Objective : How Sales is impacted by TV ad, Radio Ad , Newspaper AD?

In [1]:
```
# import the library
import pandas as pd # handle the data set
import numpy as np # numerical python
import matplotlib.pyplot as plt # data visualisation library
```

Read and understand data

In [2]:
```
# read the csv file
df = pd.read_csv('Advertising Budget and Sales.csv',index_col=0)
# display first five rows
df.head()
```

Out[2]:

	TV Ad Budget ($)	Radio Ad Budget ($)	Newspaper Ad Budget ($)	Sales ($)
1	230.1	37.8	69.2	22.1
2	44.5	39.3	45.1	10.4
3	17.2	45.9	69.3	9.3
4	151.5	41.3	58.5	18.5
5	180.8	10.8	58.4	12.9

In [3]:
```
# change the columns names
df.columns = ['TV','Radio','Newspaper','Sales']
df.head()
```

Out[3]:

	TV	Radio	Newspaper	Sales
1	230.1	37.8	69.2	22.1
2	44.5	39.3	45.1	10.4
3	17.2	45.9	69.3	9.3
4	151.5	41.3	58.5	18.5
5	180.8	10.8	58.4	12.9

In [4]:
```
# check number of rows and columns
df.shape # 200 rows and 4columns
```

Out[4]:
```
(200, 4)
```

In [5]:
```
# check null values
df.isna().sum() # this has no null values
```

Out[5]:
```
TV           0
Radio        0
Newspaper    0
Sales        0
dtype: int64
```

In [6]:
```
# check the data type of columns
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 200 entries, 1 to 200
Data columns (total 4 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   TV         200 non-null    float64
 1   Radio      200 non-null    float64
 2   Newspaper  200 non-null    float64
 3   Sales      200 non-null    float64
dtypes: float64(4)
memory usage: 7.8 KB
```

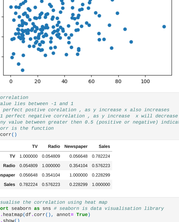
In [7]:
```
# check the statistical summary
df.describe()
```

Out[7]:

	TV	Radio	Newspaper	Sales
count	200.000000	200.000000	200.000000	200.000000
mean	147.042500	23.264000	30.554000	14.022500
std	85.854236	14.846809	21.778621	5.217457
min	0.700000	0.000000	0.300000	1.600000
25%	74.375000	9.975000	12.750000	10.375000
50%	149.750000	22.900000	25.750000	12.900000
75%	218.825000	36.525000	45.100000	17.400000
max	296.400000	49.600000	114.000000	27.000000

Visualise the data

In [8]:
```
## Find the relation between variable we use scatter plot
# relation between TV and sales
plt.figure(figsize=(6,4))
plt.scatter(x=df.TV, y=df.Sales)
plt.show()
```



In [9]:
```
## Find the relation between variable we use scatter plot
# relation between Radio and sales
plt.figure(figsize=(6,4))
plt.scatter(x=df.Radio, y=df.Sales)
plt.show()
```

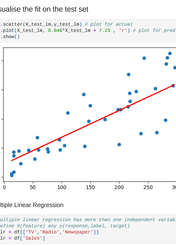
In [10]:
```
## Find the relation between variable we use scatter plot
# relation between Newspaper and sales
plt.figure(figsize=(6,4))
plt.scatter(x=df.Newspaper, y=df.Sales)
plt.show()
```

In [11]:
```
# Correlation
# value lies between -1 and 1
# 1 perfect postive correlation , as y increase x also increases
# -1 perfect negative correlation , as y increase  x will decrease
# any value between greater then 0.5 (positive or negative) indicates high correlation
# we use in the function
df.corr()
```

Out[11]:

	TV	Radio	Newspaper	Sales
TV	1.000000	0.054809	0.056648	0.782224
Radio	0.054809	1.000000	0.354104	0.576223
Newspaper	0.056648	0.354104	1.000000	0.228299
Sales	0.782224	0.576223	0.228299	1.000000

In [12]:
```
#visualise the correlation using heat map
import seaborn as sns # seaborn is data visualisation library
sns.heatmap(df.corr(), annot= True)
plt.show()
```



Perform Simple linear regression

- y = mx +c (equation for a+straight line)
- y will take sales , x will take as TV
- sales = m(TV) + c
- Find best fit line by minimising the error.

Split X and y

In [13]:
```
# Define X and y
X= df[['TV']] # two square brackets , series was converted to data frame
y=df['Sales']
```

In [14]:
```
X.shape
```

Out[14]:
```
(200, 1)
```

In [15]:
```
X.head()
```

Out[15]:

	TV
1	230.1
2	44.5
3	17.2
4	151.5
5	180.8

In [16]:
```
y.head()
```

Out[16]:
```
1    22.1
2    10.4
3     9.3
4    18.5
5    12.9
Name: Sales, dtype: float64
```

Split Train and test

- Train data will be used for training the model
- Test will be used for testing

In [17]:
```
# import the library for train-test split
# test = 20% , train = 80%
from sklearn.model_selection import train_test_split
X_train_lm,X_test_lm, y_train_lm, y_test_lm = train_test_split(X,y , test_size=0.2 , random_state=21)
```

In [18]:
```
# check the shape
X_train_lm.shape
```

Out[18]:
```
(160, 1)
```

Build the linear model

In [19]:
```
# import the library for linear model from sklearn
from sklearn.linear_model import LinearRegression
lm = LinearRegression()
```

In [20]:
```
# Train the model using fit method
lm.fit(X_train_lm,y_train_lm)
```

Out[20]:
```
LinearRegression()
```

In [22]:
```
# Value of m and c
print('Value of m is: ', lm.coef_)
print('Value of c is: ', lm.intercept_)
```

```
Value of m is:  [0.04574335]
Value of c is:  7.238713738761318
```

Predict the values for test

In [23]:
```
# use predict function to test for our test set
y_pred = lm.predict(X_test_lm)
```

Evaluate our model

In [26]:
```
# RMSE (root mean squared error and R^2)
from sklearn.metrics import mean_squared_error , r2_score
# RMSE
np.sqrt(mean_squared_error(y_test_lm,y_pred))
```

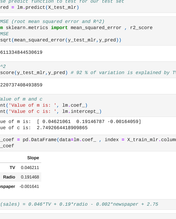
Out[26]:
```
3.2466572285569755
```

In [27]:
```
# R^2
r2_score(y_test_lm,y_pred) # 70 % of variation is explained by TV
```

Out[27]:
```
0.7035304268409084
```

Visualise the fit on the test set

In [29]:
```
plt.scatter(X_test_lm,y_test_lm) # plot for actual
plt.plot(X_test_lm, 0.045*X_test_lm + 7.23 , 'r') # plot for predicted
plt.show()
```



Multiple Linear Regression

In [33]:
```
# Multiple linear regression has more than one independent variable
# Define X(feature) any y(response,label, target)
X_mlr = df[['TV','Radio','Newspaper']]
y_mlr = df['Sales']
```

In [34]:
```
# Split into train and test
X_train_mlr,X_test_mlr,y_train_mlr,y_test_mlr = train_test_split(X_mlr,y_mlr, test_size=0.2, random_state=21)
```

In [36]:
```
# check the shape
X_train_mlr.shape
```

Out[36]:
```
(160, 3)
```

In [37]:
```
# Train the model using fit method
lm.fit(X_train_mlr,y_train_mlr)
```

Out[37]:
```
LinearRegression()
```

In [39]:
```
# use predict function to test for our test set
y_pred = lm.predict(X_test_mlr)
```

In [40]:
```
# RMSE (root mean squared error and R^2)
from sklearn.metrics import mean_squared_error , r2_score
# RMSE
np.sqrt(mean_squared_error(y_test_mlr,y_pred))
```

Out[40]:
```
1.6611334044536619
```

In [41]:
```
# R^2
r2_score(y_test_mlr,y_pred) # 92 % of variation is explained by TV,radio and newspaper
```

Out[41]:
```
0.9220737408493859
```

In [42]:
```
# Value of m and c
print('Value of m is: ', lm.coef_)
print('Value of c is: ', lm.intercept_)
```

```
Value of m is:  [ 0.04621951  0.19148787 -0.00104959]
Value of c is:  2.7492664418909865
```

In [44]:
```
mlr_coef = pd.DataFrame(data=lm.coef_ , index = X_train_mlr.columns , columns=['Slope'])
mlr_coef
```

Out[44]:

	Slope
TV	0.046211
Radio	0.191488
Newspaper	-0.001041

In [48]:
```
# y(sales) = 0.046*TV + 0.19*radio - 0.002*newspaper + 2.75
```

In [ ]:
```

```