Third Party Signs and Traffic Accidents in Toronto

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Introduction

- Distracted driving is not a new phenomenon
- Audible distractions
  - Music, passengers, horns, sirens, etc.
- Visual distractions
  - Pedestrians, animals, advertisements, cell phones, etc.

Background

- City of Toronto enacted its Sign By-law in 2010
- Signage is divided into two categories:
  - **First-party signs** – identifies business or service at the location
  - **Third-party signs** – advertisements for goods or services not related to the business on premises
- Permits are required for third-party signs

Literature Review

- Other articles on distracted driving:
  - The role of roadside advertising signs in distracting drivers (https://www.researchgate.net/publication/222691471_The_role_of_roadside_advertising_signs_in_distracting_drivers)
  - Digital signage is a distracted driving hazard (https://www.myparkingsign.com/blog/digitalsignage-distracted-driving/)

Research Question

Does the presence of third-party signs affect the volume of traffic accidents in Toronto?

Data and Description

- Third-party Signs Inventory (https://www.toronto.ca/city-government/data-researchmaps/open-data/open-data-catalogue/business/#9b6f952e-52d7-1fc4-51f6-4ad6bc913218)
- Toronto Police Service – Killed or Seriously Injured (KSI) Data (http://data.torontopolice.on.ca/datasets/ksi/data)
- SimplyAnalytics – Census Tracts and Demographic Data (https://simplyanalytics.com/)

Methodology

- Geospatial analytics - determine location of signs relative to location of traffic accidents
- Geospatial Autocorrelation used to uncover geographic relationships between signs and the number of traffic accidents
- Visualizations and backing statistics

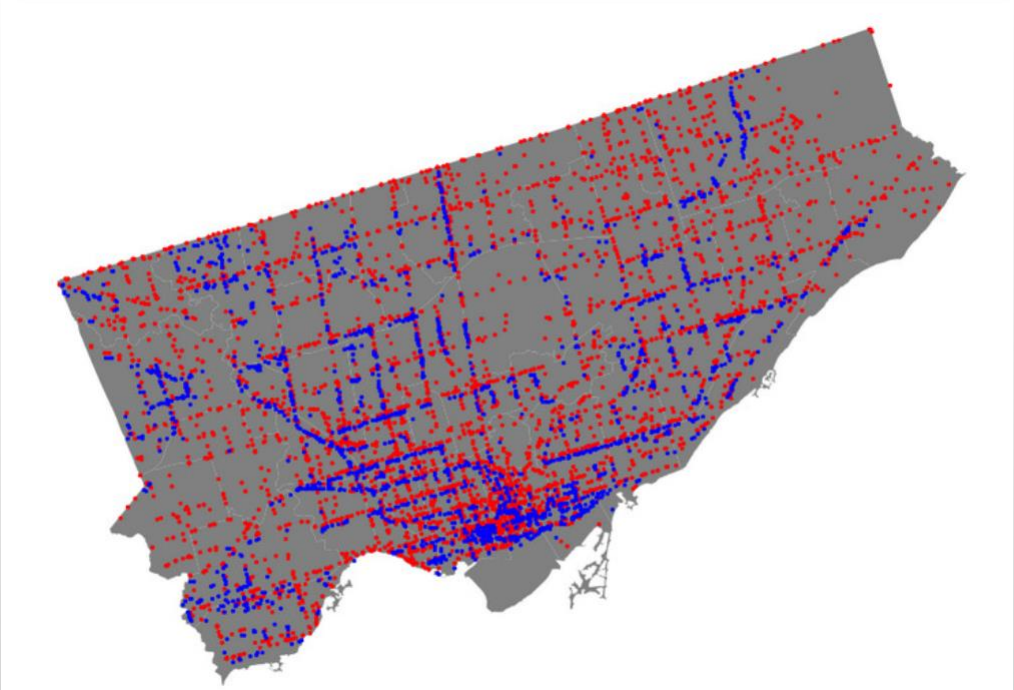
Python Environment

- Python 3.5.8
- Non-geographic libraries:
  - Pandas 0.25.0
  - Numpy 1.16.4
  - Xlrd 1.2.0
- Visualization libraries:
  - Matplotlib 3.1.1
  - Seaborn 0.9.0

Python Environment (Continued)

- Geographic and spatial libraries:
  - Geopandas 0.5.1
  - Shapely 1.6.4.post1
  - Fiona 1.8.4
  - Pycrs 1.0.1
  - Pysal 2.0.0

Locations of Signs and Accidents

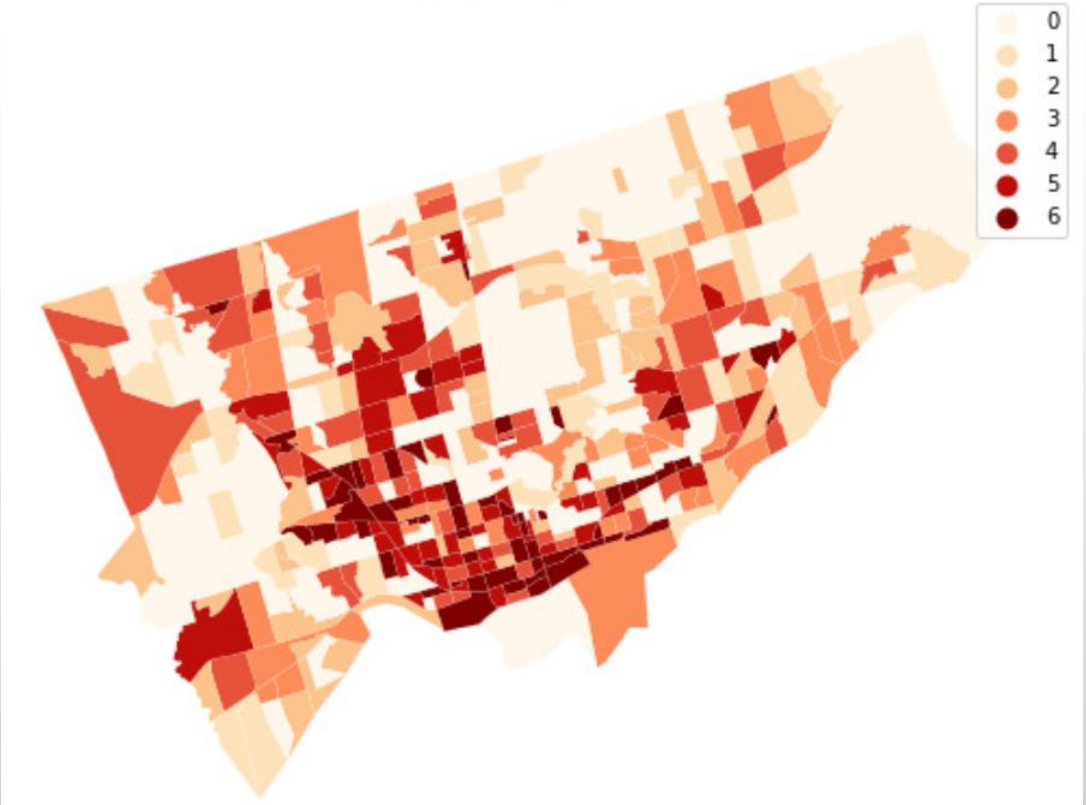


- Blue marks represent sign locations
- Red marks represent accident locations
- Overlapping of colours is evident
- Large clustering exists in the south-central tracts

Question:

Is there a geospatial relationship to the location of the signs amongst themselves within the city?

Signs per Square Km



- Darker colours show tracts with greater density of signs per square Km

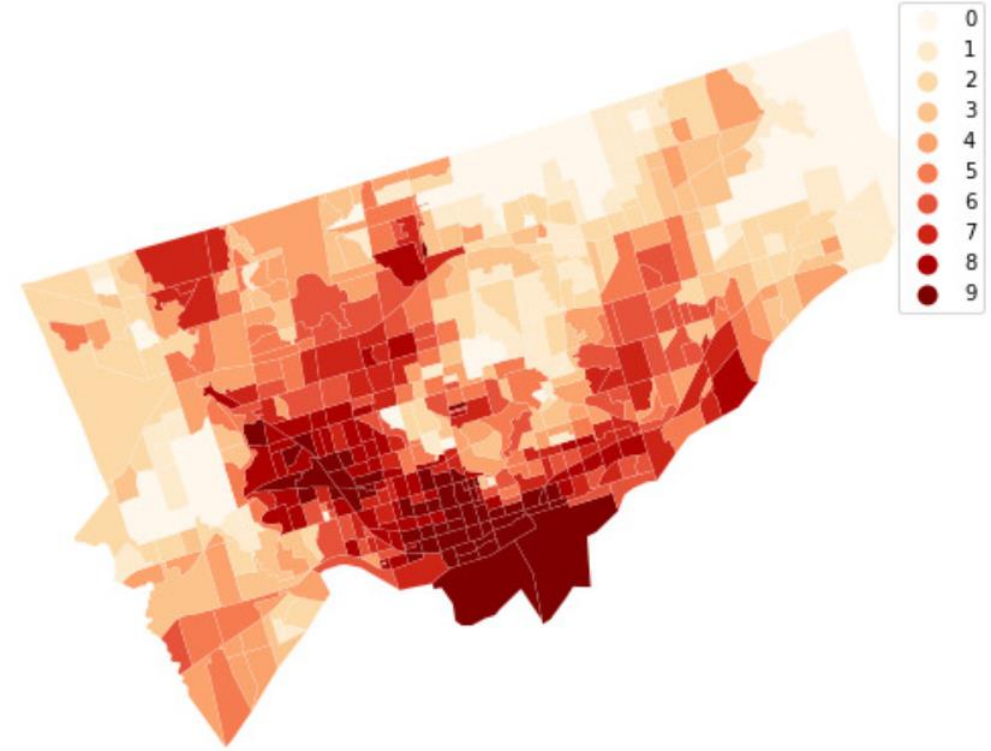
Spatial Autocorrelation

- Displays clusters of similar regions based on a given feature or attribute
- PySAL library provides the tools necessary to conduct spatial autocorrelation analysis

What is Similarity?

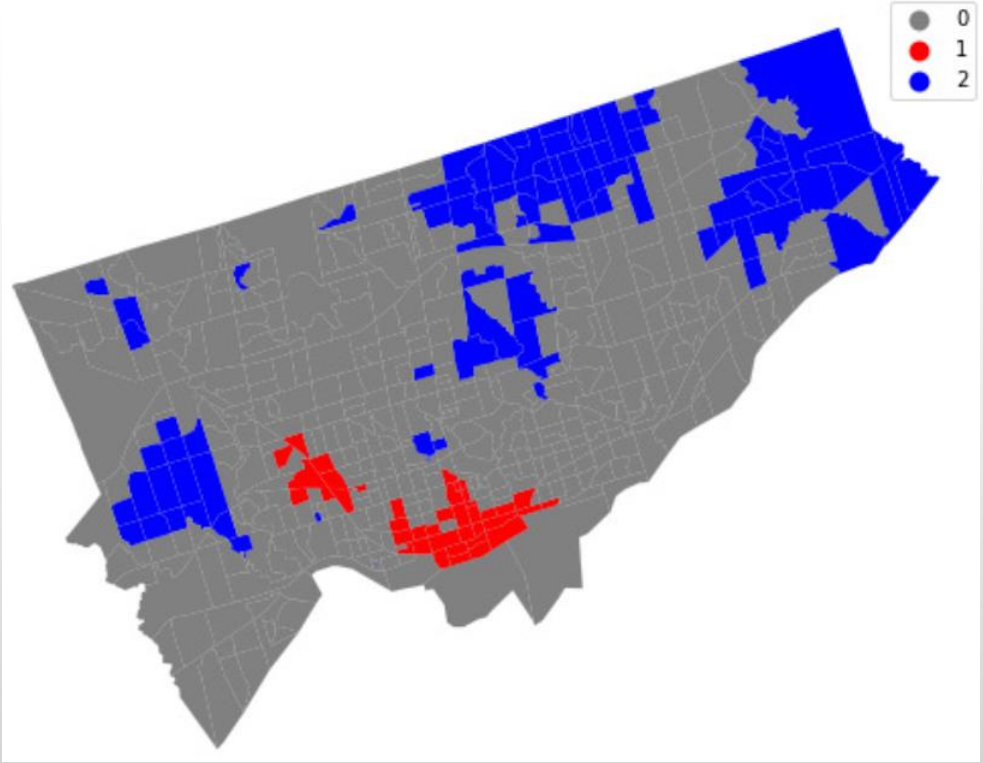
- Spatial Similarity
  - spatial weights are used to determine which regions are neighbours (ie. neighbours are spatially similar)
- Attribute Similarity
  - spatial lag is the measurement used to determine how similar a feature is between neighbouring regions

Spatial Autocorrelation Visualized



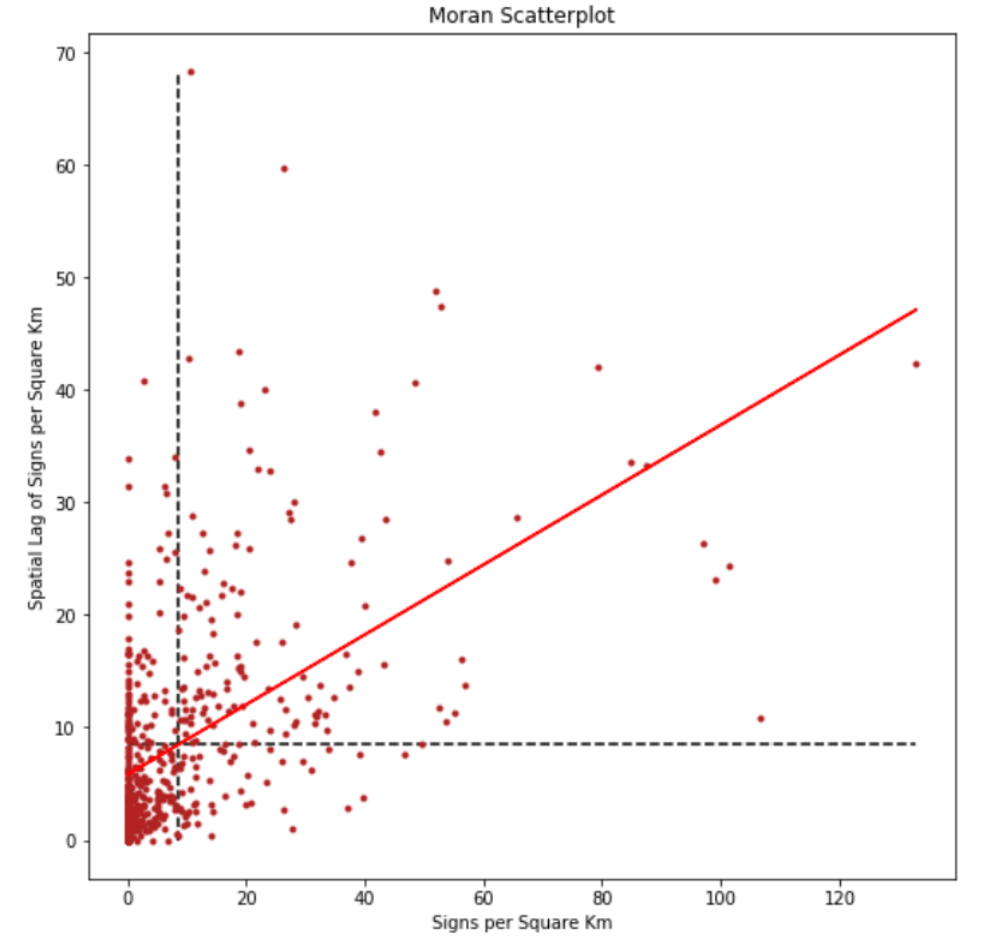
- Spatial Lag of Signs per Square Km
- Clustering appears in the south and upwards through the central-west tracts (darker)
- Visually there appears to be some spatial correlation amongst the census tracts

Local Indicators of Spatial Association (LISA) Visualized



- Red clusters indicate significantly higher number of signs per square Km
- Blue clusters indicate significantly lower number of signs per square Km

Moran Scatterplot



- Scatterplot of Signs per Square Km vs. their spatial lag
- Moran's I value is shown as the red line
- A positive relationship is visible

Statistical Results

- Moran's $I = 0.31$
  - since this is positive, there is some clustering of similar values
  - since this is somewhat close to zero, there may be some randomness to these values
- p-value = 0.001
  - reject the null; I was not generated by chance

Question:

Is there a geospatial relationship to the location of the signs and the number of nearby traffic accidents?

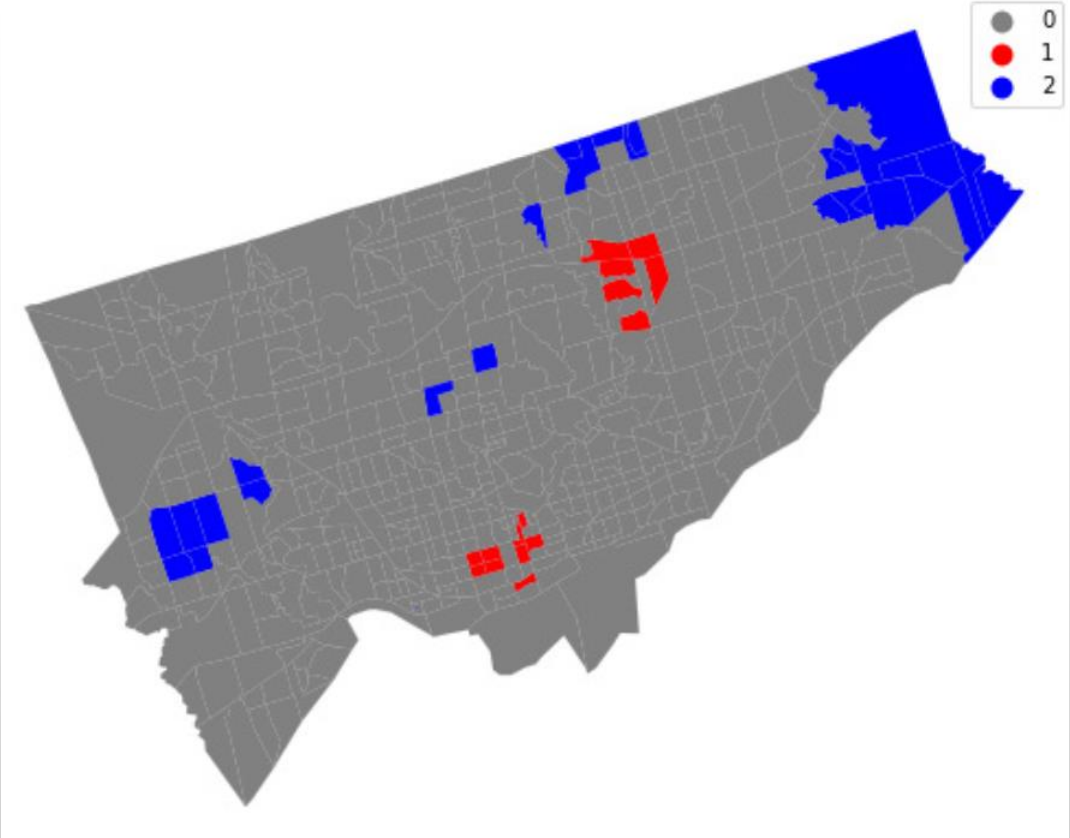
Accidents per Sign per Square Km

- Darker colours show tracts with greater density of accidents per sign per square Km

Spatial Autocorrelation Visualized

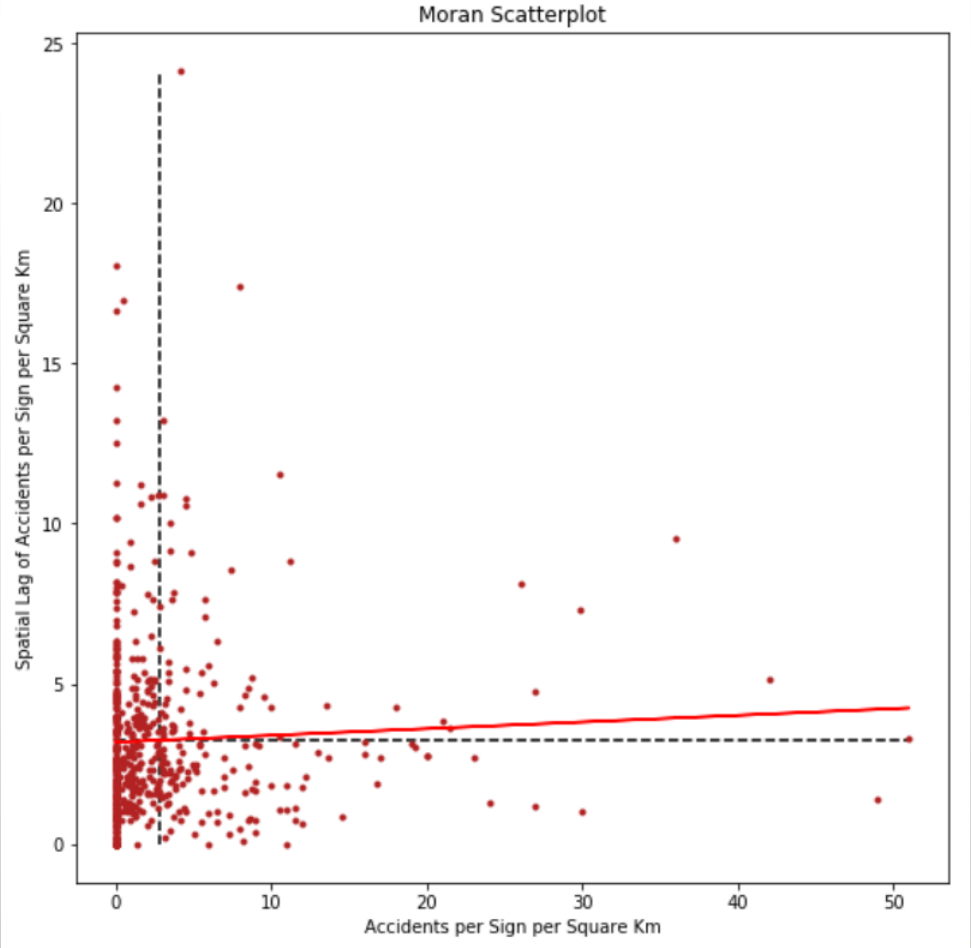
- Spatial Lag of Accidents per Sign per Square Km
- Clustering is visible, but appears to be more randomly dispersed across the city in comparison to the spatial lag map of the signs per square Km

LISA Visualized



- Red clusters indicate significantly higher number of accidents per sign per square Km
- Blue clusters indicate significantly lower number of accidents per sign per square Km

Moran Scatterplot



- Scatterplot of Accidents per Sign per Square Km vs. their spatial lag
- Moran's I value is shown as the red line
- A positive relationship is visible, but it is very weak

Statistical Results

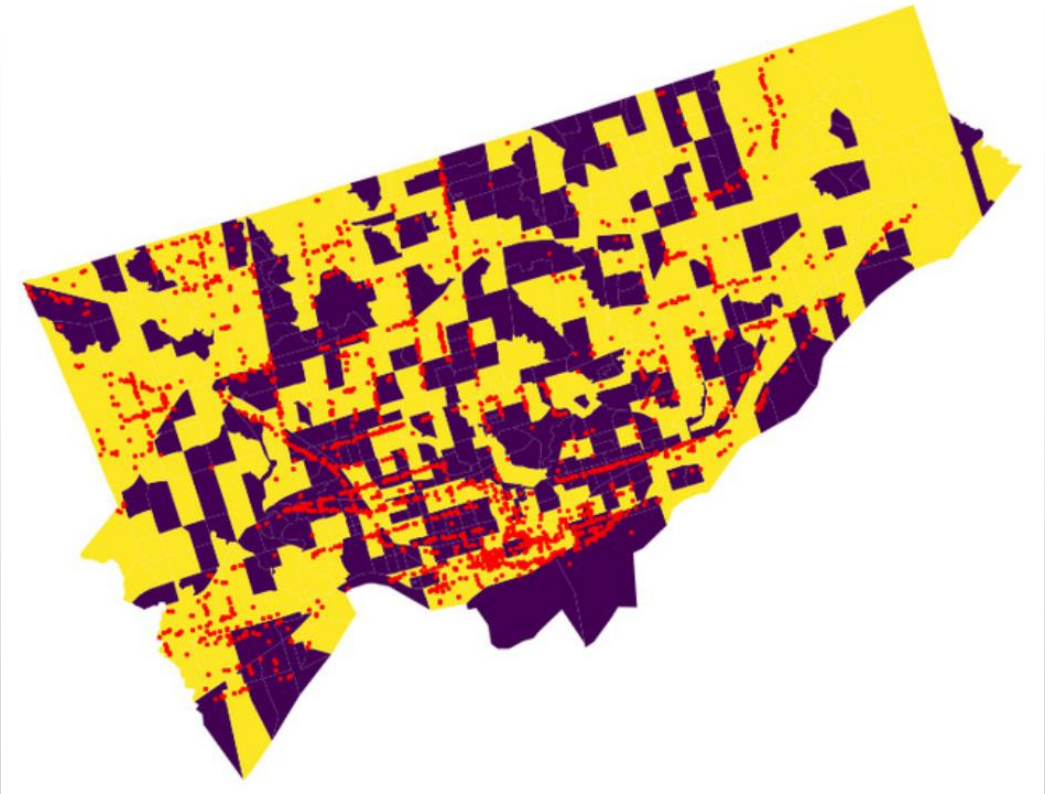
- Moran's $I = 0.02$
  - since this is only barely positive, there is very little to no clustering of similar values
  - since this is almost zero, there is close to perfect randomness in these values
- p-value = 0.181
  - Cannot reject the null; I could have generated by chance

Question:

Is there a demographic reason that could help explain this lack of relationship?

- Most advertising signs (61.4%) are found in census tracts with above average population (AAP)
- Check for a relationship in only these census tracts

Sign Locations and Population

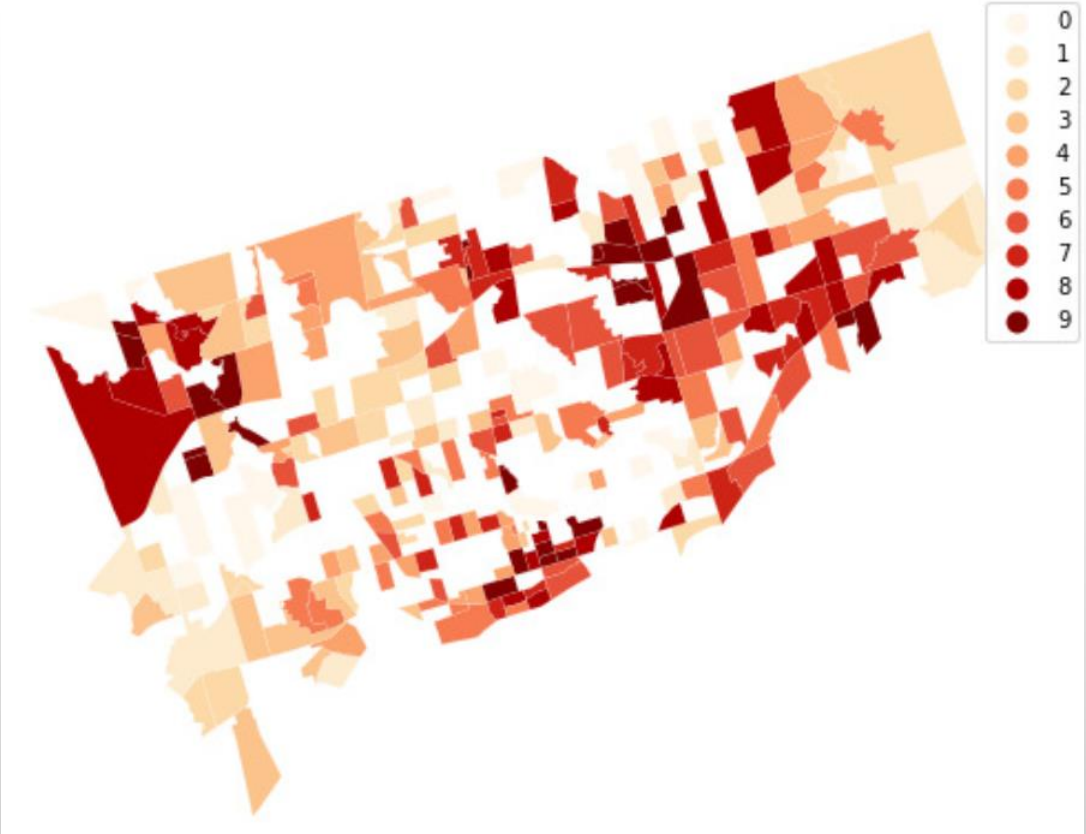


- Sign locations are shown in red
- Census tracts with above average population (AAP) are shown in yellow
- Purple areas will be excluded

Accidents per Sign per Square Km - AAP Tracts Only

- Darker colours show tracts with greater density of accidents per sign per square Km
- Gaps between some census tracts represent areas below the average population

Spatial Autocorrelation Visualized

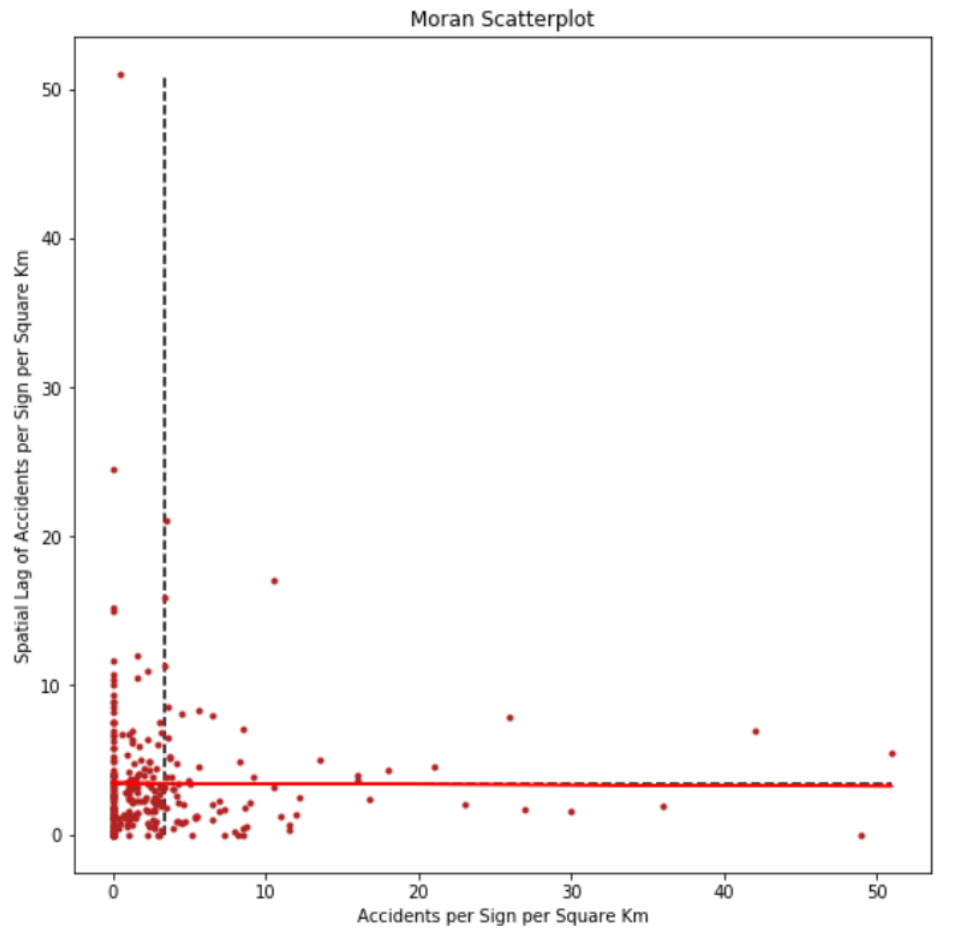


- Spatial Lag of Accidents per Sign per Square Km in AAP Census Tracts
- Similar results to the total spatial lag of accidents per square Km map
- Clustering is visible, but appears to be randomly dispersed across the city

LISA Visualized

- Red clusters indicate significantly higher number of accidents per sign per square Km in AAP census tracts
- Blue clusters indicate significantly lower number of accidents per sign per square Km in AAP census tracts
- Both appear randomly across the city

Moran Scatterplot



- Scatterplot of Accidents per Sign per Square Km vs. their spatial lag in AAP census tracts
- Moran's I value is shown as the red line
- No correlation appears to exist

Statistical Results

- Moran's I = -0.004
  - since this is almost zero, there is close to perfect randomness and no clustering in these values
- p-value = 0.443
  - Cannot reject the null; I could have generated by chance
- Much of the spatial similarity was lost by removing low population census tracts

Conclusion

- There appears to be no correlation between the number of accidents and the presence of advertising signs in Toronto
- The volume of accidents did not necessarily increase with the presence of more signs and no statistically significant relationship was found

Thank you

…and keep your eyes on the roads