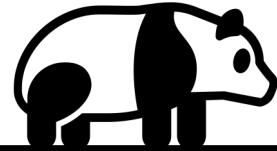


Team Plowing Panda



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- University of Toronto -

CIV1498 – Introduction to Data Science for Civil and Mineral Engineers



- Toronto had one of its most severe snowstorm events on January 16-17th, 2022 (Ranger and Casaletto, 2022):
 - ~45 cm of snow!
 - In top 10 snow events ever recorded for Toronto (Howes, 2022)
- The City was not prepared for this storm (City of Toronto, 2022):
 - Overspent money – 20% of total annual budget, \$17 M
 - Lack of visibility for Toronto citizens
 - Low snow-plow deployment rates from facilities

Snow removal after Toronto's massive winter storm in January cost city \$17M

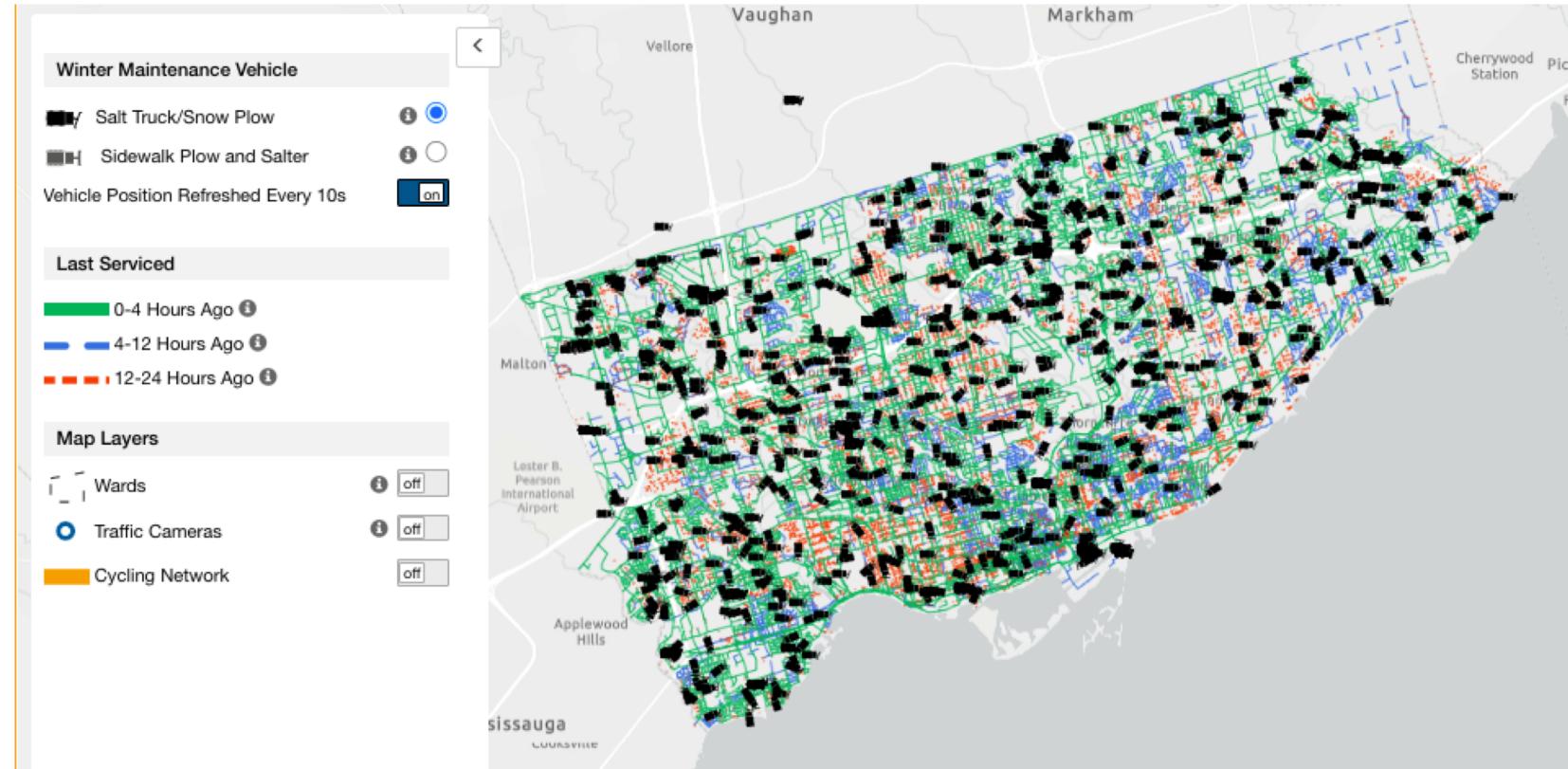


A man crosses over a snowbank in downtown Toronto as a heavy snowfall affects the greater Toronto area on Monday January 17, 2022. THE CANADIAN PRESS/Chris Young





- January storm showed the need for a deeper dive into Toronto's response to severe weather events
- PlowTO shows live snowplow locations, but does not provide historic data
- In February, the City of Toronto claimed that 600 plows and 200 trucks were deployed for future storm events (Tory, 2022)



John Tory @JohnTory

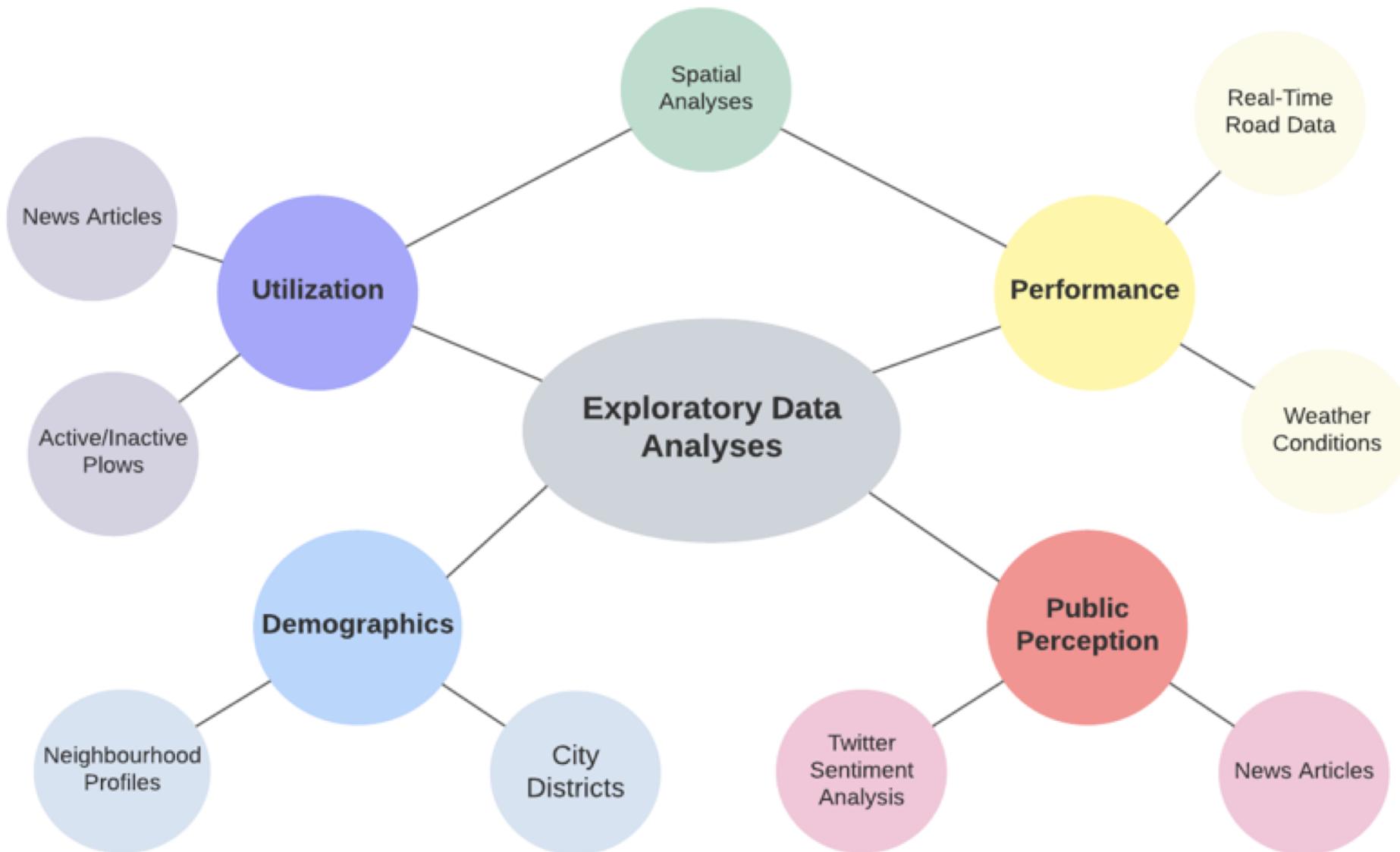
Given the amount of snow, [@CityofToronto](#) has declared this a major snow storm condition. This will help snow removal operations once snow plowing is complete. For this effort, the City has deployed:

- 600 road plows
- 200 salt trucks
- 360 sidewalk plows

toronto.ca/news/city-of-t...

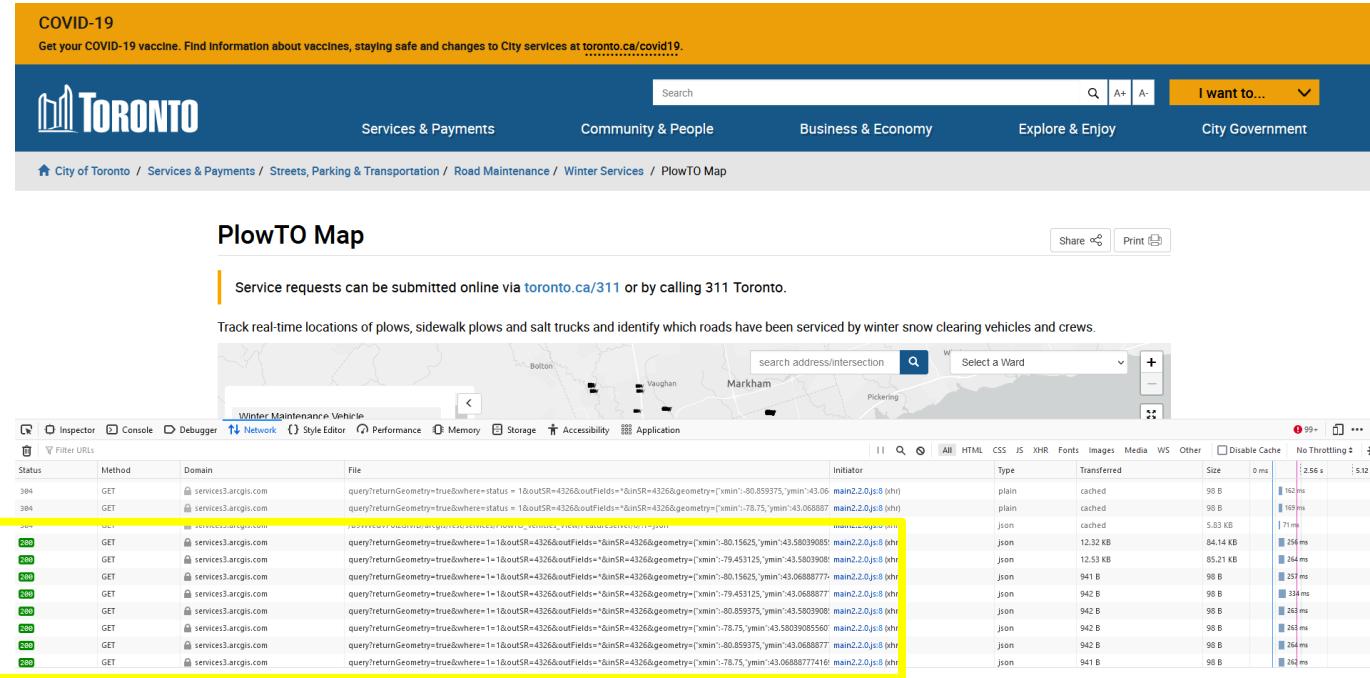
CITY OF TORONTO
DECLARES MAJOR SNOW STORM CONDITION

TO Transportation

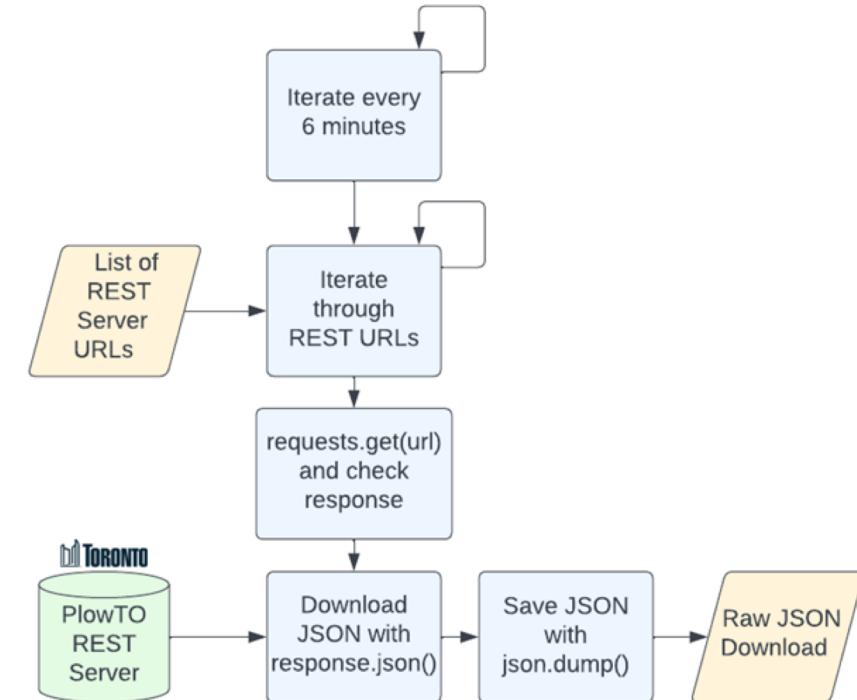


PlowTO Map Data Collection:

- PlowTO map data is supplied by the City's ArcGIS REST server
- REST server was identified by monitoring network traffic
- Python JSON request and response were used to download the live data to a local machine

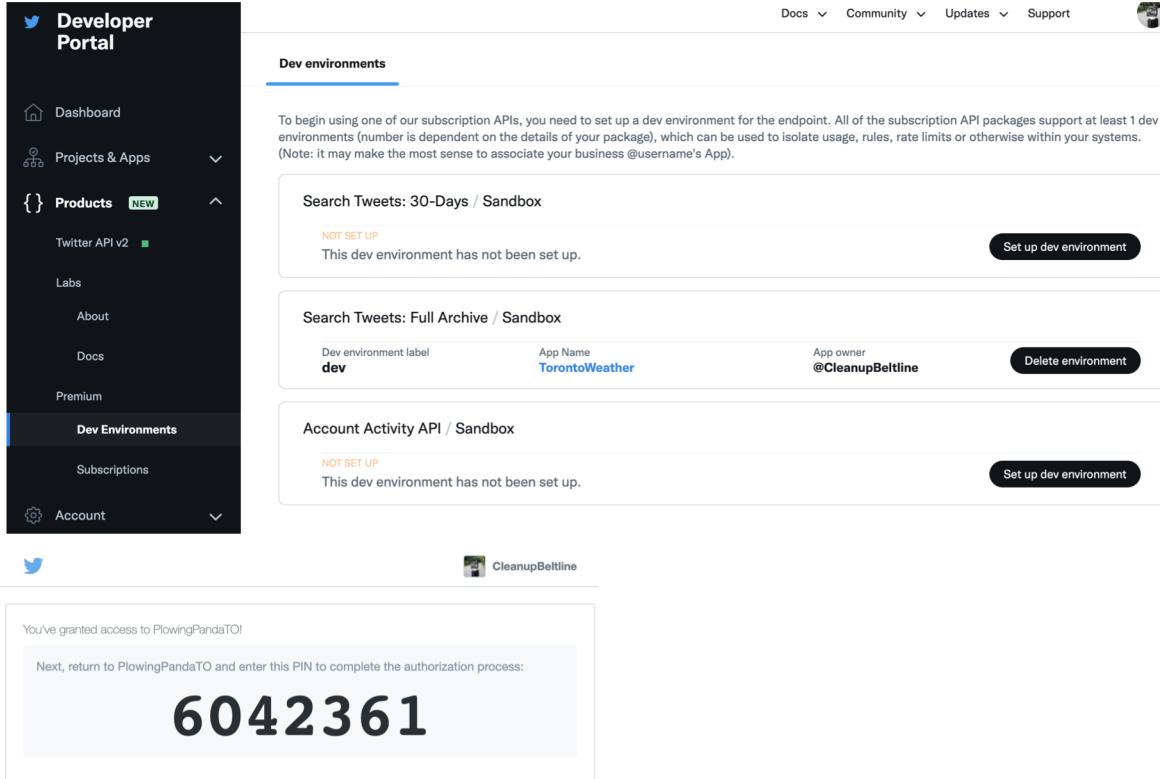


The screenshot shows the City of Toronto website with the PlowTO Map feature. The Network tab of the browser developer tools is open, displaying a list of network requests. A yellow box highlights several requests to the URL `services3.arcgis.com`. These requests are all GET requests for geometry data, with parameters like `returnGeometry=true&where=status = 1&outSR=4326&outFields=&inSR=4326&geometry='xmin:-80.859375,ymin:-43.06 main2.0;js:8 (hr)`. The responses are in JSON format, indicating real-time locations of plows and salt trucks.



Twitter Data Processing using Twitter API v.2:

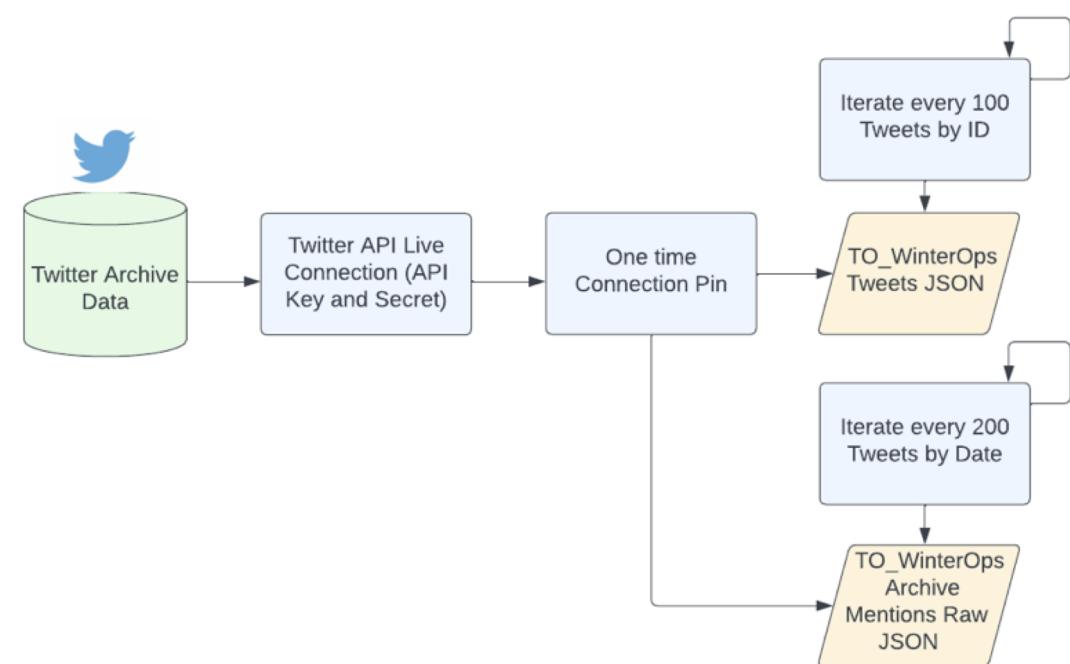
- Signed up for Elevated Access Twitter Developer account, under academic license
- Provided with Key and Secret to setup Twitter API calls
- Available to students, with APIs for archive and query capability

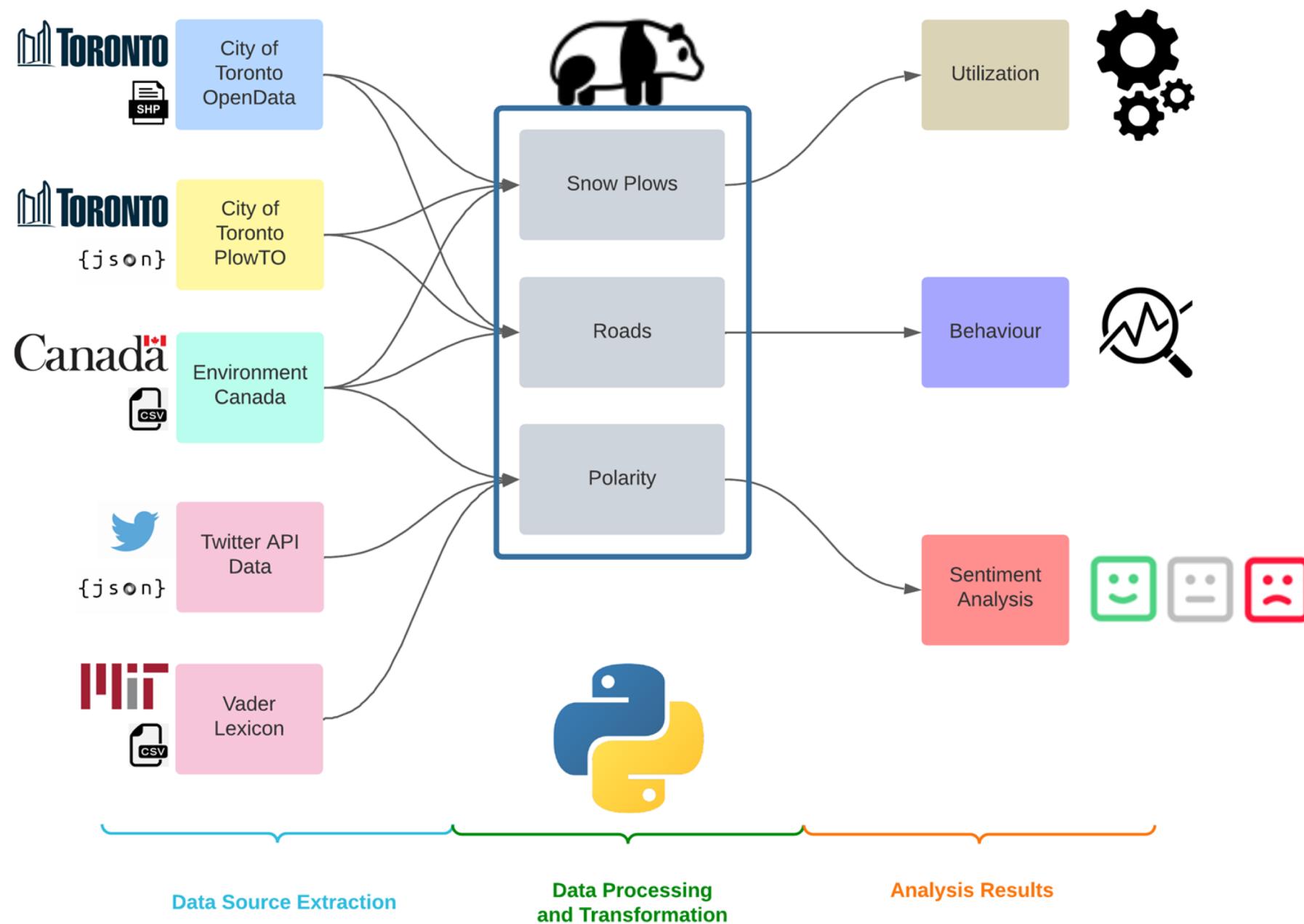


The screenshot shows the Twitter Developer Portal's Dev Environments page. On the left is a dark sidebar with links like Dashboard, Projects & Apps, Products (selected), Labs, About, Docs, Premium, Dev Environments (selected), Subscriptions, and Account. The main area has a header "Dev environments". It displays three environment configurations:

- Search Tweets: 30-Days / Sandbox**: Status: NOT SET UP. Includes a "Set up dev environment" button.
- Search Tweets: Full Archive / Sandbox**: Dev environment label: dev, App Name: TorontoWeather, App owner: @CleanupBeltline. Includes a "Delete environment" button.
- Account Activity API / Sandbox**: Status: NOT SET UP. Includes a "Set up dev environment" button.

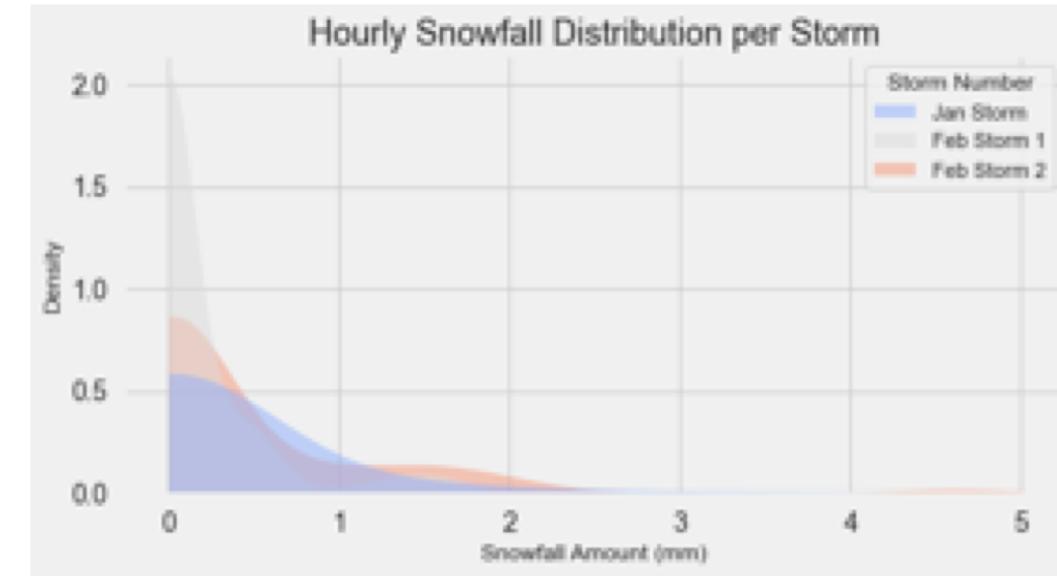
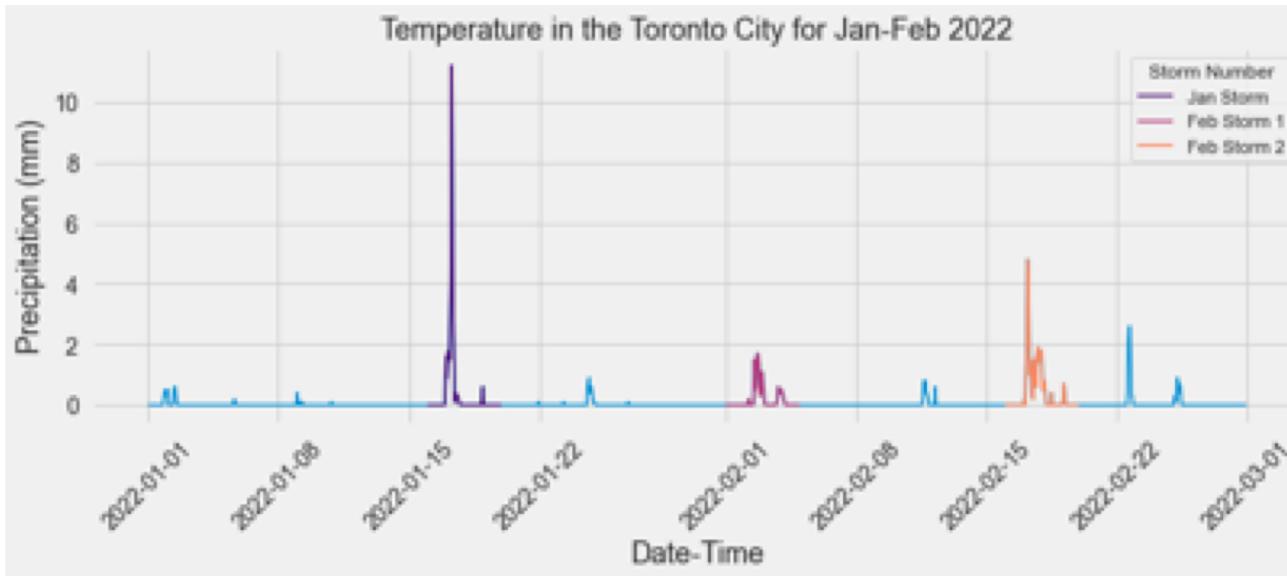
At the bottom, a message says "You've granted access to PlowingPandaTO! Next, return to PlowingPandaTO and enter this PIN to complete the authorization process:" followed by the PIN **6042361**.



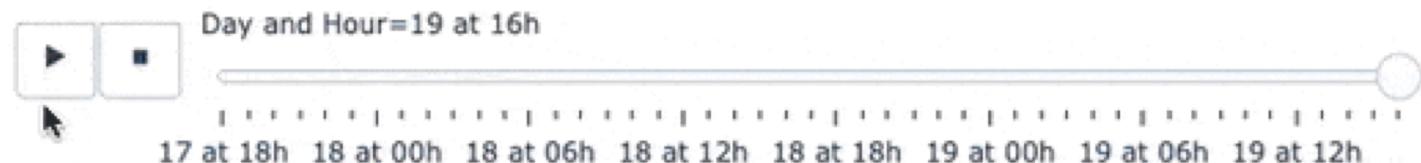
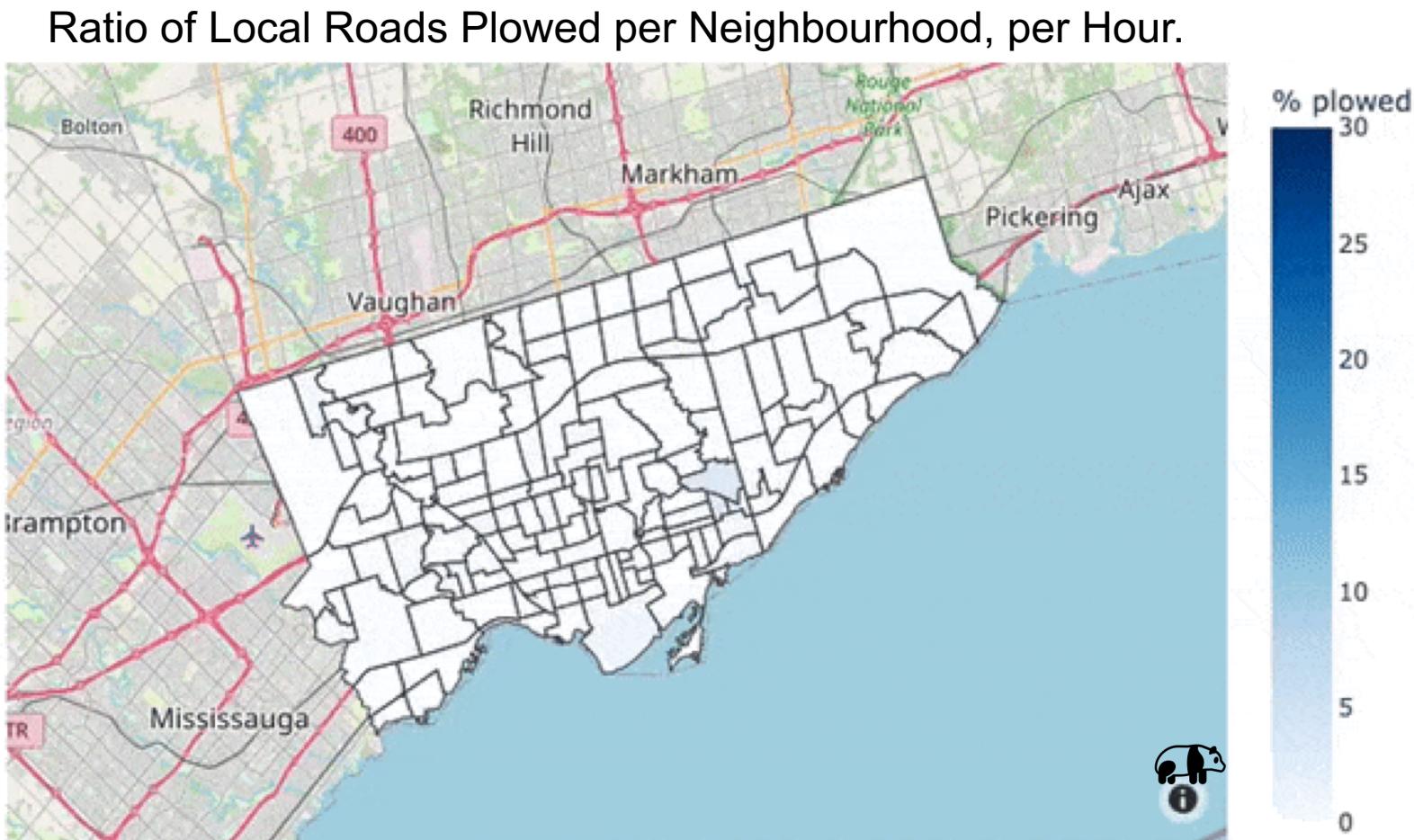


Weather Events and Data Collection:

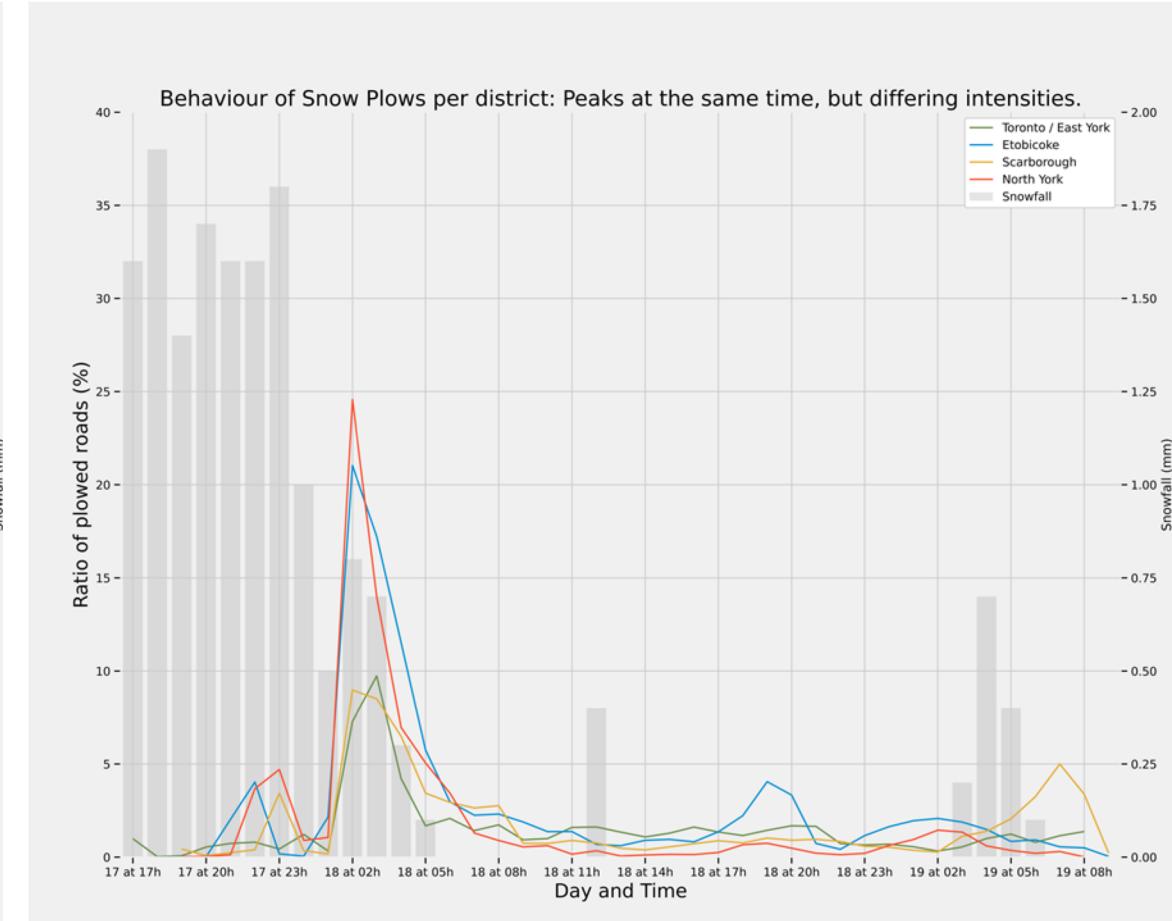
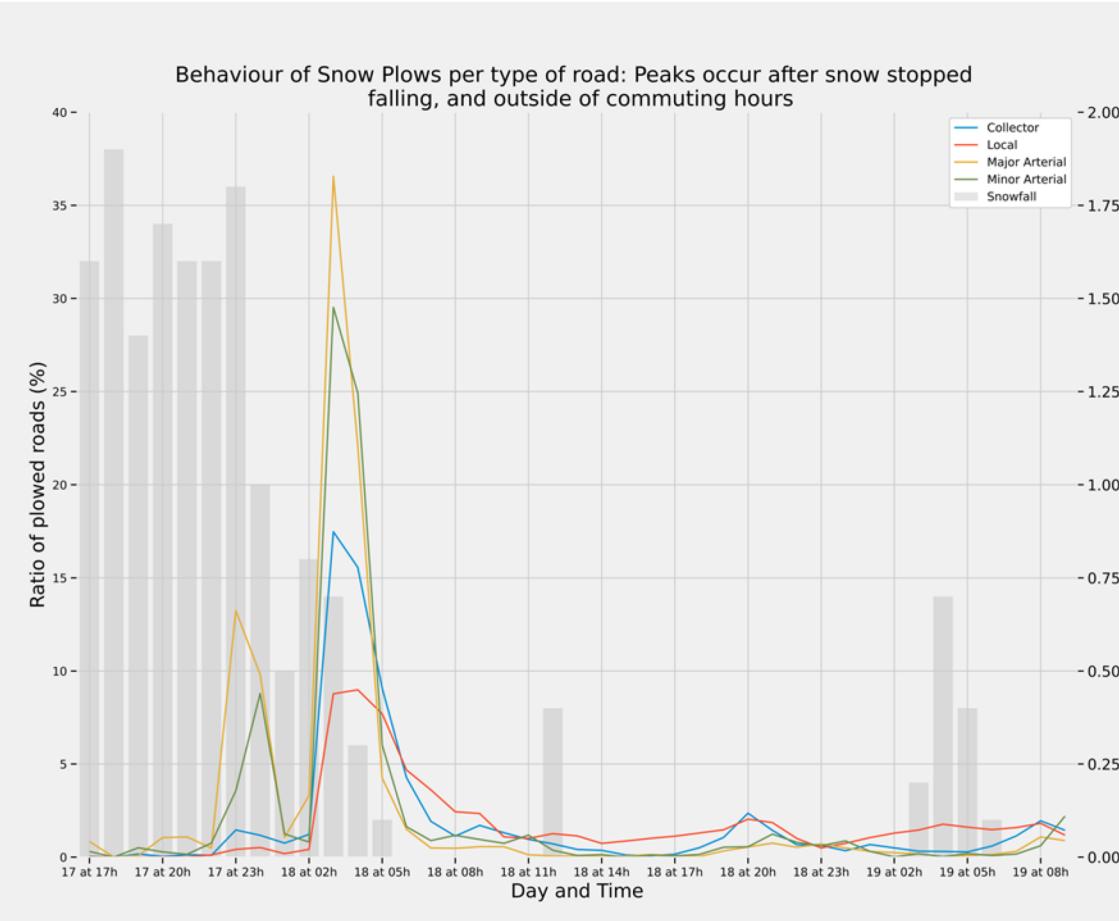
- PlowTO data was collected during two storm events in February
 - February 2nd to February 4th
 - February 16th to February 19th
- Storm timing was verified using Environment Canada weather data
- The Feb. 16th to Feb. 19th storm was selected for further analysis



- Local roads are representative of residential areas
- Heavy plowing during early hours, i.e. 2AM to 5AM.
- Continuous plowing after storm has ceased

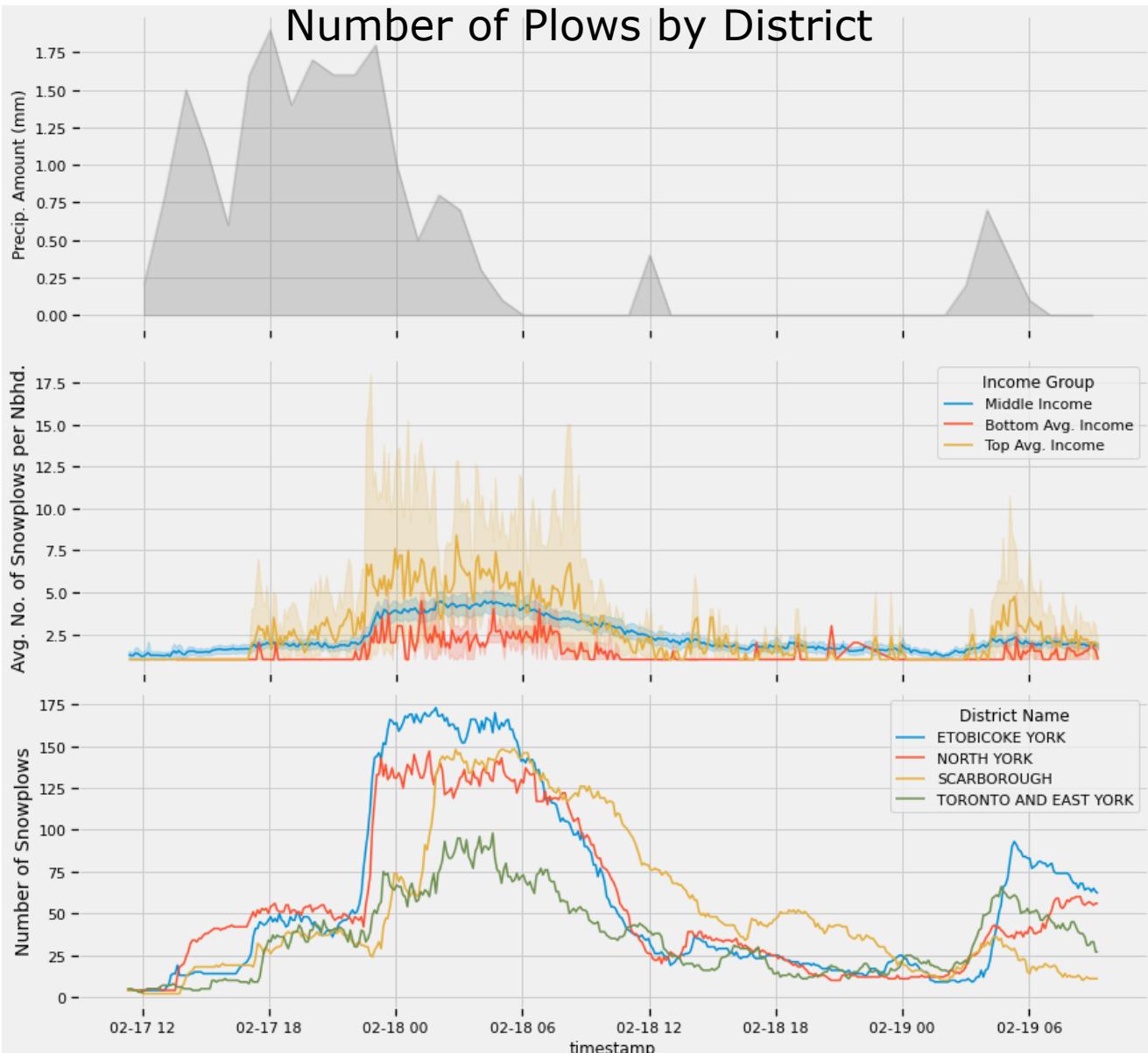


- Arterial roads are prioritized;
- Local roads are consistently plowed throughout the day;

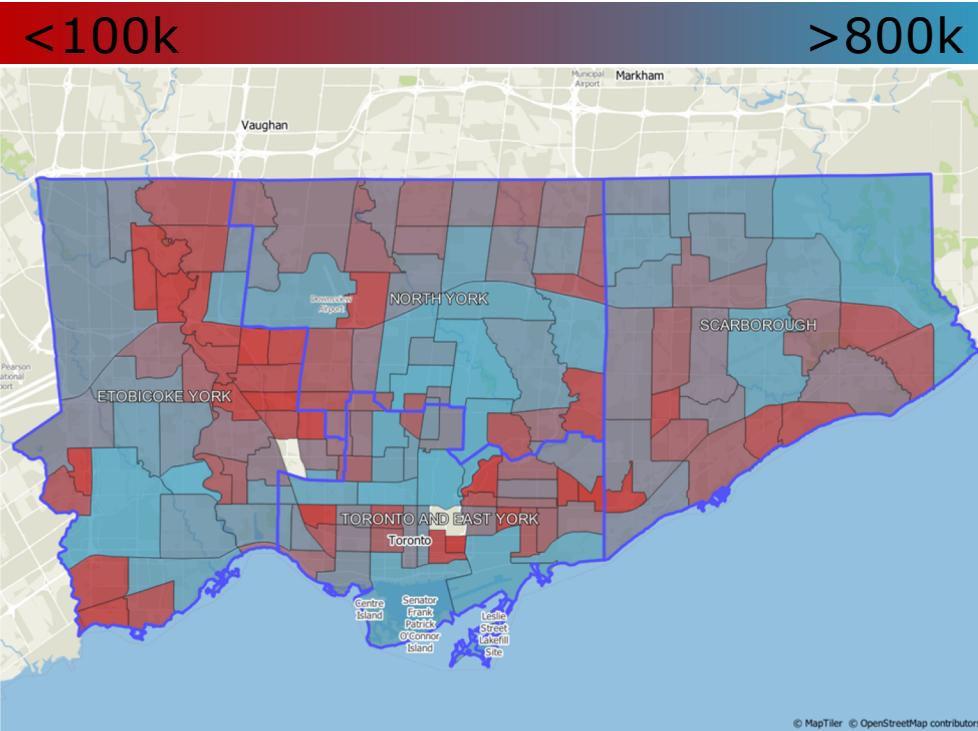




Weather, Average No. of Plows by Nbhd., and Total Number of Plows by District



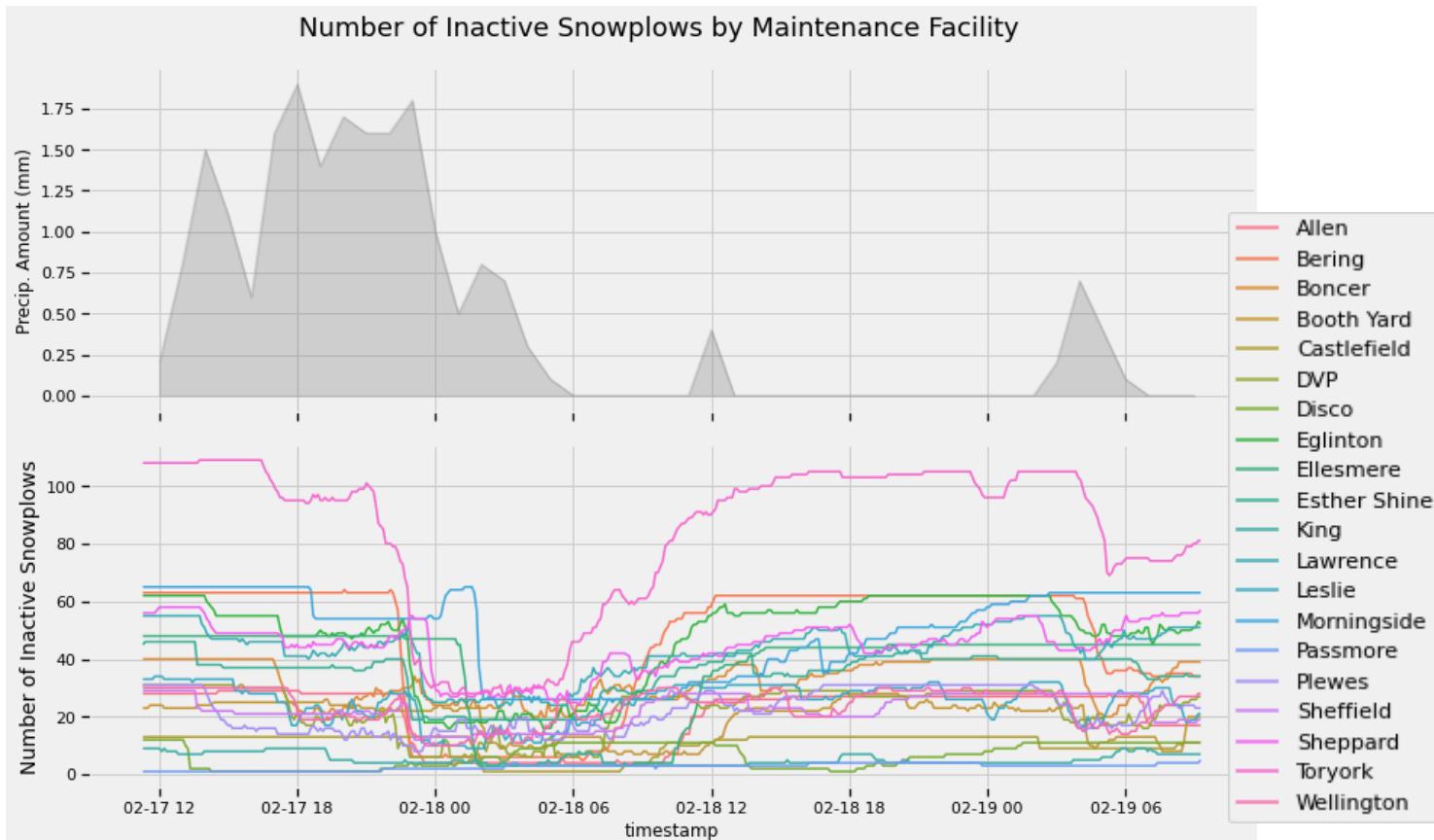
Neighbourhoods by Average After-Tax Household Income



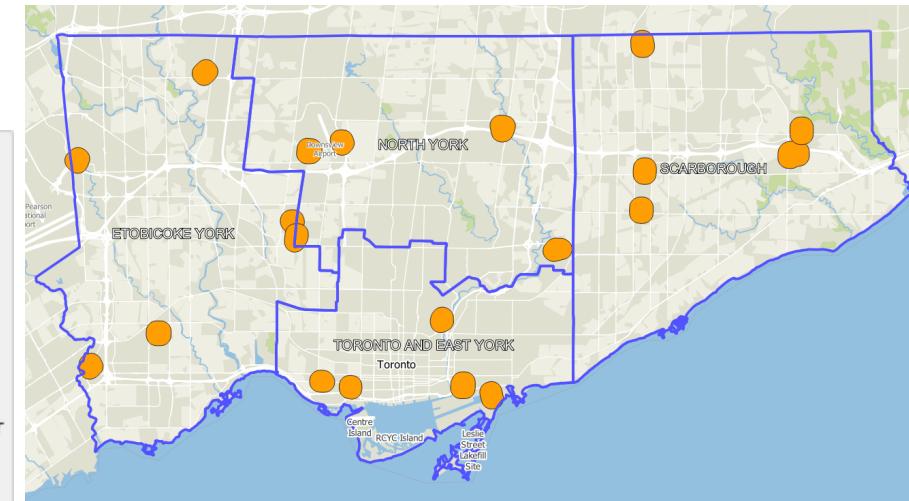
- Patterns exist but there are many factors present
- Ex: Low and high income neighbourhoods are not all the same size, density, age, infrastructure

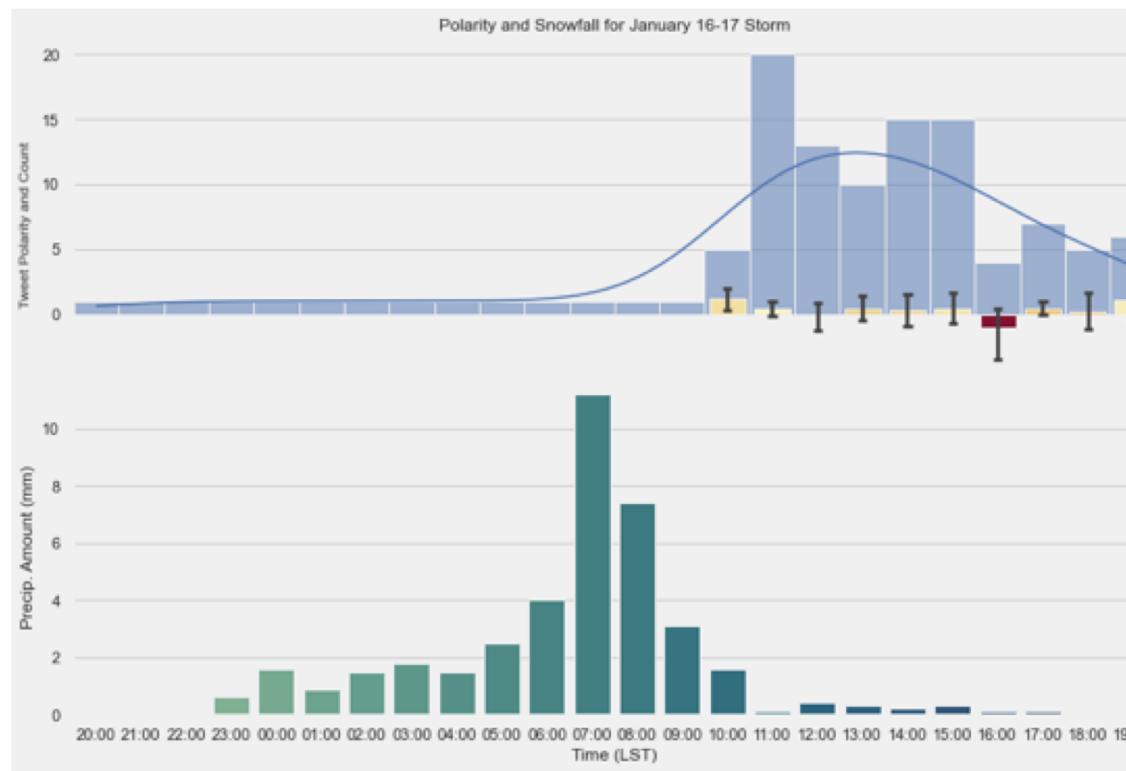


- A minimum of 13 and a maximum of 533 of the 800 plows and salt trucks were active at any single time during the Feb 17th – Feb 19th storm
- Plows generally operate after the majority of snowfall



Maintenance Facility Locations

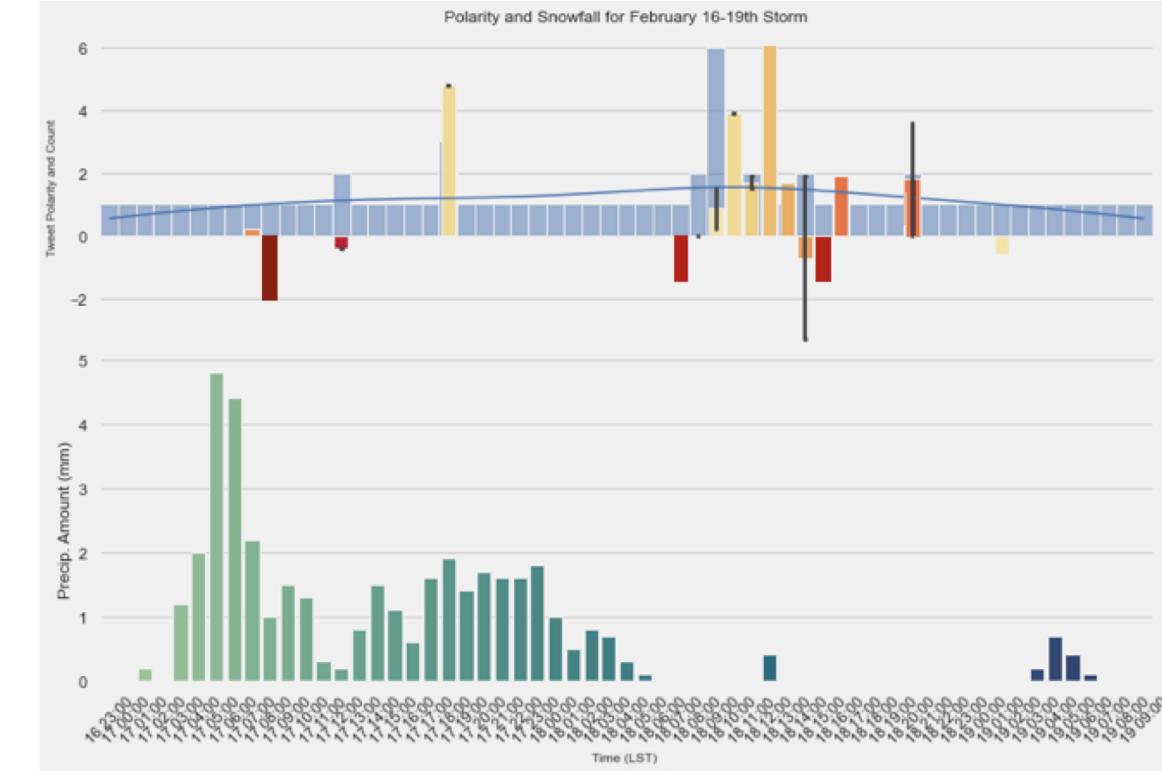




January Storm:

200 Mentions in Tweets
63% negative, 37% positive

@to_winterops @311toronto these guys are such liars and have terrible workers i have lived at my address 12 years I haven't seen anything like this



2nd February Storm:

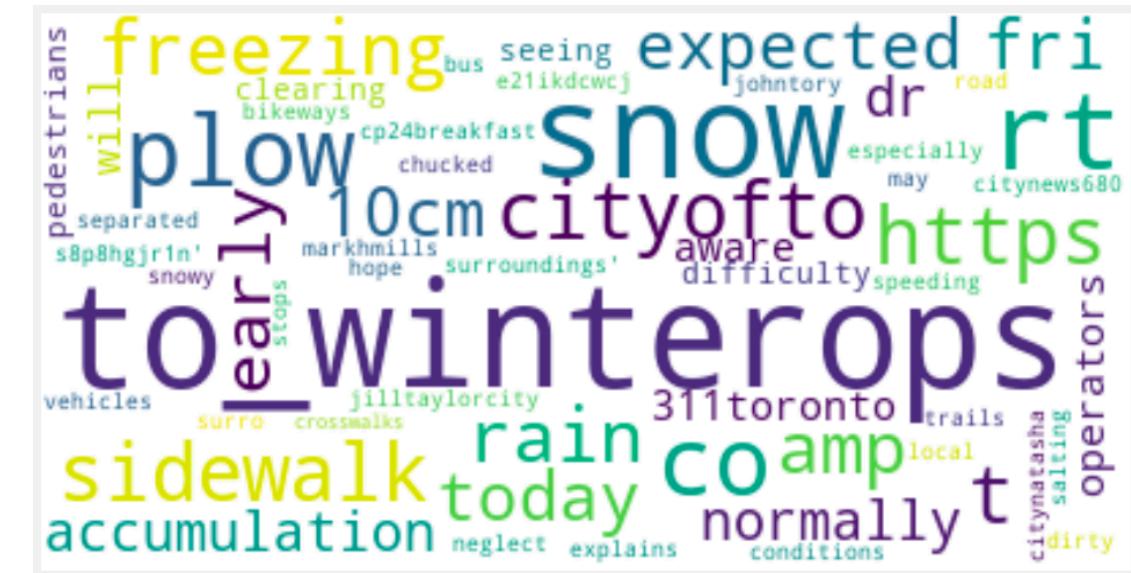
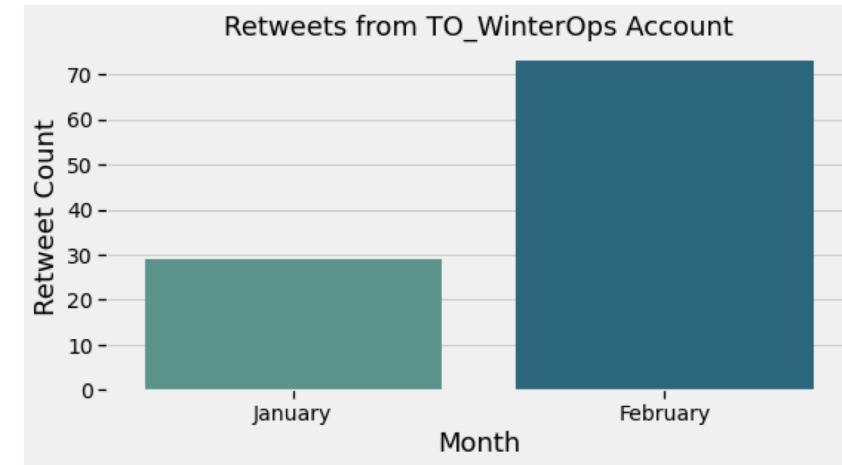
32 Mentions in Tweets
48% negative, 52% positive

@to_winterops @311toronto where can i complain about your asshat plow driver on front st and john clogging the corner



There was improvement of perception in February:

- More engagement by resharing City tweets
- In January storm, a lot of complaints about a road not being plowed
- In February storm, a lot of positive tweets focused on a road being plowed



Sentiment Analysis of TO_WinterOps cont



Conclusion:

- The city appears to have performed well in the February storms
- There seems to be a relationship between demographics and plowing behaviour
- Public perception of City generally improved since January storm

Future Work:

- Medium articles to cover Twitter, REST server access, and map creation
- Set up data server to collect and store data automatically
- Use dictionaries to extract locations from tweets, to add spatial element
- Assess the impact of other demographic information on plow performance

Thank You | Questions?



References

- City of Toronto. (2022). *January 16-17, 2022 Major Snow Event Post-Operational Report*. 32.
- Howes, N. (n.d.). *Epic January winter storm cost Toronto \$17+ million for snow removal*. Retrieved April 13, 2022, from <https://ca.news.yahoo.com/epic-january-winter-storm-cost-233439041.html>
- Ranger, M., & Casaleotto, L. (n.d.). “*Work is ongoing 24 hours a day*,” *Toronto snow removal continues after epic storm* | CityNews Toronto. Retrieved April 13, 2022, from <https://toronto.citynews.ca/2022/01/18/toronto-snow-removal-cleanup/>
- Tory, J. (2022, January 17). <https://toronto.ca/news/city-of-toronto-declares-major-snow-storm-condition-ahead-of-snow-removal-operations/> <https://t.co/6tHqyX7jNx> [Tweet]. Twitter. <https://twitter.com/JohnTory/status/1483224963553406980>