In [2]:

**import** pandas **as** pd

**import** numpy **as** np

**from** sklearn **import** linear\_model

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

In [3]:



**from** sklearn.datasets **import** load\_boston boston **=** load\_boston()

print(boston)

{'data': array([[6.3200e-03, 1.8000e+01, 2.3100e+00, ..., 1.5300e+01, 3.9690e+02, 4.9800e+00],

[2.7310e-02, 0.0000e+00, 7.0700e+00, ..., 1.7800e+01, 3.9690e+02, 9.1400e+00],

[2.7290e-02, 0.0000e+00, 7.0700e+00, ..., 1.7800e+01, 3.9283e+02, 4.0300e+00],

...,

[6.0760e-02, 0.0000e+00, 1.1930e+01, ..., 2.1000e+01, 3.9690e+02, 5.6400e+00],

[1.0959e-01, 0.0000e+00, 1.1930e+01, ..., 2.1000e+01, 3.9345e+02, 6.4800e+00],

[4.7410e-02, 0.0000e+00, 1.1930e+01, ..., 2.1000e+01, 3.9690e+02,

7.8800e+00]]), 'target': array([24. , 21.6, 34.7, 33.4, 36.2, 28.7, 22.9, 2

7.1, 16.5, 18.9, 15. ,

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 18.9, | 21.7, | 20.4, | 18.2, | 19.9, | 23.1, | 17.5, | 20.2, | 18.2, | 13.6, | 19.6, |
| 15.2, | 14.5, | 15.6, | 13.9, | 16.6, | 14.8, | 18.4, | 21. , | 12.7, | 14.5, | 13.2, |
| 13.1, | 13.5, | 18.9, | 20. , | 21. , | 24.7, | 30.8, | 34.9, | 26.6, | 25.3, | 24.7, |
| 21.2, | 19.3, | 20. , | 16.6, | 14.4, | 19.4, | 19.7, | 20.5, | 25. , | 23.4, | 18.9, |
| 35.4, | 24.7, | 31.6, | 23.3, | 19.6, | 18.7, | 16. , | 22.2, | 25. , | 33. , | 23.5, |
| 19.4, | 22. , | 17.4, | 20.9, | 24.2, | 21.7, | 22.8, | 23.4, | 24.1, | 21.4, | 20. , |
| 20.8, | 21.2, | 20.3, | 28. , | 23.9, | 24.8, | 22.9, | 23.9, | 26.6, | 22.5, | 22.2, |
| 23.6, | 28.7, | 22.6, | 22. , | 22.9, | 25. , | 20.6, | 28.4, | 21.4, | 38.7, | 43.8, |
| 33.2, | 27.5, | 26.5, | 18.6, | 19.3, | 20.1, | 19.5, | 19.5, | 20.4, | 19.8, | 19.4, |
| 21.7, | 22.8, | 18.8, | 18.7, | 18.5, | 18.3, | 21.2, | 19.2, | 20.4, | 19.3, | 22. , |
| 20.3, | 20.5, | 17.3, | 18.8, | 21.4, | 15.7, | 16.2, | 18. , | 14.3, | 19.2, | 19.6, |
| 23. , | 18.4, | 15.6, | 18.1, | 17.4, | 17.1, | 13.3, | 17.8, | 14. , | 14.4, | 13.4, |
| 15.6, | 11.8, | 13.8, | 15.6, | 14.6, | 17.8, | 15.4, | 21.5, | 19.6, | 15.3, | 19.4, |
| 17. , | 15.6, | 13.1, | 41.3, | 24.3, | 23.3, | 27. , | 50. , | 50. , | 50. , | 22.7, |
| 25. , | 50. , | 23.8, | 23.8, | 22.3, | 17.4, | 19.1, | 23.1, | 23.6, | 22.6, | 29.4, |
| 23.2, | 24.6, | 29.9, | 37.2, | 39.8, | 36.2, | 37.9, | 32.5, | 26.4, | 29.6, | 50. , |
| 32. , | 29.8, | 34.9, | 37. , | 30.5, | 36.4, | 31.1, | 29.1, | 50. , | 33.3, | 30.3, |
| 34.6, | 34.9, | 32.9, | 24.1, | 42.3, | 48.5, | 50. , | 22.6, | 24.4, | 22.5, | 24.4, |
| 20. , | 21.7, | 19.3, | 22.4, | 28.1, | 23.7, | 25. , | 23.3, | 28.7, | 21.5, | 23. , |
| 26.7, | 21.7, | 27.5, | 30.1, | 44.8, | 50. , | 37.6, | 31.6, | 46.7, | 31.5, | 24.3, |
| 31.7, | 41.7, | 48.3, | 29. , | 24. , | 25.1, | 31.5, | 23.7, | 23.3, | 22. , | 20.1, |
| 22.2, | 23.7, | 17.6, | 18.5, | 24.3, | 20.5, | 24.5, | 26.2, | 24.4, | 24.8, | 29.6, |
| 42.8, | 21.9, | 20.9, | 44. , | 50. , | 36. , | 30.1, | 33.8, | 43.1, | 48.8, | 31. , |
| 36.5, | 22.8, | 30.7, | 50. , | 43.5, | 20.7, | 21.1, | 25.2, | 24.4, | 35.2, | 32.4, |
| 32. , | 33.2, | 33.1, | 29.1, | 35.1, | 45.4, | 35.4, | 46. , | 50. , | 32.2, | 22. , |
| 20.1, | 23.2, | 22.3, | 24.8, | 28.5, | 37.3, | 27.9, | 23.9, | 21.7, | 28.6, | 27.1, |
| 20.3, | 22.5, | 29. , | 24.8, | 22. , | 26.4, | 33.1, | 36.1, | 28.4, | 33.4, | 28.2, |
| 22.8, | 20.3, | 16.1, | 22.1, | 19.4, | 21.6, | 23.8, | 16.2, | 17.8, | 19.8, | 23.1, |
| 21. , | 23.8, | 23.1, | 20.4, | 18.5, | 25. , | 24.6, | 23. , | 22.2, | 19.3, | 22.6, |
| 19.8, | 17.1, | 19.4, | 22.2, | 20.7, | 21.1, | 19.5, | 18.5, | 20.6, | 19. , | 18.7, |
| 32.7, | 16.5, | 23.9, | 31.2, | 17.5, | 17.2, | 23.1, | 24.5, | 26.6, | 22.9, | 24.1, |
| 18.6, | 30.1, | 18.2, | 20.6, | 17.8, | 21.7, | 22.7, | 22.6, | 25. , | 19.9, | 20.8, |
| 16.8, | 21.9, | 27.5, | 21.9, | 23.1, | 50. , | 50. , | 50. , | 50. , | 50. , | 13.8, |
| 13.8, | 15. , | 13.9, | 13.3, | 13.1, | 10.2, | 10.4, | 10.9, | 11.3, | 12.3, | 8.8, |
| 7.2, | 10.5, | 7.4, | 10.2, | 11.5, | 15.1, | 23.2, | 9.7, | 13.8, | 12.7, | 13.1, |
| 12.5, | 8.5, | 5. , | 6.3, | 5.6, | 7.2, | 12.1, | 8.3, | 8.5, | 5. , | 11.9, |
| 27.9, | 17.2, | 27.5, | 15. , | 17.2, | 17.9, | 16.3, | 7. , | 7.2, | 7.5, | 10.4, |
| 8.8, | 8.4, | 16.7, | 14.2, | 20.8, | 13.4, | 11.7, | 8.3, | 10.2, | 10.9, | 11. , |
| 9.5, | 14.5, | 14.1, | 16.1, | 14.3, | 11.7, | 13.4, | 9.6, | 8.7, | 8.4, | 12.8, |
| 10.5, | 17.1, | 18.4, | 15.4, | 10.8, | 11.8, | 14.9, | 12.6, | 14.1, | 13. , | 13.4, |
| 15.2, | 16.1, | 17.8, | 14.9, | 14.1, | 12.7, | 13.5, | 14.9, | 20. , | 16.4, | 17.7, |
| 19.5, | 20.2, | 21.4, | 19.9, | 19. , | 19.1, | 19.1, | 20.1, | 19.9, | 19.6, | 23.2, |
| 29.8, | 13.8, | 13.3, | 16.7, | 12. , | 14.6, | 21.4, | 23. , | 23.7, | 25. , | 21.8, |
| 20.6, | 21.2, | 19.1, | 20.6, | 15.2, | 7. , | 8.1, | 13.6, | 20.1, | 21.8, | 24.5, |

23.1, 19.7, 18.3, 21.2, 17.5, 16.8, 22.4, 20.6, 23.9, 22. , 11.9]), 'feature



\_names': array(['CRIM', 'ZN', 'INDUS', 'CHAS', 'NOX', 'RM', 'AGE', 'DIS', 'RAD',

'TAX', 'PTRATIO', 'B', 'LSTAT'], dtype='<U7'), 'DESCR': ".. \_boston\_datase

t:\n\nBoston house prices dataset\n---------------------------\n\n\*\*Data Set Charac teristics:\*\* \n\n :Number of Instances: 506 \n\n :Number of Attributes: 13 n umeric/categorical predictive. Median Value (attribute 14) is usually the target.\n

\n :Attribute Information (in order):\n - CRIM per capita crime rate by town\n - ZN proportion of residential land zoned for lots over 25,0 00 sq.ft.\n - INDUS proportion of non-retail business acres per town\n

* CHAS Charles River dummy variable (= 1 if tract bounds river; 0 otherwise)\n
* NOX nitric oxides concentration (parts per 10 million)\n - RM a verage number of rooms per dwelling\n - AGE proportion of owner-occupie d units built prior to 1940\n - DIS weighted distances to five Boston e mployment centres\n - RAD index of accessibility to radial highways\n
* TAX full-value property-tax rate per $10,000\n - PTRATIO pupil-teach er ratio by town\n - B 1000(Bk - 0.63)^2 where Bk is the proportion o f blacks by town\n - LSTAT % lower status of the population\n - ME DV Median value of owner-occupied homes in $1000's\n\n :Missing Attribute Va lues: None\n\n :Creator: Harrison, D. and Rubinfeld, D.L.\n\nThis is a copy of U CI ML housing dataset.\nhttps://archive.ics.uci.edu/ml/machine-learning-databases/h ousing/\n\n\nThis dataset was taken from the StatLib library which is maintained at Carnegie Mellon University.\n\nThe Boston house-price data of Harrison, D. and Rubi nfeld, D.L. 'Hedonic\nprices and the demand for clean air', J. Environ. Economics & Management,\nvol.5, 81-102, 1978. Used in Belsley, Kuh & Welsch, 'Regression diag nostics\n...', Wiley, 1980. N.B. Various transformations are used in the table on

\npages 244-261 of the latter.\n\nThe Boston house-price data has been used in many machine learning papers that address regression\nproblems. \n \n.. topic:: Re ferences\n\n - Belsley, Kuh & Welsch, 'Regression diagnostics: Identifying Influe ntial Data and Sources of Collinearity', Wiley, 1980. 244-261.\n - Quinlan,R. (19 93). Combining Instance-Based and Model-Based Learning. In Proceedings on the Tenth International Conference of Machine Learning, 236-243, University of Massachusetts, Amherst. Morgan Kaufmann.\n", 'filename': 'C:\\Users\\HP\\Anaconda3\\lib\\site-pack ages\\sklearn\\datasets\\data\\boston\_house\_prices.csv'}

In [4]:

boston.feature\_names

Out[4]: array(['CRIM', 'ZN', 'INDUS', 'CHAS', 'NOX', 'RM', 'AGE', 'DIS', 'RAD', 'TAX', 'PTRATIO', 'B', 'LSTAT'], dtype='<U7')

In [5]:

boston.target

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Out[5]: | array([24. , | 21.6, | 34.7, | 33.4, | 36.2, | 28.7, | 22.9, | 27.1, | 16.5, | 18.9, | 15. , |
|  | 18.9, | 21.7, | 20.4, | 18.2, | 19.9, | 23.1, | 17.5, | 20.2, | 18.2, | 13.6, | 19.6, |
|  | 15.2, | 14.5, | 15.6, | 13.9, | 16.6, | 14.8, | 18.4, | 21. , | 12.7, | 14.5, | 13.2, |
|  | 13.1, | 13.5, | 18.9, | 20. , | 21. , | 24.7, | 30.8, | 34.9, | 26.6, | 25.3, | 24.7, |
|  | 21.2, | 19.3, | 20. , | 16.6, | 14.4, | 19.4, | 19.7, | 20.5, | 25. , | 23.4, | 18.9, |
|  | 35.4, | 24.7, | 31.6, | 23.3, | 19.6, | 18.7, | 16. , | 22.2, | 25. , | 33. , | 23.5, |
|  | 19.4, | 22. , | 17.4, | 20.9, | 24.2, | 21.7, | 22.8, | 23.4, | 24.1, | 21.4, | 20. , |
|  | 20.8, | 21.2, | 20.3, | 28. , | 23.9, | 24.8, | 22.9, | 23.9, | 26.6, | 22.5, | 22.2, |
|  | 23.6, | 28.7, | 22.6, | 22. , | 22.9, | 25. , | 20.6, | 28.4, | 21.4, | 38.7, | 43.8, |
|  | 33.2, | 27.5, | 26.5, | 18.6, | 19.3, | 20.1, | 19.5, | 19.5, | 20.4, | 19.8, | 19.4, |
|  | 21.7, | 22.8, | 18.8, | 18.7, | 18.5, | 18.3, | 21.2, | 19.2, | 20.4, | 19.3, | 22. , |
|  | 20.3, | 20.5, | 17.3, | 18.8, | 21.4, | 15.7, | 16.2, | 18. , | 14.3, | 19.2, | 19.6, |
|  | 23. , | 18.4, | 15.6, | 18.1, | 17.4, | 17.1, | 13.3, | 17.8, | 14. , | 14.4, | 13.4, |
|  | 15.6, | 11.8, | 13.8, | 15.6, | 14.6, | 17.8, | 15.4, | 21.5, | 19.6, | 15.3, | 19.4, |
|  | 17. , | 15.6, | 13.1, | 41.3, | 24.3, | 23.3, | 27. , | 50. , | 50. , | 50. , | 22.7, |
|  | 25. , | 50. , | 23.8, | 23.8, | 22.3, | 17.4, | 19.1, | 23.1, | 23.6, | 22.6, | 29.4, |
|  | 23.2, | 24.6, | 29.9, | 37.2, | 39.8, | 36.2, | 37.9, | 32.5, | 26.4, | 29.6, | 50. , |
|  | 32. , | 29.8, | 34.9, | 37. , | 30.5, | 36.4, | 31.1, | 29.1, | 50. , | 33.3, | 30.3, |
|  | 34.6, | 34.9, | 32.9, | 24.1, | 42.3, | 48.5, | 50. , | 22.6, | 24.4, | 22.5, | 24.4, |
|  | 20. , | 21.7, | 19.3, | 22.4, | 28.1, | 23.7, | 25. , | 23.3, | 28.7, | 21.5, | 23. , |
|  | 26.7, | 21.7, | 27.5, | 30.1, | 44.8, | 50. , | 37.6, | 31.6, | 46.7, | 31.5, | 24.3, |
|  | 31.7, | 41.7, | 48.3, | 29. , | 24. , | 25.1, | 31.5, | 23.7, | 23.3, | 22. , | 20.1, |
|  | 22.2, | 23.7, | 17.6, | 18.5, | 24.3, | 20.5, | 24.5, | 26.2, | 24.4, | 24.8, | 29.6, |
|  | 42.8, | 21.9, | 20.9, | 44. , | 50. , | 36. , | 30.1, | 33.8, | 43.1, | 48.8, | 31. , |
|  | 36.5, | 22.8, | 30.7, | 50. , | 43.5, | 20.7, | 21.1, | 25.2, | 24.4, | 35.2, | 32.4, |
|  | 32. , | 33.2, | 33.1, | 29.1, | 35.1, | 45.4, | 35.4, | 46. , | 50. , | 32.2, | 22. , |
|  | 20.1, | 23.2, | 22.3, | 24.8, | 28.5, | 37.3, | 27.9, | 23.9, | 21.7, | 28.6, | 27.1, |
|  | 20.3, | 22.5, | 29. , | 24.8, | 22. , | 26.4, | 33.1, | 36.1, | 28.4, | 33.4, | 28.2, |
|  | 22.8, | 20.3, | 16.1, | 22.1, | 19.4, | 21.6, | 23.8, | 16.2, | 17.8, | 19.8, | 23.1, |
|  | 21. , | 23.8, | 23.1, | 20.4, | 18.5, | 25. , | 24.6, | 23. , | 22.2, | 19.3, | 22.6, |
|  | 19.8, | 17.1, | 19.4, | 22.2, | 20.7, | 21.1, | 19.5, | 18.5, | 20.6, | 19. , | 18.7, |
|  | 32.7, | 16.5, | 23.9, | 31.2, | 17.5, | 17.2, | 23.1, | 24.5, | 26.6, | 22.9, | 24.1, |
|  | 18.6, | 30.1, | 18.2, | 20.6, | 17.8, | 21.7, | 22.7, | 22.6, | 25. , | 19.9, | 20.8, |
|  | 16.8, | 21.9, | 27.5, | 21.9, | 23.1, | 50. , | 50. , | 50. , | 50. , | 50. , | 13.8, |
|  | 13.8, | 15. , | 13.9, | 13.3, | 13.1, | 10.2, | 10.4, | 10.9, | 11.3, | 12.3, | 8.8, |
|  | 7.2, | 10.5, | 7.4, | 10.2, | 11.5, | 15.1, | 23.2, | 9.7, | 13.8, | 12.7, | 13.1, |
|  | 12.5, | 8.5, | 5. , | 6.3, | 5.6, | 7.2, | 12.1, | 8.3, | 8.5, | 5. , | 11.9, |
|  | 27.9, | 17.2, | 27.5, | 15. , | 17.2, | 17.9, | 16.3, | 7. , | 7.2, | 7.5, | 10.4, |
|  | 8.8, | 8.4, | 16.7, | 14.2, | 20.8, | 13.4, | 11.7, | 8.3, | 10.2, | 10.9, | 11. , |
|  | 9.5, | 14.5, | 14.1, | 16.1, | 14.3, | 11.7, | 13.4, | 9.6, | 8.7, | 8.4, | 12.8, |
|  | 10.5, | 17.1, | 18.4, | 15.4, | 10.8, | 11.8, | 14.9, | 12.6, | 14.1, | 13. , | 13.4, |
|  | 15.2, | 16.1, | 17.8, | 14.9, | 14.1, | 12.7, | 13.5, | 14.9, | 20. , | 16.4, | 17.7, |
|  | 19.5, | 20.2, | 21.4, | 19.9, | 19. , | 19.1, | 19.1, | 20.1, | 19.9, | 19.6, | 23.2, |
|  | 29.8, | 13.8, | 13.3, | 16.7, | 12. , | 14.6, | 21.4, | 23. , | 23.7, | 25. , | 21.8, |
|  | 20.6, | 21.2, | 19.1, | 20.6, | 15.2, | 7. , | 8.1, | 13.6, | 20.1, | 21.8, | 24.5, |
|  | 23.1, | 19.7, | 18.3, | 21.2, | 17.5, | 16.8, | 22.4, | 20.6, | 23.9, | 22. , | 11.9]) |

In [6]:

x **=** pd.DataFrame(boston.data, columns **=** boston.feature\_names) y **=** pd.DataFrame(boston.target)

In [7]:

x.head(10)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Out[7]: |  | | | | | | | | | | | | | |
|  |  | **CRIM** | **ZN** | **INDUS** | **CHAS** | **NOX** | **RM** | **AGE** | **DIS** | **RAD** | **TAX** | **PTRATIO** | **B** | **LSTAT** |
|  | 0 | 0.00632 | 18.0 | 2.31 | 0.0 | 0.538 | 6.575 | 65.2 | 4.0900 | 1.0 | 296.0 | 15.3 | 396.90 | 4.98 |
|  | 1 | 0.02731 | 0.0 | 7.07 | 0.0 | 0.469 | 6.421 | 78.9 | 4.9671 | 2.0 | 242.0 | 17.8 | 396.90 | 9.14 |
|  | 2 | 0.02729 | 0.0 | 7.07 | 0.0 | 0.469 | 7.185 | 61.1 | 4.9671 | 2.0 | 242.0 | 17.8 | 392.83 | 4.03 |
|  | 3 | 0.03237 | 0.0 | 2.18 | 0.0 | 0.458 | 6.998 | 45.8 | 6.0622 | 3.0 | 222.0 | 18.7 | 394.63 | 2.94 |
|  | 4 | 0.06905 | 0.0 | 2.18 | 0.0 | 0.458 | 7.147 | 54.2 | 6.0622 | 3.0 | 222.0 | 18.7 | 396.90 | 5.33 |
|  | 5 | 0.02985 | 0.0 | 2.18 | 0.0 | 0.458 | 6.430 | 58.7 | 6.0622 | 3.0 | 222.0 | 18.7 | 394.12 | 5.21 |
|  | 6 | 0.08829 | 12.5 | 7.87 | 0.0 | 0.524 | 6.012 | 66.6 | 5.5605 | 5.0 | 311.0 | 15.2 | 395.60 | 12.43 |
|  | 7 | 0.14455 | 12.5 | 7.87 | 0.0 | 0.524 | 6.172 | 96.1 | 5.9505 | 5.0 | 311.0 | 15.2 | 396.90 | 19.15 |
|  | 8 | 0.21124 | 12.5 | 7.87 | 0.0 | 0.524 | 5.631 | 100.0 | 6.0821 | 5.0 | 311.0 | 15.2 | 386.63 | 29.93 |
|  | 9 | 0.17004 | 12.5 | 7.87 | 0.0 | 0.524 | 6.004 | 85.9 | 6.5921 | 5.0 | 311.0 | 15.2 | 386.71 | 17.10 |

In [8]:

y.head(10)

Out[8]:

**0**

0 24.0

1 21.6

2 34.7

3 33.4

4 36.2

5 28.7

6 22.9

7 27.1

8 16.5

9 18.9

In [9]:

reg **=** linear\_model.LinearRegression()

In [10]:

x\_train, x\_test, y\_train, y\_test **=** train\_test\_split(x, y, test\_size**=**0.20, random\_state**=**

In [11]:

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

Out[11]: LinearRegression(copy\_X=True, fit\_intercept=True, n\_jobs=None, normalize=False)

In [12]:

print(reg.coef\_)

[[-1.13055924e-01 3.01104641e-02 4.03807204e-02 2.78443820e+00

-1.72026334e+01 4.43883520e+00 -6.29636221e-03 -1.44786537e+00 2.62429736e-01 -1.06467863e-02 -9.15456240e-01 1.23513347e-02

-5.08571424e-01]]

In [13]:

y\_pred **=** reg.predict(x\_test) print(y\_pred)

[[28.99672362]

[36.02556534]

[14.81694405]

[25.03197915]

[18.76987992]

[23.25442929]

[17.66253818]

[14.34119 ]

[23.01320703]

[20.63245597]

[24.90850512]

[18.63883645]

[-6.08842184]

[21.75834668]

[19.23922576]

[26.19319733]

[20.64773313]

[ 5.79472718]

[40.50033966]

[17.61289074]

[27.24909479]

[30.06625441]

[11.34179277]

[24.16077616]

[17.86058499]

[15.83609765]

[22.78148106]

[14.57704449]

[22.43626052]

[19.19631835]

[22.43383455]

[25.21979081]

[25.93909562]

[17.70162434]

[16.76911711]

[16.95125411]

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