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

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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?

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*

Methods

Choropleth map

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Proportional symbol map

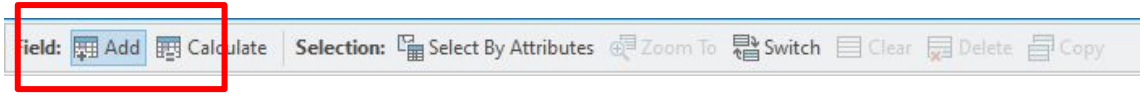
Temporal difference

- 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.

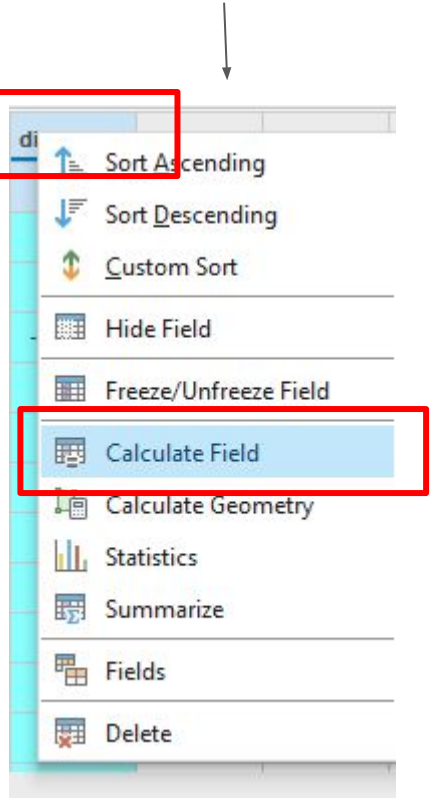


2.

Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Default	Precision	Scale	Length
☑	☐	diff_2021h	diff_2021h	Float	☐	☐	Numeric		0	0	
☑	☐	dif_1420as	dif_1420as	Float	☐	☐	Numeric		0	0	
☑	☐	dif_2021as	dif_2021as	Float	☐	☐	Numeric		0	0	
☑	☐	dif_1421be	dif_1421be	Float	☐	☐	Numeric		0	0	
☑	☐	dif_1420be	dif_1420be	Float	☐	☐	Numeric		0	0	
☑	☐	dif_2021be	dif_2021be	Float	☐	☐	Numeric		0	0	
☑	☐	df_1421bec	df_1421bec	Long	☐	☐	Numeric		5	0	
☑	☐	diff_1420	diff_1420	Float	☐	☐	Numeric		0	0	
☑	☐	dif_2021at	dif_2021at	Float	☐	☐	Numeric		0	0	
☑	☐	dif_1421at	dif_1421at	Float	☐	☐	Numeric		0	0	
☑	☐	dif_1420at	dif_1420at	Float	☐	☐	Numeric		0	0	

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

3.



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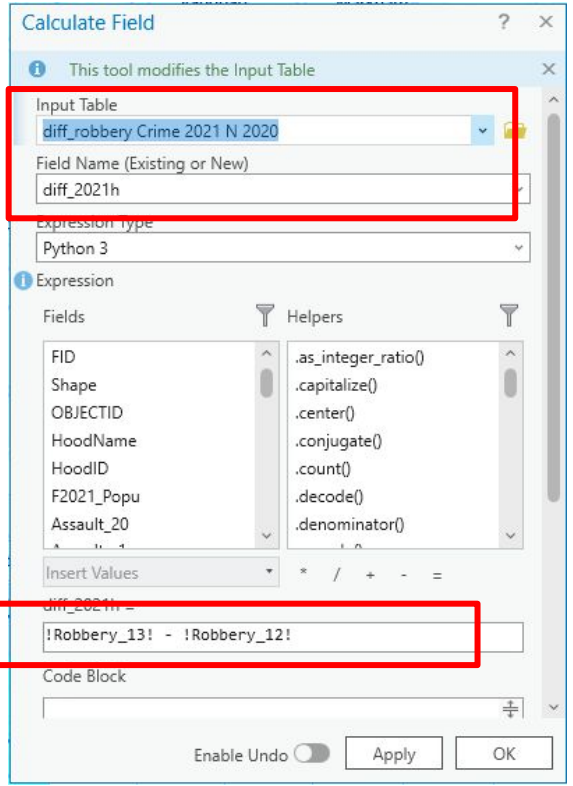

Increase in crime rate

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
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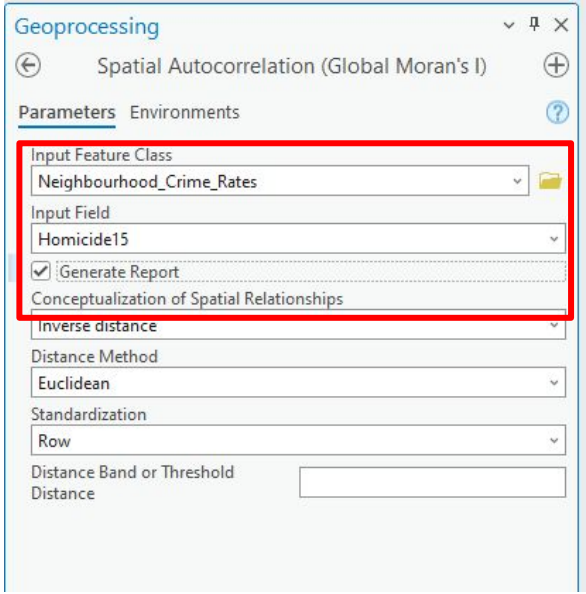
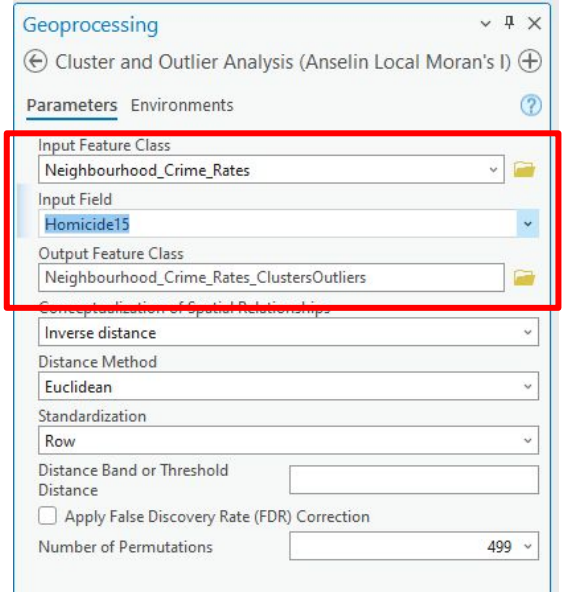
Local Moran's I & Global Moran's I

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





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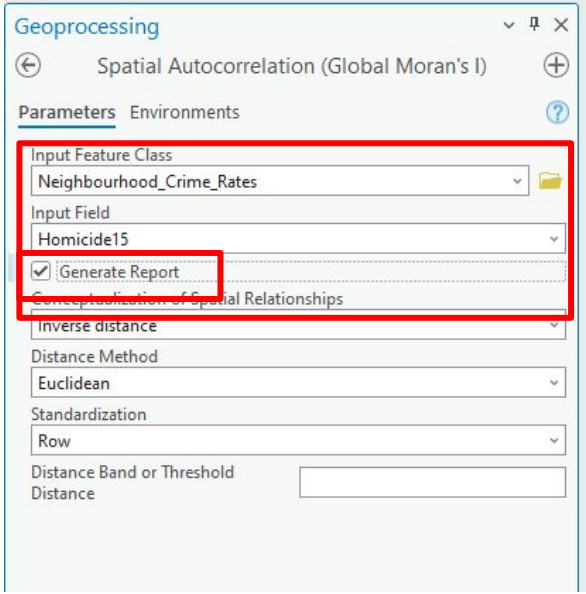

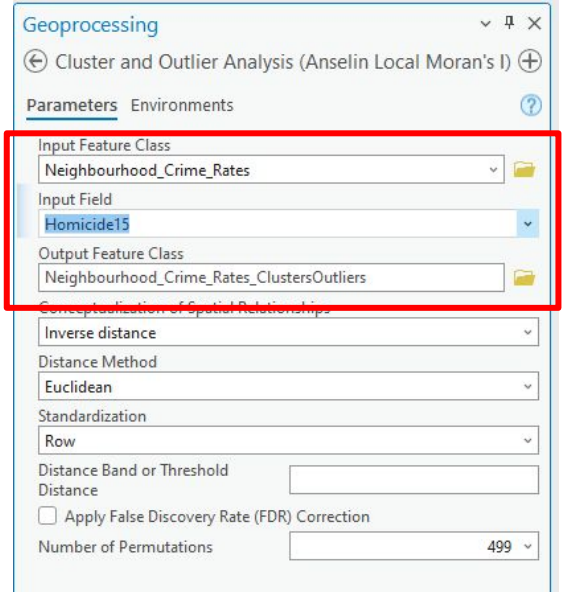

Hotspot analysis

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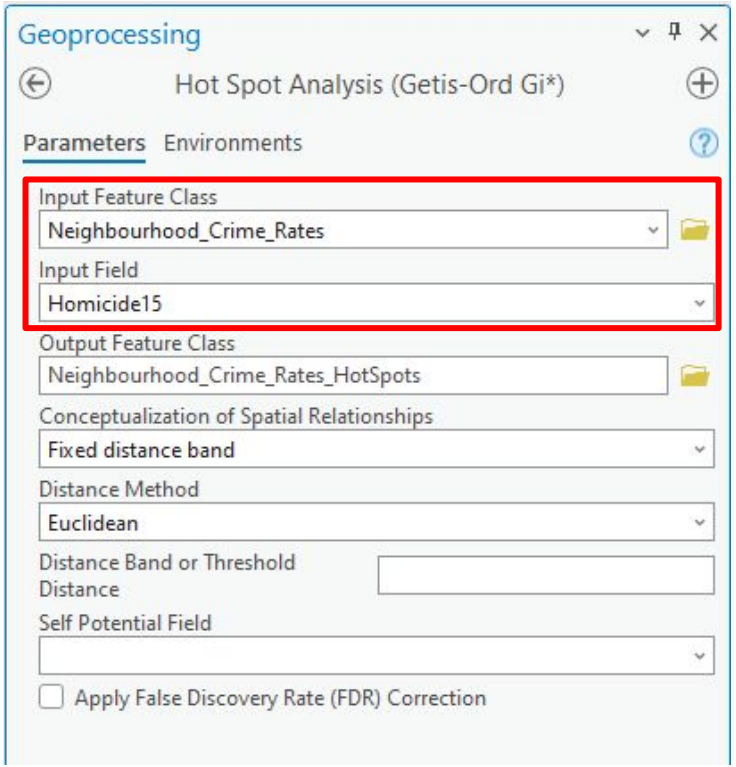
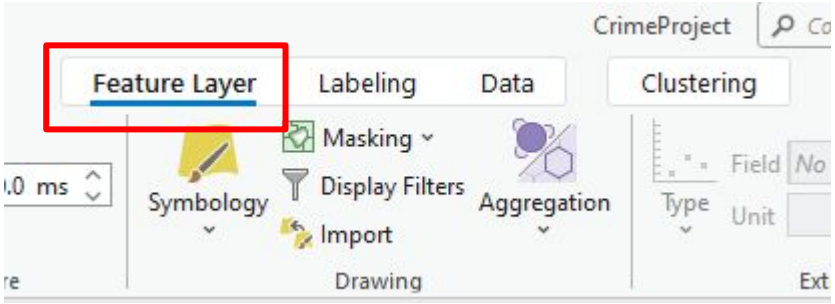
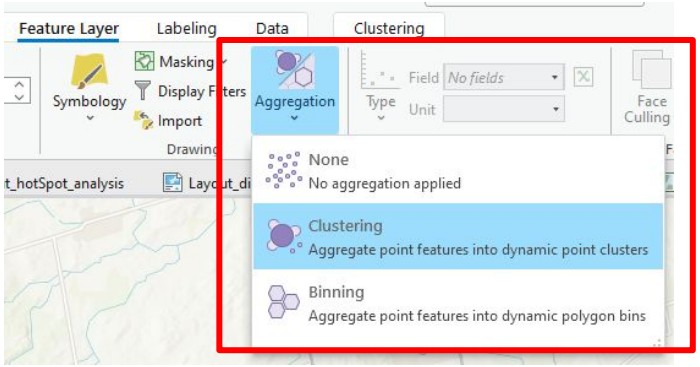
  - Auto-theft
  - Robbery
  - Assault



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

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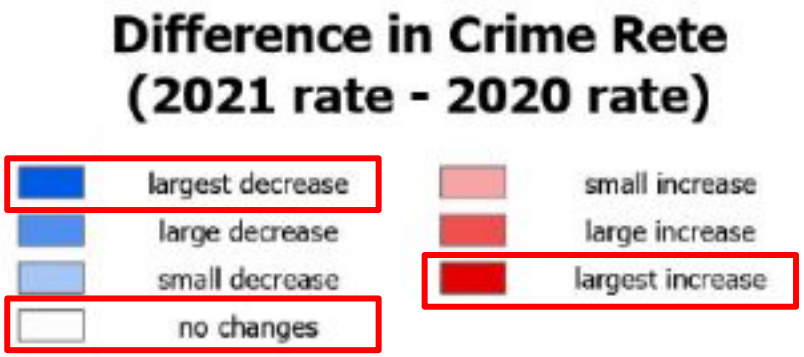
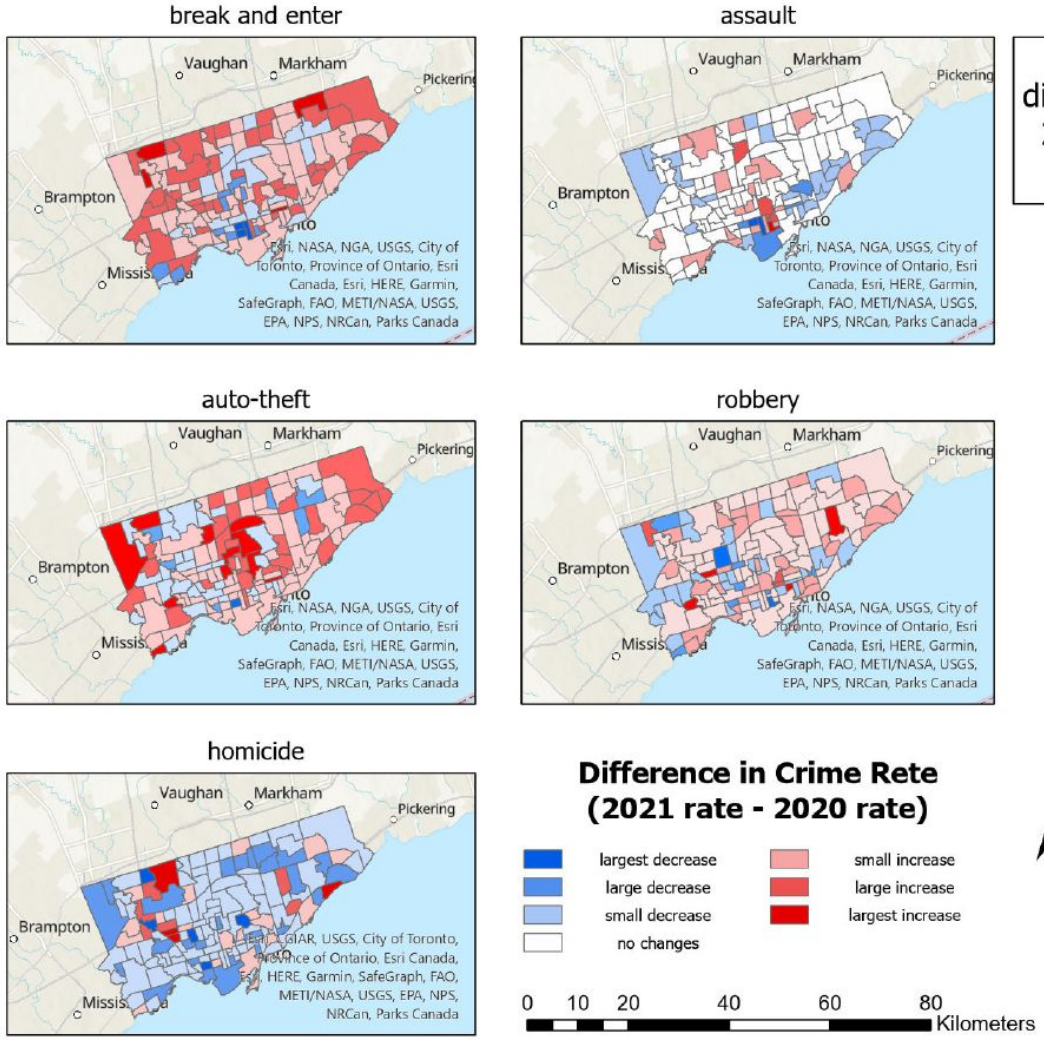
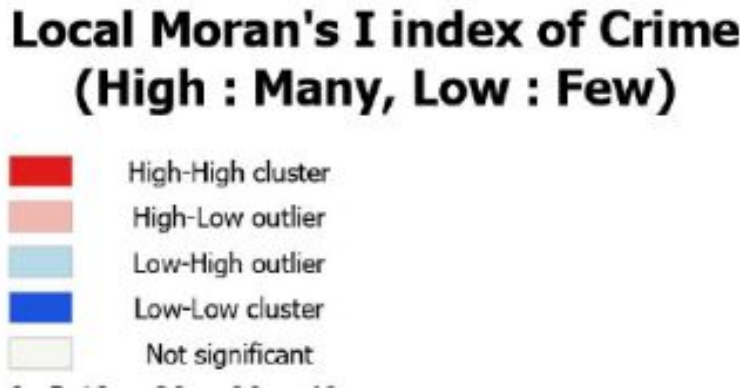
  - 2021 crime rate - 2020 crime rate
- Homicide
  - 2021 crime rate - 2020 crime rate



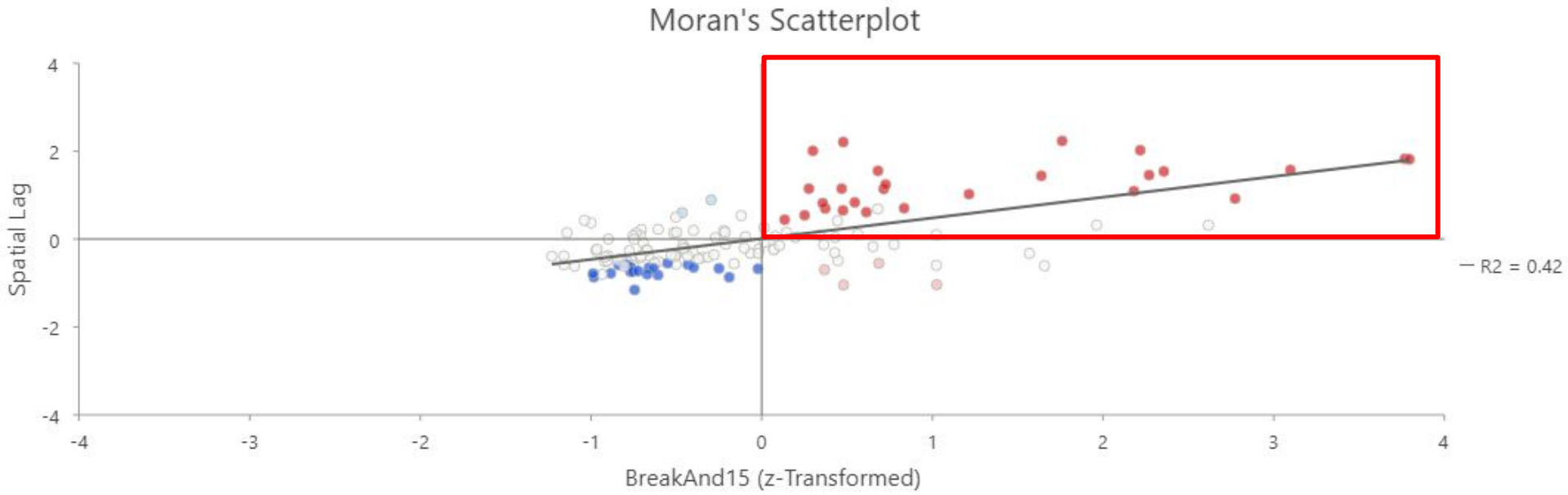

break and enter
assault
auto-theft
robbery
homicide
Vaughan
Markham
Pickering
Brampton
Esri, NASA, NGA, USGS, City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, NRCan, Parks Canada
Crime rate differences between 2020 and 2021 in Toronto
Made by Seongjin
Difference in Crime Rete (2021 rate - 2020 rate)
largest decrease
large decrease
small decrease
no changes
small increase
large increase
largest increase
N
0 10 20 40 60 80
Kilometers
Data reference: "Neighbourhood Crime Rates" from Toronto Police

Local Moran's I

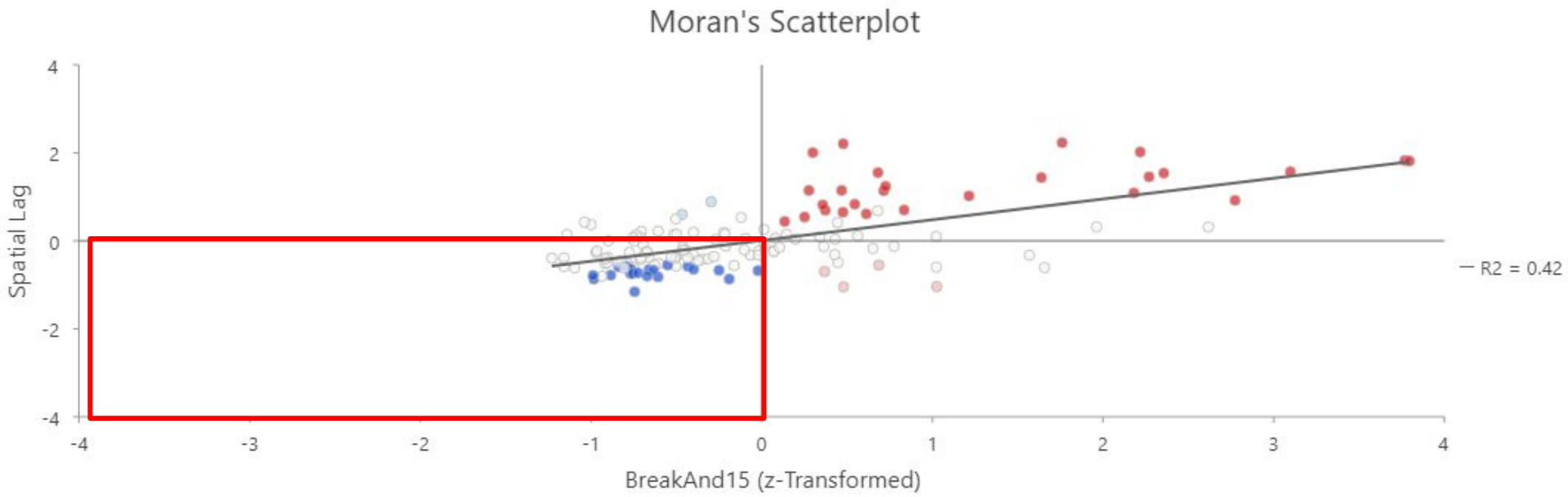
- Purpose: To see the *high and low clustering of crime* in Toronto
  - There are **two variables**: clusterings of the **neighborhood itself**, clusterings of the **surroundings**
  - High-high = **high** clustered itself + **high** clustered surroundings
  - High-low = **high** clustered itself + **low** 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



Break and Enter Moran’s Scatterplot



Break and Enter Moran’s Scatterplot



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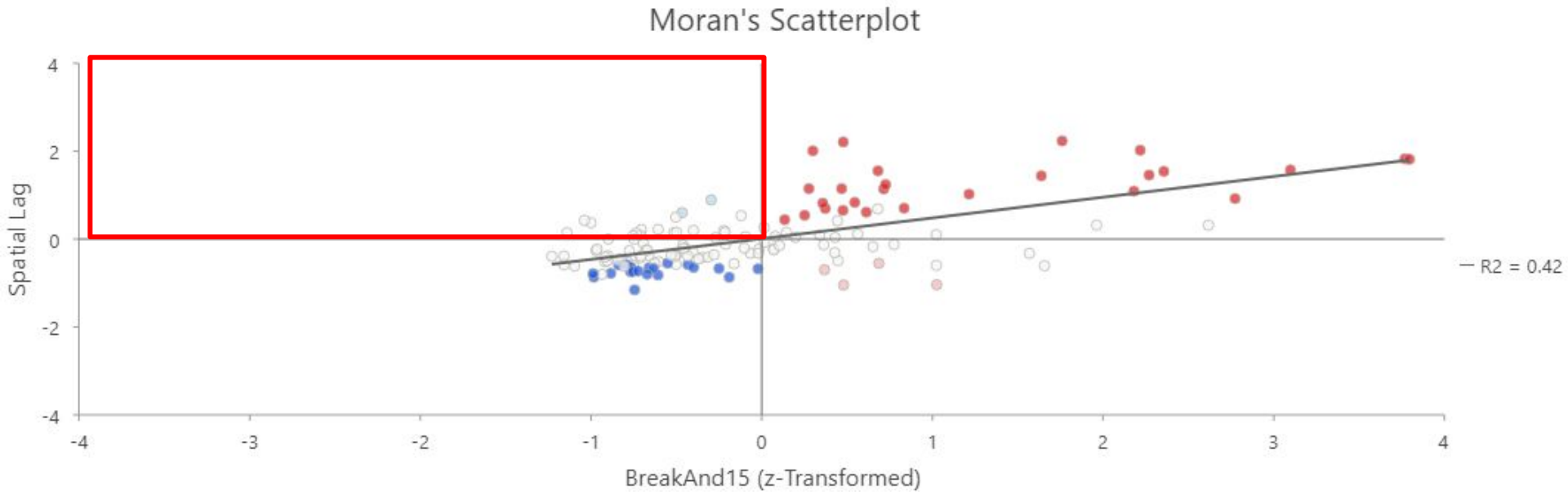

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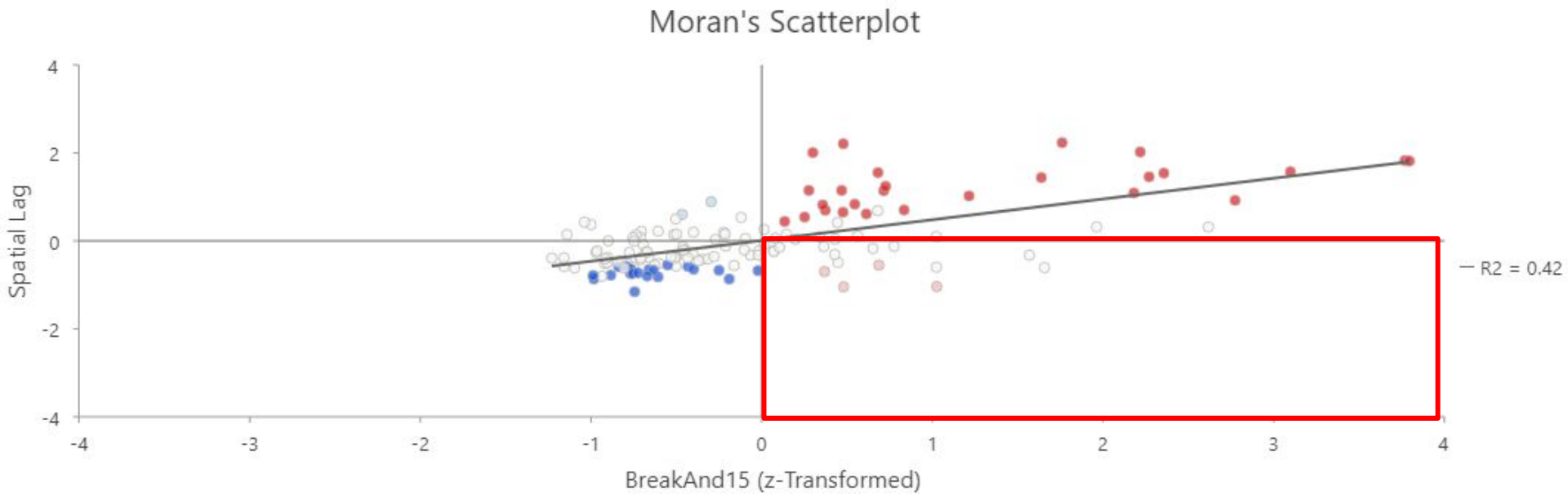

Local Moran's I

- 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
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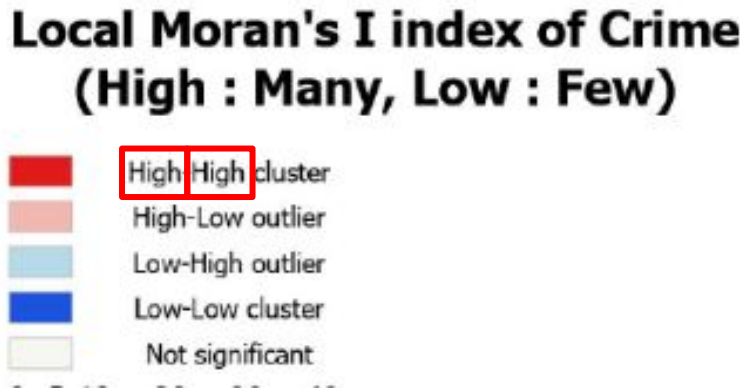
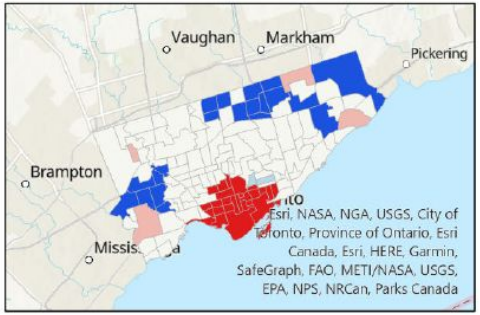
  - Break and enter
  - Auto theft
- Violent Crime
  - Robbery
  - Assault
  - homicide



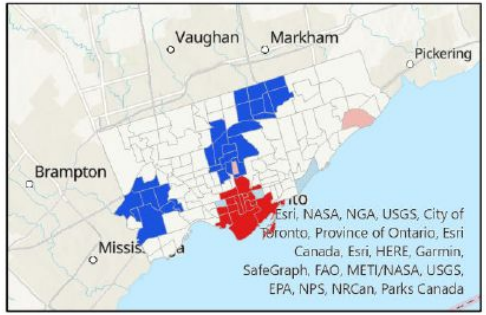
Local Moran's I of Crime Rate in 2021 in Toronto

Made by Seongjin

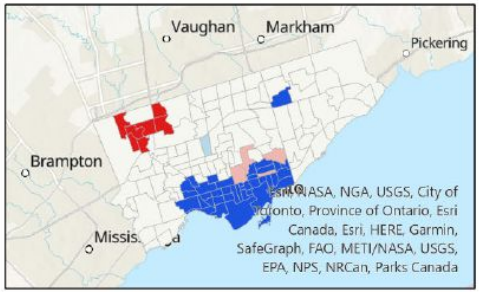
break and enter



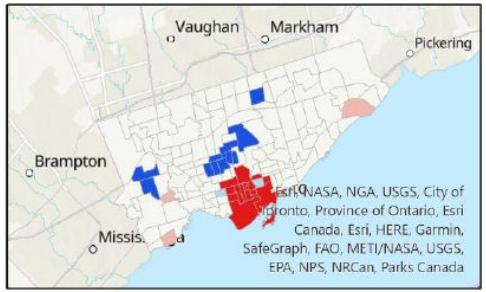
assault



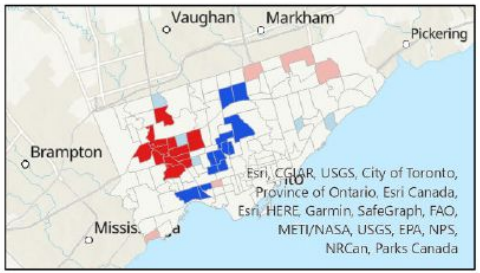
auto-theft



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

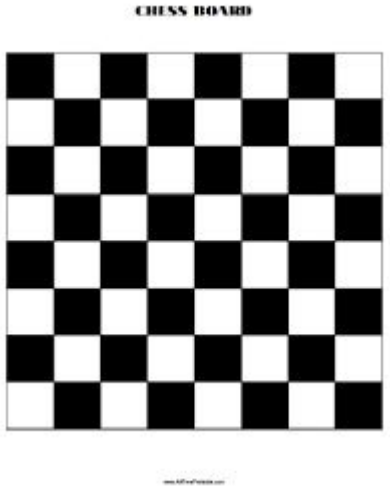
0 5 10 20 30 40 Kilometers

N

Data reference: "Neighbourhood Crime Rates" from Toronto Police

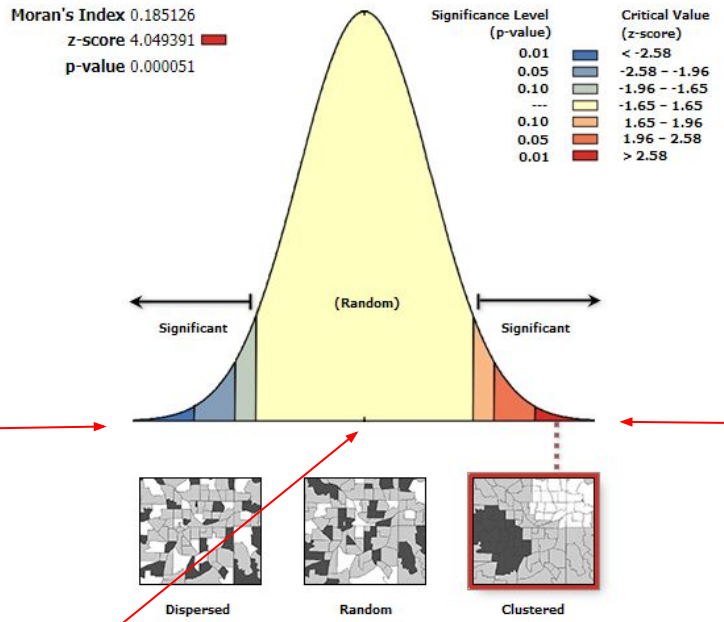
Global Moran’s I

- 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



Made by
Seongjin

Spatial Autocorrelation Report



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.

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

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

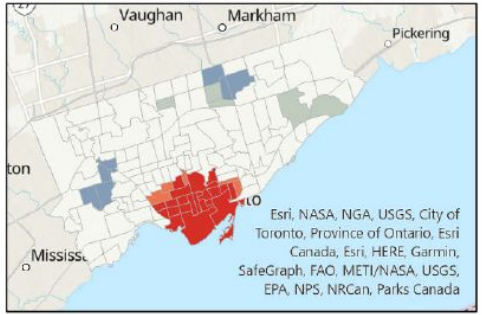
Hot spot analysis

- 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

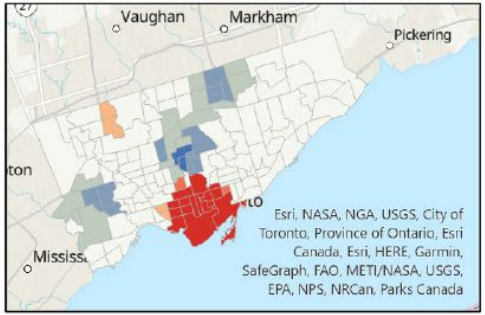
Hotspot analysis of crimes in 2021 in Toronto

Made by Seongjin

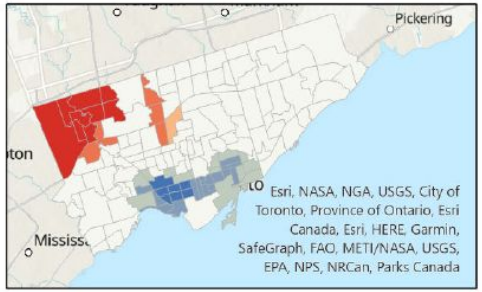
break and enter



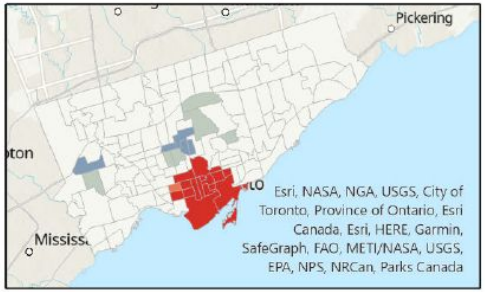
assault



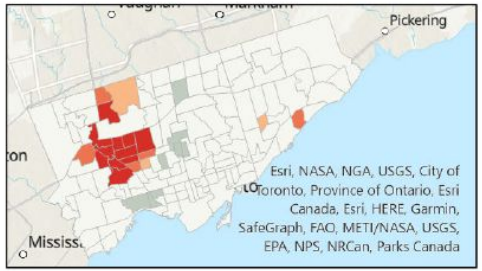
auto-theft



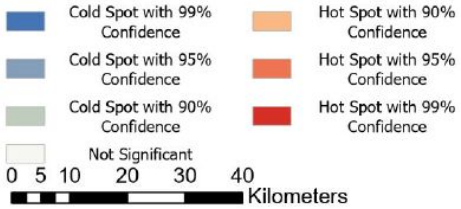
robbery



homicide

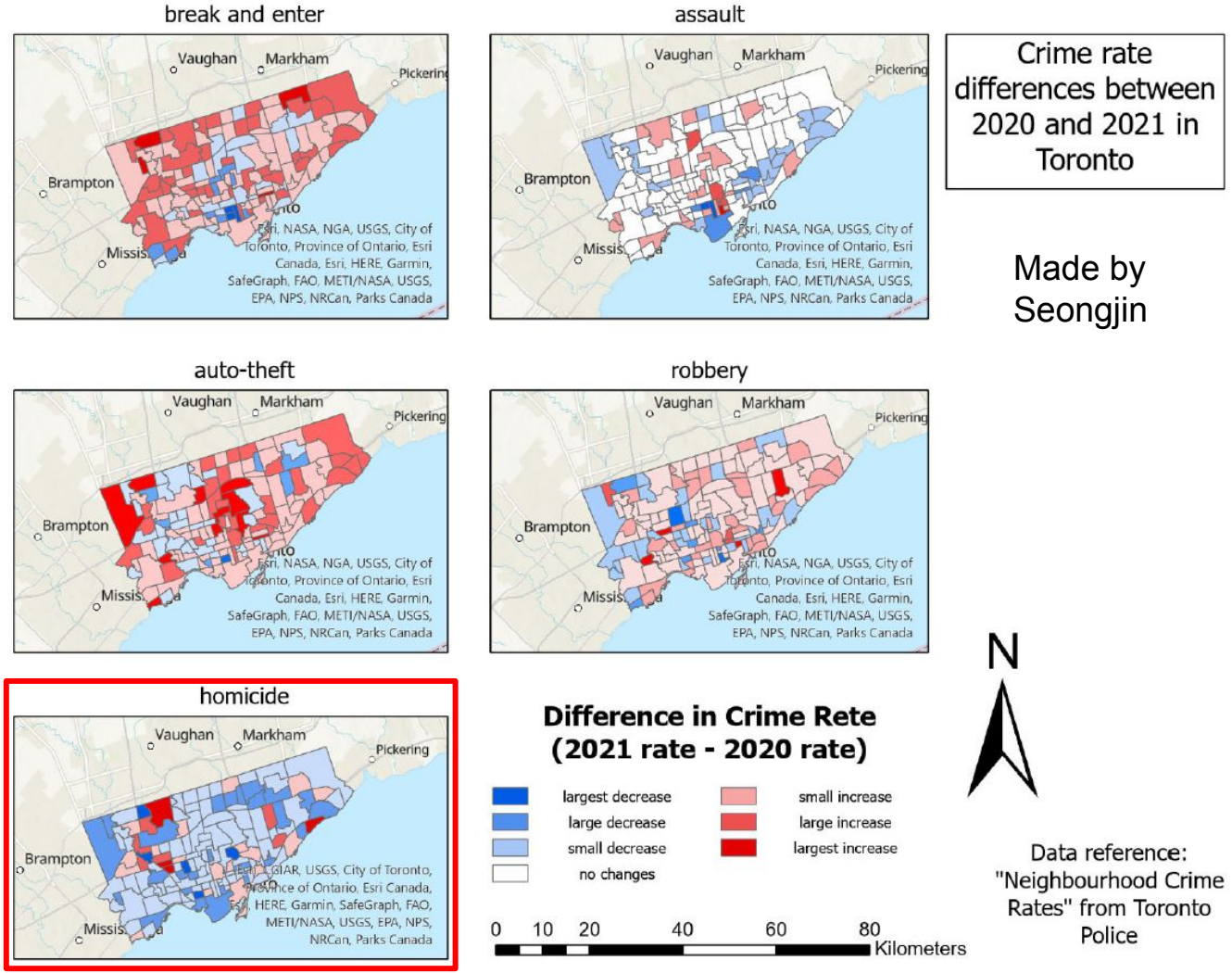


hotspot of crime (cold : blue, hot : red)



Data reference: "Neighbourhood Crime Rates" from Toronto Police

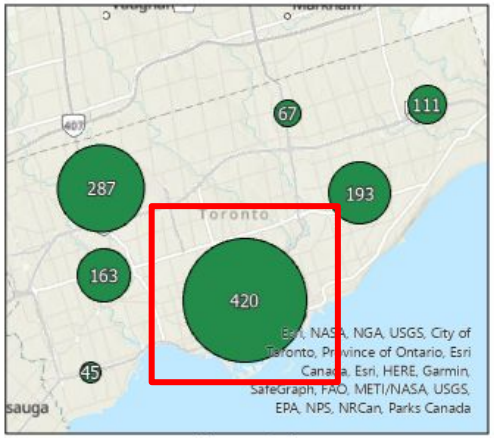
Going back to the previous temporal differences result…


break and enter
assault
auto-theft
robbery
homicide
Vaughan
Markham
Pickering
Brampton
Esri, NASA, NGA, USGS, City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, NRCan, Parks Canada
Esri, GIAR, USGS, City of Toronto, Province of Ontario, Esri Canada, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NPS, NRCan, Parks Canada
Crime rate differences between 2020 and 2021 in Toronto
Made by Seongjin
Difference in Crime Rete (2021 rate - 2020 rate)
largest decrease
large decrease
small decrease
no changes
small increase
large increase
largest increase
0 10 20 40 60 80
Kilometers
N
Data reference: "Neighbourhood Crime Rates" from Toronto Police

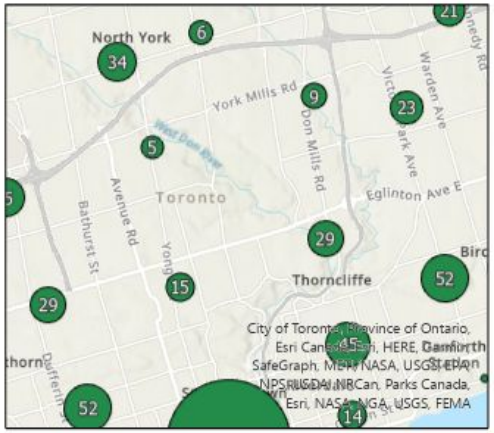
Finding Clusterings using Homicide data

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

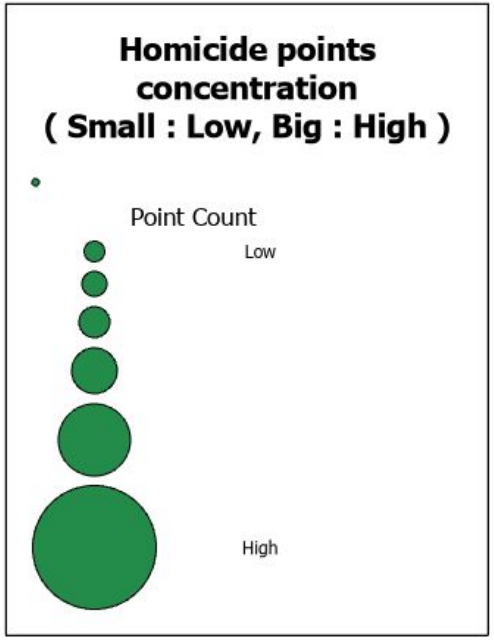
Aggregation Clustering of Toronto Homicide occurrence



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

So we’ve been looking at my analyses

- Reasons of crime increase

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?

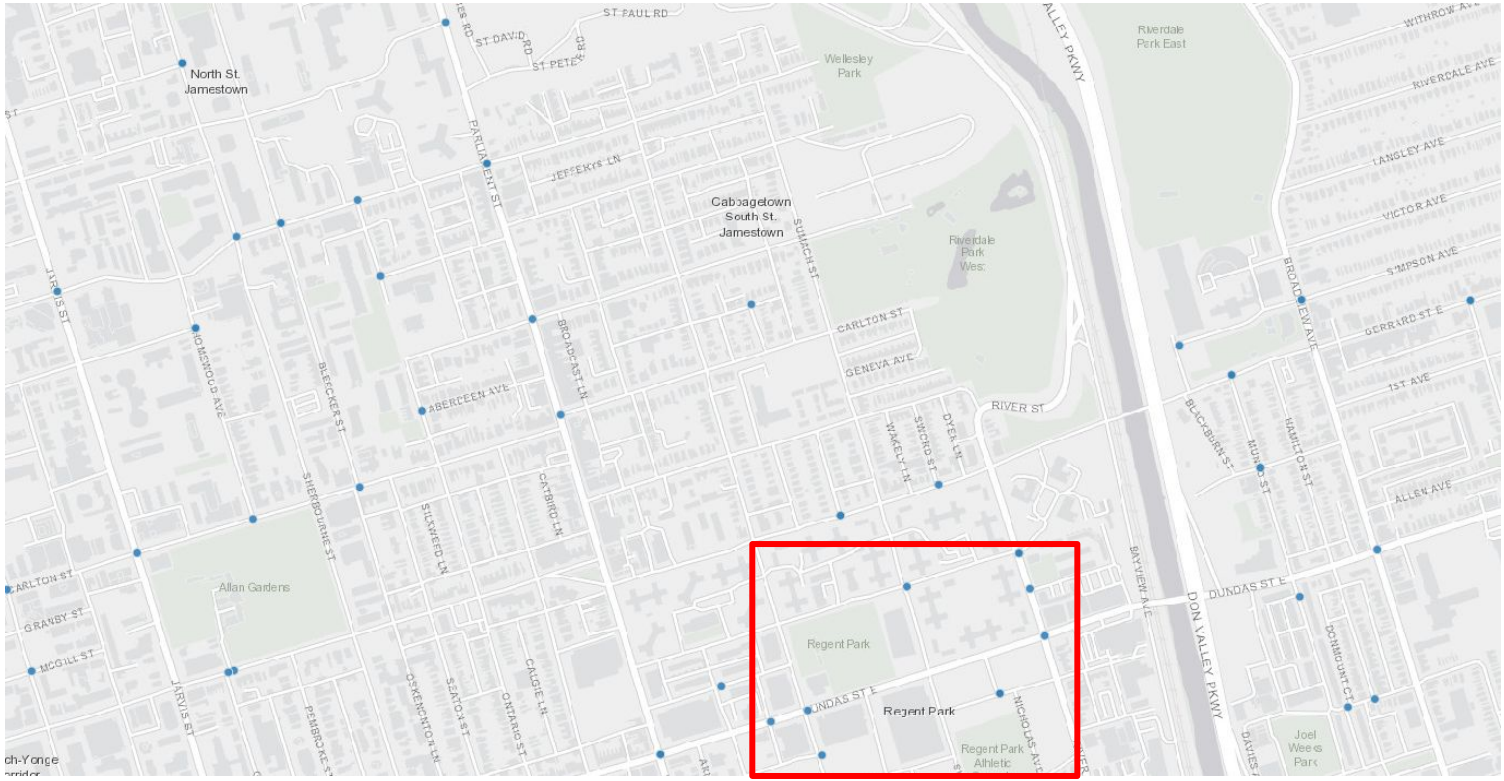
Discussion: Factors that increase the crime rate

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

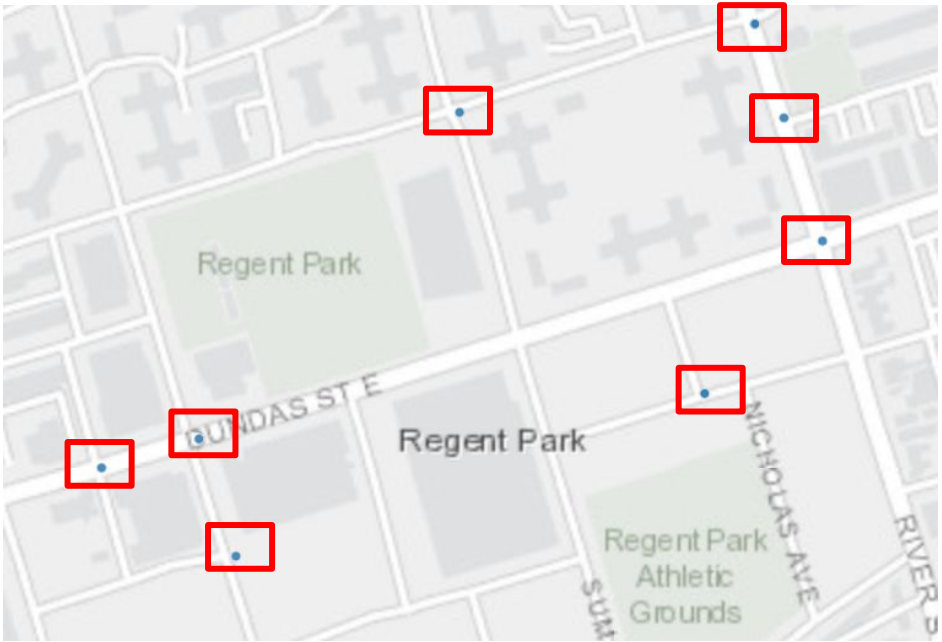
But now,

- Let’s look at the crime occurrence ***data points*** without any spatial analysis

Discussion: problem with Homicide ASR RC TBL-002



Discussion: problem with Homicide ASR RC TBL-002



Discussion: let’s step back and think

- Is it wrong to have an inaccurate location data?

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**?*

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?

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

- **Solution** : “Homicide Crime” data -> “Neighborhood Crime rate” data

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)

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