

```
In [1]: from sklearn.datasets import load_boston
from sklearn.linear_model import SGDRegressor
from sklearn.metrics import mean_squared_error
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt
import numpy as np
from prettytable import PrettyTable
import prettytable
%matplotlib inline
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
import math
```

```
In [2]: a=load_boston()
x=a.data
y=a.target
x=StandardScaler().fit_transform(x)
```

Sklearn SGD implementation

```
In [3]: lr=SGDRegressor()
lr.fit(x,y)
```

```
Out[3]: SGDRegressor(alpha=0.0001, average=False, early_stopping=False, epsilon=0.1,
 eta0=0.01, fit_intercept=True, l1_ratio=0.15,
 learning_rate='invscaling', loss='squared_loss', max_iter=None,
 n_iter=None, n_iter_no_change=5, penalty='l2', power_t=0.25,
 random_state=None, shuffle=True, tol=None, validation_fraction=0.1,
 verbose=0, warm_start=False)
```

```
In [4]: mse_sklearn=mean_squared_error(y,lr.predict(x))
mse_sklearn
```

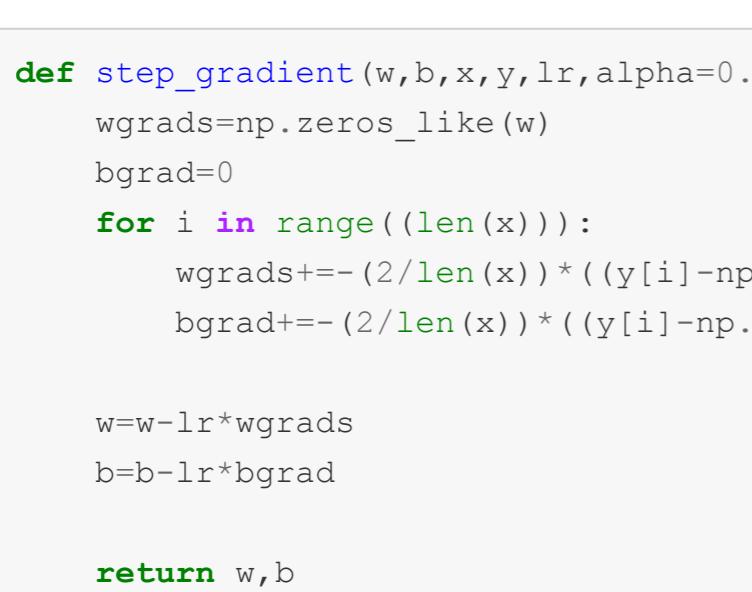
```
Out[4]: 22.741680590825236
```

```
In [5]: lr.coef_
```

```
Out[5]: array([-0.6172394 ,  0.55071579, -0.44571707,  0.83244945, -0.99143772,
 3.09740386, -0.19855041, -2.28908276,  0.86142294, -0.51841993,
-1.80006985,  0.93561104, -3.43862106])
```

```
In [6]: plt.scatter(y,lr.predict(x))
plt.xlabel('actual values')
plt.ylabel('predicted values')
```

```
Out[6]: Text(0, 0.5, 'predicted values')
```



Our own SGD implementation

```
In [7]: def step_gradient(w,b,x,y,lr,alpha=0.0001):
    wgrads=np.zeros_like(w)
    bgrad=0
    for i in range(len(x)):
        wgrads+=-(2/len(x))*(y[i]-np.dot(w,x[i])-b)*x[i]+(alpha*(2*w))#gradient with respect to weights
        bgrad+=-(2/len(x))*((y[i]-np.dot(w,x[i])-b))#gradient with respect to intercept

    w=w-lr*wgrads
    b=b-lr*bgrad

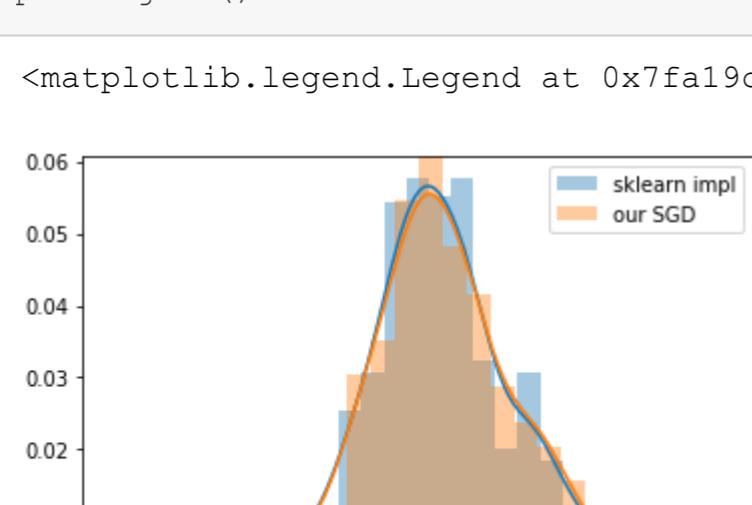
    return w,b
```

```
In [8]: def gradient_descent(x,y,eta0=0.01):
    fl=x.shape[1]
    w=np.random.normal(0,1,size=(fl,),)
    b=np.random.random()
    best_loss=mean_squared_error(y,np.dot(x,w)+b)
    loss_improved=True
    iteration=0
    lr=eta0
    while loss_improved:
        iteration=iteration+1
        w,b=step_gradient(w,b,x,y,lr)
        if iteration>5:#if loss is not much decreasing after 5 iterations we will terminate
            curr_loss=mean_squared_error(y,np.dot(x,w)+b)
            if (best_loss-curr_loss)>0.001:
                best_loss=curr_loss
            else:
                loss_improved=False
        lr=eta0/math.pow(iteration,0.25) #gradually decreasing learning rate
    return w,b

w,b=gradient_descent(x,y)
```

```
In [9]: plt.scatter(y,np.dot(x,w)+b)
plt.xlabel('actual values')
plt.ylabel('predicted values')
```

```
Out[9]: Text(0, 0.5, 'predicted values')
```



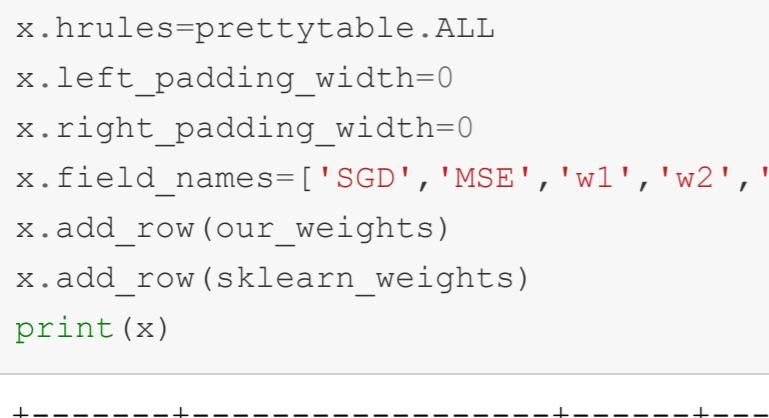
```
In [10]: mse_ours=mean_squared_error(y,np.dot(x,w)+b)
mse_ours
```

```
Out[10]: 22.13081245773643
```

Distribution of predictions

```
In [11]: sns.distplot(lr.predict(x),label='sklearn impl')
sns.distplot(np.dot(x,w)+b,label='our SGD')
plt.legend()
```

```
Out[11]: <matplotlib.legend.Legend at 0x7fa19c20c358>
```



Conclusions

```
In [12]: w=np.round(w,3)
sklearn_weights=np.array(lr.coef_)
sklearn_weights=np.round(sklearn_weights,3)
our_weights=list(w)
our_weights.insert(0,mse_ours)
our_weights.insert(0,'Our SGD')
sklearn_weights=list(sklearn_weights)
sklearn_weights.insert(0,mse_sklearn)
sklearn_weights.insert(0,'Sklearn')

x=PrettyTable()
x.hrules=prettytable.ALL
x.left_padding_width=0
x.right_padding_width=0
x.field_names=['SGD','MSE','w1','w2','w3','w4','w5','w6','w7','w8','w9','w10','w11','w12','w13']
x.add_row(our_weights)
x.add_row(sklearn_weights)
print(x)
```

SGD	MSE	w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12	w13
Our SGD	22.13081245773643	-0.776	0.768	-0.0	0.714	-1.451	2.956	-0.081	-2.453	1.894	-1.459	-1.965	0.895	-3.606
Sklearn	22.741680590825236	-0.617	0.551	-0.446	0.832	-0.991	3.097	-0.199	-2.289	0.861	-0.518	-1.8	0.936	-3.439