Pedaling Against Theft:

An Analysis of Bicycle Theft in the City of Toronto

CME538 – PRESENTED BY P^3, DECEMBER 2, 2024

Quick Fact

Did you know that over *3,000* bikes are reported stolen in Toronto each year? [1]

```python
def best_transportation_mode(convenience, cost_efficiency, environmental_impact, health_benefits):
    modes = {
        'bike': {'convenience': 7, 'cost_efficiency': 9, 'environmental_impact': 9, 'health_benefits': 10},
        'car': {'convenience': 8, 'cost_efficiency': 4, 'environmental_impact': 2, 'health_benefits': 1},
        'bus': {'convenience': 6, 'cost_efficiency': 7, 'environmental_impact': 6, 'health_benefits': 3},
        'subway': {'convenience': 8, 'cost_efficiency': 8, 'environmental_impact': 7, 'health_benefits': 2},
        'plane': {'convenience': 2, 'cost_efficiency': 1, 'environmental_impact': 1, 'health_benefits': 1},
    }

    scores = {}
    for mode, values in modes.items():
        score = (values['convenience'] * convenience +
                 values['cost_efficiency'] * cost_efficiency +
                 values['environmental_impact'] * environmental_impact +
                 values['health_benefits'] * health_benefits)
        scores[mode] = score

    # Find the mode with the highest score
    best_mode = max(scores, key=scores.get)
    return best_mode

convenience_weight = 0.25
cost_efficiency_weight = 0.25
environmental_weight = 0.25
health_benefits_weight = 0.25

best_mode = best_transportation_mode(convenience_weight, cost_efficiency_weight, environmental_weight, health_benefits_weight)
print(f"The best transportation mode is: {best_mode} !!!")
```

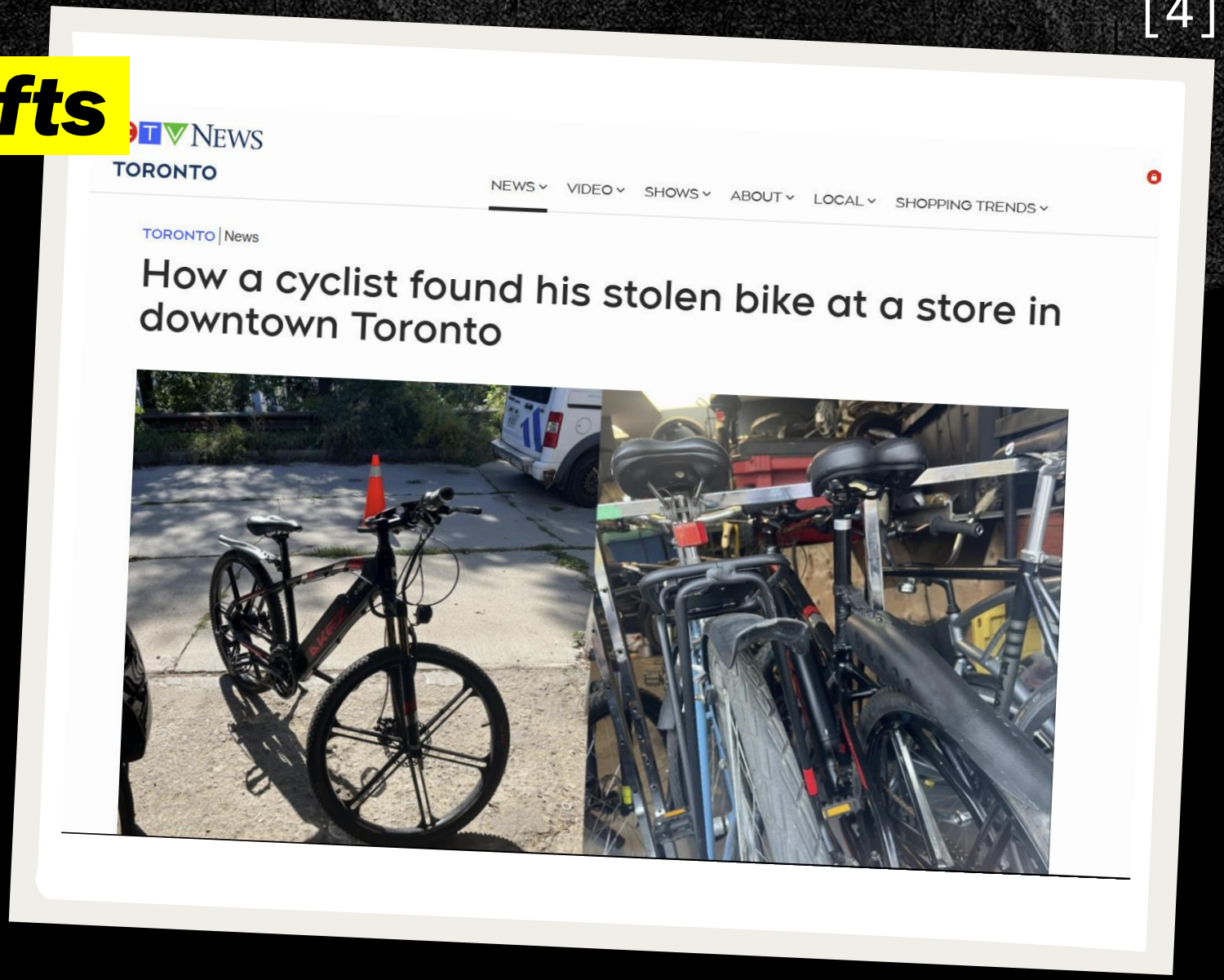
✓ 0.0s

```
The best transportation mode is: bike !!!
```

Why do we Need to Pay Attention to Bike Theft?

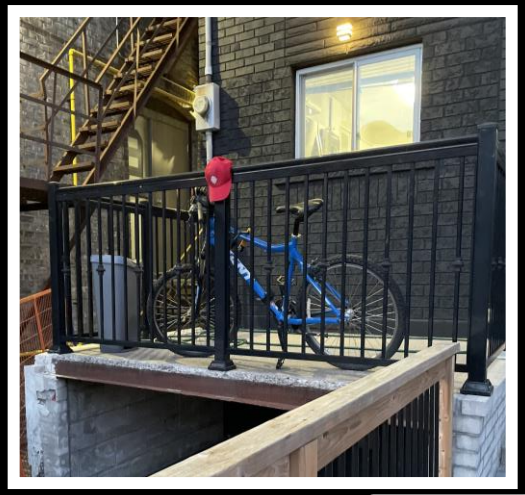
Why do Bike Thefts Occur?

- There is a prominent black market [2] for stolen bikes in the heart of Toronto.
- One infamous operation was the Queen West Bicycle Shop – which had stocked roughly 2,800 stolen bicycles [3].



Personal Experience

- Bikes can become a necessity for commuters aside from being a fun recreational activity [5].
- Jason – has experienced two instances of bicycle theft & has inadvertently contributed to the local bicycle black market scene.

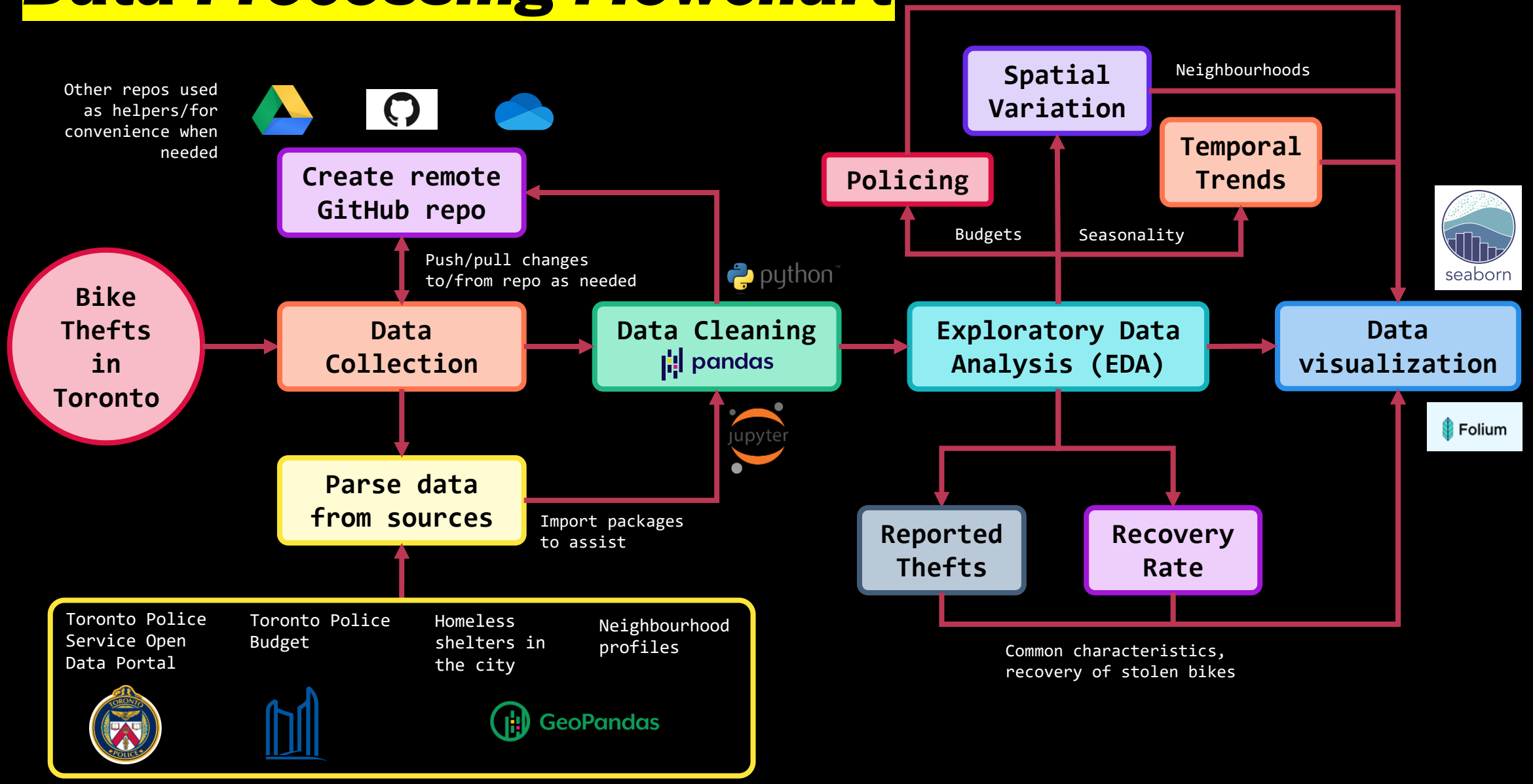


Data Overview

1. Toronto Police Services Bicycle Thefts Open Data [6]
2. Toronto Police Services Budget By Command Data [7]
3. Daily Shelter and Overnight Service Occupancy & Capacity – City of Toronto Open Data [8]
4. Neighbourhood Profiles – City of Toronto Open Data [9]

PRIMARY_OFFENCE	OCC_DATE	OCC_YEAR	OCC_MONTH
B&E	12/26/2013 5:00:00 AM	2013	December
THEFT UNDER	9/30/2013 5:00:00 AM	2013	September
THEFT UNDER	12/25/2013 5:00:00 AM	2013	December
THEFT UNDER	12/25/2013 5:00:00 AM	2013	December
THEFT UNDER	12/30/2013 5:00:00 AM	2013	December
HEFT UNDER	1/1/2014 5:00:00 AM	2014	January
HEFT UNDER	12/31/2013 5:00:00 AM	2013	December
HEFT UNDER	7/1/2013 5:00:00 AM	2013	July
HEFT UNDER	12/31/2013 5:00:00 AM	2013	December
EFT UNDER	1/4/2014 5:00:00 AM	2014	January
EFT UNDER	1/3/2014 5:00:00 AM	2014	January
THEFT UNDER	12/23/2013 5:00:00 AM	2013	December
THEFT FROM MOTOR VEHICLE UNDER	1/4/2014 5:00:00 AM	2014	January

Data Processing Flowchart



Analysis Methodology

TPS Budget & Bike Theft Data Collection:

- Accessed the TPS open data from TPS website
- Performed EDA on different relationships such as Number of Theft VS Neighborhoods, Number of Theft VS TOD, Number of Theft VS Month etc..
- The Budget Dataset was cleaned to exclude any revenue values – and analysis was performed only on 'Community Safety Command'

City of Toronto Shelter & Neighbourhood Data Collection:

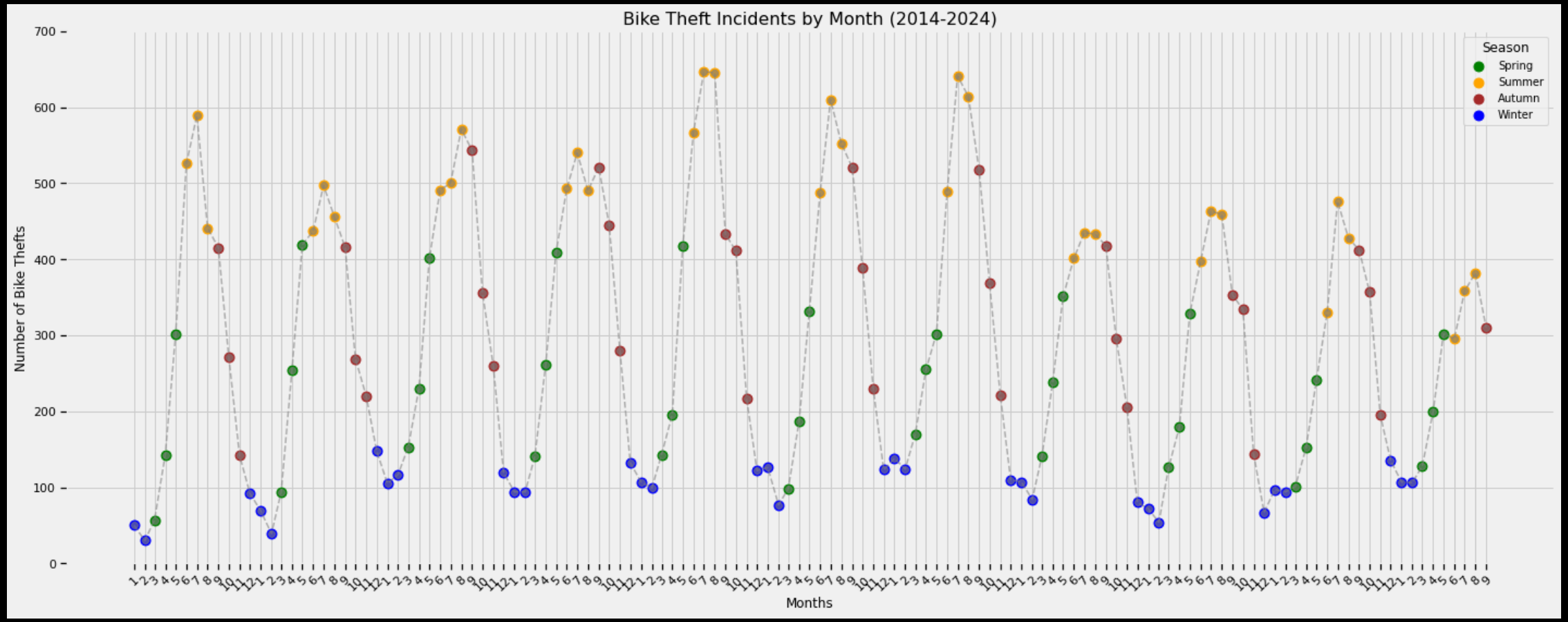
- Accessed the City of Toronto open data from City of Toronto website
- Performed data cleaning and selection. Grouped key metrics (Shelter usage rate, neighbourhood income, neighbourhood popular commuting methods) to support EDA of Bike Theft relationships.
- Point coordinates and Multipolygon coordinates used to create a Folium plot

Key Findings

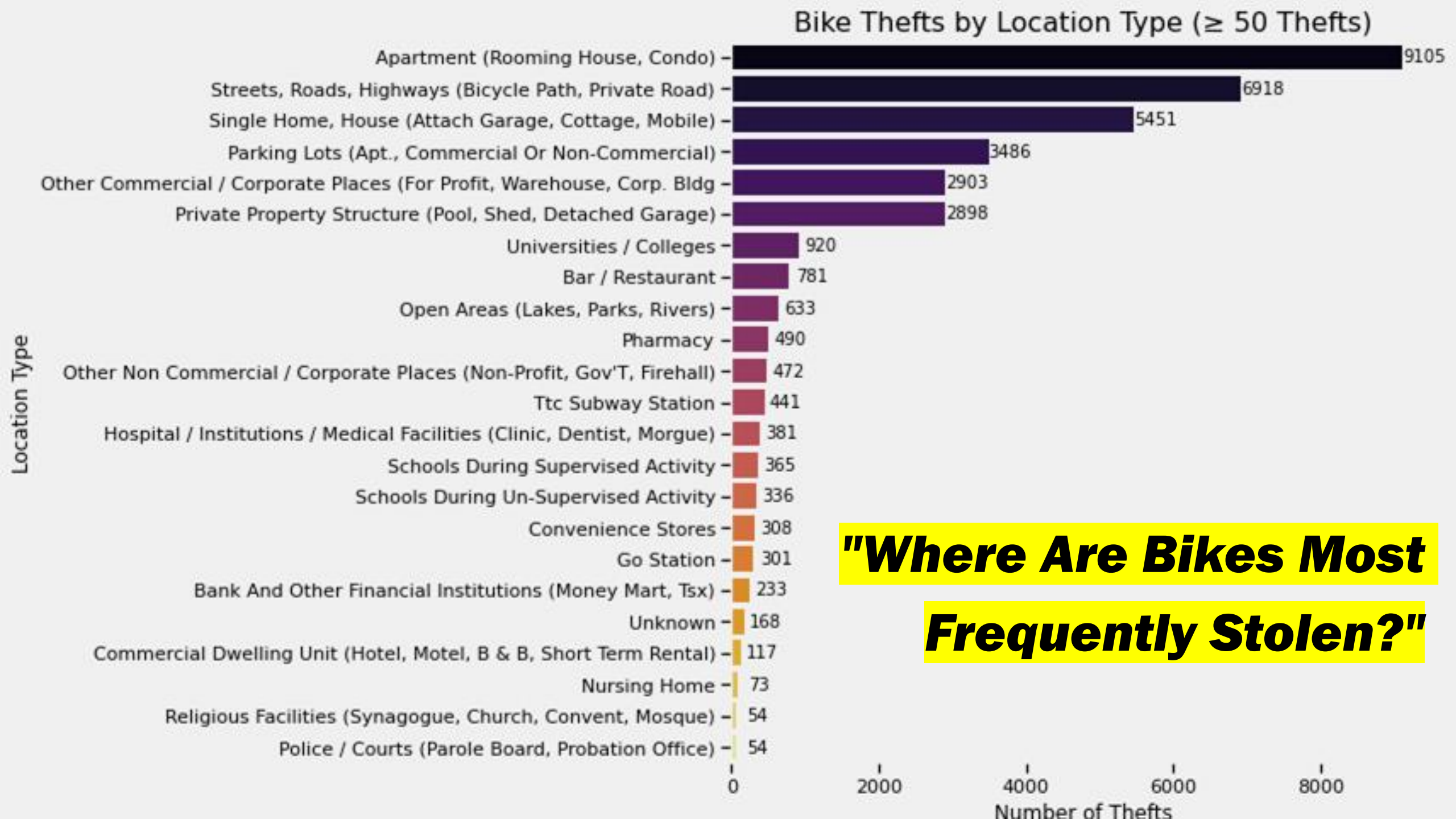

```
homeless_gdf = gpd.GeoDataFrame(
    homeless_coordinates,
    geometry=gpd.points_from_xy(homeless_coordinates['2'], homeless_coordinates['1'])  #'1' for x, '2' for y
)

#ensure 'neighbourhood_choro' is a GeoDataFrame with 'geometry' column
neighbourhood_gdf = gpd.GeoDataFrame(neighbourhood_choro, geometry='geometry')

#align CRS for both GeoDataFrames
if homeless_gdf.crs != neighbourhood_gdf.crs:
    homeless_gdf = homeless_gdf.set_crs(neighbourhood_gdf.crs, allow_override=True)

#sort neighborhoods by 'Number of Thefts' and get the top 10 area names
top_10_areas = neighbourhood_gdf.sort_values(by='Number of Thefts', ascending=False).head(10)['AREA_NAME'].tolist()

#GeoDataFrame filter to include only the top 10 neighborhoods
top_10_gdf = neighbourhood_gdf[neighbourhood_gdf['AREA_NAME'].isin(top_10_areas)]

#spatial join to check which shelters are within the top 10 neighborhoods
joined_gdf = gpd.sjoin(homeless_gdf, top_10_gdf, how="inner", op='within')


num_shelters_within = len(joined_gdf)

total_shelters = len(homeless_gdf)

#calculate the percentage
percentage_within = (num_shelters_within / total_shelters) * 100

print(f"Percentage of homeless shelters within top 10 neighborhoods: {percentage_within:.2f}%")
```

✓ 0.0s

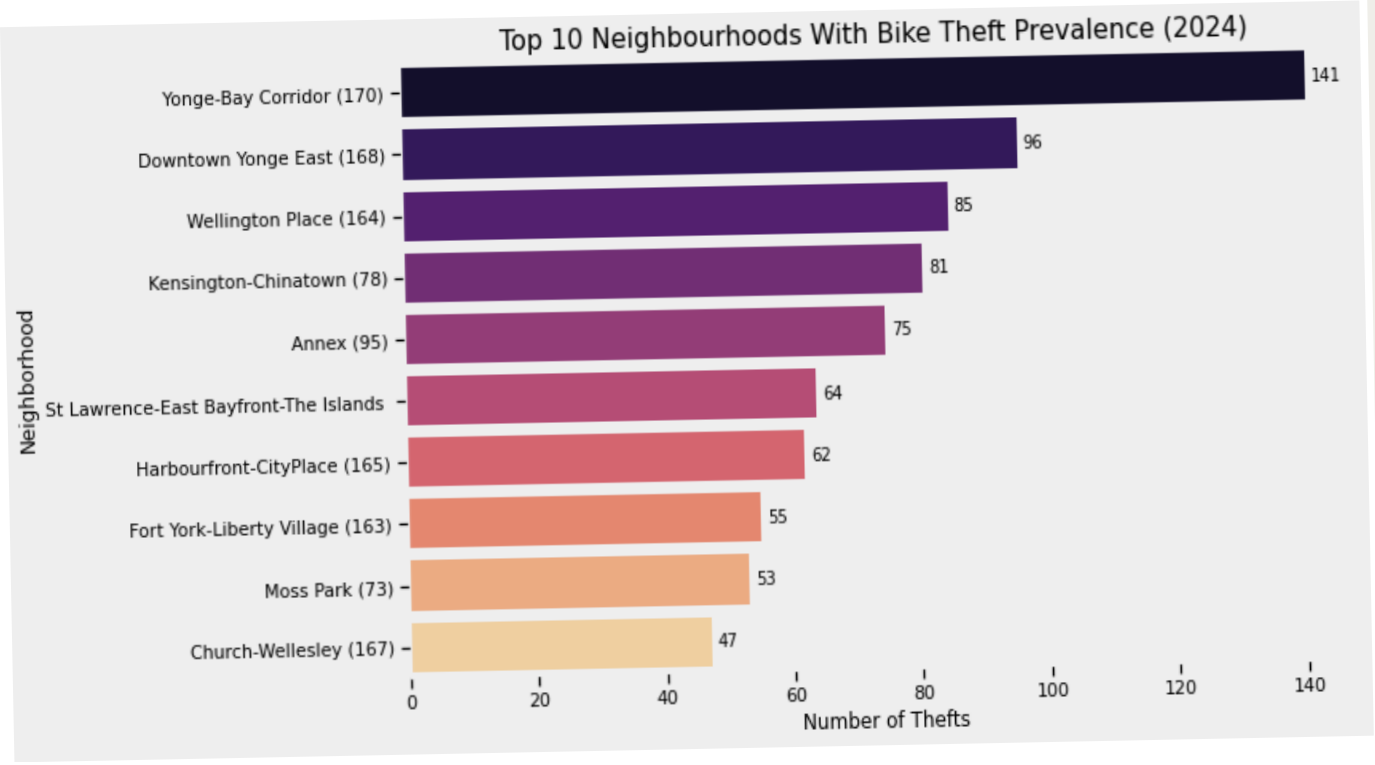
```
Percentage of homeless shelters within top 10 neighborhoods: 38.14%
```



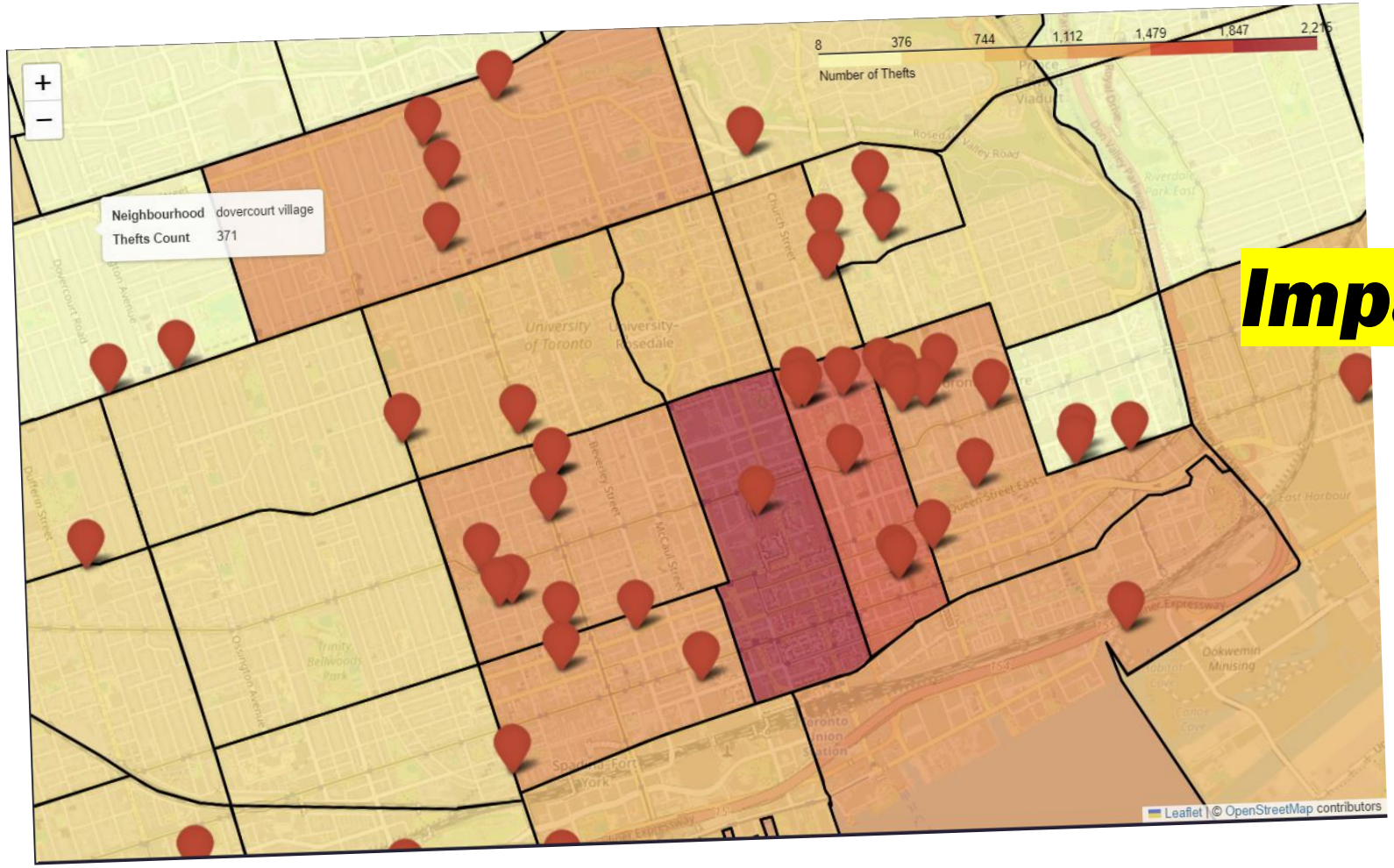
Visualizing Seasonal Trends in Bike Theft Incidents


Bike Thefts by Location Type (≥ 50 Thefts)
Location Type
Apartment (Rooming House, Condo)
9105
Streets, Roads, Highways (Bicycle Path, Private Road)
6918
Single Home, House (Attach Garage, Cottage, Mobile)
5451
Parking Lots (Apt., Commercial Or Non-Commercial)
3486
Other Commercial / Corporate Places (For Profit, Warehouse, Corp. Bldg
2903
Private Property Structure (Pool, Shed, Detached Garage)
2898
Universities / Colleges
920
Bar / Restaurant
781
Open Areas (Lakes, Parks, Rivers)
633
Pharmacy
490
Other Non Commercial / Corporate Places (Non-Profit, Gov'T, Firehall)
472
Ttc Subway Station
441
Hospital / Institutions / Medical Facilities (Clinic, Dentist, Morgue)
381
Schools During Supervised Activity
365
Schools During Un-Supervised Activity
336
Convenience Stores
308
Go Station
301
Bank And Other Financial Institutions (Money Mart, Tsx)
233
Unknown
168
Commercial Dwelling Unit (Hotel, Motel, B & B, Short Term Rental)
117
Nursing Home
73
Religious Facilities (Synagogue, Church, Convent, Mosque)
54
Police / Courts (Parole Board, Probation Office)
54
0
2000
4000
6000
8000
Number of Thefts
"Where Are Bikes Most Frequently Stolen?"

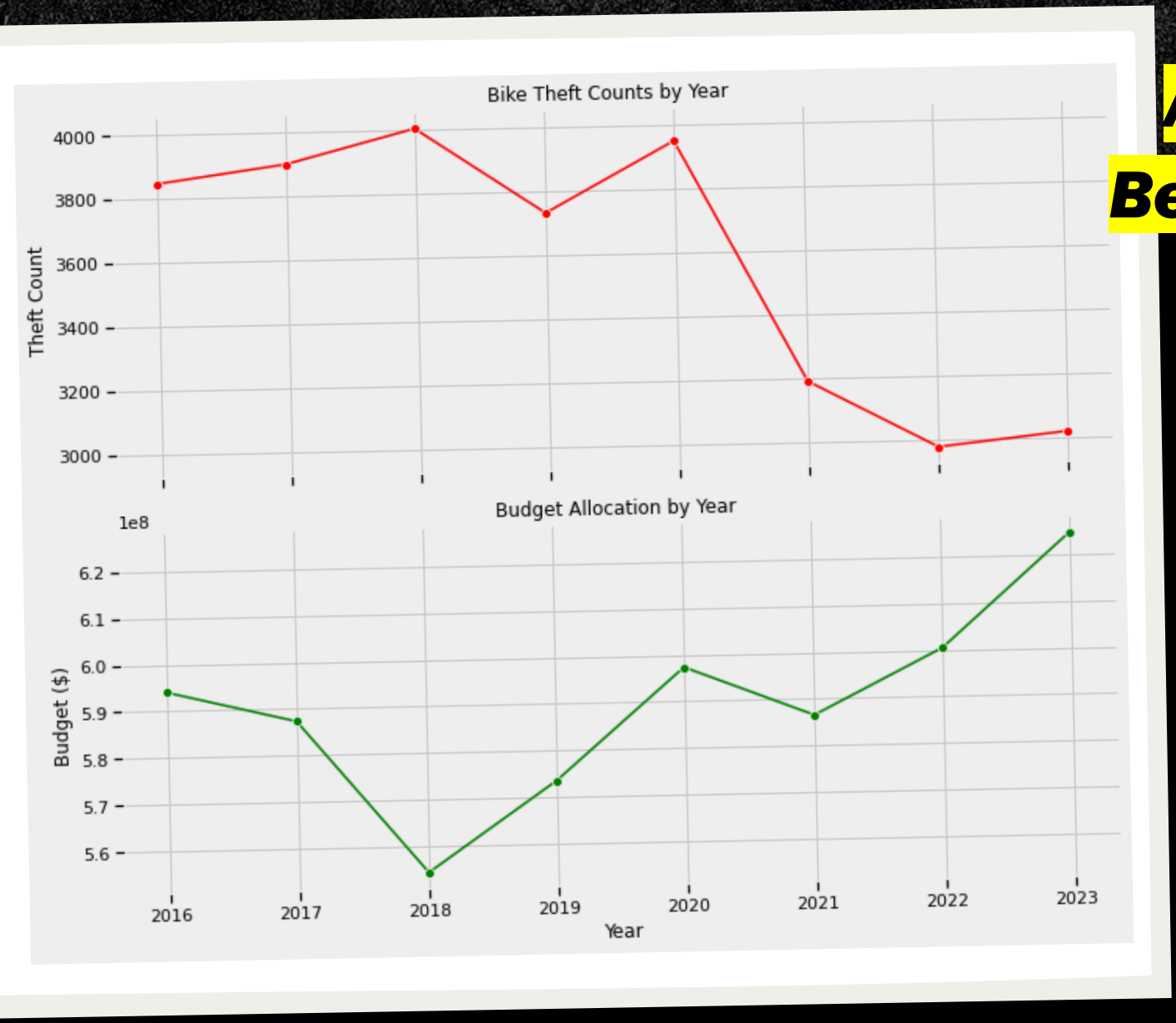
Bike Theft Hotspots in Toronto: Analyzing Neighborhood Vulnerabilities



- Commonalities among these neighborhoods include high population density, robust cycling infrastructure, proximity to transit hubs, and significant commercial and tourist activities. These factors make these areas prime targets for bike theft.



Impact of Homeless Shelters on Neighborhood Safety



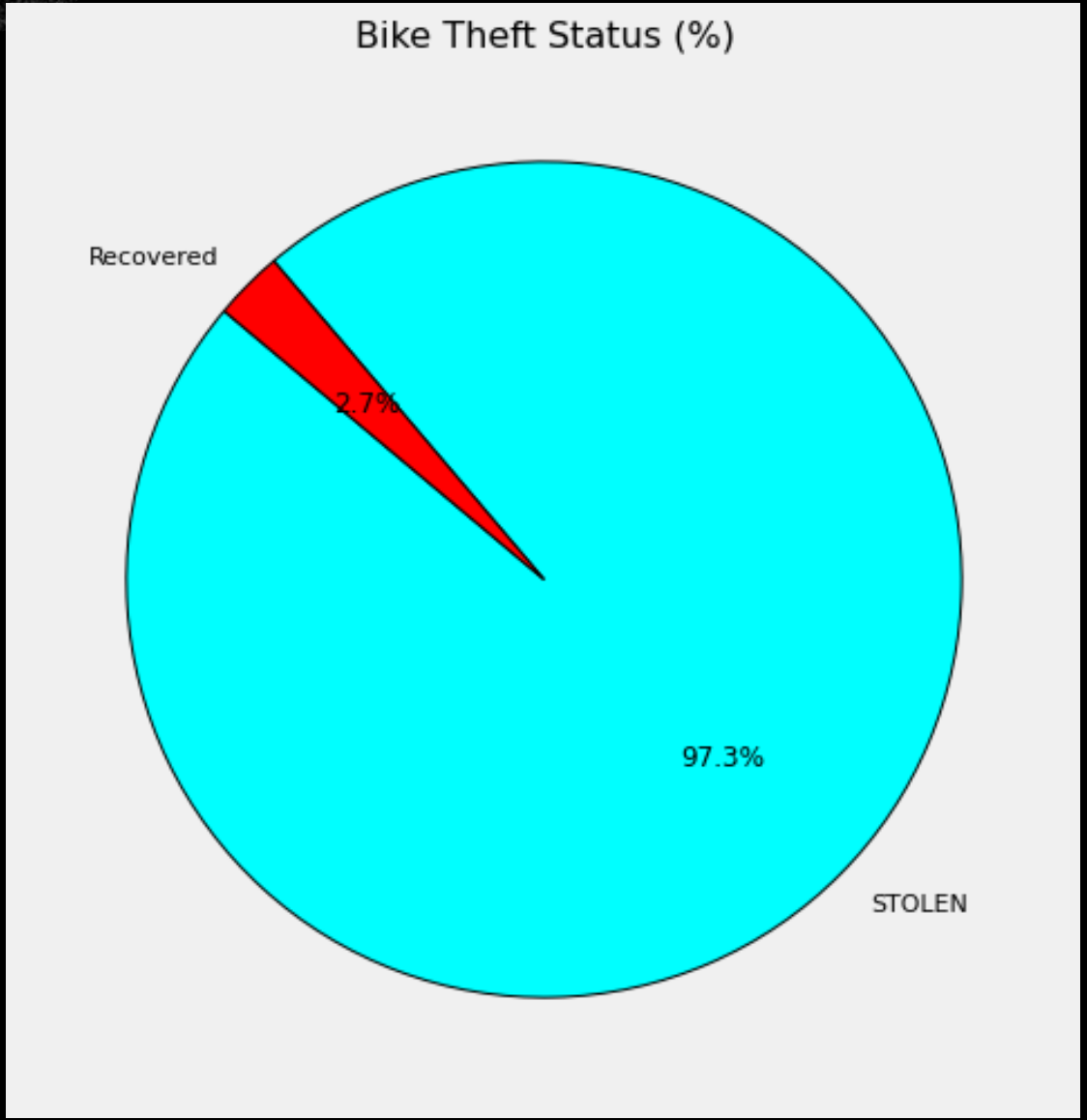
Analyzing the Correlation Between Budget Allocation and Bike Theft Counts

- This dual-axis line chart shows the yearly bike theft counts alongside the budget allocations for bike safety and theft prevention from 2016 to 2023.
- Notice the trends in how budget changes align with the increase or decrease in bike theft incidents.

Recovery of Stolen Bikes: A Significant Challenge

- The overwhelming majority, 97.3%, of stolen bikes remain unrecovered, underscoring the severity of the theft problem and the challenges in retrieval efforts.

- Improvements are discussed.



Recommendations

Enhanced Security

Registration and Tracking

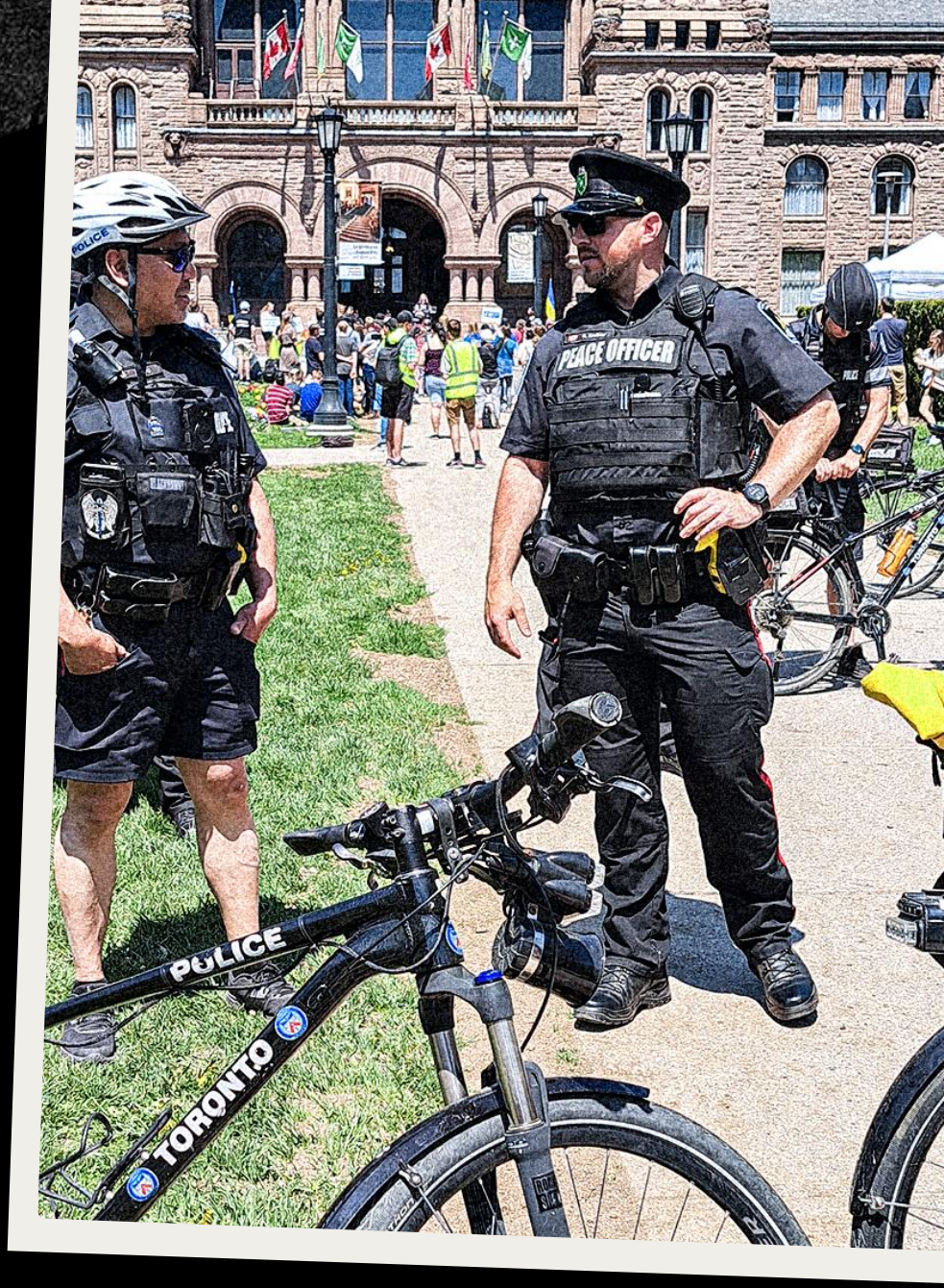
Policy and Legislation

Enhanced Security in Hotspots

- **Deploy more resources**: Increase police patrols and surveillance in bike theft hotspots during Spring and Summer, when thefts peak.

- **Community watch**: Encourage the formation or reinforcement of neighborhood watch programs specifically tailored to monitor bike theft.

- **Increase Police funding:** Additional patrols, specialized bike theft task forces, and advanced surveillance technology in high-risk areas.



Registration and Tracking

- **Bike registration programs:** Promote and possibly mandate the registration of bikes to create a deterrent for thieves and aid in the recovery process [10].

- **Use of GPS trackers:** Encourage cyclists to install GPS trackers on their bikes, which can help locate them if stolen.

Policy and Legal Framework Enhancement

- **Tougher Penalties and Fast-Track Courts**: Advocate for stricter penalties for bike theft and the establishment of fast-track courts to handle such cases, which could act as a deterrent.

- **Support and Compensation**: Consider policies for compensating victims of bike theft, possibly through community funds or insurance programs.

Conclusion

Thank You for Listening!

References

[1] TPS Crime Statistics - Bicycle Thefts. Available: https://data.torontopolice.on.ca/pages/c78364ab031747359fa8afb78febdd3d.

[2] 5 Factors That Can Contribute To Bike Theft. Available: https://www.handi-hut.com/5-factors-that-can-contribute-to-bike-theft/#:~:text=Inadequate%20Locking%20Mechanisms,and%20easy%20theft%20without%20complications.

[3] Bloor West Villager, "Queen West bike shop owner granted bail,“ Toronto.Com, 2008. Available: https://www.toronto.com/life/queen-west-bike-shop-owner-granted-bail/article_7704752b-b25c-5eab-ac5b-79861fb1bdb9.html.

[4] A. Arsenych, "How a cyclist found his stolen bike at a store in downtown Toronto," CTV News Toronto, 2023. Available: https://toronto.ctvnews.ca/how-a-cyclist-found-his-stolen-bike-at-a-store-in-downtown-toronto-1.6592183.

[5] N. Brockbank, "Here's where your bike is most likely to get stolen in Toronto," CBC, 2017. Available: https://www.cbc.ca/news/canada/toronto/worst-toronto-neighbourhoods-bike-theft-1.4421633.

[6] (Sep 18). Bicycle Thefts Open Data. Available: https://data.torontopolice.on.ca/datasets/TorontoPS::bicycle-thefts-open-data/about.

[7] (Sep 18). Public Safety Data Portal - Budget by Command. Available: https://data.torontopolice.on.ca/datasets/TorontoPS::budget-by-command/explore.

[8] (Nov 28). Daily Shelter & Overnight Service Usage. Available: https://www.toronto.ca/city-government/data-research-maps/research-reports/housing-and-homelessness-research-and-reports/shelter-census/.

[9] Neighbourhood Profiles. Available: https://www.toronto.ca/city-government/data-research-maps/neighbourhoods-communities/neighbourhood-profiles/.

[10] Bicycle Registration. Available: https://www.tps.ca/services/bicycle-registration/.