Linear Regression Multivariate

load boston house data

```
### what is pickle
import pickle

my_list = ['a', 'b', 'c']

with open('./data.pickle', 'wb') as fw:
    pickle.dump(my_list, fw)

with open('./data.pickle', 'rb') as fr:
    data = pickle.load(fr)

print(data)
```

```
['a', 'b', 'c']
```

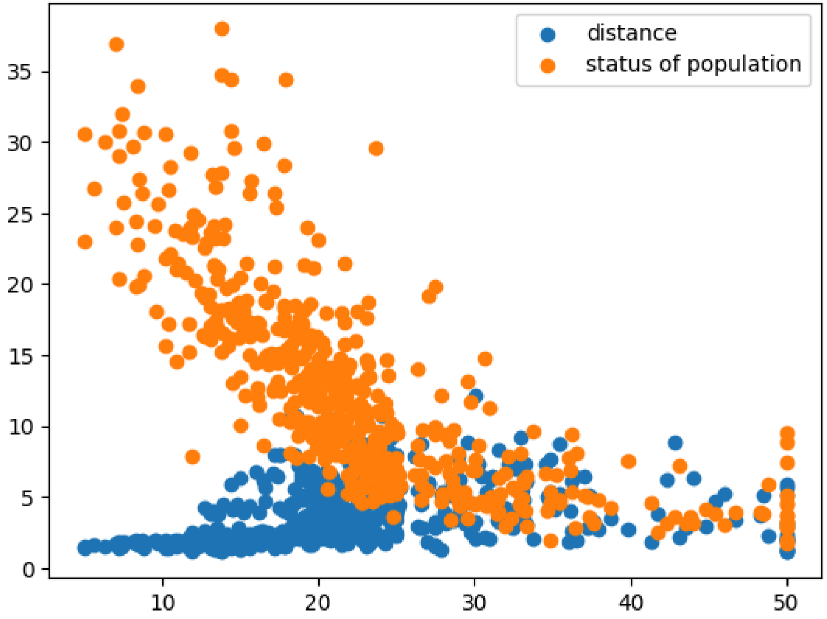
```
# load data using pkl
import pandas as pd

with open('./boston_house.pkl', 'rb') as f:
    boston_house = pickle.load(f)

ph = pd.DataFrame(boston_house.data, columns=boston_house.feature_names)
ph['PRICE'] = boston_house.target

display(ph)
```

	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	PRICE
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	24.0
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	21.6
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	34.7
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	33.4
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	36.2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
501	0.06263	0.0	11.93	0.0	0.573	6.593	69.1	2.4786	1.0	273.0	21.0	391.99	9.67	22.4
502	0.04527	0.0	11.93	0.0	0.573	6.120	76.7	2.2875	1.0	273.0	21.0	396.90	9.08	20.6
503	0.06076	0.0	11.93	0.0	0.573	6.976	91.0	2.1675	1.0	273.0	21.0	396.90	5.64	23.9
504	0.10959	0.0	11.93	0.0	0.573	6.794	89.3	2.3889	1.0	273.0	21.0	393.45	6.48	22.0
505	0.04741	0.0	11.93	0.0	0.573	6.030	80.8	2.5050	1.0	273.0	21.0	396.90	7.88	11.9

506 rows × 14 columns

다음 단계: ph변수로 코드 생성 | 추천 차트 보기 | New interactive sheet

```
# check data set
import matplotlib.pyplot as plt

plt.scatter(ph['PRICE'], ph['DIS'], label='distance')
plt.scatter(ph['PRICE'], ph['LSTAT'], label='status of population')
plt.legend()
plt.show()
```

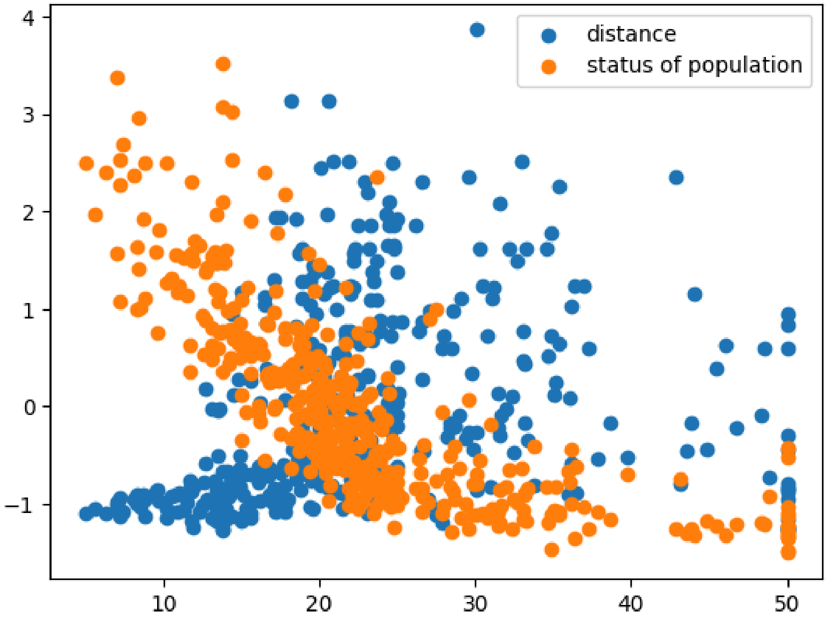


split dataset

```
# split data
from sklearn.model_selection import train_test_split
x = boston_house['data']
y = boston_house['target']

#print(x)
#print(x.shape)

#print(y.shape)

x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=24)

#print(x_train.shape)
#print(x_test.shape)
#print(y_train.shape)
#print(y_test.shape)
```

pre-processing (z-score normalization)

```
# standardization
x_offset = x_train.mean(axis=0)
x_scale = x_train.std(axis=0)
y_offset = y_train.mean(axis=0)

xm_train = (x_train - x_offset) / x_scale
xm_test = (x_test - x_offset) / x_scale


# show
bh = pd.DataFrame(xm_train, columns=boston_house. feature_names)
bh['PRICE'] = y_train

plt.scatter(bh['PRICE'], bh['DIS'], label='distance')
plt.scatter(bh['PRICE'], bh['LSTAT'], label='status of population' )
plt.legend()
plt.show()
```



linear regression (using LinearRegression of scikit-learn)

```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error

model = LinearRegression()
```

```
model.fit(xm_train, y_train) ## Learning
y_pred_test = model.predict(xm_test) ## Prediction


# y_test vs y_pred_test
# (y_test - ypred_test)^2

mse_test = mean_squared_error(y_test, y_pred_test)
print(mse_test)
```

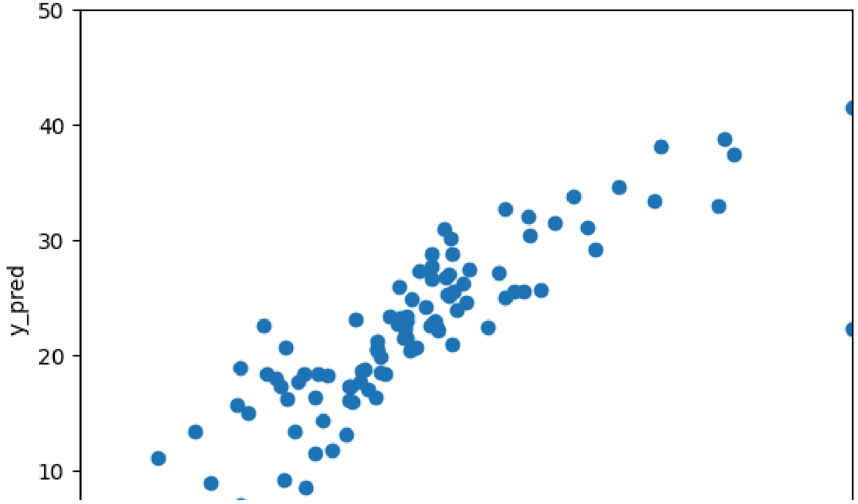
```
23.67448444173476
```

linear regression (using optimize of scikit-learn)

```
import numpy as np
from scipy.optimize import minimize

def linear_regression (params, X, y) :
  W = params[:-1]
  b = params [-1]
  # y_pred = np. dot (X, w) + b
  y_pred = W @ X.T + b
  mse = np.mean ((y_pred - y) ** 2)
  return mse


# xm_train.shape[1] : the number of features
# + 1 : bias = 14( 1 1 1 1 1 1 1 1 1 1 1 1 .. 1) [:-1] [-1]

initial_guess = np.zeros (xm_train.shape[1] + 1)

result = minimize(linear_regression, initial_guess, args=(xm_train, y_train))
W_opt, b_opt = result.x[:-1], result.x[-1]
#print(result)

## Test
y_pred_test = W_opt @ xm_test.T + b_opt
mse_test = mean_squared_error (y_test, y_pred_test)
print (f'mse: {mse_test}')

# draw graph
plt.scatter(y_test, y_pred_test)
plt.xlabel('y_test')
plt.ylabel('y_pred' )
plt.xlim(0, 50)
```

```
    plt.ylim(0, 50)
    plt.show()
```

```
mse: 23.674481577650777
```


y_pred