Implementing SGD Linear Regressor

1.1 Importing necessary Libraries

```
# Importing necessary libraries
import numpy as np
import pandas as pd
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
from sklearn.metrics import mean_absolute_error,mean_squared_error
%matplotlib inline
from numpy import random
import warnings
warnings.filterwarnings('ignore')
```

1.2 Importing and getting basic info about the dataset

```
from sklearn.datasets import load_boston
boston = load_boston()
print(boston.data.shape)
print(boston.feature_names)
data = boston.data
```

1.3 Standardising and splitting the input

```
# Standardising the data
sc = StandardScaler()
standardised_data = sc.fit_transform(data)
new_feature = np.ones(boston.data.shape[0])
final_data = np.vstack((new_feature,standardised_data.T)).T

# Getting actual prices of the house
target_price = boston.target

# Train and Test split of data
X_train, X_test, Y_train, Y_test = train_test_split(final_data, target_price, test
```

1.4 Training SGDRegressor with necessary parameters

```
def SGD_Linear_Regressor(X_train,Y_train):
  # Number of epochs to run the model
```

```
    epoch = 1000

    #learning rate
    r = 0.001

    # Number of training points
    m = X_train.shape[0]

    # batch size
    batch = 20

    # Shuffle the input data by generating 'm' unique random numbers of range (0-m)
    random_ids = random.choice(m,m,replace=False)
    X_train_shuffled = X_train[random_ids,:]
    y_train_shuffled = Y_train[random_ids]

    #Create mini batches of size 20
    mini_batches = [(X_train_shuffled[i:i+batch,:], y_train_shuffled[i:i+batch]) for

    # Initialize the weight vector
    weight_vector = np.random.normal(0,1,final_data.shape[1])
    print(weight_vector)

    #temp weight matrix to store the intermediate weights
    temp_weights = np.zeros(final_data.shape[1])

    # converging the model
    while(epoch >=0):
        mean_weights = []
        for batch in mini_batches:
            X_batch = batch[0]
            Y_batch = batch[1]
            for j in range(0,final_data.shape[1]):
                intd_sum = 0
                for i in range(0,X_batch.shape[0]):
                    #  weight[j] = weight[j] - (r/m)*((Σfrom i=1 to K)of(((weight.T
                    intd_sum += (((np.sum(sc.inverse_transform(weight_vector[1:14] *
                temp_weights[j] = weight_vector[j] - ((r/X_batch.shape[0])*intd_sum)
            weight_vector = temp_weights
            mean_weights.append(weight_vector.mean())
        epoch -= 1
    return weight_vector,mean_weights

# Get the final weight vector
final_weight_vector,mean_weights = SGD_Linear_Regressor(X_train,Y_train)
```

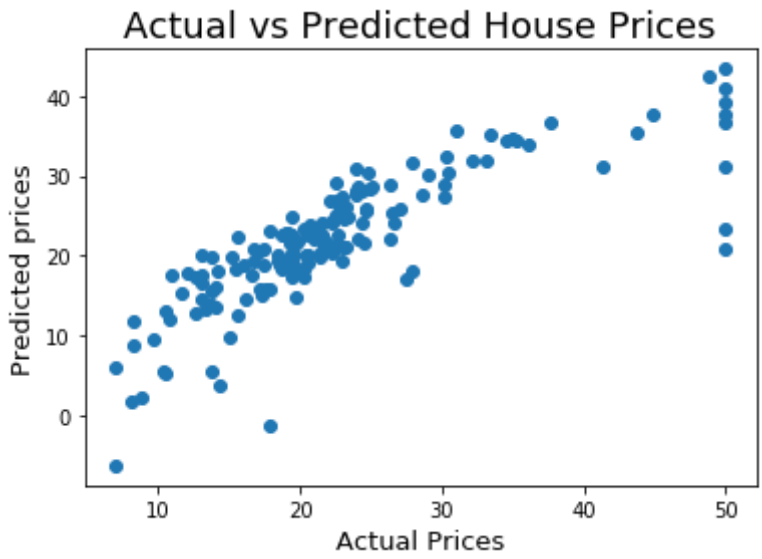
```
[ 0.54006448  0.99926257 -0.88724573 -1.75738542 -0.03202348  0.02710486
  1.06954151  1.33483576  0.77556327 -0.5021375  -1.21905008  1.08390898
 -0.8552094  -0.80845973]
```

1.5 Running the model on test data

```
# predicting the prices on test data
```

```
predictions = np.zeros(X_test.shape[0])
for i in range(0,X_test.shape[0]):
    predictions[i] = np.sum(sc.inverse_transform(final_weight_vector[1:14]*X_test[

# Plotting the Scatter plot of Actual Price VS Predicted Price
plt.scatter(Y_test, predictions)
plt.xlabel("Actual Prices",size = 13)
plt.ylabel("Predicted prices",size =13)
plt.title("Actual vs Predicted House Prices",size=18)
plt.show()
```




```
# MSE and RMSE of the above model
print("MSE : ",mean_squared_error(Y_test, predictions))
print("RMSE : ",np.sqrt(mean_squared_error(Y_test,predictions)))
```

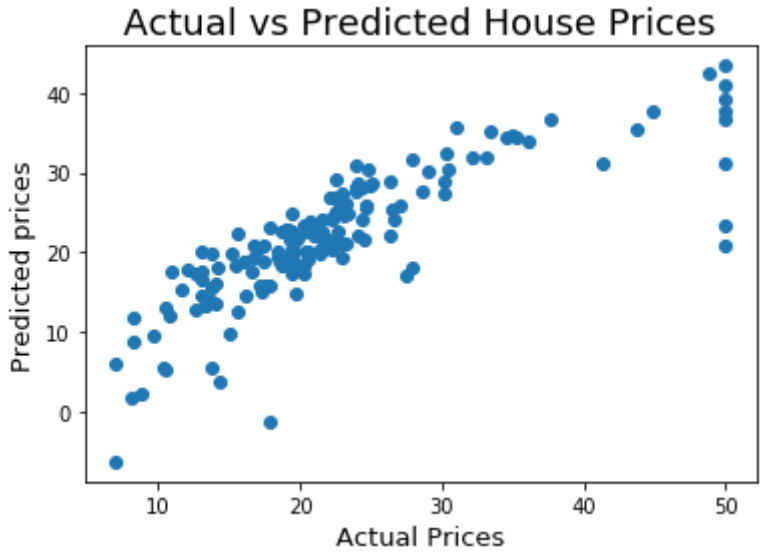
```
MSE :  32.547744389980366
RMSE :  5.7050630487296425
```

Applying SK-Learn's SGD model

```
from sklearn.linear_model import SGDRegressor
reg = SGDRegressor(max_iter=1000, eta0=0.001)
reg.fit(X_train, Y_train)

weight_vector_sklearn = reg.coef_
predictions_sk_learn = reg.predict(X_test)

plt.scatter(Y_test, predictions)
plt.xlabel("Actual Prices",size = 13)
plt.ylabel("Predicted prices",size =13)
plt.title("Actual vs Predicted House Prices",size=18)
plt.show()
```




```
# MSE and RMSE of the Sk-Learns Linear Regressor
print("MSE : ",mean_squared_error(Y_test, predictions_sk_learn))
print("RMSE : ",np.sqrt(mean_squared_error(Y_test,predictions_sk_learn)))
```

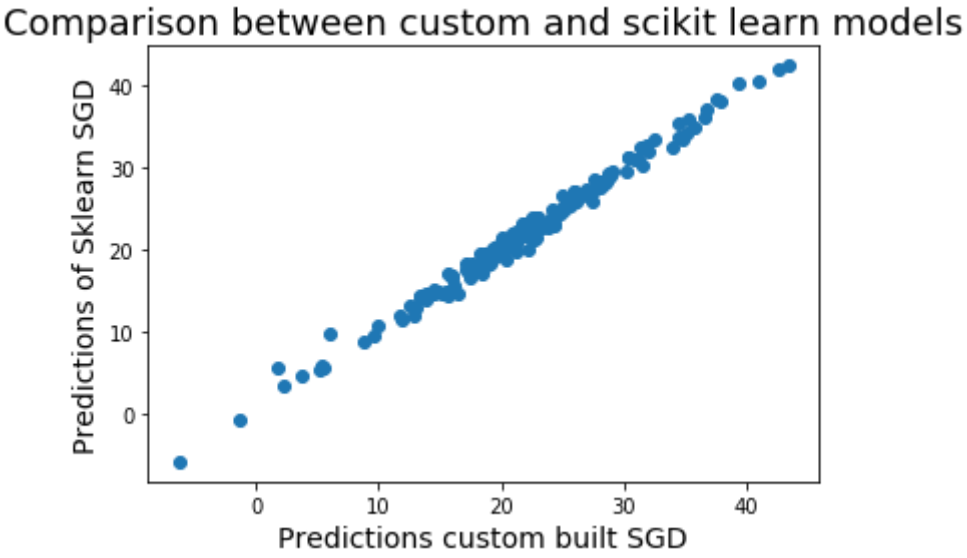
```
MSE :  31.775878180807624
RMSE :  5.637009684292517
```

Comparing both models

```
# Sample predictions vs actual
print(f'Sample Actual vs Prediction Prices for custom built SGD: {list(zip(Y_test[
print("==========================================================================
print(f'Sample Actual vs Prediction Prices for Scikit-Learn SGD: {list(zip(Y_test[
```

```
Sample Actual vs Prediction Prices for custom built SGD: [(37.6, 36.814034258
==========================================================================
Sample Actual vs Prediction Prices for Scikit-Learn SGD: [(37.6, 37.123805339
```

```
# Comparing the predictions of both models
plt.scatter(predictions, predictions_sk_learn)
plt.xlabel("Predictions custom built SGD",size=14)
plt.ylabel("Predictions of Sklearn SGD",size=14)
plt.title("Comparison between custom and scikit learn models",size=18)
plt.show()
```



Obervations

Comparing the MSE and RMSE given by both models, we can say that with 1000 iterations, both m the same performance.

```
from prettytable import PrettyTable
table = PrettyTable()

table.field_names = ['Model','MSE','RMSE']
table.add_row(["Custom built SGD","32.54","5.70"])
table.add_row(["Sk-Learns's SGD","31.77","5.63"])
print(table)
```

```
+------------------+-------+------+
|      Model       |  MSE  | RMSE |
+------------------+-------+------+
| Custom built SGD | 32.54 | 5.70 |
| Sk-Learns's SGD  | 31.77 | 5.63 |
+------------------+-------+------+
```