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Experiment – 4

Aim: - Implementation of Linear Regression for Single Variate and Multi-variate

Theory: -

Linear Regression: - Linear regression is one of the easiest and most popular Machine Learning algorithms. It is a statistical method that is used for predictive analysis. Linear regression makes predictions for continuous/real or numeric variables such as sales, salary, age, product price, etc.
Linear regression algorithm shows a linear relationship between a dependent (y) and one or more independent (x) variables, hence called linear regression. Since linear regression shows the linear relationship, which means it finds how the value of the dependent variable is changing according to the value of the independent variable. The linear regression model provides a sloped straight line representing the relationship between the variables.

Types of Linear Regression: -
Linear regression can be further divided into two types of the algorithm:
1. Simple Linear Regression: If a single independent variable is used to predict the value of a numerical dependent variable, then such a Linear Regression algorithm is called Simple Linear Regression.
2. Multiple Linear regression: If more than one independent variable is used to predict the value of a numerical dependent variable, then such a Linear Regression algorithm is called Multiple Linear Regression.

Linear Regression Line: -
A linear line showing the relationship between the dependent and independent variables is called a regression line. A regression line can show two types of relationship:
1. Positive Linear Relationship: If the dependent variable increases on the Y-axis and the independent variable increases on X-axis, then such a relationship is termed a positive linear relationship.
2. Negative Linear Relationship: If the dependent variable decreases on the Y-axis and the independent variable increases on the X-axis, then such a relationship is called a negative linear relationship.

Implementation: -

```
# Connecting to drive
from google.colab import drive
drive.mount('/content/drive')

# Importing python packages or libraries
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn import metrics
from sklearn.metrics import mean_squared_error
from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split

# Pre-processing
df = pd.read_csv('/content/drive/MyDrive/cars.csv')

df.describe()
```

	Volume	Weight	CO2
count	36.000000	36.000000	36.000000
mean	1611.111111	1292.277778	102.027778
std	388.975047	242.123889	7.454571
min	900.000000	790.000000	90.000000
25%	1475.000000	1117.250000	97.750000
50%	1600.000000	1329.000000	99.000000
75%	2000.000000	1418.250000	105.000000
max	2500.000000	1746.000000	120.000000

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 36 entries, 0 to 35
Data columns (total 5 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   Car     36 non-null     object
 1   Model   36 non-null     object
 2   Volume  36 non-null     int64
 3   Weight  36 non-null     int64
 4   CO2     36 non-null     int64
dtypes: int64(3), object(2)
memory usage: 1.5+ KB
```

for i in df.columns:
  print(i)

```
Car
Model
Volume
Weight
CO2
```

Part A: Single-Variable Linear Regression

 # Splitting the dataset into training and testing set
X = pd.DataFrame(df, columns = ['Volume'])
X.head()

	Volume
0	1000
1	1200
2	1000
3	900
4	1500

y = df['CO2'].to_numpy()
y

```
array([ 99,  95,  95,  90, 105, 105,  90,  92,  98,  99,  99, 101,  99,
        94,  97,  97,  99, 104, 104, 105,  94,  99,  99,  99,  99, 102,
       104, 114, 109, 114, 115, 117, 104, 108, 109, 120])
```

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.3, random_state = 354)

 # Linear Regression Model
reg = LinearRegression()
reg.fit(X_train, y_train)
print(f'Coefficients: {reg.coef_}')
print(f'Intercept: {reg.intercept_}')
print(f'Variance score: {reg.score(X, y)}')

```
Coefficients: [0.0103012]
Intercept: 85.95807228915663
Variance score: 0.34244852442152063
```

```
# Finding Mean Squared Error
y_pred = reg.predict(X_test)
print(f'Mean squared error is: {mean_squared_error(y_test, y_pred)}')
```

```
Mean squared error is: 27.00550540915029
```

```
# Predicting values for the testing set
data = {'Actual Values': y_test, 'Predicted Values': y_pred}
prediction = pd.DataFrame(data)
prediction
```

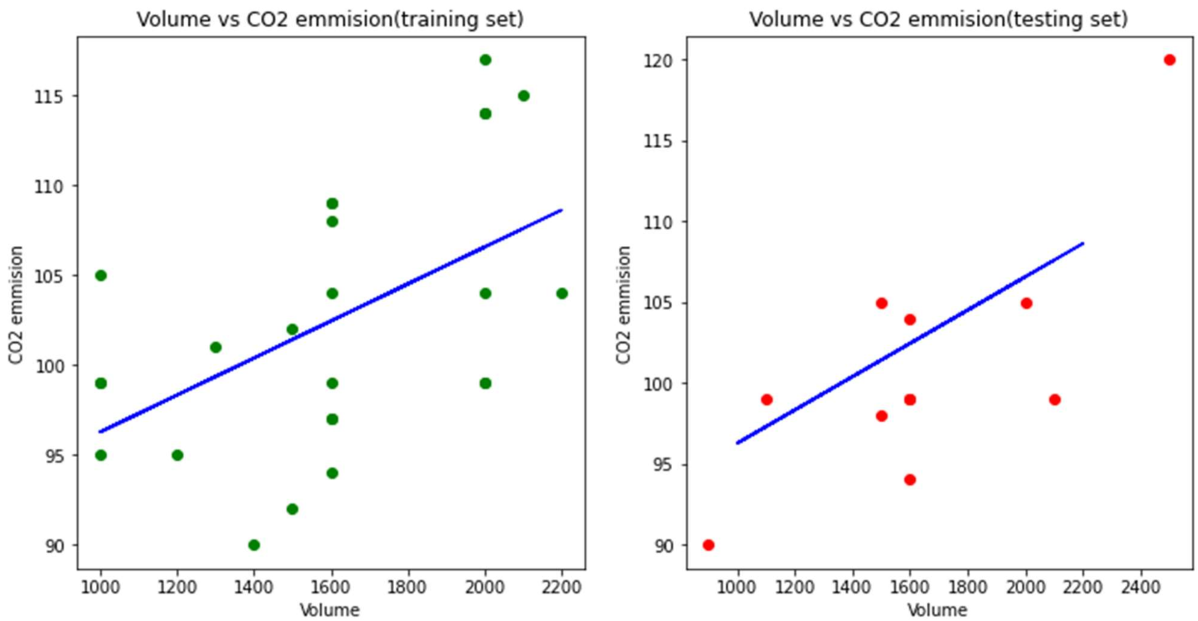
	Actual Values	Predicted Values
0	99	97.289398
1	98	101.409880
2	105	106.560482
3	105	101.409880
4	99	102.440000
5	99	102.440000
6	99	107.590602
7	120	111.711084
8	90	95.229157
9	104	102.440000
10	94	102.440000

```
# Plotting graphs
fig, ax = plt.subplots(1, 2, figsize = (12, 6))

ax[0].scatter(X_train, y_train, color = 'green')
ax[0].plot(X_train, reg.predict(X_train), color = 'blue')
ax[0].set_title("Volume vs CO2 emmision(training set)")
ax[0].set_xlabel("Volume")
ax[0].set_ylabel("CO2 emmision")

ax[1].scatter(X_test, y_test, color = 'red')
ax[1].plot(X_train, reg.predict(X_train), color = 'blue')
ax[1].set_title("Volume vs CO2 emmision(testing set)")
ax[1].set_xlabel("Volume")
ax[1].set_ylabel("CO2 emmision")

plt.show()
```



Part B: Multi-Variable Linear Regression

 # Splitting the dataset into training and testing set
X = pd.DataFrame(df, columns = ['Volume', 'Weight'])
X.head()

	Volume	Weight
0	1000	790
1	1200	1160
2	1000	929
3	900	865
4	1500	1140

y = df['CO2'].to_numpy()
y

```
array([ 99,  95,  95,  90, 105, 105,  90,  92,  98,  99,  99, 101,  99,
        94,  97,  97,  99, 104, 104, 105,  94,  99,  99,  99,  99, 102,
       104, 114, 109, 114, 115, 117, 104, 108, 109, 120])
```

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.25, random_state = 6384)

```
# Linear Regression Model
reg = LinearRegression()
reg.fit(X_train, y_train)
print(f'Coefficients: {reg.coef_}')
print(f'Intercept: {reg.intercept_}')
print(f'Variance score: {reg.score(X, y)}')
```

```
Coefficients: [0.00919187 0.00885163]
Intercept: 75.1474651075566
Variance score: 0.357527211889605
```

```
# Finding Mean Squared Error
y_pred = reg.predict(X_test)
print(f'Mean squared error is: {mean_squared_error(y_test, y_pred)}')
```

```
Mean squared error is: 31.312828817542588
```

```
# Predicting values for the testing set
data = {'Actual Values': y_test, 'Predicted Values': y_pred}
prediction = pd.DataFrame(data)
prediction
```

	Actual Values	Predicted Values
0	104	106.720130
1	115	108.657254
2	105	92.562498
3	101	95.860007
4	104	100.786217
5	90	91.076806
6	99	101.936929
7	99	93.933117
8	104	106.699661

Conclusion: -

Implemented Linear Regression for Single and Multi-variable and found the MSE in both cases as well as plotted the regression line in the case of single-variable.