In [0]:

```
import warnings
warnings.filterwarnings("ignore")
from sklearn.datasets import load_boston
from random import seed
from random import randrange
from csv import reader
from math import sqrt
from sklearn.preprocessing import StandardScaler
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from prettytable import PrettyTable
from sklearn.linear_model import SGDRegressor
from sklearn import preprocessing
from sklearn.metrics import mean_squared_error
import sklearn
from sklearn.model_selection import train_test_split
```

(6th Assinment) Implementation of SGD

- > using sklean sgd

Get the data

In [173]:

```
boston = load_boston()
boston.data.shape
```

Out[173]:

```
(506, 13)
```

In [174]:

```
columnNames = boston.feature_names
print(columnNames)
Data = pd.DataFrame(boston.data, columns = columnNames)
```

```
['CRIM' 'ZN' 'INDUS' 'CHAS' 'NOX' 'RM' 'AGE' 'DIS' 'RAD' 'TAX' 'PTRATIO'
 'B' 'LSTAT']
```

In [175]:

```
Data_Labels = boston.target
Data_Labels.shape
#print(Data_Labels)
```

Out[175]:

```
(506,)
```

In [176]:

```
Data["PRICE"] = Data_Labels
print(Data.shape)
print(Data.head(2))
```

```
(506, 14)
      CRIM    ZN  INDUS  CHAS    NOX  ...    TAX  PTRATIO      B  LSTAT  PRICE
0  0.00632  18.0   2.31   0.0  0.538  ...  296.0     15.3  396.9   4.98   24.0
1  0.02731   0.0   7.07   0.0  0.469  ...  242.0     17.8  396.9   9.14   21.6

[2 rows x 14 columns]
```

Replace nan values

In [177]:

```
Data.isnull().sum()
Data.isnull().values.any()
```

Out[177]:

```
False
```

In [178]:

```
Data.apply(lambda x: x.fillna(x.mean()),axis=0)
print('done')
```

```
done
```

Train_test_split

In [205]:

```
X_train, X_test, Y_train, Y_test = train_test_split(Data, Data["PRICE"],test_size = 0.2)

X_train.shape, X_test.shape, Y_train.shape, Y_test.shape
print(X_train.head(10))
```

```
         CRIM    ZN  INDUS  CHAS    NOX  ...    TAX  PTRATIO       B  LSTAT  PRICE
334   0.03738   0.0   5.19   0.0  0.515  ...  224.0     20.2  389.40   6.75   20.7
287   0.03871  52.5   5.32   0.0  0.405  ...  293.0     16.6  396.90   7.14   23.2
164   2.24236   0.0  19.58   0.0  0.605  ...  403.0     14.7  395.11  11.64   22.7
225   0.52693   0.0   6.20   0.0  0.504  ...  307.0     17.4  382.00   4.63   50.0
444  12.80230   0.0  18.10   0.0  0.740  ...  666.0     20.2  240.52  23.79   10.8
299   0.05561  70.0   2.24   0.0  0.400  ...  358.0     14.8  371.58   4.74   29.0
159   1.42502   0.0  19.58   0.0  0.871  ...  403.0     14.7  364.31   7.39   23.3
289   0.04297  52.5   5.32   0.0  0.405  ...  293.0     16.6  371.72   9.51   24.8
70    0.08826   0.0  10.81   0.0  0.413  ...  305.0     19.2  383.73   6.72   24.2
84    0.05059   0.0   4.49   0.0  0.449  ...  247.0     18.5  396.90   9.62   23.9

[10 rows x 14 columns]
```

In [206]:

```
Y_train.isnull().sum()
```

Out[206]:

```
0
```

use our implementation of the sgd

Implementation of Stochastic Gradient Descent by taking 10 random samples

1.**First Standadize the data**

In [0]:

```
from sklearn import preprocessing
scaler=preprocessing.StandardScaler()
std_scale = scaler.fit(X_train[['CRIM', 'ZN','INDUS','CHAS','NOX','RM','AGE','DIS','RAD','TAX','PTR
ATIO','B','LSTAT']])

train_standadized= std_scale.transform(X_train[['CRIM', 'ZN','INDUS','CHAS','NOX','RM','AGE','DIS'
,'RAD','TAX','PTRATIO','B','LSTAT']])

test_standadized= std_scale.transform(X_test[['CRIM',
'ZN','INDUS','CHAS','NOX','RM','AGE','DIS','RAD','TAX','PTRATIO','B','LSTAT']])
```

In [0]:

```
X_train_standadized = pd.DataFrame(train_standadized, columns = columnNames)
X_test_standadized = pd.DataFrame(test_standadized, columns = columnNames)
# X_train_standadized['PRICE']=X_train['PRICE']
# test_standadized['PRICE']=X_test['PRICE']
# print(X_train_standadized.head(2))
```

In [0]:

```
Y_train=np.array(Y_train)
Y_test=np.array(Y_test)
```

In [210]:

```
print(Y_train)
print(Y_train.shape)
print(X_train_standadized.shape)
```

```
[20.7 23.2 22.7 50.  10.8 29.  23.3 24.8 24.2 23.9 10.9 21.7 43.5 20.3
 18.7 36.2 26.6 14.1 14.9 42.8 20.1 16.1 25.3 24.1 19.8 23.2 13.4 22.6
 25.  21.9 18.1  7.2  5.  21.7 18.8 17.3 25.2 20.8 20.5 36.  27.1 21.4
 30.1 24.6 28.7 18.9 14.5 23.  20.  24.3 13.2 14.5 19.5 27.5 27.5 10.9
 20.1 24.5 48.8 21.2 35.2 23.1 20.6 29.  14.4  8.3  9.5 20.3 17.7 19.6
 13.5 12.7 35.4 28.4 29.6 26.2 20.7 50.  19.1 17.2  8.8 26.6 17.5  9.6
 33.4 18.8 16.5 46.  15.2 27.1  8.5 48.3 50.  22.6 22.  19.6 19.8 17.8
 21.5 22.8 22.9 13.3 24.4 29.4  8.8 13.9 11.9 23.   7.4 21.7  7.2 33.
 37.6 23.2 23.9 13.3 23.8 18.5 23.5 27.  16.1 20.8 16.3 13.8 19.3 19.9
 15.  18.2 17.5 14.3 27.5 50.  19.1 15.6 10.2  8.7 24.3 15.6 36.4 15.4
 16.2 15.4 20.4 19.4 10.2 17.6 13.1 24.7 23.1 20.2 21.2 33.2 34.6 20.3
 22.5 17.8 19.1 17.5 23.7 18.2 21.   7.5 19.6 19.8 24.  36.5 18.7 22.2
 34.9 34.9 19.4 36.2 13.5 37.2  5.  16.1 24.8 21.9 23.  50.  32.9 28.5
 20.1 28.  16.4 11.7 23.1 27.9 23.1 28.7 22.5 21.9 43.1 18.3 14.3 22.
 19.9 24.5 24.3 21.1 29.1 15.1 17.8 11.  31.5 16.5 19.2 23.7 34.7 25.1
 17.  25.  17.9 35.4 15.6 29.1 21.  25.  19.  16.6 20.9 27.9 14.5 21.2
 37.  11.7 21.4 15.   8.5 21.4 20.  44.  19.3 24.7 30.5 33.1 19.  18.5
 20.5 24.1 31.7 20.6 30.7 20.3  7.2 21.7 12.1 21.2 11.3 12.3 24.4 22.6
 30.3 23.  20.4 10.2 22.  36.1 10.4 12.5 33.8  7.  22.3 21.1 15.2 19.3
 23.3 14.8 18.4 33.1  9.7 22.8 22.8 18.2 18.6 13.8 13.8 14.9 17.8 39.8
 20.1 14.9 50.  20.6 25.  50.  10.4 18.  22.9 20.5 24.8 13.3 13.  14.1
 15.7 21.6 21.4 23.8 22.2 23.1 21.2 31.6 33.4  5.6 50.  21.7 23.9 15.6
 18.9 20.6 23.9  8.1 21.7 22.6 32.2 11.8 14.1 15.2 23.4 20.  22.4 17.1
  8.4 35.1 25.  14.  50.   8.4 13.4 23.8 21.5 24.8 19.7 21.7 25.  16.7
 22.3 23.2 13.1 19.7 18.9 26.4 18.5 26.7 20.6 48.5 13.9 22.9 26.5 23.1
 19.5 17.4 22.4 15.  29.8 31.1 12.7 19.4 11.8 16.6 18.6 19.4 20.8 23.6
 23.3 21.6 17.1 19.5 23.8 11.9 23.9 22.7 20.1 28.1 24.4 38.7 24.1 22.2
 22.5 18.4 32.7 22.9 29.8 20.9 24.7 20.2  6.3 22.6 45.4 23.3 32.4 46.7
 24.6 23.4 21.  21.8 42.3 31.5 19.5 22.  28.6 17.2 32.  50. ]
(404,)
(404, 13)
```

In [0]:

```
X_train_standadized['PRICE']=Y_train
X_test_standadized['PRICE']=Y_test
```

In [212]:

```
print(X_train_standadized.shape)
print(X_test_standadized.shape)
```

```
(404, 14)
(102, 14)
```

In [214]:

```
# X_train_standadized.isnull()
# X_train_standadized.fillna(X_train_standadized.mean())
X_train_standadized.isnull().sum()
```

Out[214]:

```
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
PRICE      0
dtype: int64
```

Sgd

In [216]:

```
# for references
#https://github.com/gauravtheP/Implementing-Stochastic-Gradient-
Descent/blob/master/LinearRegression_SGD_BostonHomePrices.ipynb


#First step initilize the weights and b
#formla of slope s=mx+b.
# mx is the weights*x1....weights_d*xd
# b is the intercept term

m = X_train.shape[0]
weight = np.random.randn(13)*np.sqrt(2/m)    # defining initial random weight from normal distributi
on
b = np.random.randn(1)*np.sqrt(2/m)    # generating initial random y-intercept from normal distribut
ion

# initilize learing rate
learningRate = 0.2
print(m,weight,b,learningRate)



for i in range(2000):     # running 2000 iterations
    Data_batch_10 = X_train_standadized.sample(n = 10)    # taking 10 stochastic samples
    X_temp = Data_batch_10.drop("PRICE", axis = 1, inplace = False)     # DROP the price label, beca
use this is the output label we have to predict.
    #X = pd.DataFrame(X_temp, columns = columnNames)
    X=X_temp
    Y = Data_batch_10["PRICE"]
    PartialGradient = np.empty(13)# in this we store the partial derivate with respect to w...we
have 13 features
```

```
    sum2 = 0

    # Update the weights-------------------------------

    # formula  (w0=w1-lr*derivate)in every iteration
    # step 1.
    #First calculate the derivative

    for j in range(13):      # as there are 13 dimensions in our dataset and dimensions of weight sh
ould also be same as dimension of our dataset
        sum1 = 0
        for k in range(10):
            sum1 += -2 * X.iloc[k][j] * (Y.iloc[k] - np.dot(weight, X.iloc[k]) - b)  # this is a
derivative of linear regression w.r.t 'w
        PartialGradient[j] = sum1

    # step 2.

    #multiply with learning rate
    PartialGradient *= learningRate


    #step 3.
    #Update the weights

    for l in range(13):
        weight[l] -= PartialGradient[l]  # updating weights



    # Update the Intercepts or (b's)-------------------------------

    for m in range(10):
        sum2 += -2 * (Y.iloc[m]- np.dot(weight, X.iloc[m]) - b)      # this is the derivative of line
ar regression w.r.t 'b'
    b = b - learningRate * sum2        #updating y-intercept 'b'


    # in every iteration u have to reduce the learing rate bro
    learningRate = 0.01 / pow(i+1, 0.25)      #learning rate at every iteration


    # just add the regularization term to it

    weight = weight + 0.0001*np.dot(weight, weight)   #adding l2 regularization
    b = b + 0.0001*np.dot(weight, weight) #adding L2 regularization

print("Weight = "+str(weight))
print("b = "+str(b))
```

```
404 [-0.05070079  0.0712384   0.08144204  0.07292133  0.08974328 -0.02311549
  0.05826553  0.06273903  0.03671033  0.08477603 -0.03625468 -0.01312975
  0.02192867] [0.05113992] 0.2
Weight = [-0.37323154  1.12154017  0.33532632  0.9809546  -1.56284412  2.96585827
  0.2735731  -2.06909773  2.44753151 -2.04799992 -1.92889464  1.37829867
 -3.571989  ]
b = [22.50551]
```

In [0]:

```
# time for testdata.. with our updated weights and coeffcients

import math
test_temp = X_test_standadized.drop("PRICE", axis = 1, inplace = False)
test_data = test_temp
test_labels = Y_test
y_predicted = []


for i in range(102):
    test_i = 0
    test_i = np.dot(weight, test_data.iloc[i]) + b[0]  #making prediction by using optimize values
of weights obtained from SGD
    y_predicted.append(test_i)
```

In [218]:

```
#Make the preditions


d1 = {'True Labels': Y_test, 'Predicted Labels': y_predicted}
df1 = pd.DataFrame(data = d1)
```

Out[218]:

	True Labels	Predicted Labels
0	37.9	33.334242
1	17.4	21.800972
2	32.0	33.397457
3	21.4	23.868016
4	24.0	24.482675
5	10.5	7.064670
6	32.5	30.260659
7	16.2	20.378662
8	13.8	6.204524
9	31.2	29.220315
10	14.6	19.574461
11	30.1	28.514383
12	22.2	22.807205
13	16.0	19.560288
14	20.0	21.440489
15	37.3	34.491675
16	28.7	25.592522
17	33.3	36.924060
18	30.1	34.527321
19	12.6	19.075508
20	13.4	15.519259
21	13.6	13.989936
22	19.6	17.967815
23	14.6	8.956924
24	16.7	20.091204
25	11.5	14.353944
26	12.7	11.308697
27	43.8	34.642620
28	33.2	31.879714
29	16.8	20.052274
...	...	...
72	19.4	17.517550
73	14.2	18.114418
74	21.8	20.660067
75	50.0	35.576825
76	22.1	25.962113
77	16.8	21.190917
78	28.4	30.030470
79	17.4	15.968831
80	20.6	18.707107
81	50.0	41.193903

	True Labels	Predicted Labels
82	24.4	25.668611
83	17.8	23.916903
84	23.1	16.042816
85	22.0	26.632707
86	22.0	27.979294
87	12.8	13.656081
88	13.6	12.733423
89	50.0	22.406194
90	25.0	24.008349
91	29.9	30.733601
92	20.0	22.622859
93	18.4	19.360220
94	15.3	20.740001
95	41.7	38.497240
96	13.4	13.344773
97	8.3	14.126229
98	30.8	31.212733
99	19.3	19.908967
100	13.1	14.358364
101	28.2	32.090944

102 rows × 2 columns

In [219]:

```
Mean_Sq_Error = mean_squared_error(Y_test, y_predicted)
print(Mean_Sq_Error)
```

```
24.68779995681416
```

In [220]:

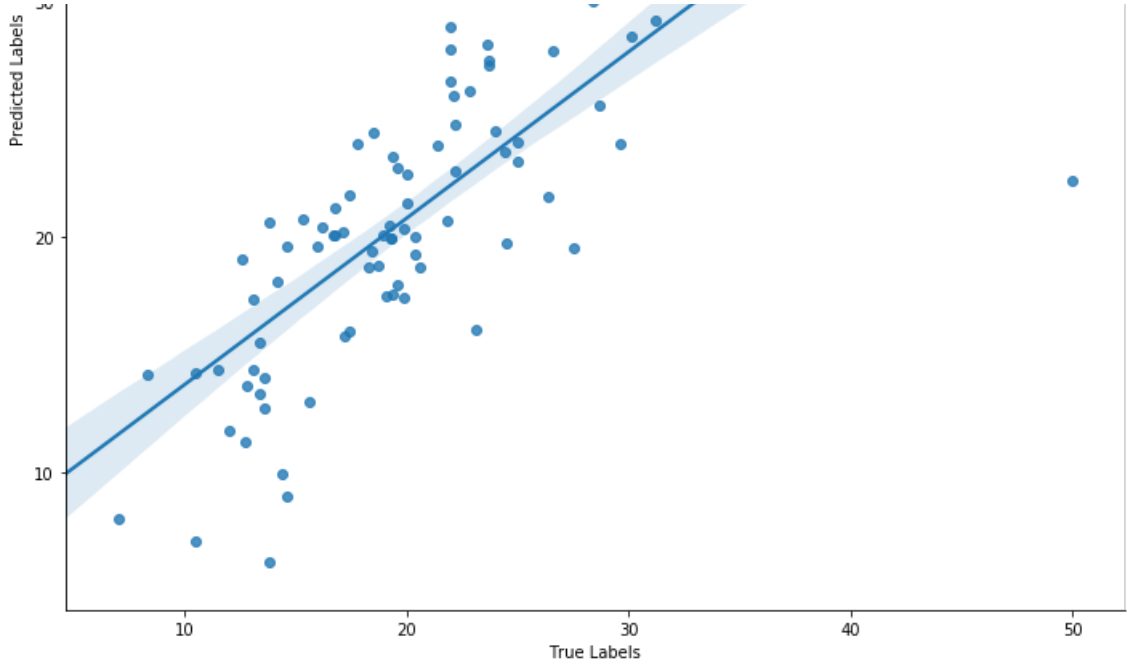
```
import seaborn as sns
lm1 = sns.lmplot(x="True Labels", y="Predicted Labels", data = df1, size = 10)

fig1 = lm1.fig

fig1.suptitle("With Manual Implementation(Without Sklearn)", fontsize=18)

sns.set(font_scale = 1.5)
```

```
/usr/local/lib/python3.6/dist-packages/seaborn/regression.py:546: UserWarning: The `size` paramter
has been renamed to `height`; please update your code.
  warnings.warn(msg, UserWarning)
```



Sklearn implementation

In [223]:

```
X_temp = X_train_standadized.drop("PRICE", axis = 1, inplace = False)
X=X_temp
Y = Y_train

X_test_temp = X_test_standadized.drop("PRICE", axis = 1, inplace = False)
X_te=X_test_temp
Y_te = Y_test

clf = SGDRegressor(shuffle = False, learning_rate= 'invscaling', max_iter = 2000)
clf.fit(X, Y)# fir train data

Y_pred = clf.predict(X_te)# predict test error

print("Weight = "+str(clf.coef_))
print("Y Intercept = "+str(clf.intercept_))
```

```
Weight = [-0.92923444  0.80810734 -0.02142847  0.81761804 -2.02014517  2.46852323
 -0.02994358 -2.91655848  2.16393634 -1.33702632 -2.17771005  0.90810995
 -3.66821822]
Y Intercept = [22.30660382]
```

In [224]:

```
d2 = {'True Labels': Y_te, 'Predicted Labels': Y_pred}
df2 = pd.DataFrame(data = d2)
df2
```

Out[224]:

	True Labels	Predicted Labels
0	37.9	33.114366
1	17.4	22.728829
2	32.0	32.951590
3	21.4	24.724204
4	24.0	25.072981
5	10.5	6.692912
6	32.5	30.351692
7	16.2	20.520831

	True Labels	Predicted Labels
8	13.8	6.607847
9	31.2	28.303887
10	14.6	19.250599
11	30.1	24.541417
12	22.2	21.815888
13	16.0	18.137431
14	20.0	22.140637
15	37.3	33.085148
16	28.7	25.054250
17	33.3	35.846128
18	30.1	34.487408
19	12.6	18.197055
20	13.4	16.451031
21	13.6	14.844595
22	19.6	17.553750
23	14.6	9.155418
24	16.7	19.571965
25	11.5	14.432359
26	12.7	12.804000
27	43.8	34.736089
28	33.2	31.944591
29	16.8	20.548093
...	...	...
72	19.4	17.294825
73	14.2	18.165053
74	21.8	21.274724
75	50.0	35.088224
76	22.1	26.630241
77	16.8	20.658325
78	28.4	29.792436
79	17.4	15.883859
80	20.6	16.351618
81	50.0	39.806554
82	24.4	23.449878
83	17.8	22.339037
84	23.1	17.196446
85	22.0	27.264998
86	22.0	26.995809
87	12.8	13.320283
88	13.6	12.556716
89	50.0	23.745185
90	25.0	24.263381
91	29.9	31.160953
92	20.0	23.050383
93	18.4	18.767396
94	15.3	20.837044
95	41.7	37.297985
96	13.4	13.435849
97	8.3	13.310258
98	30.8	30.430116
99	19.3	20.302008

	True Labels	Predicted Labels
100	13.1	14.252085
101	28.2	31.630373

102 rows × 2 columns

In [225]:

```
Mean_Sq_Error = mean_squared_error(Y_te, Y_pred)
Mean_Sq_Error
```

Out[225]:

```
25.072849774836367
```

In [226]:

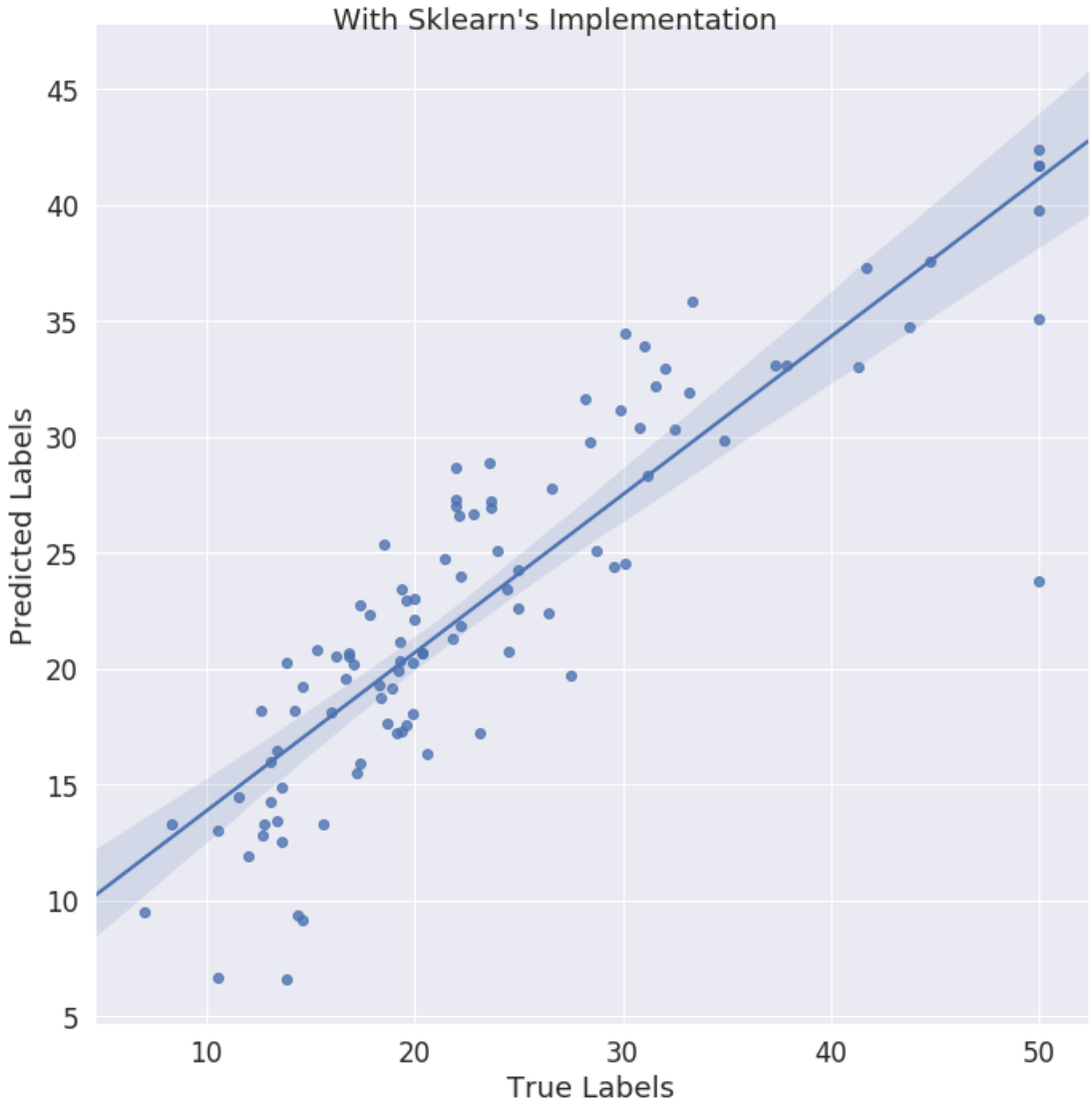
```
lm2 = sns.lmplot(x="True Labels", y="Predicted Labels", data = df2, size = 10)

fig2 = lm2.fig

# Add a title to the Figure
fig2.suptitle("With Sklearn's Implementation", fontsize=18)

sns.set(font_scale = 1.5)
```

```
/usr/local/lib/python3.6/dist-packages/seaborn/regression.py:546: UserWarning: The `size` paramter
has been renamed to `height`; please update your code.
  warnings.warn(msg, UserWarning)
```



Result:

Sklearn SGD impementation error- > 25.07

My SGD impementation error- > 24.68

In [0]:

```
```