Assignment _N0-4

1 Assignment No:04

Import libraries and create alias for Pandas, Numpy

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

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

[ ]:
```
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,B,LSTAT,MEDV\n0,0.00632,18.0,2.31,0.0,0.538,6.575,65.2,4.09,1,296,15.3,396.9,4.98,24.0\n1,0.02731,0.0,7.07,0.0,0.469,6.421,78.9,4.9671,2,242,17.8,396.9,9.14,21.6\n2,0.02729,0.0,7.07,0.0,0.469,7.185,61.1,4.9671,2,242,17.8,392.83,4.03,34.7\n3,0.03237,0.0,2.18,0.0,0.458,6.998,45.8,6.0622,3,222,18.7,394.63,2.94,33.4\n4,0.06905,0.0,2.18,0.0,0.458,7.147,54.2,6.0622,3,222,18.7,396.9,12.715432098765433,36.2\n5,0.02985,0.0,2.18,0.0,0.458,6.43,58.7,6.0622,3,222,18.7,394.12,5.21,28.7\n6,0.08829,12.5,7.87,0.06995884773662552,0.524,6.012,66.6,5.5605,5,311,15.2,395.6,12.43,22.9\n7,0.14455,12.5,7.87,0.0,0.524,6.172,96.1,5.9505,5,311,15.2,396.9,19.15,27.1\n8,0.21124,12.5,7.87,0.0,0.524,5.631,100.0,6.0821,5,311,15.2,386.63,29.93,16.5\n9,0.17004,12.5,7.87,0.06995884773662552,0.524,6.004,85.9,6.5921,5,311,15.2,386.71,17.1,18.9\n10,0.22489,12.5,7.87,0.0,0.524,6.377,94.3,6.3467,5,311,15.2,392.52,20.45,15.0\n11,0.11747,12.5,7.87,0.0,0.524,6.009,82.9,6.2267,5,311,15.2,396.9,13.27,18.9\n12,0.09378,12.5,7.87,0.0,0.524,5.889,39.0,5.4509,5,311,15.2,390.5,15.71,21.7\n13,0.62976,0.0,8.14,0.0,0.538,5.949,61.8,4.7075,4,307,21.0,396.9,8.26,20.4\n14,0.63796,0.0,8.14,0.06995884773662552,0.538,6.096,84.5,4.4619,4,307,21.0,380.02,10.26,18.2\n15,0.62739,0.0,8.14,0.0,0.538,5.834,56.5,4.4986,4,307,21.0,395.62,8.47,19.9\n16,1.05393,0.0,8.14,0.0,0.538,5.935,29.3,4.4986,4,307,21.0,386.85,6.58,23.1\n17,0.7842,0.0,8.14,0.0,0.538,5.99,81.7,4.2579,4,307,21.0,386.75,14.67,17.5\n18,0.80271,0.0,8.14,0.0,0.538,5.456,36.6,3.7965,4,307,21.0,288.99,11.69,20.2\n19,0.7258,0.0,8.14,0.0,0.538,5.727,69.5,3.7965,4,307,21.0,390.95,11.28
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,18.2\n20,1.25179,0.0,8.14,0.0,0.538,5.57,98.1,3.7979,4,307,21.0,376.57,21.02,13.6\n21,0.85204,0.0,8.14,0.0,0.538,5.965,89.2,4.0123,4,307,21.0,392.53,13.83,19.6\n22,1.23247,0.0,8.14,0.0,0.538,6.142,91.7,3.9769,4,307,21.0,396.9,18.72,15.2\n23,0.98843,0.0,8.14,0.0,0.538,5.813,100.0,4.0952,4,307,21.0,394.54,19.88,14.5\n24,0.75026,0.0,8.14,0.0,0.538,5.924,94.1,4.3996,4,307,21.0,394.33,16.3,15.6\n25,0.84054,0.0,8.14,0.0,0.538,5.599,85.7,4.4546,4,307,21.0,303.42,16.51,13.9\n26,0.67191,0.0,8.14,0.0,0.538,5.813,90.3,4.682,4,307,21.0,376.88,14.81,16.6\n27,0.95577,0.0,8.14,0.0,0.538,6.047,88.8,4.4534,4,307,21.0,306.38,17.28,14.8\n28,0.77299,0.0,8.14,0.0,0.538,6.495,94.4,4.4547,4,307,21.0,387.94,12.8,18.4\n29,1.00245,0.0,8.14,0.0,0.538,6.674,87.3,4.239,4,307,21.0,380.23,11.98,21.0\n30,1.13081,0.0,8.14,0.0,0.538,5.713,94.1,4.233,4,307,21.0,360.17,22.6,12.7\n31,1.35472,0.0,8.14,0.0,0.538,6.072,100.0,4.175,4,307,21.0,376.73,13.04,14.5\n32,1.38799,0.0,8.14,0.0,0.538,5.95,82.0,3.99,4,307,21.0,232.6,27.71,13.2\n33,1.15172,0.0,8.14,0.0,0.538,5.701,95.0,3.7872,4,307,21.0,358.77,18.35,13.1\n34,1.61282,0.0,8.14,0.0,0.538,6.096,96.9,3.7598,4,307,21.0,248.31,20.34,13.5\n35,0.06417,0.0,5.96,0.0,0.499,5.933,68.2,3.3603,5,279,19.2,396.9,12.715432098765433,18.9\n36,0.09744,0.0,11.083991769547325,0.0,0.499,5.841,61.4,3.3779,5,279,19.2,377.56,11.41,20.0\n37,0.08014,0.0,5.96,0.0,0.499,5.85,41.5,3.9342,5,279,19.2,396.9,8.77,21.0\n38,0.17505,0.0,5.96,0.0,0.499,5.966,30.2,3.8473,5,279,19.2,393.43,10.13,24.7\n39,0.02763,75.0,2.95,0.0,0.428,6.595,21.8,5.4011,3,252,18.3,395.63,4.32,30.8\n40,0.03359,75.0,2.95,0.0,0.428,7.024,15.8,5.4011,3,252,18.3,395.62,1.98,34.9\n41,0.12744,0.0,6.91,0.0,0.448,6.77,2.9,5.7209,3,233,17.9,385.41,4.84,26.6\n42,0.1415,0.0,6.91,0.0,0.448,6.169,6.6,5.7209,3,233,17.9,383.37,5.81,25.3\n43,0.15936,0.0,6.91,0.06995884773662552,0.448,6.211,6.5,5.7209,3,233,17.9,394.46,7.44,24.7\n44,0.12269,0.0,6.91,0.0,0.448,6.069,40.0,5.7209,3,233,17.9,389.39,9.55,21.2\n45,0.17142,0.0,6.91,0.0,0.448,5.682,33.8,5.1004,3,233,17.9,396.9,10.21,19.3\n46,0.18836,0.0,6.91,0.0,0.448,5.786,33.3,5.1004,3,233,17.9,396.9,14.15,20.0\n47,0.22927,0.0,11.083991769547325,0.0,0.448,6.03,85.5,5.6894,3,233,17.9,392.74,18.8,16.6\n48,0.25387,0.0,6.91,0.0,0.448,5.399,95.3,5.87,3,233,17.9,396.9,30.81,14.4\n49,0.21977,0.0,6.91,0.0,0.448,5.602,62.0,6.0877,3,233,17.9,396.9,16.2,19.4\n50,0.08873,21.0,5.64,0.0,0.439,5.963,45.7,6.8147,4,243,16.8,395.56,13.45,19.7\n51,0.04337,21.0,11.083991769547325,0.0,0.439,6.115,63.0,6.8147,4,243,16.8,393.97,9.43,20.5\n52,0.0536,21.0,5.64,0.0,0.439,6.511,21.1,6.8147,4,243,16.8,396.9,5.28,25.0\n53,3.6118739711934156,21.0,5.64,0.0,0.439,5.998,21.4,6.8147,4,243,16.8,396.9,8.43,23.4\n54,0.0136,75.0,4.0,0.0,0.41,5.888,47.6,7.3197,3,469,21.1,396.9,14.8,18.9\n55,0.01311,90.0,1.22,0.0,0.403,7.249,21.9,8.6966,5,226,17.9,395.93,4.81,35.4\n56,0.02055,85.0,0.74,0.0,0.41,6.383,35.7,9.1876,2,313,17.3,396.9,5.77,24.7\n57,0.01432,100.0,1.32,0.0,0.411,6.816,40.5,8.3248,5,256,15.1,392.9,3.95,31.6\n58,0.15445,25.0,5.13,0.0,0.453,6.145,29.2,7.8148,8,284,19.7,390.68,6.86,23.3\n59,0.10328,25.0,5.13,0.0,0.453,5.927,47.2,6.932,8,284,19.7,396.9,9.22,19.6\n60,0.14932,25.0,5.13,0.0,0.453,5.741,66.2,7.2254,8,284,19.7,395.11,13.15,18.7\n61,0.17171,25.0,5.13,0.0,0.453,5.966,93.4,6.8185,8,284,19.7,378.08,14.44,16.0\n62,0.11027,25.0,5.13,0.0,0.453,6.456,67.8,7.2255,8,284,19.7,396.9,6.73,22.2\n63,0.1265,25.0,5.13,0.0,0.453,6.762,43.4,7.9809,8,284,19.7,395.58,9.5,25.0\n64,0.01951,17.5,1.38,0.0,0.4161,7.104,59.5,9.2229,3,216,18.6,393.24,8.05,33.0\n65,0.03584,80.0,3.37,0.0,0.398,6.29,17.8,6.6115,4,337,16.1,396.9,4.67,23.5\n66,0.04379,80.0,3.37,0.0,0.398,5.787,31.1,6.6115,4,337,16.1,396.9,10.24,19.4\n67,0.05789,12.5,6.07,0.0,0.409,5.878,21.4,6.498,4,

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2.78,9.69,28.7\n218,0.11069,0.0,13.89,1.0,0.55,5.951,93.8,2.8893,5,276,16.4,396.
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2,5,224,20.2,396.9,9.29,18.7\n341,0.01301,35.0,1.52,0.0,0.442,7.241,49.3,7.0379,
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22,15.9,389.96,8.65,16.5\n343,0.02543,55.0,3.78,0.0,0.484,6.696,56.4,5.7321,5,37
0,17.6,396.9,7.18,23.9\n344,0.03049,55.0,11.083991769547325,0.0,0.484,6.874,28.1
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8,67.6,2.5329,24,666,20.2,374.68,12.715432098765433,29.8\n474,8.05579,0.0,18.1,0
.0,0.584,5.427,95.4,2.4298,24,666,20.2,352.58,18.14,13.8\n475,6.39312,0.0,18.1,0
.0,0.584,6.162,97.4,2.206,24,666,20.2,302.76,24.1,13.3\n476,4.87141,0.0,18.1,0.0
,0.614,6.484,93.6,2.3053,24,666,20.2,396.21,18.68,16.7\n477,15.0234,0.0,18.1,0.0
,0.614,5.304,97.3,2.1007,24,666,20.2,349.48,24.91,12.0\n478,10.233,0.0,18.1,0.0,
0.614,6.185,96.7,2.1705,24,666,20.2,379.7,18.03,14.6\n479,14.3337,0.0,18.1,0.069
95884773662552,0.614,6.229,88.0,1.9512,24,666,20.2,383.32,13.11,21.4\n480,5.8240
1,0.0,18.1,0.0,0.532,6.242,64.7,3.4242,24,666,20.2,396.9,10.74,23.0\n481,5.70818
,0.0,18.1,0.0,0.532,6.75,74.9,3.3317,24,666,20.2,393.07,7.74,23.7\n482,5.73116,0

.0,18.1,0.06995884773662552,0.532,7.061,77.0,3.4106,24,666,20.2,395.28,7.01,25.0
\n483,2.81838,0.0,18.1,0.0,0.532,5.762,40.3,4.0983,24,666,20.2,392.92,10.42,21.8
\n484,2.37857,0.0,18.1,0.0,0.583,5.871,41.9,3.724,24,666,20.2,370.73,13.34,20.6\
n485,3.67367,0.0,18.1,0.0,0.583,6.312,51.9,3.9917,24,666,20.2,388.62,10.58,21.2\
n486,5.69175,0.0,18.1,0.0,0.583,6.114,79.8,3.5459,24,666,20.2,392.68,14.98,19.1\
n487,4.83567,0.0,18.1,0.0,0.583,5.905,53.2,3.1523,24,666,20.2,388.22,11.45,20.6\
n488,0.15086,0.0,27.74,0.0,0.609,5.454,92.7,1.8209,4,711,20.1,395.09,18.06,15.2\
n489,0.18337,0.0,27.74,0.0,0.609,5.414,98.3,1.7554,4,711,20.1,344.05,23.97,7.0\n
490,0.20746,0.0,27.74,0.0,0.609,5.093,98.0,1.8226,4,711,20.1,318.43,29.68,8.1\n4
91,0.10574,0.0,27.74,0.0,0.609,5.983,98.8,1.8681,4,711,20.1,390.11,18.07,13.6\n4
92,0.11132,0.0,27.74,0.0,0.609,5.983,83.5,2.1099,4,711,20.1,396.9,13.35,20.1\n49
3,0.17331,0.0,9.69,0.0,0.585,5.707,54.0,2.3817,6,391,19.2,396.9,12.01,21.8\n494,
0.27957,0.0,9.69,0.0,0.585,5.926,42.6,2.3817,6,391,19.2,396.9,13.59,24.5\n495,0.
17899,0.0,9.69,0.0,0.585,5.67,28.8,2.7986,6,391,19.2,393.29,17.6,23.1\n496,0.289
6,0.0,9.69,0.0,0.585,5.39,72.9,2.7986,6,391,19.2,396.9,21.14,19.7\n497,0.26838,0
.0,9.69,0.0,0.585,5.794,70.6,2.8927,6,391,19.2,396.9,14.1,18.3\n498,0.23912,0.0,
9.69,0.0,0.585,6.019,65.3,2.4091,6,391,19.2,396.9,12.92,21.2\n499,0.17783,0.0,9.
69,0.0,0.585,5.569,73.5,2.3999,6,391,19.2,395.77,15.1,17.5\n500,0.22438,0.0,9.69
,0.0,0.585,6.027,79.7,2.4982,6,391,19.2,396.9,14.33,16.8\n501,0.06263,0.0,11.93,
0.0,0.573,6.593,69.1,2.4786,1,273,21.0,391.99,12.715432098765433,22.4\n502,0.045
27,0.0,11.93,0.0,0.573,6.12,76.7,2.2875,1,273,21.0,396.9,9.08,20.6\n503,0.06076,
0.0,11.93,0.0,0.573,6.976,91.0,2.1675,1,273,21.0,396.9,5.64,23.9\n504,0.10959,0.
0,11.93,0.0,0.573,6.794,89.3,2.3889,1,273,21.0,393.45,6.48,22.0\n505,0.04741,0.0
,11.93,0.0,0.573,6.03,68.51851851851852,2.505,1,273,21.0,396.9,7.88,11.9\n'}

[ ]:
```
df=pd.read_csv("Boston_housing.csv")
```

[ ]:
```
df
```

[ ]:

	Unnamed: 0	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
0	0	0.00632	18.0	2.31	0.0	0.538	6.575	65.200000	4.0900	1	296	15.3	396.90	4.980000	24.0
1	1	0.02731	0.0	7.07	0.0	0.469	6.421	78.900000	4.9671	2	242	17.8	396.90	9.140000	21.6
2	2	0.02729	0.0	7.07	0.0	0.469	7.185	61.100000	4.9671	2	242	17.8	392.83	4.030000	34.7
3	3	0.03237	0.0	2.18	0.0	0.458	6.998	45.800000	6.0622	3	222	18.7	394.63	2.940000	33.4
4	4	0.06905	0.0	2.18	0.0	0.458	7.147	54.200000	6.0622						
..	…	…	…	…	…	…	…	…	…						
501	501	0.06263	0.0	11.93	0.0	0.573	6.593	69.100000	2.4786						
502	502	0.04527	0.0	11.93	0.0	0.573	6.120	76.700000	2.2875						
503	503	0.06076	0.0	11.93	0.0	0.573	6.976	91.000000	2.1675						
504	504	0.10959	0.0	11.93	0.0	0.573	6.794	89.300000	2.3889						
505	505	0.04741	0.0	11.93	0.0	0.573	6.030	68.518519	2.5050						

```
4      3  222     18.7  396.90  12.715432  36.2
..   …  …       …     …          …   …
501    1  273     21.0  391.99  12.715432  22.4
502    1  273     21.0  396.90   9.080000  20.6
503    1  273     21.0  396.90   5.640000  23.9
504    1  273     21.0  393.45   6.480000  22.0
505    1  273     21.0  396.90   7.880000  11.9

[506 rows x 15 columns]
```

[ ]:

Basic operations

[ ]:
```
df.head(30)
```

[ ]:

	Unnamed: 0	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	\
0	0	0.00632	18.0	2.31	0.000000	0.538	6.575	65.2	4.0900	
1	1	0.02731	0.0	7.07	0.000000	0.469	6.421	78.9	4.9671	
2	2	0.02729	0.0	7.07	0.000000	0.469	7.185	61.1	4.9671	
3	3	0.03237	0.0	2.18	0.000000	0.458	6.998	45.8	6.0622	
4	4	0.06905	0.0	2.18	0.000000	0.458	7.147	54.2	6.0622	
5	5	0.02985	0.0	2.18	0.000000	0.458	6.430	58.7	6.0622	
6	6	0.08829	12.5	7.87	0.069959	0.524	6.012	66.6	5.5605	
7	7	0.14455	12.5	7.87	0.000000	0.524	6.172	96.1	5.9505	
8	8	0.21124	12.5	7.87	0.000000	0.524	5.631	100.0	6.0821	
9	9	0.17004	12.5	7.87	0.069959	0.524	6.004	85.9	6.5921	
10	10	0.22489	12.5	7.87	0.000000	0.524	6.377	94.3	6.3467	
11	11	0.11747	12.5	7.87	0.000000	0.524	6.009	82.9	6.2267	
12	12	0.09378	12.5	7.87	0.000000	0.524	5.889	39.0	5.4509	
13	13	0.62976	0.0	8.14	0.000000	0.538	5.949	61.8	4.7075	
14	14	0.63796	0.0	8.14	0.069959	0.538	6.096	84.5	4.4619	
15	15	0.62739	0.0	8.14	0.000000	0.538	5.834	56.5	4.4986	
16	16	1.05393	0.0	8.14	0.000000	0.538	5.935	29.3	4.4986	
17	17	0.78420	0.0	8.14	0.000000	0.538	5.990	81.7	4.2579	
18	18	0.80271	0.0	8.14	0.000000	0.538	5.456	36.6	3.7965	
19	19	0.72580	0.0	8.14	0.000000	0.538	5.727	69.5	3.7965	
20	20	1.25179	0.0	8.14	0.000000	0.538	5.570	98.1	3.7979	
21	21	0.85204	0.0	8.14	0.000000	0.538	5.965	89.2	4.0123	
22	22	1.23247	0.0	8.14	0.000000	0.538	6.142	91.7	3.9769	
23	23	0.98843	0.0	8.14	0.000000	0.538	5.813	100.0	4.0952	
24	24	0.75026	0.0	8.14	0.000000	0.538	5.924	94.1	4.3996	
25	25	0.84054	0.0	8.14	0.000000	0.538	5.599	85.7	4.4546	
26	26	0.67191	0.0	8.14	0.000000	0.538	5.813	90.3	4.6820	
27	27	0.95577	0.0	8.14	0.000000	0.538	6.047	88.8	4.4534	
28	28	0.77299	0.0	8.14	0.000000	0.538	6.495	94.4	4.4547	
29	29	1.00245	0.0	8.14	0.000000	0.538	6.674	87.3	4.2390	

	RAD	TAX	PTRATIO	B	LSTAT	MEDV
0	1	296	15.3	396.90	4.980000	24.0
1	2	242	17.8	396.90	9.140000	21.6
2	2	242	17.8	392.83	4.030000	34.7
3	3	222	18.7	394.63	2.940000	33.4
4	3	222	18.7	396.90	12.715432	36.2
5	3	222	18.7	394.12	5.210000	28.7
6	5	311	15.2	395.60	12.430000	22.9
7	5	311	15.2	396.90	19.150000	27.1
8	5	311	15.2	386.63	29.930000	16.5
9	5	311	15.2	386.71	17.100000	18.9
10	5	311	15.2	392.52	20.450000	15.0
11	5	311	15.2	396.90	13.270000	18.9
12	5	311	15.2	390.50	15.710000	21.7
13	4	307	21.0	396.90	8.260000	20.4
14	4	307	21.0	380.02	10.260000	18.2
15	4	307	21.0	395.62	8.470000	19.9
16	4	307	21.0	386.85	6.580000	23.1
17	4	307	21.0	386.75	14.670000	17.5
18	4	307	21.0	288.99	11.690000	20.2
19	4	307	21.0	390.95	11.280000	18.2
20	4	307	21.0	376.57	21.020000	13.6
21	4	307	21.0	392.53	13.830000	19.6
22	4	307	21.0	396.90	18.720000	15.2
23	4	307	21.0	394.54	19.880000	14.5
24	4	307	21.0	394.33	16.300000	15.6
25	4	307	21.0	303.42	16.510000	13.9
26	4	307	21.0	376.88	14.810000	16.6
27	4	307	21.0	306.38	17.280000	14.8
28	4	307	21.0	387.94	12.800000	18.4
29	4	307	21.0	380.23	11.980000	21.0

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 506 entries, 0 to 505
Data columns (total 15 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   Unnamed: 0  506 non-null    int64
 1   CRIM        506 non-null    float64
 2   ZN          506 non-null    float64
 3   INDUS       506 non-null    float64
 4   CHAS        506 non-null    float64
 5   NOX         506 non-null    float64
 6   RM          506 non-null    float64
```

```
 7   AGE         506 non-null    float64
 8   DIS         506 non-null    float64
 9   RAD         506 non-null    int64
 10  TAX         506 non-null    int64
 11  PTRATIO     506 non-null    float64
 12  B           506 non-null    float64
 13  LSTAT       506 non-null    float64
 14  MEDV        506 non-null    float64
dtypes: float64(12), int64(3)
memory usage: 59.4 KB
```

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

[ ]:
```
       Unnamed: 0        CRIM          ZN       INDUS        CHAS         NOX  \
count  506.000000  506.000000  506.000000  506.000000  506.000000  506.000000
mean   252.500000    3.611874   11.211934   11.083992    0.069959    0.554695
std    146.213884    8.545770   22.921051    6.699165    0.250233    0.115878
min      0.000000    0.006320    0.000000    0.460000    0.000000    0.385000
25%    126.250000    0.083235    0.000000    5.190000    0.000000    0.449000
50%    252.500000    0.290250    0.000000    9.900000    0.000000    0.538000
75%    378.750000    3.611874   11.211934   18.100000    0.000000    0.624000
max    505.000000   88.976200  100.000000   27.740000    1.000000    0.871000

                RM         AGE         DIS         RAD         TAX     PTRATIO  \
count  506.000000  506.000000  506.000000  506.000000  506.000000  506.000000
mean     6.284634   68.518519    3.795043    9.549407  408.237154   18.455534
std      0.702617   27.439466    2.105710    8.707259  168.537116    2.164946
min      3.561000    2.900000    1.129600    1.000000  187.000000   12.600000
25%      5.885500   45.925000    2.100175    4.000000  279.000000   17.400000
50%      6.208500   74.450000    3.207450    5.000000  330.000000   19.050000
75%      6.623500   93.575000    5.188425   24.000000  666.000000   20.200000
max      8.780000  100.000000   12.126500   24.000000  711.000000   22.000000

                B       LSTAT        MEDV
count  506.000000  506.000000  506.000000
mean   356.674032   12.715432   22.532806
std     91.294864    7.012739    9.197104
min      0.320000    1.730000    5.000000
25%    375.377500    7.230000   17.025000
50%    391.440000   11.995000   21.200000
75%    396.225000   16.570000   25.000000
max    396.900000   37.970000   50.000000
```

#Data Preprocessing

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


[ ]:
```
      Unnamed: 0   CRIM     ZN  INDUS   CHAS    NOX     RM    AGE    DIS  \
0          False  False  False  False  False  False  False  False  False
1          False  False  False  False  False  False  False  False  False
2          False  False  False  False  False  False  False  False  False
3          False  False  False  False  False  False  False  False  False
4          False  False  False  False  False  False  False  False  False
..           …      …      …      …      …      …      …      …      …
501        False  False  False  False  False  False  False  False  False
502        False  False  False  False  False  False  False  False  False
503        False  False  False  False  False  False  False  False  False
504        False  False  False  False  False  False  False  False  False
505        False  False  False  False  False  False  False  False  False

       RAD    TAX  PTRATIO      B  LSTAT   MEDV
0    False  False    False  False  False  False
1    False  False    False  False  False  False
2    False  False    False  False  False  False
3    False  False    False  False  False  False
4    False  False    False  False  False  False
..     …      …       …      …      …      …
501  False  False    False  False  False  False
502  False  False    False  False  False  False
503  False  False    False  False  False  False
504  False  False    False  False  False  False
505  False  False    False  False  False  False

[506 rows x 15 columns]
```

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

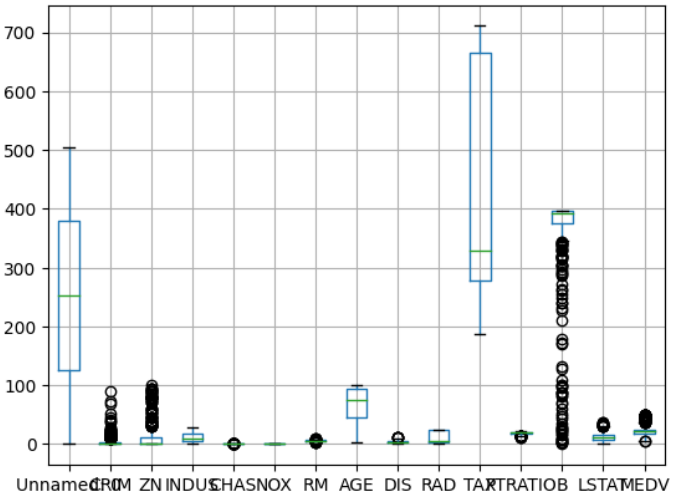
[ ]:
```
Unnamed: 0    0
CRIM          0
ZN            0
INDUS         0
CHAS          0
NOX           0
RM            0
AGE           0
DIS           0
RAD           0
TAX           0
PTRATIO       0
B             0
LSTAT         0
MEDV          0
dtype: int64
```

Checking for Outliers

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

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

[ ]: <Axes: >



[ ]:
```
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
```

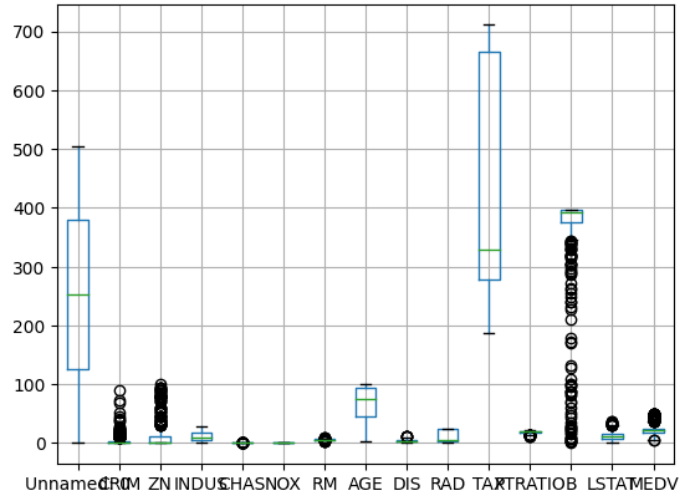
[ ]:
```
Int64Index([398, 405], dtype='int64')
```

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

```
<ipython-input-20-a2400eefca7a>: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()
```

[ ]: <Axes: >



Preparing the data for training the model

[ ]:
```
X = df.drop(['MEDV'], axis = 1) #independent variables
Y = df['MEDV'] #dependent variables
```

[ ]:
```
X
```

[ ]:
```
     Unnamed: 0     CRIM    ZN  INDUS  CHAS    NOX     RM    AGE     DIS  \
0             0  0.00632  18.0   2.31   0.0  0.538  6.575  65.20  4.0900
1             1  0.02731   0.0   7.07   0.0  0.469  6.421  78.90  4.9671
2             2  0.02729   0.0   7.07   0.0  0.469  7.185  61.10  4.9671
3             3  0.03237   0.0   2.18   0.0  0.458  6.998  45.80  6.0622
4             4  0.06905   0.0   2.18   0.0  0.458  7.147  54.20  6.0622
..          ...      ...   ...    ...   ...    ...    ...    ...     ...
501         501  0.06263   0.0  11.93   0.0  0.573  6.593  69.10  2.4786
502         502  0.04527   0.0  11.93   0.0  0.573  6.120  76.70  2.2875
503         503  0.06076   0.0  11.93   0.0  0.573  6.976  91.00  2.1675
504         504  0.10959   0.0  11.93   0.0  0.573  6.794  89.30  2.3889
505         505  0.04741   0.0  11.93   0.0  0.573  6.030  68.52  2.5050

     RAD  TAX  PTRATIO       B  LSTAT
0      1  296     15.3  396.90   4.98
1      2  242     17.8  396.90   9.14
2      2  242     17.8  392.83   4.03
3      3  222     18.7  394.63   2.94
4      3  222     18.7  396.90  12.71
..   ...  ...      ...     ...    ...
501    1  273     21.0  391.99  12.71
502    1  273     21.0  396.90   9.08
503    1  273     21.0  396.90   5.64
504    1  273     21.0  393.45   6.48
505    1  273     21.0  396.90   7.88

[506 rows x 14 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([32.81311732, 22.59285562, 27.99228066, 23.95801611,  6.48919687,
       14.09086134, 21.66762269, 29.18518046, 32.64247713, 13.04706855,
       20.39287447, 21.64650684, 13.27281042, 23.93698727,  5.91093077,
       19.28486113,  9.22745418, 45.26891144, 30.82181868, 17.40173659,
       17.97892153, 21.52494015, 23.24616629, 19.24247982, 34.89711624,
       13.71707597, 21.15223649, 35.52855633, 19.14925327, 13.65485436,
       13.74362446, 22.37210349, 14.99382113, 31.63219947, 25.38375494,
       16.19954413, 24.79758417,  9.76399303, 15.04127642, 21.40008464,
       33.04500293, 28.43002048, 25.14727115, 15.69062724, 31.91941907,
       25.49100247, 14.20061604,  7.86764569, 27.80099607, 25.59429509,
        5.11278297, 28.18226676, 17.05255151, 29.85588981, 19.37235156,
       16.46700339, 18.56895878, 13.10226966,  8.90261082, 19.44093614,
       33.87671079, 32.84343025, 24.03926149, 19.9668276 , 22.78281473,
       26.79208079, 21.19958973, 17.77949426, 32.39200824, 10.47985478,
       19.09213401, 31.71742431, 18.79105646, 15.82304869, 18.59449812,
       14.76346969, 24.0403686 , 23.77513132, 17.29119121, 13.22444946,
       20.30875385, 24.25579584, 17.67223286, 25.25614125, 23.0240047 ,
       27.91602835, 36.7446593 , 16.42684582, 12.04918718, 34.95510801,
       31.41658291, 20.29218738, 39.77862616, 28.7508426 , 28.41851631,
       17.51598081, 26.67117052, 40.36804604, 27.67542427, 17.24904894,
       37.44715313, 35.85421585, 14.16155354, 27.86304661, 22.04494892,
```

```
24.86707059, 21.14024419, 23.5066229 , 28.09395694, 29.54600855,
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25.71311329, 19.56374427, 30.75655153, 10.01958069, 24.3401924 ,
17.34664411, 17.08699962, 22.78321009, 21.78731639, 12.35813462,
25.33935977, 28.39080031, 20.88629682, 12.33537917, 24.94036961,
26.51019347, 25.69363016, 23.68554725, 25.92724441, 19.37672388,
20.86151643, 36.0485522 , 21.24580436, 36.43205868, 25.69959571,
20.86856078, 15.66896363, 32.06946255, 21.39878442, 28.0073226 ,
14.82930128, 32.66495146, 14.49759695,  1.63617473, 19.50246502,
13.8690706 , 37.66533072, 16.40821139, 14.69516707, 26.71114367,
23.65265524, 18.09413407, 31.29094562, 25.07848893, 27.54053246,
24.7338705 , 22.80629365, 22.62443522, 11.11156119, 21.08768248,
11.73191838, 17.52090607, 12.42033984, 27.70955386, 15.34695622,
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14.55668366, 23.32528627, 21.41565907, 14.78225921, 17.25397428,
13.20490994, 24.1785951 , 12.47029156, 35.41176561, 13.99599511,
43.27576949, 31.65805217, 34.78904666, 22.17588285, 15.97443071,
26.82186758, 29.20538928, 13.86122327, 26.87222614, 36.34794955,
16.82683638, 11.38692405, 34.6685182 , 35.94176066, 18.04361285,
21.36229114, 18.34290236, 24.33120351, 19.78122488, 27.10667584,
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26.47451583, 20.20732483, 21.52609401, 16.04439095, 17.92498581,
21.3026883 , 27.92226263, 20.07751545,  6.95084656, 16.31976288,
32.33713417, 35.41215728, 16.51577609, 18.75023732, 21.92819238,
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22.92693837, 27.0538829 , 25.79808944, 32.82227206, 14.85950403,
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23.7924752 , 22.67218571, 11.95307757, 19.94019035, 33.34902305,
24.6422943 , 17.78858846, 33.26317393, 22.04796731, 28.87021853,
32.03060743, 36.51977709, 22.09466919, 24.18457288, 23.19842557,
31.90965447, 22.43237991, 18.2766533 , 22.11874232, 29.29161678,
22.73404901, 22.19356004, 17.15048559, 17.37841636, 16.99334332,
16.93254337, 16.7537439 , 32.03123942, 23.49073021, 17.54254409,
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30.92945569, 30.07060287, 21.33424392, 20.33195429, 36.18879402,
20.3660625 , 33.2900504 , 20.93191618, 31.58834981, 30.37914983,
37.39315381, 26.07330464, 21.01766192, 29.24253422, 15.89847147,
26.21582763, 21.65351253, 29.89912736, 10.57465537, 31.14672528,
 6.19747028, 15.27425013, 20.47104299, 35.5770489 , 31.9178623 ,
12.11969062, 13.68298773, 21.76023224, 34.76429586, 18.85939486,
18.71877161, 14.88318114, 25.06141149, 40.94969602, 25.19385215,
42.13230746, 25.53787237, 21.12499173, 11.82180286, 15.84336134,
14.15153456, 18.48234043,  3.01898018, 27.80465939, 26.55454391,
41.63887783, 21.77585498, 21.16144862, 34.02141179, 33.15943999,
 9.6230867 , 24.68765128, 43.74101279, 21.85416225, 17.65627057,
26.32063336, 18.69069526,  6.34873533, 18.84833389, 35.57374501,
16.27911231, 23.94254936, 13.16515921, 24.54504811, 18.27279239,
```



```
17.15422685, 18.57463353, 32.94507083, 19.64004666, 29.7691586 ,
32.03839692, 41.72538931, 18.55498485, 16.037751  , 38.33202537,
17.91190403, 10.69857314, 14.86051024, 25.28528015, 19.39814291,
16.43225805, 26.57912893, 13.37793727,  5.90660578, 18.67757697,
10.8861992 , 28.39026301,  4.68960057, 28.66478738, 32.8970624 ,
22.41627955, 16.40187146, 17.91615805, 20.9349613 , 34.05620487,
28.2252698 , 19.30423927, 20.58339329,  6.76131383, 28.88043978,
25.18987646, 22.24592143, 13.89499506, 24.83663458, 19.23765293,
 8.71288591, 26.79230071, 15.77590707, 31.79688643, 31.96631865,
25.01479778, 18.46322712, 30.69309066, 21.22649259, 26.09634655,
24.39423043, 31.13189182, 24.54081491, 31.31955106, 17.56320701,
19.97749055, 18.74856961, 41.39314728, 25.558767  , 19.14181302,
33.48991385, 23.82668099, 18.39222559, 23.23313284])
```

[ ]:
```
ytrain
```

[ ]:
```
220    26.7
71     21.7
240    22.0
6      22.9
417    10.4
       …
323    18.5
192    36.4
117    19.2
47     16.6
172    23.1
Name: MEDV, Length: 404, dtype: float64
```

[ ]:
```
ytest
```

[ ]:
```
329    22.6
371    50.0
219    23.0
403     8.3
78     21.2
       …
56     24.7
455    14.1
60     18.7
213    28.1
108    19.8
Name: MEDV, Length: 102, dtype: float64
```

Model evaluation

[ ]:
```
from sklearn.metrics import mean_squared_error
mse = mean_squared_error(ytrain, ytrain_pred)
print("The model performance for training set")
print("--------------------------------------")
print('MSE is {}'.format(mse))
print("\n")
```

```
The model performance for training set
--------------------------------------
MSE is 20.003837579318024
```

[ ]:
```
mse = mean_squared_error(ytest, ytest_pred)
print("The model performance for testing set")
print("--------------------------------------")
print('MSE is {}'.format(mse))
print("\n\n\n")
```

```
The model performance for testing set
--------------------------------------
MSE is 34.836745559085536
```

[ ]:
```
from sklearn.metrics import  mean_absolute_error

# Assuming ytrain and ytrain_pred are your actual and predicted values␣
 ↪respectively
mae = mean_absolute_error(ytrain, ytrain_pred)

print("The model performance for training set")
print("--------------------------------------")
print('MAE is {}'.format(mae))
print("\n")
```

```
The model performance for training set
--------------------------------------
MAE is 3.146473740056485
```

[ ]:
```
mae = mean_absolute_error(ytest, ytest_pred)

print("The model performance for training set")
```



```
print("--------------------------------------")
print('MAE is {}'.format(mae))
print("\n")
```

```
The model performance for training set
--------------------------------------
MAE is 3.9595421344408983
```

[ ]:
```
from sklearn.metrics import r2_score
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")
```

```
The model performance for training set
--------------------------------------
RMSE is 4.472564988831132
R2 score is 0.7650579804734076
```

[ ]:
```
# 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 testing set
--------------------------------------
RMSE is 5.902266137602195
R2 score is 0.57217962224962
```

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()
```