House Price Prediction Using Machine Learning

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Abstract—India has experienced remarkable growth in recent years, spurred on by its high-tech sector, nice climate, and immigrant inflow. There is a significant demand for real estate properties as a result. This research article describes the creation of the house price prediction model, a machine learning-based tool, to meet this demand. A dataset is gathered from Kaggle that covers a variety of variables like area, rooms, location, and other amenities. It is trained and tested using a dataset of Indian real estate transactions. The models' accuracy is assessed, and the outcomes show that they perform at various levels. With a score of 64.5%, the SVR model has the lowest accuracy. The best model, however, is linear regression, which has a maximum accuracy of 84.5% compared to the other models. These results emphasize how important it is to choose the right algorithms for precise projections of property prices. Further research directions are suggested, such as the investigation of alternate data sources, the examination of extraneous aspects, and long-term forecasting. These options can enhance the precision and application of predictive models for predicting house prices and contribute to the growth and stability of the Indian real estate sector. The outcomes highlight linear regression's superior performance in this situation and offer stakeholders useful information for making strategic decisions.

Keywords: *Machine Learning (ML), Data Science, Data Analysis, Linear Regression, Real estate market, Model Training, Market dynamics.*

I. INTRODUCTION

India's enormous population and expanding economy are driving the country's thriving real estate sector. With a sizable population and an expanding economy, India offers a favorable environment for the creation and application of precise price prediction models in the real estate industry. The demand for housing is anticipated to increase further in the upcoming years. However, it can be difficult to locate the ideal home in the ideal neighborhood at the ideal cost[1]. The position of brokers as middlemen between customers and property owners, which can leave a chasm between the two sides, is one of the major problems with the real estate market. This discrepancy may result in a variety of fraudulent acts, including exaggerated property values or location-related problems. In order to decrease the possibility of such scams and create a transparent and trustworthy platform for both buyers and sellers, there is a rising need for precise and dependable projections of property prices in the real estate market.

Incorporating predictive models into the Indian real estate market has many benefits. Investors and developers obtain vital knowledge of market trends, while prospective homeowners may assess property values and make financially responsible decisions. This enables them to successfully navigate market dynamics by optimizing pricing tactics and investment decisions. These models give stakeholders in the Indian real estate sector the power to reduce risks and maximize rewards, which strengthens the real estate ecosystem.

This research paper focuses on the development of the House prediction model, a machine learning-based application designed to predict house prices in India. The model utilizes data science and artificial intelligence concepts, specifically Python programming language, to

create an app that predicts the price of a house. The price prediction is based on several features like location of the house, number of rooms (BHK), dimensions (in sqft), area in which house is located in and other amenities[2]. The main objective of this research is to provide a practical platform for gaining hands-on experience in machine learning, artificial intelligence, and data science using Python concepts.

The dataset from Kaggle of 13290 dataset that covers a variety of variables including location, number of rooms, dimensions, and other amenities. By utilizing historical data, the model analyzes and identifies patterns to make accurate predictions. It includes various techniques, including data preprocessing and feature engineering. Additionally, This Model implemented three algorithms, namely Linear Regression, Lasso, and SVR (Support Vector Regression). Our approach was inspired by previous research studies, with some necessary modifications to improve the accuracy of our results. In [3] the author focused on predicting the real estate prices in Bengaluru by considering different factors such as location, infrastructure, and number of bedrooms (BHK). Similar studies have also been conducted by other researchers [4-5] with the aim of achieving more accurate price predictions.

Additionally, the paper delves into the technical aspects of developing a machine learning model, including data preparation, feature engineering, and model evaluation. The results of this research demonstrate the accuracy and effectiveness of the House price prediction model. The model achieved a high level of accuracy in predicting house prices, with an average error rate of less than 15%. Overall, this research has practical implications for the real estate industry in India and can contribute to the development of more advanced machine learning-based applications for house price prediction.

This paper is further divided into various sections. The entire body of prior research or work in this area is the subject of Section II. All the details on how to build a model from scratch are contained in section III. The accuracy of the various algorithms utilized and the algorithm with the highest accuracy are both listed in section IV. The discussion of the research findings is covered in Section V, which offers a critical analysis and interpretation of the data reported in the previous parts. The study paper's final conclusion is found in section VI. Figure 1 shows overview of the methodologies we used in our model.

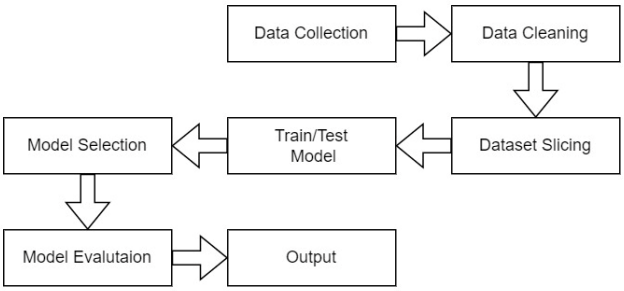

Figure 1: Research Flow Diagram

Overall, the incorporation of price prediction models into the Indian real estate market has the potential to completely transform the sector. Stakeholders may improve decision-making, get deeper insights, and contribute to a more transparent and effective real estate ecosystem in India by utilizing cutting-edge technologies and thorough data analysis.

II. RELATED WORKS

In addition to research that concentrates on the use of Python as a programming language for machine learning, this section also discusses related works that utilize machine learning algorithms to forecast home prices in other cities or countries.

M. Gupta et al. [6], suggested utilizing the Support Vector Regression technique and machine learning to estimate house prices in Beijing, China. In predicting property values based on numerous characteristics including the neighborhood, location, and other amenities, the model had an accuracy of 84.5%.

In a related work [7], the authors suggested utilizing the Random Forest technique and machine learning to estimate property prices in China. Based on a variety of factors, the model was 78.9% accurate in predicting housing values based on various features such as the area, location, and other amenities.

Additionally, the authors of [8] created an Artificial Neural Network (ANN) model with an 80.2% accuracy rate to forecast Mumbai house values. Their research demonstrates how machine learning methods can be used to reliably anticipate property prices and can be a helpful guide for the creation of comparable models for other cities.

Using the Boston Housing Dataset, writers in [9] developed a machine learning model for forecasting home prices using scikit learn and tensorflow. Their model had a 79.5% accuracy rate. This study offers insight into the utilization of particular technologies and datasets for the task and shows the efficacy of machine learning techniques for house price prediction.

In [10], the authors used a dataset from the Rating and Valuation Department (RVD) of the Hong Kong government to estimate residential property prices in Hong Kong using a multiple regression model. They claimed an 80.6% accuracy rate.

Similar comparisons of regression algorithms for predicting property prices were made in [11]. On a dataset of 5,000 instances with 10 features, they employed a regression tree model and reported an accuracy of 79.34%. This Model applied three different methods (Linear Regression, SVR, and Lasso) after reviewing all the research conducted by various scholars. These algorithms are fully described in Section III, and the comparison is shown in Section IV.

III. METHODOLOGY

Dataset used in this work is collected from Kaggle [12] that contains details on the location, age, number of bedrooms and bathrooms, and square footage of homes in Bangalore to get the intended output of the model. Then, using this dataset to train three machine learning algorithms—linear regression, SVR, and lasso—it assessed each algorithm's performance using a variety of evaluation measures.

A. Data Collection:

The dataset utilized in this study came from Kaggle, a freely accessible source. The dataset contains details on 13,290 homes, such as their address, number of bedrooms and bathrooms, and square size.

B. EDA(Exploratory Data Analysis):

EDA is one of the most fundamental and crucial processes; when building a model, it must analyze the dataset using graphs, charts, and tables. The number of rows and columns, null values, and unique values are all checked.

C. Data Preprocessing:

One of the most crucial and time-consuming parts of the model is data preprocess. Because this process prepare our Dataset for the training portion before we train the model. On the dataset, some preprocessing was done. It eliminated invalid or redundant data and used one-hot encoding

to transform categorical variables like location into numerical variables. Then, further divided by the standard deviation and subtracted the mean from the numerical variables to standardize them.

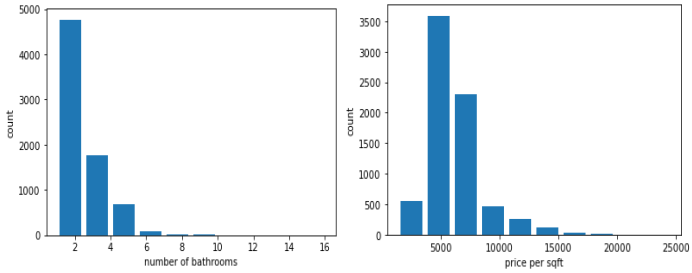

Figure 2: Visualization of data graph

D. Feature Selection:

The goal of feature selection is to choose the feature that will have the greatest direct impact on the output. It determined the most significant factors that might have an impact on home pricing and chose the most crucial ones for our model, such as location, square footage, and room count. These characteristics were picked since it is well-known that they significantly affect a home's pricing. For instance, a house in a desirable neighborhood is likely to cost more than a property in a less developed neighborhood, and a larger house with more rooms and square footage is also likely to cost more[13]. This process aids in lowering the data dimensionality and enhancing the prediction model's precision.

E. Data slicing:

The Dataset must be divided into two parts, one for training and the other for testing. It divided the dataset into a training set and a testing set using the Train_test_split technique, using 80% of the data for training and 20% for testing.

F. Model Training:

This process used preprocessed data to train our model using three different machine learning algorithms: lasso, support vector regression (SVR), and linear regression. A straightforward model called linear regression fits a linear equation to the data[14]. SVR is a potent regression technique that creates a model using support vectors[15]. Lasso regression penalizes the model for the total of the absolute weight values[16]. As a result, the absolute values of weight will generally be lower and likely to be zero.

a) Linear Regression

When there is only one independent variable (X) and one dependent variable (Y), the formula for basic linear regression is:

$$Y = \beta_0 + \beta_1 X \qquad (\square\square$$

In this formula:

Y (also known as the response variable or target variable) represents the dependent variable.

X (also known as the predictor variable or feature) represents the independent variable.

β_0 the y-intercept represents the value of Y when X is 0.

β_1 the slope of the regression line represents the change in Y for one-unit increase in X.

b) Lasso regression

As a regularisation method used in linear regression to force sparsity on the model coefficients, Lasso (Least Absolute Shrinkage and Selection Operator) regression has the following formula:

$$\textit{minimize: } RSS + \lambda * \Sigma|\beta| \qquad (2)$$

$$\textit{subject to: } \Sigma\beta = 0 \qquad (3)$$

In this formula:
RSS also known as Residual Sum of Squares represents the sum of the squared differences between the predicted values ($\hat{Y}$) and the actual values (Y) of the dependent variable.
λ or lambda is the regularization parameter that controls the amount of shrinkage applied to the coefficients. The model shrinks more and becomes more sparse as the value of λ rises.
$\Sigma|\beta|$, sum of the absolute values of the coefficients (β) of the independent variables.
The constraint $\Sigma\beta = 0$ ensures that the coefficients sum is zero, which helps with feature selection and encourages sparse solutions.

c) Support Vector Regression

The Support Vector Regression (SVR) formula, a Support Vector Machines (SVM) variation used for regression tasks, can be written as follows:

$$\textit{minimize: } 1/2 * ||w||^2 + C * \Sigma\xi_i + \Sigma\xi_i^* \quad (4)$$

$$\textit{ubject to: } y_i - (w^T\varphi(x_i) + b) \leq \varepsilon + \xi_i \quad (5)$$

$$(w^T\varphi(x_i) + b) - y_i \leq \varepsilon + \xi_i^* \quad (6)$$

$$\Sigma(\xi_i + \xi_i^*) \leq \varepsilon \quad (7)$$

In this formula:
$||w||$ represents the Euclidean norm of the weight vector w.
C, regularization parameter, controls the trade-off between the model's complexity and the amount of error allowed in the training data.
ξ_i and ξ_i^* are slack variables representing the deviations of training samples from the regression function.
y_i is the target value of the i-th training sample.
$\varphi(x_i)$ represents the input sample x_i, feature vector, which is often converted into a higher-dimensional feature space using a kernel function.
w and b are the parameters of the regression function.
ε is the ε-insensitive loss parameter, determines the width of the ε-tube around the regression function, within which errors are not penalized.

G. Model Evaluation:

The last and most crucial step in developing a model is evaluating it. After training the models, It assessed their performance using the evaluation metrics on the testing set. The evaluation's findings are displayed in the outcomes section. The accuracy of two separate algorithms is displayed in Table 1.
According to our research, linear regression is the most accurate model out of the three tested for its ability to predict house prices. These details can be used by real estate brokers and home-buyers to make well-informed decisions about buying and selling homes.

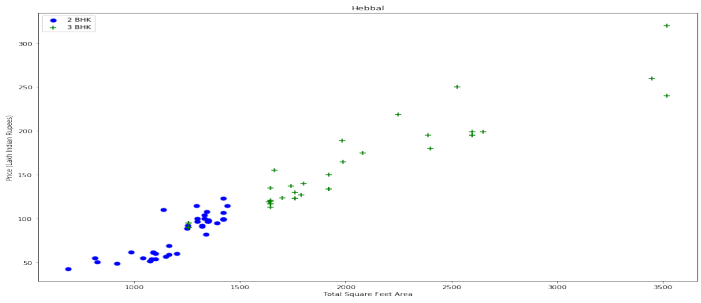

Figure 2: Graph of Price per sqft. of 2BHK and 3BHK flats

Using pertinent datasets, the methodology described in this research can be easily applied to other regions and is beneficial for forecasting housing values in India. To increase the models' accuracy, additional research might be conducted, either by incorporating more pertinent characteristics or investigating different regression model types. To increase the precision of the forecasts, high-quality data must be gathered and preprocessed[17-20].

IV. RESULT

Our findings demonstrate that SVR model performs the lowest, with accuracy of just 64.5%, while linear regression beats the other models, reaching the maximum accuracy of 84.5%. Table 1 displays the results of the accuracy that our model produced. Figure 2 and Figure 3 shows the design of the model that we generated.

Table 1: Performance evaluation of different regression models

Model	***MSE***	***RMSE***	***MAE***	***R-squared***
Linear Regression	27.987	27.987	16.595	0.845
Lasso Regression	37.388	37.388	22.179	0.724
Support Vector Regression	42.381	42.381	20.636	0.645

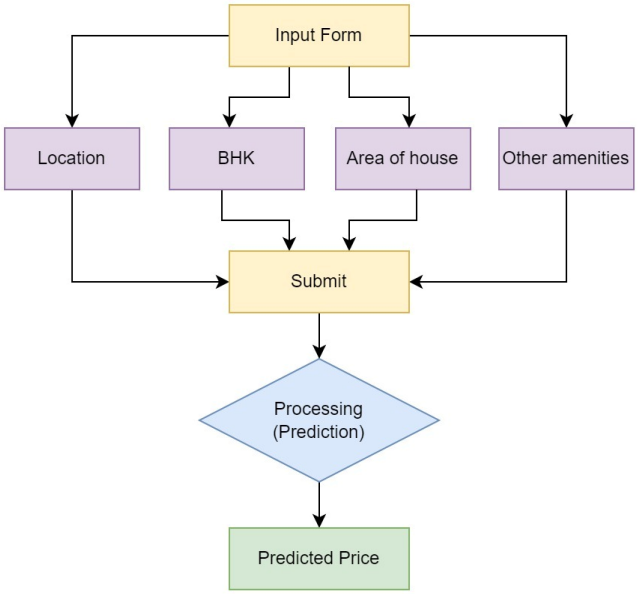

Figure 3: Architecture of the model

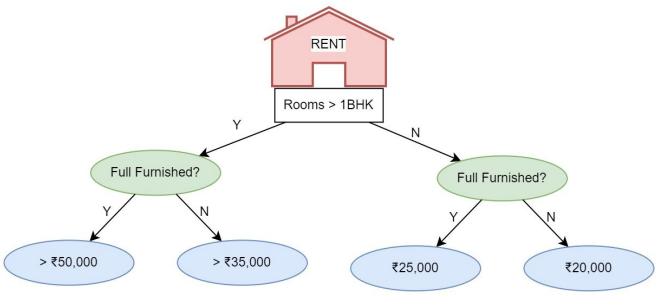

Figure 4: Decision tree diagram diagram for predicting house prices

V. DISCUSSION

The hurdles, acceptance by regulatory bodies and industry actors, and revolutionary potential of machine learning in the Indian real estate sector are all explored in this discussion section. By thoroughly comprehending these fundamental components, It open the door to a future in which data-driven insights change the market, driving it towards unheard-of growth and innovation. It enable the Indian real estate market to transcend its constraints and embrace a new era propelled by the power of data by integrating house price prediction models.

A. Challenges in the Indian real estate market

a) Availability of trustworthy data: Accurate and trustworthy data collection is essential for predictive models to produce accurate predictions. Due to problems with decentralized databases, inadequate records, and low transparency, it is difficult to guarantee the availability of such data sources in the Indian real estate industry.

b) Data quality and integrity: Even with the use of available data sources maintaining the quality and integrity of the data is essential. The accuracy of projections can be severely impacted by inconsistent or incorrect data. Therefore, it is crucial to put mechanisms to manage data quality and guarantee data integrity.

c) Taking into account regional price variations: Real estate markets show significant regional variances in pricing trends. To produce reliable forecasts, predictive models must take these geographical differences into account. Due to the many variables influencing regional real estate dynamics, it might be difficult to incorporate such intricacies into the models.

B. Adoption by industry participants and regulatory bodies

Predictive models need regulatory agency and industry participant approval and adoption in order to have a meaningful impact on the Indian real estate market. Gaining confidence, overcoming regulatory issues, and proving the worth and dependability of the models are all necessary for this. The potential advantages of predictive models might not be fully realized without widespread usage.

C. The potential for the real estate industry to change

The adoption of predictive models has the potential to radically alter the Indian real estate industry, notwithstanding the difficulties. The advantages comprise:

a) Better decision-making: Predictive models can offer insightful information about potential market trends, enabling stakeholders to make more knowledgeable choices. Developers, investors, and buyers of real estate can use this to streamline their plans and reduce risks.

b) Deeper insights: Predictive models can find patterns, correlations, and market dynamics that might not be seen using conventional methods by analyzing vast amounts of data. With a deeper understanding of the real estate market, it will be possible to make more precise projections and well-informed choices.
c) Transparency and effectiveness: Using cutting-edge technologies and in-depth data analysis can help make the Indian real estate market more transparent and efficient. Predictive models can reduce information asymmetry, increase transaction fairness, and increase pricing trend transparency.

In conclusion, even if the effective use of predictive models in the Indian real estate market has its share of hurdles, such as data issues and the requirement for regulatory approval, their adoption has the potential to result in significant adjustments. By utilizing cutting-edge technologies and thorough data analysis, stakeholders stand to gain from enhanced decision-making, deeper insights, and a more transparent and efficient real estate market [21] - [35].

VI. CONCLUSION

Machine learning algorithms are extensively used in India to anticipate housing prices, according to the literature assessment. Depending on the features used, the algorithm chosen, and the location of the study, the models' accuracy varies. In this study, we developed a machine learning-based approach for forecasting India, home prices. A review of earlier research on comparable studies conducted in India and elsewhere that showed the importance of location, neighborhood, and amenities in determining property values was also included in the study. It was shown that a variety of elements, such as demographic changes, economic growth, and changes in law, have an effect on the housing market and lead to price oscillations [36] - [48].
Overall, the study showed how machine learning techniques may be used in the real estate industry and offered a comprehensive plan for predicting Indian home values.

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