# yash-dsbdal-a4

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Create a Linear Regression Model using Python/R to predict home prices using Boston Housing Dataset (https://www.kaggle.com/c/boston-housing). The Boston Housing dataset contains information about various houses in Boston through different parameters. There are 506 samples and 14 feature variables in this dataset. The objective is to predict the value of prices of the house using the given features. **bold text**

### Import libraries and create alias for Pandas, Numpy and Matplotlib

[ ]:
```
import pandas as pd
import numpy as np
```

### Import the Boston Housing dataset

[ ]:
```
from google.colab import files
files.upload()
```

```
<IPython.core.display.HTML object>
```

```
Saving boston_housing.csv to boston_housing.csv
```

[ ]:
```
{'boston_housing.csv': b'crim,zn,indus,chas,nox,rm,age,dis,rad,tax,ptratio,black
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.693,4.519,100.0,1.6582,24,666.0,20.2,88.27,36.98,7.0\n18.0846,0.0,18.1,0,0.679,
6.434,100.0,1.8347,24,666.0,20.2,27.25,29.05,7.2\n10.8342,0.0,18.1,0,0.679,6.782
,90.8,1.8195,24,666.0,20.2,21.57,25.79,7.5\n25.9406,0.0,18.1,0,0.679,5.304,89.1,
1.6475,24,666.0,20.2,127.36,26.64,10.4\n73.5341,0.0,18.1,0,0.679,5.957,100.0,1.8
026,24,666.0,20.2,16.45,20.62,8.8\n11.8123,0.0,18.1,0,0.718,6.824,76.5,1.794,24,
666.0,20.2,48.45,22.74,8.4\n11.0874,0.0,18.1,0,0.718,6.411,100.0,1.8589,24,666.0
,20.2,318.75,15.02,16.7\n7.022589999999999,0.0,18.1,0,0.718,6.006,95.3,1.8746,24
,666.0,20.2,319.98,15.7,14.2\n12.0482,0.0,18.1,0,0.614,5.648,87.6,1.9512,24,666.
0,20.2,291.55,14.1,20.8\n7.05042,0.0,18.1,0,0.614,6.103,85.1,2.0218,24,666.0,20.
2,2.52,23.29,13.4\n8.792119999999999,0.0,18.1,0,0.584,5.565,70.6,2.0635,24,666.0
,20.2,3.65,17.16,11.7\n15.8603,0.0,18.1,0,0.679,5.896,95.4,1.9096,24,666.0,20.2,
7.68,24.39,8.3\n12.2472,0.0,18.1,0,0.584,5.837,59.7,1.9976,24,666.0,20.2,24.65,1
5.69,10.2\n37.6619,0.0,18.1,0,0.679,6.202,78.7,1.8629,24,666.0,20.2,18.82,14.52,
10.9\n7.36711,0.0,18.1,0,0.679,6.193,78.1,1.9356,24,666.0,20.2,96.73,21.52,11.0\
n9.33889,0.0,18.1,0,0.679,6.38,95.6,1.9682,24,666.0,20.2,60.72,24.08,9.5\n8.4921
3,0.0,18.1,0,0.584,6.348,86.1,2.0527,24,666.0,20.2,83.45,17.64,14.5\n10.0623,0.0
,18.1,0,0.584,6.833,94.3,2.0882,24,666.0,20.2,81.33,19.69,14.1\n6.44405,0.0,18.1
,0,0.584,6.425,74.8,2.2004,24,666.0,20.2,97.95,12.03,16.1\n5.5810699999999995,0.
0,18.1,0,0.713,6.436,87.9,2.3158,24,666.0,20.2,100.19,16.22,14.3\n13.9134,0.0,18
.1,0,0.713,6.208,95.0,2.2222,24,666.0,20.2,100.63,15.17,11.7\n11.1604,0.0,18.1,0
,0.74,6.629,94.6,2.1247,24,666.0,20.2,109.85,23.27,13.4\n14.4208,0.0,18.1,0,0.74
,6.461,93.3,2.0026,24,666.0,20.2,27.49,18.05,9.6\n15.1772,0.0,18.1,0,0.74,6.152,
100.0,1.9142,24,666.0,20.2,9.32,26.45,8.7\n13.6781,0.0,18.1,0,0.74,5.935,87.9,1.
8206,24,666.0,20.2,68.95,34.02,8.4\n9.39063,0.0,18.1,0,0.74,5.627,93.9,1.8172,24
,666.0,20.2,396.9,22.88,12.8\n22.0511,0.0,18.1,0,0.74,5.818,92.4,1.8662,24,666.0
,20.2,391.45,22.11,10.5\n9.72418,0.0,18.1,0,0.74,6.406,97.2,2.0651,24,666.0,20.2
,385.96,19.52,17.1\n5.66637,0.0,18.1,0,0.74,6.219,100.0,2.0048,24,666.0,20.2,395
.69,16.59,18.4\n9.96654,0.0,18.1,0,0.74,6.485,100.0,1.9784,24,666.0,20.2,386.73,
18.85,15.4\n12.8023,0.0,18.1,0,0.74,5.854,96.6,1.8956,24,666.0,20.2,240.52,23.79
,10.8\n10.6718,0.0,18.1,0,0.74,6.459,94.8,1.9879,24,666.0,20.2,43.06,23.98,11.8\
n6.288069999999999,0.0,18.1,0,0.74,6.341,96.4,2.072,24,666.0,20.2,318.01,17.79,1
4.9\n9.92485,0.0,18.1,0,0.74,6.251,96.6,2.198,24,666.0,20.2,388.52,16.44,12.6\n9
.329089999999999,0.0,18.1,0,0.713,6.185,98.7,2.2616,24,666.0,20.2,396.9,18.13,14
.1\n7.52601,0.0,18.1,0,0.713,6.417,98.3,2.185,24,666.0,20.2,304.21,19.31,13.0\n6
.71772,0.0,18.1,0,0.713,6.749,92.6,2.3236,24,666.0,20.2,0.32,17.44,13.4\n5.44114
,0.0,18.1,0,0.713,6.655,98.2,2.3552,24,666.0,20.2,355.29,17.73,15.2\n5.09017,0.0
,18.1,0,0.713,6.297,91.8,2.3682,24,666.0,20.2,385.09,17.27,16.1\n8.24809,0.0,18.
1,0,0.713,7.393,99.3,2.4527,24,666.0,20.2,375.87,16.74,17.8\n9.513630000000001,0
.0,18.1,0,0.713,6.728,94.1,2.4961,24,666.0,20.2,6.68,18.71,14.9\n4.75237,0.0,18.
1,0,0.713,6.525,86.5,2.4358,24,666.0,20.2,50.92,18.13,14.1\n4.668830000000001,0.
0,18.1,0,0.713,5.976,87.9,2.5806,24,666.0,20.2,10.48,19.01,12.7\n8.20058,0.0,18.
1,0,0.713,5.936,80.3,2.7792,24,666.0,20.2,3.5,16.94,13.5\n7.75223,0.0,18.1,0,0.7
13,6.301,83.7,2.7831,24,666.0,20.2,272.21,16.23,14.9\n6.80117,0.0,18.1,0,0.713,6

.081,84.4,2.7175,24,666.0,20.2,396.9,14.7,20.0\n4.812130000000001,0.0,18.1,0,0.7
13,6.701,90.0,2.5975,24,666.0,20.2,255.23,16.42,16.4\n3.69311,0.0,18.1,0,0.713,6
.376,88.4,2.5671,24,666.0,20.2,391.43,14.65,17.7\n6.65492,0.0,18.1,0,0.713,6.317
,83.0,2.7344,24,666.0,20.2,396.9,13.99,19.5\n5.82115,0.0,18.1,0,0.713,6.513,89.9
,2.8016,24,666.0,20.2,393.82,10.29,20.2\n7.83932,0.0,18.1,0,0.655,6.209,65.4,2.9
634,24,666.0,20.2,396.9,13.22,21.4\n3.1636,0.0,18.1,0,0.655,5.759,48.2,3.0665,24
,666.0,20.2,334.4,14.13,19.9\n3.7749800000000002,0.0,18.1,0,0.655,5.952,84.7,2.8
715,24,666.0,20.2,22.01,17.15,19.0\n4.422280000000001,0.0,18.1,0,0.584,6.003,94.
5,2.5403,24,666.0,20.2,331.29,21.32,19.1\n15.5757,0.0,18.1,0,0.58,5.926,71.0,2.9
084,24,666.0,20.2,368.74,18.13,19.1\n13.0751,0.0,18.1,0,0.58,5.713,56.7,2.8237,2
4,666.0,20.2,396.9,14.76,20.1\n4.34879,0.0,18.1,0,0.58,6.167,84.0,3.0334,24,666.
0,20.2,396.9,16.29,19.9\n4.03841,0.0,18.1,0,0.532,6.229,90.7,3.0993,24,666.0,20.
2,395.33,12.87,19.6\n3.56868,0.0,18.1,0,0.58,6.437,75.0,2.8965,24,666.0,20.2,393
.37,14.36,23.2\n4.64689,0.0,18.1,0,0.614,6.98,67.6,2.5329,24,666.0,20.2,374.68,1
1.66,29.8\n8.05579,0.0,18.1,0,0.584,5.427,95.4,2.4298,24,666.0,20.2,352.58,18.14
,13.8\n6.39312,0.0,18.1,0,0.584,6.162,97.4,2.206,24,666.0,20.2,302.76,24.1,13.3\
n4.87141,0.0,18.1,0,0.614,6.484,93.6,2.3053,24,666.0,20.2,396.21,18.68,16.7\n15.
0234,0.0,18.1,0,0.614,5.304,97.3,2.1007,24,666.0,20.2,349.48,24.91,12.0\n10.233,
0.0,18.1,0,0.614,6.185,96.7,2.1705,24,666.0,20.2,379.7,18.03,14.6\n14.3337,0.0,1
8.1,0,0.614,6.229,88.0,1.9512,24,666.0,20.2,383.32,13.11,21.4\n5.824009999999995
,0.0,18.1,0,0.532,6.242,64.7,3.4242,24,666.0,20.2,396.9,10.74,23.0\n5.708180000
0000005,0.0,18.1,0,0.532,6.75,74.9,3.3317,24,666.0,20.2,393.07,7.74,23.7\n5.7311
6,0.0,18.1,0,0.532,7.061,77.0,3.4106,24,666.0,20.2,395.28,7.01,25.0\n2.81838,0.0
,18.1,0,0.532,5.762,40.3,4.0983,24,666.0,20.2,392.92,10.42,21.8\n2.37857,0.0,18.
1,0,0.583,5.871,41.9,3.724,24,666.0,20.2,370.73,13.34,20.6\n3.6736699999999995,0
.0,18.1,0,0.583,6.312,51.9,3.9917,24,666.0,20.2,388.62,10.58,21.2\n5.69175,0.0,1
8.1,0,0.583,6.114,79.8,3.5459,24,666.0,20.2,392.68,14.98,19.1\n4.835669999999995
,0.0,18.1,0,0.583,5.905,53.2,3.1523,24,666.0,20.2,388.22,11.45,20.6\n0.15086,0.
0,27.74,0,0.609,5.454,92.7,1.8209,4,711.0,20.1,395.09,18.06,15.2\n0.18337,0.0,27
.74,0,0.609,5.414,98.3,1.7554,4,711.0,20.1,344.05,23.97,7.0\n0.20745999999999998
,0.0,27.74,0,0.609,5.093,98.0,1.8226,4,711.0,20.1,318.43,29.68,8.1\n0.1057400000
0000001,0.0,27.74,0,0.609,5.983,98.8,1.8681,4,711.0,20.1,390.11,18.07,13.6\n0.11
132,0.0,27.74,0,0.609,5.983,83.5,2.1099,4,711.0,20.1,396.9,13.35,20.1\n0.17331,0
.0,9.69,0,0.585,5.707,54.0,2.3817,6,391.0,19.2,396.9,12.01,21.8\n0.27957,0.0,9.6
9,0,0.585,5.926,42.6,2.3817,6,391.0,19.2,396.9,13.59,24.5\n0.17899,0.0,9.69,0,0.
585,5.67,28.8,2.7986,6,391.0,19.2,393.29,17.6,23.1\n0.2896,0.0,9.69,0,0.585,5.39
,72.9,2.7986,6,391.0,19.2,396.9,21.14,19.7\n0.26838,0.0,9.69,0,0.585,5.794,70.6,
2.8927,6,391.0,19.2,396.9,14.1,18.3\n0.23911999999999997,0.0,9.69,0,0.585,6.019,
65.3,2.4091,6,391.0,19.2,396.9,12.92,21.2\n0.17783,0.0,9.69,0,0.585,5.569,73.5,2
.3999,6,391.0,19.2,395.77,15.1,17.5\n0.22438000000000002,0.0,9.69,0,0.585,6.027,
79.7,2.4982,6,391.0,19.2,396.9,14.33,16.8\n0.06262999999999999,0.0,11.93,0,0.573
,6.593,69.1,2.4786,1,273.0,21.0,391.99,9.67,22.4\n0.04527,0.0,11.93,0,0.573,6.12
,76.7,2.2875,1,273.0,21.0,396.9,9.08,20.6\n0.06076,0.0,11.93,0,0.573,6.976,91.0,
2.1675,1,273.0,21.0,396.9,5.64,23.9\n0.10959,0.0,11.93,0,0.573,6.794,89.3,2.3889
,1,273.0,21.0,393.45,6.48,22.0\n0.04741,0.0,11.93,0,0.573,6.03,80.8,2.505,1,273.
0,21.0,396.9,7.88,11.9\n'}

### Read Dataset

[ ]:
```
df=pd.read_csv("/content/boston_housing.csv")
```

[ ]:
```
df
```

[ ]:
```
        crim    zn  indus  chas    nox     rm   age     dis  rad    tax  \
0    0.00632  18.0   2.31     0  0.538  6.575  65.2  4.0900    1  296.0
1    0.02731   0.0   7.07     0  0.469  6.421  78.9  4.9671    2  242.0
2    0.02729   0.0   7.07     0  0.469  7.185  61.1  4.9671    2  242.0
3    0.03237   0.0   2.18     0  0.458  6.998  45.8  6.0622    3  222.0
4    0.06905   0.0   2.18     0  0.458  7.147  54.2  6.0622    3  222.0
..       ...   ...    ...   ...    ...    ...   ...     ...  ...    ...
501  0.06263   0.0  11.93     0  0.573  6.593  69.1  2.4786    1  273.0
502  0.04527   0.0  11.93     0  0.573  6.120  76.7  2.2875    1  273.0
503  0.06076   0.0  11.93     0  0.573  6.976  91.0  2.1675    1  273.0
504  0.10959   0.0  11.93     0  0.573  6.794  89.3  2.3889    1  273.0
505  0.04741   0.0  11.93     0  0.573  6.030  80.8  2.5050    1  273.0

     ptratio   black  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   5.33  36.2
..       ...     ...    ...   ...
501     21.0  391.99   9.67  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]
```

### Basic Operations

[ ]:
```
df.head()
```

[ ]:
```
      crim    zn  indus  chas    nox     rm   age     dis  rad    tax  \
0  0.00632  18.0   2.31     0  0.538  6.575  65.2  4.0900    1  296.0
1  0.02731   0.0   7.07     0  0.469  6.421  78.9  4.9671    2  242.0
2  0.02729   0.0   7.07     0  0.469  7.185  61.1  4.9671    2  242.0
3  0.03237   0.0   2.18     0  0.458  6.998  45.8  6.0622    3  222.0
4  0.06905   0.0   2.18     0  0.458  7.147  54.2  6.0622    3  222.0

   ptratio   black  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   5.33  36.2
```

[ ]:
```
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     506 non-null    float64
 1   zn       506 non-null    float64
 2   indus    506 non-null    float64
 3   chas     506 non-null    int64
 4   nox      506 non-null    float64
 5   rm       506 non-null    float64
 6   age      506 non-null    float64
 7   dis      506 non-null    float64
 8   rad      506 non-null    int64
 9   tax      506 non-null    float64
 10  ptratio  506 non-null    float64
 11  black    506 non-null    float64
 12  lstat    506 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  506.000000  506.000000  506.000000  506.000000  506.000000  506.000000
mean     3.613524   11.363636   11.136779    0.069170    0.554695    6.284634
std      8.601545   23.322453    6.860353    0.253994    0.115878    0.702617
min      0.006320    0.000000    0.460000    0.000000    0.385000    3.561000
25%      0.082045    0.000000    5.190000    0.000000    0.449000    5.885500
50%      0.256510    0.000000    9.690000    0.000000    0.538000    6.208500
75%      3.677083   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       black  \
count  506.000000  506.000000  506.000000  506.000000  506.000000  506.000000
mean    68.574901    3.795043    9.549407  408.237154   18.455534  356.674032
std     28.148861    2.105710    8.707259  168.537116    2.164946   91.294864
min      2.900000    1.129600    1.000000  187.000000   12.600000    0.320000
25%     45.025000    2.100175    4.000000  279.000000   17.400000  375.377500
50%     77.500000    3.207450    5.000000  330.000000   19.050000  391.440000
```

```
75%     94.075000    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  506.000000  506.000000
mean    12.653063   22.532806
std      7.141062    9.197104
min      1.730000    5.000000
25%      6.950000   17.025000
50%     11.360000   21.200000
75%     16.955000   25.000000
max     37.970000   50.000000
```

### Data Preprocessing

[ ]:
```
df.isna()
```

[ ]:
```
      crim     zn  indus   chas    nox     rm    age    dis    rad    tax  \
0    False  False  False  False  False  False  False  False  False  False
1    False  False  False  False  False  False  False  False  False  False
2    False  False  False  False  False  False  False  False  False  False
3    False  False  False  False  False  False  False  False  False  False
4    False  False  False  False  False  False  False  False  False  False
..     …    …    …    …    …    …    …    …    …    …
501  False  False  False  False  False  False  False  False  False  False
502  False  False  False  False  False  False  False  False  False  False
503  False  False  False  False  False  False  False  False  False  False
504  False  False  False  False  False  False  False  False  False  False
505  False  False  False  False  False  False  False  False  False  False

     ptratio  black  lstat   medv
0      False  False  False  False
1      False  False  False  False
2      False  False  False  False
3      False  False  False  False
4      False  False  False  False
..       …    …    …    …
501    False  False  False  False
502    False  False  False  False
503    False  False  False  False
504    False  False  False  False
505    False  False  False  False

[506 rows x 14 columns]
```

[ ]:
```
df.isna().sum()
```

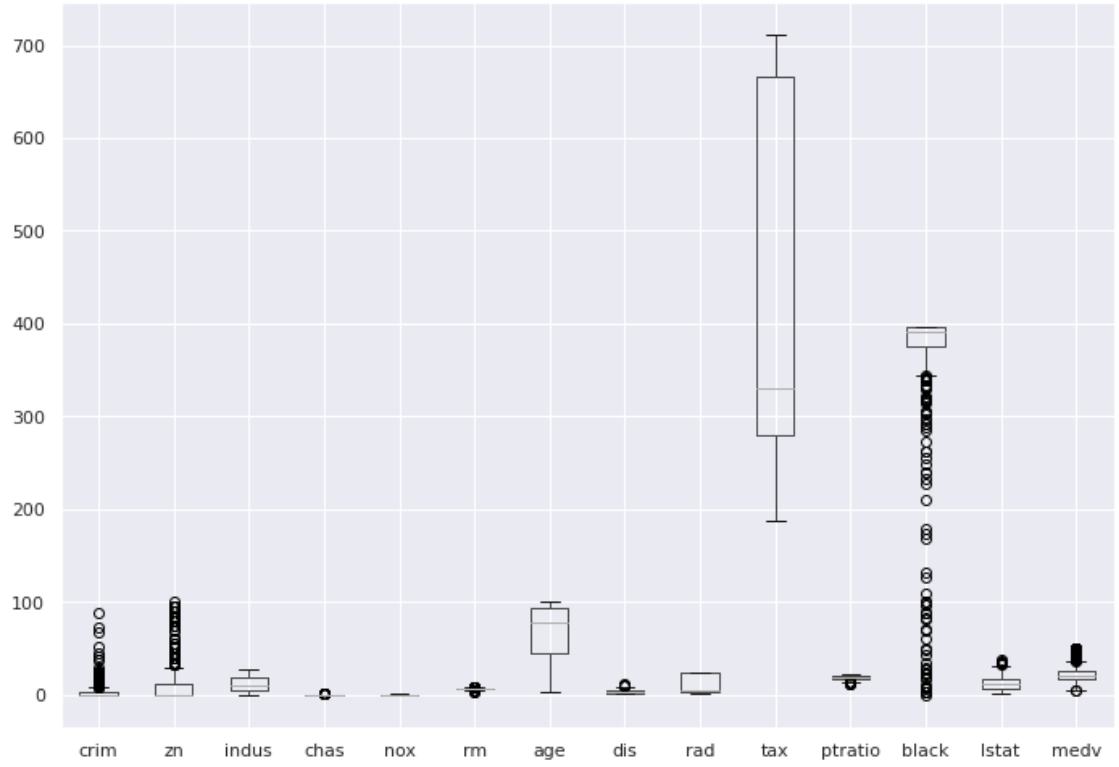
[ ]:
```
crim       0
zn         0
indus      0
chas       0
nox        0
rm         0
age        0
dis        0
rad        0
tax        0
ptratio    0
black      0
lstat      0
medv       0
dtype: int64
```

### Checking for Outliers

[ ]:
```
import seaborn as sns
import matplotlib.pyplot as plt
```

[ ]:
```
df.boxplot()
```

[ ]:
```
<AxesSubplot:>
```



[ ]:
```
Q1 = df['medv'].quantile(0.25)
Q3 = df['medv'].quantile(0.75)
IQR = Q3 - Q1
Lower_limit = Q1 - 1.5 * IQR
Upper_limit = Q3 + 1.5 * IQR
print(f'Q1 = {Q1}, Q3 = {Q3}, IQR = {IQR}, Lower_limit = {Lower_limit},␣
 ↪Upper_limit = {Upper_limit}')
```

```
Q1 = 17.025, Q3 = 25.0, IQR = 7.975000000000001, Lower_limit =
5.0624999999999964, Upper_limit = 36.962500000000006
```

[ ]:
```
outliers_medv=[]
for i in df.medv:
    if i<Lower_limit or i>Upper_limit:
       outliers_medv.append(i)
print("outliers are",outliers_medv)
```

```
outliers are [38.7, 43.8, 41.3, 50.0, 50.0, 50.0, 50.0, 37.2, 39.8, 37.9, 50.0,
37.0, 50.0, 42.3, 48.5, 50.0, 44.8, 50.0, 37.6, 46.7, 41.7, 48.3, 42.8, 44.0,
50.0, 43.1, 48.8, 50.0, 43.5, 45.4, 46.0, 50.0, 37.3, 50.0, 50.0, 50.0, 50.0,
50.0, 5.0, 5.0]
```

[ ]:
```
df[df.medv<Lower_limit].index
```

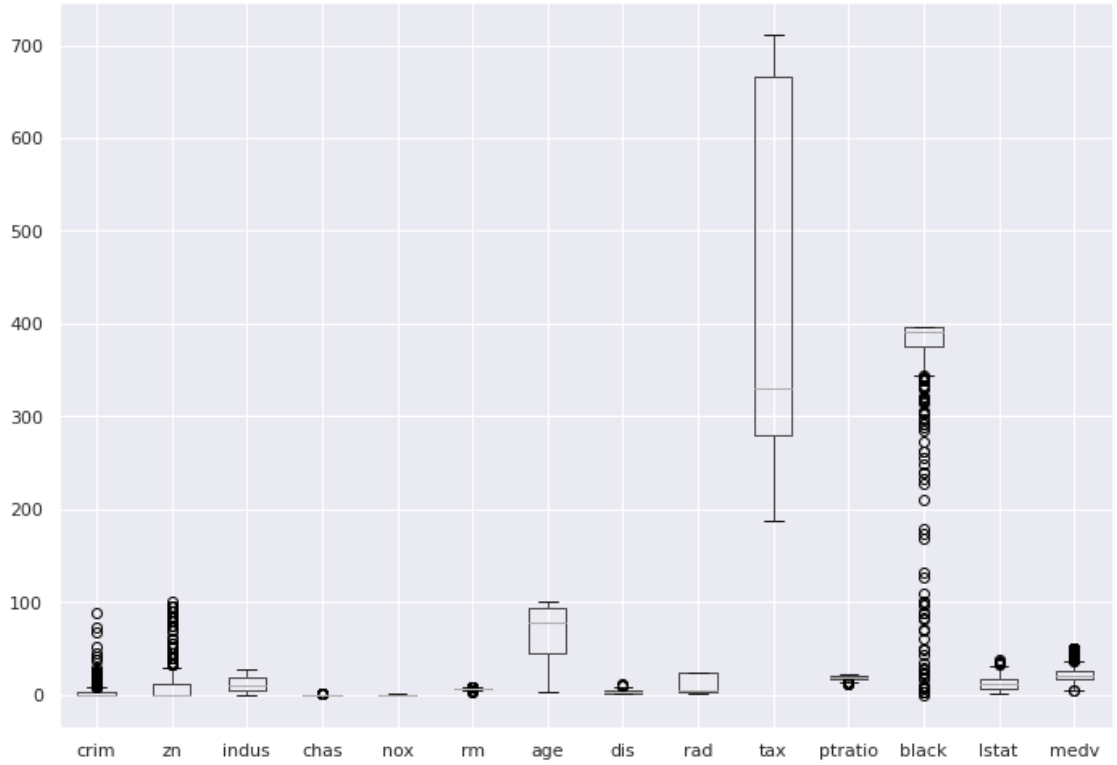
[ ]:
```
Int64Index([398, 405], dtype='int64')
```

[ ]:
```
df1=df.drop(df[df.medv<Lower_limit].index & df[df.medv>Upper_limit].index)
```

```
<ipython-input-66-b1eaccd07bbd>:1: FutureWarning: Index.__and__ operating as a
set operation is deprecated, in the future this will be a logical operation
matching Series.__and__.  Use index.intersection(other) instead.
  df1=df.drop(df[df.medv<Lower_limit].index & df[df.medv>Upper_limit].index)
```

[ ]:
```
df1.boxplot()
```

[ ]:
```
<AxesSubplot:>
```




[ ]:
```
outliers_medv=[]
for i in df2.medv:
    if i<Lower_limit or i>Upper_limit:
       outliers_medv.append(i)
print("outliers are",outliers_medv)
```

```
outliers are []
```

[ ]:
```
df2
```

[ ]:

| | crim | zn | indus | chas | nox | rm | age | dis | rad | tax | \ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.00632 | 18.0 | 2.31 | 0 | 0.538 | 6.575 | 65.2 | 4.0900 | 1 | 296.0 | |
| 1 | 0.02731 | 0.0 | 7.07 | 0 | 0.469 | 6.421 | 78.9 | 4.9671 | 2 | 242.0 | |
| 2 | 0.02729 | 0.0 | 7.07 | 0 | 0.469 | 7.185 | 61.1 | 4.9671 | 2 | 242.0 | |
| 3 | 0.03237 | 0.0 | 2.18 | 0 | 0.458 | 6.998 | 45.8 | 6.0622 | 3 | 222.0 | |
| 4 | 0.06905 | 0.0 | 2.18 | 0 | 0.458 | 7.147 | 54.2 | 6.0622 | 3 | 222.0 | |
| .. | … | … | … | … | … | … | … | … | … | … | |
| 501 | 0.06263 | 0.0 | 11.93 | 0 | 0.573 | 6.593 | 69.1 | 2.4786 | 1 | 273.0 | |
| 502 | 0.04527 | 0.0 | 11.93 | 0 | 0.573 | 6.120 | 76.7 | 2.2875 | 1 | 273.0 | |
| 503 | 0.06076 | 0.0 | 11.93 | 0 | 0.573 | 6.976 | 91.0 | 2.1675 | 1 | 273.0 | |
| 504 | 0.10959 | 0.0 | 11.93 | 0 | 0.573 | 6.794 | 89.3 | 2.3889 | 1 | 273.0 | |
| 505 | 0.04741 | 0.0 | 11.93 | 0 | 0.573 | 6.030 | 80.8 | 2.5050 | 1 | 273.0 | |

```
     ptratio   black  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   5.33  36.2
..       …     …     …   …
501     21.0  391.99   9.67  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

[466 rows x 14 columns]
```

**Preparing the data for training the model**

[ ]:
```
X = df.drop(['medv'], axis = 1)
Y = df['medv']
```

[ ]:
```
X
```

[ ]:
```
        crim    zn  indus  chas    nox     rm   age     dis  rad    tax  \
0    0.00632  18.0   2.31     0  0.538  6.575  65.2  4.0900    1  296.0
1    0.02731   0.0   7.07     0  0.469  6.421  78.9  4.9671    2  242.0
2    0.02729   0.0   7.07     0  0.469  7.185  61.1  4.9671    2  242.0
3    0.03237   0.0   2.18     0  0.458  6.998  45.8  6.0622    3  222.0
4    0.06905   0.0   2.18     0  0.458  7.147  54.2  6.0622    3  222.0
..       …   …     …   …     …   …   …      …  …     …
501  0.06263   0.0  11.93     0  0.573  6.593  69.1  2.4786    1  273.0
502  0.04527   0.0  11.93     0  0.573  6.120  76.7  2.2875    1  273.0
503  0.06076   0.0  11.93     0  0.573  6.976  91.0  2.1675    1  273.0
504  0.10959   0.0  11.93     0  0.573  6.794  89.3  2.3889    1  273.0
505  0.04741   0.0  11.93     0  0.573  6.030  80.8  2.5050    1  273.0

     ptratio   black  lstat
0       15.3  396.90   4.98
1       17.8  396.90   9.14
2       17.8  392.83   4.03
3       18.7  394.63   2.94
4       18.7  396.90   5.33
..       …     …     …
501     21.0  391.99   9.67
502     21.0  396.90   9.08
503     21.0  396.90   5.64
504     21.0  393.45   6.48
505     21.0  396.90   7.88
```

```
[506 rows x 13 columns]
```

[ ]:
```
Y
```

[ ]:
```
0      24.0
1      21.6
2      34.7
3      33.4
4      36.2
       …
501    22.4
502    20.6
503    23.9
504    22.0
505    11.9
Name: medv, Length: 506, dtype: float64
```

### Splitting the data into training and testing sets

[ ]:
```
from sklearn.model_selection import train_test_split
xtrain, xtest, ytrain, ytest = train_test_split(x, y, test_size =0.
 ↪2,random_state = 0)
```

### Training and testing the model

[ ]:
```
import sklearn
from sklearn.linear_model import LinearRegression
lm = LinearRegression()
```

[ ]:
```
model=lm.fit(xtrain, ytrain)
```

[ ]:
```
model
```

[ ]:
```
LinearRegression()
```

### Predict the y_pred for all values of train_x and test_x

[ ]:
```
ytrain_pred = lm.predict(xtrain)
ytest_pred = lm.predict(xtest)
ytrain_pred
```

[ ]:
```
array([307., 305., 300., 311., 666., 666., 273., 329., 403., 666., 311.,
       432., 311., 277., 666., 437., 666., 198., 398., 666., 233., 391.,
       304., 188., 222., 330., 284., 254., 666., 666., 711., 403., 666.,
       226., 307., 403., 330., 666., 666., 391., 193., 243., 398., 307.,
       402., 222., 666., 666., 304., 222., 437., 223., 437., 358., 188.,
       307., 345., 307., 666., 307., 216., 307., 216., 287., 287., 281.,
```

```
       666., 666., 265., 666., 666., 403., 666., 666., 391., 391., 666.,
       243., 666., 666., 224., 403., 384., 287., 284., 280., 193., 666.,
       666., 264., 270., 304., 264., 270., 329., 666., 304., 216., 270.,
       307., 264., 329., 403., 403., 403., 330., 666., 403., 247., 307.,
       666., 337., 304., 666., 437., 384., 666., 242., 666., 307., 307.,
       403., 315., 666., 307., 432., 300., 384., 666., 304., 296., 330.,
       432., 403., 666., 188., 264., 432., 666., 351., 666., 437., 398.,
       411., 193., 188., 285., 307., 666., 666., 666., 307., 437., 307.,
       666., 233., 284., 402., 223., 293., 276., 305., 279., 666., 307.,
       666., 352., 666., 276., 307., 666., 289., 403., 224., 666., 437.,
       277., 384., 334., 335., 334., 277., 666., 398., 277., 224., 307.,
       264., 345., 307., 276., 307., 437., 432., 403., 666., 666., 252.,
       254., 666., 398., 304., 304., 307., 293., 666., 391., 307., 403.,
       281., 273., 666., 384., 403., 403., 307., 370., 384., 666., 437.,
       307., 264., 666., 304., 273., 666., 330., 304., 666., 307., 430.,
       289., 223., 307., 666., 222., 187., 188., 216., 241., 398., 193.,
       666., 666., 254., 289., 666., 193., 666., 281., 222., 264., 311.,
       666., 247., 264., 279., 666., 284., 233., 223., 243., 277., 666.,
       666., 666., 188., 307., 284., 666., 437., 398., 307., 233., 666.,
       296., 348., 666., 666., 276., 335., 222., 391., 296., 666., 244.,
       270., 666., 276., 666., 403., 345., 222., 233., 284., 666., 666.,
       277., 216., 307., 403., 403., 224., 193., 666., 437., 666., 273.,
       264., 287., 224., 247., 188., 711., 666., 666., 666., 666., 270.,
       281., 264., 432., 666., 245., 256., 666., 287., 264., 666., 666.,
       233., 384., 666., 666., 223., 666., 279., 666., 243., 666., 666.,
       437., 245., 307., 193., 666., 403., 403., 330., 348., 307., 307.,
       437., 193., 666., 666., 293., 666., 666., 666., 403., 300., 711.,
       296., 276., 224., 666., 666., 224., 329., 300., 666., 432., 666.,
       264., 305., 224., 307., 403., 224., 711., 296., 711., 252., 265.,
       304., 666., 270., 666., 305., 247., 245., 300., 254., 277., 311.,
       666., 255., 330., 287., 398., 432., 233., 296.])
```

[ ]:
```
ytrain
```

[ ]:
```
220    307.0
71     305.0
240    300.0
6      311.0
417    666.0
       …
323    287.0
192    398.0
117    432.0
47     233.0
172    296.0
Name: tax, Length: 404, dtype: float64
```

### Model evaluation

[ ]:
```
mse = mean_squared_error(ytrain, ytrain_pred)

print("The model performance for training set")
print("--------------------------------------")
print('MSE is {}'.format(mse))
print("\n")

# model evaluation for testing set
#y_test_predict = lin_model.predict(X_test)
mse = mean_squared_error(ytest, ytest_pred)


print("The model performance for testing set")
print("--------------------------------------")
print('MSE is {}'.format(mse))
print("\n\n\n")

rmse = (np.sqrt(mean_squared_error(ytrain, ytrain_pred)))
r2 = r2_score(ytrain, ytrain_pred)

print("The model performance for training set")
print("--------------------------------------")
print('RMSE is {}'.format(rmse))
print('R2 score is {}'.format(r2))
print("\n")

# model evaluation for testing set
#y_test_predict = lin_model.predict(X_test)
rmse = (np.sqrt(mean_squared_error(ytest, ytest_pred)))
r2 = r2_score(ytest, ytest_pred)

print("The model performance for testing set")
print("--------------------------------------")
print('RMSE is {}'.format(rmse))
print('R2 score is {}'.format(r2))
```

```
The model performance for training set
--------------------------------------
MSE is 6.432156251261397e-26

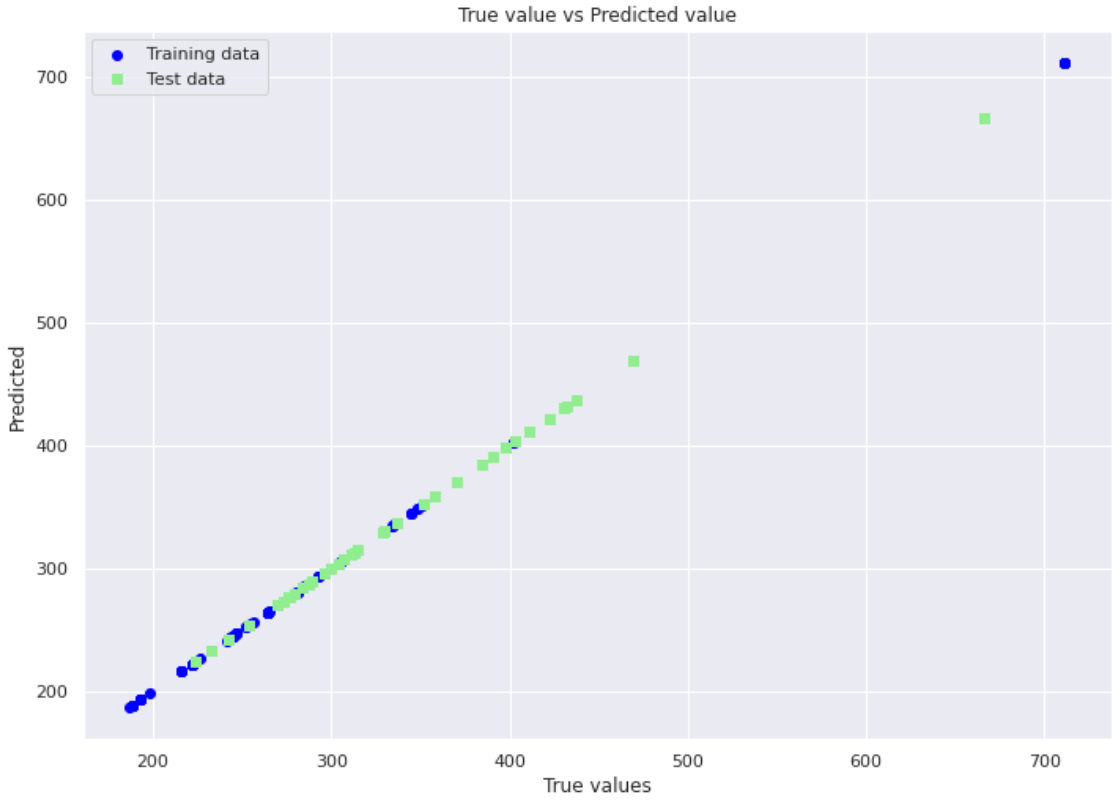

The model performance for testing set
--------------------------------------
MSE is 5.362323766464221e-26
```

```
The model performance for training set
--------------------------------------
RMSE is 2.5361696022272244e-13
R2 score is 1.0


The model performance for testing set
--------------------------------------
RMSE is 2.315669183295451e-13
R2 score is 1.0
```

**Plotting the linear regression model**

[ ]:
```
plt.scatter(ytrain ,ytrain_pred,c='blue',marker='o',label='Training data')
plt.scatter(ytest,ytest_pred ,c='lightgreen',marker='s',label='Test data')
plt.xlabel('True values')
plt.ylabel('Predicted')
plt.title("True value vs Predicted value")
plt.legend(loc= 'upper left')
#plt.hlines(y=0,xmin=0,xmax=50)
plt.plot()
plt.show()
```



[ ]: