Linear Regression (boston dataset)

December 18, 2022

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import sklearn as sl
from sklearn import linear_model
from sklearn.linear_model import LinearRegression
from sklearn.datasets import load_boston
```

[2]:
```
df=load_boston()
```

```
C:\Users\Deepak\ana-conda-3\lib\site-packages\sklearn\utils\deprecation.py:87:
FutureWarning: Function load_boston is deprecated; `load_boston` is deprecated
in 1.0 and will be removed in 1.2.

    The Boston housing prices dataset has an ethical problem. You can refer to
    the documentation of this function for further details.

    The scikit-learn maintainers therefore strongly discourage the use of this
    dataset unless the purpose of the code is to study and educate about
    ethical issues in data science and machine learning.

    In this special case, you can fetch the dataset from the original
    source::

        import pandas as pd
        import numpy as np


        data_url = "http://lib.stat.cmu.edu/datasets/boston"
        raw_df = pd.read_csv(data_url, sep="\s+", skiprows=22, header=None)
        data = np.hstack([raw_df.values[::2, :], raw_df.values[1::2, :2]])
        target = raw_df.values[1::2, 2]

    Alternative datasets include the California housing dataset (i.e.
    :func:`~sklearn.datasets.fetch_california_housing`) and the Ames housing
    dataset. You can load the datasets as follows::

        from sklearn.datasets import fetch_california_housing
```

```
        housing = fetch_california_housing()

    for the California housing dataset and::

        from sklearn.datasets import fetch_openml
        housing = fetch_openml(name="house_prices", as_frame=True)

    for the Ames housing dataset.

  warnings.warn(msg, category=FutureWarning)
```

[3]:
```
df
```

[3]:
```
{'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, 27.1, 16.5, 18.9,
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        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,
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        19.4, 22. , 17.4, 20.9, 24.2, 21.7, 22.8, 23.4, 24.1, 21.4, 20. ,
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        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. ,
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        25. , 50. , 23.8, 23.8, 22.3, 17.4, 19.1, 23.1, 23.6, 22.6, 29.4,
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        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,
```

```
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        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. ,
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        20.3, 22.5, 29. , 24.8, 22. , 26.4, 33.1, 36.1, 28.4, 33.4, 28.2,
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        19.8, 17.1, 19.4, 22.2, 20.7, 21.1, 19.5, 18.5, 20.6, 19. , 18.7,
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 'feature_names': array(['CRIM', 'ZN', 'INDUS', 'CHAS', 'NOX', 'RM', 'AGE',
'DIS', 'RAD',
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dataset\n---------------------------\n\n**Data Set Characteristics:**  \n\n
:Number of Instances: 506 \n\n    :Number of Attributes: 13 numeric/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 25,000 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
average number of rooms per dwelling\n        - AGE      proportion of owner-
occupied units built prior to 1940\n        - DIS      weighted distances to
five Boston employment centres\n        - RAD      index of accessibility to
radial highways\n        - TAX      full-value property-tax rate per $10,000\n
- PTRATIO  pupil-teacher ratio by town\n        - B        1000(Bk - 0.63)^2
where Bk is the proportion of black people by town\n        - LSTAT    % lower
status of the population\n        - MEDV     Median value of owner-occupied
homes in $1000's\n\n    :Missing Attribute Values: None\n\n    :Creator:
```

```
Harrison, D. and Rubinfeld, D.L.\n\nThis is a copy of UCI ML housing
dataset.\nhttps://archive.ics.uci.edu/ml/machine-learning-
databases/housing/\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 Rubinfeld, 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 diagnostics\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:: References\n\n   - Belsley,
Kuh & Welsch, 'Regression diagnostics: Identifying Influential Data and Sources
of Collinearity', Wiley, 1980. 244-261.\n   - Quinlan,R. (1993). 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': 'boston_house_prices.csv',
 'data_module': 'sklearn.datasets.data'}
```

[4]:
```
dataset=pd.DataFrame(df.data)
```

[5]:
```
dataset
```

[5]:

	0	1	2	3	4	5	6	7	8	9	10	\
0	0.00632	18.0	2.31	0.0	0.538	6.575	65.2	4.0900	1.0	296.0	15.3	
1	0.02731	0.0	7.07	0.0	0.469	6.421	78.9	4.9671	2.0	242.0	17.8	
2	0.02729	0.0	7.07	0.0	0.469	7.185	61.1	4.9671	2.0	242.0	17.8	
3	0.03237	0.0	2.18	0.0	0.458	6.998	45.8	6.0622	3.0	222.0	18.7	
4	0.06905	0.0	2.18	0.0	0.458	7.147	54.2	6.0622	3.0	222.0	18.7	
..	…	…	…	…	…	…	…	…	…	…	…	
501	0.06263	0.0	11.93	0.0	0.573	6.593	69.1	2.4786	1.0	273.0	21.0	
502	0.04527	0.0	11.93	0.0	0.573	6.120	76.7	2.2875	1.0	273.0	21.0	
503	0.06076	0.0	11.93	0.0	0.573	6.976	91.0	2.1675	1.0	273.0	21.0	
504	0.10959	0.0	11.93	0.0	0.573	6.794	89.3	2.3889	1.0	273.0	21.0	
505	0.04741	0.0	11.93	0.0	0.573	6.030	80.8	2.5050	1.0	273.0	21.0	

	11	12
0	396.90	4.98
1	396.90	9.14
2	392.83	4.03
3	394.63	2.94
4	396.90	5.33
..	…	…
501	391.99	9.67
502	396.90	9.08
503	396.90	5.64
504	393.45	6.48
505	396.90	7.88

[506 rows x 13 columns]

[6]:
```
X=dataset
y=df.target
```

[7]:
```
y
```

[7]:
```
array([24. , 21.6, 34.7, 33.4, 36.2, 28.7, 22.9, 27.1, 16.5, 18.9, 15. ,
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       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,
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       33.2, 27.5, 26.5, 18.6, 19.3, 20.1, 19.5, 19.5, 20.4, 19.8, 19.4,
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       23. , 18.4, 15.6, 18.1, 17.4, 17.1, 13.3, 17.8, 14. , 14.4, 13.4,
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       25. , 50. , 23.8, 23.8, 22.3, 17.4, 19.1, 23.1, 23.6, 22.6, 29.4,
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       34.6, 34.9, 32.9, 24.1, 42.3, 48.5, 50. , 22.6, 24.4, 22.5, 24.4,
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       22.2, 23.7, 17.6, 18.5, 24.3, 20.5, 24.5, 26.2, 24.4, 24.8, 29.6,
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       20.3, 22.5, 29. , 24.8, 22. , 26.4, 33.1, 36.1, 28.4, 33.4, 28.2,
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        8.8,  8.4, 16.7, 14.2, 20.8, 13.4, 11.7,  8.3, 10.2, 10.9, 11. ,
```

```
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       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])
```

[8]:
```python
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.30, random_state=42)
X_train
```

[8]:
```
            0     1      2    3      4      5     6       7     8      9   \
5     0.02985   0.0   2.18  0.0  0.458  6.430  58.7  6.0622   3.0  222.0
116   0.13158   0.0  10.01  0.0  0.547  6.176  72.5  2.7301   6.0  432.0
45    0.17142   0.0   6.91  0.0  0.448  5.682  33.8  5.1004   3.0  233.0
16    1.05393   0.0   8.14  0.0  0.538  5.935  29.3  4.4986   4.0  307.0
468  15.57570   0.0  18.10  0.0  0.580  5.926  71.0  2.9084  24.0  666.0
..        …    …      …    …      …      …     …       …     …      …
106   0.17120   0.0   8.56  0.0  0.520  5.836  91.9  2.2110   5.0  384.0
270   0.29916  20.0   6.96  0.0  0.464  5.856  42.1  4.4290   3.0  223.0
348   0.01501  80.0   2.01  0.0  0.435  6.635  29.7  8.3440   4.0  280.0
435  11.16040   0.0  18.10  0.0  0.740  6.629  94.6  2.1247  24.0  666.0
102   0.22876   0.0   8.56  0.0  0.520  6.405  85.4  2.7147   5.0  384.0

       10      11     12
5    18.7  394.12   5.21
116  17.8  393.30  12.04
45   17.9  396.90  10.21
16   21.0  386.85   6.58
468  20.2  368.74  18.13
..    …       …      …
106  20.9  395.67  18.66
270  18.6  388.65  13.00
348  17.0  390.94   5.99
435  20.2  109.85  23.27
102  20.9   70.80  10.63

[354 rows x 13 columns]
```

[9]:
```python
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
```

[10]:
```python
X_train=scaler.fit_transform(X_train)
```

[11]:
```
X_test=scaler.transform(X_test)
```

[12]:
```
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import cross_val_score
```

[13]:
```
regression=LinearRegression()
regression.fit(X_train,y_train)
```

[13]:
```
LinearRegression()
```

[14]:
```
mse=cross_val_score(regression,X_train,y_train,scoring='neg_mean_squared_error',cv=10)
```

[15]:
```
np.mean(mse)
```

[15]:
```
-25.55066079166079
```

[16]:
```
reg_pred=regression.predict(X_test)
```

[17]:
```
reg_pred
```

[17]:
```
array([28.64896005, 36.49501384, 15.4111932 , 25.40321303, 18.85527988,
       23.14668944, 17.3921241 , 14.07859899, 23.03692679, 20.59943345,
       24.82286159, 18.53057049, -6.86543527, 21.80172334, 19.22571177,
       26.19191985, 20.27733882,  5.61596432, 40.44887974, 17.57695918,
       27.44319095, 30.1715964 , 10.94055823, 24.02083139, 18.07693812,
       15.934748  , 23.12614028, 14.56052142, 22.33482544, 19.3257627 ,
       22.16564973, 25.19476081, 25.31372473, 18.51345025, 16.6223286 ,
       17.50268505, 30.94992991, 20.19201752, 23.90440431, 24.86975466,
       13.93767876, 31.82504715, 42.56978796, 17.62323805, 27.01963242,
       17.19006621, 13.80594006, 26.10356557, 20.31516118, 30.08649576,
       21.3124053 , 34.15739602, 15.60444981, 26.11247588, 39.31613646,
       22.99282065, 18.95764781, 33.05555669, 24.85114223, 12.91729352,
       22.68101452, 30.80336295, 31.63522027, 16.29833689, 21.07379993,
       16.57699669, 20.36362023, 26.15615896, 31.06833034, 11.98679953,
       20.42550472, 27.55676301, 10.94316981, 16.82660609, 23.92909733,
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       22.06972676, 24.64152943, 10.7382866 , 19.68622564, 23.63678009,
       12.07974981, 18.47894211, 25.52713393, 20.93461307, 24.6955941 ,
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```
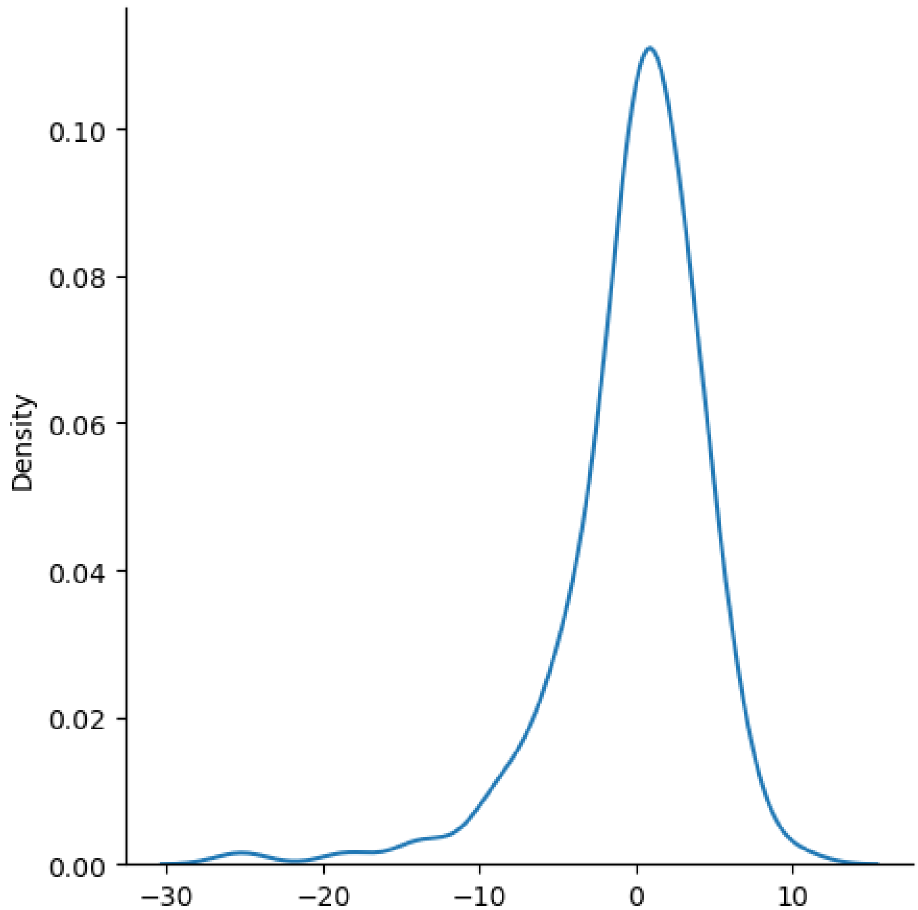

```
16.86242766, 28.99330526, 24.95467894, 16.73633557,  6.12858395,
26.65990044, 23.34007187, 17.40367164, 13.38594123, 39.98342478,
16.68286302, 18.28561759])
```

[18]:
```
import seaborn as sns
sns.displot(reg_pred-y_test,kind='kde')
```

[18]: <seaborn.axisgrid.FacetGrid at 0x244e5ed5790>



[19]:
```
from sklearn.metrics import r2_score
```

[20]:
```
score=r2_score(reg_pred,y_test)
```

[21]:
```
score
```

[21]: 0.6693702691495591

[ ]:
```

```