```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error,
r2_score

df=pd.read_csv("HousingData.csv")

df
```

```
        CRIM    ZN  INDUS  CHAS    NOX     RM   AGE     DIS  RAD  TAX
\
0    0.00632  18.0   2.31   0.0  0.538  6.575  65.2  4.0900    1  296

1    0.02731   0.0   7.07   0.0  0.469  6.421  78.9  4.9671    2  242

2    0.02729   0.0   7.07   0.0  0.469  7.185  61.1  4.9671    2  242

3    0.03237   0.0   2.18   0.0  0.458  6.998  45.8  6.0622    3  222

4    0.06905   0.0   2.18   0.0  0.458  7.147  54.2  6.0622    3  222

..       ...   ...    ...   ...    ...    ...   ...     ...  ...  ...

501  0.06263   0.0  11.93   0.0  0.573  6.593  69.1  2.4786    1  273

502  0.04527   0.0  11.93   0.0  0.573  6.120  76.7  2.2875    1  273

503  0.06076   0.0  11.93   0.0  0.573  6.976  91.0  2.1675    1  273

504  0.10959   0.0  11.93   0.0  0.573  6.794  89.3  2.3889    1  273

505  0.04741   0.0  11.93   0.0  0.573  6.030   NaN  2.5050    1  273


     PTRATIO       B  LSTAT  MEDV
0       15.3  396.90   4.98  24.0
1       17.8  396.90   9.14  21.6
2       17.8  392.83   4.03  34.7
3       18.7  394.63   2.94  33.4
4       18.7  396.90    NaN  36.2
..       ...     ...    ...   ...
501     21.0  391.99    NaN  22.4
502     21.0  396.90   9.08  20.6
503     21.0  396.90   5.64  23.9
504     21.0  393.45   6.48  22.0
505     21.0  396.90   7.88  11.9
```

```
[506 rows x 14 columns]
```

```
df.head()
```

```
      CRIM    ZN  INDUS  CHAS    NOX     RM   AGE     DIS  RAD  TAX
PTRATIO  \
0  0.00632  18.0   2.31   0.0  0.538  6.575  65.2  4.0900    1  296
15.3
1  0.02731   0.0   7.07   0.0  0.469  6.421  78.9  4.9671    2  242
17.8
2  0.02729   0.0   7.07   0.0  0.469  7.185  61.1  4.9671    2  242
17.8
3  0.03237   0.0   2.18   0.0  0.458  6.998  45.8  6.0622    3  222
18.7
4  0.06905   0.0   2.18   0.0  0.458  7.147  54.2  6.0622    3  222
18.7

        B  LSTAT  MEDV
0  396.90   4.98  24.0
1  396.90   9.14  21.6
2  392.83   4.03  34.7
3  394.63   2.94  33.4
4  396.90    NaN  36.2
```

```
df.tail()
```

```
        CRIM   ZN  INDUS  CHAS    NOX     RM   AGE     DIS  RAD  TAX
PTRATIO  \
501  0.06263  0.0  11.93   0.0  0.573  6.593  69.1  2.4786    1  273
21.0
502  0.04527  0.0  11.93   0.0  0.573  6.120  76.7  2.2875    1  273
21.0
503  0.06076  0.0  11.93   0.0  0.573  6.976  91.0  2.1675    1  273
21.0
504  0.10959  0.0  11.93   0.0  0.573  6.794  89.3  2.3889    1  273
21.0
505  0.04741  0.0  11.93   0.0  0.573  6.030   NaN  2.5050    1  273
21.0

          B  LSTAT  MEDV
501  391.99    NaN  22.4
502  396.90   9.08  20.6
503  396.90   5.64  23.9
504  393.45   6.48  22.0
505  396.90   7.88  11.9
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
```

```
Data columns (total 14 columns):
 #   Column   Non-Null Count  Dtype  
---  ------   --------------  -----  
 0   CRIM     486 non-null    float64
 1   ZN       486 non-null    float64
 2   INDUS    486 non-null    float64
 3   CHAS     486 non-null    float64
 4   NOX      506 non-null    float64
 5   RM       506 non-null    float64
 6   AGE      486 non-null    float64
 7   DIS      506 non-null    float64
 8   RAD      506 non-null    int64  
 9   TAX      506 non-null    int64  
 10  PTRATIO  506 non-null    float64
 11  B        506 non-null    float64
 12  LSTAT    486 non-null    float64
 13  MEDV     506 non-null    float64
dtypes: float64(12), int64(2)
memory usage: 55.5 KB
```

```
df.describe()
```

```
              CRIM          ZN       INDUS        CHAS          NOX
RM  \
count  486.000000  486.000000  486.000000  486.000000  506.000000
506.000000
mean     3.611874   11.211934   11.083992    0.069959    0.554695
6.284634
std      8.720192   23.388876    6.835896    0.255340    0.115878
0.702617
min      0.006320    0.000000    0.460000    0.000000    0.385000
3.561000
25%      0.081900    0.000000    5.190000    0.000000    0.449000
5.885500
50%      0.253715    0.000000    9.690000    0.000000    0.538000
6.208500
75%      3.560263   12.500000   18.100000    0.000000    0.624000
6.623500
max     88.976200  100.000000   27.740000    1.000000    0.871000
8.780000

              AGE         DIS         RAD         TAX     PTRATIO
B  \
count  486.000000  506.000000  506.000000  506.000000  506.000000
506.000000
mean    68.518519    3.795043    9.549407  408.237154   18.455534
356.674032
std     27.999513    2.105710    8.707259  168.537116    2.164946
91.294864
min      2.900000    1.129600    1.000000  187.000000   12.600000
```

```
0.320000
25%     45.175000    2.100175    4.000000  279.000000   17.400000
375.377500
50%     76.800000    3.207450    5.000000  330.000000   19.050000
391.440000
75%     93.975000    5.188425   24.000000  666.000000   20.200000
396.225000
max    100.000000   12.126500   24.000000  711.000000   22.000000
396.900000
```

```
             LSTAT        MEDV
count  486.000000  506.000000
mean    12.715432   22.532806
std      7.155871    9.197104
min      1.730000    5.000000
25%      7.125000   17.025000
50%     11.430000   21.200000
75%     16.955000   25.000000
max     37.970000   50.000000
```

```
df.shape
```

```
(506, 14)
```

```
df.isnull().sum()
```

```
CRIM       20
ZN         20
INDUS      20
CHAS       20
NOX         0
RM          0
AGE        20
DIS         0
RAD         0
TAX         0
PTRATIO     0
B           0
LSTAT      20
MEDV        0
dtype: int64
```

```
df.columns
```

```
Index(['CRIM', 'ZN', 'INDUS', 'CHAS', 'NOX', 'RM', 'AGE', 'DIS',
'RAD', 'TAX',
       'PTRATIO', 'B', 'LSTAT', 'MEDV'],
      dtype='object')
```

```
df.fillna({"CRIM": df["CRIM"].mean(),
           "ZN": df["ZN"].mean(),
```

```
            "INDUS": df["INDUS"].mean(),
            "CHAS": df["CHAS"].mean(),
            "AGE": df["AGE"].mean(),
            "LSTAT": df["LSTAT"].mean()}, inplace=True)

df.isnull().sum()
```

```
CRIM       0
ZN         0
INDUS      0
CHAS       0
NOX        0
RM         0
AGE        0
DIS        0
RAD        0
TAX        0
PTRATIO    0
B          0
LSTAT      0
MEDV       0
dtype: int64
```

```
df.corr()
```

```
             CRIM        ZN     INDUS      CHAS       NOX        RM
AGE  \
CRIM     1.000000 -0.182930  0.391161 -0.052223  0.410377 -0.215434
0.344934
ZN      -0.182930  1.000000 -0.513336 -0.036147 -0.502287  0.316550 -
0.541274
INDUS    0.391161 -0.513336  1.000000  0.058035  0.740965 -0.381457
0.614592
CHAS    -0.052223 -0.036147  0.058035  1.000000  0.073286  0.102284
0.075206
NOX      0.410377 -0.502287  0.740965  0.073286  1.000000 -0.302188
0.711461
RM      -0.215434  0.316550 -0.381457  0.102284 -0.302188  1.000000 -
0.241351
AGE      0.344934 -0.541274  0.614592  0.075206  0.711461 -0.241351
1.000000
DIS     -0.366523  0.638388 -0.699639 -0.091680 -0.769230  0.205246 -
0.724353
RAD      0.608886 -0.306316  0.593176  0.001425  0.611441 -0.209847
0.449989
TAX      0.566528 -0.308334  0.716062 -0.031483  0.668023 -0.292048
0.500589
PTRATIO  0.273384 -0.403085  0.384806 -0.109310  0.188933 -0.355501
0.262723
B       -0.370163  0.167431 -0.354597  0.050055 -0.380051  0.128069 -
```

```
0.265282
LSTAT    0.434044 -0.407549  0.567354 -0.046166  0.572379 -0.602962
0.574893
MEDV    -0.379695  0.365943 -0.478657  0.179882 -0.427321  0.695360 -
0.380223

               DIS       RAD       TAX   PTRATIO         B     LSTAT
MEDV
CRIM    -0.366523  0.608886  0.566528  0.273384 -0.370163  0.434044 -
0.379695
ZN       0.638388 -0.306316 -0.308334 -0.403085  0.167431 -0.407549
0.365943
INDUS   -0.699639  0.593176  0.716062  0.384806 -0.354597  0.567354 -
0.478657
CHAS    -0.091680  0.001425 -0.031483 -0.109310  0.050055 -0.046166
0.179882
NOX     -0.769230  0.611441  0.668023  0.188933 -0.380051  0.572379 -
0.427321
RM       0.205246 -0.209847 -0.292048 -0.355501  0.128069 -0.602962
0.695360
AGE     -0.724353  0.449989  0.500589  0.262723 -0.265282  0.574893 -
0.380223
DIS      1.000000 -0.494588 -0.534432 -0.232471  0.291512 -0.483429
0.249929
RAD     -0.494588  1.000000  0.910228  0.464741 -0.444413  0.468440 -
0.381626
TAX     -0.534432  0.910228  1.000000  0.460853 -0.441808  0.524545 -
0.468536
PTRATIO -0.232471  0.464741  0.460853  1.000000 -0.177383  0.373343 -
0.507787
B        0.291512 -0.444413 -0.441808 -0.177383  1.000000 -0.368886
0.333461
LSTAT   -0.483429  0.468440  0.524545  0.373343 -0.368886  1.000000 -
0.721975
MEDV     0.249929 -0.381626 -0.468536 -0.507787  0.333461 -0.721975
1.000000
```

```python
# Selecting features (columns 0 to 12) and target (column 13)
X = df.iloc[:, 0:13]
y = df.iloc[:, 13]

x_train, x_test, y_train, y_test = train_test_split(X,
y,test_size=0.2,random_state=42)

print(x_train)
```

```
         CRIM         ZN  INDUS  CHAS     NOX     RM        AGE
DIS  RAD  \
477  15.02340   0.000000  18.10   0.0  0.6140  5.304  97.300000
2.1007   24
```

```
15    0.62739   0.000000   8.14   0.0  0.5380  5.834  56.500000
4.4986    4
332   0.03466  11.211934   6.06   0.0  0.4379  6.031  23.300000
6.6407    1
423   7.05042   0.000000  18.10   0.0  0.6140  6.103  68.518519
2.0218   24
19    0.72580   0.000000   8.14   0.0  0.5380  5.727  69.500000
3.7965    4
..        ...        ...    ...   ...     ...    ...        ...     ..
.  ...
106   0.17120   0.000000   8.56   0.0  0.5200  5.836  91.900000
2.2110    5
270   0.29916  20.000000   6.96   0.0  0.4640  5.856  42.100000
4.4290    3
348   0.01501  80.000000   2.01   0.0  0.4350  6.635  29.700000
8.3440    4
435  11.16040   0.000000  18.10   0.0  0.7400  6.629  94.600000
2.1247   24
102   0.22876   0.000000   8.56   0.0  0.5200  6.405  85.400000
2.7147    5

     TAX  PTRATIO       B  LSTAT
477  666     20.2  349.48  24.91
15   307     21.0  395.62   8.47
332  304     16.9  362.25   7.83
423  666     20.2    2.52  23.29
19   307     21.0  390.95  11.28
..   ...      ...     ...    ...
106  384     20.9  395.67  18.66
270  223     18.6  388.65  13.00
348  280     17.0  390.94   5.99
435  666     20.2  109.85  23.27
102  384     20.9   70.80  10.63

[404 rows x 13 columns]
```

```
x_train.shape
```

```
(404, 13)
```

```
print(x_test)
```

```
         CRIM    ZN      INDUS  CHAS    NOX     RM         AGE     DIS
RAD  \
173   0.09178   0.0  11.083992   0.0  0.510  6.416   68.518519  2.6463
5
274   0.05644  40.0   6.410000   1.0  0.447  6.758   32.900000  4.0776
4
491   0.10574   0.0  27.740000   0.0  0.609  5.983   98.800000  1.8681
4
```

```
72    0.09164   0.0  10.810000   0.0  0.413  6.065    7.800000  5.2873
4
452   5.09017   0.0  18.100000   0.0  0.713  6.297   91.800000  2.3682
24
..        ...   ...        ...   ...    ...    ...         ...     ...
...
412  18.81100   0.0  18.100000   0.0  0.597  4.628  100.000000  1.5539
24
436  14.42080   0.0  18.100000   0.0  0.740  6.461   93.300000  2.0026
24
411  14.05070   0.0  18.100000   0.0  0.597  6.657  100.000000  1.5275
24
86    0.05188   0.0   4.490000   0.0  0.449  6.015   45.100000  4.4272
3
75    0.09512   0.0  12.830000   0.0  0.437  6.286   45.000000  4.5026
5

     TAX  PTRATIO       B  LSTAT
173  296     16.6  395.50   9.04
274  254     17.6  396.90   3.53
491  711     20.1  390.11  18.07
72   305     19.2  390.91   5.52
452  666     20.2  385.09  17.27
..   ...      ...     ...    ...
412  666     20.2   28.79  34.37
436  666     20.2   27.49  18.05
411  666     20.2   35.05  21.22
86   247     18.5  395.99  12.86
75   398     18.7  383.23   8.94

[102 rows x 13 columns]

x_test.shape

(102, 13)

print(y_train)

477    12.0
15     19.9
332    19.4
423    13.4
19     18.2
       ...
106    19.5
270    21.1
348    24.5
435    13.4
102    18.6
Name: MEDV, Length: 404, dtype: float64
```

```
y_train.shape
```

```
(404,)
```

```
print(y_test)
```

```
173    23.6
274    32.4
491    13.6
72     22.8
452    16.1
       ...
412    17.9
436     9.6
411    17.2
86     22.5
75     21.4
Name: MEDV, Length: 102, dtype: float64
```

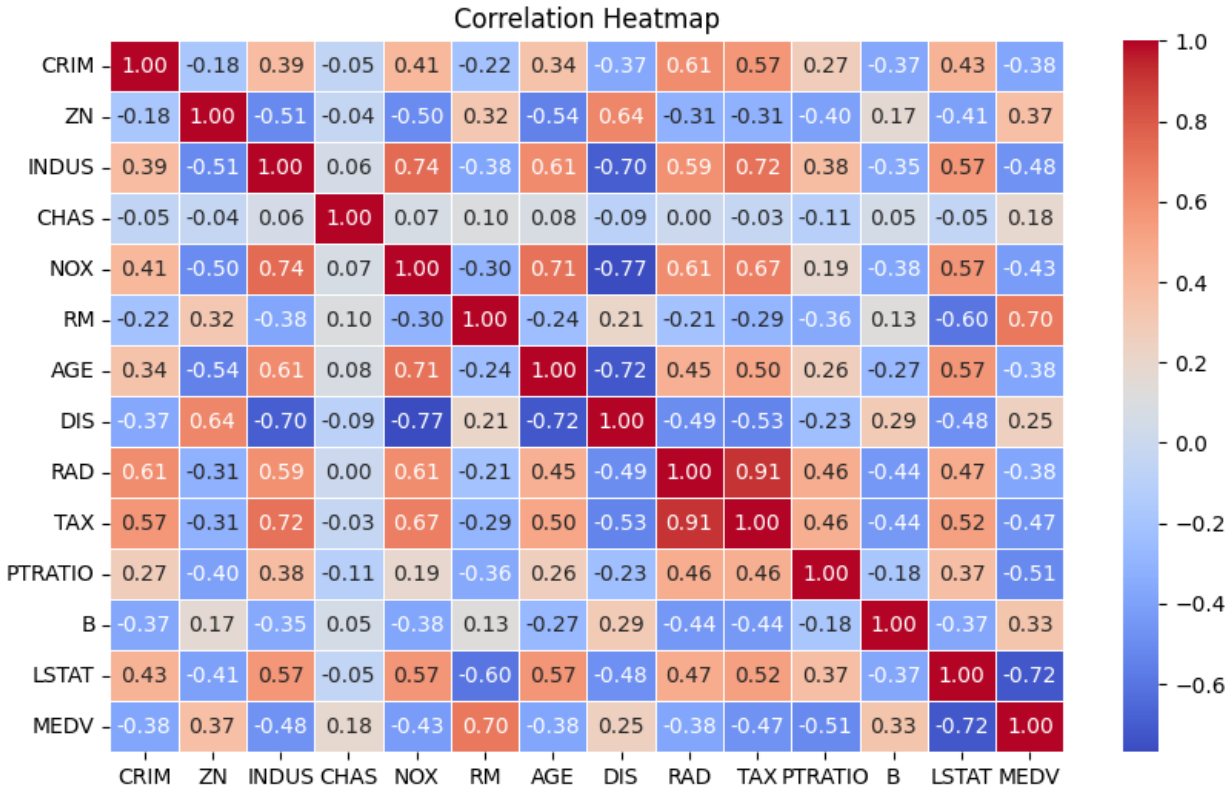
```
y_test.shape
```

```
(102,)
```

```
corr_matrix = df.corr()

# Set up the heatmap
plt.figure(figsize=(10, 6))  # Adjust figure size
sns.heatmap(corr_matrix, annot=True, cmap="coolwarm", fmt=".2f",
linewidths=0.5)

# Show the plot
plt.title("Correlation Heatmap")
plt.show()
```




```
linear_regression=LinearRegression()

linear_regression.fit(x_train,y_train)
```

```
LinearRegression()
```

```
y_pred=linear_regression.predict(x_test)

mae = mean_absolute_error(y_test, y_pred)
mse = mean_squared_error(y_test, y_pred)
rmse = np.sqrt(mse)
r2 = r2_score(y_test, y_pred)

print(f"Mean Absolute Error: {mae}")
print(f"Mean Squared Error: {mse}")
print(f"Root Mean Squared Error: {rmse}")
print(f"R-squared Score: {r2}")
```

```
Mean Absolute Error: 3.149923357345782
Mean Squared Error: 25.017672023842703
Root Mean Squared Error: 5.001766890194174
R-squared Score: 0.658852019550814
```

```
# Visualization: Actual vs. Predicted Prices
plt.figure(figsize=(8, 6))
sns.scatterplot(x=y_test, y=y_pred)
```

```
plt.xlabel("Actual ")
plt.ylabel("Predicted ")
plt.title("Actual vs. Predicted Prices")
plt.show()
```