

dl-practical-1

February 17, 2024

```
[1]: import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

```
[2]: # from sklearn import datasets
# boston = datasets.load_boston()
# boston
```

```
[3]: boston = pd.read_csv("BostonHousing.csv")
boston
```

```
[3]:
```

	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	
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242	
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242	
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222	
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222	
..	
501	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273	
502	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273	
503	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273	
504	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273	
505	0.04741	0.0	11.93	0	0.573	6.030	80.8	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	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]

```
[4]: boston.shape
```

```
[4]: (506, 14)
```

```
[5]: boston.columns
```

```
[5]: Index(['crim', 'zn', 'indus', 'chas', 'nox', 'rm', 'age', 'dis', 'rad', 'tax',  
        'ptratio', 'b', 'lstat', 'medv'],  
        dtype='object')
```

```
[6]: df= pd.DataFrame(boston)  
df.columns = boston.columns  
df.columns
```

```
[6]: Index(['crim', 'zn', 'indus', 'chas', 'nox', 'rm', 'age', 'dis', 'rad', 'tax',  
        'ptratio', 'b', 'lstat', 'medv'],  
        dtype='object')
```

```
[7]: df
```

```
[7]:
```

	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	
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242	
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242	
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222	
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222	
..	
501	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273	
502	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273	
503	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273	
504	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273	
505	0.04741	0.0	11.93	0	0.573	6.030	80.8	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	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]

```
[8]: df.head
```

```
[8]: <bound method NDFrame.head of
age      dis  rad  tax  \
0    0.00632  18.0   2.31    0  0.538  6.575  65.2  4.0900    1  296
1    0.02731   0.0   7.07    0  0.469  6.421  78.9  4.9671    2  242
2    0.02729   0.0   7.07    0  0.469  7.185  61.1  4.9671    2  242
3    0.03237   0.0   2.18    0  0.458  6.998  45.8  6.0622    3  222
4    0.06905   0.0   2.18    0  0.458  7.147  54.2  6.0622    3  222
..      ...  ...  ...  ...  ...  ...  ...  ...  ...
501  0.06263   0.0  11.93    0  0.573  6.593  69.1  2.4786    1  273
502  0.04527   0.0  11.93    0  0.573  6.120  76.7  2.2875    1  273
503  0.06076   0.0  11.93    0  0.573  6.976  91.0  2.1675    1  273
504  0.10959   0.0  11.93    0  0.573  6.794  89.3  2.3889    1  273
505  0.04741   0.0  11.93    0  0.573  6.030  80.8  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   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]>

```
[9]: boston["medv"].shape
```

```
[9]: (506,)
```

```
[10]: df['price'] = boston["medv"]
df['price']
df
```

```
[10]:      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
1    0.02731   0.0   7.07    0  0.469  6.421  78.9  4.9671    2  242
2    0.02729   0.0   7.07    0  0.469  7.185  61.1  4.9671    2  242
3    0.03237   0.0   2.18    0  0.458  6.998  45.8  6.0622    3  222
```

4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222
..		
501	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273
502	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273
503	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273
504	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273
505	0.04741	0.0	11.93	0	0.573	6.030	80.8	2.5050	1	273

	ptratio	b	lstat	medv	price
0	15.3	396.90	4.98	24.0	24.0
1	17.8	396.90	9.14	21.6	21.6
2	17.8	392.83	4.03	34.7	34.7
3	18.7	394.63	2.94	33.4	33.4
4	18.7	396.90	5.33	36.2	36.2
..
501	21.0	391.99	9.67	22.4	22.4
502	21.0	396.90	9.08	20.6	20.6
503	21.0	396.90	5.64	23.9	23.9
504	21.0	393.45	6.48	22.0	22.0
505	21.0	396.90	7.88	11.9	11.9

[506 rows x 15 columns]

```
[11]: df.head()
df = df.drop(["medv"], axis=1)
```

```
[12]: df.tail()
```

```
[12]:
```

	crim	zn	indus	chas	nox	rm	age	dis	rad	tax	ptratio	\
501	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273	21.0	
502	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273	21.0	
503	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273	21.0	
504	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273	21.0	
505	0.04741	0.0	11.93	0	0.573	6.030	80.8	2.5050	1	273	21.0	

	b	lstat	price
501	391.99	9.67	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

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

```
[13]:
```

	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	b \
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	price
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

[14]: df

[14]:

	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
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222
..
501	0.06263	0.0	11.93	0	0.573	6.593	69.1	2.4786	1	273
502	0.04527	0.0	11.93	0	0.573	6.120	76.7	2.2875	1	273
503	0.06076	0.0	11.93	0	0.573	6.976	91.0	2.1675	1	273
504	0.10959	0.0	11.93	0	0.573	6.794	89.3	2.3889	1	273
505	0.04741	0.0	11.93	0	0.573	6.030	80.8	2.5050	1	273

	ptratio	b	lstat	price
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]

```
[15]: 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    int64
10  ptratio     506 non-null    float64
11  b           506 non-null    float64
12  lstat       506 non-null    float64
13  price       506 non-null    float64
dtypes: float64(11), int64(3)
memory usage: 55.5 KB

```

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

```

[16]:
count    crim      zn      indus      chas      nox      rm \
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      b \

```

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	price
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

```
[17]: x = boston
      y = boston["medv"]

      x = x.drop(["medv", "price"], axis=1)
      x
```

```
[17]:      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
1    0.02731   0.0   7.07    0  0.469  6.421  78.9  4.9671   2  242
2    0.02729   0.0   7.07    0  0.469  7.185  61.1  4.9671   2  242
3    0.03237   0.0   2.18    0  0.458  6.998  45.8  6.0622   3  222
4    0.06905   0.0   2.18    0  0.458  7.147  54.2  6.0622   3  222
..      ...   ...   ...   ...   ...   ...   ...   ...   ...
501  0.06263   0.0  11.93    0  0.573  6.593  69.1  2.4786   1  273
502  0.04527   0.0  11.93    0  0.573  6.120  76.7  2.2875   1  273
503  0.06076   0.0  11.93    0  0.573  6.976  91.0  2.1675   1  273
504  0.10959   0.0  11.93    0  0.573  6.794  89.3  2.3889   1  273
505  0.04741   0.0  11.93    0  0.573  6.030  80.8  2.5050   1  273
```

	ptratio	b	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]

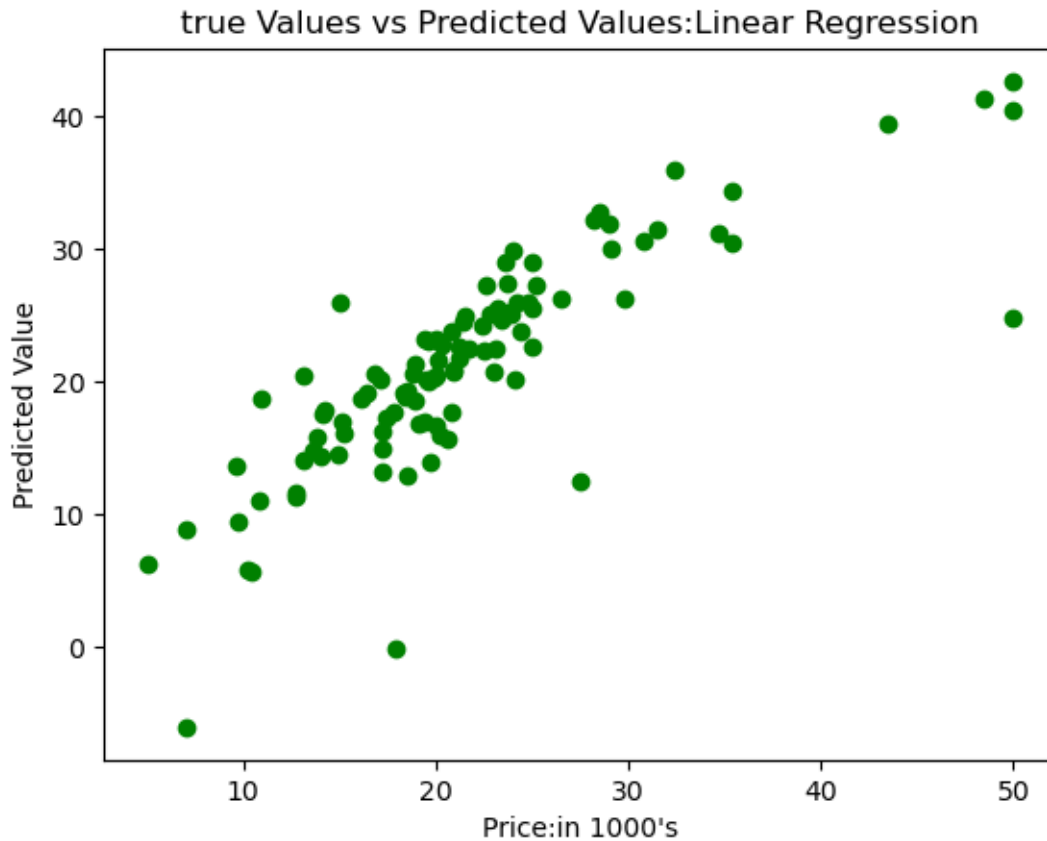
```
[18]: from sklearn.model_selection import train_test_split
xtrain,xtest,ytrain, ytest = train_test_split(x,y,test_size=0.2, random_state=42)
print('xtrain shape:', xtrain.shape)
print('xtest shape:', xtest.shape)
print('ytrain shape:', ytrain.shape)
print('ytest shape:', ytest.shape)
```

```
xtrain shape: (404, 13)
xtest shape: (102, 13)
ytrain shape: (404,)
ytest shape: (102,)
```

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

lr.fit(xtrain, ytrain)
y_pred = lr.predict(xtest)
```

```
[20]: plt.scatter(ytest,y_pred, c = 'green')
plt.xlabel("Price:in 1000's")
plt.ylabel("Predicted Value")
plt.title("true Values vs Predicted Values:Linear Regression")
plt.show()
```

```
[21]: from sklearn.metrics import mean_squared_error, mean_absolute_error
mse = mean_squared_error(ytest, y_pred)
mae = mean_absolute_error(ytest, y_pred)
print("MSE",mse)
print("MAE",mae)
```

MSE 24.29111947497371
MAE 3.1890919658878745

```
[22]: pip install tensorflow
```

Requirement already satisfied: tensorflow in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (2.15.0)
Requirement already satisfied: tensorflow-intel==2.15.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow) (2.15.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (1.60.0)
Requirement already satisfied: tensorboard<2.16,>=2.15 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-

```

intel==2.15.0->tensorflow) (2.15.1)
Requirement already satisfied: gast!=0.5.0,!0.5.1,!0.5.2,>=0.2.1 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (0.5.4)
Requirement already satisfied: h5py>=2.9.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (3.7.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (0.31.0)
Requirement already satisfied: google-pasta>=0.1.1 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (0.2.0)
Requirement already satisfied: absl-py>=1.0.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (2.0.0)
Requirement already satisfied: opt-einsum>=2.3.2 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (3.3.0)
Requirement already satisfied: six>=1.12.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (1.16.0)
Requirement already satisfied: keras<2.16,>=2.15.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (2.15.0)
Requirement already satisfied:
protobuf!=4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.20.3
in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (4.23.4)
Requirement already satisfied: flatbuffers>=23.5.26 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (23.5.26)
Requirement already satisfied: wrapt<1.15,>=1.11.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (1.14.1)
Requirement already satisfied: typing-extensions>=3.6.6 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (4.4.0)
Requirement already satisfied: ml-dtypes~=0.2.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (0.2.0)
Requirement already satisfied: astunparse>=1.6.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (1.6.3)
Requirement already satisfied: tensorflow-estimator<2.16,>=2.15.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-
intel==2.15.0->tensorflow) (2.15.0)
Requirement already satisfied: termcolor>=1.1.0 in

```

c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-intel==2.15.0->tensorflow) (2.4.0)

Requirement already satisfied: libclang>=13.0.0 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-intel==2.15.0->tensorflow) (16.0.6)

Requirement already satisfied: setuptools in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-intel==2.15.0->tensorflow) (65.6.3)

Requirement already satisfied: packaging in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-intel==2.15.0->tensorflow) (22.0)

Requirement already satisfied: numpy<2.0.0,>=1.23.5 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorflow-intel==2.15.0->tensorflow) (1.23.5)

Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.15.0->tensorflow) (0.38.4)

Requirement already satisfied: requests<3,>=2.21.0 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (2.28.1)

Requirement already satisfied: markdown>=2.6.8 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (3.4.1)

Requirement already satisfied: google-auth-oauthlib<2,>=0.5 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (1.2.0)

Requirement already satisfied: werkzeug>=1.0.1 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (2.2.2)

Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (0.7.2)

Requirement already satisfied: google-auth<3,>=1.6.3 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (2.26.1)

Requirement already satisfied: pyasn1-modules>=0.2.1 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (0.2.8)

Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (4.9)

Requirement already satisfied: cachetools<6.0,>=2.0.0 in c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow) (5.3.2)

Requirement already satisfied: requests-oauthlib>=0.7.0 in

```
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from google-auth-
oauthlib<2,>=0.5->tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow)
(1.3.1)
Requirement already satisfied: idna<4,>=2.5 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from
requests<3,>=2.21.0->tensorboard<2.16,>=2.15->tensorflow-
intel==2.15.0->tensorflow) (3.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from
requests<3,>=2.21.0->tensorboard<2.16,>=2.15->tensorflow-
intel==2.15.0->tensorflow) (1.26.14)
Requirement already satisfied: charset-normalizer<3,>=2 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from
requests<3,>=2.21.0->tensorboard<2.16,>=2.15->tensorflow-
intel==2.15.0->tensorflow) (2.0.4)
Requirement already satisfied: certifi>=2017.4.17 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from
requests<3,>=2.21.0->tensorboard<2.16,>=2.15->tensorflow-
intel==2.15.0->tensorflow) (2022.12.7)
Requirement already satisfied: MarkupSafe>=2.1.1 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from
werkzeug>=1.0.1->tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow)
(2.1.1)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from
pyasn1-modules>=0.2.1->google-
auth<3,>=1.6.3->tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow)
(0.4.8)
Requirement already satisfied: oauthlib>=3.0.0 in
c:\users\d_comp_rsl-14\anaconda3\lib\site-packages (from requests-
oauthlib>=0.7.0->google-auth-
oauthlib<2,>=0.5->tensorboard<2.16,>=2.15->tensorflow-intel==2.15.0->tensorflow)
(3.2.2)
Note: you may need to restart the kernel to use updated packages.
```

```
[23]: import tensorflow as tf
```

```
WARNING:tensorflow:From C:\Users\D_COMP_RSL-14\anaconda3\lib\site-
packages\keras\src\losses.py:2976: The name
tf.losses.sparse_softmax_cross_entropy is deprecated. Please use
tf.compat.v1.losses.sparse_softmax_cross_entropy instead.
```

```
[24]: model = tf.keras.Sequential([
    tf.keras.layers.Dense(64, activation = "relu", input_shape = (xtrain.
↪shape[1],)),
    tf.keras.layers.Dense(32, activation = "relu"),
```

```

tf.keras.layers.Dense(32, activation = "relu"),
tf.keras.layers.Dense(16, activation = "relu"),
tf.keras.layers.Dense(16, activation = "relu"),
tf.keras.layers.Dense(16, activation = "relu"),
tf.keras.layers.Dense(16, activation = "relu"),
tf.keras.layers.Dense(4, activation = "relu"),
tf.keras.layers.Dense(4, activation = "relu"),
tf.keras.layers.Dense(4, activation = "relu"),
tf.keras.layers.Dense(4, activation = "relu"),
tf.keras.layers.Dense(1)
])

#compile the model
# model.compile(optimize = "adam", loss = "mean_squared_error")
model.compile(
    optimizer="adam", loss="mean_squared_error",
)

#training the model
model.fit(xtrain, ytrain, epochs = 100, batch_size = 32, validation_data = (
    xtest, ytest))

```

WARNING:tensorflow:From C:\Users\D_COMP_RSL-14\anaconda3\lib\site-packages\keras\src\backend.py:873: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From C:\Users\D_COMP_RSL-14\anaconda3\lib\site-packages\keras\src\optimizers_init_.py:309: The name tf.train.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

Epoch 1/100

WARNING:tensorflow:From C:\Users\D_COMP_RSL-14\anaconda3\lib\site-packages\keras\src\utils\tf_utils.py:492: The name tf.ragged.RaggedTensorValue is deprecated. Please use tf.compat.v1.ragged.RaggedTensorValue instead.

13/13 [=====] - 1s 12ms/step - loss: 531.0935 - val_loss: 359.5944

Epoch 2/100

13/13 [=====] - 0s 3ms/step - loss: 296.0754 - val_loss: 168.1124

Epoch 3/100

13/13 [=====] - 0s 3ms/step - loss: 151.8157 - val_loss: 105.3534

Epoch 4/100

13/13 [=====] - 0s 3ms/step - loss: 98.7675 - val_loss: 77.9986

Epoch 5/100

13/13 [=====] - 0s 3ms/step - loss: 77.9852 - val_loss:
58.6664
Epoch 6/100
13/13 [=====] - 0s 3ms/step - loss: 70.4117 - val_loss:
58.6350
Epoch 7/100
13/13 [=====] - 0s 3ms/step - loss: 68.4452 - val_loss:
54.5906
Epoch 8/100
13/13 [=====] - 0s 2ms/step - loss: 66.7722 - val_loss:
50.5532
Epoch 9/100
13/13 [=====] - 0s 3ms/step - loss: 66.9944 - val_loss:
54.3777
Epoch 10/100
13/13 [=====] - 0s 3ms/step - loss: 64.8295 - val_loss:
48.7082
Epoch 11/100
13/13 [=====] - 0s 2ms/step - loss: 66.3774 - val_loss:
51.1064
Epoch 12/100
13/13 [=====] - 0s 3ms/step - loss: 64.6522 - val_loss:
49.4561
Epoch 13/100
13/13 [=====] - 0s 3ms/step - loss: 64.9206 - val_loss:
47.0116
Epoch 14/100
13/13 [=====] - 0s 3ms/step - loss: 64.6209 - val_loss:
47.7423
Epoch 15/100
13/13 [=====] - 0s 3ms/step - loss: 62.9563 - val_loss:
46.3756
Epoch 16/100
13/13 [=====] - 0s 4ms/step - loss: 63.5322 - val_loss:
48.2528
Epoch 17/100
13/13 [=====] - 0s 2ms/step - loss: 63.0355 - val_loss:
49.6976
Epoch 18/100
13/13 [=====] - 0s 3ms/step - loss: 65.4980 - val_loss:
44.3866
Epoch 19/100
13/13 [=====] - 0s 3ms/step - loss: 62.1621 - val_loss:
44.3758
Epoch 20/100
13/13 [=====] - 0s 3ms/step - loss: 61.2256 - val_loss:
44.0224
Epoch 21/100

13/13 [=====] - 0s 3ms/step - loss: 60.7027 - val_loss:
 46.9821
 Epoch 22/100
 13/13 [=====] - 0s 3ms/step - loss: 60.0809 - val_loss:
 43.2675
 Epoch 23/100
 13/13 [=====] - 0s 3ms/step - loss: 60.1894 - val_loss:
 43.7324
 Epoch 24/100
 13/13 [=====] - 0s 4ms/step - loss: 59.7814 - val_loss:
 48.6358
 Epoch 25/100
 13/13 [=====] - 0s 2ms/step - loss: 57.1992 - val_loss:
 41.5828
 Epoch 26/100
 13/13 [=====] - 0s 3ms/step - loss: 57.2508 - val_loss:
 43.9158
 Epoch 27/100
 13/13 [=====] - 0s 3ms/step - loss: 56.3480 - val_loss:
 41.0554
 Epoch 28/100
 13/13 [=====] - 0s 3ms/step - loss: 55.5309 - val_loss:
 39.8151
 Epoch 29/100
 13/13 [=====] - 0s 3ms/step - loss: 56.0406 - val_loss:
 40.6015
 Epoch 30/100
 13/13 [=====] - 0s 3ms/step - loss: 54.8669 - val_loss:
 39.0748
 Epoch 31/100
 13/13 [=====] - 0s 3ms/step - loss: 52.8558 - val_loss:
 41.7233
 Epoch 32/100
 13/13 [=====] - 0s 3ms/step - loss: 52.9321 - val_loss:
 37.4937
 Epoch 33/100
 13/13 [=====] - 0s 3ms/step - loss: 51.8801 - val_loss:
 36.4263
 Epoch 34/100
 13/13 [=====] - 0s 2ms/step - loss: 52.4387 - val_loss:
 35.8386
 Epoch 35/100
 13/13 [=====] - 0s 3ms/step - loss: 52.8059 - val_loss:
 34.9450
 Epoch 36/100
 13/13 [=====] - 0s 3ms/step - loss: 53.2450 - val_loss:
 37.9993
 Epoch 37/100

13/13 [=====] - 0s 3ms/step - loss: 51.1519 - val_loss:
33.9660
Epoch 38/100
13/13 [=====] - 0s 3ms/step - loss: 46.3837 - val_loss:
32.5956
Epoch 39/100
13/13 [=====] - 0s 3ms/step - loss: 45.9624 - val_loss:
31.9798
Epoch 40/100
13/13 [=====] - 0s 3ms/step - loss: 42.0337 - val_loss:
29.8441
Epoch 41/100
13/13 [=====] - 0s 3ms/step - loss: 38.9012 - val_loss:
30.5171
Epoch 42/100
13/13 [=====] - 0s 3ms/step - loss: 38.9385 - val_loss:
26.2836
Epoch 43/100
13/13 [=====] - 0s 3ms/step - loss: 36.2193 - val_loss:
30.4848
Epoch 44/100
13/13 [=====] - 0s 3ms/step - loss: 44.6549 - val_loss:
27.0303
Epoch 45/100
13/13 [=====] - 0s 2ms/step - loss: 39.8271 - val_loss:
27.7019
Epoch 46/100
13/13 [=====] - 0s 2ms/step - loss: 31.7255 - val_loss:
32.0925
Epoch 47/100
13/13 [=====] - 0s 3ms/step - loss: 31.7874 - val_loss:
22.4291
Epoch 48/100
13/13 [=====] - 0s 4ms/step - loss: 28.1231 - val_loss:
21.1052
Epoch 49/100
13/13 [=====] - 0s 3ms/step - loss: 26.8713 - val_loss:
23.1906
Epoch 50/100
13/13 [=====] - 0s 3ms/step - loss: 25.2792 - val_loss:
21.0548
Epoch 51/100
13/13 [=====] - 0s 3ms/step - loss: 24.0504 - val_loss:
20.6442
Epoch 52/100
13/13 [=====] - 0s 3ms/step - loss: 25.3845 - val_loss:
20.5635
Epoch 53/100

13/13 [=====] - 0s 3ms/step - loss: 22.5797 - val_loss:
19.8655
Epoch 54/100
13/13 [=====] - 0s 2ms/step - loss: 23.0996 - val_loss:
20.0406
Epoch 55/100
13/13 [=====] - 0s 3ms/step - loss: 23.2041 - val_loss:
18.5361
Epoch 56/100
13/13 [=====] - 0s 3ms/step - loss: 21.0703 - val_loss:
19.7018
Epoch 57/100
13/13 [=====] - 0s 2ms/step - loss: 19.9015 - val_loss:
17.8457
Epoch 58/100
13/13 [=====] - 0s 4ms/step - loss: 22.8467 - val_loss:
19.0501
Epoch 59/100
13/13 [=====] - 0s 3ms/step - loss: 18.5041 - val_loss:
27.5702
Epoch 60/100
13/13 [=====] - 0s 3ms/step - loss: 25.2095 - val_loss:
17.2567
Epoch 61/100
13/13 [=====] - 0s 3ms/step - loss: 20.2535 - val_loss:
17.0932
Epoch 62/100
13/13 [=====] - 0s 3ms/step - loss: 18.3595 - val_loss:
16.3483
Epoch 63/100
13/13 [=====] - 0s 3ms/step - loss: 19.4249 - val_loss:
17.8332
Epoch 64/100
13/13 [=====] - 0s 3ms/step - loss: 23.5327 - val_loss:
17.5708
Epoch 65/100
13/13 [=====] - 0s 3ms/step - loss: 20.5194 - val_loss:
19.2009
Epoch 66/100
13/13 [=====] - 0s 3ms/step - loss: 19.8342 - val_loss:
20.1949
Epoch 67/100
13/13 [=====] - 0s 3ms/step - loss: 16.2523 - val_loss:
17.3630
Epoch 68/100
13/13 [=====] - 0s 3ms/step - loss: 21.8602 - val_loss:
23.4677
Epoch 69/100

13/13 [=====] - 0s 3ms/step - loss: 28.0702 - val_loss:
22.5328
Epoch 70/100
13/13 [=====] - 0s 4ms/step - loss: 20.4832 - val_loss:
16.8809
Epoch 71/100
13/13 [=====] - 0s 2ms/step - loss: 17.0807 - val_loss:
25.5888
Epoch 72/100
13/13 [=====] - 0s 4ms/step - loss: 22.4243 - val_loss:
19.0807
Epoch 73/100
13/13 [=====] - 0s 2ms/step - loss: 20.6161 - val_loss:
27.5627
Epoch 74/100
13/13 [=====] - 0s 2ms/step - loss: 19.8051 - val_loss:
15.4125
Epoch 75/100
13/13 [=====] - 0s 3ms/step - loss: 17.0223 - val_loss:
16.1945
Epoch 76/100
13/13 [=====] - 0s 3ms/step - loss: 21.1633 - val_loss:
28.2010
Epoch 77/100
13/13 [=====] - 0s 3ms/step - loss: 17.9331 - val_loss:
17.9399
Epoch 78/100
13/13 [=====] - 0s 3ms/step - loss: 15.6556 - val_loss:
15.5284
Epoch 79/100
13/13 [=====] - 0s 3ms/step - loss: 16.1378 - val_loss:
16.4073
Epoch 80/100
13/13 [=====] - 0s 3ms/step - loss: 16.6644 - val_loss:
15.3933
Epoch 81/100
13/13 [=====] - 0s 3ms/step - loss: 17.2126 - val_loss:
17.5033
Epoch 82/100
13/13 [=====] - 0s 3ms/step - loss: 17.3583 - val_loss:
15.9124
Epoch 83/100
13/13 [=====] - 0s 3ms/step - loss: 17.4267 - val_loss:
17.4182
Epoch 84/100
13/13 [=====] - 0s 3ms/step - loss: 14.9855 - val_loss:
16.1205
Epoch 85/100

13/13 [=====] - 0s 3ms/step - loss: 15.9315 - val_loss:
15.8443
Epoch 86/100
13/13 [=====] - 0s 3ms/step - loss: 16.3260 - val_loss:
18.5767
Epoch 87/100
13/13 [=====] - 0s 3ms/step - loss: 17.4861 - val_loss:
26.2119
Epoch 88/100
13/13 [=====] - 0s 3ms/step - loss: 17.1532 - val_loss:
15.0027
Epoch 89/100
13/13 [=====] - 0s 3ms/step - loss: 15.1649 - val_loss:
20.3914
Epoch 90/100
13/13 [=====] - 0s 3ms/step - loss: 16.1853 - val_loss:
16.1956
Epoch 91/100
13/13 [=====] - 0s 3ms/step - loss: 17.0510 - val_loss:
18.7796
Epoch 92/100
13/13 [=====] - 0s 3ms/step - loss: 18.2264 - val_loss:
16.3026
Epoch 93/100
13/13 [=====] - 0s 3ms/step - loss: 15.8905 - val_loss:
16.3001
Epoch 94/100
13/13 [=====] - 0s 3ms/step - loss: 15.2754 - val_loss:
14.9355
Epoch 95/100
13/13 [=====] - 0s 2ms/step - loss: 15.3748 - val_loss:
14.8073
Epoch 96/100
13/13 [=====] - 0s 3ms/step - loss: 13.8166 - val_loss:
16.5145
Epoch 97/100
13/13 [=====] - 0s 3ms/step - loss: 15.6118 - val_loss:
15.4720
Epoch 98/100
13/13 [=====] - 0s 2ms/step - loss: 15.3506 - val_loss:
18.6705
Epoch 99/100
13/13 [=====] - 0s 4ms/step - loss: 17.1897 - val_loss:
17.3047
Epoch 100/100
13/13 [=====] - 0s 2ms/step - loss: 16.1138 - val_loss:
15.8737

[24]: <keras.src.callbacks.History at 0x26bdaff56f0>

```
[25]: #evaluate the model  
loss = model.evaluate(xtest, ytest)  
print(f"MSE of test data = {loss}")
```

4/4 [=====] - 0s 5ms/step - loss: 15.8737
MSE of test data = 15.87368392944336