In [2]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

In [3]:

```
from sklearn.linear_model import LinearRegression
from sklearn import linear_model
```

In [4]:

```
df = pd.read_csv("F:\clg\Advertising.csv")      # loading the data
```

In [6]:

```
df.head()    #showing first five data
```

Out[6]:

	Month	TV	radio	newspaper	sales
0	Jan-00	230.1	37.8	69.2	22.1
1	Feb-00	44.5	39.3	45.1	10.4
2	Mar-00	17.2	45.9	69.3	9.3
3	Apr-00	151.5	41.3	58.5	18.5
4	May-00	180.8	10.8	58.4	12.9

In [7]:

```
df.info()    #by info method we cheak the whole dataset
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 200 entries, 0 to 199
Data columns (total 5 columns):
 #   Column     Non-Null Count  Dtype  
---  ------     --------------  -----  
 0   Month      200 non-null    object 
 1   TV         200 non-null    float64
 2   radio      200 non-null    float64
 3   newspaper  200 non-null    float64
 4   sales      200 non-null    float64
dtypes: float64(4), object(1)
memory usage: 7.9+ KB
```

In [8]:

```
df.describe()     #by describe method we cheak statistical approach
```

Out[8]:

	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

In [9]:

```
df.shape
```

Out[9]:

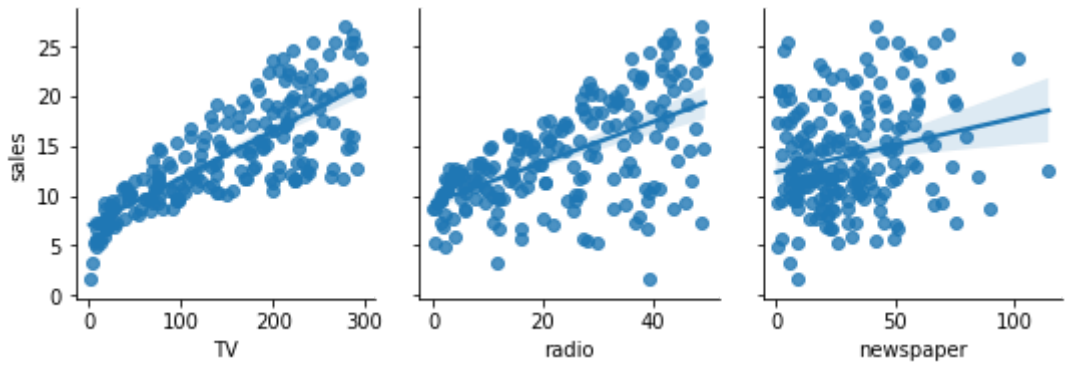
```
(200, 5)
```

In [31]:

```
sns.pairplot(df,x_vars=['TV','radio','newspaper'],   #the variable is continuous, this
 is a regression problem.
             y_vars='sales',kind='reg')          # visualize the relationship between t
he IV and the DV using scatterplots
                                          #we see that TV is more impact in sales
```

Out[31]:

```
<seaborn.axisgrid.PairGrid at 0x1d1afb06648>
```



In [32]:

```
df.corr()             # The diagonal of the above matirx shows the auto-correlation of t
he variables.
                       # It is always 1.
                       # observe that the correlation betweeb TV and Sales is highest i.
e. 0.78 and
                      # then betweeb sales and radio i.e. 0.576.
                      # correlations can vary from -1 to +1.
                       # Closer to +1 means strong positive correlation and close -1 mean
s strong negative correlation.
                      # Closer to 0 means not very strongly correlated.
```

Out[32]:

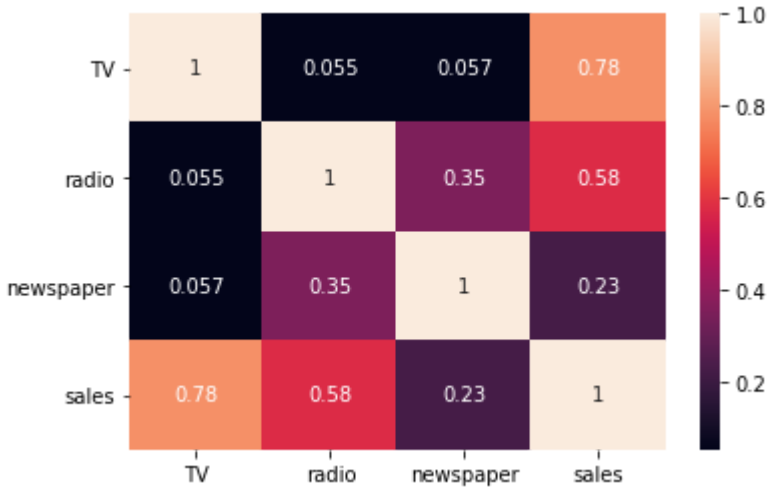
	TV	radio	newspaper	sales
TV	1.000000	0.054809	0.056648	0.782224
radio	0.054809	1.000000	0.354104	0.576223
newspaper	0.056648	0.354104	1.000000	0.228299
sales	0.782224	0.576223	0.228299	1.000000

In [12]:

```
sns.heatmap(  df.corr() , annot = True)
```

Out[12]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1d1acb7d188>
```



LINEAR REGRESSION:

In [13]:

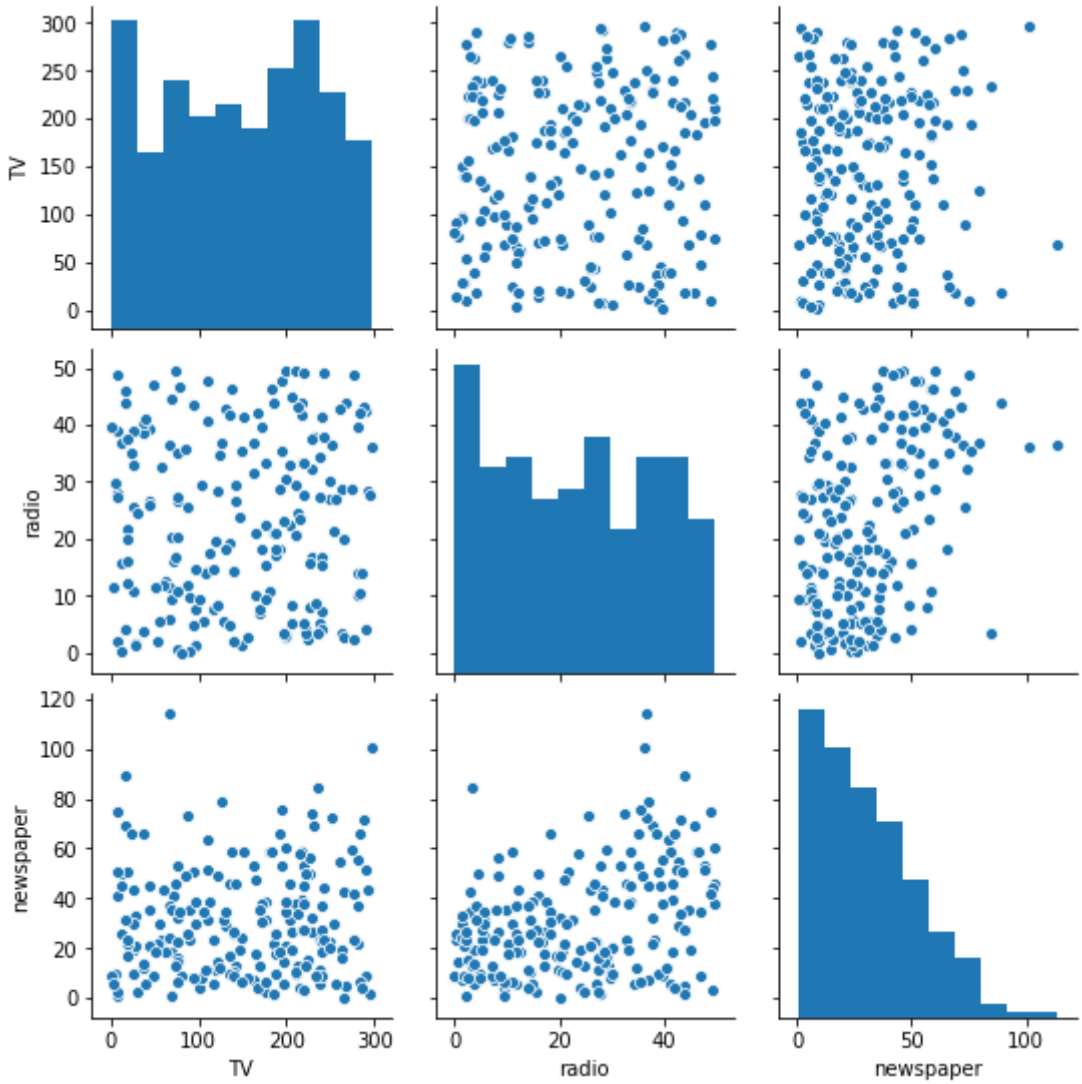
```
X = df[['TV', 'radio', 'newspaper']]
y = df['sales']
```

In [34]:

```
sns.pairplot(X)
```

Out[34]:

```
<seaborn.axisgrid.PairGrid at 0x1d1af686d88>
```



In [15]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=1,  test_size=0.
3)
```

In [17]:

```
print(X_train.shape)
print(y_train.shape)
print(X_test.shape)
print(y_test.shape)
```

```
(140, 3)
(140,)
(60, 3)
(60,)
```

In [18]:

```
regressor=LinearRegression()
regressor.fit(X_train,y_train)
```

Out[18]:

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=F
alse)
```

In [22]:

```
y_pred = regressor.predict(X_test)
```

In [23]:

```
y_test
```

Out[23]:

58	23.8
40	16.6
34	9.5
102	14.8
184	17.6
198	25.5
95	16.9
4	12.9
29	10.5
168	17.1
171	14.5
18	11.3
11	17.4
89	16.7
110	13.4
118	15.9
159	12.9
35	12.8
136	9.5
59	18.4
51	10.7
16	12.5
44	8.5
94	11.5
31	11.9
162	14.9
38	10.1
28	18.9
193	19.6
27	15.9
47	23.2
165	11.9
194	17.3
177	11.7
176	20.2
97	15.5
174	11.5
73	11.0
69	22.3
172	7.6
108	5.3
107	8.7
189	6.7
14	19.0
56	5.5
19	14.6
114	14.6
39	21.5
185	22.6
124	19.7
98	25.4
123	15.2
119	6.6
53	21.2
33	17.4
179	12.6
181	12.2
106	7.2
199	13.4

```
138     9.6
Name: sales, dtype: float64
```

In [24]:

```
y_pred
```

Out[24]:

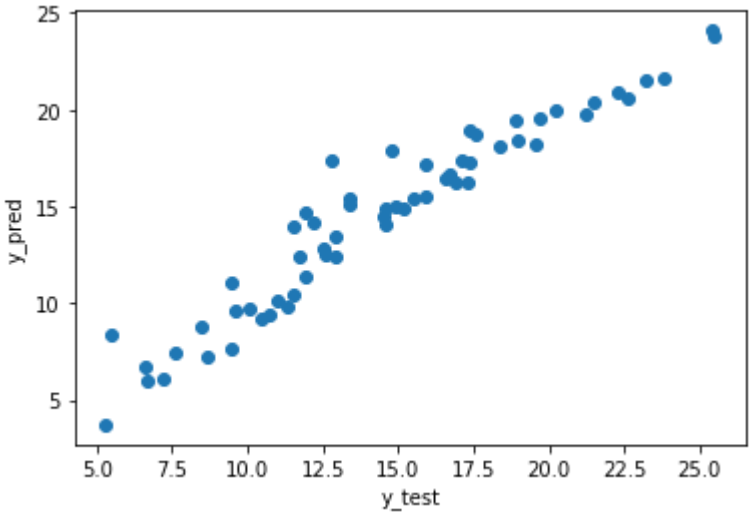
```
array([21.66318307, 16.44137936,  7.69144625, 17.9163172 , 18.67047113,
       23.79199311, 16.2825425 , 13.44138683,  9.15294033, 17.32475313,
       14.43922876,  9.84019547, 17.26329945, 16.62853147, 15.09158705,
       15.50173894, 12.43404074, 17.32591521, 11.04327486, 18.05652777,
        9.35309526, 12.79465958,  8.73413846, 10.47225333, 11.38216042,
       15.02658554,  9.7406823 , 19.44676903, 18.19211174, 17.20178728,
       21.56359539, 14.70484262, 16.2635213 , 12.37098906, 19.97059316,
       15.36768988, 14.00399515, 10.0772945 , 20.91891557,  7.43833283,
        3.67031166,  7.27760354,  5.99523188, 18.41497546,  8.31868226,
       14.1090252 , 14.93697583, 20.35882814, 20.56271636, 19.55380813,
       24.10360923, 14.84985778,  6.71474914, 19.77761567, 18.93996367,
       12.5109195 , 14.20052652,  6.10844697, 15.3695344 ,  9.56769111])
```

In [48]:

```
plt.scatter(y_test,y_pred)        #in this graph we see that there is linear relation b
etween y_test and y _pred.
plt.xlabel('y_test')
plt.ylabel('y_pred')
```

Out[48]:

```
Text(0, 0.5, 'y_pred')
```



In [36]:

```
import statsmodels.api as sm
```

In [37]:

```
X = np.append(arr=np.ones((200,1)).astype(int),values = X,axis = 1)
```

In [38]:

```
X
```

Out[38]:

```
array([[  1. , 230.1,  37.8,  69.2],
       [  1. ,  44.5,  39.3,  45.1],
       [  1. ,  17.2,  45.9,  69.3],
       [  1. , 151.5,  41.3,  58.5],
       [  1. , 180.8,  10.8,  58.4],
       [  1. ,   8.7,  48.9,  75. ],
       [  1. ,  57.5,  32.8,  23.5],
       [  1. , 120.2,  19.6,  11.6],
       [  1. ,   8.6,   2.1,   1. ],
       [  1. , 199.8,   2.6,  21.2],
       [  1. ,  66.1,   5.8,  24.2],
       [  1. , 214.7,  24. ,   4. ],
       [  1. ,  23.8,  35.1,  65.9],
       [  1. ,  97.5,   7.6,   7.2],
       [  1. , 204.1,  32.9,  46. ],
       [  1. , 195.4,  47.7,  52.9],
       [  1. ,  67.8,  36.6, 114. ],
       [  1. , 281.4,  39.6,  55.8],
       [  1. ,  69.2,  20.5,  18.3],
       [  1. , 147.3,  23.9,  19.1],
       [  1. , 218.4,  27.7,  53.4],
       [  1. , 237.4,   5.1,  23.5],
       [  1. ,  13.2,  15.9,  49.6],
       [  1. , 228.3,  16.9,  26.2],
       [  1. ,  62.3,  12.6,  18.3],
       [  1. , 262.9,   3.5,  19.5],
       [  1. , 142.9,  29.3,  12.6],
       [  1. , 240.1,  16.7,  22.9],
       [  1. , 248.8,  27.1,  22.9],
       [  1. ,  70.6,  16. ,  40.8],
       [  1. , 292.9,  28.3,  43.2],
       [  1. , 112.9,  17.4,  38.6],
       [  1. ,  97.2,   1.5,  30. ],
       [  1. , 265.6,  20. ,   0.3],
       [  1. ,  95.7,   1.4,   7.4],
       [  1. , 290.7,   4.1,   8.5],
       [  1. , 266.9,  43.8,   5. ],
       [  1. ,  74.7,  49.4,  45.7],
       [  1. ,  43.1,  26.7,  35.1],
       [  1. , 228. ,  37.7,  32. ],
       [  1. , 202.5,  22.3,  31.6],
       [  1. , 177. ,  33.4,  38.7],
       [  1. , 293.6,  27.7,   1.8],
       [  1. , 206.9,   8.4,  26.4],
       [  1. ,  25.1,  25.7,  43.3],
       [  1. , 175.1,  22.5,  31.5],
       [  1. ,  89.7,   9.9,  35.7],
       [  1. , 239.9,  41.5,  18.5],
       [  1. , 227.2,  15.8,  49.9],
       [  1. ,  66.9,  11.7,  36.8],
       [  1. , 199.8,   3.1,  34.6],
       [  1. , 100.4,   9.6,   3.6],
       [  1. , 216.4,  41.7,  39.6],
       [  1. , 182.6,  46.2,  58.7],
       [  1. , 262.7,  28.8,  15.9],
       [  1. , 198.9,  49.4,  60. ],
       [  1. ,   7.3,  28.1,  41.4],
       [  1. , 136.2,  19.2,  16.6],
```

```
       [  1. , 210.8,  49.6,  37.7],
       [  1. , 210.7,  29.5,   9.3],
       [  1. ,  53.5,   2. ,  21.4],
       [  1. , 261.3,  42.7,  54.7],
       [  1. , 239.3,  15.5,  27.3],
       [  1. , 102.7,  29.6,   8.4],
       [  1. , 131.1,  42.8,  28.9],
       [  1. ,  69. ,   9.3,   0.9],
       [  1. ,  31.5,  24.6,   2.2],
       [  1. , 139.3,  14.5,  10.2],
       [  1. , 237.4,  27.5,  11. ],
       [  1. , 216.8,  43.9,  27.2],
       [  1. , 199.1,  30.6,  38.7],
       [  1. , 109.8,  14.3,  31.7],
       [  1. ,  26.8,  33. ,  19.3],
       [  1. , 129.4,   5.7,  31.3],
       [  1. , 213.4,  24.6,  13.1],
       [  1. ,  16.9,  43.7,  89.4],
       [  1. ,  27.5,   1.6,  20.7],
       [  1. , 120.5,  28.5,  14.2],
       [  1. ,   5.4,  29.9,   9.4],
       [  1. , 116. ,   7.7,  23.1],
       [  1. ,  76.4,  26.7,  22.3],
       [  1. , 239.8,   4.1,  36.9],
       [  1. ,  75.3,  20.3,  32.5],
       [  1. ,  68.4,  44.5,  35.6],
       [  1. , 213.5,  43. ,  33.8],
       [  1. , 193.2,  18.4,  65.7],
       [  1. ,  76.3,  27.5,  16. ],
       [  1. , 110.7,  40.6,  63.2],
       [  1. ,  88.3,  25.5,  73.4],
       [  1. , 109.8,  47.8,  51.4],
       [  1. , 134.3,   4.9,   9.3],
       [  1. ,  28.6,   1.5,  33. ],
       [  1. , 217.7,  33.5,  59. ],
       [  1. , 250.9,  36.5,  72.3],
       [  1. , 107.4,  14. ,  10.9],
       [  1. , 163.3,  31.6,  52.9],
       [  1. , 197.6,   3.5,   5.9],
       [  1. , 184.9,  21. ,  22. ],
       [  1. , 289.7,  42.3,  51.2],
       [  1. , 135.2,  41.7,  45.9],
       [  1. , 222.4,   4.3,  49.8],
       [  1. , 296.4,  36.3, 100.9],
       [  1. , 280.2,  10.1,  21.4],
       [  1. , 187.9,  17.2,  17.9],
       [  1. , 238.2,  34.3,   5.3],
       [  1. , 137.9,  46.4,  59. ],
       [  1. ,  25. ,  11. ,  29.7],
       [  1. ,  90.4,   0.3,  23.2],
       [  1. ,  13.1,   0.4,  25.6],
       [  1. , 255.4,  26.9,   5.5],
       [  1. , 225.8,   8.2,  56.5],
       [  1. , 241.7,  38. ,  23.2],
       [  1. , 175.7,  15.4,   2.4],
       [  1. , 209.6,  20.6,  10.7],
       [  1. ,  78.2,  46.8,  34.5],
       [  1. ,  75.1,  35. ,  52.7],
       [  1. , 139.2,  14.3,  25.6],
       [  1. ,  76.4,   0.8,  14.8],
       [  1. , 125.7,  36.9,  79.2],
```

```
       [  1. ,  19.4,  16. ,  22.3],
       [  1. , 141.3,  26.8,  46.2],
       [  1. ,  18.8,  21.7,  50.4],
       [  1. , 224. ,   2.4,  15.6],
       [  1. , 123.1,  34.6,  12.4],
       [  1. , 229.5,  32.3,  74.2],
       [  1. ,  87.2,  11.8,  25.9],
       [  1. ,   7.8,  38.9,  50.6],
       [  1. ,  80.2,   0. ,   9.2],
       [  1. , 220.3,  49. ,   3.2],
       [  1. ,  59.6,  12. ,  43.1],
       [  1. ,   0.7,  39.6,   8.7],
       [  1. , 265.2,   2.9,  43. ],
       [  1. ,   8.4,  27.2,   2.1],
       [  1. , 219.8,  33.5,  45.1],
       [  1. ,  36.9,  38.6,  65.6],
       [  1. ,  48.3,  47. ,   8.5],
       [  1. ,  25.6,  39. ,   9.3],
       [  1. , 273.7,  28.9,  59.7],
       [  1. ,  43. ,  25.9,  20.5],
       [  1. , 184.9,  43.9,   1.7],
       [  1. ,  73.4,  17. ,  12.9],
       [  1. , 193.7,  35.4,  75.6],
       [  1. , 220.5,  33.2,  37.9],
       [  1. , 104.6,   5.7,  34.4],
       [  1. ,  96.2,  14.8,  38.9],
       [  1. , 140.3,   1.9,   9. ],
       [  1. , 240.1,   7.3,   8.7],
       [  1. , 243.2,  49. ,  44.3],
       [  1. ,  38. ,  40.3,  11.9],
       [  1. ,  44.7,  25.8,  20.6],
       [  1. , 280.7,  13.9,  37. ],
       [  1. , 121. ,   8.4,  48.7],
       [  1. , 197.6,  23.3,  14.2],
       [  1. , 171.3,  39.7,  37.7],
       [  1. , 187.8,  21.1,   9.5],
       [  1. ,   4.1,  11.6,   5.7],
       [  1. ,  93.9,  43.5,  50.5],
       [  1. , 149.8,   1.3,  24.3],
       [  1. ,  11.7,  36.9,  45.2],
       [  1. , 131.7,  18.4,  34.6],
       [  1. , 172.5,  18.1,  30.7],
       [  1. ,  85.7,  35.8,  49.3],
       [  1. , 188.4,  18.1,  25.6],
       [  1. , 163.5,  36.8,   7.4],
       [  1. , 117.2,  14.7,   5.4],
       [  1. , 234.5,   3.4,  84.8],
       [  1. ,  17.9,  37.6,  21.6],
       [  1. , 206.8,   5.2,  19.4],
       [  1. , 215.4,  23.6,  57.6],
       [  1. , 284.3,  10.6,   6.4],
       [  1. ,  50. ,  11.6,  18.4],
       [  1. , 164.5,  20.9,  47.4],
       [  1. ,  19.6,  20.1,  17. ],
       [  1. , 168.4,   7.1,  12.8],
       [  1. , 222.4,   3.4,  13.1],
       [  1. , 276.9,  48.9,  41.8],
       [  1. , 248.4,  30.2,  20.3],
       [  1. , 170.2,   7.8,  35.2],
       [  1. , 276.7,   2.3,  23.7],
       [  1. , 165.6,  10. ,  17.6],
```

```
[  1. , 156.6,   2.6,   8.3],
[  1. , 218.5,   5.4,  27.4],
[  1. ,  56.2,   5.7,  29.7],
[  1. , 287.6,  43. ,  71.8],
[  1. , 253.8,  21.3,  30. ],
[  1. , 205. ,  45.1,  19.6],
[  1. , 139.5,   2.1,  26.6],
[  1. , 191.1,  28.7,  18.2],
[  1. , 286. ,  13.9,   3.7],
[  1. ,  18.7,  12.1,  23.4],
[  1. ,  39.5,  41.1,   5.8],
[  1. ,  75.5,  10.8,   6. ],
[  1. ,  17.2,   4.1,  31.6],
[  1. , 166.8,  42. ,   3.6],
[  1. , 149.7,  35.6,   6. ],
[  1. ,  38.2,   3.7,  13.8],
[  1. ,  94.2,   4.9,   8.1],
[  1. , 177. ,   9.3,   6.4],
[  1. , 283.6,  42. ,  66.2],
[  1. , 232.1,   8.6,   8.7]])
```

In [40]:

```
X_opt = X[:,[0,1,2,3]]
```

In [41]:

```
X_opt
```

Out[41]:

```
array([[  1. , 230.1,  37.8,  69.2],
       [  1. ,  44.5,  39.3,  45.1],
       [  1. ,  17.2,  45.9,  69.3],
       [  1. , 151.5,  41.3,  58.5],
       [  1. , 180.8,  10.8,  58.4],
       [  1. ,   8.7,  48.9,  75. ],
       [  1. ,  57.5,  32.8,  23.5],
       [  1. , 120.2,  19.6,  11.6],
       [  1. ,   8.6,   2.1,   1. ],
       [  1. , 199.8,   2.6,  21.2],
       [  1. ,  66.1,   5.8,  24.2],
       [  1. , 214.7,  24. ,   4. ],
       [  1. ,  23.8,  35.1,  65.9],
       [  1. ,  97.5,   7.6,   7.2],
       [  1. , 204.1,  32.9,  46. ],
       [  1. , 195.4,  47.7,  52.9],
       [  1. ,  67.8,  36.6, 114. ],
       [  1. , 281.4,  39.6,  55.8],
       [  1. ,  69.2,  20.5,  18.3],
       [  1. , 147.3,  23.9,  19.1],
       [  1. , 218.4,  27.7,  53.4],
       [  1. , 237.4,   5.1,  23.5],
       [  1. ,  13.2,  15.9,  49.6],
       [  1. , 228.3,  16.9,  26.2],
       [  1. ,  62.3,  12.6,  18.3],
       [  1. , 262.9,   3.5,  19.5],
       [  1. , 142.9,  29.3,  12.6],
       [  1. , 240.1,  16.7,  22.9],
       [  1. , 248.8,  27.1,  22.9],
       [  1. ,  70.6,  16. ,  40.8],
       [  1. , 292.9,  28.3,  43.2],
       [  1. , 112.9,  17.4,  38.6],
       [  1. ,  97.2,   1.5,  30. ],
       [  1. , 265.6,  20. ,   0.3],
       [  1. ,  95.7,   1.4,   7.4],
       [  1. , 290.7,   4.1,   8.5],
       [  1. , 266.9,  43.8,   5. ],
       [  1. ,  74.7,  49.4,  45.7],
       [  1. ,  43.1,  26.7,  35.1],
       [  1. , 228. ,  37.7,  32. ],
       [  1. , 202.5,  22.3,  31.6],
       [  1. , 177. ,  33.4,  38.7],
       [  1. , 293.6,  27.7,   1.8],
       [  1. , 206.9,   8.4,  26.4],
       [  1. ,  25.1,  25.7,  43.3],
       [  1. , 175.1,  22.5,  31.5],
       [  1. ,  89.7,   9.9,  35.7],
       [  1. , 239.9,  41.5,  18.5],
       [  1. , 227.2,  15.8,  49.9],
       [  1. ,  66.9,  11.7,  36.8],
       [  1. , 199.8,   3.1,  34.6],
       [  1. , 100.4,   9.6,   3.6],
       [  1. , 216.4,  41.7,  39.6],
       [  1. , 182.6,  46.2,  58.7],
       [  1. , 262.7,  28.8,  15.9],
       [  1. , 198.9,  49.4,  60. ],
       [  1. ,   7.3,  28.1,  41.4],
       [  1. , 136.2,  19.2,  16.6],
       [  1. , 210.8,  49.6,  37.7],
```

```
[  1. , 210.7,  29.5,   9.3],
[  1. ,  53.5,   2. ,  21.4],
[  1. , 261.3,  42.7,  54.7],
[  1. , 239.3,  15.5,  27.3],
[  1. , 102.7,  29.6,   8.4],
[  1. , 131.1,  42.8,  28.9],
[  1. ,  69. ,   9.3,   0.9],
[  1. ,  31.5,  24.6,   2.2],
[  1. , 139.3,  14.5,  10.2],
[  1. , 237.4,  27.5,  11. ],
[  1. , 216.8,  43.9,  27.2],
[  1. , 199.1,  30.6,  38.7],
[  1. , 109.8,  14.3,  31.7],
[  1. ,  26.8,  33. ,  19.3],
[  1. , 129.4,   5.7,  31.3],
[  1. , 213.4,  24.6,  13.1],
[  1. ,  16.9,  43.7,  89.4],
[  1. ,  27.5,   1.6,  20.7],
[  1. , 120.5,  28.5,  14.2],
[  1. ,   5.4,  29.9,   9.4],
[  1. , 116. ,   7.7,  23.1],
[  1. ,  76.4,  26.7,  22.3],
[  1. , 239.8,   4.1,  36.9],
[  1. ,  75.3,  20.3,  32.5],
[  1. ,  68.4,  44.5,  35.6],
[  1. , 213.5,  43. ,  33.8],
[  1. , 193.2,  18.4,  65.7],
[  1. ,  76.3,  27.5,  16. ],
[  1. , 110.7,  40.6,  63.2],
[  1. ,  88.3,  25.5,  73.4],
[  1. , 109.8,  47.8,  51.4],
[  1. , 134.3,   4.9,   9.3],
[  1. ,  28.6,   1.5,  33. ],
[  1. , 217.7,  33.5,  59. ],
[  1. , 250.9,  36.5,  72.3],
[  1. , 107.4,  14. ,  10.9],
[  1. , 163.3,  31.6,  52.9],
[  1. , 197.6,   3.5,   5.9],
[  1. , 184.9,  21. ,  22. ],
[  1. , 289.7,  42.3,  51.2],
[  1. , 135.2,  41.7,  45.9],
[  1. , 222.4,   4.3,  49.8],
[  1. , 296.4,  36.3, 100.9],
[  1. , 280.2,  10.1,  21.4],
[  1. , 187.9,  17.2,  17.9],
[  1. , 238.2,  34.3,   5.3],
[  1. , 137.9,  46.4,  59. ],
[  1. ,  25. ,  11. ,  29.7],
[  1. ,  90.4,   0.3,  23.2],
[  1. ,  13.1,   0.4,  25.6],
[  1. , 255.4,  26.9,   5.5],
[  1. , 225.8,   8.2,  56.5],
[  1. , 241.7,  38. ,  23.2],
[  1. , 175.7,  15.4,   2.4],
[  1. , 209.6,  20.6,  10.7],
[  1. ,  78.2,  46.8,  34.5],
[  1. ,  75.1,  35. ,  52.7],
[  1. , 139.2,  14.3,  25.6],
[  1. ,  76.4,   0.8,  14.8],
[  1. , 125.7,  36.9,  79.2],
[  1. ,  19.4,  16. ,  22.3],
```

```
[  1. , 141.3,  26.8,  46.2],
[  1. ,  18.8,  21.7,  50.4],
[  1. , 224. ,   2.4,  15.6],
[  1. , 123.1,  34.6,  12.4],
[  1. , 229.5,  32.3,  74.2],
[  1. ,  87.2,  11.8,  25.9],
[  1. ,   7.8,  38.9,  50.6],
[  1. ,  80.2,   0. ,   9.2],
[  1. , 220.3,  49. ,   3.2],
[  1. ,  59.6,  12. ,  43.1],
[  1. ,   0.7,  39.6,   8.7],
[  1. , 265.2,   2.9,  43. ],
[  1. ,   8.4,  27.2,   2.1],
[  1. , 219.8,  33.5,  45.1],
[  1. ,  36.9,  38.6,  65.6],
[  1. ,  48.3,  47. ,   8.5],
[  1. ,  25.6,  39. ,   9.3],
[  1. , 273.7,  28.9,  59.7],
[  1. ,  43. ,  25.9,  20.5],
[  1. , 184.9,  43.9,   1.7],
[  1. ,  73.4,  17. ,  12.9],
[  1. , 193.7,  35.4,  75.6],
[  1. , 220.5,  33.2,  37.9],
[  1. , 104.6,   5.7,  34.4],
[  1. ,  96.2,  14.8,  38.9],
[  1. , 140.3,   1.9,   9. ],
[  1. , 240.1,   7.3,   8.7],
[  1. , 243.2,  49. ,  44.3],
[  1. ,  38. ,  40.3,  11.9],
[  1. ,  44.7,  25.8,  20.6],
[  1. , 280.7,  13.9,  37. ],
[  1. , 121. ,   8.4,  48.7],
[  1. , 197.6,  23.3,  14.2],
[  1. , 171.3,  39.7,  37.7],
[  1. , 187.8,  21.1,   9.5],
[  1. ,   4.1,  11.6,   5.7],
[  1. ,  93.9,  43.5,  50.5],
[  1. , 149.8,   1.3,  24.3],
[  1. ,  11.7,  36.9,  45.2],
[  1. , 131.7,  18.4,  34.6],
[  1. , 172.5,  18.1,  30.7],
[  1. ,  85.7,  35.8,  49.3],
[  1. , 188.4,  18.1,  25.6],
[  1. , 163.5,  36.8,   7.4],
[  1. , 117.2,  14.7,   5.4],
[  1. , 234.5,   3.4,  84.8],
[  1. ,  17.9,  37.6,  21.6],
[  1. , 206.8,   5.2,  19.4],
[  1. , 215.4,  23.6,  57.6],
[  1. , 284.3,  10.6,   6.4],
[  1. ,  50. ,  11.6,  18.4],
[  1. , 164.5,  20.9,  47.4],
[  1. ,  19.6,  20.1,  17. ],
[  1. , 168.4,   7.1,  12.8],
[  1. , 222.4,   3.4,  13.1],
[  1. , 276.9,  48.9,  41.8],
[  1. , 248.4,  30.2,  20.3],
[  1. , 170.2,   7.8,  35.2],
[  1. , 276.7,   2.3,  23.7],
[  1. , 165.6,  10. ,  17.6],
[  1. , 156.6,   2.6,   8.3],
```

```
[  1. , 218.5,   5.4,  27.4],
[  1. ,  56.2,   5.7,  29.7],
[  1. , 287.6,  43. ,  71.8],
[  1. , 253.8,  21.3,  30. ],
[  1. , 205. ,  45.1,  19.6],
[  1. , 139.5,   2.1,  26.6],
[  1. , 191.1,  28.7,  18.2],
[  1. , 286. ,  13.9,   3.7],
[  1. ,  18.7,  12.1,  23.4],
[  1. ,  39.5,  41.1,   5.8],
[  1. ,  75.5,  10.8,   6. ],
[  1. ,  17.2,   4.1,  31.6],
[  1. , 166.8,  42. ,   3.6],
[  1. , 149.7,  35.6,   6. ],
[  1. ,  38.2,   3.7,  13.8],
[  1. ,  94.2,   4.9,   8.1],
[  1. , 177. ,   9.3,   6.4],
[  1. , 283.6,  42. ,  66.2],
[  1. , 232.1,   8.6,   8.7]])
```

In [43]:

```
regressor_ols = sm.OLS (endog = y,exog = X_opt, data= df).fit()
regressor_ols.summary()
```

Out[43]:

OLS Regression Results

Dep. Variable:	sales	**R-squared:**	0.897
Model:	OLS	**Adj. R-squared:**	0.896
Method:	Least Squares	**F-statistic:**	570.3
Date:	Fri, 01 May 2020	**Prob (F-statistic):**	1.58e-96
Time:	11:11:59	**Log-Likelihood:**	-386.18
No. Observations:	200	**AIC:**	780.4
Df Residuals:	196	**BIC:**	793.6
Df Model:	3		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	2.9389	0.312	9.422	0.000	2.324	3.554
x1	0.0458	0.001	32.809	0.000	0.043	0.049
x2	0.1885	0.009	21.893	0.000	0.172	0.206
x3	-0.0010	0.006	-0.177	0.860	-0.013	0.011

Omnibus:	60.414	**Durbin-Watson:**	2.084
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	151.241
Skew:	-1.327	**Prob(JB):**	1.44e-33
Kurtosis:	6.332	**Cond. No.**	454.

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Model1 has much higer adjusted R squared and hence a preferred model Since the p-value for neawspaper is higher than 0.05, it doesn't have significant influence on the dependent variable and hence can be canceled.

In [44]:

```
X_opt = X[:,[0,1,2]]
```

In [45]:

```
X_opt
```

Out[45]:

```
array([[  1. , 230.1,  37.8],
       [  1. ,  44.5,  39.3],
       [  1. ,  17.2,  45.9],
       [  1. , 151.5,  41.3],
       [  1. , 180.8,  10.8],
       [  1. ,   8.7,  48.9],
       [  1. ,  57.5,  32.8],
       [  1. , 120.2,  19.6],
       [  1. ,   8.6,   2.1],
       [  1. , 199.8,   2.6],
       [  1. ,  66.1,   5.8],
       [  1. , 214.7,  24. ],
       [  1. ,  23.8,  35.1],
       [  1. ,  97.5,   7.6],
       [  1. , 204.1,  32.9],
       [  1. , 195.4,  47.7],
       [  1. ,  67.8,  36.6],
       [  1. , 281.4,  39.6],
       [  1. ,  69.2,  20.5],
       [  1. , 147.3,  23.9],
       [  1. , 218.4,  27.7],
       [  1. , 237.4,   5.1],
       [  1. ,  13.2,  15.9],
       [  1. , 228.3,  16.9],
       [  1. ,  62.3,  12.6],
       [  1. , 262.9,   3.5],
       [  1. , 142.9,  29.3],
       [  1. , 240.1,  16.7],
       [  1. , 248.8,  27.1],
       [  1. ,  70.6,  16. ],
       [  1. , 292.9,  28.3],
       [  1. , 112.9,  17.4],
       [  1. ,  97.2,   1.5],
       [  1. , 265.6,  20. ],
       [  1. ,  95.7,   1.4],
       [  1. , 290.7,   4.1],
       [  1. , 266.9,  43.8],
       [  1. ,  74.7,  49.4],
       [  1. ,  43.1,  26.7],
       [  1. , 228. ,  37.7],
       [  1. , 202.5,  22.3],
       [  1. , 177. ,  33.4],
       [  1. , 293.6,  27.7],
       [  1. , 206.9,   8.4],
       [  1. ,  25.1,  25.7],
       [  1. , 175.1,  22.5],
       [  1. ,  89.7,   9.9],
       [  1. , 239.9,  41.5],
       [  1. , 227.2,  15.8],
       [  1. ,  66.9,  11.7],
       [  1. , 199.8,   3.1],
       [  1. , 100.4,   9.6],
       [  1. , 216.4,  41.7],
       [  1. , 182.6,  46.2],
       [  1. , 262.7,  28.8],
       [  1. , 198.9,  49.4],
       [  1. ,   7.3,  28.1],
       [  1. , 136.2,  19.2],
       [  1. , 210.8,  49.6],
```

```
[  1. , 210.7,  29.5],
[  1. ,  53.5,   2. ],
[  1. , 261.3,  42.7],
[  1. , 239.3,  15.5],
[  1. , 102.7,  29.6],
[  1. , 131.1,  42.8],
[  1. ,  69. ,   9.3],
[  1. ,  31.5,  24.6],
[  1. , 139.3,  14.5],
[  1. , 237.4,  27.5],
[  1. , 216.8,  43.9],
[  1. , 199.1,  30.6],
[  1. , 109.8,  14.3],
[  1. ,  26.8,  33. ],
[  1. , 129.4,   5.7],
[  1. , 213.4,  24.6],
[  1. ,  16.9,  43.7],
[  1. ,  27.5,   1.6],
[  1. , 120.5,  28.5],
[  1. ,   5.4,  29.9],
[  1. , 116. ,   7.7],
[  1. ,  76.4,  26.7],
[  1. , 239.8,   4.1],
[  1. ,  75.3,  20.3],
[  1. ,  68.4,  44.5],
[  1. , 213.5,  43. ],
[  1. , 193.2,  18.4],
[  1. ,  76.3,  27.5],
[  1. , 110.7,  40.6],
[  1. ,  88.3,  25.5],
[  1. , 109.8,  47.8],
[  1. , 134.3,   4.9],
[  1. ,  28.6,   1.5],
[  1. , 217.7,  33.5],
[  1. , 250.9,  36.5],
[  1. , 107.4,  14. ],
[  1. , 163.3,  31.6],
[  1. , 197.6,   3.5],
[  1. , 184.9,  21. ],
[  1. , 289.7,  42.3],
[  1. , 135.2,  41.7],
[  1. , 222.4,   4.3],
[  1. , 296.4,  36.3],
[  1. , 280.2,  10.1],
[  1. , 187.9,  17.2],
[  1. , 238.2,  34.3],
[  1. , 137.9,  46.4],
[  1. ,  25. ,  11. ],
[  1. ,  90.4,   0.3],
[  1. ,  13.1,   0.4],
[  1. , 255.4,  26.9],
[  1. , 225.8,   8.2],
[  1. , 241.7,  38. ],
[  1. , 175.7,  15.4],
[  1. , 209.6,  20.6],
[  1. ,  78.2,  46.8],
[  1. ,  75.1,  35. ],
[  1. , 139.2,  14.3],
[  1. ,  76.4,   0.8],
[  1. , 125.7,  36.9],
[  1. ,  19.4,  16. ],
```

```
[  1. , 141.3,  26.8],
[  1. ,  18.8,  21.7],
[  1. , 224. ,   2.4],
[  1. , 123.1,  34.6],
[  1. , 229.5,  32.3],
[  1. ,  87.2,  11.8],
[  1. ,   7.8,  38.9],
[  1. ,  80.2,   0. ],
[  1. , 220.3,  49. ],
[  1. ,  59.6,  12. ],
[  1. ,   0.7,  39.6],
[  1. , 265.2,   2.9],
[  1. ,   8.4,  27.2],
[  1. , 219.8,  33.5],
[  1. ,  36.9,  38.6],
[  1. ,  48.3,  47. ],
[  1. ,  25.6,  39. ],
[  1. , 273.7,  28.9],
[  1. ,  43. ,  25.9],
[  1. , 184.9,  43.9],
[  1. ,  73.4,  17. ],
[  1. , 193.7,  35.4],
[  1. , 220.5,  33.2],
[  1. , 104.6,   5.7],
[  1. ,  96.2,  14.8],
[  1. , 140.3,   1.9],
[  1. , 240.1,   7.3],
[  1. , 243.2,  49. ],
[  1. ,  38. ,  40.3],
[  1. ,  44.7,  25.8],
[  1. , 280.7,  13.9],
[  1. , 121. ,   8.4],
[  1. , 197.6,  23.3],
[  1. , 171.3,  39.7],
[  1. , 187.8,  21.1],
[  1. ,   4.1,  11.6],
[  1. ,  93.9,  43.5],
[  1. , 149.8,   1.3],
[  1. ,  11.7,  36.9],
[  1. , 131.7,  18.4],
[  1. , 172.5,  18.1],
[  1. ,  85.7,  35.8],
[  1. , 188.4,  18.1],
[  1. , 163.5,  36.8],
[  1. , 117.2,  14.7],
[  1. , 234.5,   3.4],
[  1. ,  17.9,  37.6],
[  1. , 206.8,   5.2],
[  1. , 215.4,  23.6],
[  1. , 284.3,  10.6],
[  1. ,  50. ,  11.6],
[  1. , 164.5,  20.9],
[  1. ,  19.6,  20.1],
[  1. , 168.4,   7.1],
[  1. , 222.4,   3.4],
[  1. , 276.9,  48.9],
[  1. , 248.4,  30.2],
[  1. , 170.2,   7.8],
[  1. , 276.7,   2.3],
[  1. , 165.6,  10. ],
[  1. , 156.6,   2.6],
```

```
[  1. , 218.5,   5.4],
[  1. ,  56.2,   5.7],
[  1. , 287.6,  43. ],
[  1. , 253.8,  21.3],
[  1. , 205. ,  45.1],
[  1. , 139.5,   2.1],
[  1. , 191.1,  28.7],
[  1. , 286. ,  13.9],
[  1. ,  18.7,  12.1],
[  1. ,  39.5,  41.1],
[  1. ,  75.5,  10.8],
[  1. ,  17.2,   4.1],
[  1. , 166.8,  42. ],
[  1. , 149.7,  35.6],
[  1. ,  38.2,   3.7],
[  1. ,  94.2,   4.9],
[  1. , 177. ,   9.3],
[  1. , 283.6,  42. ],
[  1. , 232.1,   8.6]])
```

In [46]:

```
regressor_ols = sm.OLS (endog = y,exog = X_opt, data= df).fit()
regressor_ols.summary()
```

Out[46]:

OLS Regression Results

Dep. Variable:	sales	**R-squared:**	0.897
Model:	OLS	**Adj. R-squared:**	0.896
Method:	Least Squares	**F-statistic:**	859.6
Date:	Fri, 01 May 2020	**Prob (F-statistic):**	4.83e-98
Time:	11:13:37	**Log-Likelihood:**	-386.20
No. Observations:	200	**AIC:**	778.4
Df Residuals:	197	**BIC:**	788.3
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	2.9211	0.294	9.919	0.000	2.340	3.502
x1	0.0458	0.001	32.909	0.000	0.043	0.048
x2	0.1880	0.008	23.382	0.000	0.172	0.204

Omnibus:	60.022	**Durbin-Watson:**	2.081
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	148.679
Skew:	-1.323	**Prob(JB):**	5.19e-33
Kurtosis:	6.292	**Cond. No.**	425.

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

From the results, r-sq adjusted is 0.896 which is slightly closer to 1. This implies that 89% of the variability in our dependent variable "sales" is explained by this model. Then we can see that p-value of independent variables are less then 0.05.so independent variables('tv','newspaper') have significant influence on the dependent variable('sales').