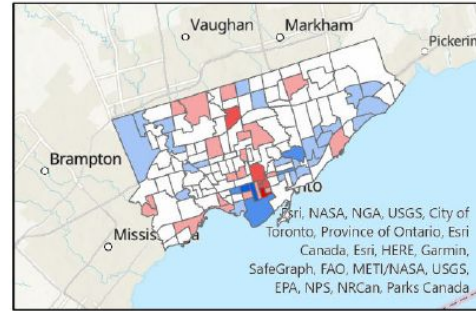


Data reference:
"Neighbourhood Crime
Rates" from Toronto
Police

break and enter



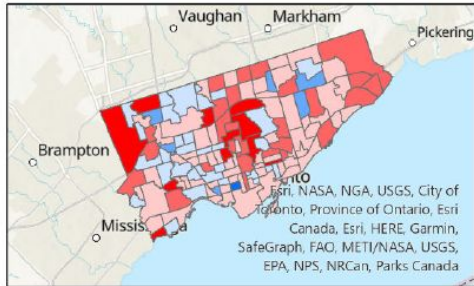
assault



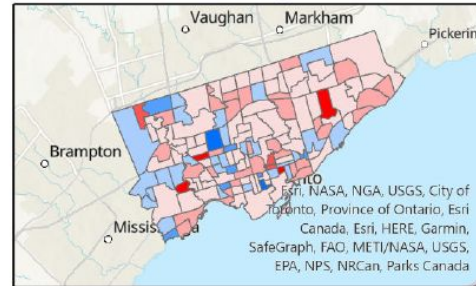
Crime rate
differences between
2020 and 2021 in
Toronto

Made by
Seongjin

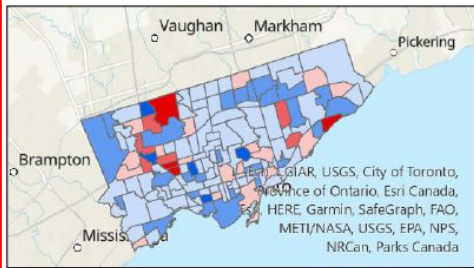
auto-theft



robbery



homicide



Difference in Crime Rate (2021 rate - 2020 rate)

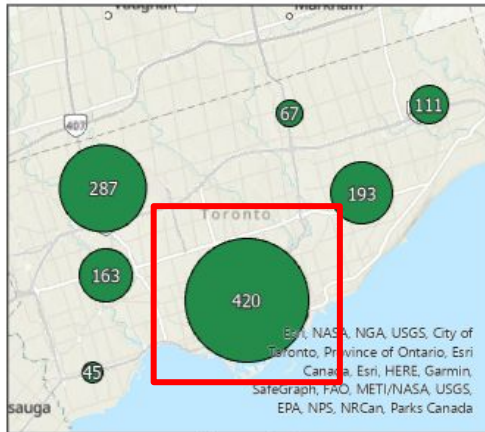


Data reference:
"Neighbourhood Crime
Rates" from Toronto
Police

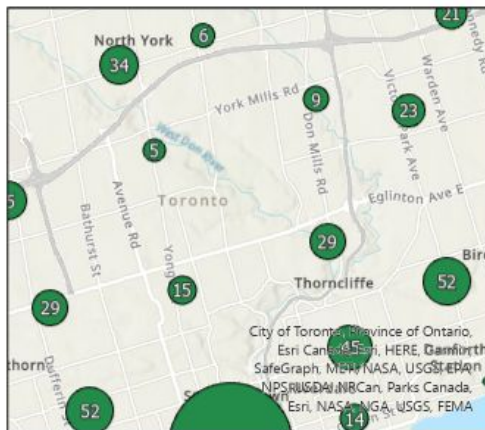
Finding Clusterings using Homicide data

- Look deeper into homicide crime data using ***Homicide ASR RC TBL-002*** data

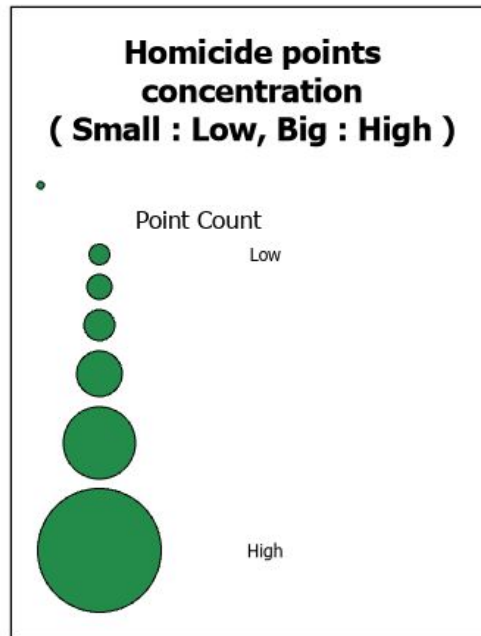
Aggregation Clustering of Toronto Homicide occurrence



Zoom Out



Zoom In



0 1.5 3 6 9 12 Kilometers

Made by
Seongjin

Data Reference:
Homicide ASR RC
TBL-002 from Toronto
Police

Discussion: Other statistics of crime rate

- Assault :11.0% increase for all types of assault
- Theft of motor vehicle : 47.8% increase
- Breaking and entering : 5.2% increase
- 16.7% **decrease** in homicide

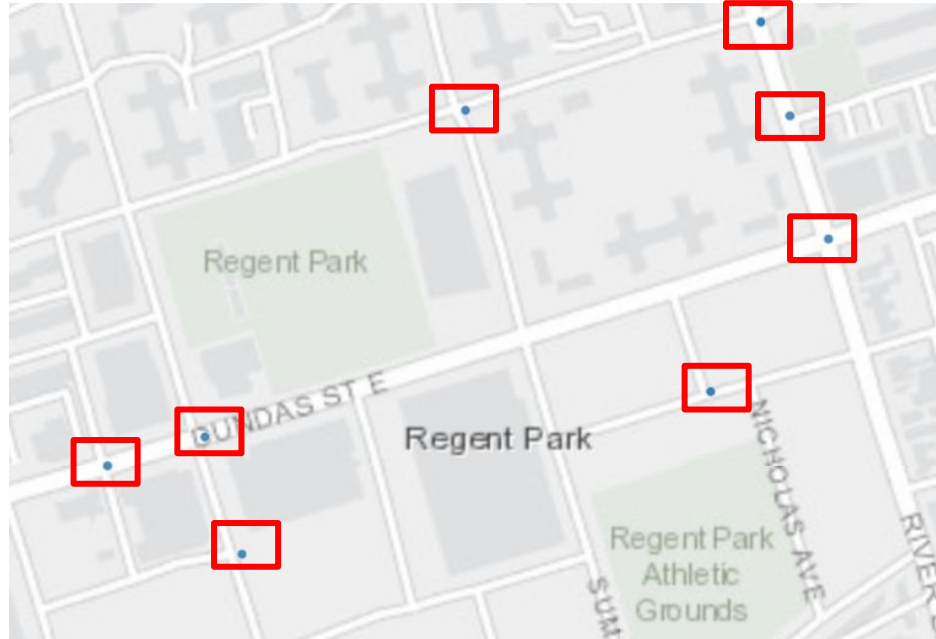
Discussion: what are the factors of causing the increase?

Discussion: Factors that increase the crime rate

- High proportion of young people
- High level of economic disadvantage
- Greater residential instability

Ch-Yonge
Corridor

Discussion: problem with Homicide ASR RC TBL-002



Discussion

- Is it wrong to have an inaccurate location data? **NO**
- “Even though some data contains inaccurate information, All data are valuable or **has a meaning to it.**”
 - By Haydn Lawrence, former UTSC professor

Discussion: *why* **NO**?

- According to multiple police departments,
 - Privacy of the victims
 - To develop a safe neighborhood environment

Discussion: *Then, how* to measure the severity of crime?

- **Solution** : “Homicide Crime” data -> “Neighborhood Crime rate” data
- *Because,*
 - Conceal the crime location -> *satisfying* “Privacy of the victims”
 - Provide the number of crime and its rate for each Neighborhood -> we can *still do* analysis
 - Per crime type
 - Per year
 - Per neighborhood

Conclusion

- The crime rate has gone up recently! Specifically at downtown regions.
- Factors:
 - High proportion of young people
 - High level of economic disadvantage
 - Greater residential instability
- However,
 - The homicide rate dropped.

Reference (APA)

Blair, A. (2021, August 18). *Criminologist: Don't rely on HPD crime maps - they're often inaccurate*. <https://www.hawaiinewsnow.com>.

Retrieved November 14, 2022, from

<https://www.hawaiinewsnow.com/2021/08/19/criminologist-dont-rely-hpd-crime-maps-theyre-often-inaccurate/>

Boyko, J. (2021, August 13). *2018 toronto van attack*. The Canadian Encyclopedia. Retrieved November 14, 2022, from

<https://www.thecanadianencyclopedia.ca/en/article/2018-toronto-van-attack>

Charron, M. (2009). *Neighbourhood characteristics and the distribution of police-reported crime in the City of Toronto*. Statistics

Canada, Canadian Centre for Justice Statistics.

Mohammadi, A., Bergquist, R., Fathi, G., Pishgar, E., de Melo, S. N., Sharifi, A., & Kiani, B. (2022). Homicide rates are spatially

associated with built environment and socio-economic factors: A study in the neighbourhoods of Toronto, Canada. *BMC Public*

Health, 22(1). <https://doi.org/10.1186/s12889-022-13807-4>

Reference (APA)

- Rusnell , C., & Fralick, S. (2010, August 19). *Police crime maps don't show public full picture*. CBCnews. Retrieved November 11, 2022, from <https://www.cbc.ca/news/canada/edmonton/police-crime-maps-don-t-show-public-full-picture-1.884440>
- Torstar Open Data Team. (2022, November 10). *Thirty-eight auto thefts reported in Old Toronto Last Week (Nov. 10)*. thestar.com. Retrieved November 10, 2022, from <https://www.thestar.com/news/gta/local-crime/2022/11/10/thirty-eight-auto-thefts-reported-in-old-toronto-last-week-nov-10.html>
- Toronto Police Service. *TPS Crime Statistics - HomicideHomicide*. Public Safety Data Portal. Retrieved November 18, 2022, from <https://data.torontopolice.on.ca/pages/homicide>
- Toronto Police Service. *Neighbourhood crime rates*. Public Safety Data Portal. Retrieved November 18, 2022, from <https://data.torontopolice.on.ca/datasets/TorontoPS::neighbourhood-crime-rates-2/about>
- Vilkhov, I. (2022, September 23). *Toronto crime rates in 2022*. Vilkhov Law. Retrieved November 14, 2022, from <https://vilkhovlaw.ca/toronto-crime-rates/>
- Wang, L., Lee, G., & Williams, I. (2019). The spatial and social patterning of property and violent crime in Toronto neighbourhoods: A spatial-quantitative approach. *ISPRS International Journal of Geo-Information*, 8(1), 51. <https://doi.org/10.3390/ijgi8010051>