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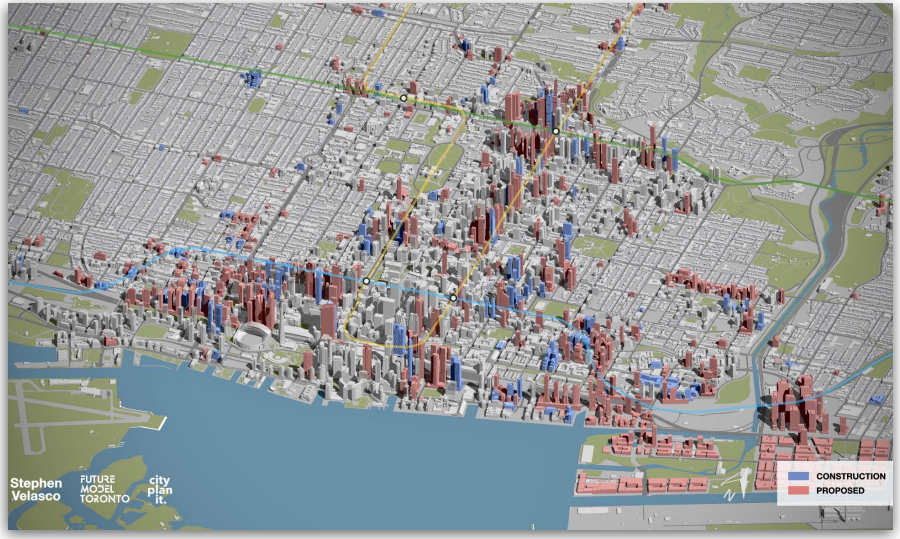
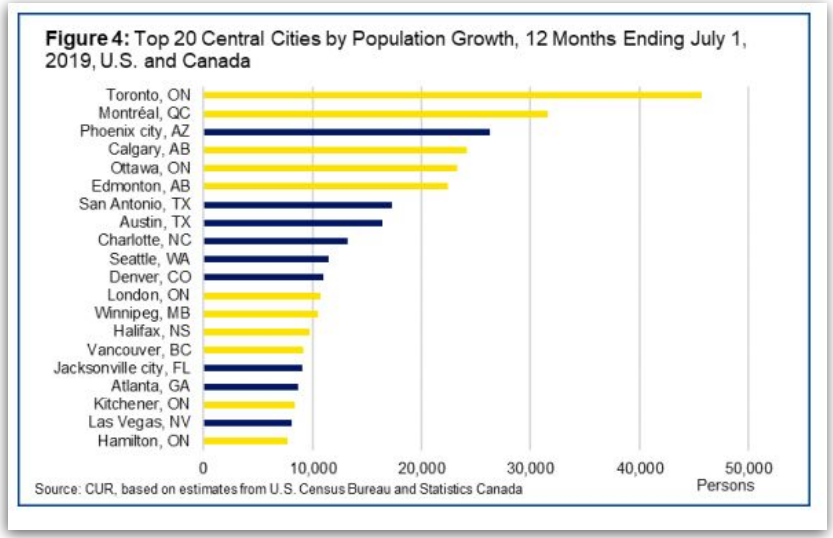
Transit Accessibility in Toronto

Background





Toronto is **by far** the fastest growing city in North America.

Background

Toronto is undergoing the **single largest** transit expansion program in North America.

Understanding the Problems

1. **Rapid population growth is straining the transportation network.**
   Transit lines are overcrowded, traffic congestion is worsening, and average commute times are growing longer.

2. **The city has a crippling housing crisis.**
   Rent is becoming a far bigger financial burden, forcing people to live further away from essential services and convenient transportation options

3. **Equity and climate change concerns are growing.**
   Sustainable transportation options (transit, cycling, walking) are critical for reducing societal externalities and climate impact

Accessibility

01

A measure of the ease of "**access to opportunity**" from a given point.

Examples:

- The number of grocery stores within a 15 minute walk
- The amount of time it takes to reach the nearest hospital

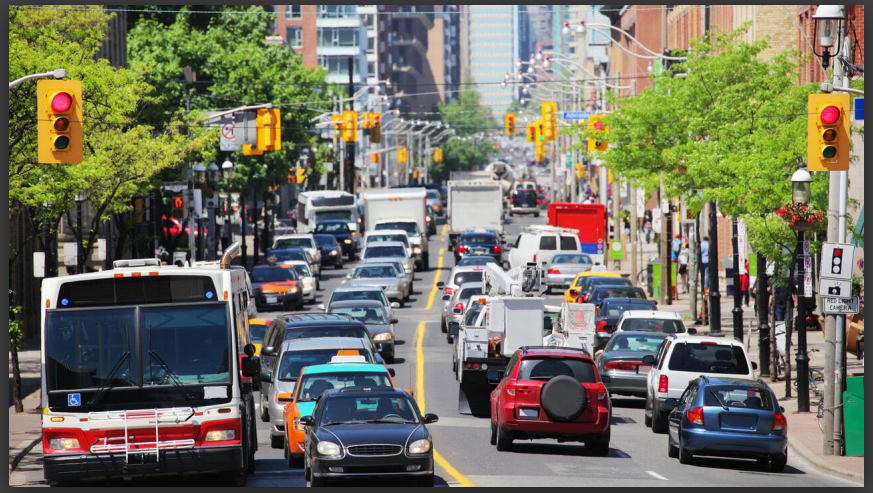
Accessibility

02

We measure “opportunity” in terms of **points of interest**.

Points of Interest (POI):
Hospitals, Pharmacies, Restaurants, Grocery Stores, Universities, and Places of Work

Project Objective



1. **Understand** how the current public transit network in Toronto influences residents' access to opportunity
2. Through spatial and temporal analyses, **examine** public transport accessibility through the lens of the city's transit network, demographics, and built form

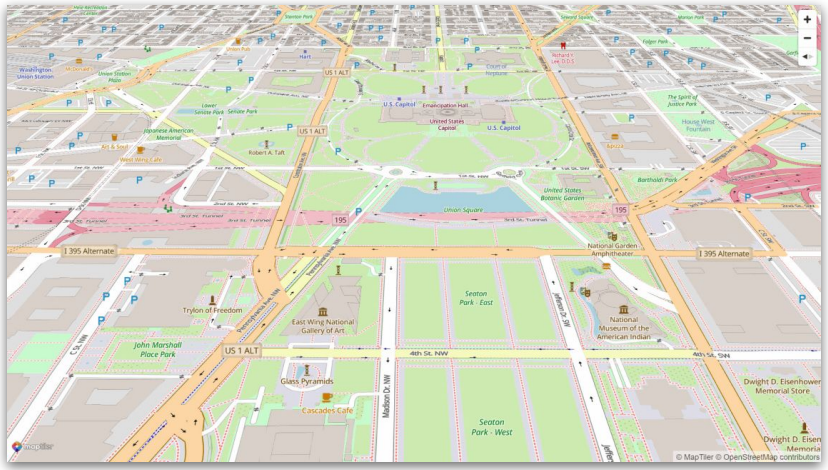
Research Question:

Comparing the current and future (2030) transit network, how efficiently can points of interest be accessed within the City of Toronto?

Methodology

Datasets

- **Open Street Maps**
  - Points of Interest
- **Statistics Canada**
  - Toronto population
  - Census demographics
- **Toronto Open Data**
  - Toronto Geographic Shapefiles
  - TTC GTFS Data
- **Metrolinx Open Data**
  - Toronto 2030 Transit Network



Process

STATUS	TECHNOLOGY	NAME	Shape_Le
Proposed	Priority Bus	Bayly	12759.26
Proposed	LRT / BRT	Simcoe BRT	10223.29
Proposed	Priority Bus	Trafalgar North	8333.61
Proposed	Priority Bus	Brant	6397.38
Proposed	Priority Bus	Hamilton Mohawk (T-Line)	20928.69
Proposed	Priority Bus	Brock Rd.	11513.15
Propo	LRT / BRT	Jane South	14305.95
Propos	LRT / BRT	Trafalgar	7999.22
Pro	LRT / BRT	Leslie North	4082.10
Propo	LRT / BRT	Finch West LRT Extension	6337.01

1

Data Parsing

Datasets are loaded into a Postgres database, organized, and cleaned.

Data Analysis

Using Python, SQL, and Jupyter, the data is analyzed to determine key accessibility metrics.

TTC Routes

```
[4]: ttc_routes = gpd.read_file("./data/TTC Routes/RTP_TRANSIT_NETWORK.shp")
     display(ttc_routes.info())
     display(ttc_routes.crs)
     itable(ttc_routes.drop(columns="geometry"))
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
RangeIndex: 127 entries, 0 to 126
Data columns (total 5 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   STATUS       127 non-null    object
 1   TECHNOLOGY   127 non-null    object
 2   NAME         127 non-null    object
 3   Shape_Leng   127 non-null    float64
 4   geometry     127 non-null    geometry
dtypes: float64(1), geometry(1), object(3)
memory usage: 5.1+ KB
None
<Projected CRS: EPSG:2952>
```

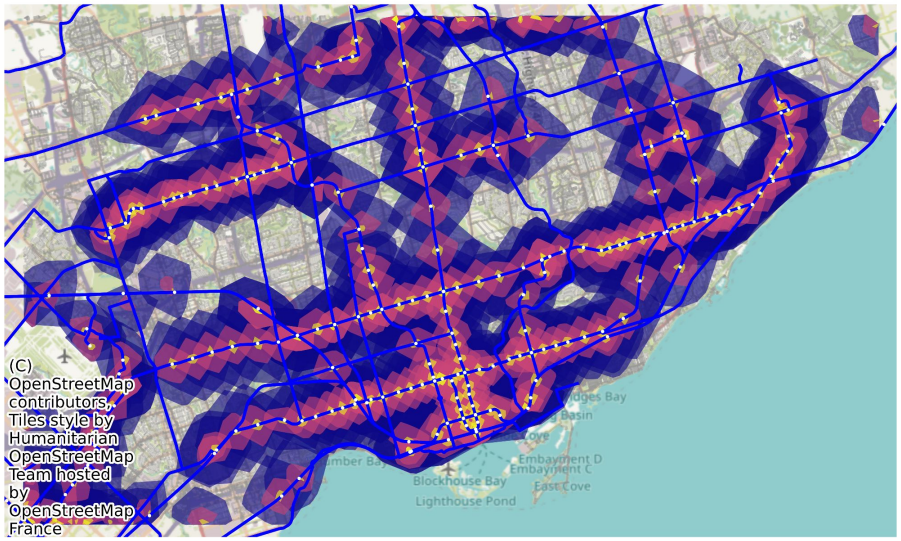
2

3

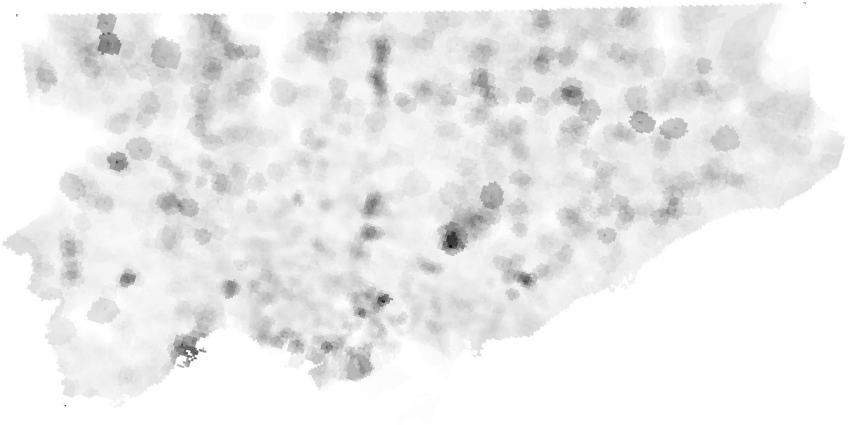
Interpretation

Data is visualized in either QGIS or Matplotlib, to support analytical findings.

Analysis



Isochrone Map



Heat Map

Developing Isochrones

Isochrone maps were developed through an extensive process with various python packages.

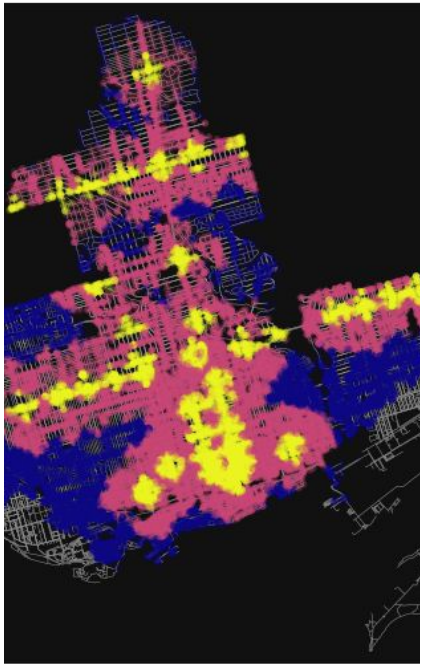
01 | Download and Project OSM Data via the **OSMnx Library**

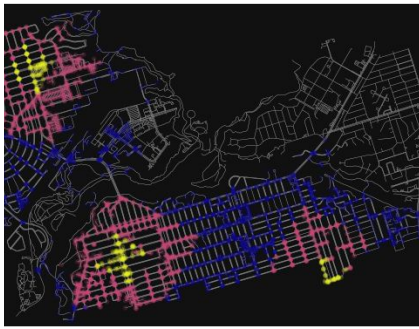
02 | Project OSM Data to the CRS of the dataset

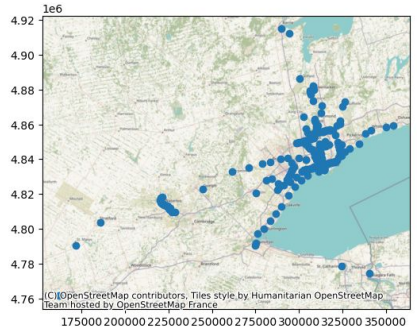
03 | Calculate Ego Graphs for each **transit station point**

04 | Calculate **travel time** for each Ego Graph

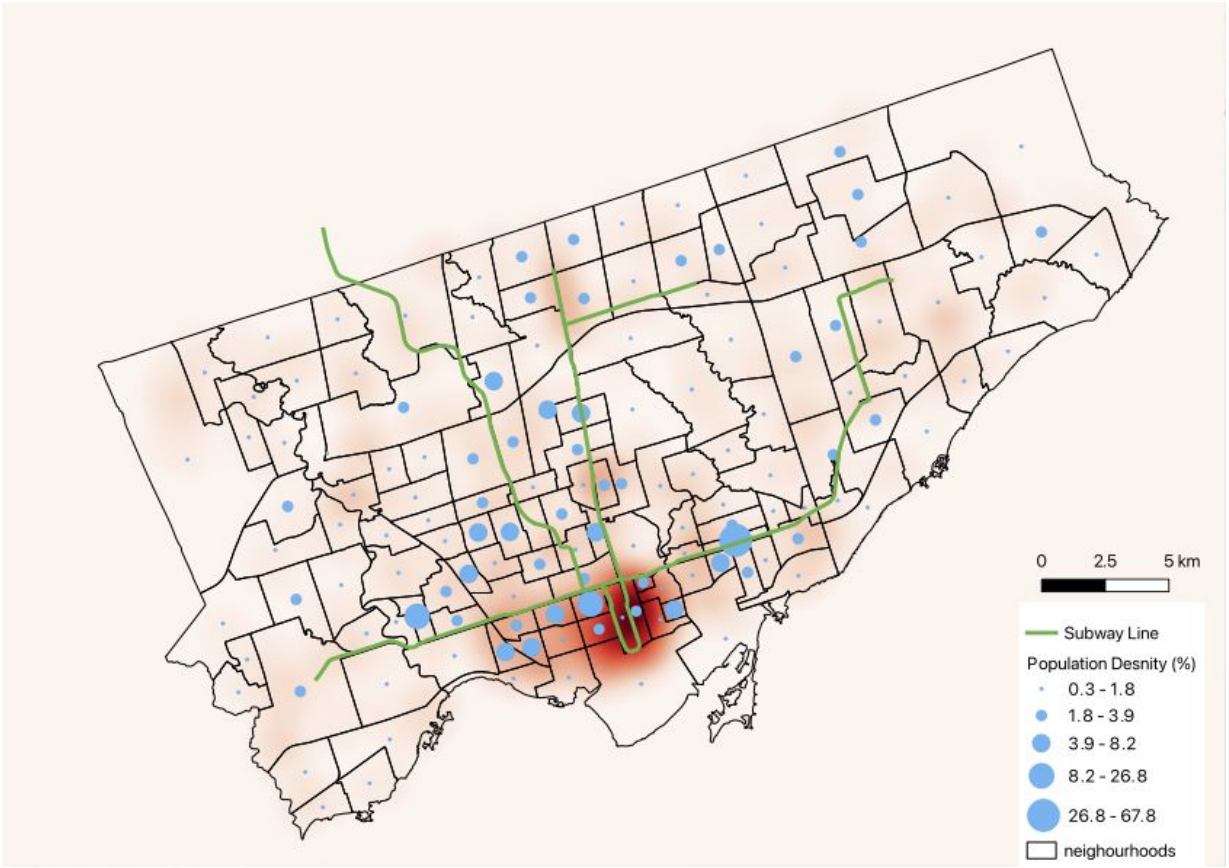
05 | Calculate polygons using convex hulls of each grouping







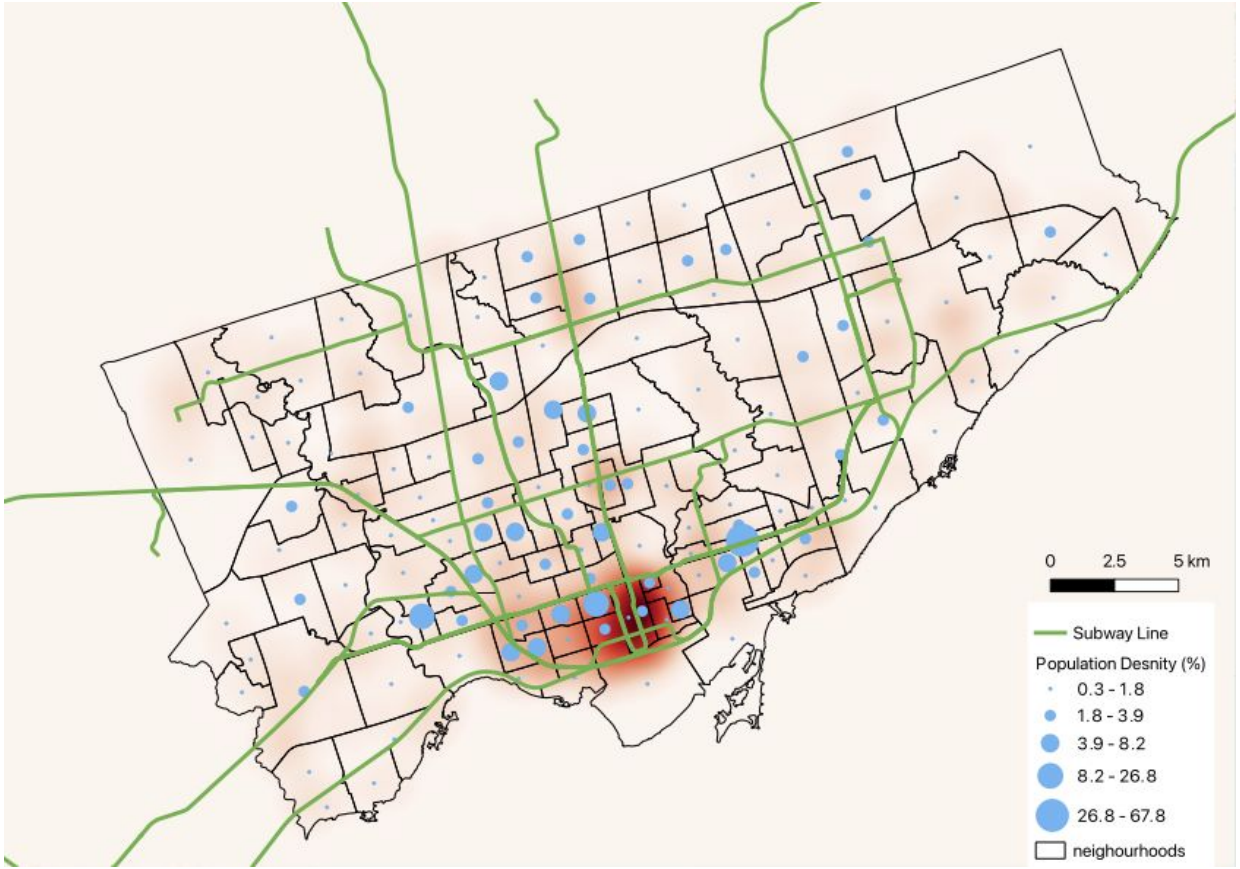
Results



Heat Map displaying POI's and the current Rapid Transit Network, alongside Population Density

Findings

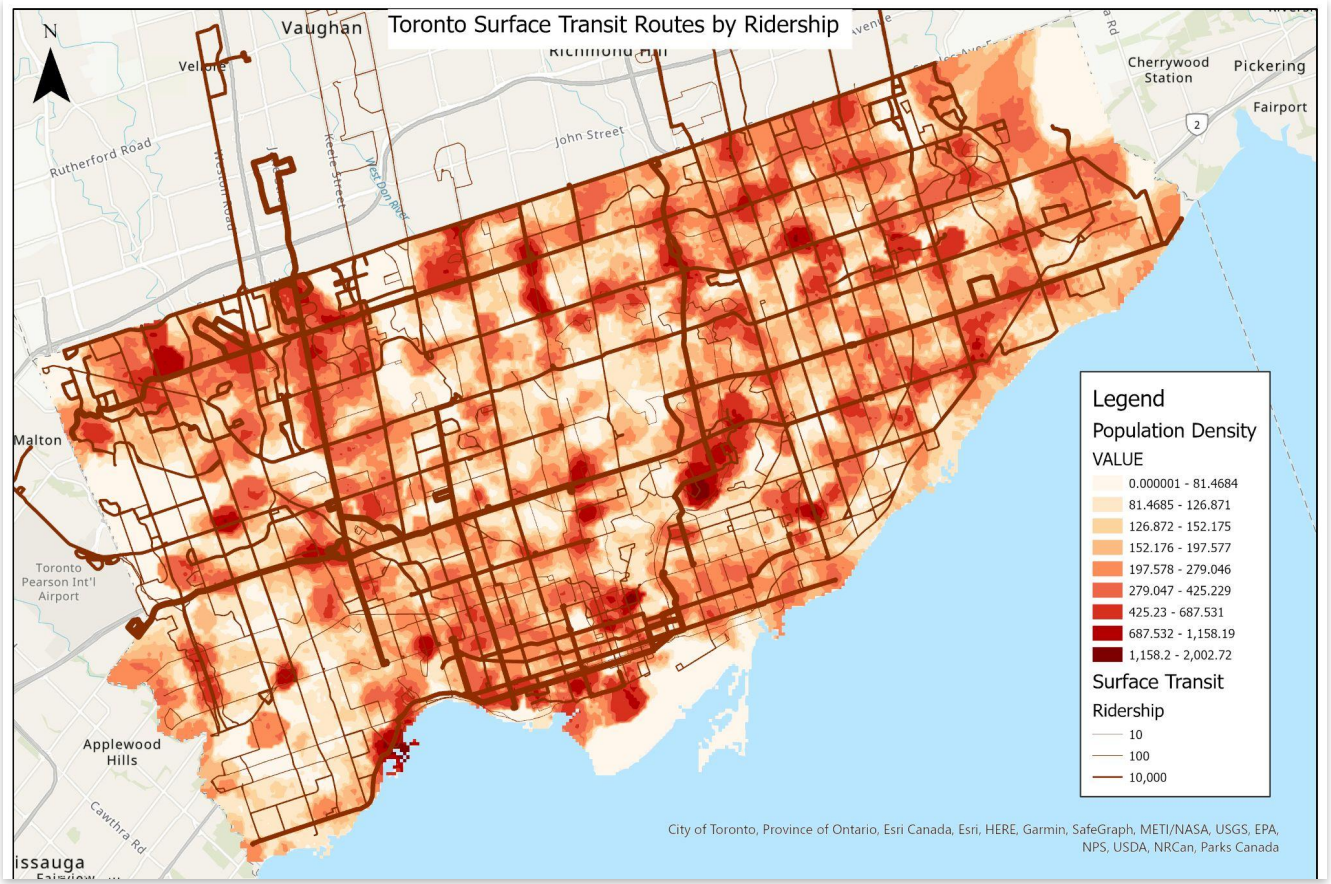
- Toronto's downtown core has a high density of POI's
- Areas surrounding the TTC seem to contain the most POI's



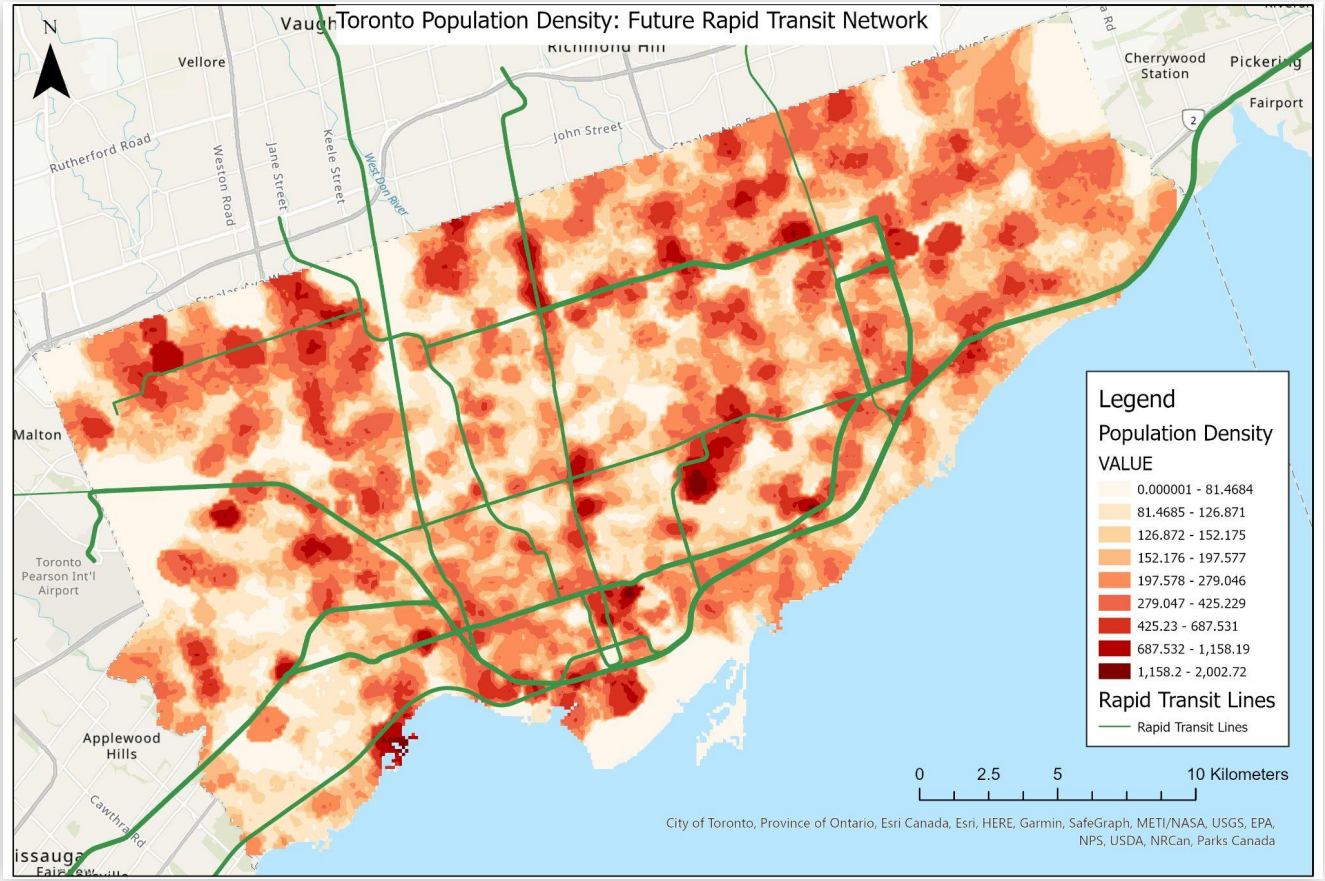
Heat Map displaying POI and the future transit network, alongside population Density

Findings

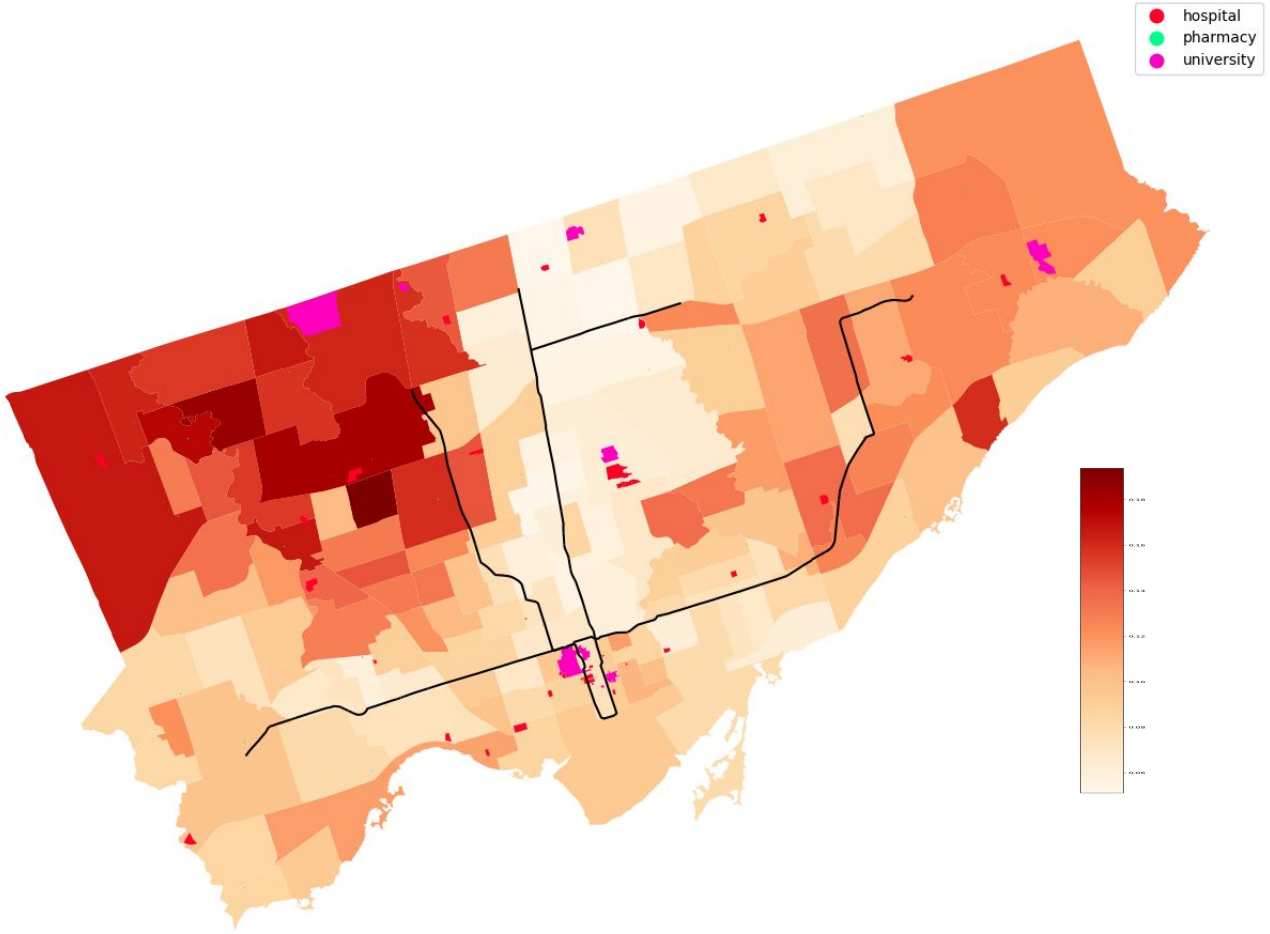
- The network extension encompases a lot more of Toronto's denser neighborhoods



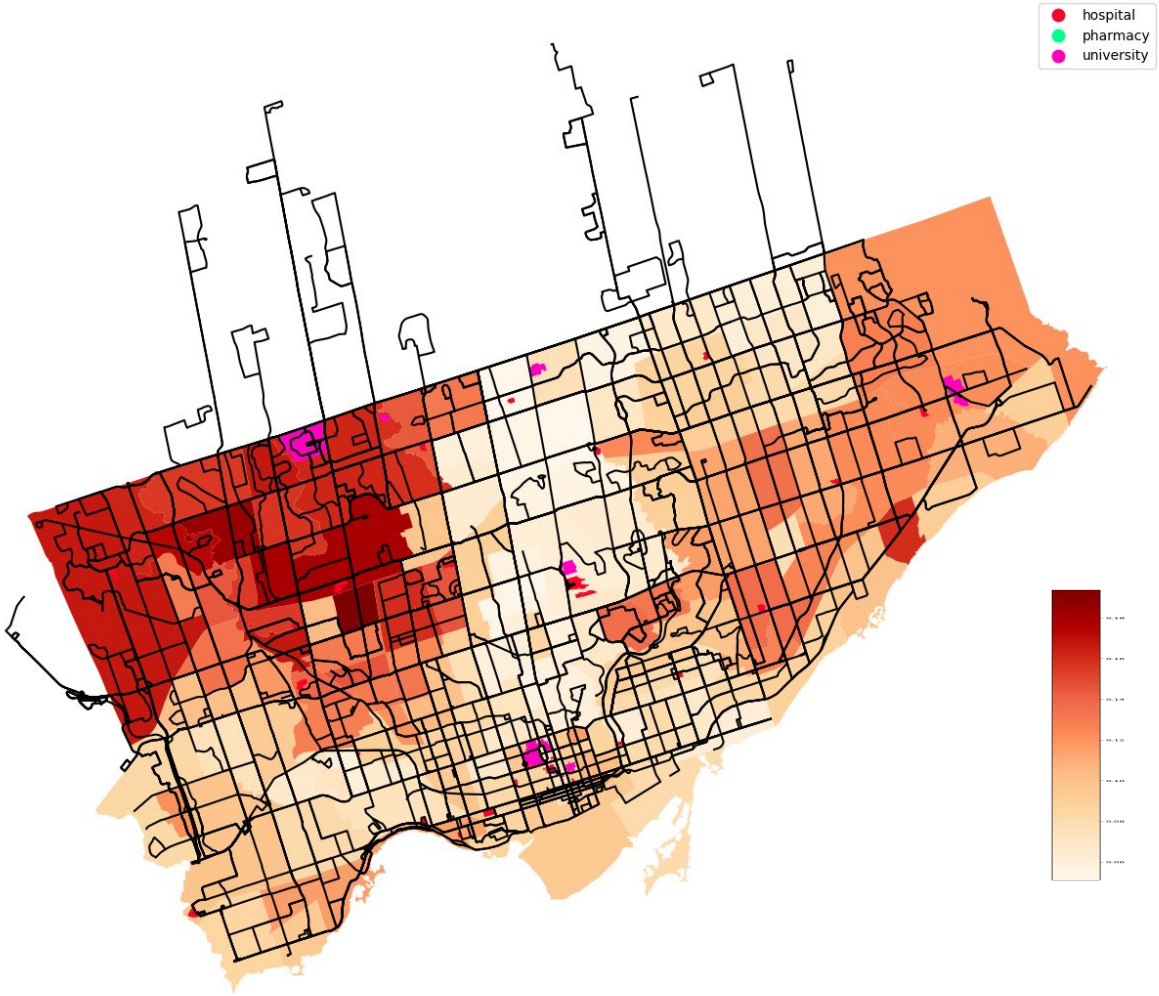
Heat Map Displaying Population Density Overlaid with Bus Transit Network



Heat Map Displaying Population Density Overlaid with Future Rapid Transit Network



Subway network, overlaid with healthcare and Universities POI alongside Covid-19 Infection Rate

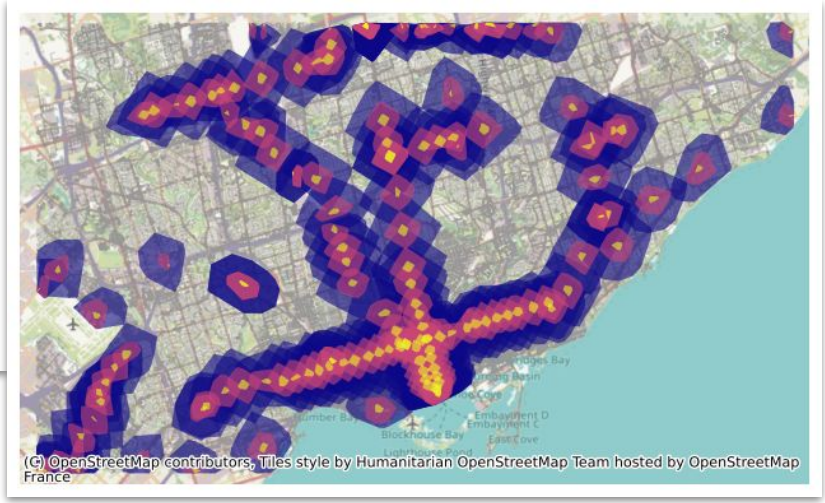


Bus and Streetcar network, overlaid with healthcare and Universities POI alongside Covid-19 Infection Rate

Yellow: <5 minutes; Red: <15 minutes; Blue: <30 minutes

Current rapid transit network:

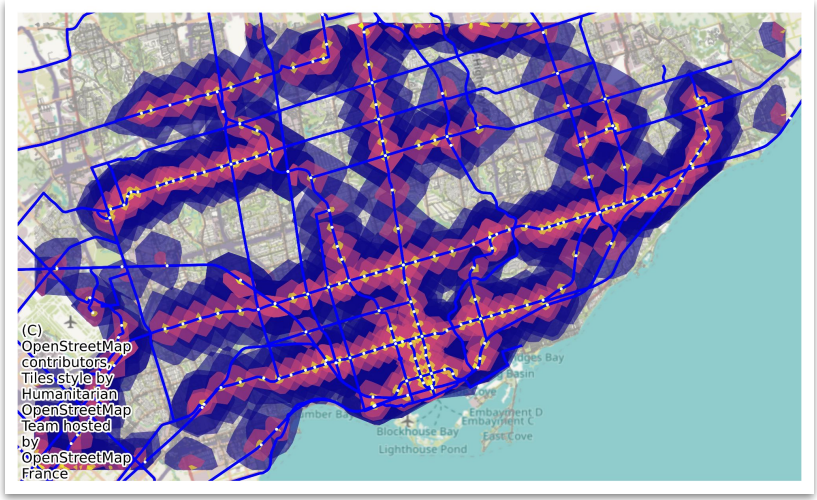
- **32.9%** of Toronto population within a 15 minute walk
- **35.5%** of POIs within a 15 minute walk



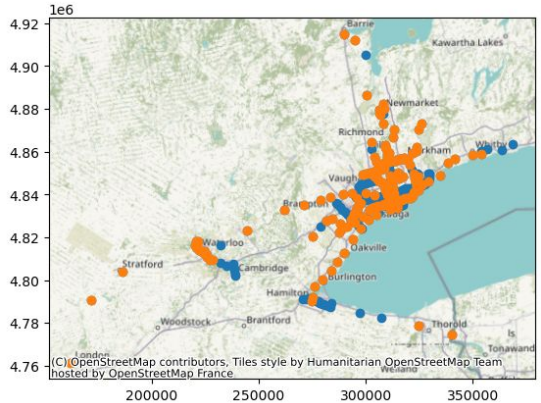
Isochrone of future Rapid Transit stations

Toronto's transit expansion represents a massive increase in accessibility.

- **72.4%** of Toronto population within a 15 minute walk
- **71.3%** of POIs within a 15 minute walk



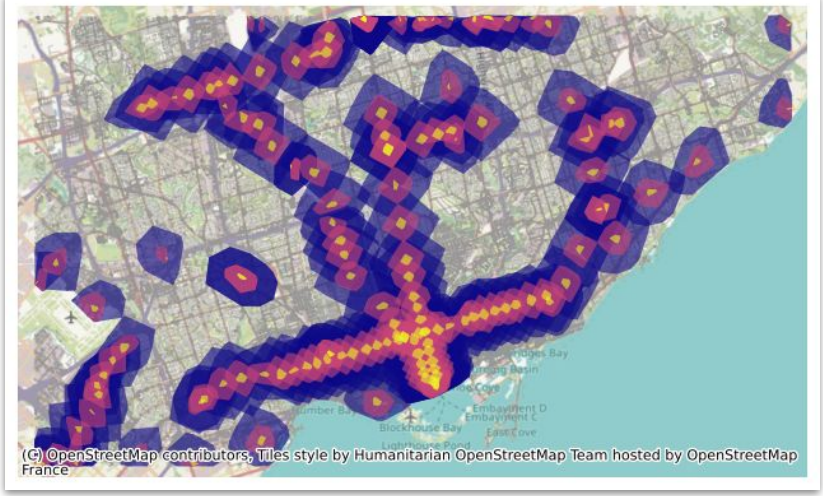
Isochrone of future Rapid Transit stations



Existing public transport infrastructure

Further Comparisons of Scaling between Existing and Future Public Transport Infrastructure

- **72.7%** increase in number of potential stops
- **86%** increase in accessible area within 30 minute walk



Potential Limitations of Study

- Our results heavily rely on OpenStreetMaps data which may incur limitations in the form of sampling biases amongst others
- OSM data may have errors where streets or distances of a street may be off if not completely incorrect.
- Geometrical simplifications and compressions may result in loss of accuracies.
- Isochrone maps were generated with intersections as nodes. Therefore, there is rounding.
- No time-scale of any form is considered, reduces applicability of results to different traffic loads.
- Population and Census data from 2016, slightly dated

Future Objectives

- Reduce potential previously discussed errors
  - OSM data may be super sampled and cross-referenced with larger or more developed datasets
  - Insert POIs into street graph network to reduce roundings and approximations
  - Using traffic data, apply time scale to vary travel times on edges of street network graphs.
- Calculate isochrones for different modes of transportations separately
- Study relationships between current public transportation bandwidth and current population information and contrast with predicted population growths and future public transportation networks in a more quantitative manner.

Conclusion

- The existing rapid transit network lacks coverage of population density and POIs
    - Many suburban neighbourhoods reliant on bus routes for accessibility
- Development of the future transit network represents a substantial increase in accessibility.
    - Large future increase in population may potentially not be able to be supported by the current and future transit plan.
- Accessibility to POI still seem heavily accessible within old Toronto, however less so within the suburbs and north of Toronto
- Health Networks may potentially not be enough to support those reliant on public transit

Thank you.

Rendu d'artiste - sous réserve de modifications. Les propositions de communautés axées sur le transport en commun ne sont pas illustrées

Artist's rendering – subject to change. Transit-Oriented Community proposals not shown.

Reflection

- Issues that occurred
  - Determining a methodology
  - Coding environment issues
  - Cleaning the data
  - Interpreting the results
- Things that went well
  - QGIS didn’t crash towards the end (third time's the charm)
  - Good team work
  - Learned how to perform multitude of geospatial analytics