06 sandyLinearRegression

August 5, 2019

```
In [9]: 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 import preprocessing
        import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        from prettytable import PrettyTable
        from sklearn import preprocessing
        from sklearn.metrics import mean_squared_error
        from sklearn.model_selection import train_test_split
        from sklearn.linear_model import SGDRegressor
        from sklearn.linear_model import LinearRegression
        import seaborn as sns
```

0.1 Loading Boston Data

```
In [3]: boston = load_boston()
        print(boston.data.shape)
        print(boston.target.shape)
```

```
(506, 13)
(506,)
```

```
In [4]: print(boston.feature_names)
```

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

0.2 Loading data into X and Class labels into Y

```
In [25]: X = boston.data
         Y = boston.target
```

In [26]:
```
df=pd.DataFrame(X)
X=df.as_matrix()
df.head()
```

Out[26]:

	0	1	2	3	4	5	6	7	8	9	10	11	12
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

0.3 Splitting the data using 80:20 scheme

In [61]:
```
x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size = 0.2, random_sta
print(X_train.shape)
print(X_test.shape)
print(Y_train.shape)
print(Y_test.shape)
```

```
(354, 13)
(152, 13)
(354,)
(152,)
```

In [62]:
```
# standardaising data
scaler  = preprocessing.StandardScaler()
x_train = scaler.fit_transform(x_train)
x_test  = scaler.transform(x_test)
```

In [63]:
```
df_train=pd.DataFrame(x_train)
df_train['PRICE']=y_train

df_train.head()
```

Out[63]:

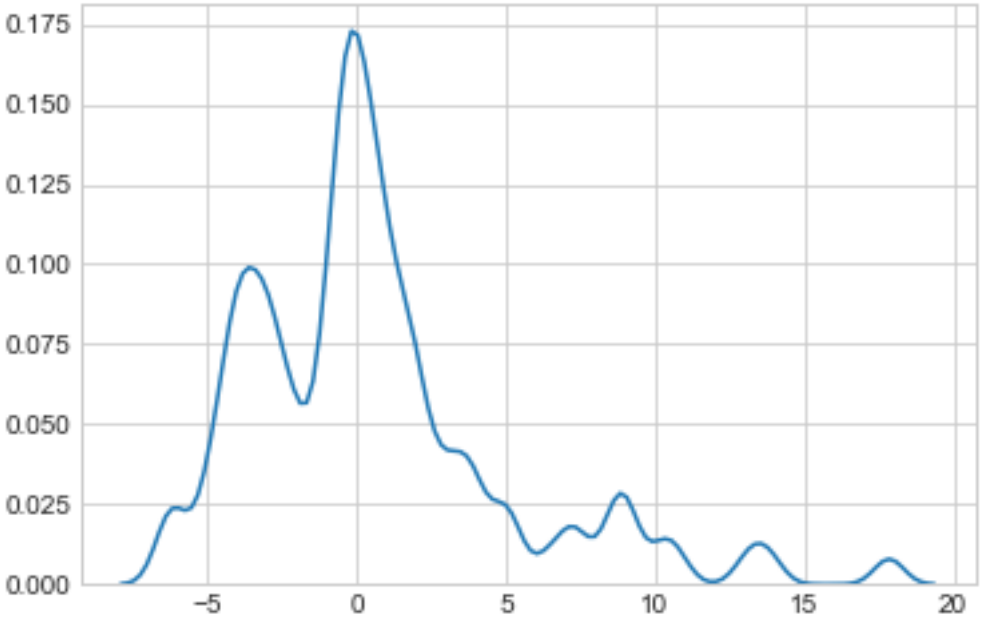
	0	1	2	3	4	5	6	PRICE
0	-0.276470	-0.507766	-0.402012	-0.272888	-0.118484	-0.848834	0.963877	
1	-0.407464	3.331365	-1.431888	3.664502	-1.314148	2.361809	-1.516597	
2	8.064832	-0.507766	1.078157	-0.272888	1.112090	-0.478931	1.140549	
3	-0.403977	-0.507766	0.161225	-0.272888	0.186977	-0.243407	0.317257	
4	0.696610	-0.507766	1.078157	-0.272888	1.234274	0.166954	1.140549	

```
          7         8         9        10        11        12  PRICE
0 -0.022455 -0.636453 -0.583618  1.175619 -0.000302  0.835288   13.1
1  0.999022 -0.981745 -1.231926 -2.202859  0.412907 -1.325495   50.0
2 -0.988813  1.665490  1.551633  0.810378 -3.849276  1.158196    8.8
3 -0.752702 -0.981745 -0.785842  1.175619  0.428424 -0.483373   20.6
4 -1.068474  1.665490  1.551633  0.810378  0.194665  1.114099   12.1
```

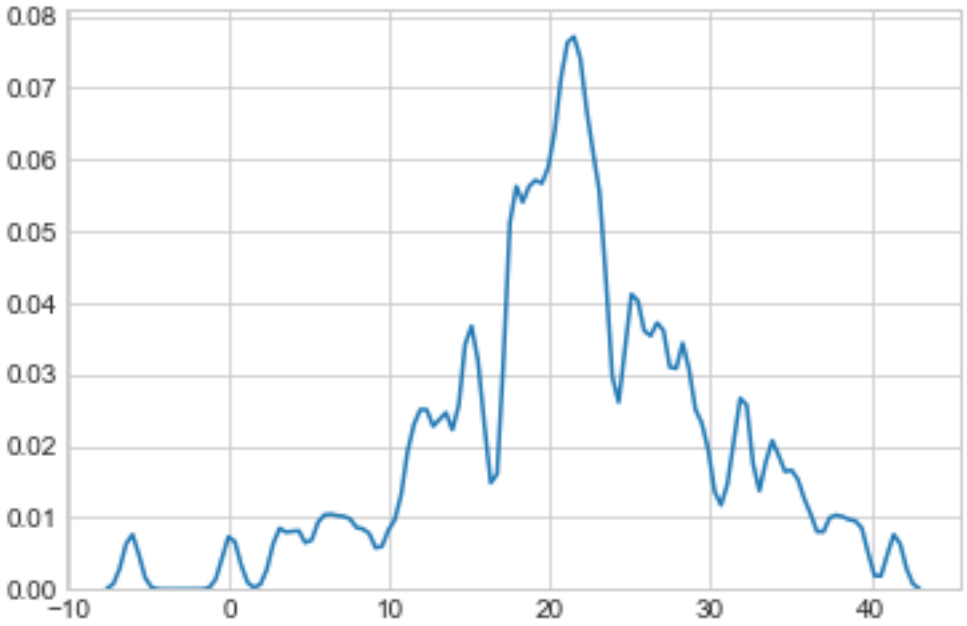
In [64]:
```
# code source:https://medium.com/@haydar_ai/learning-data-science-day-9-linear-regres

lr = LinearRegression()
lr.fit(x_train, y_train)

y_pred = lm.predict(x_test)

plt.scatter(y_test, y_pred)
plt.xlabel("Prices: $Y_i$")
plt.ylabel("Predicted prices: $\hat{Y}_i$")
plt.title("Prices vs Predicted prices: $Y_i$ vs $\hat{Y}_i$")
plt.show()
```

In [65]:
```
delta_y = y_test - y_pred;

sns.set_style('whitegrid')
```

```
sns.kdeplot(np.array(delta_y), bw=0.5)
plt.show()
```



In [66]:
```
sns.set_style('whitegrid')
sns.kdeplot(np.array(y_pred), bw=0.5)
plt.show()
```



Our implementation of sgd regressor

In [67]:
```
#SGD implementation for linear regression

W,B,iteration,rate,k = np.zeros(shape=(1,13)),0,750,0.1,25 #intialise W and B to zero


while iteration>=0 :
    w,b,delta_w,delta_b = W,B,np.zeros(shape=(1,13)),0
    data = df_train.sample(25)                #sampling random k=batch size=20 data
    x = np.array(data.drop('PRICE',axis=1))
    y = np.array(data['PRICE'])

    for i in range(25):
        delta_w += (-2)*x[i]*(y[i]-(np.dot(w,x[i])+b))    #partial differentiation wrt
        delta_b += (-2)*(y[i]-(np.dot(w,x[i])+b))         #partial differentiation wrt

    W=(w-rate*(delta_w)/k)
    B=(b-rate*(delta_b)/k)

    rate = rate/1.01
    iteration-=1


print(W)
print(B)
```

```
[[-1.07422688  1.08020469 -0.27064925  0.82836113 -1.70461634  2.49358007
  -0.15126247 -3.19234351  2.49732179 -1.36096905 -1.99745611  1.06086766
  -4.11716864]]
[22.74675212]
```

In [68]:
```
#prediction on x_test
#https://www.geeksforgeeks.org/numpy-asscalar-in-python/
y_predic=[]
for i in range(len(x_test)):
    val=np.dot(W,x_test[i])+B  #val= wTx+b
    y_predic.append(np.asscalar(val))
```

In [69]:
```
#Scatter plot of actual price vs predicted price

plt.scatter(y_test,y_predic)
plt.xlabel('Actual price')
plt.ylabel('Predictd price')
plt.title('Actual price vs Predicted price')
plt.show()
```


```
In [70]: MSE_lr=mean_squared_error(y_test,y_predic)
         print('mean squared error =',MSE_lr)

mean squared error = 20.65873224554908
```

In built sklearn implementation of sgdregressor

```
In [71]: #SGD regression sklearn implementation

         model=SGDRegressor(learning_rate='constant',eta0=0.01,penalty=None,max_iter=100)
         model.fit(x_train,y_train)
         y_pred_sgd=model.predict(x_test)

         #Scatter plot of actual price vs predicted price

         plt.scatter(y_test,y_pred_sgd)
         plt.xlabel('Actual price')
         plt.ylabel('Predictd price')
         plt.title('Actual price vs Predicted price')
         plt.show()
```


```
In [72]: MSE_sgd=mean_squared_error(y_test,y_pred_sgd)
         print('mean squared error =',MSE_sgd)

mean squared error = 21.42882223955226
```

```
In [74]: #Comparison between weights obtained from own implementation and weights obtained fro
         from prettytable import PrettyTable
         pt = PrettyTable()
         pt.field_names=['Weight vector manual','Weight vector SGD sklearn']
         weight_sgd=model.coef_
         for i in range(13):
             pt.add_row([W[0][i],weight_sgd[i]])
         print(pt)
```

```
+----------------------+---------------------------+
| Weight vector manual | Weight vector SGD sklearn |
+----------------------+---------------------------+
| -1.0742268830153774  |    -1.0814436969619463    |
|  1.0802046933986134  |     1.2186197394107143    |
| -0.2706492522496202  |     0.3347283550663289    |
|  0.8283611307986145  |     1.0990377545782293    |
| -1.7046163410427286  |    -1.7143672837622372    |
|  2.4935800735761005  |     2.5737039126860775    |
| -0.15126247088004796 |   -0.044158347456554795   |
```

```
| -3.1923435055807774  |     -3.42950094184944     |
|  2.4973217928950686  |     3.1829729279890917    |
| -1.3609690514959618  |    -2.0517136506922613    |
| -1.9974561076490327  |    -2.3067492679999453    |
|  1.0608676597211895  |     1.0587783850521952    |
|  -4.117168642152379  |     -4.366105882172545    |
+----------------------+---------------------------+
```

0.3.1 Conclusion

Here we are getting desired results as both values of mean square error from SGDRegressor and our implementation of sgdregressor are similar and close to each other.