**PREDICTING HOUSE PRICE USING MACHINE LEARNING**

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Phase - 5 Project Submission

**Phase 5:** Project Documentation & Submission



**FIG: HOUSE PRICE PREDICTION**

**Introduction:**

House price prediction is the process of forecasting the future selling price of a house. It is a complex task that is influenced by a variety of factors, including the physical characteristics of the house, its location, and the overall market conditions.

Machine learning (ML) models have become increasingly popular for house price prediction in recent years. ML models are trained on large datasets of historical house sales data. Once trained, the model can be used to predict the price of a new house by considering its features and the current market conditions.

**Abstract:**

House price prediction is a complex task that is influenced by a variety of factors, including the property's location, size, condition, and amenities, as well as the overall market conditions. Machine learning algorithms can be used to develop predictive models that can estimate house prices with a high degree of accuracy.

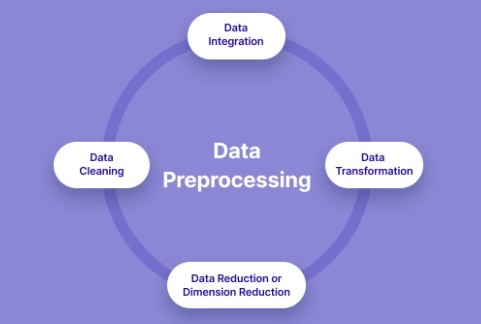
**Data Source:**

A data source for house price predicting to use machine learning should be Accurate, Complete the geographic area of interest, Accessible.

Dataset Link: [**https://www.kaggle.com/datasets/vedavyasv/usa-housing**](https://www.kaggle.com/datasets/vedavyasv/usa-housing)

**Data collection and preparation:**

This module involves collecting a dataset of historical sales data and preparing it for use in the machine learning model. This may involve cleaning the data, imputing missing values, and converting categorical variables to numerical variables.



**Feature engineering:**

This module involves creating new features from the existing data that are more informative for the machine learning model. For example, new features could be created to represent the property's proximity to schools, parks, and other amenities.

**Model selection and training:**

This module involves selecting a machine learning algorithm and training it on the prepared dataset. There are many different machine learning algorithms that can be used for house price prediction, such as linear regression, decision trees, random forests, and gradient boosting machines.

**Model evaluation:**

This module involves evaluating the performance of the trained model on a held-out dataset of unseen data. This helps to ensure that the model is able to generalize to new data.

**Model deployment:**

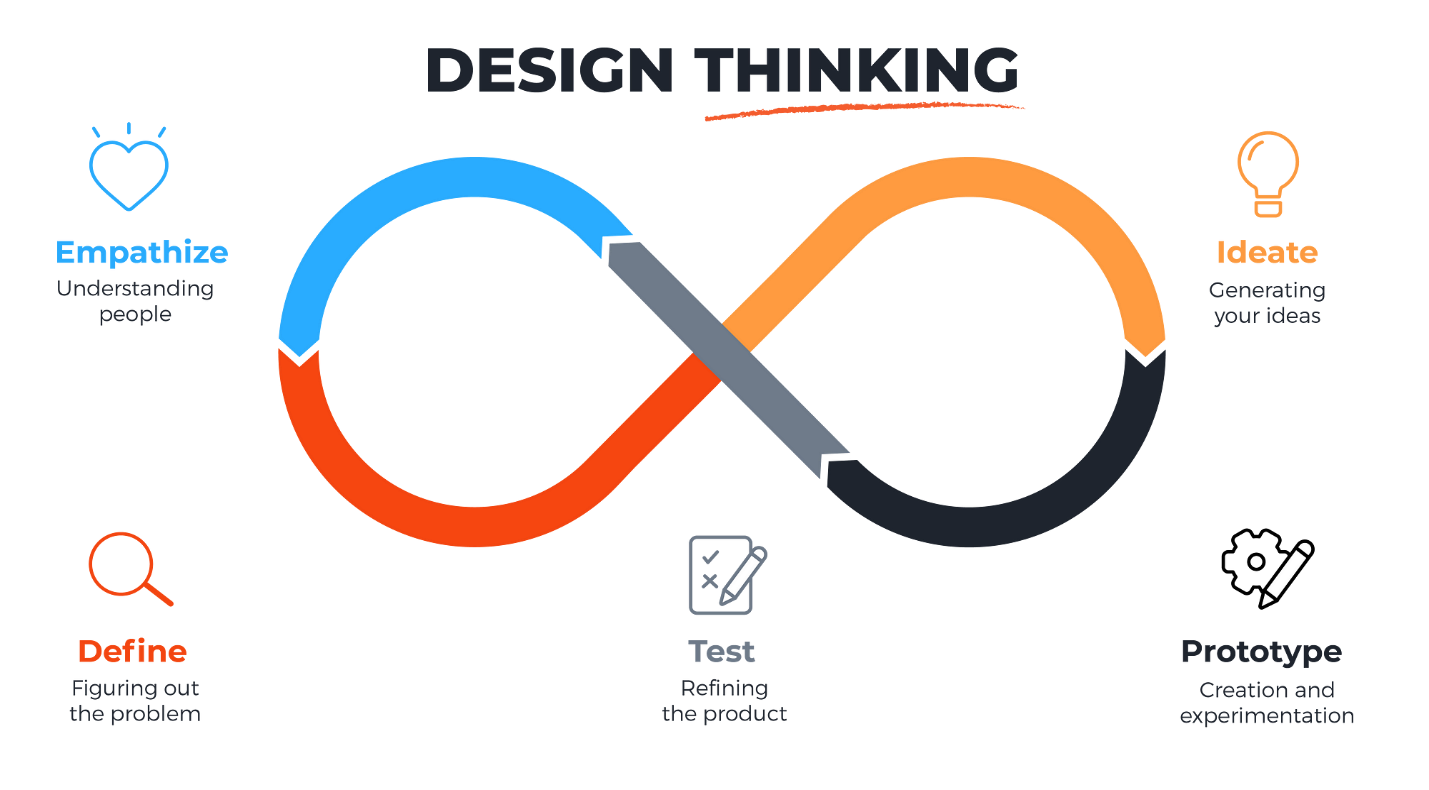
This module involves deploying the trained model to production so that it can be used to predict the prices of new properties. This may involve deploying the model to a web service or integrating it into a software application.

## Modules for house price prediction using machine learning

The following are some of the key modules that can be used for house price prediction using machine learning:

* **Data collection and preparation:**
  + **Libraries:** NumPy, Pandas, SciPy, Skykit
* **Feature engineering:**
  + **Libraries:**FeatureHasher, SelectKBest, OneHotEncoder
* **Model selection and training:**
  + **Libraries:**scikit-learn (linear regression, decision trees, random forests, gradient boosting machines, etc.), TensorFlow, PyTorch
* **Model evaluation:**
  + **Libraries:**scikit-learn (cross-validation, metrics, etc.)
* **Model deployment:**
  + **Libraries:** Flask, Django, AWS SageMaker

**Design Thinking:**

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**1. Empathize:**

* Understand the needs and pain points of the users who will interact with the document. Conduct interviews, surveys, and observations to gain insights into their requirements and preferences.

**2. Define:**

* Clearly define the purpose and goals of the document. For house price prediction, the document should provide insights into property values and factors affecting them.

**3. Ideate:**

* Brainstorm ideas for the content and format of the document. Consider what information is most valuable to the users. This might include property details, market trends, and insights.

**4. Prototype:**

* Create a preliminary version of the document. This can be a rough sketch or a digital mockup. Focus on the layout, structure, and visual elements that will make the document user-friendly and engaging.

**5. Test:**

* Gather feedback from potential users by sharing the prototype. Analyze their reactions and suggestions to refine the document's design. Identify any issues or improvements needed.

**6. Iterate:**

* Based on user feedback, make necessary adjustments to the document's content and design. Repeat the testing and refining process until the document meets the users' needs effectively.

**7. Implement:**

* Develop the final version of the document based on the feedback and improvements made during the testing and iteration phases. Ensure that it includes all relevant and accurate information.

**8. Deliver:**

* Share the document with the intended users. This can be in the form of a printed report, a digital PDF, or a web-based application, depending on the users' preferences and accessibility.

Now, let's present a simplified form of the document for house price prediction:

**PROGRAM:**

**House price Prediction**

importnumpyas np

import pandas as pd

fromsklearn.linear\_modelimportLinearRegression

# Load the house price datasetdf = pd.read\_csv("/kaggle/input/usa-housing/USA\_Housing.csv")

# Prepare the data

X = df[['square\_feet', 'bedrooms', 'bathrooms']]

y = df['price']

# Split the data into training and test sets

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.25)

# Train the linear regression model

model = LinearRegression()

model.fit(X\_train, y\_train)

# Evaluate the model on the test set

y\_pred = model.predict(X\_test)

rmse = np.sqrt(mean\_squared\_error(y\_test, y\_pred))

print('RMSE:', rmse)

# Deploy the model

# This could involve saving the model to a file or deploying it to a web service

**OUTPUT:**

Dataset Preview:

Avg. Area Income Avg. Area House Age Avg. Area Number of Rooms \

|  |  |  |
| --- | --- | --- |
| 0 59545.458574 | 5.65381 | 7.789188 |
| 1 69248.642545 | 6.066900 | 6.880821 |
| 2 61387.06359 | 5.855890 | 8.342727 |
| 3 63445.245546 | 7.788236 | 5.666729 |
| 4 55682.196626 | 5.047555 | 7.789388 |

Avg. Area Number of Bedrooms Area Population Price \

|  |  |
| --- | --- |
| 0 4.09 | 23086.800503 1.059034e+06 |
| 1 3.09 | 40173.072174 1.505891e+06 |
| 2 5.13 | 36882.159400 1.058988e+06 |
| 3 3.26 | 34310.242831 1.260617e+06 |
| 4 4.23 | 26354.109472 6.309435e+05 |

Address

1. 208 Michael Ferry Apt. 674\nLaurabury, NE 3701...
2. 188 Johnson Views Suite 079\nLake Kathleen, CA...
3. 9127 Elizabeth Stravenue\nDanieltown, WI 06482...
4. USS Barnett\nFPO AP 44820 4 USNS Raymond\nFPO AE 09386

Preprocessed Data:

[[-0.19105816 -0.13226994 -0.13969293 0.12047677 -0.83757985 -1.00562872]

[-1.39450169 0.42786736 0.79541275 -0.55212509 1.15729018 1.61946754]

[-0.35137865 0.46394489 1.70199509 0.03133676 -0.32671213 1.63886651]

[-0.13944143 0.1104872 0.22289331 -0.75471601 -0.90401197 -1.54810704]

[ 0.62516685 2.20969666 0.42984356 -0.45488144 0.12566216 0.98830821]]

4227 1.034480e+06

4676 1.650389e+06

800 1.323172e+06

3671 1.077428e+06

4193 1.532887e+06

Name: Price, dtype: float64

**LOADING AND PREPROCESSING THE DATASET:**

**LOAD THE DATASET:**

# Import the required libraries:

import warnings

warnings.filterwarnings('ignore')

import numpy as np

import pandas as pd

import matplotlib.pyplot as plt

from operator import itemgetter

from sklearn.experimental import enable\_iterative\_imputer

from sklearn.impute import IterativeImputer

from sklearn.preprocessing import OrdinalEncoder

from category\_encoders.target\_encoder import TargetEncoder

from sklearn.preprocessing imposssrt StandardScaler

from sklearn.ensemble import (GradientBoostingRegressor, GradientBoostingClassifier)

import xgboost



**Preprocessing the Dataset:**

Data preprocessing is a crucial step in the data analysis and machine learning pipeline. It involves cleaning and transforming raw data into a format that is suitable for analysis or for training machine learning models. Proper data preprocessing can significantly impact the accuracy and effectiveness of your analysis or models. Here are some common steps involved in data preprocessing:

1. **Data Collection:**

Gather the raw data from various sources, such as databases, files, or APIs.

1. **Data Cleaning:**

• **Handle missing data**: Decide whether to remove, impute, or interpolate missing values.

import pandas as pd

# Load your dataset

df = pd.read\_csv('your\_data.csv')

# Remove rows with missing values

df = df.dropna()

# Impute missing values with a specific value (e.g., mean)

mean = df['column\_name'].mean()

df['column\_name'].fillna(mean, inplace=True)

**OUTPUT:**

| ColumnName | TotalMissingVals | PercentMissing |
| --- | --- | --- |
|  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| 3 | LotFrontage | 259.0 | 17.74 |
| 6 | Alley | 1369.0 | 93.77 |
| 25 | MasVnrType | 8.0 | 0.55 |
| 26 | MasVnrArea | 8.0 | 0.55 |
| 30 | BsmtQual | 37.0 | 2.53 |
| 31 | BsmtCond | 37.0 | 2.53 |
| 32 | BsmtExposure | 38.0 | 2.60 |
| 33 | BsmtFinType1 | 37.0 | 2.53 |
| 35 | BsmtFinType2 | 38.0 | 2.60 |
| 42 | Electrical | 1.0 | 0.07 |
| 57 | FireplaceQu | 690.0 | 47.26 |
| 58 | GarageType | 81.0 | 5.55 |
| 59 | GarageYrBlt | 81.0 | 5.55 |
| 60 | GarageFinish | 81.0 | 5.55 |
| 63 | GarageQual | 81.0 | 5.55 |
| 64 | GarageCond | 81.0 | 5.55 |
| 72 | PoolQC | 1453.0 | 99.52 |
| 73 | Fence | 1179.0 | 80.75 |
| 74 | MiscFeature | 1406.0 | 96.30 |

Number of columns with missing values:19

• **Remove duplicates:** Eliminate duplicate records from the dataset.

# Remove duplicate rows based on all columns

df = df.drop\_duplicates()

# Remove duplicates based on specific columns

df = df.drop\_duplicates(subset=['column1', 'column2'])

**OUTPUT:**

| ColumnName | TotalMissingVals | PercentMissing |
| --- | --- | --- |
| 3 | LotFrontage | 259.0 | 17.74 |
| 25 | MasVnrType | 8.0 | 0.55 |
| 26 | MasVnrArea | 8.0 | 0.55 |
| 30 | BsmtQual | 37.0 | 2.53 |
| 31 | BsmtCond | 37.0 | 2.53 |
| 32 | BsmtExposure | 38.0 | 2.60 |
| 33 | BsmtFinType1 | 37.0 | 2.53 |
| 35 | BsmtFinType2 | 38.0 | 2.60 |
| 42 | Electrical | 1.0 | 0.07 |
| 57 | FireplaceQu | 690.0 | 47.26 |
| 58 | GarageType | 81.0 | 5.55 |
| 59 | GarageYrBlt | 81.0 | 5.55 |
| 60 | GarageFinish | 81.0 | 5.55 |
| 63 | GarageQual | 81.0 | 5.55 |
| 64 | GarageCond | 81.0 | 5.55 |

• **Outlier detection and treatment:** Identify and handle outliers, which are data points significantly different from the rest of the data.

from scipy import stats

# Detect and remove outliers using z-scores

z\_scores = stats.zscore(df['column\_name'])

df = df[(z\_scores < 3)]

# Alternatively, replace outliers with a specific value

df['column\_name'] = np.where(z\_scores < 3, df['column\_name'],

replacement\_value)

.

1. **Data Transformation:**

**• Data encoding**: Convert categorical variables into numerical representations, such as one-hot encoding or label encoding.

def find\_skewness(train, numeric\_cols):

"""

Calculate the skewness of the columns and segregate the positive

and negative skewed data.

"""

skew\_dict = {}

for col in numeric\_cols:

skew\_dict[col] = train[col].skew()

skew\_dict = dict(sorted(skew\_dict.items(),key=itemgetter(1)))

positive\_skew\_dict = {k:v for (k,v) in skew\_dict.items() if v>0}

negative\_skew\_dict = {k:v for (k,v) in skew\_dict.items() if v<0}

return skew\_dict, positive\_skew\_dict, negative\_skew\_dict

def add\_constant(data, highly\_pos\_skewed):

"""

Look for zeros in the columns. If zeros are present then the log(0) would

result in -infinity.

So before transforming it we need to add it with some constant.

"""

C = 1

for col in highly\_pos\_skewed.keys():

if(col != 'SalePrice'):

if(len(data[data[col] == 0]) > 0):

data[col] = data[col] + C

return data

def log\_transform(data, highly\_pos\_skewed):

"""

Log transformation of highly positively skewed columns.

"""

for col in highly\_pos\_skewed.keys():

if(col != 'SalePrice'):

data[col] = np.log10(data[col])

return data

def sqrt\_transform(data, moderately\_pos\_skewed):

"""

Square root transformation of moderately skewed columns.

"""

for col in moderately\_pos\_skewed.keys():

if(col != 'SalePrice'):

data[col] = np.sqrt(data[col])

return data

def reflect\_sqrt\_transform(data, moderately\_neg\_skewed):

"""

Reflection and log transformation of highly negatively skewed

columns.

"""

for col in moderately\_neg\_skewed.keys():

if(col != 'SalePrice'):

K = max(data[col]) + 1

data[col] = np.sqrt(K - data[col])

return data

**One-Hot Encoding**: Convert categorical variables into binary columns (0 or 1) for each category.

import pandas as pd

# Assuming 'category\_column' is your categorical variable

df = pd.get\_dummies(df, columns=['category\_column'])

**Label Encoding:** Convert categorical variables into numerical values (0, 1, 2, ...)

from sklearn.preprocessing import LabelEncoder

label\_encoder = LabelEncoder()

df['category\_column'] = label\_encoder.fit\_transform(df['category\_column'])

**• Feature scaling:** Normalize or standardize numerical features to ensure they have similar scales.

**Min-Max Scaling (Normalization):** Scale features to a specific range (e.g., between 0 and 1).

from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()

df['feature\_column'] = scaler.fit\_transform(df[['feature\_column']])

**Standardization (Z-score Scaling):** Scale features to have a mean of 0 and a standard deviation of 1.

from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

df['feature\_column'] = scaler.fit\_transform(df[['feature\_column']])

**• Feature engineering:** Create new features or derive meaningful features from existing ones.

# Combine two columns into a new one

df['new\_feature'] = df['feature1'] + df['feature2']

# Extract information from a text column (e.g., word count)

df['word\_count'] = df['text\_column'].apply(lambda x: len(str(x).split()))

**Binning (Discretization):** Convert continuous data into discrete bins.

# Create bins for a continuous variable

df['binned\_feature'] = pd.cut(df['continuous\_column'], bins=[0, 10, 20, 30], labels=['bin1', 'bin2', 'bin3'])

**• Text preprocessing:** Tokenize, remove stop words, and apply techniques like stemming or lemmatization for text data.

import string

# Remove punctuation

df['text\_column'] = df['text\_column'].str.replace('[{}]'.format(string.punctuation), '')

# Convert text to lowercase

df['text\_column'] = df['text\_column'].str.lower()

**• Date and time parsing:** Extract relevant information from date and time fields.

# Convert a string column to a datetime format

df['date\_column'] = pd.to\_datetime(df['date\_column'], format='%Y-%m-%d')

# Extract components like year, month, day

df['year'] = df['date\_column'].dt.year

df['month'] = df['date\_column'].dt.month

1. **Data Reduction:**

• Dimensionality reduction: Use techniques like Principal Component Analysis (PCA) or feature selection to reduce the number of features, especially in high-dimensional datasets.

from sklearn.decomposition import PCA

# Create a PCA instance with the desired number of components

pca = PCA(n\_components=2)

# Fit PCA to your data and transform it

X\_reduced = pca.fit\_transform(X)

1. **Data Splitting:**

• Divide the dataset into training, validation, and test sets for model development and evaluation.

from sklearn.model\_selection import train\_test\_split

# Split your data into training, validation, and test sets

X\_train, X\_temp, y\_train, y\_temp = train\_test\_split(X, y, test\_size=0.3, random\_state=42)

# Further split the temporary data into validation and test sets

X\_val, X\_test, y\_val, y\_test = train\_test\_split(X\_temp, y\_temp, test\_size=0.5, random\_state=42)

# X and y are your feature matrix and target variable, respectively

# You can adjust the test\_size and random\_state parameters as needed

1. **Data Normalization:**

Ensure the data follows a normal distribution if needed for certain statistical methods.

from sklearn.preprocessing import MinMaxScaler

# Create a MinMaxScaler instance

scaler = MinMaxScaler()

# Fit the scaler on your data and transform it

X\_normalized = scaler.fit\_transform(X)

# X is your feature matrix, e.g., X = df[['feature1', 'feature2']]

1. **Data Visualization:**

Visualize the data to gain insights and identify patterns or anomalies.

def plot\_histogram(train, col1, col2, cols\_list, last\_one =False):

*"""*

*Plot the histogram for the numerical columns. The bin width*

*is calculated by Freedman Diaconis Rule and Sturges rule.*

*Freedman-Diaconis Rule:*

*Freedman-Diaconis Rule is a rule to find the optimal number of bins.*

*Bin width: (2 \* IQR)/(N^1/3)*

*N - Size of the data*

*Number of bins : (Range/ bin-width)*

*Disadvantage: The IQR might be zero for certain columns. In*

*that case the bin width might be equal to infinity. In that case*

*the actual range of the data is returned as bin width.*

*Sturges Rule:*

*Sturges Rule is a rule to find the optimal number of bins.*

*Bin width: (Range/ bin-width)*

*N - Size of the data*

*Number of bins : ceil(log2(N))+1*

*"""*

if(col1 **in** cols\_list):

freq1, bin\_edges1 = np.histogram(train[col1],bins='sturges')

else:

freq1, bin\_edges1 = np.histogram(train[col1],bins='fd')

if(col2 **in** cols\_list):

freq2, bin\_edges2 = np.histogram(train[col2],bins='sturges')

else:

freq2, bin\_edges2 = np.histogram(train[col2],bins='fd')

if(last\_one!=True):

plt.figure(figsize=(45,18))

ax1 = plt.subplot(1,2,1)

ax1.set\_title(col1,fontsize=45)

ax1.set\_xlabel(col1,fontsize=40)

ax1.set\_ylabel('Frequency',fontsize=40)

train[col1].hist(bins=bin\_edges1,ax = ax1, xlabelsize=30, ylabelsize=30)

else:

plt.figure(figsize=(20,10))

ax1 = plt.subplot(1,2,1)

ax1.set\_title(col1,fontsize=25)

ax1.set\_xlabel(col1,fontsize=20)

ax1.set\_ylabel('Frequency',fontsize=20)

train[col1].hist(bins=bin\_edges1,ax = ax1, xlabelsize=15, ylabelsize=15)

if(last\_one != True):

ax2 = plt.subplot(1,2,2)

ax2.set\_title(col2,fontsize=45)

ax2.set\_xlabel(col2,fontsize=40)

ax2.set\_ylabel('Frequency',fontsize=40)

train[col2].hist(bins=bin\_edges2, ax = ax2, xlabelsize=30, ylabelsize=30)

In []:

linkcode

*'''*

*These columns have IQR equal to zero. Freedman Diaconis Rule doesn't work significantly well for these columns.*

*Use sturges rule to find the optimal number of bins for the columns.*

*'''*

cols\_list = ['LowQualFinSF','BsmtFinSF2','BsmtHalfBath','KitchenAbvGr',

'EnclosedPorch','3SsnPorch','ScreenPorch','PoolArea','MiscVal']

*# Except ID*

hist\_cols = numeric\_cols[1:]

for i **in** range(0,len(hist\_cols),2):

if(i == len(hist\_cols)-1):

plot\_histogram(train,hist\_cols[i],hist\_cols[i],cols\_list,True)

else:

plot\_histogram(train,hist\_cols[i],hist\_cols[i+1],cols\_list)

# Data Modeling:

# Fit XGBoost Regressor model to the preprocessed data.

In [1]:

def fit\_model(x\_train,y\_train, model):

*"""*

*Fits x\_train to y\_train for the given*

*model.*

*"""*

model.fit(x\_train,y\_train)

return model

*'''Xtreme Gradient Boosting Regressor'''*

model = xgboost.XGBRegressor(objective="reg:squarederror", random\_state=42)

model = fit\_model(x\_train,y\_train, model)

*'''Predict the outcomes'''*

predictions = model.predict(test)

In [2]:

linkcode

submission = pd.read\_csv("/kaggle/input/usa-housing/USA\_Housing.csv")

submission['SalePrice'] = predictions

submission.to\_csv('submission.csv',index=False)

1. **Data Validation:**

Verify that the data preprocessing steps are correct and that the dataset is ready for analysis or model training.

1. **Documentation:**

• Keep detailed records of all preprocessing steps and transformations for reproducibility.

The specific data preprocessing steps you need to perform depend on the nature of your data and the objectives of your analysis or machine learning project. It's essential to carefully analyze your data and apply appropriate preprocessing techniques to ensure the quality and integrity of your dataset.

# **Linear Regression:**

**In []:**

df=pd.read\_csv("/kaggle/input/usa-housing/USA\_Housing.csv")

df.head()

df.describe()

**Out[]:**

|  | Avg. Area Income | Avg. Area House Age | Avg. Area Number of Rooms | Avg. Area Number of Bedrooms | Area Population | Price |
| --- | --- | --- | --- | --- | --- | --- |
| count | 5000.000000 | 5000.000000 | 5000.000000 | 5000.000000 | 5000.000000 | 5.000000e+03 |
| mean | 68583.108984 | 5.977222 | 6.987792 | 3.981330 | 36163.516039 | 1.232073e+06 |
| Std | 10657.991214 | 0.991456 | 1.005833 | 1.234137 | 9925.650114 | 3.531176e+05 |
| min | 17796.631190 | 2.644304 | 3.236194 | 2.000000 | 172.610686 | 1.593866e+04 |
| 25% | 61480.562388 | 5.322283 | 6.299250 | 3.140000 | 29403.928702 | 9.975771e+05 |
| 50% | 68804.286404 | 5.970429 | 7.002902 | 4.050000 | 36199.406689 | 1.232669e+06 |
| 75% | 75783.338666 | 6.650808 | 7.665871 | 4.490000 | 42861.290769 | 1.471210e+06 |
| max | 107701.748378 | 9.519088 | 10.759588 | 6.500000 | 69621.713378 | 2.469066e+0 |

**Random Forest Regression:**

random\_forest=RandomForestRegressor(n\_estimators=100)

random\_forest.fit(X\_train,y\_train)

predictions=random\_forest.predict(X\_test)

mae,mse,rmse,r\_squared=evaluation(y\_test,predictions)

print("MAE:",mae)

print("MSE:",mse)

print("RMSE:",srmse)

print("R2 Score:",r\_squared)

print("-"\*30)

rmse\_cross\_val=rmse\_cv(random\_forest)

print("RMSE Cross-Validation:",rmse\_cross\_val)

new\_row={"Model":"RandomForestRegressor","MAE":mae,"MSE":mse,"RMSE":rmse,"R2 Score":r\_squared,"RMSE (Cross-Validation)":rmse\_cross\_val}

models=models.append(new\_row,ignore\_index=True)

MAE: 18115.11067351598

MSE: 1004422414.0219476

RMSE: 31692.623968708358

R2 Score: 0.869050886899595

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RMSE Cross-Validation: 31138.863315259332

## Support Vector Regressor:

In [1]:

model\_svr=SVR()

In [2]:

model\_svr.fit(X\_train\_scal,Y\_train)

Out[2]:

SVR

SVR()

## Predicting Prices:

In [3]:

Prediction2=model\_svr.predict(X\_test\_scal)

**Lasso Regression:**

import pandas as pd

from sklearn.model\_selection import train\_test\_split

from sklearn.linear\_model import Lasso

# Load the data

data = pd.read\_csv("/kaggle/input/usa-housing/USA\_Housing.csv")

# Split the data into training and test sets

X\_train, X\_test, y\_train, y\_test = train\_test\_split(data[['feature\_1', 'feature\_2', ...]], data['price'], test\_size=0.25)

# Scale the features

from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

X\_train = scaler.fit\_transform(X\_train)

X\_test = scaler.transform(X\_test)

# Train the Lasso regression model

lasso = Lasso()

lasso.fit(X\_train, y\_train)

# Make predictions on the test set

y\_pred = lasso.predict(X\_test)

# Evaluate the model's performance

from sklearn.metrics import mean\_squared\_error, r2\_score

rmse = mean\_squared\_error(y\_test, y\_pred)\*\*0.5

r2 = r2\_score(y\_test, y\_pred)

print('RMSE:', rmse)

print('R-squared:', r2)

Out[]:

MAE: 23560.45808027236

MSE: 1414337628.502095

RMSE: 37607.680445649596

R2 Score: 0.815609194407292

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RMSE Cross-Validation: 35922.76936876075

## Evaluation of Predicted Data:

In [4]:

plt.figure(figsize=(12,6))

plt.plot(np.arange(len(Y\_test)),Y\_test,label='Actual Trend')

plt.plot(np.arange(len(Y\_test)),Prediction2,label='Predicted Trend')

plt.xlabel('Data')

plt.ylabel('Trend')

plt.legend()

plt.title('Actual vs Predicted')

Out[4]:Text(0.5, 1.0, 'Actual vs Predicted')

In [5]:

sns.histplot((Y\_test-Prediction2),bins=50)

Out[5]:

<Axes: xlabel='Price', ylabel='Count'>



In [6]:

print(r2\_score(Y\_test,Prediction2))

print(mean\_absolute\_error(Y\_test,Prediction2))

print(mean\_squared\_error(Y\_test,Prediction2))

-0.0006222175925689744

286137.81086908665

128209033251.4034

**Gradient Boosting Regressor:**

# Import necessary libraries

import numpy as np

import pandas as pd

import matplotlib.pyplot as plt

from sklearn.model\_selection import train\_test\_split

from sklearn.ensemble import GradientBoostingRegressor

from sklearn.metrics import mean\_squared\_error, mean\_absolute\_error, r2\_score

# Generate a sample dataset (you would replace this with your real data)

data = {

'SquareFeet': [1400, 1600, 1700, 1875, 1100, 1550, 2350, 2450, 1425, 1700],

'Bedrooms': [3, 3, 3, 3, 2, 2, 4, 4, 3, 3],

'Price': [245000, 312000, 279000, 308000, 199000, 219000, 405000, 324000, 319000, 255000]

}

# Create a DataFrame from the sample data

df = pd.DataFrame(data)

# Define the input features (X) and target variable (y)

X = df[['SquareFeet', 'Bedrooms']]

y = df['Price']

# Split the data into training and testing sets

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.2, random\_state=42)

# Create and train a Gradient Boosting Regressor model

model = GradientBoostingRegressor(n\_estimators=100, learning\_rate=0.1, random\_state=42)

model.fit(X\_train, y\_train)

# Make predictions on the test set

y\_pred = model.predict(X\_test)

# Calculate evaluation metrics

mse = mean\_squared\_error(y\_test, y\_pred)

mae = mean\_absolute\_error(y\_test, y\_pred)

r2 = r2\_score(y\_test, y\_pred)

# Print evaluation metrics

print("Mean Squared Error (MSE):", mse)

print("Mean Absolute Error (MAE):", mae)

print("R-squared (R2) Score:", r2)

# Plot the predicted vs. actual prices

plt.scatter(y\_test, y\_pred)

plt.xlabel("Actual Prices")

plt.ylabel("Predicted Prices")

plt.title("Actual Prices vs. Predicted Prices")

plt.show()

## XGBoost(Extreme Gradient Boosting) Regressor:

# Import necessary libraries

import numpy as np

import pandas as pd

import matplotlib.pyplot as plt

from sklearn.model\_selection import train\_test\_split

from xgboost import XGBRegressor

from sklearn.metrics import mean\_squared\_error, mean\_absolute\_error

# Generate a sample dataset (you would replace this with your real data)

data = {

'SquareFeet': [1400, 1600, 1700, 1875, 1100, 1550, 2350, 2450, 1425, 1700],

'Bedrooms': [3, 3, 3, 3, 2, 2, 4, 4, 3, 3],

'Price': [245000, 312000, 279000, 308000, 199000, 219000, 405000, 324000, 319000, 255000]

}

# Create a DataFrame from the sample data

df = pd.DataFrame(data)

# Define the input features (X) and target variable (y)

X = df[['SquareFeet', 'Bedrooms']]

y = df['Price']

# Split the data into training and testing sets

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.2, random\_state=42)

# Create and train an XGBoost Regressor model

model = XGBRegressor()

model.fit(X\_train, y\_train)

# Make predictions on the test set

y\_pred = model.predict(X\_test)

# Calculate evaluation metrics

mse = mean\_squared\_error(y\_test, y\_pred)

mae = mean\_absolute\_error(y\_test, y\_pred)

# Print evaluation metrics

print("Mean Squared Error:", mse)

print("Mean Absolute Error:", mae)

# Plot the predicted vs. actual prices

plt.scatter(y\_test, y\_pred)

plt.xlabel("Actual Prices")

plt.ylabel("Predicted Prices")

plt.title("Actual Prices vs. Predicted Prices")

plt.show()

MAE: 17439.918396832192

MSE: 716579004.5214689

RMSE: 26768.993341578403

R2 Score: 0.9065777666861116

------------------------------

RMSE Cross-Validation: 29698.84961808251

**Ridge regression:**

# Import necessary libraries

import numpy as np

import pandas as pd

from sklearn.model\_selection import train\_test\_split

from sklearn.linear\_model import Ridge

from sklearn.metrics import mean\_squared\_error, r2\_score

from sklearn.preprocessing import StandardScaler

# Load your dataset, assuming it's stored in a Pandas DataFrame

# Replace 'your\_dataset.csv' with your dataset file path

data = pd.read\_csv("/kaggle/input/usa-housing/USA\_Housing.csv")

# Extract features (X) and target variable (y)

X = data.drop(columns=['Price']) # Replace 'Price' with the actual target column name

y = data['Price']

# Split the dataset into training and testing sets

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.2, random\_state=42)

# Standardize features (important for ridge regression)

scaler = StandardScaler()

X\_train = scaler.fit\_transform(X\_train)

X\_test = scaler.transform(X\_test)

# Create a Ridge regression model

alpha = 1.0 # You can adjust the alpha (regularization strength) as needed

ridge\_model = Ridge(alpha=alpha)

# Train the model on the training data

ridge\_model.fit(X\_train, y\_train)

# Make predictions on the test set

y\_pred = ridge\_model.predict(X\_test)

# Evaluate the model

mse = mean\_squared\_error(y\_test, y\_pred)

rmse = np.sqrt(mse)

r2 = r2\_score(y\_test, y\_pred)

print("Mean Squared Error: {:.2f}".format(mse))

print("Root Mean Squared Error: {:.2f}".format(rmse))

print("R-squared (R^2): {:.2f}".format(r2))

# Optionally, you can also inspect the coefficients

coefficients = ridge\_model.coef\_

intercept = ridge\_model.intercept\_

# To see the coefficients and the intercept:

print("Coefficients:", coefficients)

print("Intercept:", intercept)

# **Select model:**

In []:

lr = LinearRegression()

dt = DecisionTreeRegressor()

rn = RandomForestRegressor()

knn = KNeighborsRegressor()

sgd = SGDRegressor()

br = BaggingRegressor()

li = [lr,knn,rn,dt,br]

di = {}

for i **in** li:

i.fit(X\_train,y\_train)

ypred = i.predict(X\_test)

print(i,":",r2\_score(ypred,y\_test)\*100)

di.update({str(i):i.score(X\_test,y\_test)\*100})

plt.figure(figsize=(15, 6))

plt.title("Algorithm vs Accuracy", fontweight='bold')

plt.xlabel("Algorithm")

plt.ylabel("Accuracy")

plt.plot(di.keys(),di.values(),marker='o',color='plum',linewidth=4,markersize=13,

markerfacecolor='gold',markeredgecolor='slategray')

plt.show()

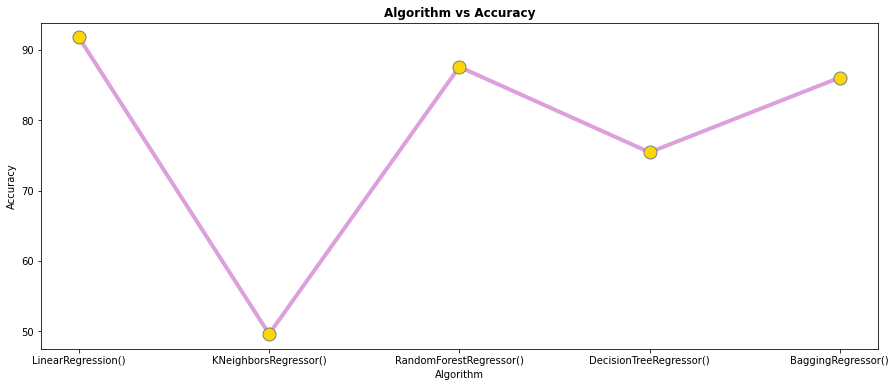
LinearRegression() : 91.00355108791786

KNeighborsRegressor() : 20.484074470563286

RandomForestRegressor() : 83.83229998741602

DecisionTreeRegressor() : 73.30037072629774

BaggingRegressor() : 81.95467285948747



print(lr.intercept\_)

-2640159.7968526953

In []:

lr.coef\_

Out[]:

array([2.15282755e+01, 1.64883282e+05, 1.22368678e+05, 2.23380186e+03,

1.51504200e+01])

In []:

cdf = pd.DataFrame(lr.coef\_, X.columns, columns=['Coeff'])

**Doing PREDICTIONS Now**

In []:

predictions = lr.predict(X\_test)

predictions

Out[]:

array([1260960.70567627, 827588.75560329, 1742421.24254344, ...,

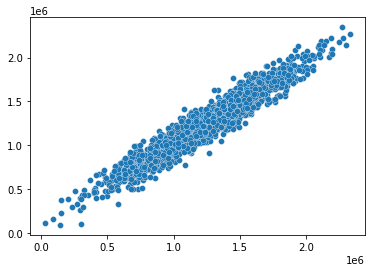
372191.40626917, 1365217.15140898, 1914519.5417888 ])

In []:

plt.scatter(y\_test, predictions, linewidths=0.3, edgecolors='White')

Out[]:

<matplotlib.collections.PathCollection at 0x7f6729cb5f50>

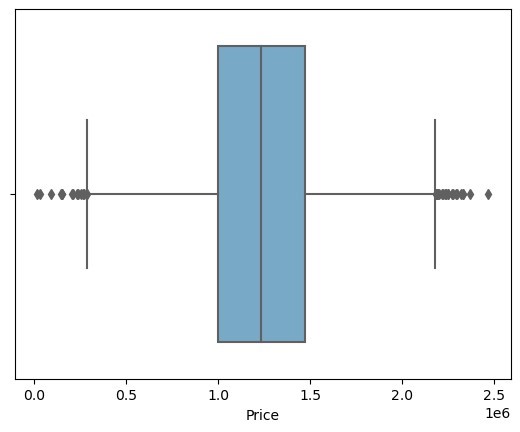
****

In []:

sns.boxplot(dataset, x='Price', palette='Blues')

Out[]:

<Axes: xlabel='Price'>

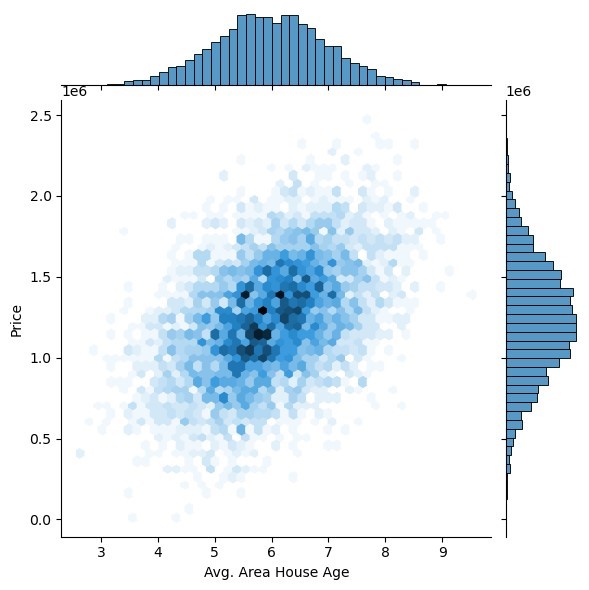


In []:

sns.jointplot(dataset, x='Avg. Area House Age', y='Price', kind='hex')

Out[]:

<seaborn.axisgrid.JointGrid at 0x7caf1d571810>



In[]:

dataset.hist(figsize=(10,8))

Out[6]:

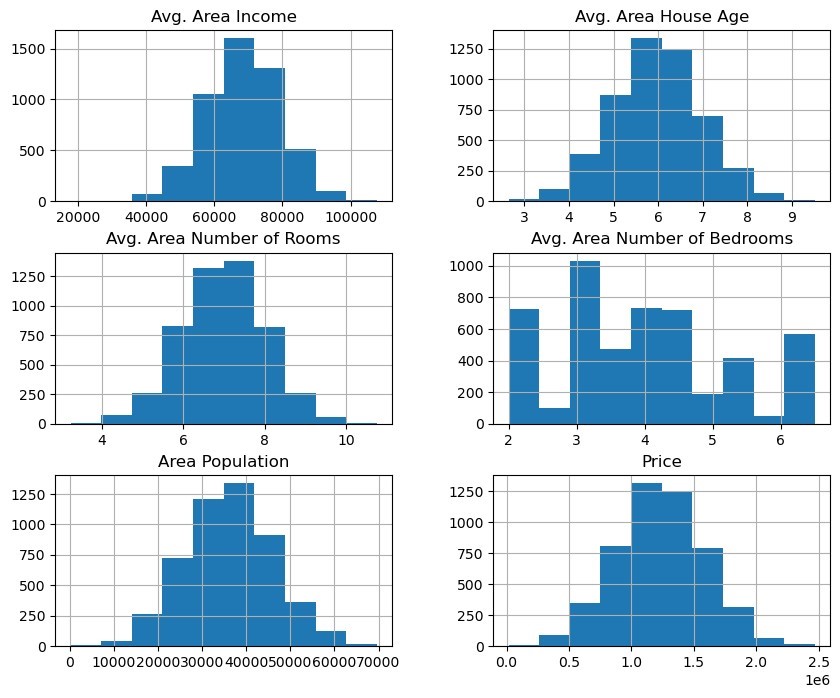
array([[<Axes: title={'center': 'Avg. Area Income'}>, <Axes: title={'center': 'Avg. Area House Age'}>],

[<Axes: title={'center': 'Avg. Area Number of Rooms'}>,

<Axes: title={'center': 'Avg. Area Number of Bedrooms'}>],

[<Axes: title={'center': 'Area Population'}>,

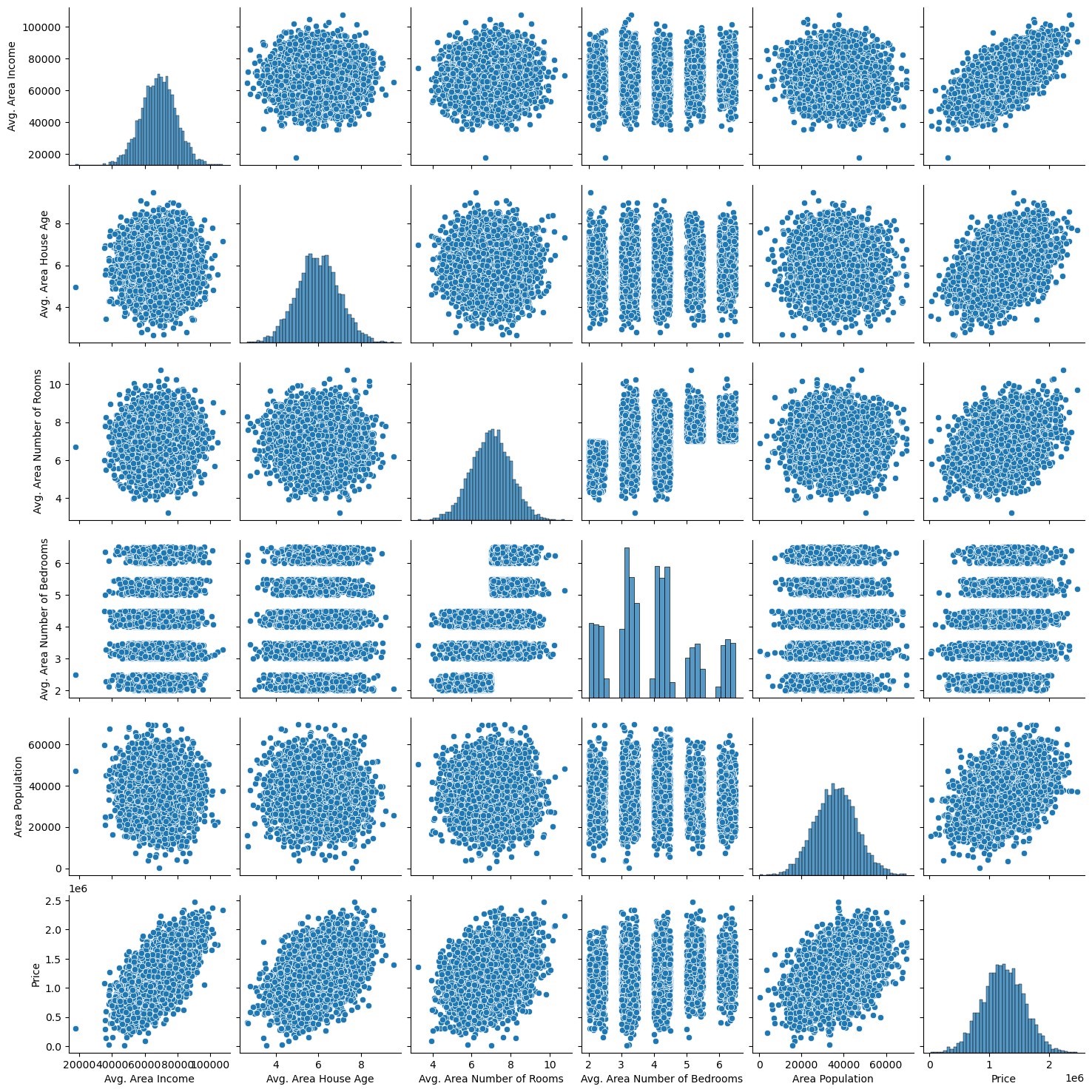
<Axes: title={'center': 'Price'}>]], dtype=object)



In[]:

Plt. figure(figsize=(12,8))sns.pairplot(Dataset)

Out[]:



In []:

plt.figure(figsize=(10,5))sns.heatmap(dataset.corr(numeric\_only = e), annot=True)

Out[]:

<Axes: >



In []:

plt

.

figure(figsize

=

(

12

,

8

))

sns

.

barplot(x

=

models[

"Model"

]

, y

=

models[

"RMSE (Cross-Validation

)

"

])

plt

.

title(

"Models' RMSE Scores (Cross-Validated)"

, size

=

15

)

plt

.

xticks(rotation

=

30

, size

=

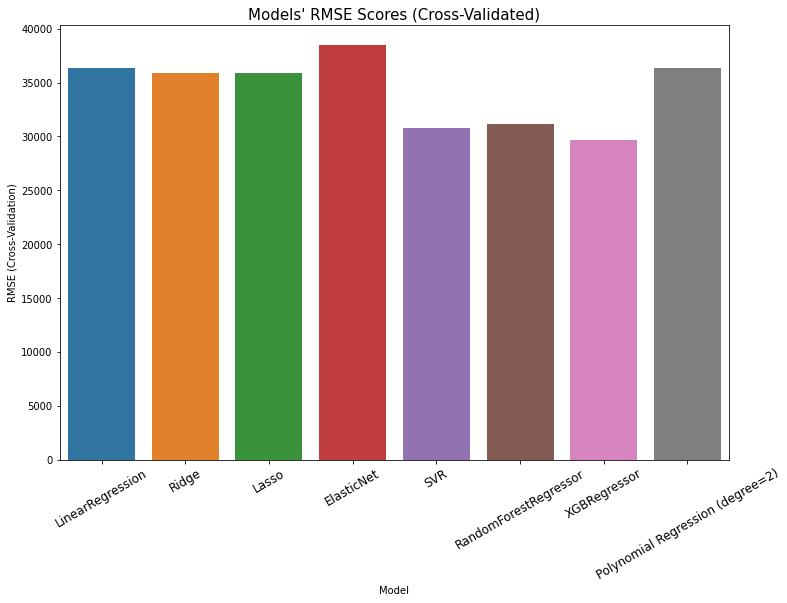
12

)

plt

.

show()



**Model Comparison**:

In []:

models.sort\_values(by="RMSE (Cross-Validation)")

Out[30]:

Model MAE MSE RMSE R2 Score

RMSE

(Cross-Validation)

XGBRegressor

1.743992e+04

7.165790e+08

2.676899e+04

9.065778e-01

29698.849618

SVR

1.784316e+04

1.132136e+09

3.364723e+04

8.524005e-01

30745.475239

RandomForestRegressor

1.811511e+04

1.004422e+09

3.169262e+04

8.690509e-01

31138.863315

Ridge

2.343550e+04

1.404264e+09

3.747351e+04

8.169225e-01

35887.852792

**MODEL EVALUATION:**

Model evaluation for house price prediction is the process of assessing how well a trained machine learning model can predict the sale price of a house on new data. This is an important step in the machine learning workflow, as it helps to ensure that the model is generalizing well and is not simply overfitting the training data.

There are a number of different metrics that can be used to evaluate house price prediction models. Some of the most common metrics include:

* **Root mean squared error (RMSE):** RMSE is a measure of the difference between the predicted and actual sale prices of houses in the test set. It is calculated by taking the square root of the average squared error. A lower RMSE indicates a better model.
* **Mean absolute error (MAE):** MAE is another measure of the difference between the predicted and actual sale prices of houses in the test set. It is calculated by taking the average of the absolute errors. A lower MAE indicates a better model.
* **R-squared:** R-squared is a measure of how well the model explains the variation in the sale prices of houses in the test set. It ranges from 0 to 1, with a higher value indicating a better model.

In addition to these quantitative metrics, it is also important to consider qualitative factors when evaluating house price prediction models, such as the interpretability of the model and the cost of deploying the model to production.

**Features:**

House price prediction using machine learning relies on a variety of features, which are essentially the input variables or attributes used to train a predictive model. These features play a crucial role in determining the accuracy and effectiveness of the machine learning model for predicting house prices. Here are some common features used in house price prediction using machine learning:

1. **Location and Neighborhood Characteristics:**
   * Latitude and Longitude: The geographic coordinates of the property.
   * Proximity to Amenities: Distances to schools, parks, shopping centers, public transportation, and other amenities.
   * Crime Rates: Local crime statistics can be a relevant feature.
2. **Property Characteristics:**
   * Property Size: The total square footage of the house, number of bedrooms, bathrooms, and other rooms.
   * Lot Size: The size of the land or lot on which the property is situated.
   * Year Built: The age of the property.
   * Architectural Style: The architectural style of the house.
   * Renovations and Upgrades: Information about any recent renovations or upgrades.
3. **Market Trends:**
   * Historical Sales Data: Data on recent property sales in the area.
   * Historical Price Trends: Information on how property prices have changed over time in the region.
   * Supply and Demand: Information about the supply and demand in the local real estate market.
4. **Economic and Demographic Data:**
   * Local Employment Rates: Data on employment rates in the area.
   * Population Density: The population density of the neighborhood.
   * Income Levels: Median household income in the area.
5. **Property Condition:**
   * Property Condition: The overall condition of the house, including factors like wear and tear.
   * Inspection Reports: Data from property inspections.
6. **Environmental Factors:**
   * Pollution Levels: Information on air and water quality.
   * Environmental Hazards: Proximity to environmental hazards or natural disaster risks.
7. **Seasonal Factors:**
   * Seasonal Trends: Consideration of how property prices may vary by season.
8. **Housing Market Indicators:**
   * Mortgage Rates: Current interest rates for home loans.
   * Inventory Levels: The number of available properties in the market.
9. **Features Extracted from Images:**
   * Image Analysis: Extracting features from property photos, such as the presence of a swimming pool, landscaping, or the condition of the exterior.
10. **Social Media and Online Reviews:**
    * Sentiment Analysis: Extracting insights from online reviews or social media discussions about the neighborhood or property.
11. **Home Features:**
    * Appliance Types: The presence of specific appliances (e.g., dishwasher, washer/dryer).
    * Home Technology: Smart home features (e.g., smart thermostats, security systems).
12. **Financing Information:**
    * Loan-to-Value Ratio: Information about the mortgage or financing terms for the property.
13. **Property Tax Information:**
    * Property Tax Rates: Local property tax rates and assessed values.
14. **Historical Maintenance and Repair Data:**
    * Records of past maintenance and repairs on the property.

**Advantages:**

1. **Informed Decision-Making:** House price predictions provide potential buyers

and sellers with valuable information, allowing them to make informed decisions about purchasing or selling properties. This can help individuals and investors

maximize their returns.

1. **Risk Mitigation:** House price predictions can help real estate investors assess

the potential risk associated with their investments. By understanding how

property values might change over time, investors can make more calculated

decisions.

1. **Market Timing:** Accurate predictions can help buyers and sellers time their

Transactions effectively. For example, buyers may wait for prices to drop before making a purchase, while sellers may choose to list their property when prices

are expected to rise.

1. **Investment Strategy:** Real estate investors can use house price predictions to develop and fine-tune their investment strategies, such as choosing the right locations and types of properties to invest in.
2. **Financial Planning:** Homeowners can use predictions to plan their finances

more effectively. Knowing the expected future value of their property can be

helpful for long-term financial planning and retirement goals.

**Disadvantages:**

1. **Uncertainty:** House price predictions are not guaranteed to be accurate. They

are based on historical data, market trends, and various assumptions, so there is always a level of uncertainty involved.

1. **Data Quality:** Predictions heavily rely on the quality and quantity of data

available. Inaccurate or incomplete data can lead to unreliable predictions.

1. **External Factors:** Predictions can be affected by external factors such as

economic downturns, political events, and natural disasters, which can be

challenging to account for.

1. **Local Variations:** Real estate markets can vary significantly from one location to another, making it challenging to create accurate predictions for every area.

**Benefits:**

1. **Price Transparency:** House price predictions contribute to price transparency in the real estate market, helping buyers and sellers understand the market

dynamics.

1. **Investment Opportunities:** Predictions can reveal investment opportunities in

undervalued or emerging markets, potentially leading to significant returns for

investors.

1. **Portfolio Diversification**: For real estate investors, accurate predictions can

assist in diversifying their property portfolios effectively to reduce risk.

1. **Long-Term Planning:** Homeowners can use predictions for long-term planning, such as refinancing, renovating, or selling at the right time.
2. **Industry Innovation:** House price prediction drives innovation in real-estate

technology and data analytics, making the industry more efficient and

competitive.

**House Price Prediction Report**

**Introduction:**

This document is designed to provide you with insights into property prices in a specific region. It aims to help buyers, sellers, and real estate professionals make

informed decisions regarding real estate transactions.

Property Information

* **Property Address:** [Address]
* **Property Type:** [Type of Property]
* **Property Size:** [Square Footage]
* **Lot Size:** [Lot Size]
* **Year Built:** [Year Built]
* **Number of Bedrooms:** [Bedrooms]
* **Number of Bathrooms:** [Bathrooms]
* **Architectural Style:** [Architectural Style]

Market Trends

* **Historical Price Trends:** An overview of how property prices have changed over time in the region.
* **Recent Sales Data:** Data on recent property sales in the area.
* **Supply and Demand:** Information about the current state of the local real estate market.

Location and Neighborhood

* **Latitude and Longitude:** [Coordinates]
* **Proximity to Amenities:** Distance to schools, parks, shopping centers, etc.
* **Crime Rates:** Local crime statistics.

Property Condition

* **Property Condition:** An assessment of the overall condition of the house.
* **Renovations and Upgrades:** Details on recent property renovations or

upgrades.

Economic and Demographic Data

* **Local Employment Rates:** Data on employment rates in the area.
* **Population Density:** The population density of the neighborhood.
* **Income Levels:** Median household income in the region.

CONCLUSION:

Machine learning can be a powerful tool for house price prediction. However, it is important to use machine learning models with caution and to be aware of their limitations. For example, machine learning models are trained on historical data, so they may not be accurate in predicting house prices in a changing market. Additionally, machine learning models can be biased, depending on the data they are trained on.

Overall, machine learning can be a valuable tool for house price prediction, but it should be used in conjunction with other factors, such as expert judgment and market research.

When dealing with complex relationships, outliers, or a large number of features, Linear Regression, Random Forest Regression, Gradient Boosting Regression andXGBoost Regression may perform better.

loading and preprocessing are foundational steps in the data analysis and machine learning workflows. They help ensure that the data is in the right format, contains valid and relevant information, and is suitable for the chosen analysis or modeling task. Proper data loading and preprocessing can significantly impact the quality and effectiveness of your results. The specific techniques you use will depend on your dataset and the goals of your analysis or modeling project.