proj_wallmart

April 9, 2024

Importing Libraries

[109]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns

import warnings
warnings.filterwarnings('ignore')
```

Loading the Dataset .csv file

[110]:
```
df = pd.read_csv('Walmart_Store_sales.csv')
```

[111]:
```
df
```

[111]:
```
      Store        Date  Weekly_Sales  Holiday_Flag  Temperature  Fuel_Price  \
0         1  05-02-2010    1643690.90             0        42.31       2.572
1         1  12-02-2010    1641957.44             1        38.51       2.548
2         1  19-02-2010    1611968.17             0        39.93       2.514
3         1  26-02-2010    1409727.59             0        46.63       2.561
4         1  05-03-2010    1554806.68             0        46.50       2.625
…       …          …            …           …           …          …
6430     45  28-09-2012     713173.95             0        64.88       3.997
6431     45  05-10-2012     733455.07             0        64.89       3.985
6432     45  12-10-2012     734464.36             0        54.47       4.000
6433     45  19-10-2012     718125.53             0        56.47       3.969
6434     45  26-10-2012     760281.43             0        58.85       3.882

             CPI  Unemployment
0     211.096358         8.106
1     211.242170         8.106
2     211.289143         8.106
3     211.319643         8.106
4     211.350143         8.106
…          …           …
6430  192.013558         8.684
6431  192.170412         8.667
6432  192.327265         8.667
```

```
6433  192.330854         8.667
6434  192.308899         8.667

[6435 rows x 8 columns]
```

[112]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 6435 entries, 0 to 6434
Data columns (total 8 columns):
 #   Column        Non-Null Count  Dtype
---  ------        --------------  -----
 0   Store         6435 non-null   int64
 1   Date          6435 non-null   object
 2   Weekly_Sales  6435 non-null   float64
 3   Holiday_Flag  6435 non-null   int64
 4   Temperature   6435 non-null   float64
 5   Fuel_Price    6435 non-null   float64
 6   CPI           6435 non-null   float64
 7   Unemployment  6435 non-null   float64
dtypes: float64(5), int64(2), object(1)
memory usage: 402.3+ KB
```

[113]:
```
df.shape
```

[113]:
```
(6435, 8)
```

- The number of Rows and Columns are 6435 and 8

[114]:
```
df.describe()
```

[114]:
```
             Store  Weekly_Sales  Holiday_Flag  Temperature   Fuel_Price  \
count  6435.000000  6.435000e+03   6435.000000  6435.000000  6435.000000
mean     23.000000  1.046965e+06      0.069930    60.663782     3.358607
std      12.988182  5.643666e+05      0.255049    18.444933     0.459020
min       1.000000  2.099862e+05      0.000000    -2.060000     2.472000
25%      12.000000  5.533501e+05      0.000000    47.460000     2.933000
50%      23.000000  9.607460e+05      0.000000    62.670000     3.445000
75%      34.000000  1.420159e+06      0.000000    74.940000     3.735000
max      45.000000  3.818686e+06      1.000000   100.140000     4.468000

               CPI  Unemployment
count  6435.000000   6435.000000
mean    171.578394      7.999151
std      39.356712      1.875885
min     126.064000      3.879000
25%     131.735000      6.891000
50%     182.616521      7.874000
```

```
75%     212.743293      8.622000
max     227.232807     14.313000
```

```
[115]: df.isna().sum()
```

```
[115]: Store           0
       Date            0
       Weekly_Sales    0
       Holiday_Flag    0
       Temperature     0
       Fuel_Price      0
       CPI             0
       Unemployment    0
       dtype: int64
```

- There is no missing values present in the dataset

```
[116]: df.dtypes
```

```
[116]: Store             int64
       Date             object
       Weekly_Sales    float64
       Holiday_Flag      int64
       Temperature     float64
       Fuel_Price      float64
       CPI             float64
       Unemployment    float64
       dtype: object
```

- As checked, the Date variable has object data-type

```
[117]: # Converting the Date data-type to datetime
```

```
[118]: from datetime import datetime

       df['Date'] = pd.to_datetime(df['Date'])
```

```
[119]: df.dtypes
```

```
[119]: Store                    int64
       Date            datetime64[ns]
       Weekly_Sales           float64
       Holiday_Flag             int64
       Temperature            float64
       Fuel_Price             float64
       CPI                    float64
       Unemployment           float64
       dtype: object
```

[120]:

```
df
```

[120]:

```
      Store        Date  Weekly_Sales  Holiday_Flag  Temperature  Fuel_Price  \
0         1  2010-05-02    1643690.90             0        42.31       2.572
1         1  2010-12-02    1641957.44             1        38.51       2.548
2         1  2010-02-19    1611968.17             0        39.93       2.514
3         1  2010-02-26    1409727.59             0        46.63       2.561
4         1  2010-05-03    1554806.68             0        46.50       2.625
…       …           …             …             …          …           …
6430     45  2012-09-28     713173.95             0        64.88       3.997
6431     45  2012-05-10     733455.07             0        64.89       3.985
6432     45  2012-12-10     734464.36             0        54.47       4.000
6433     45  2012-10-19     718125.53             0        56.47       3.969
6434     45  2012-10-26     760281.43             0        58.85       3.882

             CPI  Unemployment
0     211.096358         8.106
1     211.242170         8.106
2     211.289143         8.106
3     211.319643         8.106
4     211.350143         8.106
…          …            …
6430  192.013558         8.684
6431  192.170412         8.667
6432  192.327265         8.667
6433  192.330854         8.667
6434  192.308899         8.667

[6435 rows x 8 columns]
```

0.1 Basic Statistics tasks

1. Which store has maximum sales

[121]:

```
total_sales=df.groupby('Store')['Weekly_Sales'].sum('Weekly_Sales').round()

    # Grouping the Store number and its Weekly Sales to finding the sum of all␣
 ↪Weekly Sales of each Store
```

[122]:

```
pd.DataFrame(total_sales.sort_values().tail(1))

    # Sort the values and find the maximum Weekly Sales of the Store
```

[122]:

```
       Weekly_Sales
Store
20      301397792.0
```

- Here, the Store 20 has the maximum sales

2. Which store has maximum standard deviation i.e., the sales vary a lot. Also, find out the coefficient of mean to standard deviation

```
[123]: df_std = df.groupby('Store')['Weekly_Sales'].std()
```

```
[124]: pd.DataFrame(df_std.sort_values().tail(1))
```

```
[124]:         Weekly_Sales
        Store
        14     317569.949476
```

- The Store 14 has the maximum standard deviation

```
[125]: store_max = df[df['Store']==14].Weekly_Sales

        mean_to_std = store_max.std() / store_max.mean()*100
```

```
[126]: mean_to_std
```

```
[126]: 15.713673600948338
```

- The co-efficient of mean to std deviation of store 14 is 15.713%

3. Which store/s has good quarterly growth rate in Q3'2012

```
[127]: df.head()
```

```
[127]:    Store        Date  Weekly_Sales  Holiday_Flag  Temperature  Fuel_Price  \
        0      1  2010-05-02    1643690.90             0        42.31       2.572
        1      1  2010-12-02    1641957.44             1        38.51       2.548
        2      1  2010-02-19    1611968.17             0        39.93       2.514
        3      1  2010-02-26    1409727.59             0        46.63       2.561
        4      1  2010-05-03    1554806.68             0        46.50       2.625

                  CPI  Unemployment
        0  211.096358         8.106
        1  211.242170         8.106
        2  211.289143         8.106
        3  211.319643         8.106
        4  211.350143         8.106
```

```
[128]: q2 = df[(df['Date']>='2012-04-01')&(df['Date']<='2012-06-30')].
         ↪groupby('Store')['Weekly_Sales'].sum().round()
```

```
[129]: q2.head()
```

```
[129]: Store
        1    21036966.0
        2    25085124.0
```

```
3     5562668.0
4    28384185.0
5     4427262.0
Name: Weekly_Sales, dtype: float64
```

[130]:

```
q3 = df[(df['Date']>='2012-07-01')&(df['Date']<='2012-09-30')].
↪groupby('Store')['Weekly_Sales'].sum().round()
```

[131]:

```
q3.head()
```

[131]:

```
Store
1    18633210.0
2    22396868.0
3     4966496.0
4    25652119.0
5     3880622.0
Name: Weekly_Sales, dtype: float64
```

[132]:

```
df_q3_2012 = pd.DataFrame({'Q2 Sales':q2,'Q3 Sales':q3,'Difference':(q3 - q2),
                           'Growth Rate':(q3-q2)/q2})

df_q3_2012.sort_values(by = 'Growth Rate', ascending=False).head(1)

    # Formula of Growth Rate is (q3 - q2)/q2
    # I have taken the top store which has good Growth Rate among all
```

[132]:

```
        Q2 Sales   Q3 Sales  Difference  Growth Rate
Store
16     6626133.0  6441311.0   -184822.0    -0.027893
```

- Here, the store 16 has good quarterly growth rate in Q3'2012 which has a Growth Rate of -0.027

4. Some holidays have a negative impact on sales. Find out holidays which have higher sales than the mean sales in non-holiday season for all stores together

[133]:

```
df
```

[133]:

```
      Store        Date  Weekly_Sales  Holiday_Flag  Temperature  Fuel_Price  \
0         1  2010-05-02    1643690.90             0        42.31       2.572
1         1  2010-12-02    1641957.44             1        38.51       2.548
2         1  2010-02-19    1611968.17             0        39.93       2.514
3         1  2010-02-26    1409727.59             0        46.63       2.561
4         1  2010-05-03    1554806.68             0        46.50       2.625
…       …         …           …             …          …
6430     45  2012-09-28     713173.95             0        64.88       3.997
6431     45  2012-05-10     733455.07             0        64.89       3.985
6432     45  2012-12-10     734464.36             0        54.47       4.000
```

```
6433     45 2012-10-19     718125.53             0        56.47        3.969
6434     45 2012-10-26     760281.43             0        58.85        3.882

             CPI  Unemployment
0     211.096358         8.106
1     211.242170         8.106
2     211.289143         8.106
3     211.319643         8.106
4     211.350143         8.106
…            …             …
6430  192.013558         8.684
6431  192.170412         8.667
6432  192.327265         8.667
6433  192.330854         8.667
6434  192.308899         8.667

[6435 rows x 8 columns]
```

[134]:
```
Super_Bowl=['12-02-2010','11-02-2011','10-02-2012','08-02-2013']
Labour_Day = ['2010-09-10','2011-09-09','2012-09-07','2013-09-06']
Thanksgiving = ['2010-11-26','2011-11-25','2012-11-23','2013-11-29']
Christmas = ['2010-12-31','2011-12-30','2012-12-28','2013-12-27']

    # Created a set from the holiday events description
```

[135]:
```
Super_Bowl_Sales = round(df[df['Date'].isin(Super_Bowl)]['Weekly_Sales'].
  ↪mean(),2)
Labour_Day_Sales = round(df[df['Date'].isin(Labour_Day)]['Weekly_Sales'].
  ↪mean(),2)
Thanksgiving_Sales = round(df[df['Date'].isin(Thanksgiving)]['Weekly_Sales'].
  ↪mean(),2)
Christmas_Sales = round(df[df['Date'].isin(Christmas)]['Weekly_Sales'].mean(),2)
non_holiday_sales = round(df[df['Holiday_Flag']==0]['Weekly_Sales'].mean(),2)
```

[136]:
```
print('Super bowl: ' + str(Super_Bowl_Sales))
print('Labour Day: ' + str(Labour_Day_Sales))
print('Thanksgiving: ' + str(Thanksgiving_Sales))
print('Christmas: ' + str(Christmas_Sales))
print('Non-Holiday sales: ' +str(non_holiday_sales))
```

```
Super bowl: 1079127.99
Labour Day: 1039182.83
Thanksgiving: 1471273.43
Christmas: 960833.11
Non-Holiday sales: 1041256.38
```

- Here, Thanksgiving has the highest sales than the mean sales in non-holiday season for all stores

5. Provide a monthly and semester view of sales in units and give insights

[137]:

```
# Monthy view of Sales in units
```

[138]:

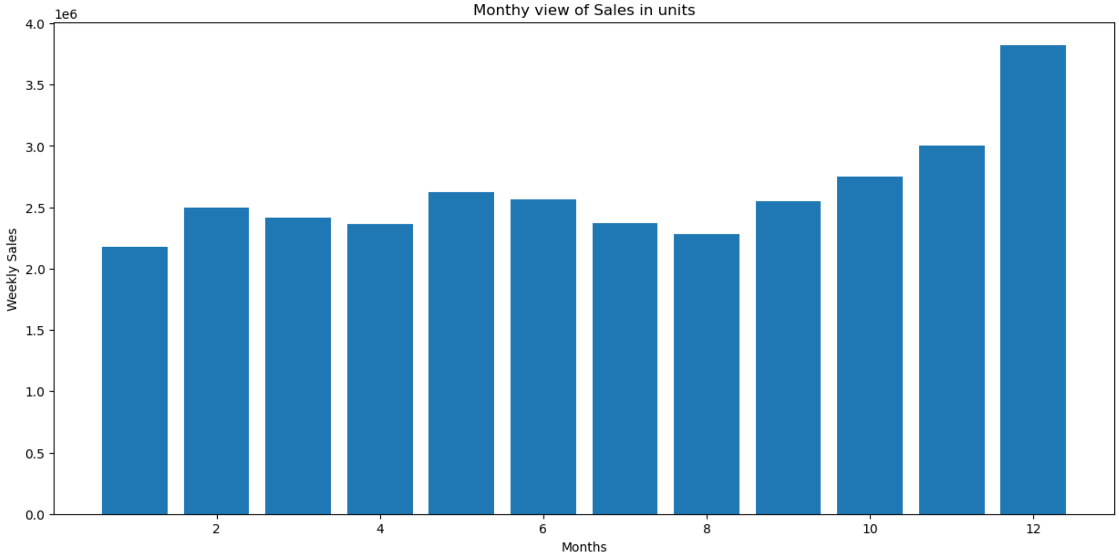
```
df['year'] = pd.DatetimeIndex(df['Date']).year
df['month'] = pd.DatetimeIndex(df['Date']).month
df['day'] = pd.DatetimeIndex(df['Date']).day
```

[139]:

```
plt.figure(figsize=(15,7))

plt.bar(df['month'],df['Weekly_Sales'])
plt.xlabel('Months')
plt.ylabel('Weekly Sales')

plt.title('Monthy view of Sales in units')
plt.show()
```



- Here, December has the highest sales

[140]:

```
# Semester view of Sales in units
```

[141]:

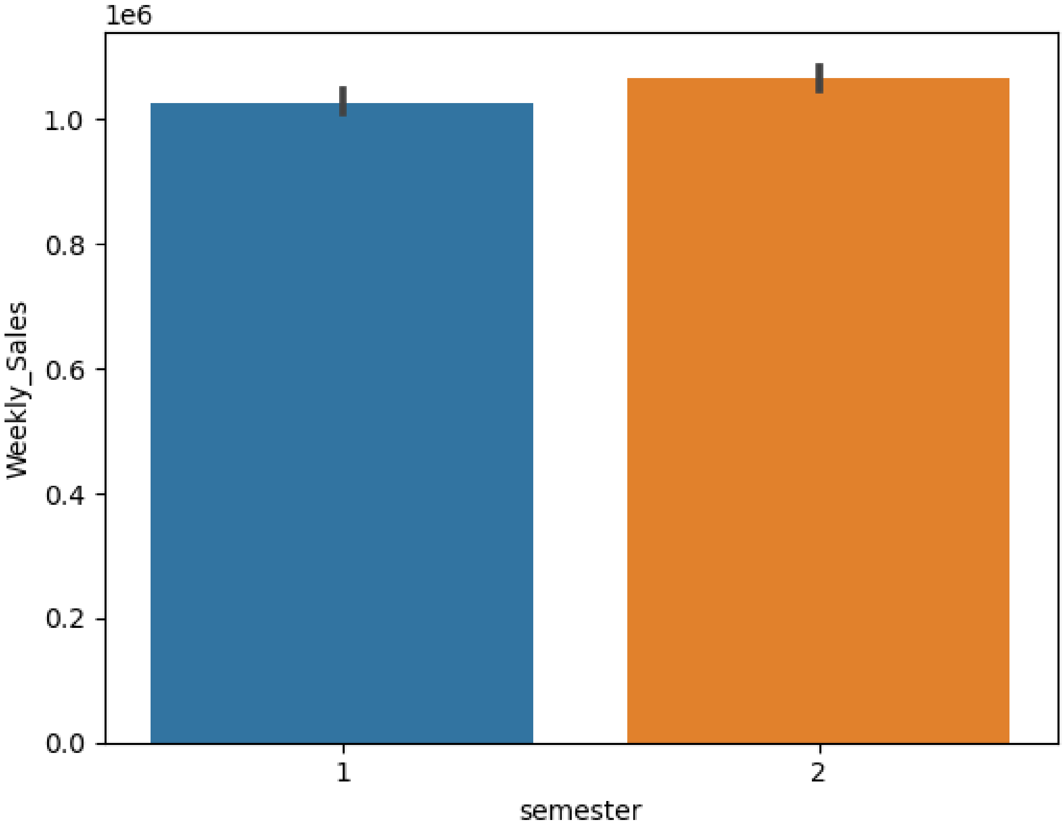
```
df['semester'] = np.where(df['month']< 7,1,2)
df['semester']
```

[141]:

```
0        1
1        2
2        1
3        1
4        1
```

```
        ..
6430    2
6431    1
6432    2
6433    2
6434    2
Name: semester, Length: 6435, dtype: int32
```

[142]:
```
semester=sns.barplot(x='semester',y='Weekly_Sales',data=df)
plt.show()
```



- Here, Semester 2 has the hightest sales in unit

0.2 Statistical Model

[143]:
```
X = df[['Store','Fuel_Price','CPI','Unemployment','day','month','year']]
Y = df['Weekly_Sales']
```

[144]:
```
# Linear Regression model
```

[145]:

```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
import sklearn
```

[146]:

```
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, train_size=0.8,␣
 ↪random_state=42)
```

[147]:

```
linear_reg = LinearRegression()
```

[148]:

```
linear_reg.fit(X_train, Y_train)
```

[148]:

```
LinearRegression()
```

[151]:

```
Y_pred = linear_reg.predict(X_test)
```

[152]:

```
print('R2 score: ' +str(r2_score(Y_test, Y_pred)))
print('Linear model accuracy: ' +str(linear_reg.score(X_train, Y_train)))
print('Mean Squared Error: ' +str(mean_squared_error(Y_test, Y_pred)))
```

```
R2 score: 0.14894500845355385
Linear model accuracy: 0.14372803259754718
Mean Squared Error: 274171250281.01086
```

[153]:

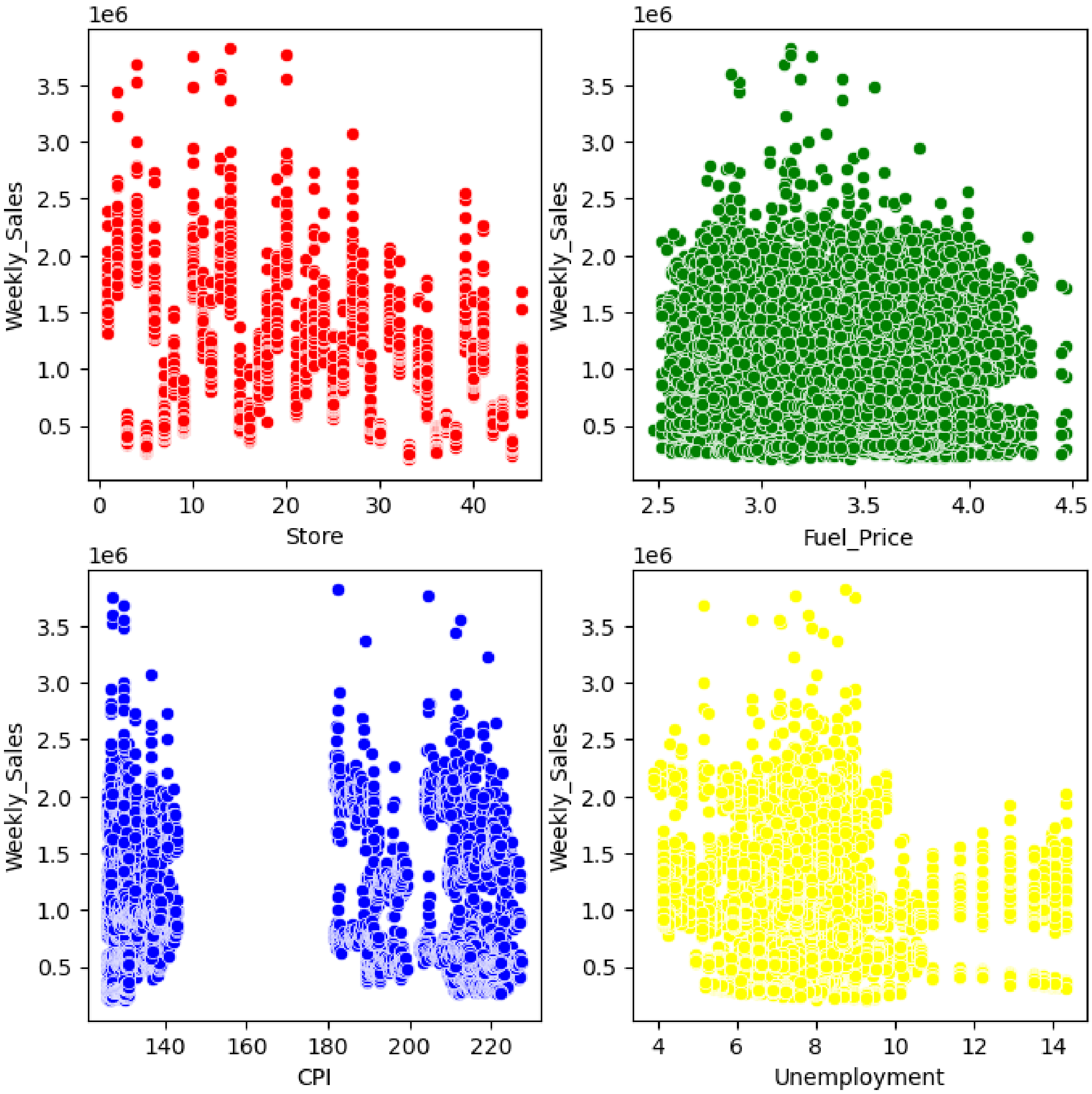
```
# Plot a scatterplot graph
```

[154]:

```
figs,axes = plt.subplots(2,2, figsize = (8,8))

sns.scatterplot(data=df, x='Store', y='Weekly_Sales', color='red', ax=axes[0,0])
sns.scatterplot(data=df, x='Fuel_Price', y='Weekly_Sales', color='green',␣
 ↪ax=axes[0,1])
sns.scatterplot(data=df, x='CPI', y='Weekly_Sales', color='blue', ax=axes[1,0])
sns.scatterplot(data=df, x='Unemployment', y='Weekly_Sales', color='yellow',␣
 ↪ax=axes[1,1])

plt.show()
```



- Linear Regression is not good fit for the model

[155]:
```
# Random Forest Model
```

[156]:
```
df.corr()
```

[156]:
```
                     Store  Weekly_Sales  Holiday_Flag  Temperature  \
Store         1.000000e+00     -0.335332 -4.386841e-16    -0.022659
Weekly_Sales -3.353320e-01      1.000000  3.689097e-02    -0.063810
Holiday_Flag -4.386841e-16      0.036891  1.000000e+00    -0.155091
Temperature  -2.265908e-02     -0.063810 -1.550913e-01     1.000000
Fuel_Price    6.002295e-02      0.009464 -7.834652e-02     0.144982
CPI          -2.094919e-01     -0.072634 -2.162091e-03     0.176888
```

```
Unemployment  2.235313e-01     -0.106176  1.096028e-02     0.101158
year          3.474318e-12     -0.018378 -5.678257e-02     0.064269
month         6.289676e-16      0.067535  3.322341e-01     0.066440
day          -1.070464e-15     -0.014873 -3.603594e-02     0.089019
semester      5.868729e-16      0.035353  2.761285e-01     0.130314

              Fuel_Price       CPI  Unemployment          year         month  \
Store           0.060023 -0.209492      0.223531  3.474318e-12  6.289676e-16
Weekly_Sales    0.009464 -0.072634     -0.106176 -1.837754e-02  6.753523e-02
Holiday_Flag   -0.078347 -0.002162      0.010960 -5.678257e-02  3.322341e-01
Temperature     0.144982  0.176888      0.101158  6.426923e-02  6.643970e-02
Fuel_Price      1.000000 -0.170642     -0.034684  7.794703e-01 -5.283174e-02
CPI            -0.170642  1.000000     -0.302020  7.479573e-02  1.478843e-03
Unemployment   -0.034684 -0.302020      1.000000 -2.418135e-01 -2.061552e-03
year            0.779470  0.074796     -0.241813  1.000000e+00 -1.390145e-01
month          -0.052832  0.001479     -0.002062 -1.390145e-01  1.000000e+00
day             0.032532  0.003966     -0.008167 -1.277942e-02  5.959249e-03
semester       -0.061948  0.002291     -0.009498 -9.683011e-02  8.642165e-01

                       day      semester
Store        -1.070464e-15  5.868729e-16
Weekly_Sales -1.487292e-02  3.535312e-02
Holiday_Flag -3.603594e-02  2.761285e-01
Temperature   8.901925e-02  1.303141e-01
Fuel_Price    3.253169e-02 -6.194830e-02
CPI           3.965821e-03  2.291341e-03
Unemployment -8.166853e-03 -9.497961e-03
year         -1.277942e-02 -9.683011e-02
month         5.959249e-03  8.642165e-01
day           1.000000e+00  3.487338e-02
semester      3.487338e-02  1.000000e+00
```

[157]:

```
from sklearn.ensemble import RandomForestRegressor
```

[175]:

```
rf = RandomForestRegressor(n_estimators = 500, max_depth=15, n_jobs=5)
rf.fit(X_train,Y_train)
```

[175]:

```
RandomForestRegressor(max_depth=15, n_estimators=500, n_jobs=5)
```

[176]:

```
Y_pred=rf.predict(X_test)
```

[177]:

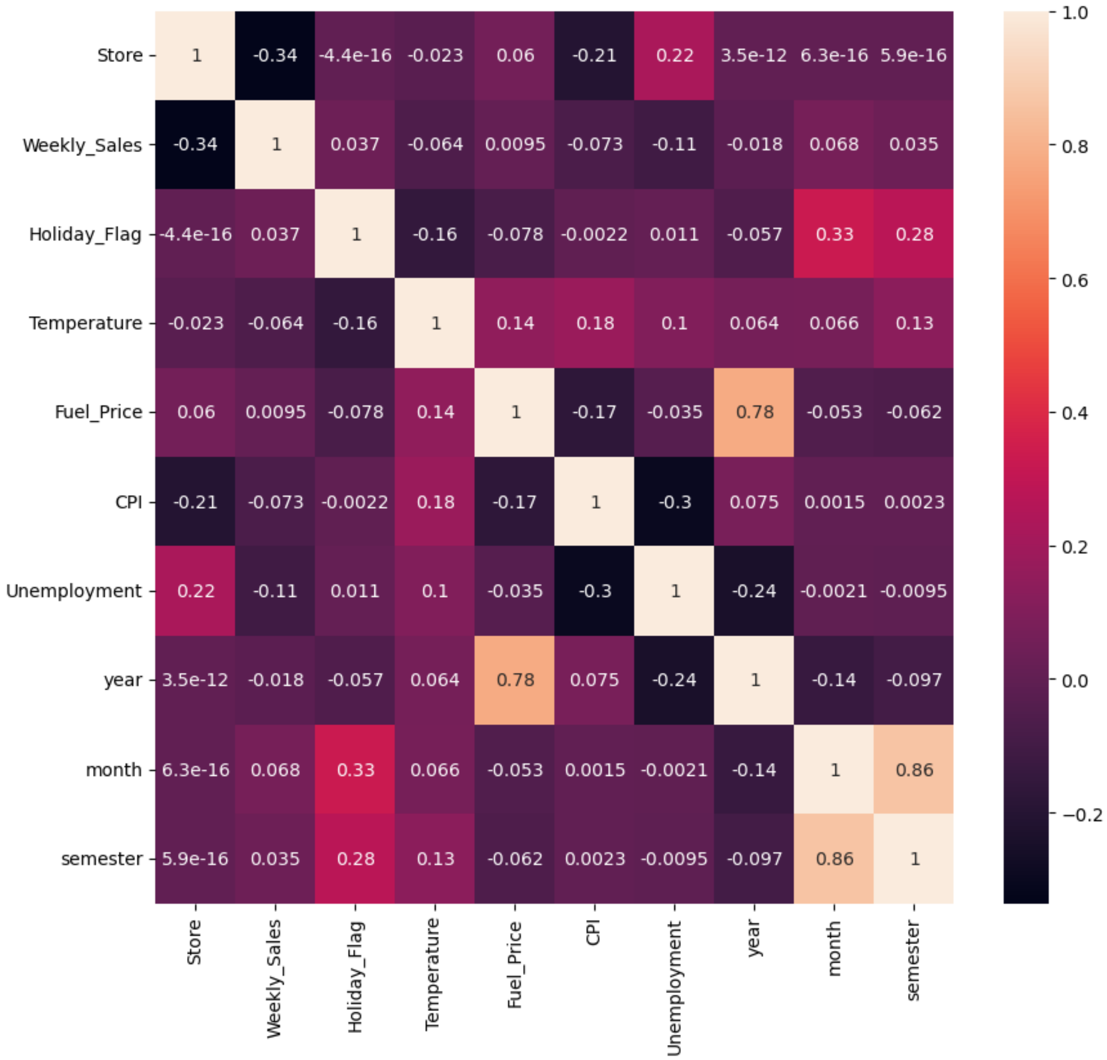
```
print('R2 score: ' +str(r2_score(Y_test, Y_pred)))
print('Root Mean Squared Error:', np.sqrt(mean_squared_error(Y_test, Y_pred)))
print('Mean Squared Error: ' +str(mean_squared_error(Y_test, Y_pred)))
```

```
R2 score: 0.9524234944111671
Root Mean Squared Error: 123802.21502366115
```

```
Mean Squared Error: 15326988444.76483
```

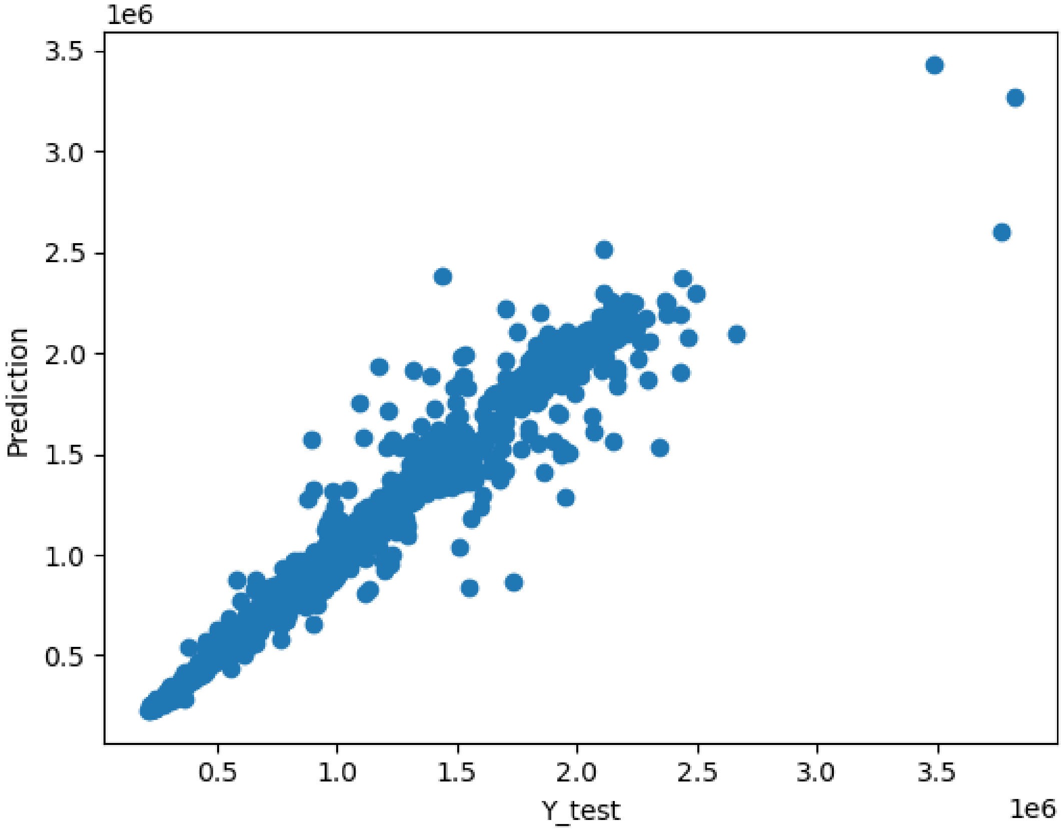
[178]:

```
plt.figure(figsize=(10,9))
sns.heatmap(df.corr(),annot=True)
plt.show()
```



[179]:

```
plt.scatter(Y_test, Y_pred)
plt.xlabel('Y_test')
plt.ylabel('Prediction')
plt.show()
```



- For Random Forest Regressor R2 score: R2 score: 0.9524234944111671 Root Mean Squared Error: 123802.21502366115 Mean Squared Error: 15326988444.76483
- The Random Forest Regressor model would be the best fit for the outcome

2. Change dates into days by creating new variable.

[164]:

```
df['day'] = pd.to_datetime(df['Date']).dt.day_name()
df.head()
```

[164]:

```
   Store        Date  Weekly_Sales  Holiday_Flag  Temperature  Fuel_Price  \
0      1  2010-05-02    1643690.90             0        42.31       2.572
1      1  2010-12-02    1641957.44             1        38.51       2.548
2      1  2010-02-19    1611968.17             0        39.93       2.514
3      1  2010-02-26    1409727.59             0        46.63       2.561
4      1  2010-05-03    1554806.68             0        46.50       2.625

          CPI  Unemployment  year  month       day  semester
0  211.096358         8.106  2010      5    Sunday         1
1  211.242170         8.106  2010     12  Thursday         2
2  211.289143         8.106  2010      2    Friday         1
```

```
3  211.319643          8.106  2010      2    Friday         1
4  211.350143          8.106  2010      5    Monday         1
```

[ ]:

```

```

[ ]:

```

```