b) Implement the linear regression using Gradient Descent method in your own code. Also implement the linear regression by using existing library (scikit-learn). Compare the performance of both implementations.

Manual Method

In [ ]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
from sklearn.linear_model import SGDRegressor
from sklearn import preprocessing, svm, datasets, linear_model
from sklearn.metrics import mean_squared_error, r2_score
from sklearn.model_selection import train_test_split

# Function for Linear Regression using Gradient Descent
def SGD(X, y, lr=0.05, epoch=10, batch_size=1):
    m, c = 0, 0                                            # Initialize P
    for _ in range(epoch):
        indexes = np.random.randint(0, len(X), batch_size) # Random Sampl
        Xs = np.take(X, indexes)
        ys = np.take(y, indexes)
        N = len(Xs)
        f = ys - (m*Xs + c)
        # Updating parameters m and b
        m -= lr * (-2 * Xs.dot(f).sum() / N)
        c -= lr * (-2 * f.sum() / N)
    return m, c

# Input: Dataset
data = pd.read_csv('sgdregress.csv')

# Taking only two attributes of the Dataset
data_binary = data[['C1','C2']]

# Eliminating NaN or missing input numbers
data_binary.fillna(method ='ffill', inplace = True)

# Dropping any rows with Nan values
data_binary.dropna(inplace = True)

# Separating the data into independent and dependent variables
# Converting each dataframe into a numpy array
X = np.array(data_binary['C1']).reshape(-1, 1)
Y = np.array(data_binary['C2']).reshape(-1, 1)

# Dividing into test and training sets
X_train, X_test, Y_train, Y_test =  train_test_split(X,Y,test_size=0.3)

# Total number of Test values
n = len(Y_test)

# Mean X and Y
mean_x_train = np.mean(X_train)
mean_y_train = np.mean(Y_train)
mean_x_test = np.mean(X_test)
```

```
mean_y_test = np.mean(Y_test)

# Training the Regression Model over Training Set
m, c = SGD(X_train, Y_train, lr=0.0001, epoch=1000, batch_size=2)

# Testing of Regression Model over Testing Set
Y_pred = m*X_test + c

# Calculating Root Mean Squares Error & R2 Score
rmse = 0
ss_tot = 0
ss_res = 0
for i in range(n):
    y_pred = c + m * X_test[i]
    rmse += (Y_test[i] - y_pred) ** 2
    ss_tot += (Y_test[i] - mean_y_test) ** 2
    ss_res += (Y_test[i] - y_pred) ** 2

rmse = np.sqrt(rmse/n)
r2 = 1 - (ss_res/ss_tot)
```

(SciKit-Learn) Method.

In [ ]:

```
# Create Linear Regression object
clf = SGDRegressor(max_iter=10000, learning_rate='constant',eta0=0.0001)

# Train the model
clf.fit(X_train,Y_train)

# Make predictions
Y_predict= clf.predict(X_test)
```

Output and Comparison of Both Methods.

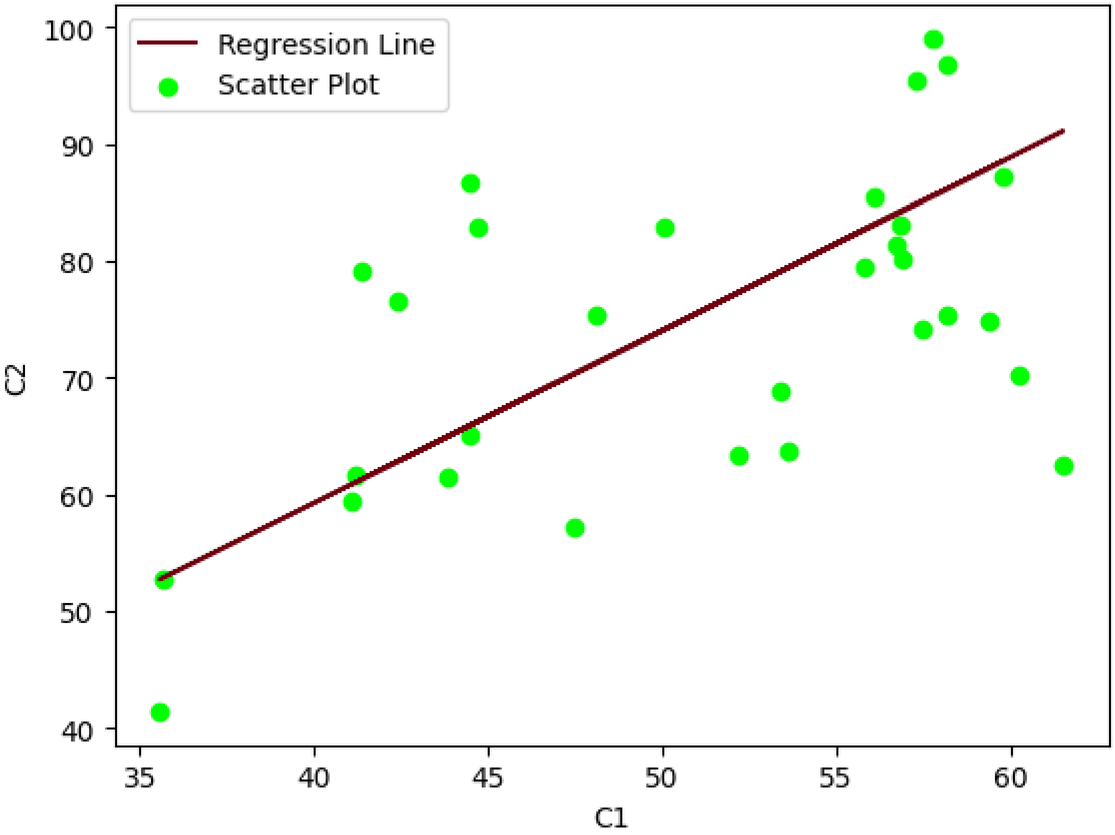
In [ ]:

```
# For Manual Method
# Plotting Line and Scatter Points
plt.plot(X_test, Y_pred, color='#70000d', label='Regression Line')
plt.scatter(X_test, Y_test, c='#00ff00', label='Scatter Plot')
plt.xlabel('C1')
plt.ylabel('C2')
plt.legend()
# Output: The Plot for Regression Line, Coefficients, RMSE and the R2 Sco
print("FOR LINEAR REGRESSION USING GRADIENT DESCENT METHOD MANUALLY \n")
plt.show()
print("\nCoefficients: m = ",m," ; c = ", c)
print('\nRMSE: %.4f' %rmse)
print('\nR2 Score: %.4f' %r2)

# For SciKit-Learn Method
# Plotting Line and Scatter Points
plt.plot(X_test, Y_predict, color='#70000d', label='Regression Line')
plt.scatter(X_test, Y_test, c='#00ff00', label='Scatter Plot')
plt.xlabel('C1')
plt.ylabel('C2')
plt.legend()
# Output: The Plot for Regression Line, Coefficients, RMSE and the R2 Sco
print("_______________________________________________________________________
print("\nFOR LINEAR REGRESSION USING GRADIENT DESCENT METHOD WITH SCIKIT-
plt.show()
```

```
print("\nCoefficients: m = ",clf.coef_," ; c = ", clf.intercept_)
print("\nRMSE: %.4f" % mean_squared_error(Y_test, Y_predict, squared = Fa
print('\nR2 Score: %.4f' % r2_score(Y_test, Y_predict))
```

```
FOR LINEAR REGRESSION USING GRADIENT DESCENT METHOD MANUALLY
```

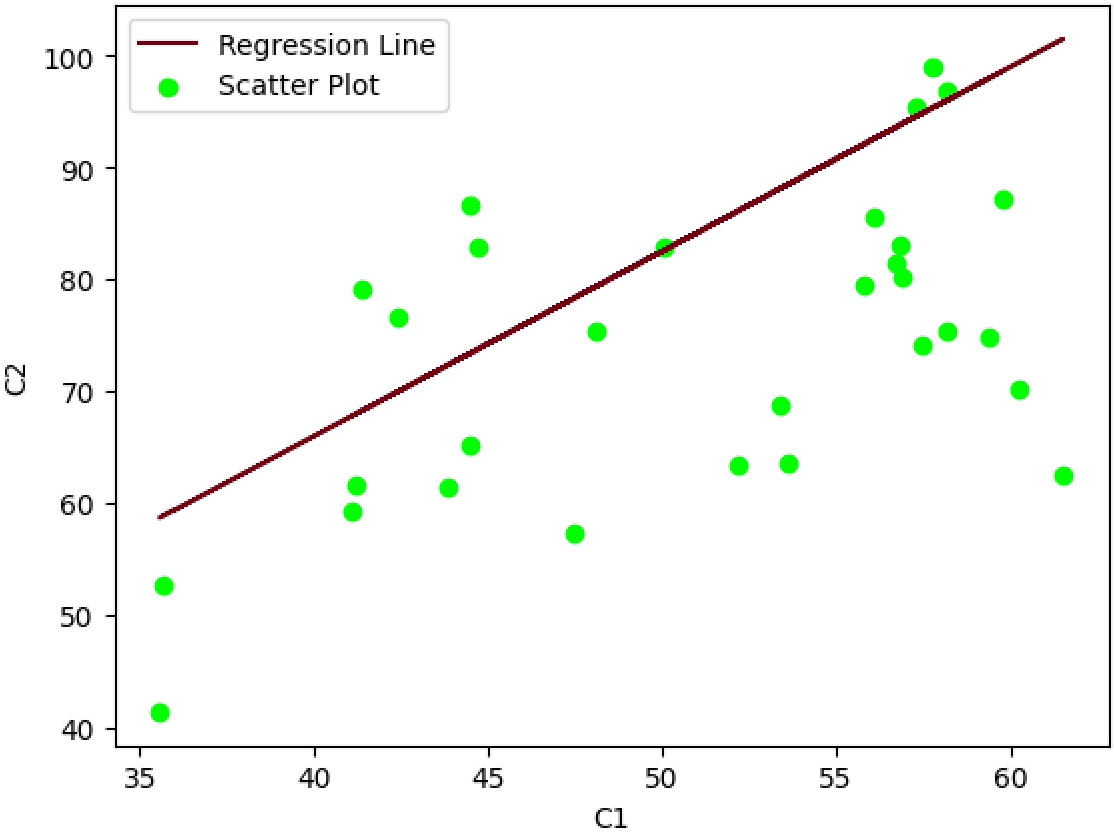


```
Coefficients: m =  1.4796655176468976  ; c =  0.064497024085429 72

RMSE: 11.8472

R2 Score: 0.2007
```

```
FOR LINEAR REGRESSION USING GRADIENT DESCENT METHOD WITH SCIKIT-LEARN
```



```
Coefficients: m =  [1.64865489]  ; c =  [0.04304978]

RMSE: 15.8981

R2 Score: -0.4393
```

On comparison, we can see that both the methods (viz. Gradient Descent Method Manually and Gradient Descent Method with SciKit-Learn) return approximately same value of Root Mean Square Error and R2 Score with a slight difference between the Coefficients calculated.

Also, on comparing the R2 Scores of both methods, it can be seen that the Model created by Manual Method fits more as compared to Model created by SciKit-Learn Method.