STA6923 Introduction to Statistical Learning

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House Price Prediction Analysis

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Data Source link:
https://www.kaggle.com/datasets/zafarali27/house-price-prediction-dataset/data

Agenda

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2. Dataset Overview
3. Exploratory Data Analysis (EDA)
4. Methodology
5. Model Comparison
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Problem Statement & Goals

Context: Real estate markets are complex economic indicators. Accurate pricing models are essential for buyers, sellers, and economists.

Goal: Predict house price using available structural and categorical features.

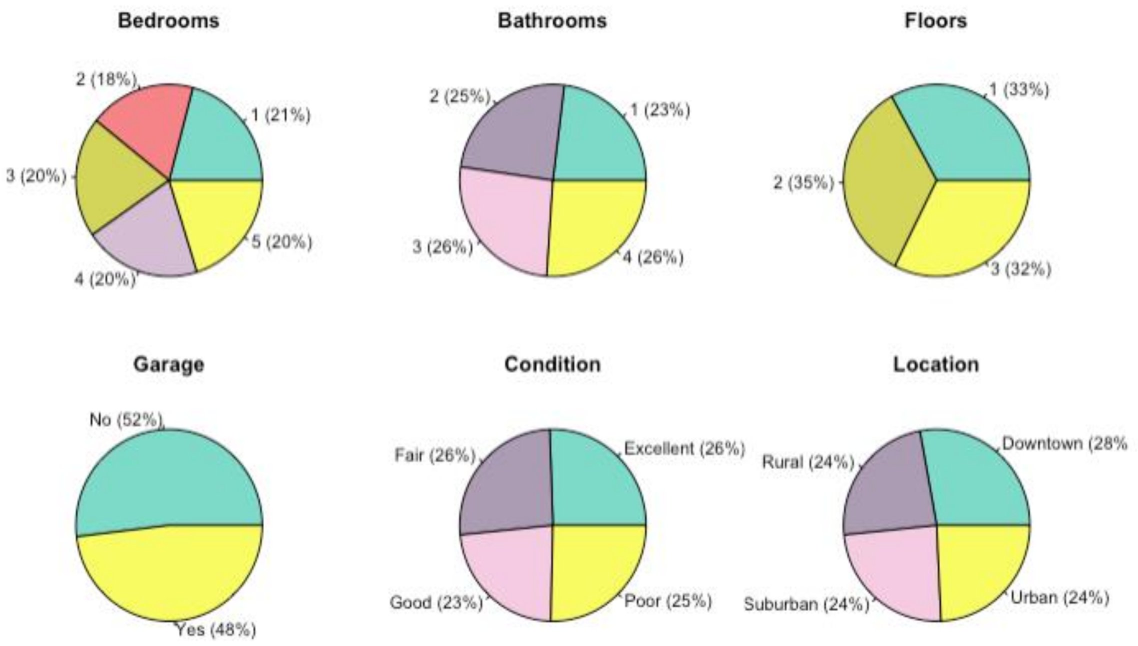
Objective: Compare different ML regression models to identify the key predictors and achieve the most accurate price prediction possible within the limitations of the dataset.

Dataset Overview

Source	Kaggle – House Price Prediction Dataset https:/www.kaggle.com/datasets/zafarali27/house-price-prediction-dataset /data
Size	2,000 observations × 10 variables
Target Variables	Price
Key Predictors	**Numeric**: Area, YearBuilt, Id **Categorical:** Bedrooms, Bathrooms, Floors, Location, Condition, Garage
Preprocessing	• No missing values in the dataset • Skewness analysis revealed symmetric distributions • Drop ID column (non-informative variable)

Exploratory Data Analysis (EDA)

Distribution analysis

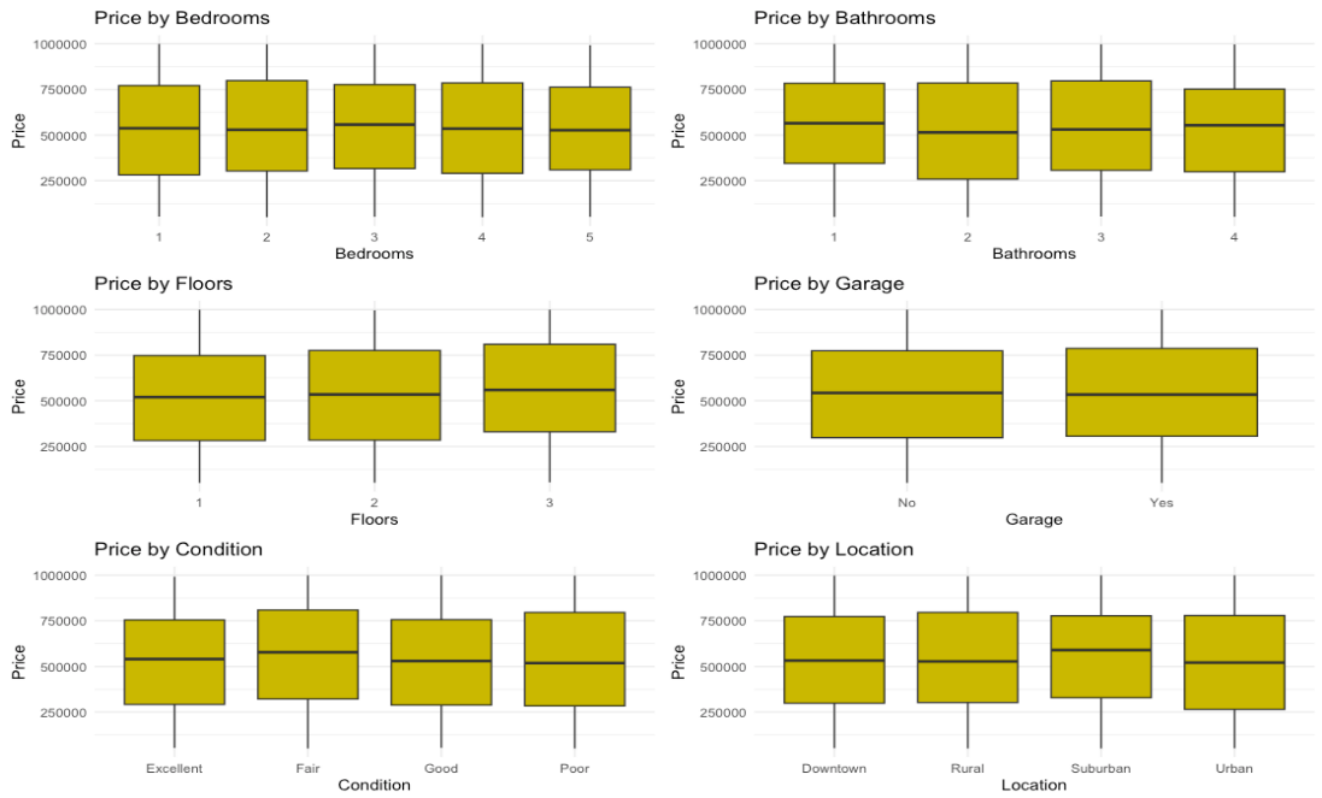


Histogram:
The distribution of house price is fairly uniform across the full range (from budget-friendly to premium luxury), with a slight linear trend.

Pie Chart:
The dataset is well-balanced and representative across the categorical features. There are no extreme imbalances in any category.

Exploratory Data Analysis (EDA)

Bivariate analysis



Box Plot:
Price distributions appear consistent across all groups, with similar medians and interquartile rangers, suggesting that these variables have not a visible influence on Price distribution.

Scatter Plot:
The scatter points are spreads uniformly across all area values with no visible trend. The regression line (red line) is horizontal, indicating that Area has no linear relationship with Price.

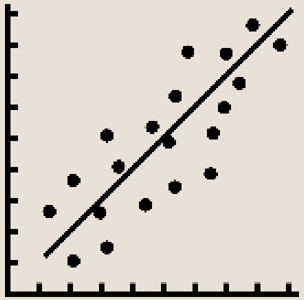
Methodology

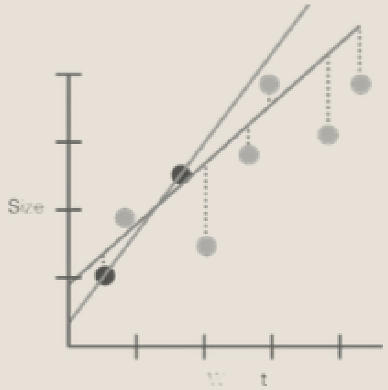
The dataset was split into 70% for training and 30% for testing.

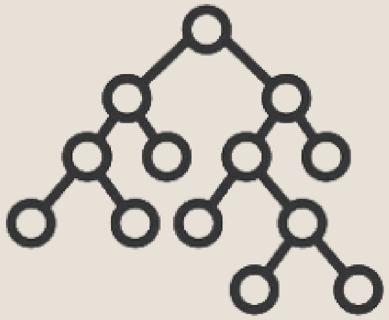
Linear Models
- Linear Regression
- Log-Linear Regression

Regularized Regression
- Ridge Regression
- LASSO Regression
- Elastic Net Regression

Ensemble Methods
- Random Forest
- Gradient Boosting







Evaluation Metrics

RMSE & MAE — lower values indicate better predictive accuracy
R^2 — higher values indicate stronger model fit

Model Comparison

Model <chr>	RMSE <dbl>	Rsquared <dbl>	MAE <dbl>
Elastic Net	277342.4	1.516719e-03	239762.3
LASSO	277343.7	1.519818e-03	239761.1
Ridge	277528.1	6.966896e-04	239967.2
Gradient Boosting	277533.5	2.078314e-03	239977.4
Linear	278576.5	2.588715e-03	239451.0
Random Forest	284466.1	1.579524e-05	243657.5
Log-Linear	292810.6	5.104606e-03	249686.0
Log-Linear + Interactions	294868.4	3.926175e-03	251405.9

Despite generally weak overall performance, **Elastic Net** was selected as the best-performing model because:

- It achieved the **lowest RMSE and MAE**, while also addressing multicollinearity and enabling automatic feature selection.
- Its structure remains close to a linear model, improving interpretability compared to more complex approaches.
- Although improvements over LASSO and Ridge are modest, it provides a balanced compromise and handles correlated predictors more effectively

However, **low R2** values and relatively high errors indicate limited overall predictive performance for this dataset. Best model still performs poorly

Recommendations / Next Steps

Prioritize Data Improvement:
Given the low model performance, future efforts should focus on acquiring richer and more representative data, particularly property characteristics and market conditions.

Reevaluate Dataset Validity:
The low R^2 values suggest that the current dataset may be noisy, incomplete, or insufficiently representative of real housing market dynamics.

Reconsider Problem Formulation:
Alternative approaches, such as predicting price ranges, may be more suitable given the limitations of the current data.

Communicate Model Limitations:
Clearly communicate to stakeholders that, given the current data and model performance, the model has limited value for accurate price prediction.

Conclusion

Elastic Net was chosen primarily for its stability and robustness rather than its predictive accuracy. Overall, the findings indicate that the dataset is unsuitable for robust house price prediction.

Meaningful practical application would require more informative and representative variables, or a reassessment of the data generation process, to ensure realistic and reliable relationships between housing prices and explanatory features.