Retail Analysis with Walmart Data

November 27, 2022

[1]:
```
# Import necessary libraries
import pandas as pd
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import dates
from datetime import datetime
```

Business Understanding Walmart is an American retail corporation that operates a chain of hypermarkets, discount department stores, and grocery stores. In this project, we focused to answer the following questions: 1.Which store has 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 3.Which store/s has good quarterly growth rate in Q3'2012 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 5.Provide a monthly and semester view of sales in units and give insights Build prediction to forecast demand. a) Linear Regression – Utilize variables like date and restructure dates as 1 for 5 Feb 2010 (starting from the earliest date in order). Hypothesize if CPI, unemployment, and fuel price have any impact on sales.

b) Change dates into days by creating new variable. Data Understanding There are sales data available for 45 stores of Walmart in Kaggle. This is the data that covers sales from 2010-02-05 to 2012-11-01.

The data contains these features:

.Store - the store number .Date - the week of sales .Weekly_Sales - sales for the given store .Holiday_Flag - whether the week is a special holiday week 1 – Holiday week 0 – Non-holiday week .Temperature - Temperature on the day of sale .Fuel_Price - Cost of fuel in the region .CPI – Prevailing consumer price index .Unemployment - Prevailing unemployment rate

[2]:
```
# Load dataset

data = pd.read_csv('Walmart_Store_sales.csv')
```

[3]:
```
data
```

[3]:

	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]
```

Data Preparation

[4]:
```
# Convert date to datetime format and show dataset information
data['Date'] =  pd.to_datetime(data['Date'])
data.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   datetime64[ns]
 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: datetime64[ns](1), float64(5), int64(2)
memory usage: 402.3 KB
```

[5]:
```
# checking for missing values
data.isnull().sum()
```

[5]:
```
Store           0
Date            0
Weekly_Sales    0
Holiday_Flag    0
Temperature     0
Fuel_Price      0
CPI             0
Unemployment    0
dtype: int64
```

[6]:
```
# Splitting Date and create new columns (Day, Month, and Year)
data["Day"] = pd.DatetimeIndex(data['Date']).day
data['Month'] = pd.DatetimeIndex(data['Date']).month
data['Year'] = pd.DatetimeIndex(data['Date']).year
data
```

[6]:

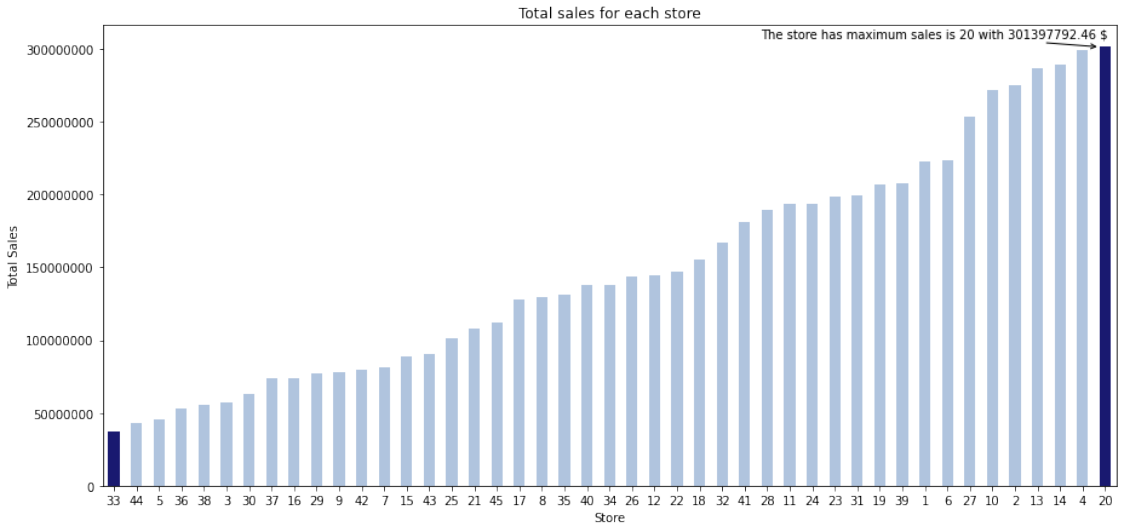
	Store	Date	Weekly_Sales	Holiday_Flag	Temperature	Fuel_Price	\
0	1	2010-05-02	1643690.90	0	42.31	2.572	
1	1	2010-12-02	1641957.44	1	38.51	2.548	
2	1	2010-02-19	1611968.17	0	39.93	2.514	
3	1	2010-02-26	1409727.59	0	46.63	2.561	
4	1	2010-05-03	1554806.68	0	46.50	2.625	
…	…	…	…	…	…	…	
6430	45	2012-09-28	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	Day	Month	Year
0	211.096358	8.106	2	5	2010
1	211.242170	8.106	2	12	2010
2	211.289143	8.106	19	2	2010
3	211.319643	8.106	26	2	2010
4	211.350143	8.106	3	5	2010
…	…	…	…	…	…
6430	192.013558	8.684	28	9	2012
6431	192.170412	8.667	10	5	2012
6432	192.327265	8.667	10	12	2012
6433	192.330854	8.667	19	10	2012
6434	192.308899	8.667	26	10	2012

[6435 rows x 11 columns]

TASK 1:WHICH STORE HAS MAXIMUM SALES?

[7]:
```
plt.figure(figsize=(15,7))

# Sum Weekly_Sales for each store, then sortded by total sales
total_sales_for_each_store = data.groupby('Store')['Weekly_Sales'].sum().
 ↪sort_values()
total_sales_for_each_store_array = np.array(total_sales_for_each_store) #␣
 ↪convert to array

# Assigning a specific color for the stores have the lowest and highest sales
clrs = ['lightsteelblue' if ((x < max(total_sales_for_each_store_array)) and (x␣
 ↪> min(total_sales_for_each_store_array))) else 'midnightblue' for x in␣
 ↪total_sales_for_each_store_array]


ax = total_sales_for_each_store.plot(kind='bar',color=clrs);

# store have maximum sales
p = ax.patches[44]
ax.annotate("The store has maximum sales is 20 with {0:.2f} $".format((p.
 ↪get_height())), xy=(p.get_x(), p.get_height()), xycoords='data',
            xytext=(0.82, 0.98), textcoords='axes fraction',
            arrowprops=dict(arrowstyle="->", connectionstyle="arc3"),
            horizontalalignment='center', verticalalignment='center')


# plot properties
plt.xticks(rotation=0)
plt.ticklabel_format(useOffset=False, style='plain', axis='y')
plt.title('Total sales for each store')
plt.xlabel('Store')
plt.ylabel('Total Sales');
```



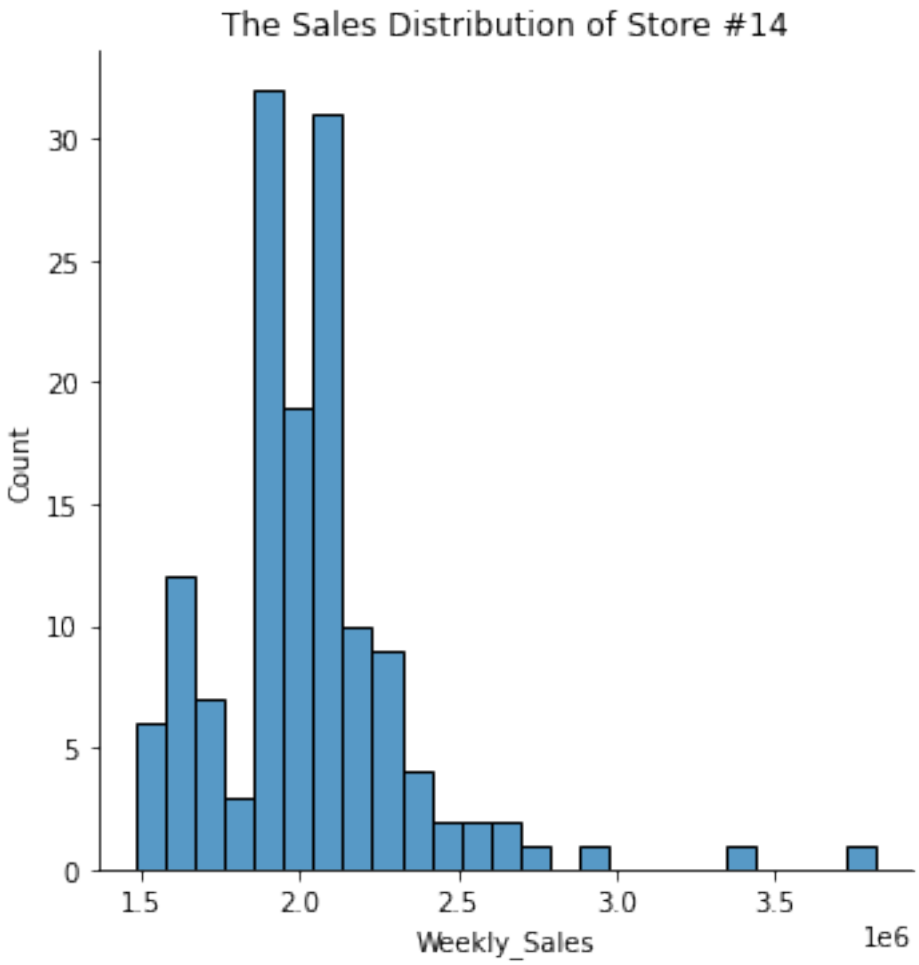
TASK 2: Which store has maximum standard deviation i.e., the sales vary a lot. Also, find out the coefficient of mean to standard deviation?

[8]:
```
# Which store has maximum standard deviation
data_std = pd.DataFrame(data.groupby('Store')['Weekly_Sales'].std().
 ↪sort_values(ascending=False))
print("The store has maximum standard deviation is "+str(data_std.head(1).
 ↪index[0])+" with {0:.0f} $".format(data_std.head(1).Weekly_Sales[data_std.
 ↪head(1).index[0]]))
```

```
The store has maximum standard deviation is 14 with 317570 $
```

[9]:
```
# Distribution of store has maximum standard deviation
plt.figure(figsize=(15,7))
sns.displot(data[data['Store'] == data_std.head(1).index[0]]['Weekly_Sales'])
plt.title('The Sales Distribution of Store #'+ str(data_std.head(1).index[0]));
```

```
<Figure size 1080x504 with 0 Axes>
```



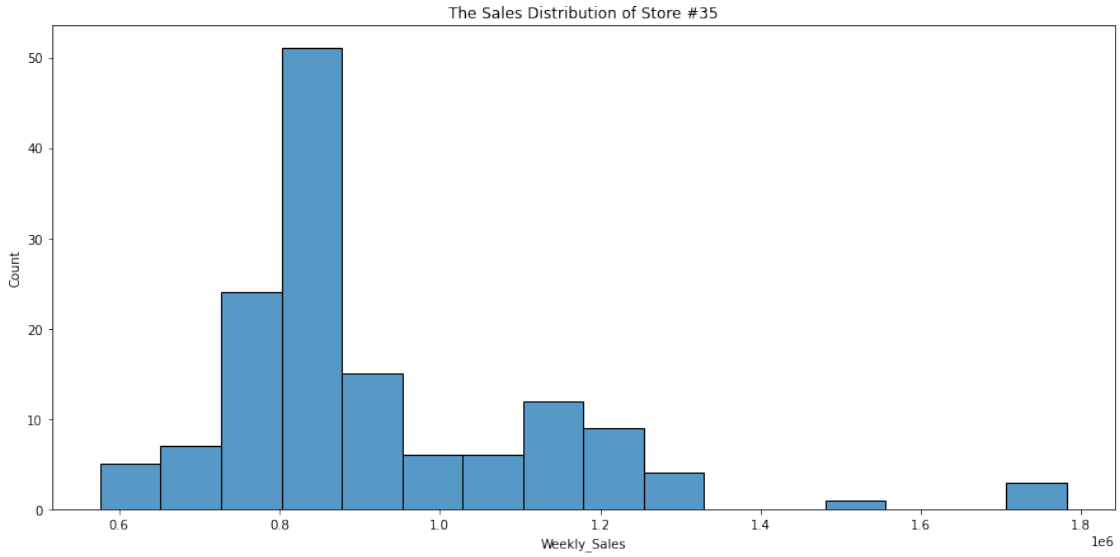
[10]:
```
# Coefficient of mean to standard deviation
coef_mean_std = pd.DataFrame(data.groupby('Store')['Weekly_Sales'].std() / data.
 ↪groupby('Store')['Weekly_Sales'].mean())
coef_mean_std = coef_mean_std.rename(columns={'Weekly_Sales':'Coefficient of␣
 ↪mean to standard deviation'})
coef_mean_std
```

[10]:

Store	Coefficient of mean to standard deviation
1	0.100292
2	0.123424
3	0.115021
4	0.127083
5	0.118668
6	0.135823
7	0.197305
8	0.116953

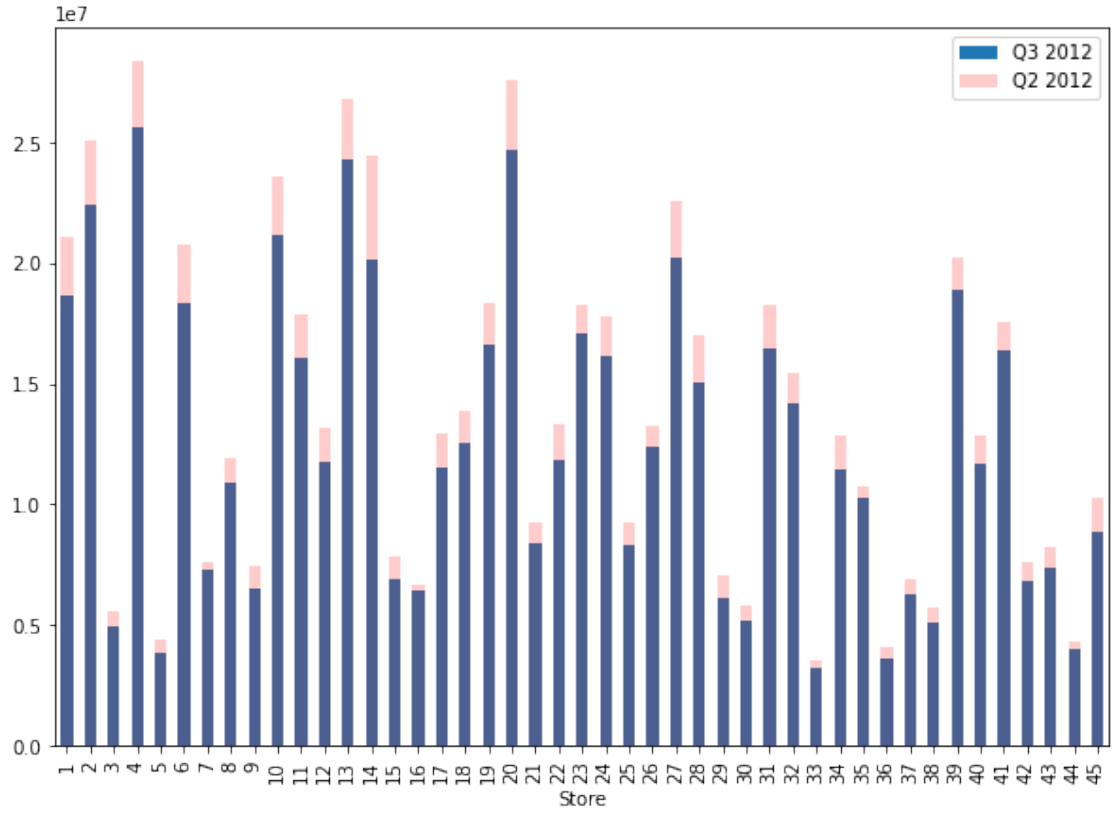
9	0.126895
10	0.159133
11	0.122262
12	0.137925
13	0.132514
14	0.157137
15	0.193384
16	0.165181
17	0.125521
18	0.162845
19	0.132680
20	0.130903
21	0.170292
22	0.156783
23	0.179721
24	0.123637
25	0.159860
26	0.110111
27	0.135155
28	0.137330
29	0.183742
30	0.052008
31	0.090161
32	0.118310
33	0.092868
34	0.108225
35	0.229681
36	0.162579
37	0.042084
38	0.110875
39	0.149908
40	0.123430
41	0.148177
42	0.090335
43	0.064104
44	0.081793
45	0.165613

[11]:
```
# Distribution of store has maximum coefficient of mean to standard deviation
coef_mean_std_max = coef_mean_std.sort_values(by='Coefficient of mean to␣
 ↪standard deviation')
plt.figure(figsize=(15,7))
sns.histplot(data[data['Store'] == coef_mean_std_max.tail(1).
 ↪index[0]]['Weekly_Sales'])
plt.title('The Sales Distribution of Store #'+str(coef_mean_std_max.tail(1).
 ↪index[0]));
```



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

[12]:
```
plt.figure(figsize=(10,7))
# Sales for third quarterly in 2012
Q3 = data[(data['Date'] > '2012-07-01') & (data['Date'] < '2012-09-30')].
 ↪groupby('Store')['Weekly_Sales'].sum()

# Sales for second quarterly in 2012
Q2 = data[(data['Date'] > '2012-04-01') & (data['Date'] < '2012-06-30')].
 ↪groupby('Store')['Weekly_Sales'].sum()

# Plotting the difference between sales for second and third quarterly
Q2.plot(ax=Q3.plot(kind='bar',legend=True),kind='bar',color='r',alpha=0.
 ↪2,legend=True);
plt.legend(['Q3 2012', 'Q2 2012']);
```



[13]:
```
#  store/s has good quarterly growth rate in Q3'2012 - .
 ↪sort_values(by='Weekly_Sales')
print('Store have good quarterly growth rate in Q3'2012 is Store '+str(Q3.
 ↪idxmax())+' With '+str(Q3.max())+' $')
```

```
Store have good quarterly growth rate in Q3'2012 is Store 4 With 25652119.35 $
```

TASK 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 Holiday Events:

Super Bowl: 12-Feb-10, 11-Feb-11, 10-Feb-12, 8-Feb-13

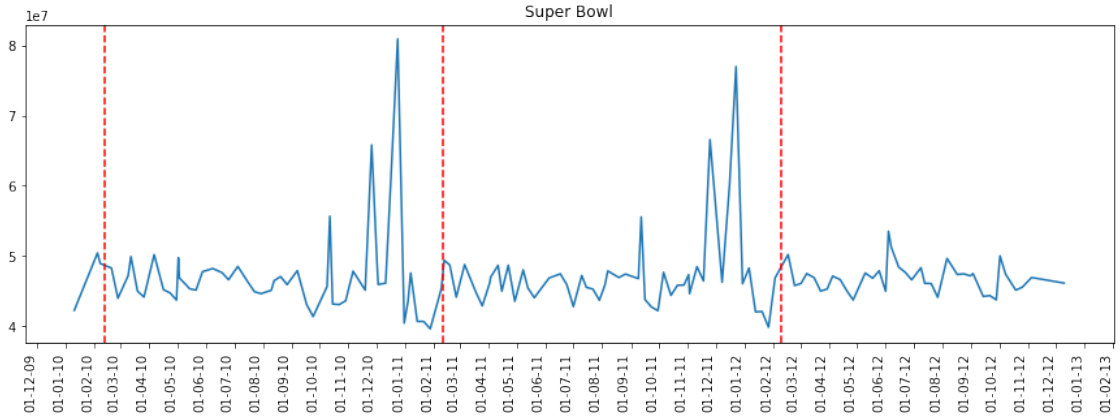
Labour Day: 10-Sep-10, 9-Sep-11, 7-Sep-12, 6-Sep-13

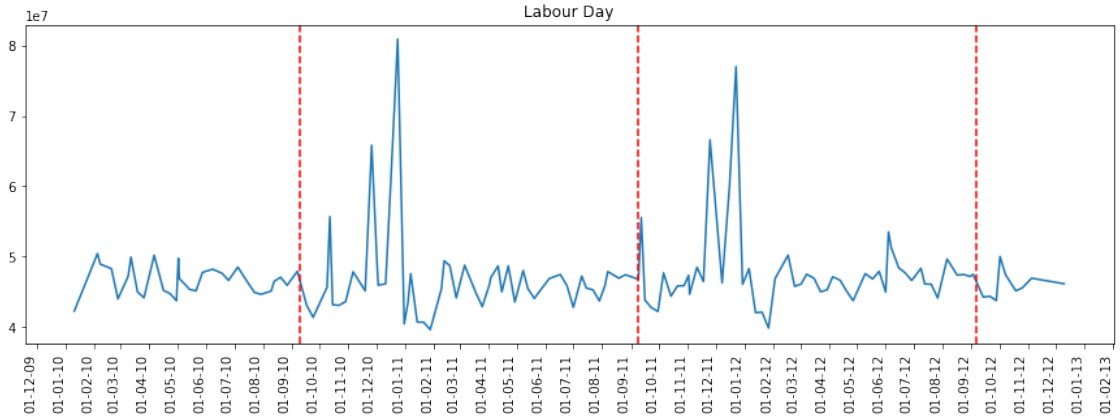
Thanksgiving: 26-Nov-10, 25-Nov-11, 23-Nov-12, 29-Nov-13

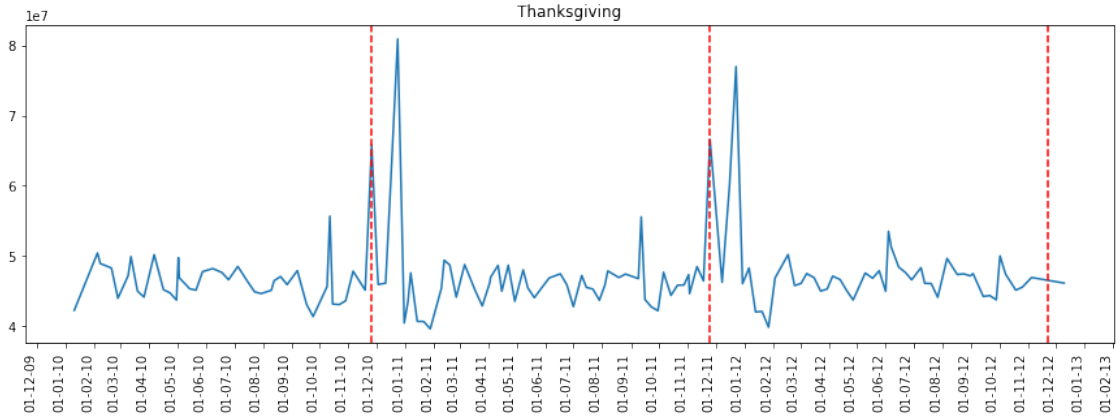
Christmas: 31-Dec-10, 30-Dec-11, 28-Dec-12, 27-Dec-13

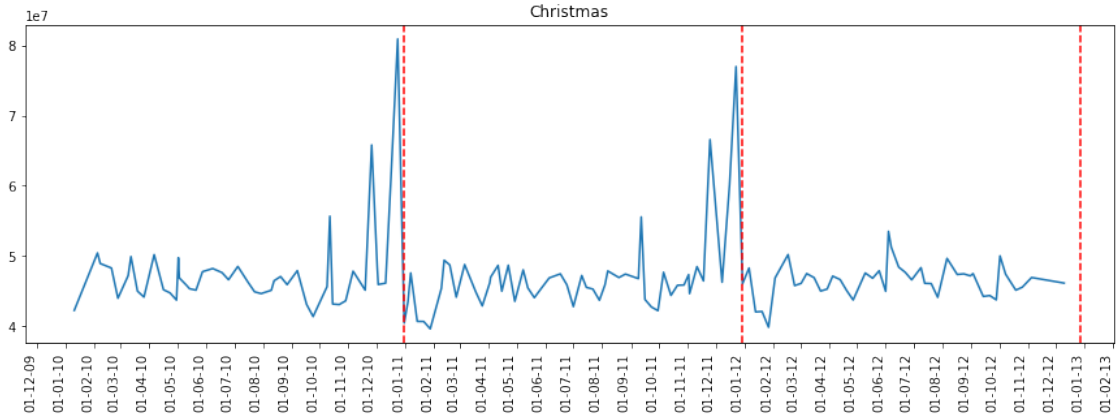
[14]:
```
def plot_line(df,holiday_dates,holiday_label):
    fig, ax = plt.subplots(figsize = (15,5))
    ax.plot(df['Date'],df['Weekly_Sales'],label=holiday_label)

    for day in holiday_dates:
        day = datetime.strptime(day, '%d-%m-%Y')
```

```
        plt.axvline(x=day, linestyle='--', c='r')


    plt.title(holiday_label)
    x_dates = df['Date'].dt.strftime('%Y-%m-%d').sort_values().unique()
    xfmt = dates.DateFormatter('%d-%m-%y')
    ax.xaxis.set_major_formatter(xfmt)
    ax.xaxis.set_major_locator(dates.DayLocator(1))
    plt.gcf().autofmt_xdate(rotation=90)
    plt.show()

total_sales = data.groupby('Date')['Weekly_Sales'].sum().reset_index()
Super_Bowl =['12-2-2010', '11-2-2011', '10-2-2012']
Labour_Day =  ['10-9-2010', '9-9-2011', '7-9-2012']
Thanksgiving =  ['26-11-2010', '25-11-2011', '23-11-2012']
Christmas = ['31-12-2010', '30-12-2011', '28-12-2012']

plot_line(total_sales,Super_Bowl,'Super Bowl')
plot_line(total_sales,Labour_Day,'Labour Day')
plot_line(total_sales,Thanksgiving,'Thanksgiving')
plot_line(total_sales,Christmas,'Christmas')
```









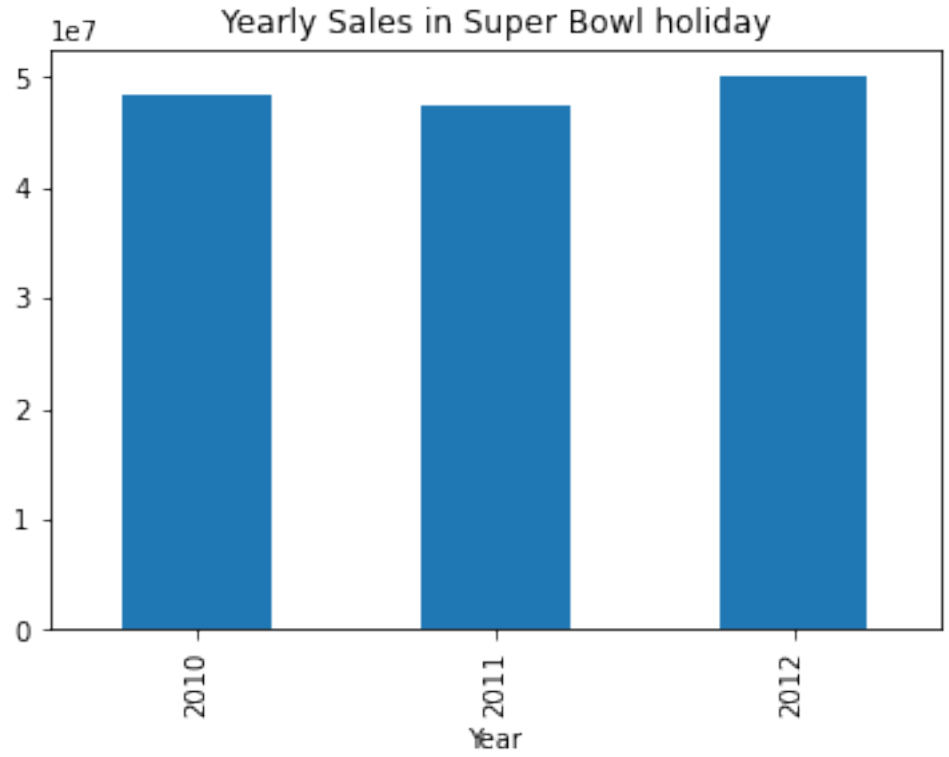
The Sales increased during thanksgiving and the sales decreased during christmas

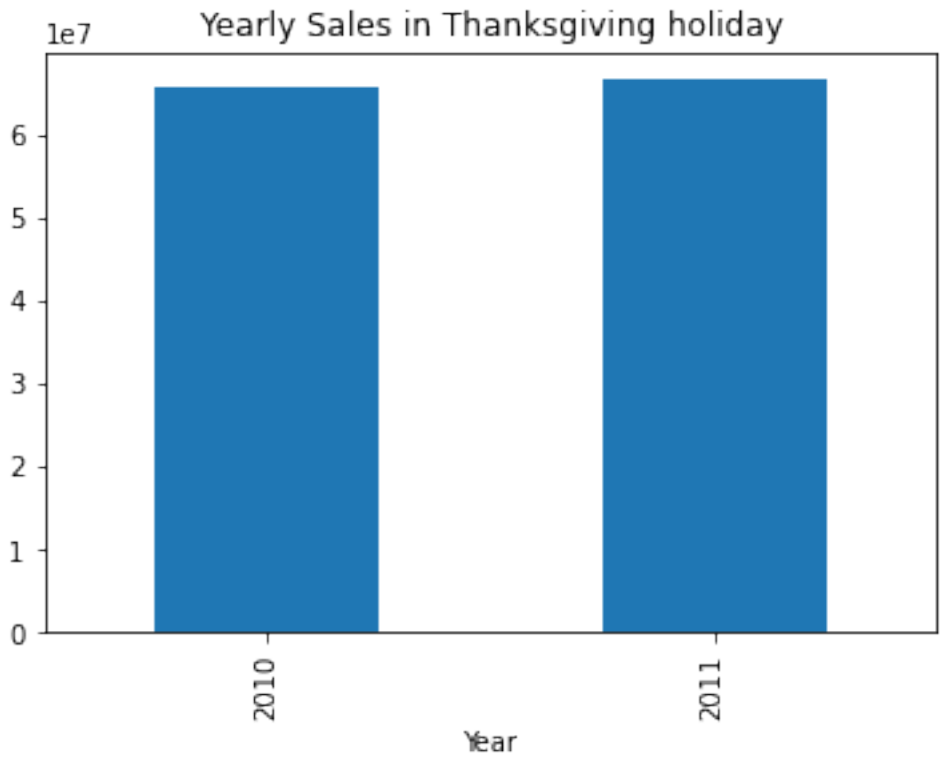
[15]:
```
data.loc[data.Date.isin(Super_Bowl)]
```

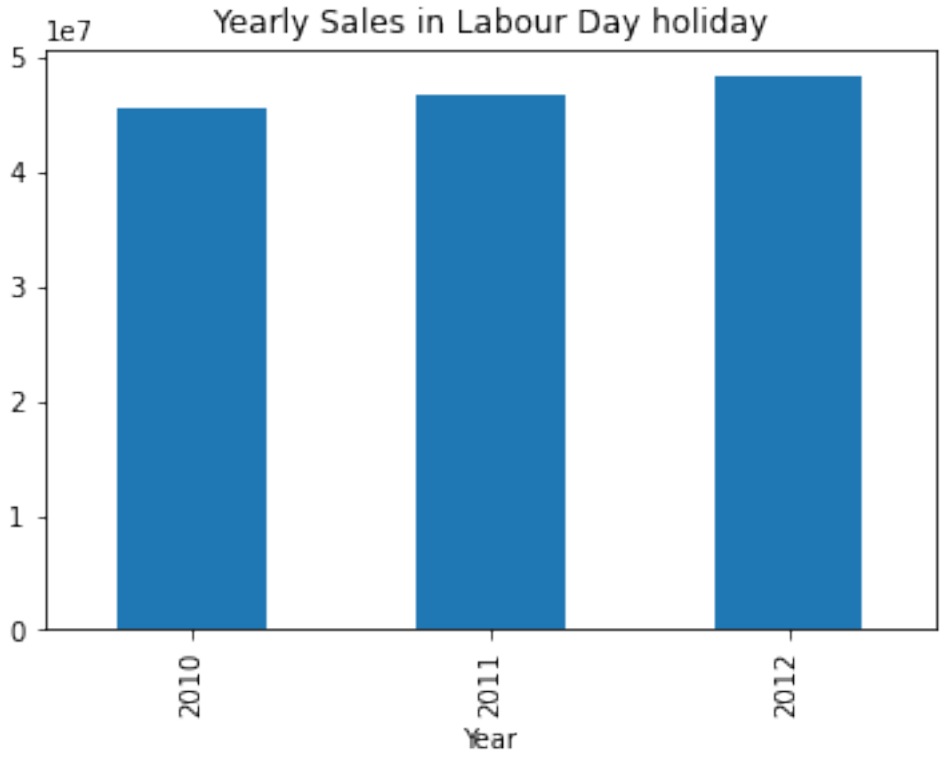
[15]:
```
      Store       Date  Weekly_Sales  Holiday_Flag  Temperature  Fuel_Price  \
1         1 2010-12-02    1641957.44             1        38.51       2.548
53        1 2011-11-02    1649614.93             1        36.39       3.022
105       1 2012-10-02    1802477.43             1        48.02       3.409
144       2 2010-12-02    2137809.50             1        38.49       2.548
196       2 2011-11-02    2168041.61             1        33.19       3.022
…       …          …             …             …            …           …
6202     44 2011-11-02     307486.73             1        30.83       3.034
6254     44 2012-10-02     325377.97             1        33.73       3.116
6293     45 2010-12-02     656988.64             1        27.73       2.773
6345     45 2011-11-02     766456.00             1        30.30       3.239
6397     45 2012-10-02     803657.12             1        37.00       3.640

                CPI  Unemployment  Day  Month  Year
1        211.242170         8.106    2     12  2010
53       212.936705         7.742    2     11  2011
105      220.265178         7.348    2     10  2012
144      210.897994         8.324    2     12  2010
196      212.592862         8.028    2     11  2011
…               …             …  …     …   …
6202     127.859129         7.224    2     11  2011
6254     130.384903         5.774    2     10  2012
6293     181.982317         8.992    2     12  2010
6345     183.701613         8.549    2     11  2011
6397     189.707605         8.424    2     10  2012

[135 rows x 11 columns]
```

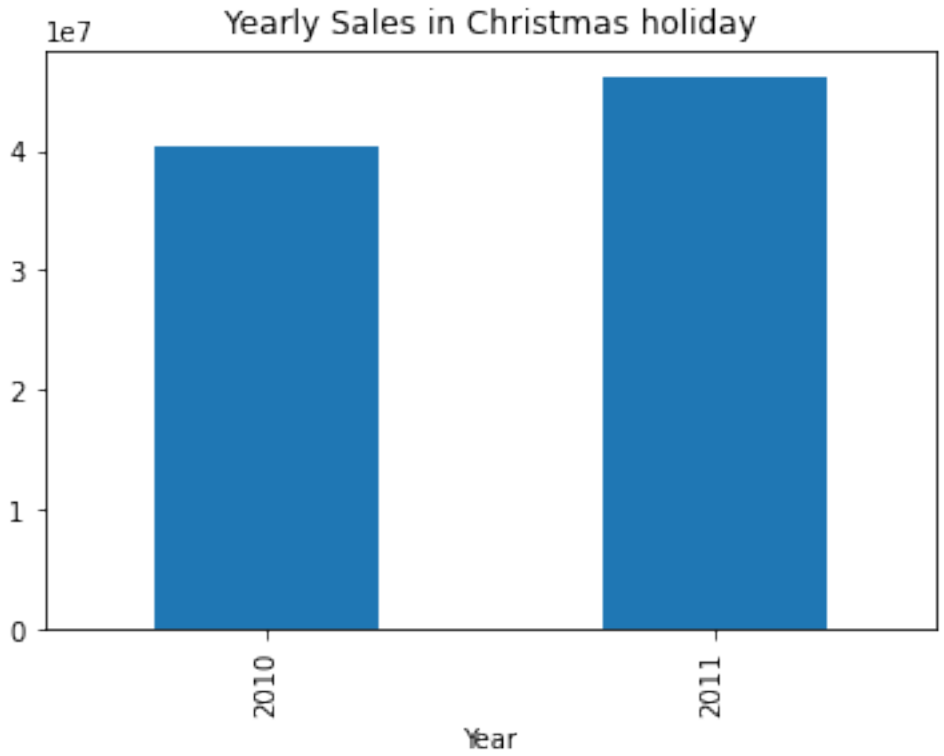
[16]:
```
# Yearly Sales in holidays
Super_Bowl_df = pd.DataFrame(data.loc[data.Date.isin(Super_Bowl)].
 ↪groupby('Year')['Weekly_Sales'].sum())
Thanksgiving_df = pd.DataFrame(data.loc[data.Date.isin(Thanksgiving)].
 ↪groupby('Year')['Weekly_Sales'].sum())
Labour_Day_df = pd.DataFrame(data.loc[data.Date.isin(Labour_Day)].
 ↪groupby('Year')['Weekly_Sales'].sum())
Christmas_df = pd.DataFrame(data.loc[data.Date.isin(Christmas)].
 ↪groupby('Year')['Weekly_Sales'].sum())

Super_Bowl_df.plot(kind='bar',legend=False,title='Yearly Sales in Super Bowl␣
 ↪holiday')
Thanksgiving_df.plot(kind='bar',legend=False,title='Yearly Sales in␣
 ↪Thanksgiving holiday')
Labour_Day_df.plot(kind='bar',legend=False,title='Yearly Sales in Labour Day␣
 ↪holiday')
Christmas_df.plot(kind='bar',legend=False,title='Yearly Sales in Christmas␣
 ↪holiday')
```

[16]: <AxesSubplot:title={'center':'Yearly Sales in Christmas holiday'},
xlabel='Year'>




Yearly Sales in Thanksgiving holiday
1e7
6
5
4
3
2
1
0
2010
2011
Year

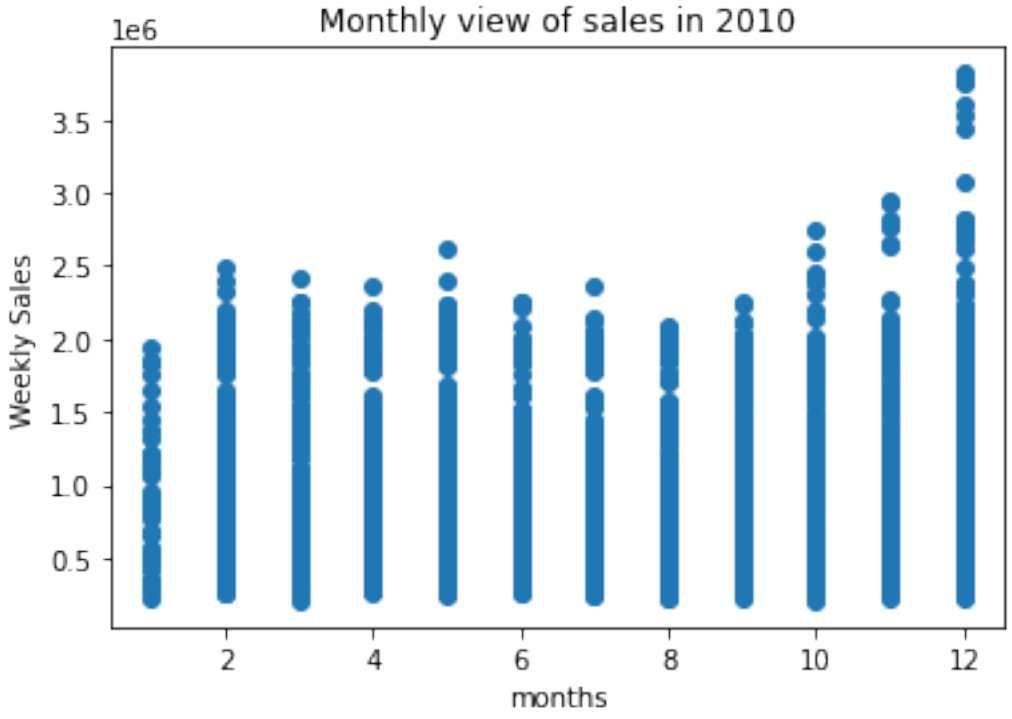

Yearly Sales in Labour Day holiday
1e7
5
4
3
2
1
0
2010
2011
2012
Year

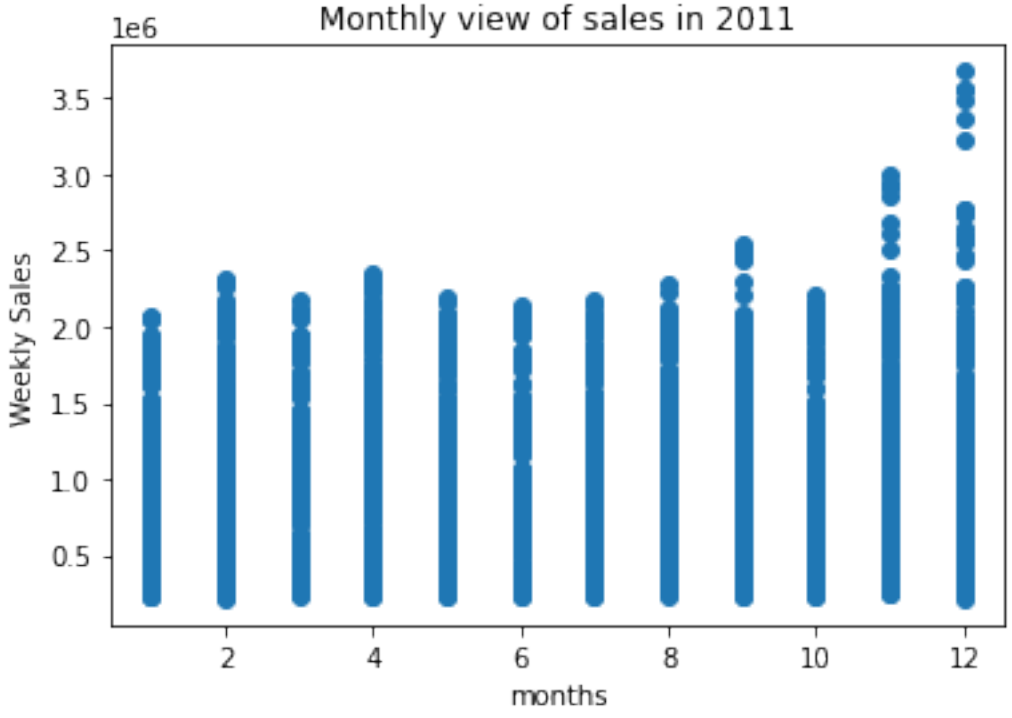


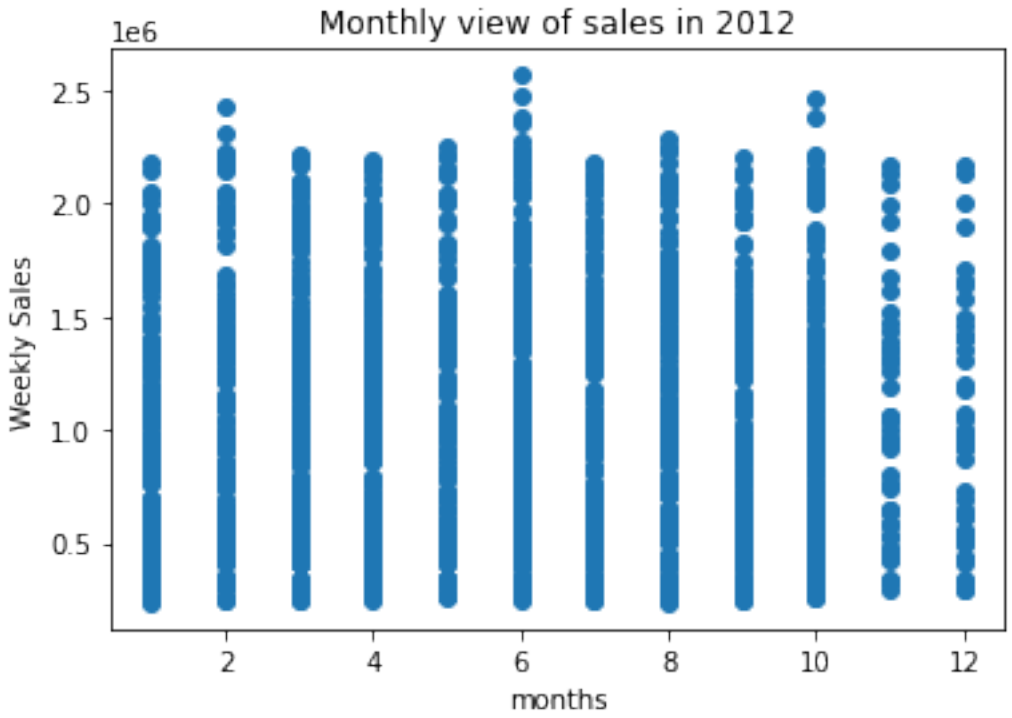
TASK 5: Provide a monthly and semester view of sales in units and give insights

[17]:
```
# Monthly view of sales for each years
plt.scatter(data[data.Year==2010]["Month"],data[data.
 ↪Year==2010]["Weekly_Sales"])
plt.xlabel("months")
plt.ylabel("Weekly Sales")
plt.title("Monthly view of sales in 2010")
plt.show()

plt.scatter(data[data.Year==2011]["Month"],data[data.
 ↪Year==2011]["Weekly_Sales"])
plt.xlabel("months")
plt.ylabel("Weekly Sales")
plt.title("Monthly view of sales in 2011")
plt.show()

plt.scatter(data[data.Year==2012]["Month"],data[data.
 ↪Year==2012]["Weekly_Sales"])
plt.xlabel("months")
plt.ylabel("Weekly Sales")
```

```
plt.title("Monthly view of sales in 2012")
plt.show()
```

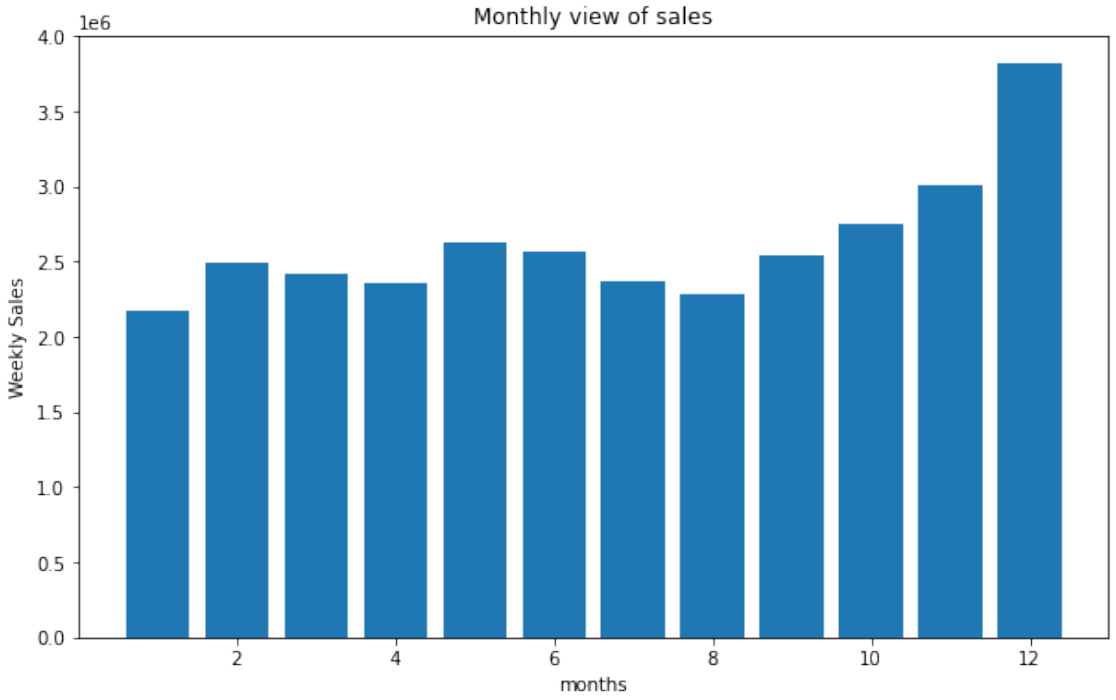






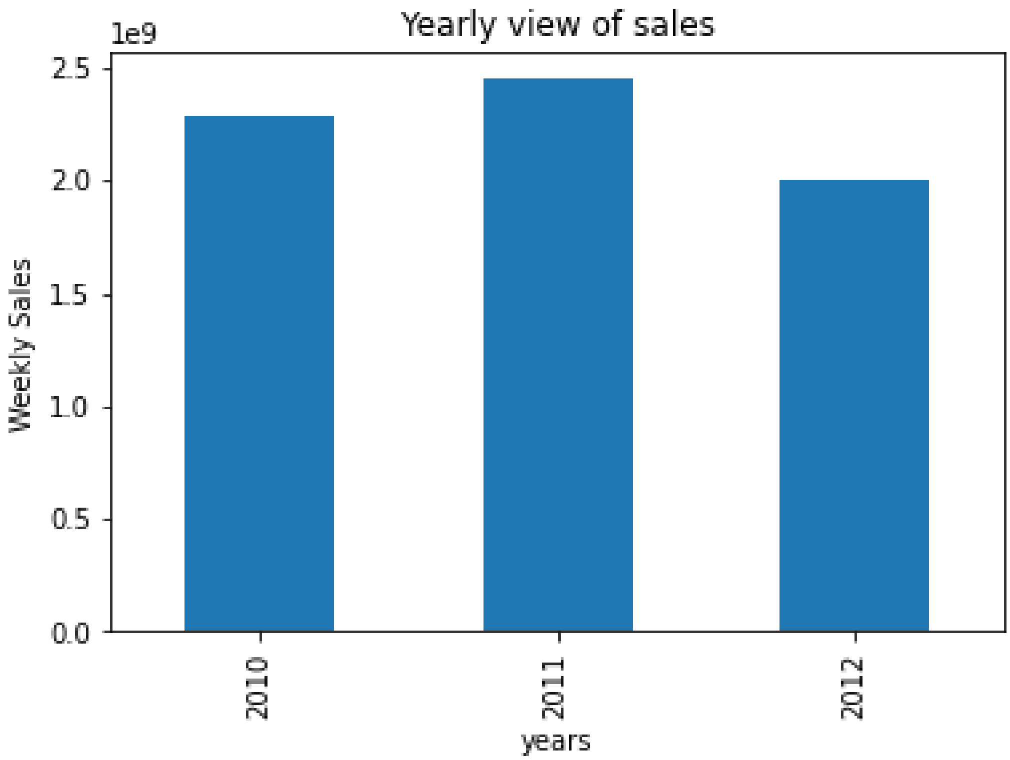
[18]:
```
# Monthly view of sales for all years
plt.figure(figsize=(10,6))
plt.bar(data["Month"],data["Weekly_Sales"])
plt.xlabel("months")
plt.ylabel("Weekly Sales")
plt.title("Monthly view of sales")
```

[18]: Text(0.5, 1.0, 'Monthly view of sales')



[19]:
```
# Yearly view of sales
plt.figure(figsize=(10,6))
data.groupby("Year")[["Weekly_Sales"]].sum().plot(kind='bar',legend=False)
plt.xlabel("years")
plt.ylabel("Weekly Sales")
plt.title("Yearly view of sales");
```

```
<Figure size 720x432 with 0 Axes>
```



Build prediction models to forecast demand (Modeling)

[20]:
```
# find outliers
fig, axs = plt.subplots(4,figsize=(6,18))
X = data[['Temperature','Fuel_Price','CPI','Unemployment']]
for i,column in enumerate(X):
    sns.boxplot(data[column], ax=axs[i])
```

```
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
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  FutureWarning
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  FutureWarning
```

```
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
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  FutureWarning
```
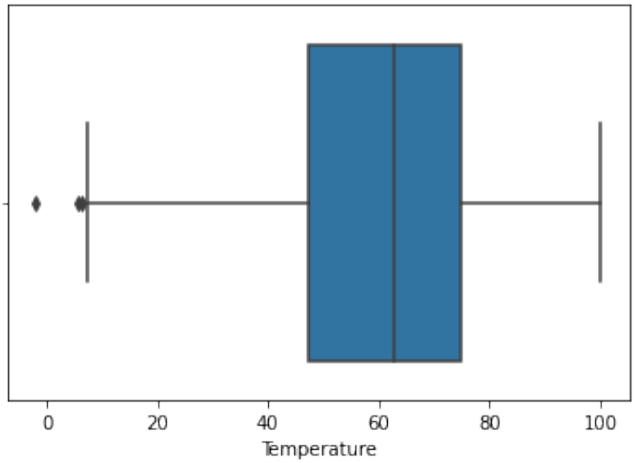
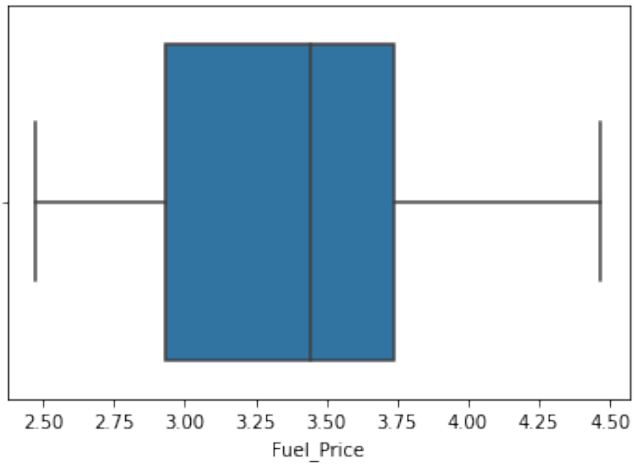
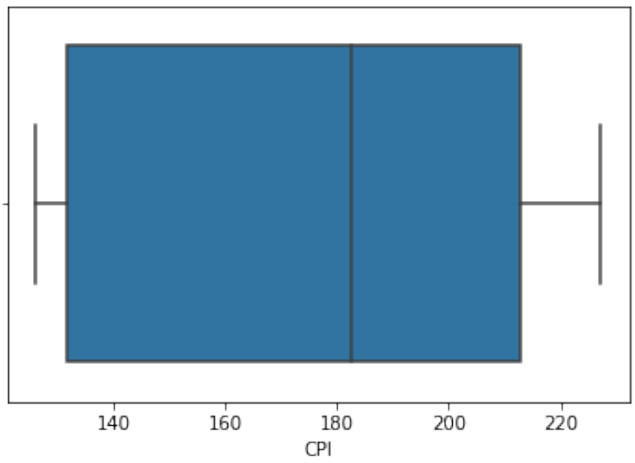
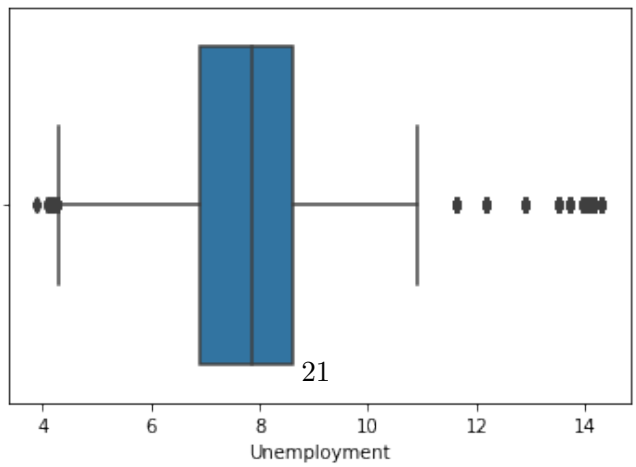


0
20
40
60
80
100
Temperature


2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
Fuel_Price


140
160
180
200
220
CPI


4
6
8
10
12
14
Unemployment

[21]:
```
# drop the outliers
data_new = data[(data['Unemployment']<10) & (data['Unemployment']>4.5) &␣
 ↪(data['Temperature']>10)]
data_new
```

[21]:

	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	Day	Month	Year
0	211.096358	8.106	2	5	2010
1	211.242170	8.106	2	12	2010
2	211.289143	8.106	19	2	2010
3	211.319643	8.106	26	2	2010
4	211.350143	8.106	3	5	2010
…	…	…	…	…	…
6430	192.013558	8.684	28	9	2012
6431	192.170412	8.667	10	5	2012
6432	192.327265	8.667	10	12	2012
6433	192.330854	8.667	19	10	2012
6434	192.308899	8.667	26	10	2012

[5658 rows x 11 columns]

[22]:
```
# check outliers
fig, axs = plt.subplots(4,figsize=(6,18))
X = data_new[['Temperature','Fuel_Price','CPI','Unemployment']]
for i,column in enumerate(X):
    sns.boxplot(data_new[column], ax=axs[i])
```

```
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only
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/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
```

```
Pass the following variable as a keyword arg: x. From version 0.12, the only
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  FutureWarning
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
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  FutureWarning
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variable as a keyword arg: x. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
  FutureWarning
```
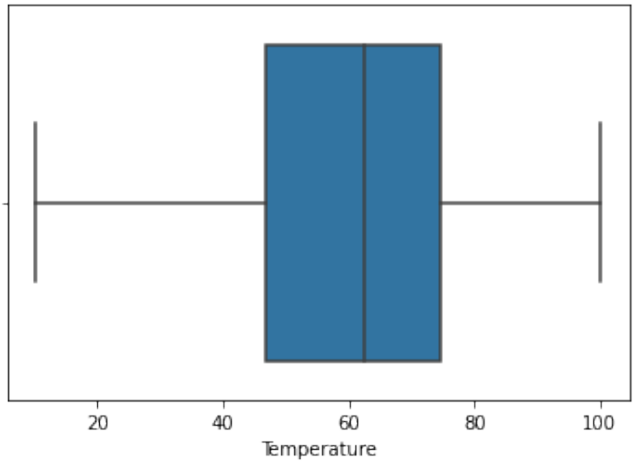
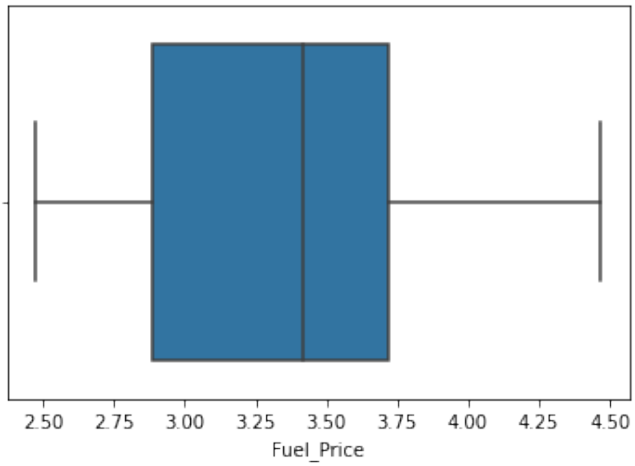
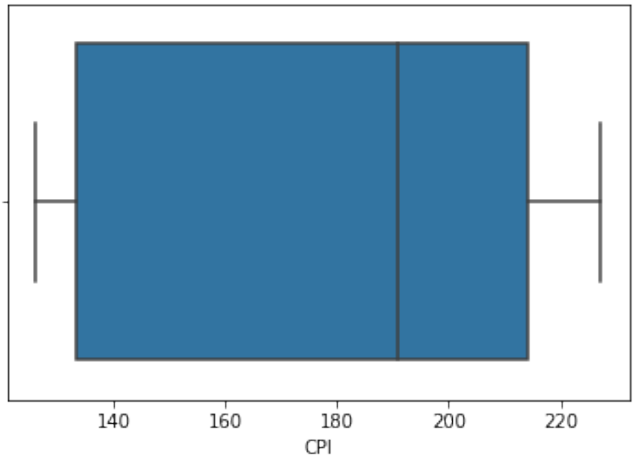
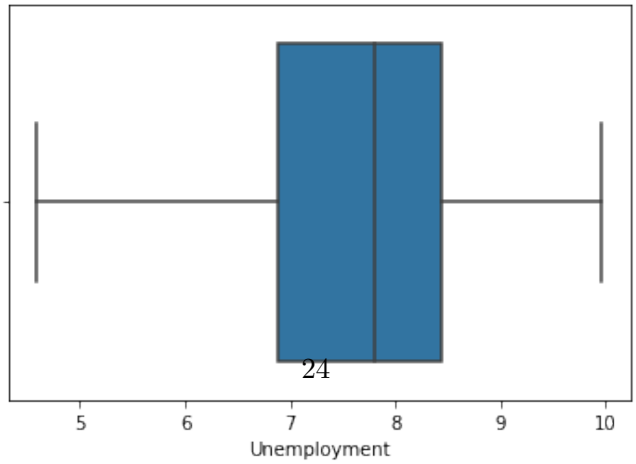


20
40
60
80
100
Temperature


2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
Fuel_Price


140
160
180
200
220
CPI


5
6
7
8
9
10
Unemployment

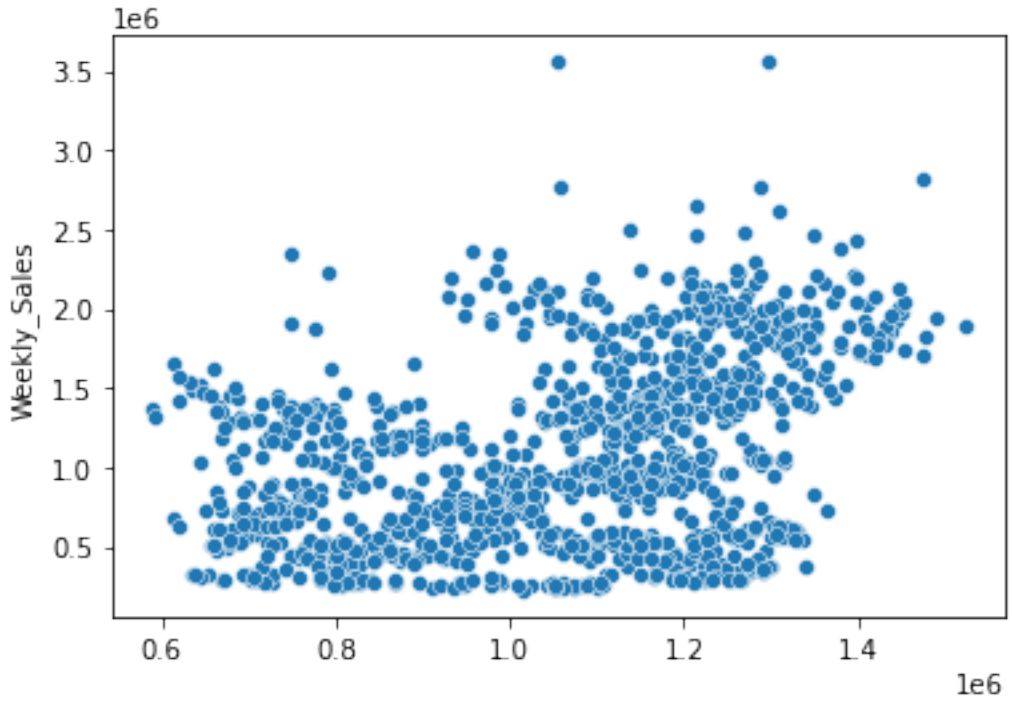
Build Model

[23]:
```
# Import sklearn
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import train_test_split
from sklearn import metrics
from sklearn.linear_model import LinearRegression
```

[24]:
```
# Select features and target
X = data_new[['Store','Fuel_Price','CPI','Unemployment','Day','Month','Year']]
y = data_new['Weekly_Sales']

# Split data to train and test (0.80:0.20)
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2)
```

[25]:
```
# Linear Regression model
print('Linear Regression:')
print()
reg = LinearRegression()
reg.fit(X_train, y_train)
y_pred = reg.predict(X_test)
print('Accuracy:',reg.score(X_train, y_train)*100)


print('Mean Absolute Error:', metrics.mean_absolute_error(y_test, y_pred))
print('Mean Squared Error:', metrics.mean_squared_error(y_test, y_pred))
print('Root Mean Squared Error:', np.sqrt(metrics.mean_squared_error(y_test,␣
 ↪y_pred)))


sns.scatterplot(y_pred, y_test);
```

```
Linear Regression:

Accuracy: 12.49406449105821
Mean Absolute Error: 451497.3449277736
Mean Squared Error: 295194169846.9532
Root Mean Squared Error: 543317.7429892689

/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
  FutureWarning
```

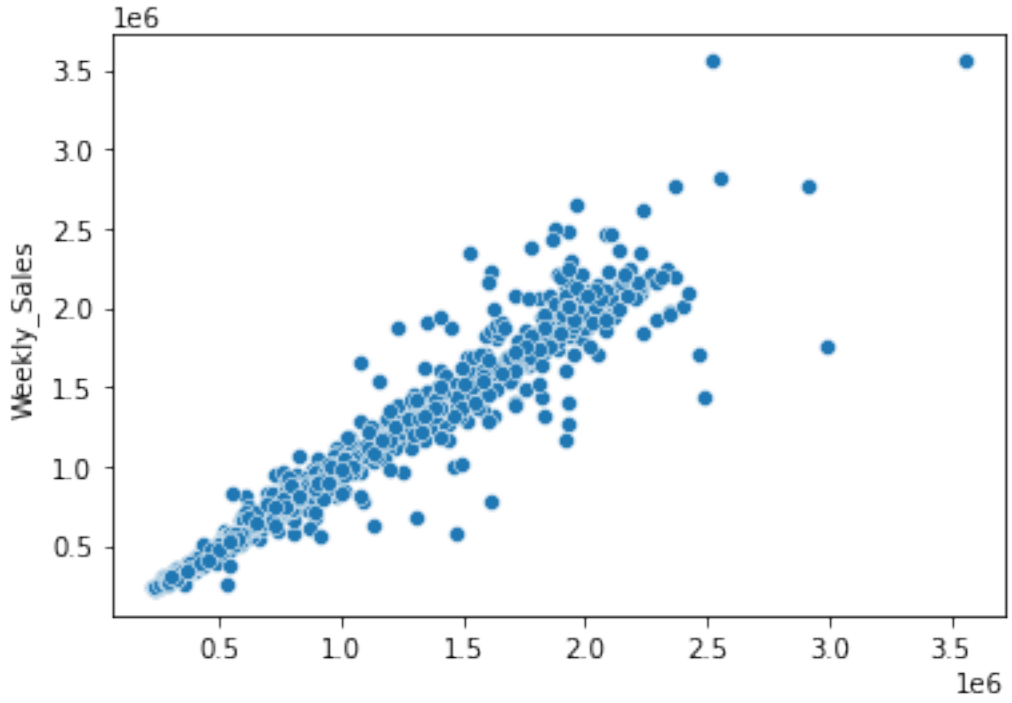


[26]:
```
# Random Forest Regressor
print('Random Forest Regressor:')
print()
rfr = RandomForestRegressor(n_estimators = 400,max_depth=15,n_jobs=5)
rfr.fit(X_train,y_train)
y_pred=rfr.predict(X_test)
print('Accuracy:',rfr.score(X_test, y_test)*100)

print('Mean Absolute Error:', metrics.mean_absolute_error(y_test, y_pred))
print('Mean Squared Error:', metrics.mean_squared_error(y_test, y_pred))
print('Root Mean Squared Error:', np.sqrt(metrics.mean_squared_error(y_test,␣
 ↪y_pred)))
sns.scatterplot(y_pred, y_test);
```

```
Random Forest Regressor:

Accuracy: 94.25813134431709
Mean Absolute Error: 72060.52013373807
Mean Squared Error: 19739873511.74879
Root Mean Squared Error: 140498.66017777106
```

```
/usr/local/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWarning:
Pass the following variables as keyword args: x, y. From version 0.12, the only
valid positional argument will be `data`, and passing other arguments without an
explicit keyword will result in an error or misinterpretation.
```

```
FutureWarning
```



[ ]: