Week 4: Deployment on Flask

Name: Deployment on Flask
Report date: 28-May-2023
Internship Batch: LISUM21
Version:1.0
Data intake by: Ece Yavuzyılmaz
Data intake reviewer : Data Glacier
Data storage location: https://github.com/eceyy/Data_Glacier_Intership_2023/tree/main/Week%204

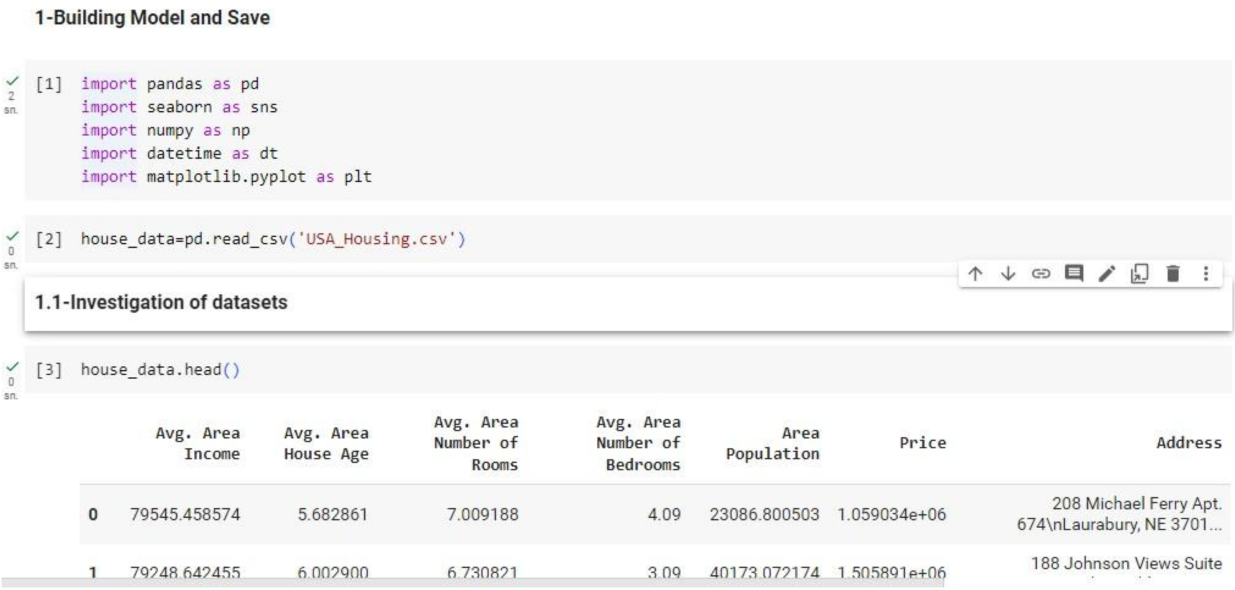
Tabular data details:

Total number of observations	5000
Total number of files	1
Total number of features	7
Base format of the file	csv
Size of the data	709 KB

1-Building Model and Save

1.1-Investigation of Datasets

Here, the dataset containing US home information was imported to predict home prices.



1-Building Model and Save

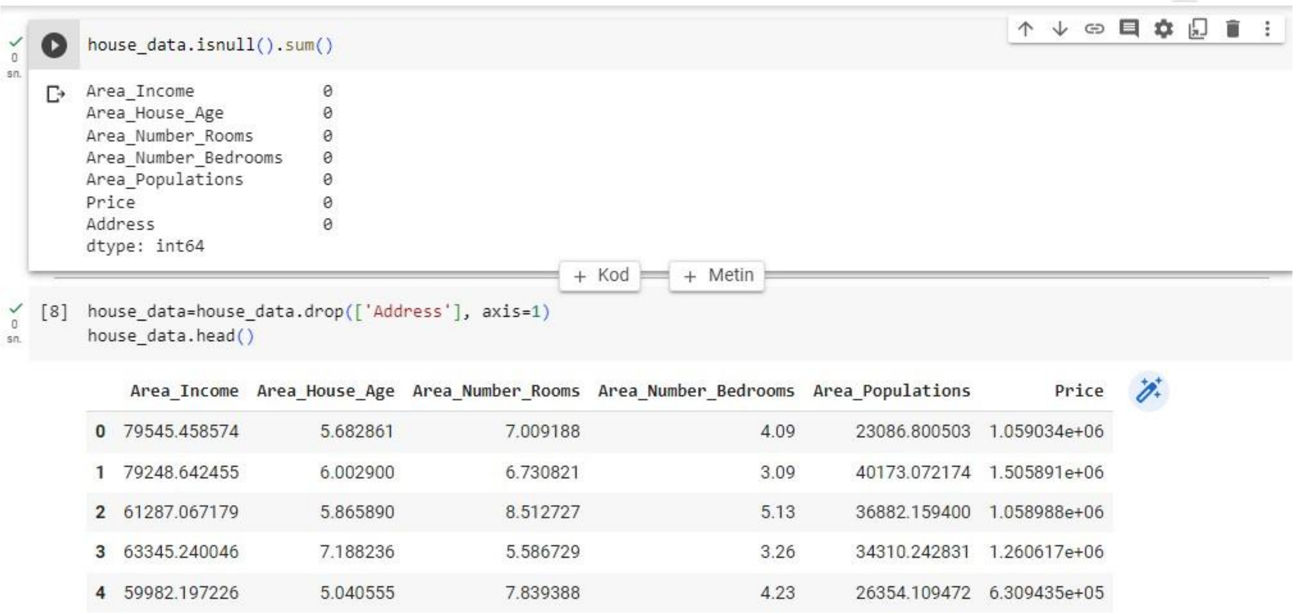
```
[1] import pandas as pd
    import seaborn as sns
    import numpy as np
    import datetime as dt
    import matplotlib.pyplot as plt
```

```
[2] house_data=pd.read_csv('USA_Housing.csv')
```

1.1-Investigation of datasets

```
[3] house_data.head()
```

	Avg. Area Income	Avg. Area House Age	Avg. Area Number of Rooms	Avg. Area Number of Bedrooms	Area Population	Price	Address
0	79545.458574	5.682861	7.009188	4.09	23086.800503	1.059034e+06	208 Michael Ferry Apt. 674\nLaurabury, NE 3701...
1	79248.642455	6.002900	6.730821	3.09	40173.072174	1.505891e+06	188 Johnson Views Suite

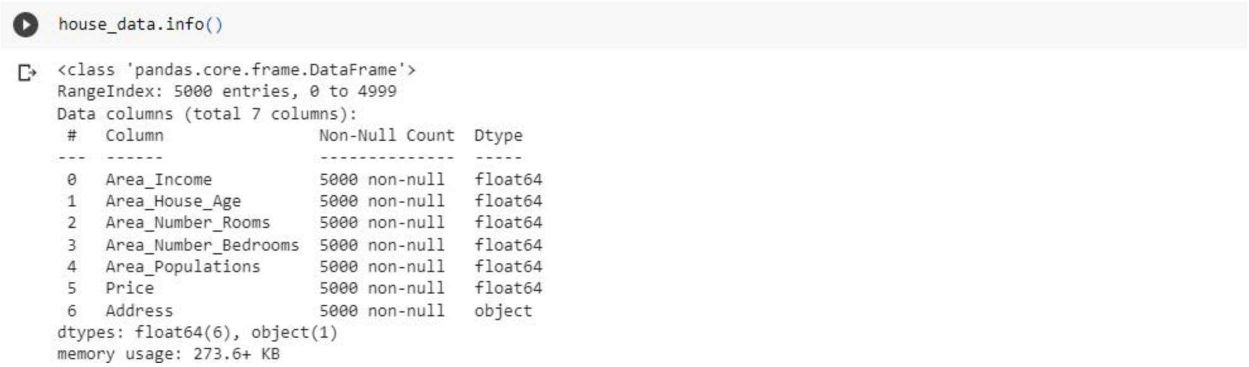


```
house_data.isnull().sum()
```

```
Area_Income             0
Area_House_Age          0
Area_Number_Rooms       0
Area_Number_Bedrooms    0
Area_Populations        0
Price                   0
Address                 0
dtype: int64
```

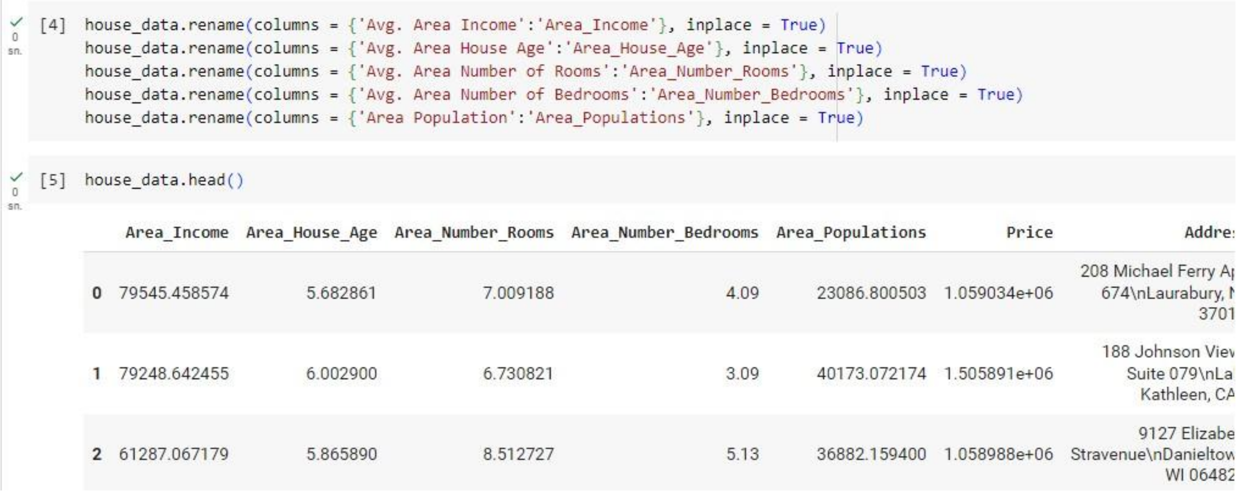
```
[8] house_data=house_data.drop(['Address'], axis=1)
    house_data.head()
```

	Area_Income	Area_House_Age	Area_Number_Rooms	Area_Number_Bedrooms	Area_Populations	Price
0	79545.458574	5.682861	7.009188	4.09	23086.800503	1.059034e+06
1	79248.642455	6.002900	6.730821	3.09	40173.072174	1.505891e+06
2	61287.067179	5.865890	8.512727	5.13	36882.159400	1.058988e+06
3	63345.240046	7.188236	5.586729	3.26	34310.242831	1.260617e+06
4	59982.197226	5.040555	7.839388	4.23	26354.109472	6.309435e+05



```
house_data.info()
```

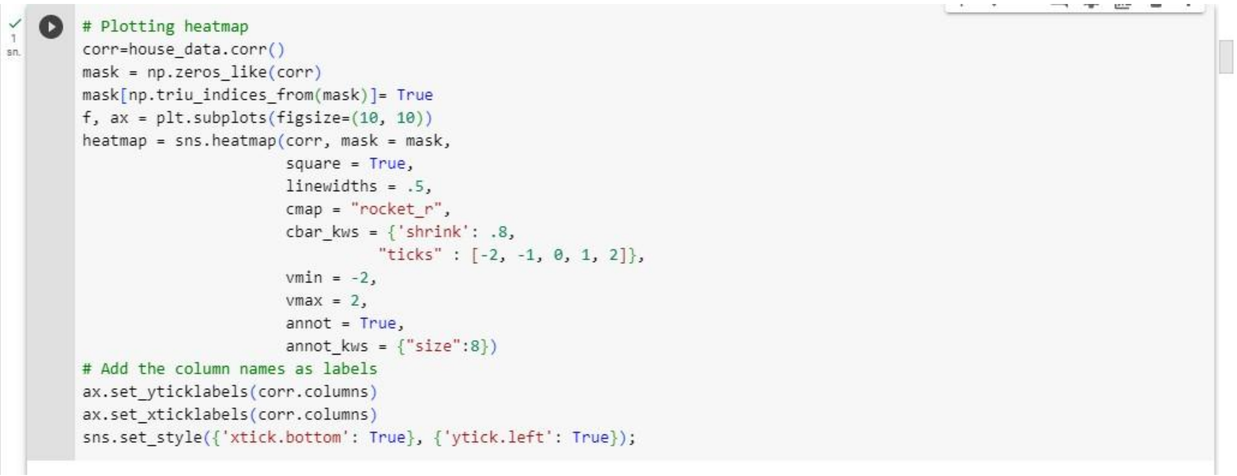
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5000 entries, 0 to 4999
Data columns (total 7 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   Area_Income           5000 non-null   float64
 1   Area_House_Age        5000 non-null   float64
 2   Area_Number_Rooms     5000 non-null   float64
 3   Area_Number_Bedrooms  5000 non-null   float64
 4   Area_Populations      5000 non-null   float64
 5   Price                 5000 non-null   float64
 6   Address               5000 non-null   object 
dtypes: float64(6), object(1)
memory usage: 273.6+ KB
```



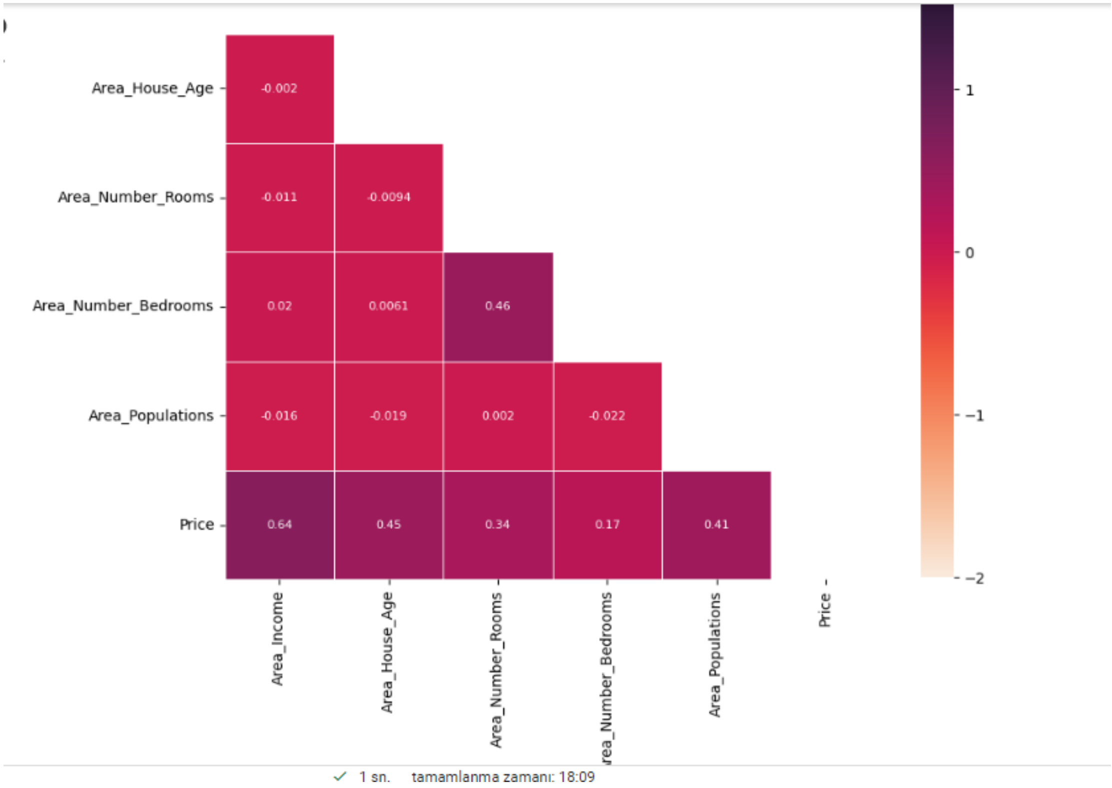
```
[4] house_data.rename(columns = {'Avg. Area Income':'Area_Income'}, inplace = True)
    house_data.rename(columns = {'Avg. Area House Age':'Area_House_Age'}, inplace = True)
    house_data.rename(columns = {'Avg. Area Number of Rooms':'Area_Number_Rooms'}, inplace = True)
    house_data.rename(columns = {'Avg. Area Number of Bedrooms':'Area_Number_Bedrooms'}, inplace = True)
    house_data.rename(columns = {'Area Population':'Area_Populations'}, inplace = True)
```

```
[5] house_data.head()
```

	Area_Income	Area_House_Age	Area_Number_Rooms	Area_Number_Bedrooms	Area_Populations	Price	Addre
0	79545.458574	5.682861	7.009188	4.09	23086.800503	1.059034e+06	208 Michael Ferry Ap 674\nLaurabury, N 3701
1	79248.642455	6.002900	6.730821	3.09	40173.072174	1.505891e+06	188 Johnson View Suite 079\nLa Kathleen, CA
2	61287.067179	5.865890	8.512727	5.13	36882.159400	1.058988e+06	9127 Elizabe Stravenue\nDanieltow WI 06482

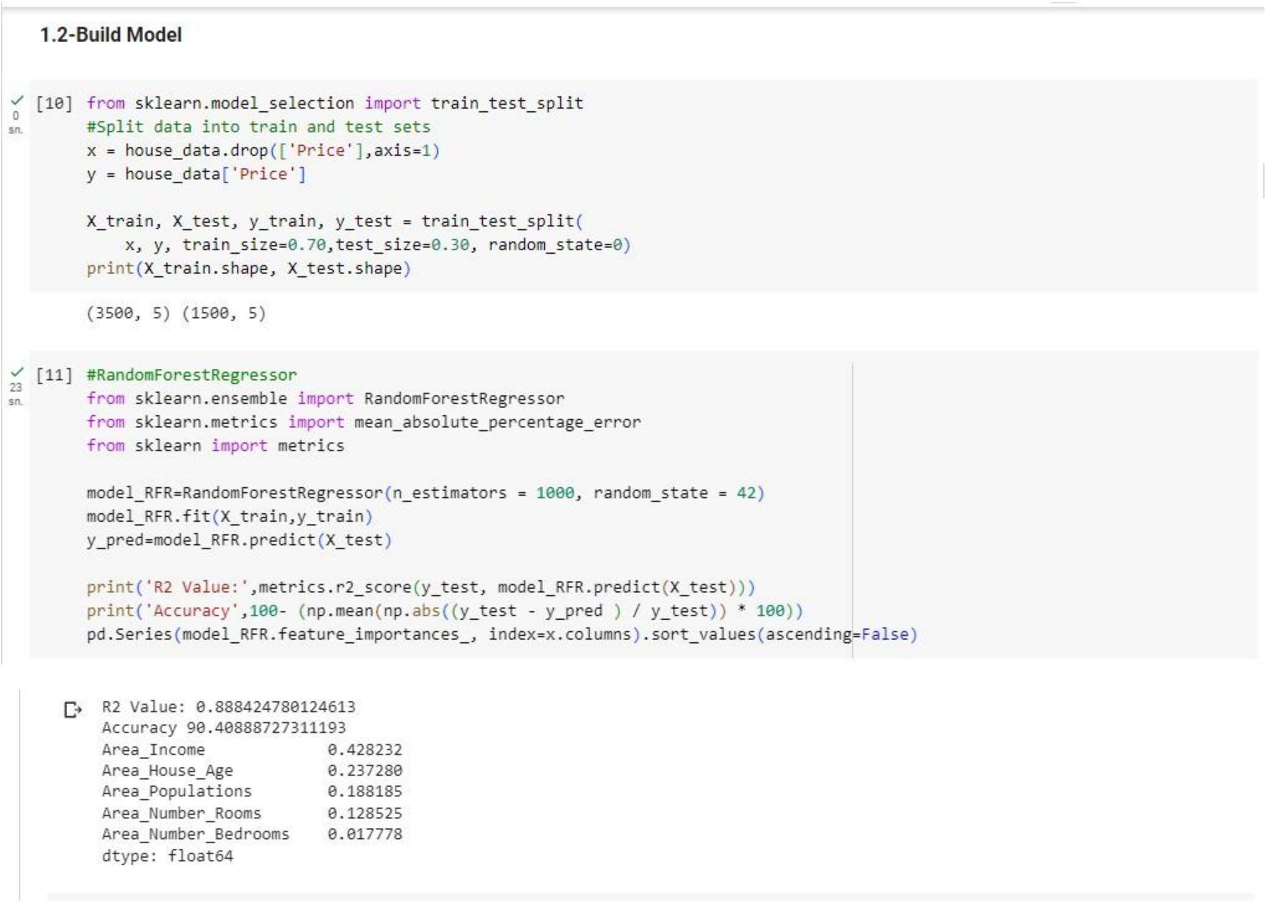


```
# Plotting heatmap
corr=house_data.corr()
mask = np.zeros_like(corr)
mask[np.triu_indices_from(mask)]= True
f, ax = plt.subplots(figsize=(10, 10))
heatmap = sns.heatmap(corr, mask = mask,
                      square = True,
                      linewidths = .5,
                      cmap = "rocket_r",
                      cbar_kws = {'shrink': .8,
                                "ticks" : [-2, -1, 0, 1, 2]},
                      vmin = -2,
                      vmax = 2,
                      annot = True,
                      annot_kws = {"size":8})
# Add the column names as labels
ax.set_yticklabels(corr.columns)
ax.set_xticklabels(corr.columns)
sns.set_style({'xtick.bottom': True}, {'ytick.left': True});
```



1.2- Build Model

After data preprocessing, machine learning model was implemented to predict house prices. Model was created with Random Forest Regressor and Linear Regression using scikit-learn. The best performance was achieved with the Linear Regression method.



1.2-Build Model

[10]

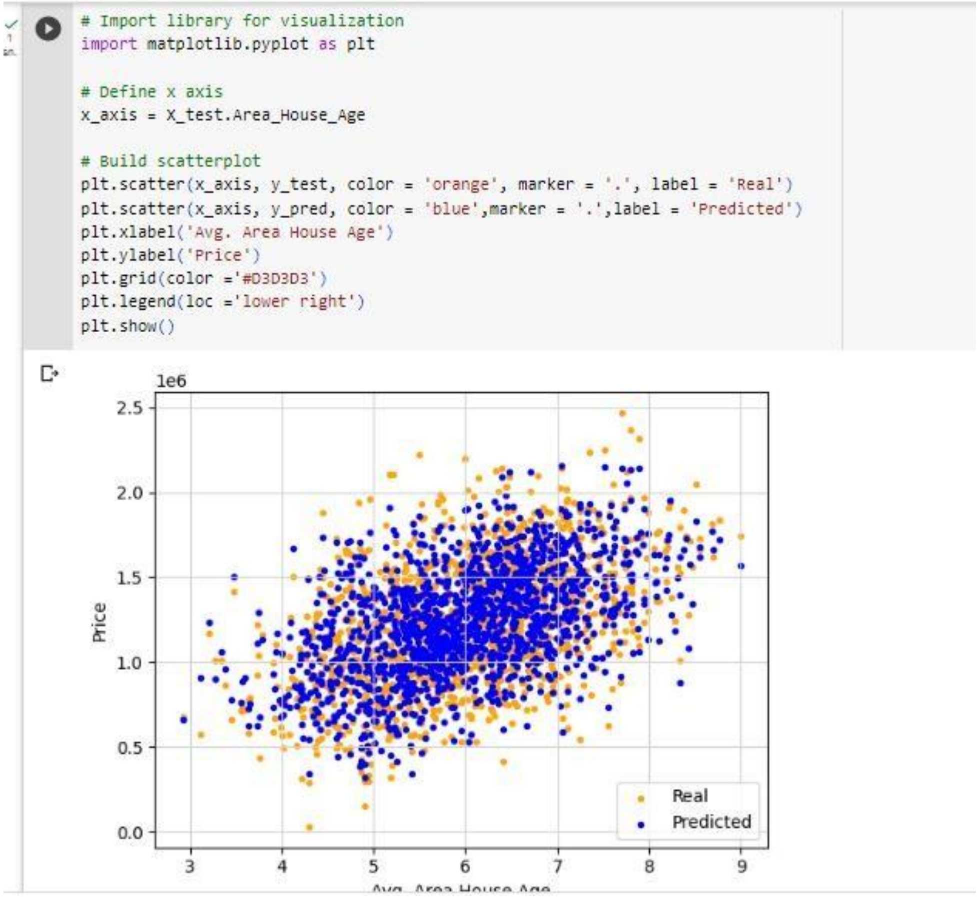
```
from sklearn.model_selection import train_test_split
#Split data into train and test sets
x = house_data.drop(['Price'],axis=1)
y = house_data['Price']

X_train, X_test, y_train, y_test = train_test_split(
    x, y, train_size=0.70,test_size=0.30, random_state=0)
print(X_train.shape, X_test.shape)
```

```
(3500, 5) (1500, 5)
```

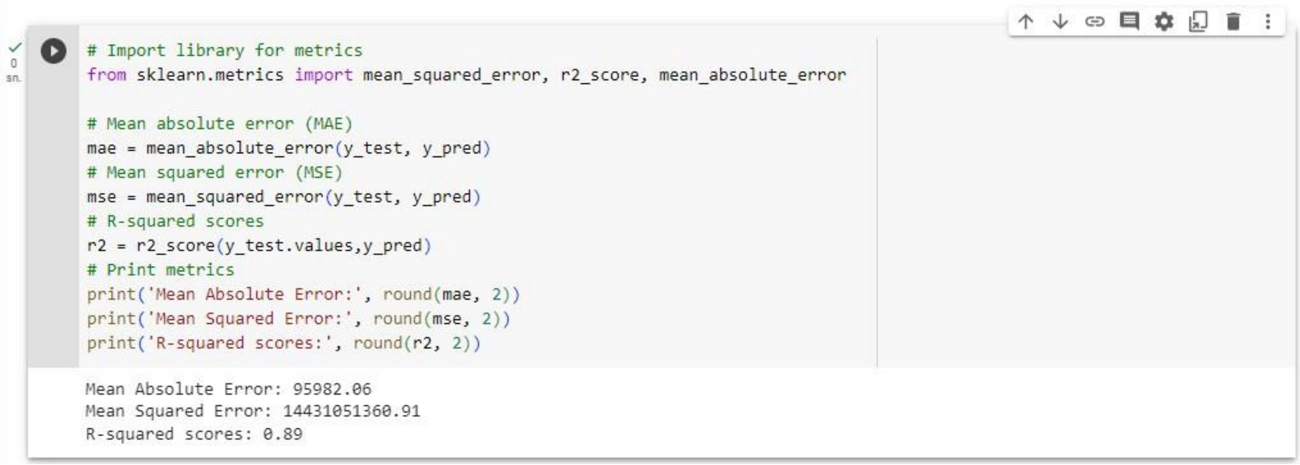
[11]

```
#RandomForestRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_absolute_percentage_error
from sklearn import metrics

model_RFR=RandomForestRegressor(n_estimators = 1000, random_state = 42)
model_RFR.fit(X_train,y_train)
y_pred=model_RFR.predict(X_test)

print('R2 Value:',metrics.r2_score(y_test, model_RFR.predict(X_test)))
print('Accuracy',100- (np.mean(np.abs((y_test - y_pred ) / y_test)) * 100))
pd.Series(model_RFR.feature_importances_, index=x.columns).sort_values(ascending=False)
```

```
R2 Value: 0.888424780124613
Accuracy 90.40888727311193
Area_Income              0.428232
Area_House_Age           0.237280
Area_Populations         0.188185
Area_Number_Rooms        0.128525
Area_Number_Bedrooms     0.017778
dtype: float64
```

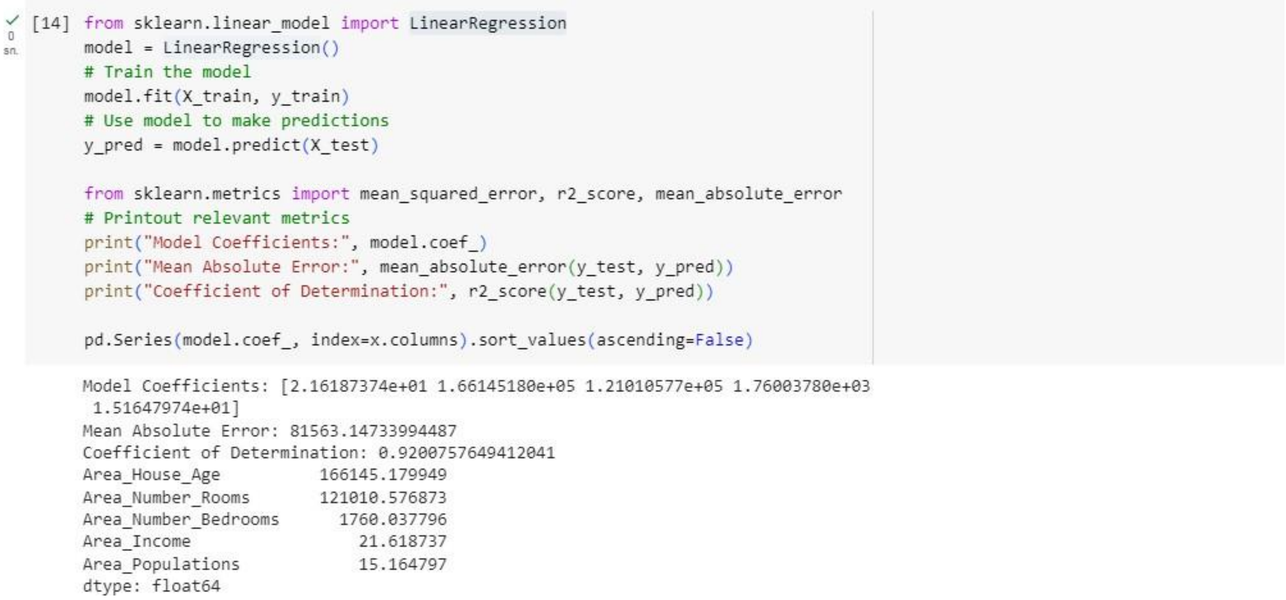


```
# Import library for visualization
import matplotlib.pyplot as plt

# Define x axis
x_axis = X_test.Area_House_Age

# Build scatterplot
plt.scatter(x_axis, y_test, color = 'orange', marker = '.', label = 'Real')
plt.scatter(x_axis, y_pred, color = 'blue',marker = '.',label = 'Predicted')
plt.xlabel('Avg. Area House Age')
plt.ylabel('Price')
plt.grid(color ='#D3D3D3')
plt.legend(loc ='lower right')
plt.show()
```



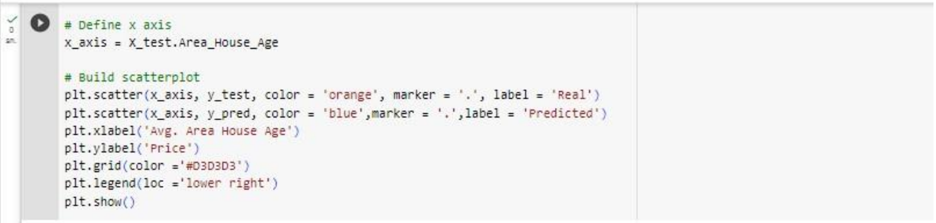
```
# Import library for metrics
from sklearn.metrics import mean_squared_error, r2_score, mean_absolute_error

# Mean absolute error (MAE)
mae = mean_absolute_error(y_test, y_pred)
# Mean squared error (MSE)
mse = mean_squared_error(y_test, y_pred)
# R-squared scores
r2 = r2_score(y_test.values,y_pred)
# Print metrics
print('Mean Absolute Error:', round(mae, 2))
print('Mean Squared Error:', round(mse, 2))
print('R-squared scores:', round(r2, 2))
```

```
Mean Absolute Error: 95982.06
Mean Squared Error: 14431051360.91
R-squared scores: 0.89
```

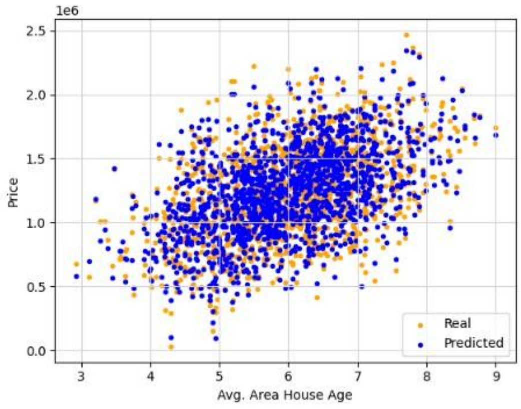


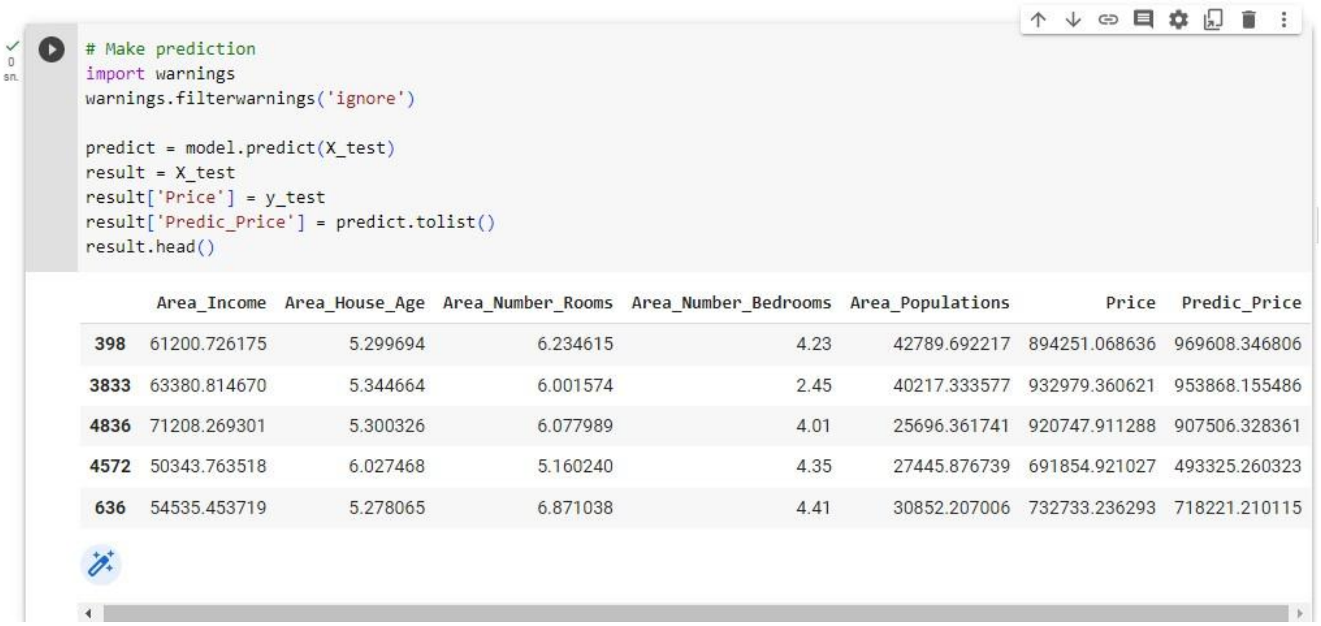
```
[14] from sklearn.linear_model import LinearRegression
     model = LinearRegression()
     # Train the model
     model.fit(X_train, y_train)
     # Use model to make predictions
     y_pred = model.predict(X_test)

     from sklearn.metrics import mean_squared_error, r2_score, mean_absolute_error
     # Printout relevant metrics
     print("Model Coefficients:", model.coef_)
     print("Mean Absolute Error:", mean_absolute_error(y_test, y_pred))
     print("Coefficient of Determination:", r2_score(y_test, y_pred))

     pd.Series(model.coef_, index=x.columns).sort_values(ascending=False)
```

```
Model Coefficients: [2.16187374e+01 1.66145180e+05 1.21010577e+05 1.76003780e+03
 1.51647974e+01]
Mean Absolute Error: 81563.14733994487
Coefficient of Determination: 0.9200757649412041
Area_House_Age          166145.179949
Area_Number_Rooms       121010.576873
Area_Number_Bedrooms      1760.037796
Area_Income                 21.618737
Area_Populations            15.164797
dtype: float64
```



```
# Define x axis
x_axis = X_test.Area_House_Age

# Build scatterplot
plt.scatter(x_axis, y_test, color = 'orange', marker = '.', label = 'Real')
plt.scatter(x_axis, y_pred, color = 'blue',marker = '.',label = 'Predicted')
plt.xlabel('Avg. Area House Age')
plt.ylabel('Price')
plt.grid(color ='#D3D3D3')
plt.legend(loc ='lower right')
plt.show()
```

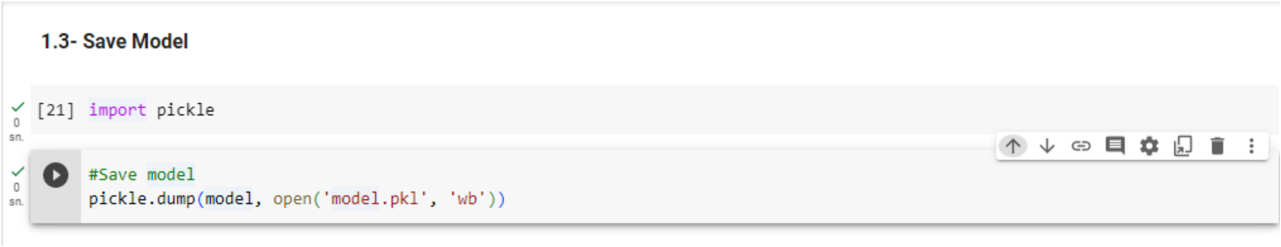




```
# Make prediction
import warnings
warnings.filterwarnings('ignore')

predict = model.predict(X_test)
result = X_test
result['Price'] = y_test
result['Predic_Price'] = predict.tolist()
result.head()
```

	Area_Income	Area_House_Age	Area_Number_Rooms	Area_Number_Bedrooms	Area_Populations	Price	Predic_Price
398	61200.726175	5.299694	6.234615	4.23	42789.692217	894251.068636	969608.346806
3833	63380.814670	5.344664	6.001574	2.45	40217.333577	932979.360621	953868.155486
4836	71208.269301	5.300326	6.077989	4.01	25696.361741	920747.911288	907506.328361
4572	50343.763518	6.027468	5.160240	4.35	27445.876739	691854.921027	493325.260323
636	54535.453719	5.278065	6.871038	4.41	30852.207006	732733.236293	718221.210115

1.3- Save Model



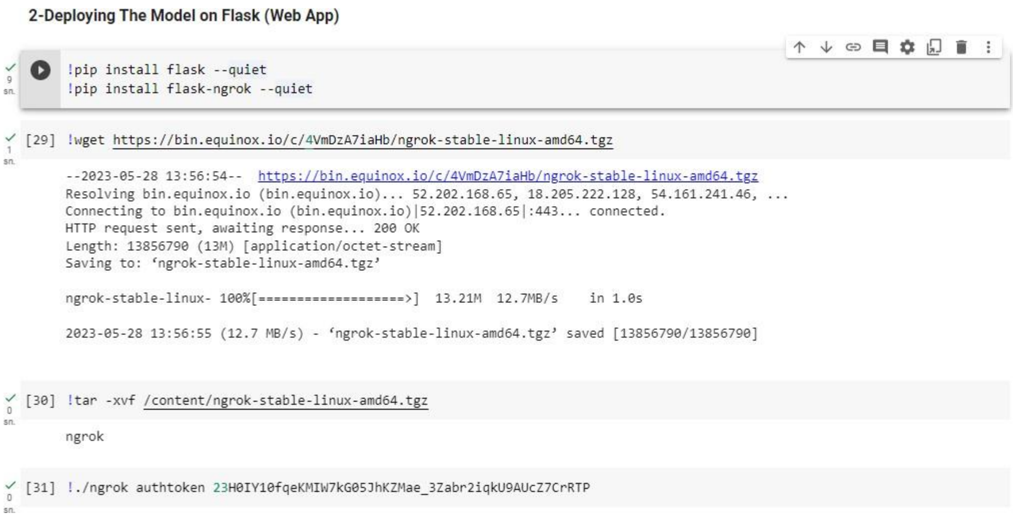
1.3- Save Model

```
[21] import pickle
```

```
#Save model
pickle.dump(model, open('model.pkl', 'wb'))
```

2-Deploying The Model on Flask (Web App)

2.1-app.py



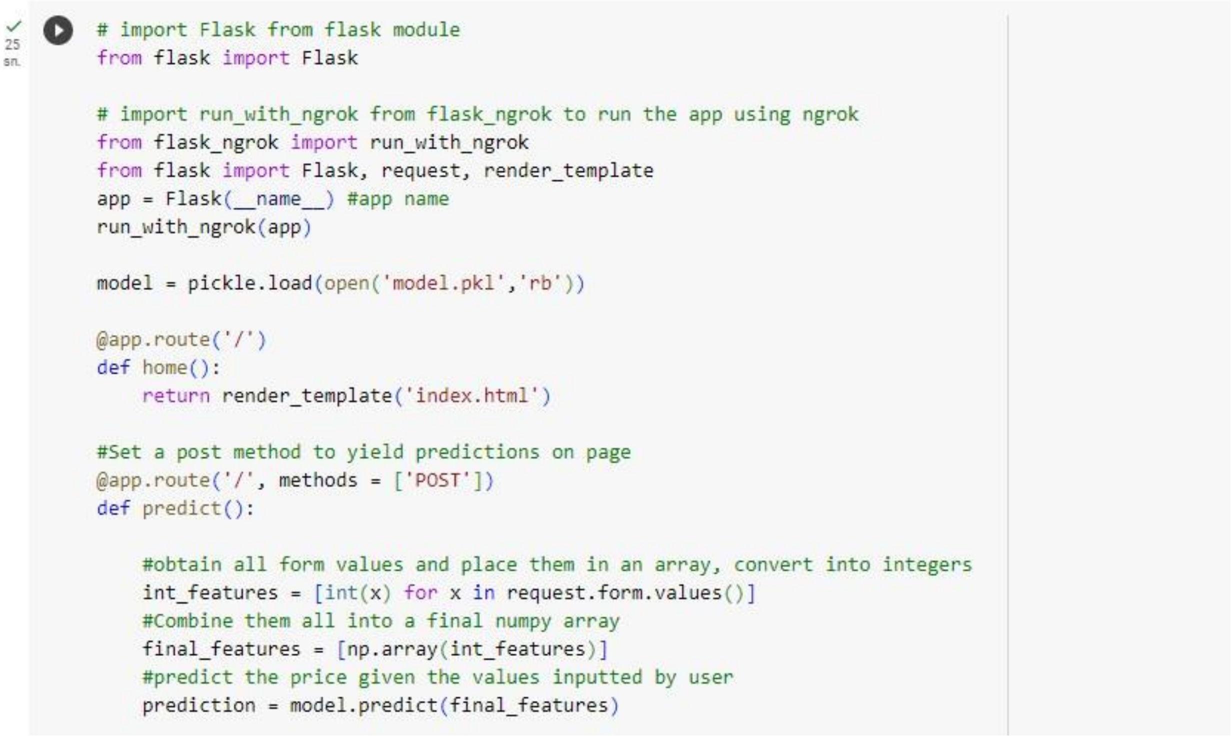
2-Deploying The Model on Flask (Web App)

```
!pip install flask --quiet
!pip install flask-ngrok --quiet
```

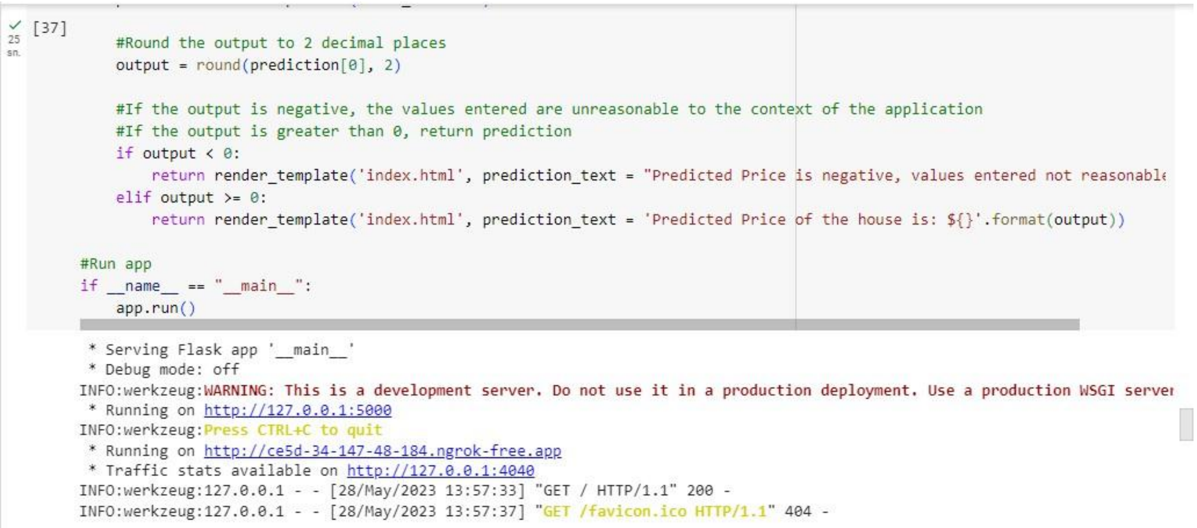
```
[29] !wget https://bin.equinox.io/c/4VmDzA7iaHb/ngrok-stable-linux-amd64.tgz

--2023-05-28 13:56:54--  https://bin.equinox.io/c/4VmDzA7iaHb/ngrok-stable-linux-amd64.tgz
Resolving bin.equinox.io (bin.equinox.io)... 52.202.168.65, 18.205.222.128, 54.161.241.46, ...
Connecting to bin.equinox.io (bin.equinox.io)|52.202.168.65|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 13856790 (13M) [application/octet-stream]
Saving to: ‘ngrok-stable-linux-amd64.tgz’

ngrok-stable-linux- 100%[===================>]  13.21M  12.7MB/s    in 1.0s

2023-05-28 13:56:55 (12.7 MB/s) - ‘ngrok-stable-linux-amd64.tgz’ saved [13856790/13856790]
```

```
[30] !tar -xvf /content/ngrok-stable-linux-amd64.tgz

ngrok
```

```
[31] !./ngrok authtoken 23H0IY10fqeKMIW7kG05JhKZMae_3Zabr2iqkU9AUcZ7CrRTP
```

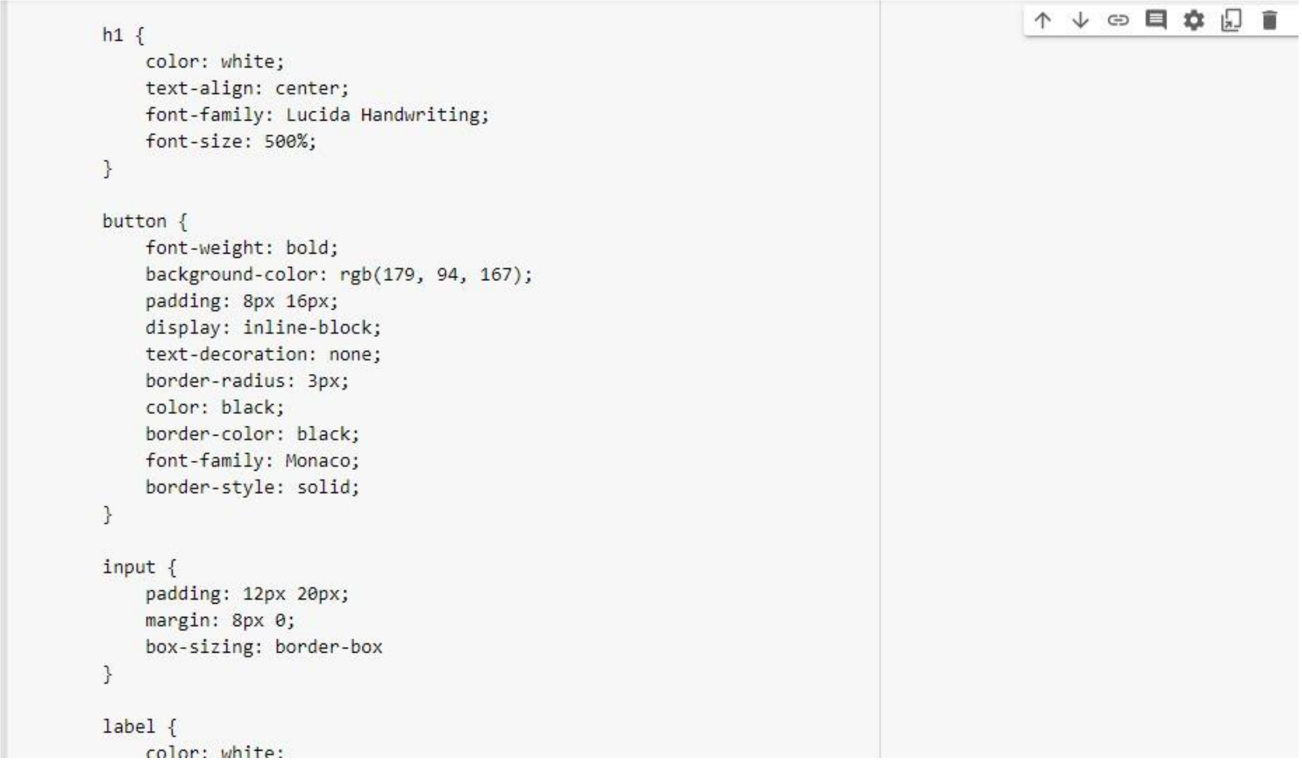


```python
# import Flask from flask module
from flask import Flask

# import run_with_ngrok from flask_ngrok to run the app using ngrok
from flask_ngrok import run_with_ngrok
from flask import Flask, request, render_template
app = Flask(__name__) #app name
run_with_ngrok(app)

model = pickle.load(open('model.pkl','rb'))

@app.route('/')
def home():
    return render_template('index.html')

#Set a post method to yield predictions on page
@app.route('/', methods = ['POST'])
def predict():

    #obtain all form values and place them in an array, convert into integers
    int_features = [int(x) for x in request.form.values()]
    #Combine them all into a final numpy array
    final_features = [np.array(int_features)]
    #predict the price given the values inputted by user
    prediction = model.predict(final_features)
```

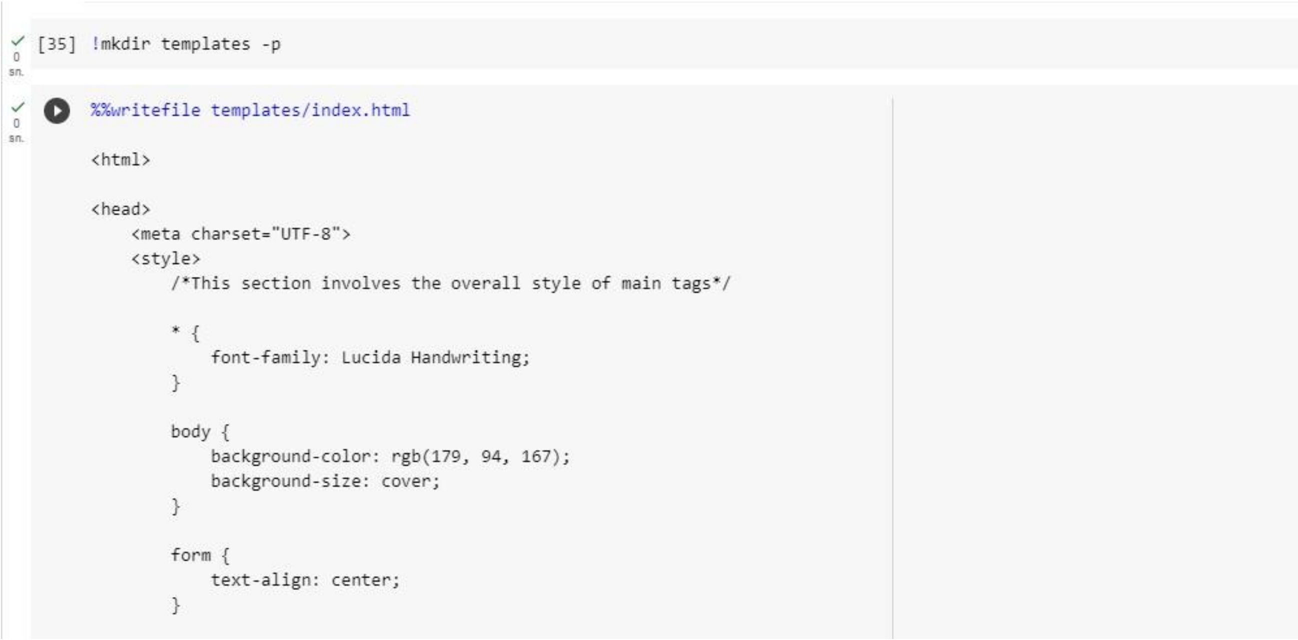


```python
    #Round the output to 2 decimal places
    output = round(prediction[0], 2)

    #If the output is negative, the values entered are unreasonable to the context of the application
    #If the output is greater than 0, return prediction
    if output < 0:
        return render_template('index.html', prediction_text = "Predicted Price is negative, values entered not reasonabl
    elif output >= 0:
        return render_template('index.html', prediction_text = 'Predicted Price of the house is: ${}'.format(output))

#Run app
if __name__ == "__main__":
    app.run()
```

```
 * Serving Flask app '__main__'
 * Debug mode: off
INFO:werkzeug:WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI serve
 * Running on http://127.0.0.1:5000
INFO:werkzeug:Press CTRL+C to quit
 * Running on http://ce5d-34-147-48-184.ngrok-free.app
 * Traffic stats available on http://127.0.0.1:4040
INFO:werkzeug:127.0.0.1 - - [28/May/2023 13:57:33] "GET / HTTP/1.1" 200 -
INFO:werkzeug:127.0.0.1 - - [28/May/2023 13:57:37] "GET /favicon.ico HTTP/1.1" 404 -
```

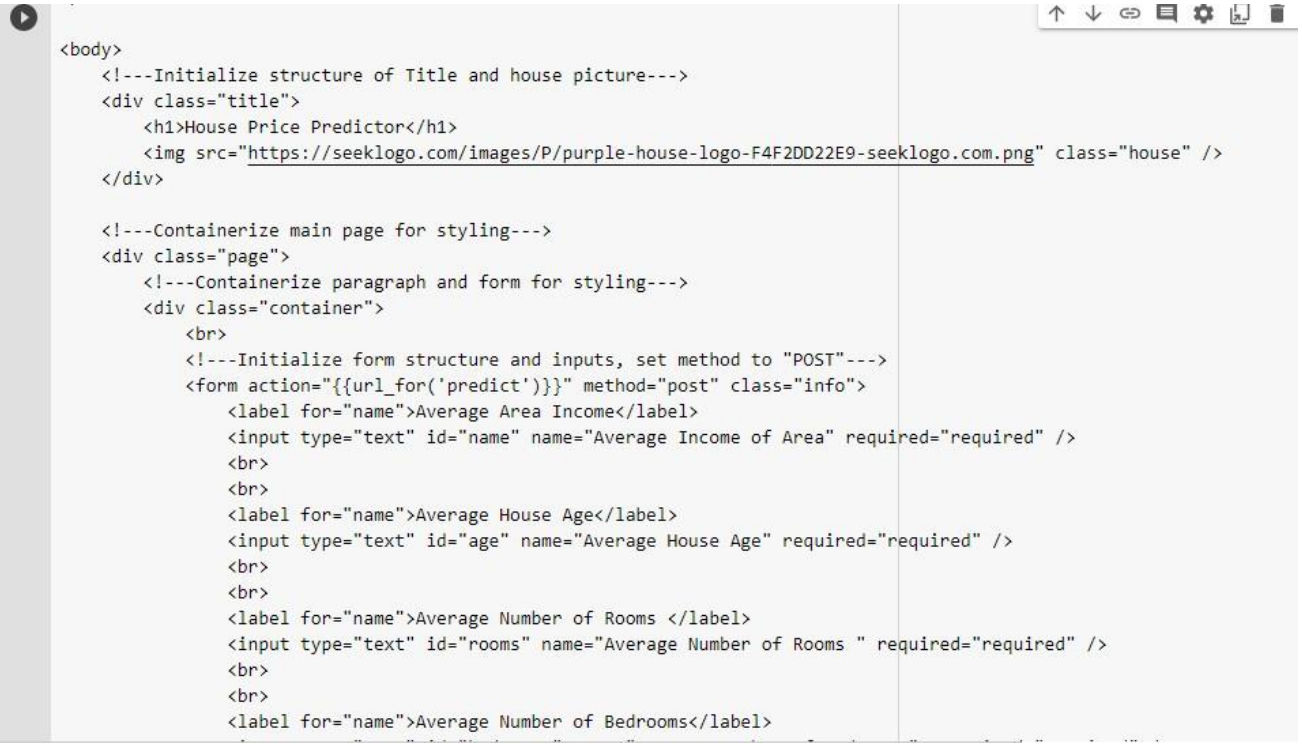


```
    h1 {
        color: white;
        text-align: center;
        font-family: Lucida Handwriting;
        font-size: 500%;
    }

    button {
        font-weight: bold;
        background-color: rgb(179, 94, 167);
        padding: 8px 16px;
        display: inline-block;
        text-decoration: none;
        border-radius: 3px;
        color: black;
        border-color: black;
        font-family: Monaco;
        border-style: solid;
    }

    input {
        padding: 12px 20px;
        margin: 8px 0;
        box-sizing: border-box
    }

    label {
        color: white;
```

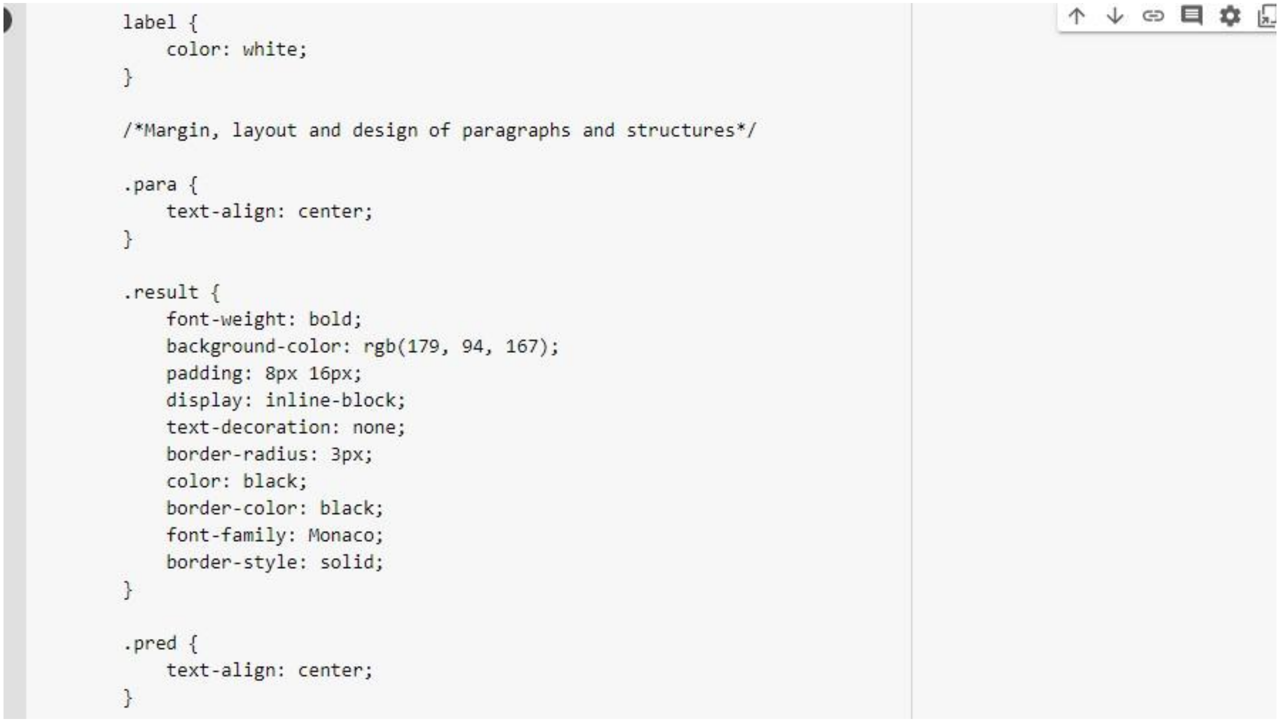


```
[35] !mkdir templates -p
```

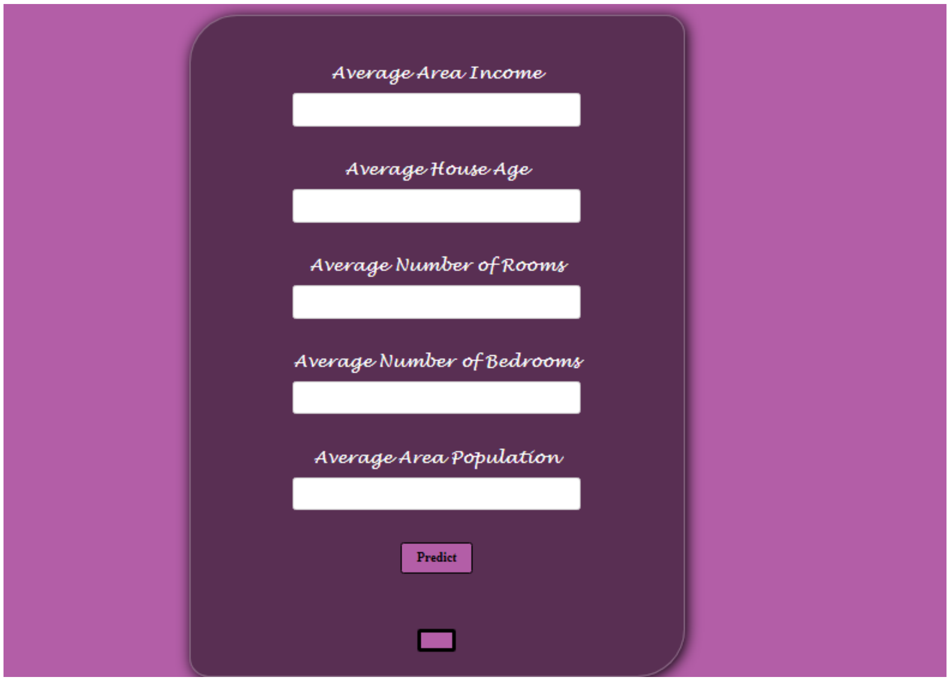
```
%%writefile templates/index.html

<html>

<head>
    <meta charset="UTF-8">
    <style>
        /*This section involves the overall style of main tags*/

        * {
            font-family: Lucida Handwriting;
        }

        body {
            background-color: rgb(179, 94, 167);
            background-size: cover;
        }

        form {
            text-align: center;
        }
```

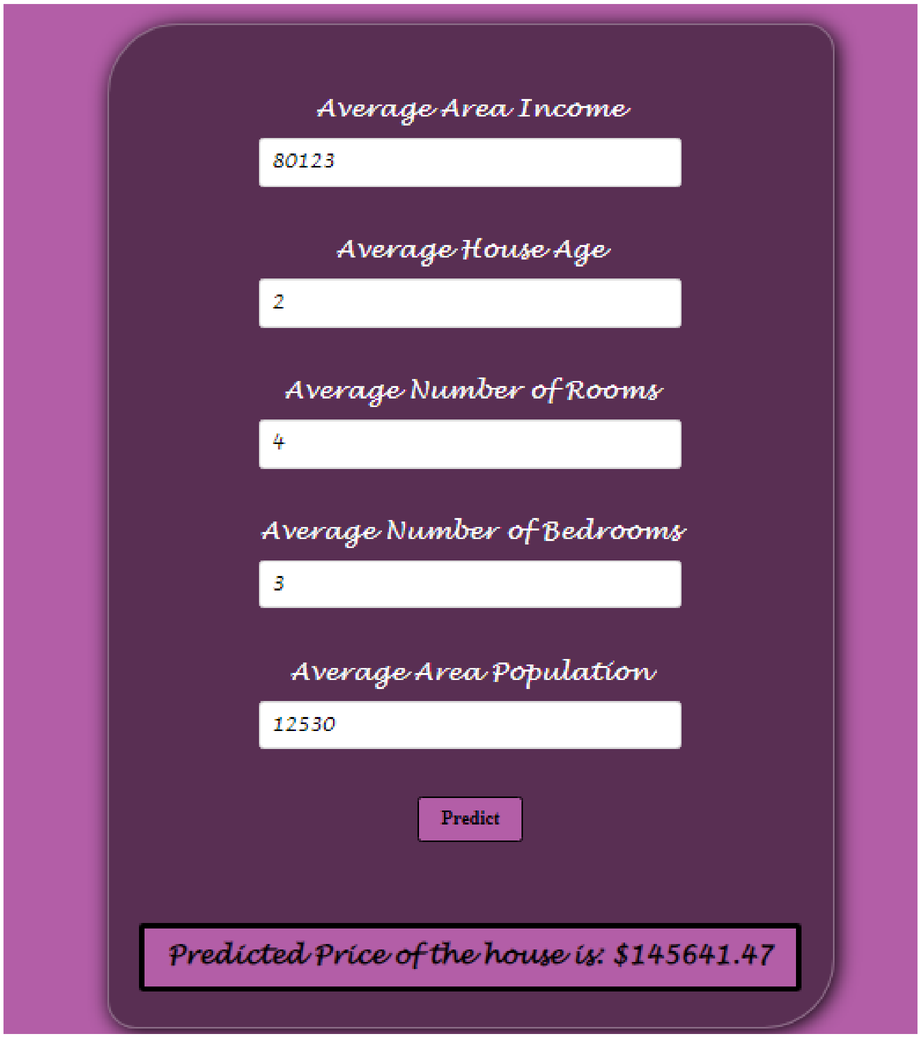


```html
<body>
    <!---Initialize structure of Title and house picture--->
    <div class="title">
        <h1>House Price Predictor</h1>
        <img src="https://seeklogo.com/images/P/purple-house-logo-F4F2DD22E9-seeklogo.com.png" class="house" />
    </div>

    <!---Containerize main page for styling--->
    <div class="page">
        <!---Containerize paragraph and form for styling--->
        <div class="container">
            <br>
            <!---Initialize form structure and inputs, set method to "POST"--->
            <form action="{{url_for('predict')}}" method="post" class="info">
                <label for="name">Average Area Income</label>
                <input type="text" id="name" name="Average Income of Area" required="required" />
                <br>
                <br>
                <label for="name">Average House Age</label>
                <input type="text" id="age" name="Average House Age" required="required" />
                <br>
                <br>
                <label for="name">Average Number of Rooms </label>
                <input type="text" id="rooms" name="Average Number of Rooms " required="required" />
                <br>
                <br>
                <label for="name">Average Number of Bedrooms</label>
```



```css
        label {
            color: white;
        }

        /*Margin, layout and design of paragraphs and structures*/

        .para {
            text-align: center;
        }

        .result {
            font-weight: bold;
            background-color: rgb(179, 94, 167);
            padding: 8px 16px;
            display: inline-block;
            text-decoration: none;
            border-radius: 3px;
            color: black;
            border-color: black;
            font-family: Monaco;
            border-style: solid;
        }

        .pred {
            text-align: center;
        }
```





Average Area Income: 80123

Average House Age: 2

Average Number of Rooms: 4

Average Number of Bedrooms: 3

Average Area Population: 12530

Predicted Price of the house is: $145641.47