# **capstone project:**

**Housing Affordability in Canada**

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**Table of Contents**

[Introduction 3](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Toc90833398)

[Focus 4](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Introduction_1)

[Motivation & Background 6](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Motivation_&_Background)

[Methodology 7](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Methodology)

[Results](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Result) 11

[Discussion](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_DIscussion) 14

[Challenges](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Challenges) 14

[Conclusion](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Conclusion) 14

[Contributes 1](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_Contribution)5

[Appendices 1](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_References)5

[References 1](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_References)5

# **[Introduction](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_Introduction)**

* One of the primary drivers of housing affordability issues in Canada is the imbalance between supply and demand. There simply aren't enough homes to meet the needs of Canadians, particularly in urban centers where populations are growing rapidly. This has led to bidding wars and skyrocketing prices, putting homeownership out of reach for many Canadians.
* Another factor that has contributed to Canada's housing affordability crisis is foreign investment. Wealthy individuals and corporations from around the world have been investing heavily in Canadian real estate, driving up prices and making it even harder for Canadians to afford a home.
* Housing affordability issues are not limited to low-income households. Even middle-class families are struggling to keep up with rising housing costs, as wages have not kept pace with the cost of living. This has led to a growing gap between the rich and poor, with many Canadians being priced out of their own communities.
* The preference for single-family homes over high-rises has also contributed to Canada's housing affordability crisis. As more and more Canadians seek out larger homes in suburban areas, the cost of land and construction has increased, making it more difficult to build affordable housing in urban centres where it's needed most.
* Housing affordability is a pressing issue in Canada, affecting renters, homeowners, and property buyers across all income levels, including the middle class.
* Housing costs in Canada have significantly risen over the last decade, making it difficult for many Canadians to obtain and maintain appropriate accommodation.
* Housing affordability will worsen over time due to a scarcity of dwellings, a preference for single-family homes over high-rises, and rising mortgage rates.
* To appreciate Canada's future housing affordability and identify the cities most likely to have a housing crisis, research is necessary.
* This presentation will look at the elements that are contributing to Canada's housing affordability problems and suggest potential remedies.

# **[FOcus](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_FOcus)**

**Factors Influencing Housing Affordability in Canada**

* Multiple factors, including land cost, housing availability, building prices, finance costs, and government regulations such as zoning and taxation, collectively influence home affordability in Canada.
* Notably, the significant rise in land prices in recent years has posed challenges for Canadians seeking to purchase homes.

**Potential Solutions to Improve Housing Affordability in Canada**

* Several options can be considered to increase home affordability in Canada, including increasing the availability of affordable housing, reducing land costs, and implementing incentives to promote the construction of affordable homes.
* Furthermore, the government can implement policies that minimize the cost of borrowing and give tax breaks to stimulate the creation of affordable housing. These policies have the potential to make housing more affordable for Canadians.
* **Attributes:**

**Frequency: Monthly**

**Table: 18-10-0205-01 (formerly CANSIM 327-0056)**

**Release date: 2022-05-19**

**Geography: Canada, Geographical region of Canada, Province or territory, Census metropolitan area, Census agglomeration**

**Population to dwellings data:**

**Provides population and housing numbers for several areas in 2021.**

**Structure to dwelling data:**

**Provides the number of homes, the number of people living in those units, and the average household size for the year 2021.**

* **Consumer Price Index(CPI) inflation data:**
* **Range : 1911 - 2021, by region**
* **Population data:**

**Range: 1946- 2022, by region**

* **Data on housing supply, price, and rental rates:**

**It includes csv files for 34 cities.**

**Range - 1990 – 2016**

**Provides information on new developments, rental rates, and vacancy rates.**

# **[Motivation & Background](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_Motivation_&_Background)**

# **[METHODOLOGY](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_Methodology)**

Our main Objectives are,

* Data collecting
* Data Cleaning
* EDA
* ML model Creation

1. Hyperparameter Tunning

* Hypothesis Test
* Flask Framework (Deployment)

**Data Collecting:**

**Data Cleaning**:

**Exploratory Data Analysis (EDA):**

1. Using our historical data, we compared the rent of houses over the course of three decades, there was a consistent upward trend in the rental rates for one-bedroom, two-bedroom, and three-bedroom houses.

Chart

Description automatically generatedChart

Description automatically generated

Chart

Description automatically generated

1. The pie chart depicts the distribution of various types of houses built in Canada, including single detached, multiple, semi-detached, row and apartment dwellings. These dwellings are classified as single detached, multiple, semi-detached, row, and flat in Ottawa. Ottawa has a total proportion of residences of 23.95%.

Graphical user interface, chart, application, Excel, pie chart

Description automatically generated

1. The time series chart displays completed housing units and residential building permits over time, including a forecast for future housing completions based on historical data.

The chart also features an average number of completed housing units per year with a reference line. This information is valuable for making informed decisions on housing investment and development.

We also forecast estimates a total of 1,320,171 permitted units for 2027.

A picture containing chart

Description automatically generated

1. The line chart displays the annual average change in the Home Price Index (HPI) over time. The forecast line depicts an expected rising trend in average housing prices, with a 1.67 percent increase in 2023. However, there is some ambiguity, emphasizing the possible variety in future house price adjustments.

**Chart, line chart

Description automatically generated**

1. The plot demonstrates the positive relationship between the migration rate and the change in disposable income in several locations, with data points characterized by color coding. It means that regions with bigger fluctuations in disposable income have higher migration rates. In particular, the Disposable Income in Ottawa is significantly greater (232.9), accompanied by proportionally higher Migration of 96,84,175.50.

A picture containing chart

Description automatically generated

1. The figure implies that places with higher rental availability rates are likely to have bigger disposable income changes, although the data is not consistent. Saskatoon, for example, had a rental availability rate of 13.00 and a disposable income rate of 2.84 in 2021, but Abbotsford had a lower rental availability rate of 0.80 but a higher disposable income rate of 5.10.

Chart, scatter chart

Description automatically generated

1. The graph illustrates notable fluctuations in interest rates and mortgage rates over the past few decades, encompassing periods of both low and high rates. This underscores the dynamic nature of these rates in the market.

Moreover, based on the graph, it is evident that interest rates are projected to increase in the year 2023, which is expected to impact mortgage rates, resulting in an upward trend in 2023.

**Chart

Description automatically generated**

**ML Model Creation:**

* The first step in creating a machine learning model is to import the essential libraries. The dataset is then imported into the model.
* The feature variables are identified as the interest rate and the change in the HPI (Housing Price Index), while the target variable is specified as the mortgage rate. This methodical technique lays the groundwork for the following steps in the machine learning model construction process.

Graphical user interface, text, application, email

Description automatically generated

* Splitting the dataset into training and testing subsets is a typical practice in machine learning to evaluate the model's performance on unknown data and avoid overfitting.
* The 80:20 split used in this example is a common split, but it can be changed to meet the specific needs of the problem at hand.
* Furthermore, using random state to establish a random seed ensures that the same split is produced every time the code is executed, making the results reproducible.

Application

Description automatically generated

* We have utilized the regression technique for developing machine learning models, as our dataset comprises continuous values and our objective is to predict mortgage rates as numeric values.
* We have chosen to build five machine learning models, namely Linear Regression, Gradient Boosting, Decision Tree, Random Forest, and Artificial Neural Network (ANN) model.
* In the regression method, we have utilized a total of four metrics for evaluation, which are as follows:
  1. MAE (Mean Absolute Error)
  2. MSE (Mean Square Error)
  3. RMSE (Root Mean Square Error)
  4. R-Square (Coefficient of Determination)

Text

Description automatically generated

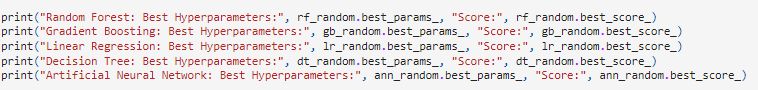
* Based on our KPI which is R-square score we determined that Gradient Boosting Regressor Model is the best model as it gives the the score 0.986222 which is close to 1 because in R-square the score is considered best if it is close to 1.

**Hyperparameter tuning:**

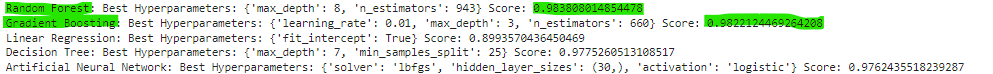
* The process of hyperparameter tuning involves trying out different combinations of hyperparameters and evaluating the model's performance on a validation set.
* We used RandomizedSearchCV method for hyperparameter tuning that is similar to GridSearchCV, but instead of trying all possible combinations of hyperparameters, it samples a fixed number of combinations from a distribution of hyperparameters.

A picture containing scatter chart

Description automatically generated



* The goal of hyperparameter tuning is to find the set of hyperparameters that gives the best performance on the validation set.



**Hypothesis Test:**

Hypothesis: There is a significant relationship between the interest rate and HPI and the mortgage rate in Canada.

To test this hypothesis, we will use a multiple regression model with the interest rate and HPI as predictor variables and the mortgage rate as the response variable. We will fit the model using the OLS method from the stats model’s library and conduct a hypothesis test on the regression coefficients.

If the hypothesis is supported by the data, we can use the regression model to predict the mortgage rate based on changes in the interest rate and HPI. This could be useful for lenders, investors, and policymakers to make informed decisions about mortgage lending and housing market trends.

Graphical user interface, text

Description automatically generated

**Flask Framework:**

We deploy our web application using flask framework. Flask is a popular web framework for building web applications in Python. It is a lightweight and flexible framework that provides a simple way to handle web requests and responses.

**Front end:**

We design our front-end using HTML and CSS.

Graphical user interface, application, website

Description automatically generated

**Back end:**

Graphical user interface, text, application, email

Description automatically generated

# **[Result](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_Result)**

Graphical user interface, text, application, chat or text message

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# **[DIscussion](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_DIscussion)**

# **[Challenges](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_Challenges)**

* **Finding dataset:** Difficulty in finding readily available datasets for the project.
* **Data cleaning:** Need to remove unwanted data and handle null values in the complex dataset.
* **Data merging:** Challenges in merging separate files to create a unified dataset for further processing.
* **Data visualization:** Difficulties encountered while using Tableau for data visualization.
* **Machine learning concepts:** Learning and studying various machine learning ideas for project implementation.
* **Model selection:** Challenge in determining the most suitable machine learning model for the project.

# **[Conclusion](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_Conclusion)**

* An increase in the interest rate and a decrease in the HPI will result in an increase in mortgage rates.
* In spite of government initiatives, regional variations exist in the major metropolitan cities of Canada like Toronto, Calgary, Ottawa, Quebec and Vancouver experiencing particularly high housing costs.
* Efforts are ongoing to address this issue, but it remains a complex challenge that requires continued attention and solutions at various levels of government and across the housing market.
* The Mortgage Rate Predictor is intended to help potential homebuyers, current homeowners wishing to refinance, real estate investors, financial planners, and anybody else looking to get a mortgage.

# **[Contribution](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_Contribution)**

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# **[References](file:///C:\\Users\\Hiren\\Downloads\\Capstone_Final_Report_Group_15.docx" \l "_References)**

# [**Appendices**](file:///C:\Users\Hiren\Downloads\Capstone_Final_Report_Group_15.docx#_References)

* **Github**:
* **Dataset**: