06 Implement SGD

April 25, 2019

```
In [1]: 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.linear_model import SGDRegressor
        from sklearn import preprocessing
        from sklearn.metrics import mean_squared_error
```

```
In [2]: #loading the data
        X = load_boston().data
        Y = load_boston().target
```

```
In [3]: #performing standardization
        scaler = preprocessing.StandardScaler().fit(X)
        X = scaler.transform(X)
        X.shape[0]
```

```
Out[3]: 506
```

1 Implementing own SGD

```
In [119]: #defining a function which computes the error at each iteration and also returns the
          error_stepwise=[]
          final_error=0
          def cost(w,b):
              terror=0

              for i in range(506):
                  terror+=(Y[i]-(np.dot(X[i],w)+b))**2
```

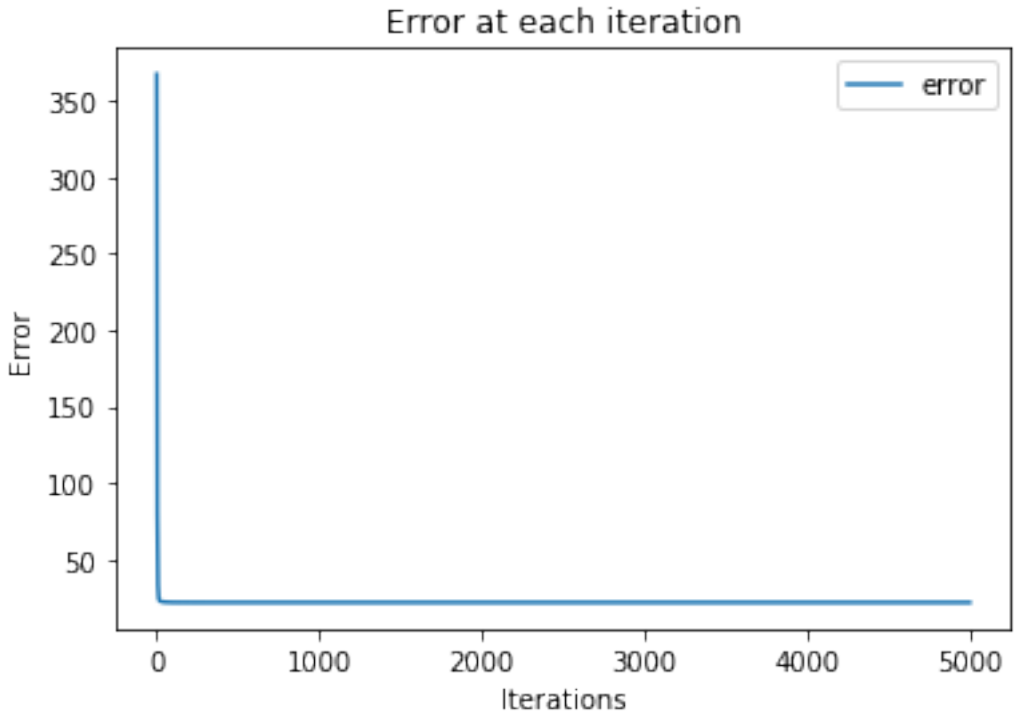
```
            terror=terror/506
            final_error=terror
            error_stepwise.append(terror)
            return final_error
        #    terror
```

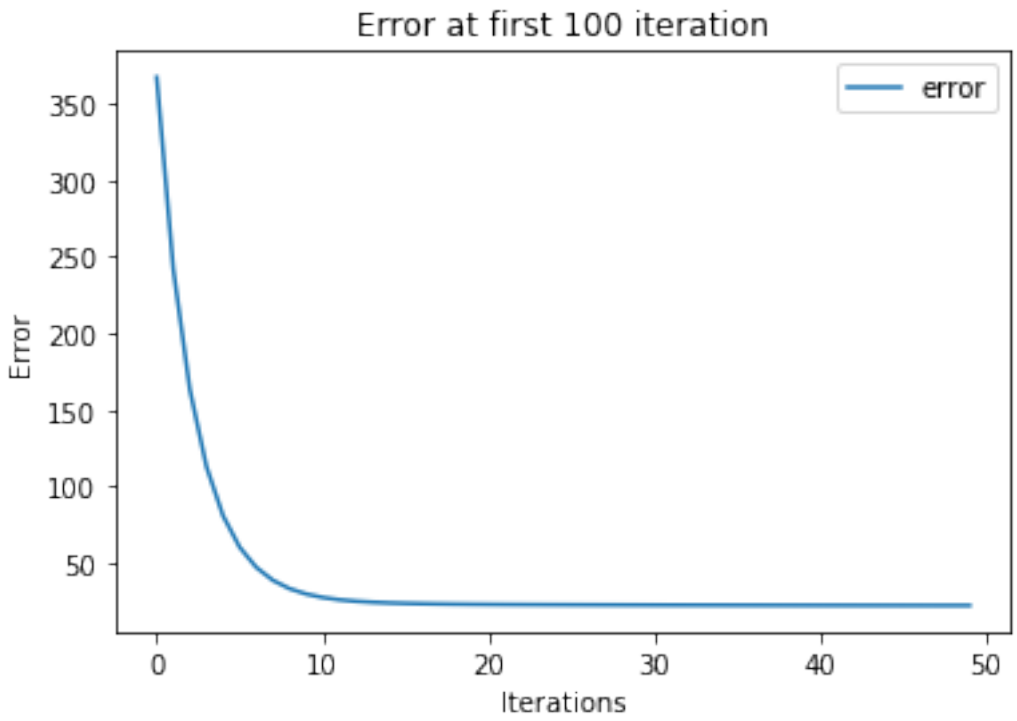
In [101]:
```
#Compute the gradient descent
#coefficient of shape of features
from tqdm import tqdm
w=np.zeros((X.shape[1],1))
wg=np.zeros((X.shape[1],1))
b=0
bg=0
#1000 iterations
for z in tqdm(range(5000)):
    wg=np.zeros((X.shape[1],1))
    bg=0
    #for each value of x
    for i in range(X.shape[0]):
        error=Y[i]-(np.dot(X[i],w)+b)
        z= (X[i]*error)
        z=np.reshape(z,(13,1))
        wg+=-2*z
        bg+=-2*(error)
    wg=wg/506
    bg=bg/506

    w=w-(0.1*wg)
    b=b-(0.1*bg)
    #to compute the error at each iteration
    cost(w,b)
```

```
100%|| 5000/5000 [00:46<00:00, 107.52it/s]
```

In [102]:
```
#plotting the error at each iteration
plt.figure(1)


plt.plot(error_stepwise,label="error")
plt.legend()
plt.xlabel("Iterations")
plt.ylabel("Error")
plt.title("Error at each iteration")

#taking only few iterations as error reaches minimum soon
plt.figure(2)
```

```
plt.plot(error_stepwise[0:50],label="error")
plt.legend()
plt.xlabel("Iterations")
plt.ylabel("Error")
plt.title("Error at first 100 iteration")
plt.show()
```

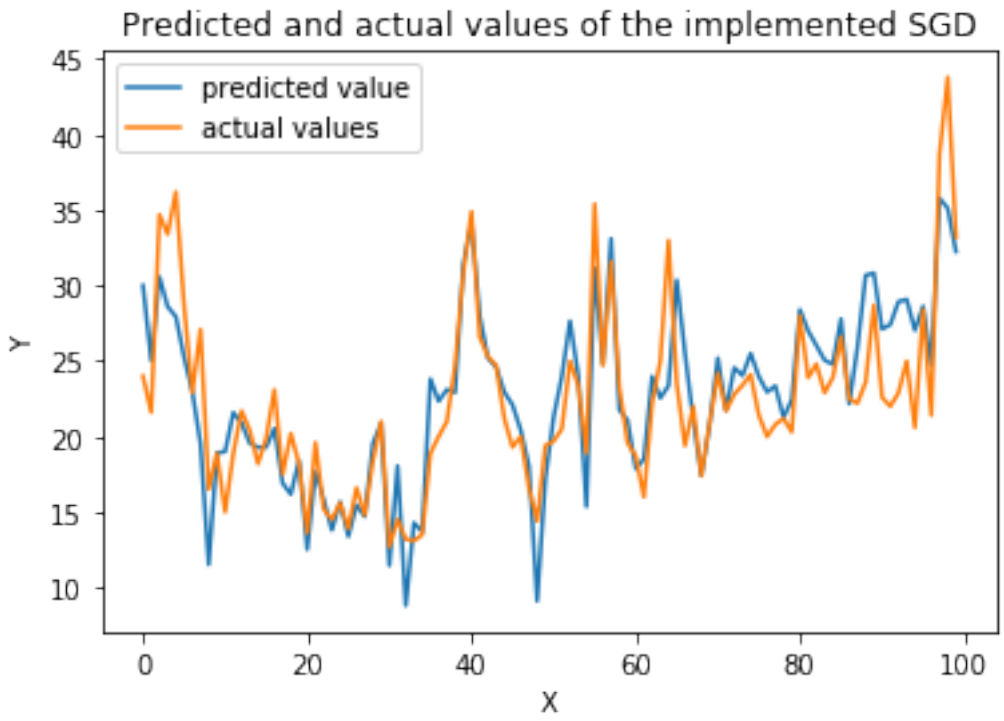




The loss function converged to minimum very soon

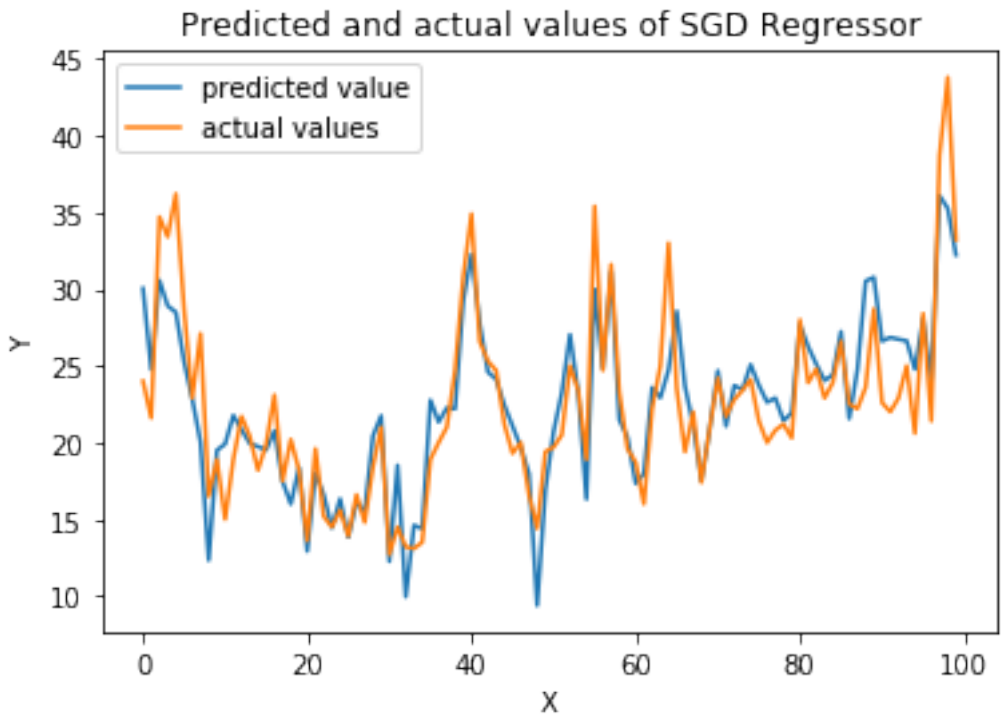
2 Comparing Sklearn SGD vs own Implemented SGD

```
In [107]: #predicted values vs actual values of implemented sgd
          y_pred=[]
          #plotting only the first 100 values to make graph clear

          for i in range(X.shape[0]):
              y_pred.append(np.dot(X[i],w)+b)

          plt.plot(y_pred[0:100],label="predicted value")
          plt.plot(Y[0:100],label="actual values")
          plt.legend()
          plt.xlabel("X")
          plt.ylabel("Y")
          plt.title("Predicted and actual values of the implemented SGD")
          plt.show()
```



Observation: predicted values and actual values are very similar

```
In [130]: #predicted values vs actual values of sklearn sgd
          clf = SGDRegressor(fit_intercept=True)
          clf.fit(X, Y)

          y_pred=clf.predict(X)
          plt.plot(y_pred[0:100],label="predicted value")
          plt.plot(Y[0:100],label="actual values")
          plt.xlabel("X")
          plt.ylabel("Y")
          plt.legend()
          plt.title("Predicted and actual values of SGD Regressor")
          plt.show()
```



Observation: predicted values and actual values are very similar

```
In [131]: #Comparing sklearn vs own SGD weights
          sklearn_weights=pd.DataFrame(clf.coef_)
          imp_weights=pd.DataFrame(w)

          weights=pd.concat([sklearn_weights, imp_weights], axis=1)
          weights.columns=['sklearn_weights', 'imp_weights']
          print("SKlearn regressor weights vs implemented SGD weights")
          weights
```

```
SKlearn regressor weights vs implemented SGD weights
```

```
Out[131]:     sklearn_weights  imp_weights
          0         -0.704309    -0.928146
          1          0.507018     1.081569
          2         -0.301946     0.140900
          3          0.788805     0.681740
          4         -1.044052    -2.056718
          5          3.172094     2.674230
          6         -0.021943     0.019466
          7         -2.095738    -3.104044
          8          1.083747     2.662218
          9         -0.551249    -2.076782
```

```
10        -1.810014    -2.060607
11         0.874671     0.849268
12        -3.320179    -3.743627
```

```
In [126]: # Comparing the MSE of sklearn vs own SGD
          print("The MSE of Sklearns SGD regressor is: ",mean_squared_error(Y, clf.predict(X)))
          mse=cost(w,b)
          print("The MSE of our implemented SGD is:", mse)
```

```
The MSE of Sklearns SGD regressor is:  22.90817192455964
The MSE of our implemented SGD is: [21.89483118]
```

2.1 Conclusion

we get slightly less error using our own implemented SGD. The loss function converged to the minimum very soon.