

Allan Salamanca April 27, 2025

MLS Home Price Index (HPI)

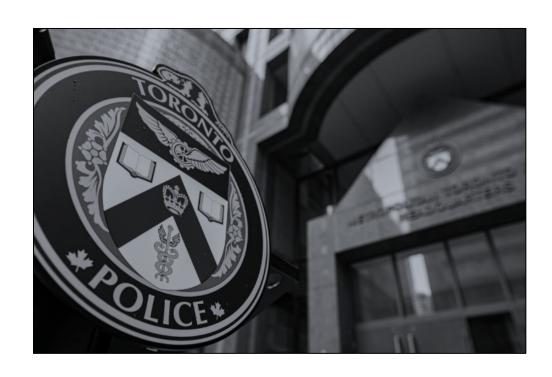


- Established by the Canadian Real Estate Association (CREA) to gauge home price levels and trends.
- Based on four property types, detached, semi-detached, townhouse and apartment.



TPS - Major Crime Indicators (MCI)





• 5 crime categories that include: Assault, Break and Enter, Auto Theft, Robbery and Theft.

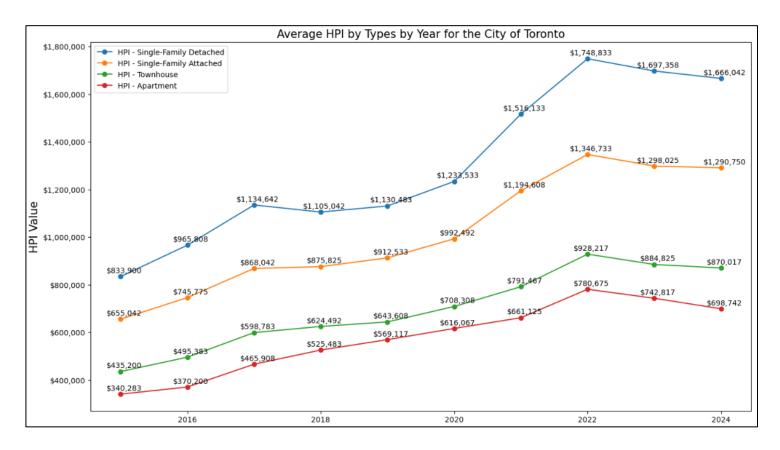
Problem Area



Home Prince Index in Toronto have increased 8% YoY from 2015 to 2024.

At the end of 2024, HPI for properties in Toronto:

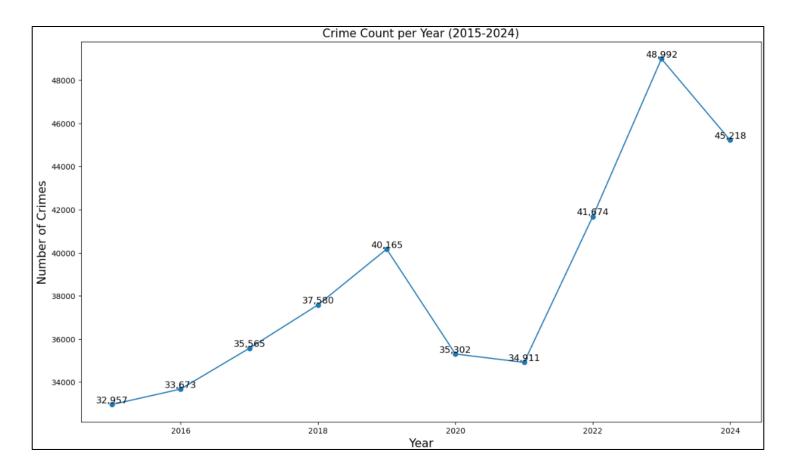
- Detached \$1.6M
- Semi-detached \$1.2M
- Townhouse \$850K
- Apartments \$670K



Problem Area



Major crime incidents have increased 4% YoY in Toronto from 2015 to 2024.



Problem Area: Data Solution



- Understand what factors affect HPI values.
- 2. Develop a linear regression model that can predict HPI values by Time Period, Crime Incidents, Property Type and Neighborhoods (Municipality Code).

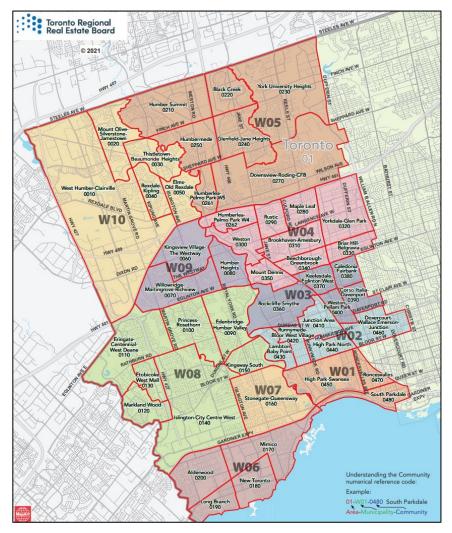
Objective:

Select the neighbourhoods with the best return on investment

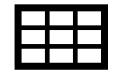
Data Preprocessing



- Data Sets:
 - Toronto Home Price Index
 - Toronto Major Crime Incidents
 - Toronto Neighbourhood Index
- Joined 3 data sets to create a master data frame based on unique neighbourhoods to a municipality code.
- Dummies created for categories: property type and neighbourhood.
- Imputed missing data using KNN, for Townhouses in specific neighbourhoods.



Data Preprocessing



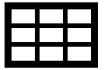
Data Summary - 16,800 rows & 45 columns

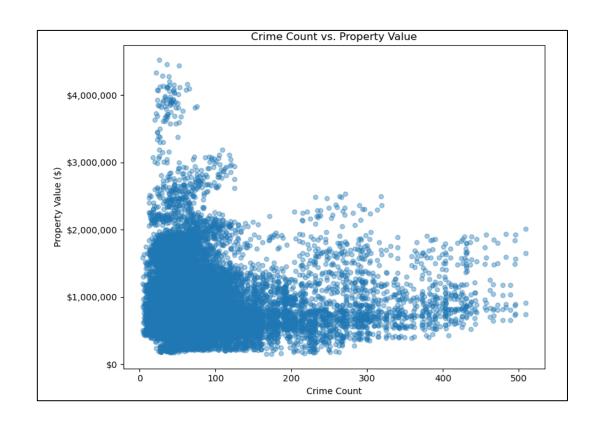
Dependent Variable - Value (HPI)

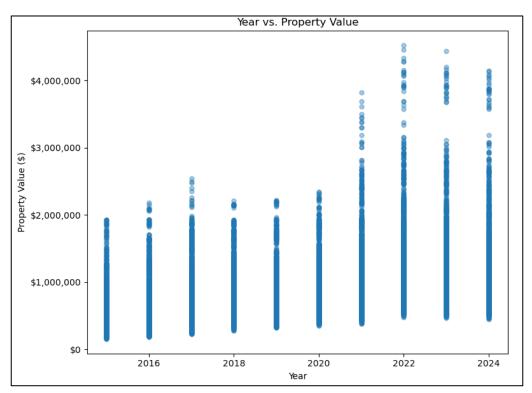
Independent Variables: Year, Crime Count, Property Type (Attribute) and Neighbourhood (Toronto Municipality)

Attribute_HPI - Single- Family Detached	Attribute_HPI - Townhouse		Month	Toronto Municipality_Toronto C01	Toronto Municipality_Toronto C02	Toronto Municipality_Toronto C03	Toronto Municipality_Toronto W04	Toronto Municipality_Toronto W05	Toronto Municipality_Toronto W06	Toronto Municipality_Toronto W07	Toronto Municipality_Toronto W08	Toronto Municipality_Toronto W09	Toronto Municipality_Toronto W10	Value	Year
1.0	0.0	44.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	849400.0	2015.0
0.0	0.0	44.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	677500.0	2015.0
0.0	1.0	44.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	415100.0	2015.0
0.0	0.0	44.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	326300.0	2015.0
1.0	0.0	62.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	805300.0	2015.0
0.0	0.0	56.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	486100.0	2024.0
1.0	0.0	58.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1062900.0	2024.0
0.0	0.0	58.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	885800.0	2024.0
0.0	1.0	58.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	709300.0	2024.0
0.0	0.0	58.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	500300.0	2024.0

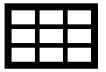
Exploratory Data Analysis

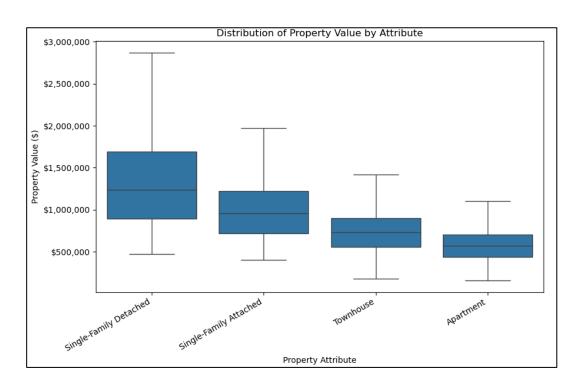


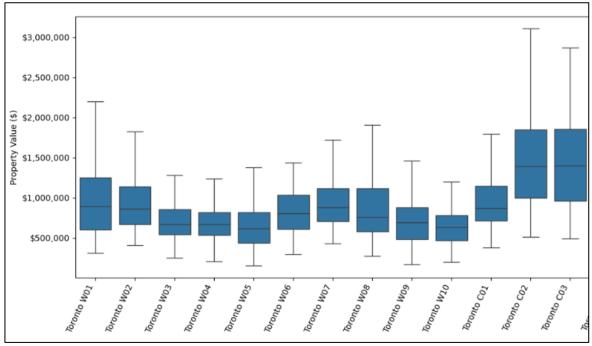




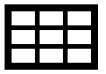
Exploratory Data Analysis







Exploratory Data Analysis



			Correlation Matrix															۲	7											
Attribute_HPI - Apartment - 100 0.33	-0.33 -0.33	-0.00 0.00	-0.00 -0.	00 -0.00	-0.00 -0	.00 -0.00	0.00	-0.00 0	0.00	0.00	0.00 0.	.00 0.0	0.00	0.00 0.0	0.0	0.00	0.00 -0.	0.00	0.00	0.00 0.	00 -0.00	-0.00	-0.00	0.00 0.	0.0-0.0	0 -0.00	-0.00	-0.00 -0.	00 -0.40	0.00
Attribute_HPI - Single-Family Attached -0.33 1.00	-0.33 -0.33	0.00 0.00	-0.00 -0.	00 -0.00	-0.00 -0	.00 -0.00	0.00	0.00 0	0.00 0.00	0.00	0.00 0.	.00 0.0	0.00	0.00 0.0	0.0	0.00	0.00 0.0	0.00	0.00	0.00 0.	00 -0.00	-0.00	-0.00	-0.00 -0	00 -0.0	0 -0.00	-0.00	-0.00 -0.	0.08	0.00
Attribute_HPI - Single-Family Detached - 0.33 0.33	1.00 -0.33	0.00 0.00	-0.00 -0.	00 -0.00	-0.00 -0	.00 -0.00	-0.00	-0.00 -0	0.00 -0.00	-0.00	-0.00 -0	.00 0.0	0.00	0.00 0.0	0.0	0.00	0.00 0.0	0.00	0.00	0.00 0.	00 -0.00	-0.00	-0.00	-0.00 -0	00 -0.0	0 -0.00	-0.00	-0.00 -0.	0.49	000
Attribute_HPI - Townhouse - 0.33 0.33	-0.33 1.00	0.00 0.00	-0.00 -0.	00 -0.00	-0.00 -0	.00 -0.00	0.00	0.00 0	0.00	0.00	0.00 0.	.00 0.0	0.00	0.00 0.0	0.0	0.00	0.00 0.0	0.00	0.00	0.00 0.	00 -0.00	-0.00	-0.00	-0.00 -0	00 -0.0	0 -0.00	-0.00	-0.00 -0.	-0.17	000
Crime Count - 0.00 0.00	0.00 0.00	1.00 0.05	0.65 -0.	03 -0.09	-0.05 -0	.13 -0.03	0.35	-0.14 -0).12 -0.11	-0.14	-0.07 -0	.09 -0.0	3 -0.03	-0.08 0.0	00 0.1	2 -0.07	-0.10 -0.	0.05	0.04	-0.06 -0	05 -0.0	0.00	-0.05	0.11 0.	39 -0.0	1 -0.16	0.05	-0.10 0.3	-0.05	014
Month - 0.00 0.00	0.00 0.00	0.05 1.00	0.00 0.	00 0.00	0.00 0.	.00 0.00	0.00	0.00 0	0.00	0.00	0.00 0.	.00 0.0	0.00	0.00 0.0	0.0	0.00	0.00 0.0	0.00	0.00	0.00 0.	00 -0.00	0.00	0.00	0.00 0.	0.0	0.00	0.00	0.00 0.0	0.02	-0.00
Toronto Municipality_Toronto C01 - 0.00 4.00	-0.00 -0.00	0.65 0.00	1.00 -0.	03 -0.03	-0.03 -0	0.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.01	-d 00
Toronto Municipality_Toronto C02 - 0.00 0.00	-0.00 -0.00	-0.03 0.00	-0.03 1.	00 -0.03	-0.03 -0	0.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.18	-0.00
Toronto Municipality_Toronto C03 - 0.00 0.00	-0.00 -0.00	-0.09 0.00	-0.03 -0.	03 1.00	-0.03 -0	0.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	0.0	3 -0.03	-0.03 -0.	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.16	-0.00
Toronto Municipality_Toronto C04 - 0.00 0.00	-0.00 -0.00	-0.05 0.00	-0.03 -0.	03 -0.03	1.00 -0	.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.0	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.10	-0.00
Toronto Municipality_Toronto C06 - 0.00 0.00	-0.00 -0.00	-0.13 0.00	-0.03 -0.	03 -0.03	-0.03 1	.00 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.	0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	03 -0.01	-d 00
Toronto Municipality_Toronto C07 - 0.00 0.00	-0.00 -0.00	-0.03 0.00	-0.03 -0.	03 -0.03	-0.03 -0	0.03 1.00	-0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.01	-0.00
Toronto Municipality_Toronto C08 - 0.00 0.00	-0.00 0.00	0.35 0.00	-0.03 -0.	03 -0.03	-0.03 -0	0.03 -0.03	1.00	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.0	0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.06	-0.00
Toronto Municipality_Toronto C09 - 0.00 0.00	-0.00 0.00	-0.14 0.00	-0.03 -0.	03 -0.03	-0.03 -0	.03 -0.03	3 -0.03	1.00 -0	0.03 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	0.0 0.0	3 -0.03	-0.03 -0.0	0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.24	-0.00
Toronto Municipality_Toronto C10 - 0.00 0.00	-0.00 0.00	-0.12 0.00	-0.03 -0.	03 -0.03	-0.03 -0	.03 -0.03	3 -0.03	-0.03 1	.00 -0.03	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	0.0	3 -0.03	-0.03 -0.	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.08	-d00
Toronto Municipality_Toronto C11 - 0.00 0.00	-0.00 0.00	-0.11 0.00	-0.03 -0.	03 -0.03	-0.03 -0	0.03 -0.03	3 -0.03	-0.03 -0	0.03 1.00	-0.03	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	0.0	3 -0.03	-0.03 -0.	0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.02	-0.00
Toronto Municipality_Toronto C12 - 0.00 0.00	-0.00 0.00	-0.14 0.00	-0.03 -0.	03 -0.03	-0.03 -0	0.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	1.00	-0.03 -0	.03 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.19	-0.00
Toronto Municipality_Toronto C13 - 0.00 0.00	-0.00 0.00	-0.07 0.00	-0.03 -0.	03 -0.03	-0.03 -0	0.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	1.00 -0	.03 -0.0	3 -0.03	-0.03 -0.	0.0	3 -0.03	-0.03 -0.	0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.00	-0.00
Toronto Municipality_Toronto C14 - 0.00 0.00	-0.00 0.00	-0.09 0.00	-0.03 -0.	03 -0.03	-0.03 -0	0.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 1	.00 -0.0	3 -0.03	-0.03 -0.	03 -0.0	3 -0.03	-0.03 -0.	0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0	03 -0.0	3 -0.03	-0.03	-0.03 -0.	0.08	-0.00
Toronto Municipality_Toronto C15 - 000 000	0.00 0.00	-0.03 0.00	-0.03 -0.	03 -0.03	-0.03 -0	.03 -0.03	3 -0.03	-0.03 -0	0.03 -0.03	-0.03	-0.03 -0	.03 1.0	0 -0.03	-0.03 -0.	0.0	3 -0.03	-0.03 -0.	3 -0.03	-0.03	-0.03 -0	03 -0.03	3 -0.03	-0.03	-0.03 -0	0.0-0.0	3 -0.03	-0.03	-0.03 -0.	0.00	-0.00

Baseline Modelling



Standard Scaler & Linear Regression

• Train score: 77%

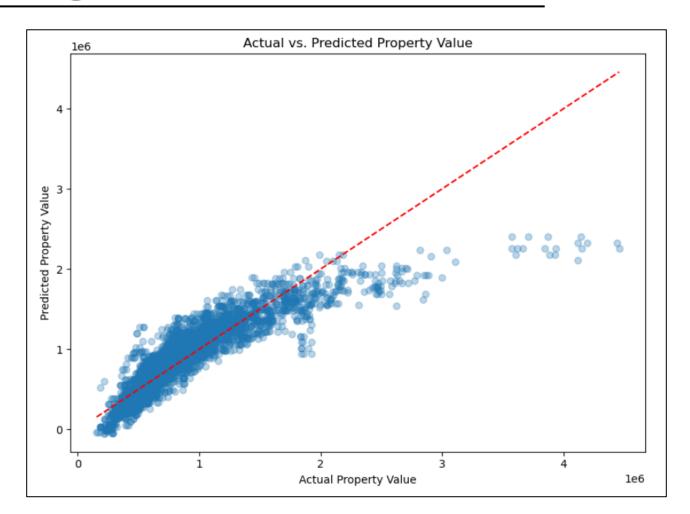
• Test score: 77%

• Test RMSE: \$247K

• Test MAE: \$167K

OLS Results

- R-Squared 0.771
- No p-value > 0.05



Next Steps



- Poor RMSE and MAE scores.
- Review wide data set when it comes to HPI values log/scale.
- Compare and asses more advanced modelling, such as RandromForestRegressor, DecisionTreeRegressor or XGBoost.
- Hyperparameter Tuning.