In [44]:

```
# 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
```

In [45]:

```
# Load dataset
data = pd.read_csv('Walmart_Store_sales.csv')
data
```

Out[45]:

	Store	Date	Weekly_Sales	Holiday_Flag	Temperature	Fuel_Price	CPI	Unemploym
0	1	05-02-2010	1643690.90	0	42.31	2.572	211.096358	8.
1	1	12-02-2010	1641957.44	1	38.51	2.548	211.242170	8.
2	1	19-02-2010	1611968.17	0	39.93	2.514	211.289143	8.
3	1	26-02-2010	1409727.59	0	46.63	2.561	211.319643	8.
4	1	05-03-2010	1554806.68	0	46.50	2.625	211.350143	8.
...	...	...	...	...	...	...	...	
6430	45	28-09-2012	713173.95	0	64.88	3.997	192.013558	8.
6431	45	05-10-2012	733455.07	0	64.89	3.985	192.170412	8.
6432	45	12-10-2012	734464.36	0	54.47	4.000	192.327265	8.
6433	45	19-10-2012	718125.53	0	56.47	3.969	192.330854	8.
6434	45	26-10-2012	760281.43	0	58.85	3.882	192.308899	8.

6435 rows × 8 columns

Data Preparation

In [46]:

```
# 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
```

In [47]:

```
# checking for missing values
data.isnull().sum()
```

Out[47]:

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

In [48]:

```
# 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
```

Out[48]:

	Store	Date	Weekly_Sales	Holiday_Flag	Temperature	Fuel_Price	CPI	Unemploy
0	1	2010-05-02	1643690.90	0	42.31	2.572	211.096358	8
1	1	2010-12-02	1641957.44	1	38.51	2.548	211.242170	8
2	1	2010-02-19	1611968.17	0	39.93	2.514	211.289143	8
3	1	2010-02-26	1409727.59	0	46.63	2.561	211.319643	8
4	1	2010-05-03	1554806.68	0	46.50	2.625	211.350143	8
...	...	...	...	...	...	...	...	
6430	45	2012-09-28	713173.95	0	64.88	3.997	192.013558	8
6431	45	2012-05-10	733455.07	0	64.89	3.985	192.170412	8
6432	45	2012-12-10	734464.36	0	54.47	4.000	192.327265	8
6433	45	2012-10-19	718125.53	0	56.47	3.969	192.330854	8
6434	45	2012-10-26	760281.43	0	58.85	3.882	192.308899	8

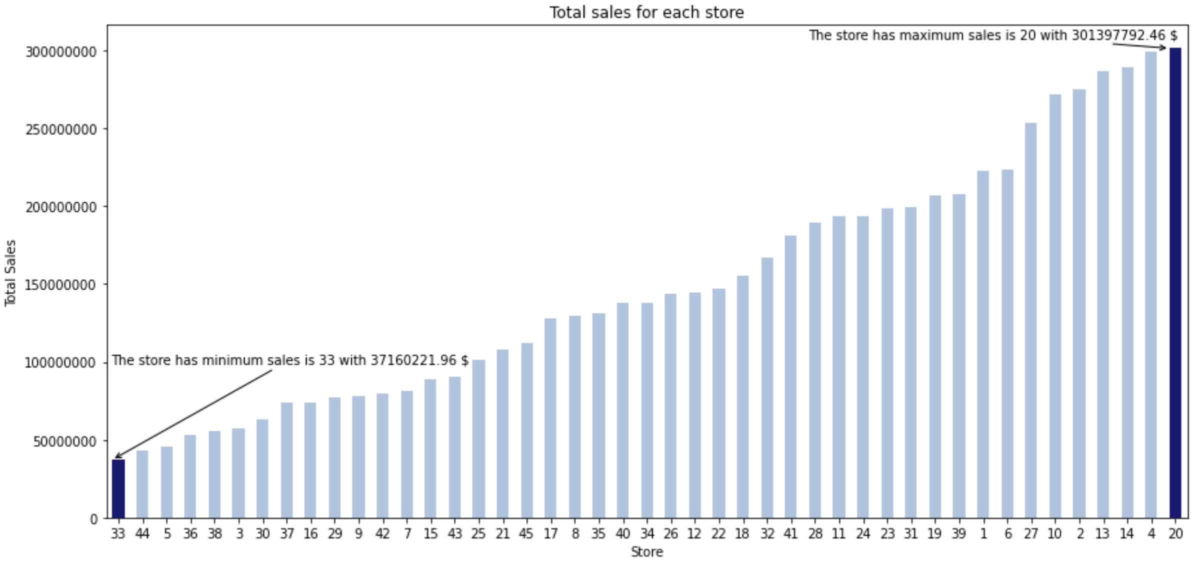
6435 rows × 11 columns

Q1: Which store has minimum and maximum sales?

In [49]:

```
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 minimum sales
p = ax.patches[0]
print(type(p.get_height()))
ax.annotate("The store has minimum sales is 33 with {0:.2f} $".format((p.get_height())), xy=(p.get_x(), p.get_height()), xycoords='data',
            xytext=(0.17, 0.32), textcoords='axes fraction',
            arrowprops=dict(arrowstyle="->", connectionstyle="arc3"),
            horizontalalignment='center', verticalalignment='center')


# 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');
```

```
<class 'numpy.float64'>
```



Q2: Which store has maximum standard deviation i.e., the sales vary a lot. Also, find out the coefficient of mean to standard deviation?

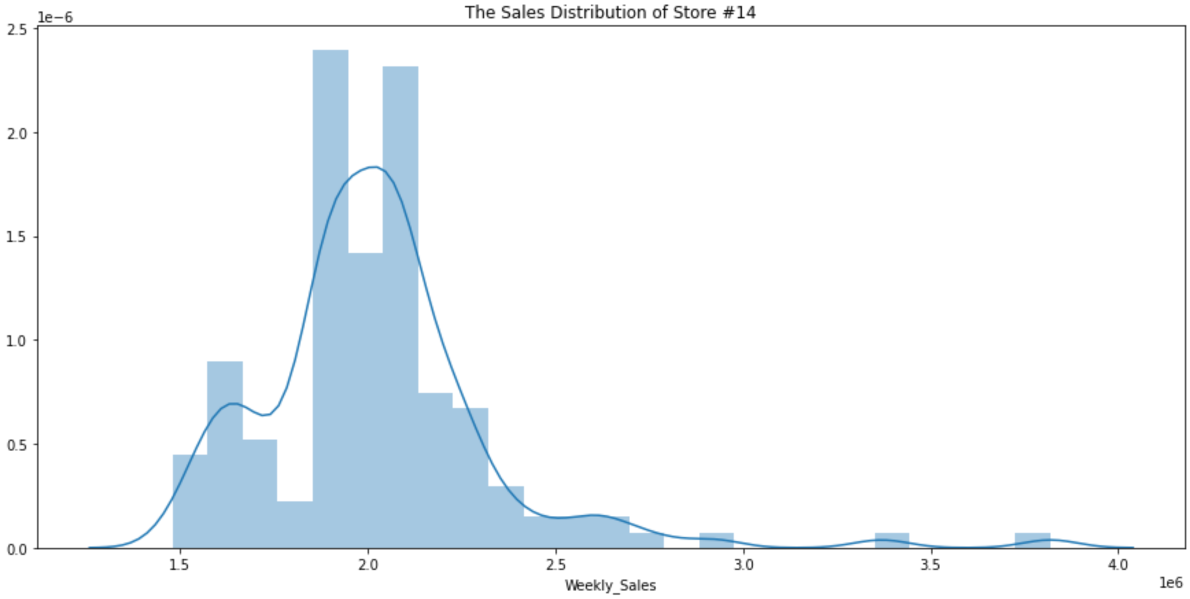
In [50]:

```
# 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 $
```

In [51]:

```
# Distribution of store has maximum standard deviation
plt.figure(figsize=(15,7))
sns.distplot(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]));
```



In [52]:

```
# 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
```

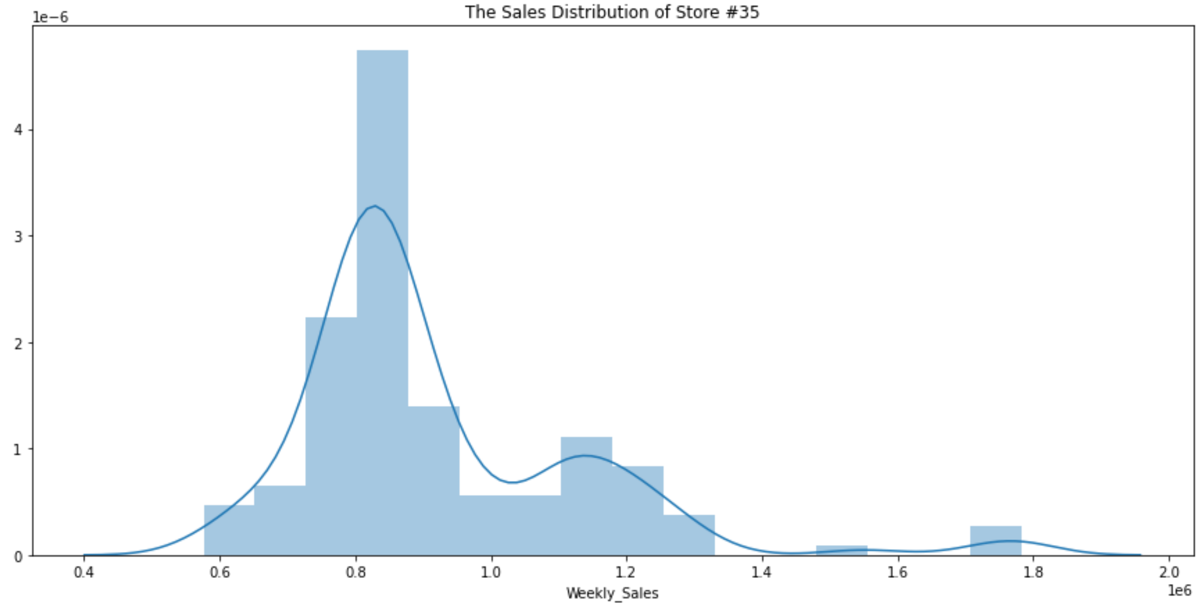
Out[52]:

	Coefficient of mean to standard deviation
Store	
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

Store	Coefficient of mean to standard deviation
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

In [53]:

```
# 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 deviatio
n')
plt.figure(figsize=(15,7))
sns.distplot(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]));
```



Q3: Which store/s has good quarterly growth rate in Q3’2012

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

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('bar',legend=True),kind='bar',color='r',alpha=0.2,legend=True); plt.legend(["Q3' 2012", "Q2' 2012"]);

In [54]:

```
#  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
$
```

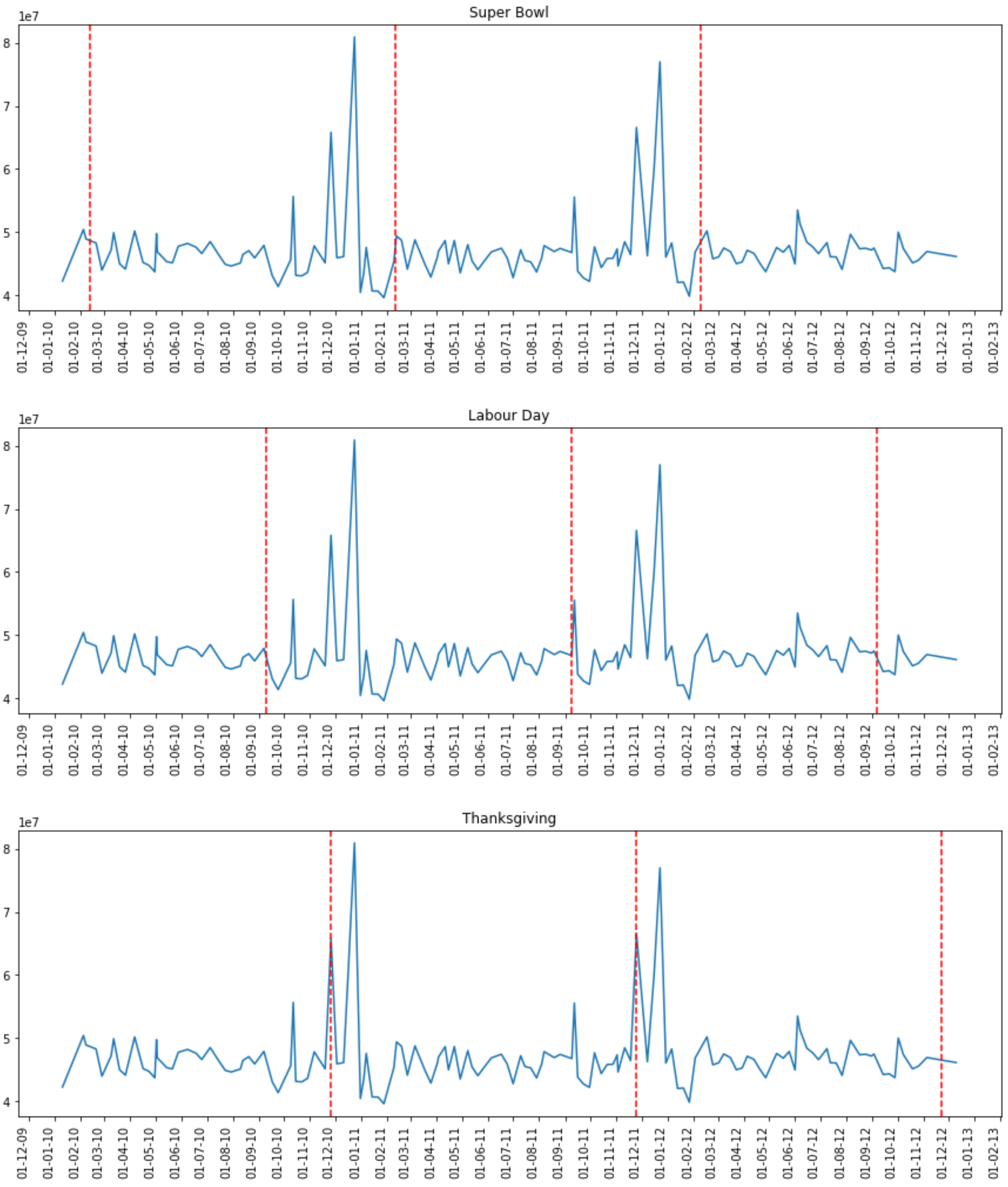
Q4: Some holidays have a negative impact on sales. Find out holidays which have higher sales than the mean sales in non-holiday season for all stores together

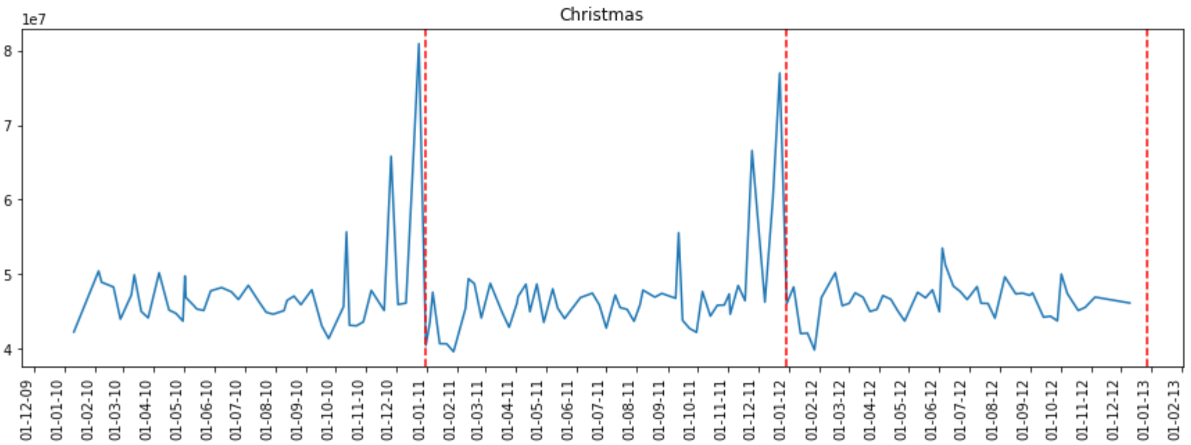
Holiday Events:

- 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

In [55]:

```
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')
```


Super Bowl
1e7
8
7
6
5
4
01-12-09
01-01-10
01-02-10
01-03-10
01-04-10
01-05-10
01-06-10
01-07-10
01-08-10
01-09-10
01-10-10
01-11-10
01-12-10
01-01-11
01-02-11
01-03-11
01-04-11
01-05-11
01-06-11
01-07-11
01-08-11
01-09-11
01-10-11
01-11-11
01-12-11
01-01-12
01-02-12
01-03-12
01-04-12
01-05-12
01-06-12
01-07-12
01-08-12
01-09-12
01-10-12
01-11-12
01-12-12
01-01-13
01-02-13
Labour Day
1e7
8
7
6
5
4
01-12-09
01-01-10
01-02-10
01-03-10
01-04-10
01-05-10
01-06-10
01-07-10
01-08-10
01-09-10
01-10-10
01-11-10
01-12-10
01-01-11
01-02-11
01-03-11
01-04-11
01-05-11
01-06-11
01-07-11
01-08-11
01-09-11
01-10-11
01-11-11
01-12-11
01-01-12
01-02-12
01-03-12
01-04-12
01-05-12
01-06-12
01-07-12
01-08-12
01-09-12
01-10-12
01-11-12
01-12-12
01-01-13
01-02-13
Thanksgiving
1e7
8
7
6
5
4
01-12-09
01-01-10
01-02-10
01-03-10
01-04-10
01-05-10
01-06-10
01-07-10
01-08-10
01-09-10
01-10-10
01-11-10
01-12-10
01-01-11
01-02-11
01-03-11
01-04-11
01-05-11
01-06-11
01-07-11
01-08-11
01-09-11
01-10-11
01-11-11
01-12-11
01-01-12
01-02-12
01-03-12
01-04-12
01-05-12
01-06-12
01-07-12
01-08-12
01-09-12
01-10-12
01-11-12
01-12-12
01-01-13
01-02-13



The sales increased during thanksgiving. And the sales decreased during christmas.

In [56]:

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

Out[56]:

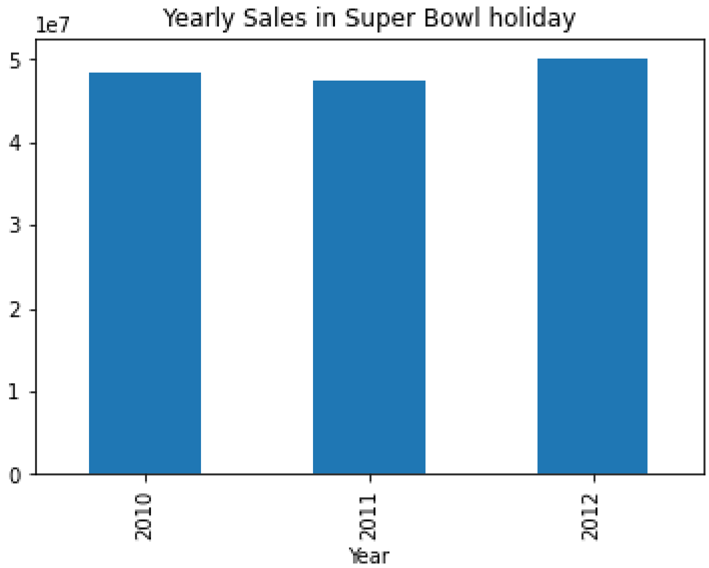
	Store	Date	Weekly_Sales	Holiday_Flag	Temperature	Fuel_Price	CPI	Unemployr
1	1	2010-12-02	1641957.44	1	38.51	2.548	211.242170	8
53	1	2011-11-02	1649614.93	1	36.39	3.022	212.936705	7
105	1	2012-10-02	1802477.43	1	48.02	3.409	220.265178	7
144	2	2010-12-02	2137809.50	1	38.49	2.548	210.897994	8
196	2	2011-11-02	2168041.61	1	33.19	3.022	212.592862	8
...	...	...	...	...	...	...	...	
6202	44	2011-11-02	307486.73	1	30.83	3.034	127.859129	7
6254	44	2012-10-02	325377.97	1	33.73	3.116	130.384903	5
6293	45	2010-12-02	656988.64	1	27.73	2.773	181.982317	8
6345	45	2011-11-02	766456.00	1	30.30	3.239	183.701613	8
6397	45	2012-10-02	803657.12	1	37.00	3.640	189.707605	8

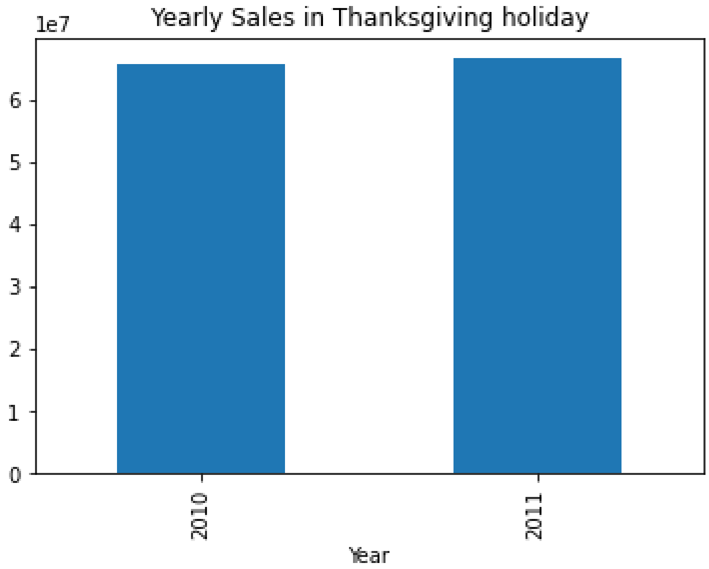
135 rows × 11 columns

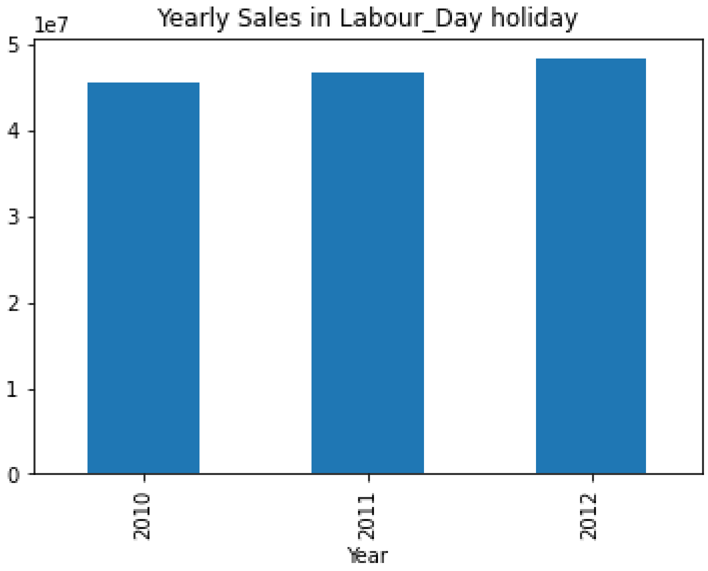
In [57]:

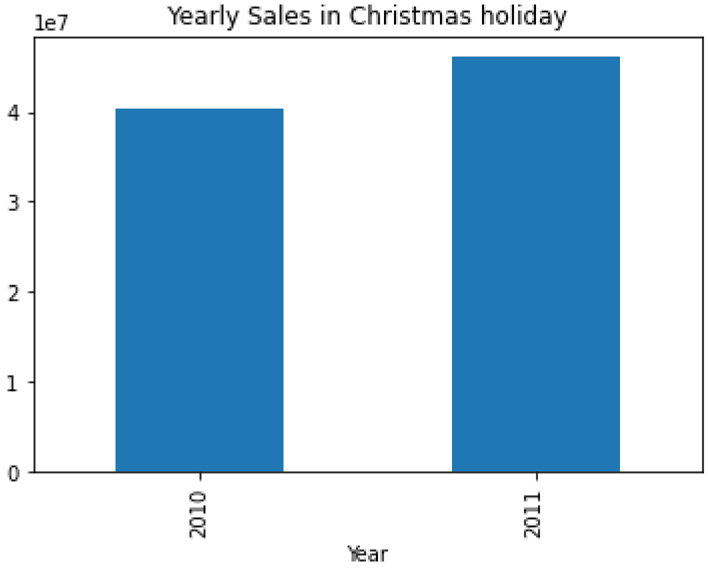
```
# Yearly Sales in holidays
Super_Bowl_df = pd.DataFrame(data.loc[data.Date.isin(Super_Bowl)].groupby('Year')['Weekly_Sales'].sum())
Thanksgiving_df = pd.DataFrame(data.loc[data.Date.isin(Thanksgiving)].groupby('Year')['Weekly_Sales'].sum())
Labour_Day_df = pd.DataFrame(data.loc[data.Date.isin(Labour_Day)].groupby('Year')['Weekly_Sales'].sum())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

```
Out[57]:

<AxesSubplot:title={'center':'Yearly Sales in Christmas holiday'}, xlabel='Ye
ar'>
```





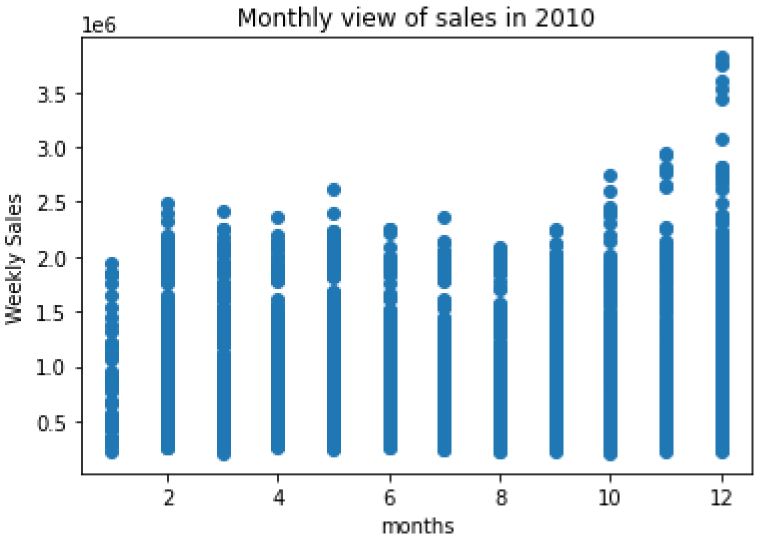


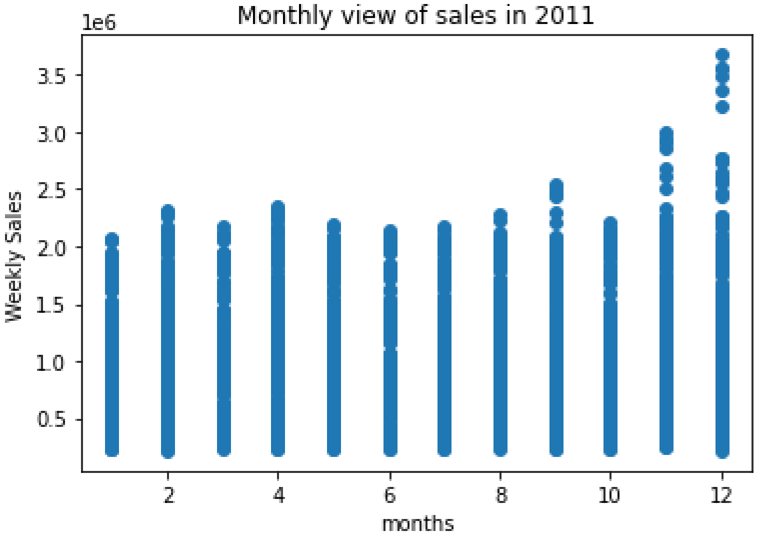


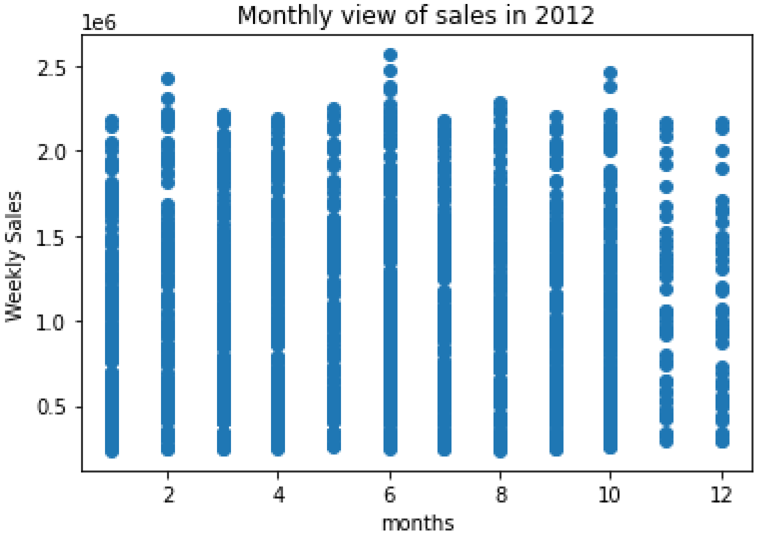
Q5: Provide a monthly and semester view of sales in units and give insights

In [58]:

```
# 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()
```


Monthly view of sales in 2010
1e6
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Weekly Sales
2
4
6
8
10
12
months


Monthly view of sales in 2011
1e6
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Weekly Sales
2
4
6
8
10
12
months

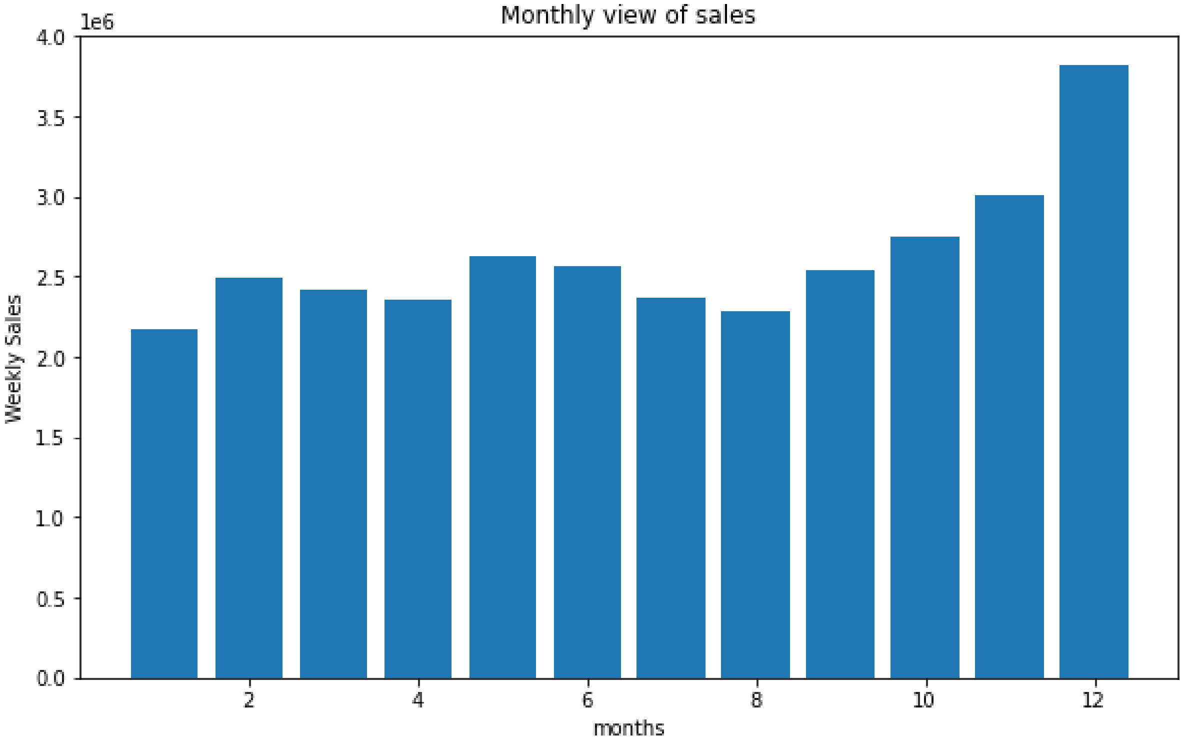

Monthly view of sales in 2012
1e6
2.5
2.0
1.5
1.0
0.5
Weekly Sales
2
4
6
8
10
12
months

In [59]:

```
# 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")
```

Out[59]:

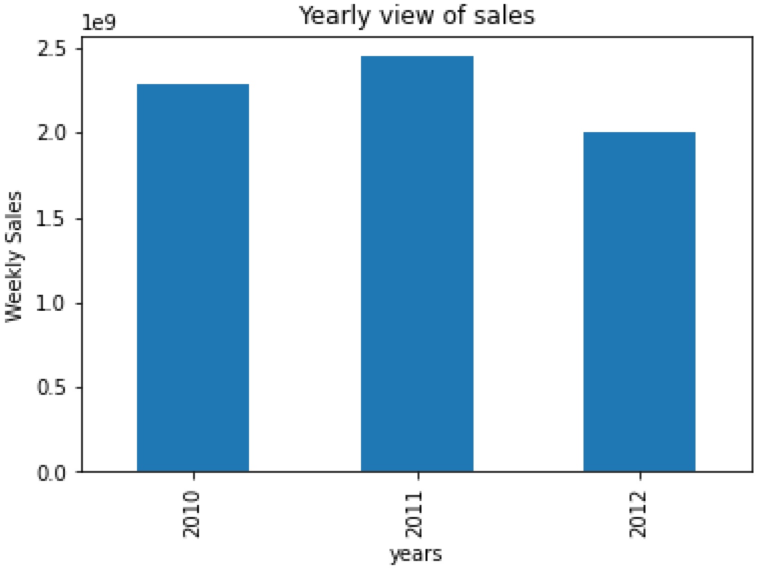
```
Text(0.5, 1.0, 'Monthly view of sales')
```



In [60]:

```
# 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");
```

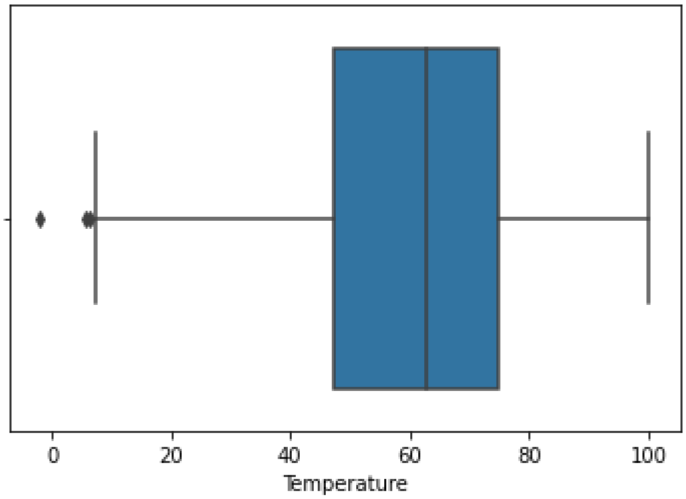
```
<Figure size 720x432 with 0 Axes>
```

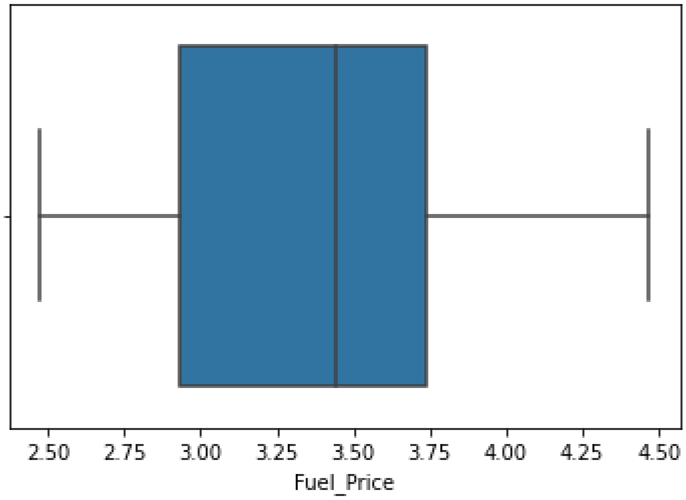


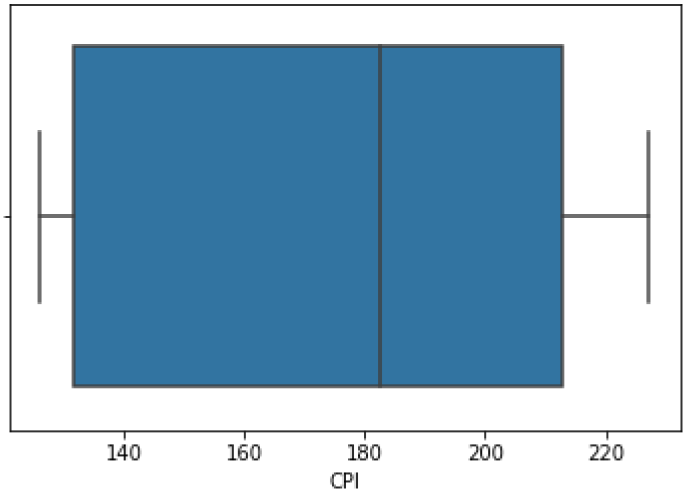
Build prediction models to forecast demand (Modeling)

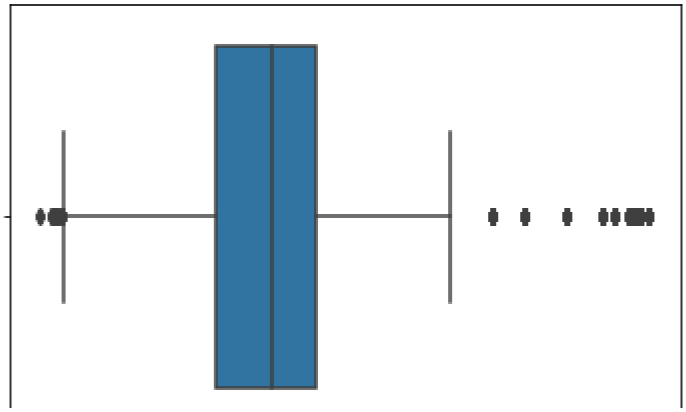
In [61]:

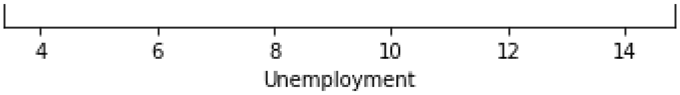
```
# find outliers
fig, axs = plt.subplots(4,figsize=(6,18))
X = data[['Temperature','Fuel_Price','CPI','Unemployment']]
for i,column in enumerate(X):
    sns.boxplot(data[column], ax=axs[i])
```


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





In [62]:

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

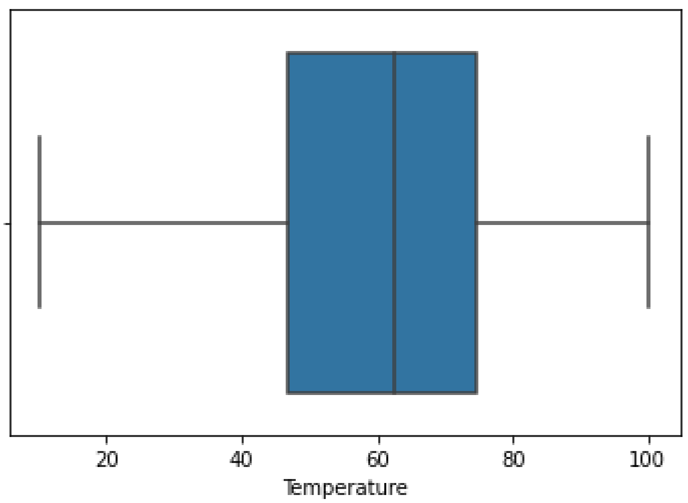
Out[62]:

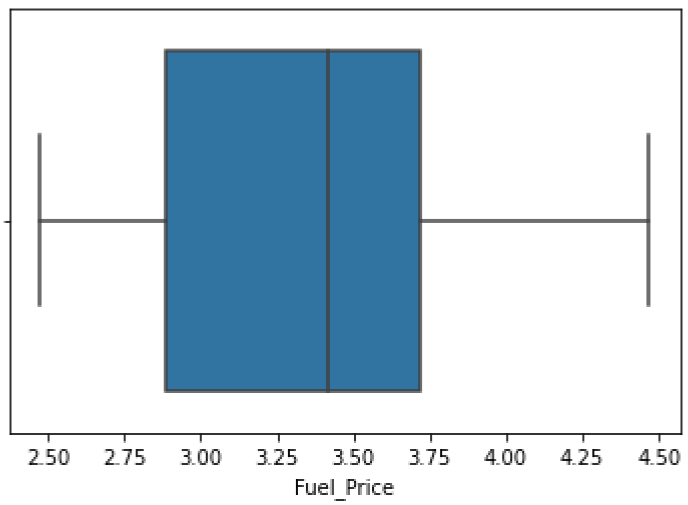
	Store	Date	Weekly_Sales	Holiday_Flag	Temperature	Fuel_Price	CPI	Unemployr
0	1	2010-05-02	1643690.90	0	42.31	2.572	211.096358	8
1	1	2010-12-02	1641957.44	1	38.51	2.548	211.242170	8
2	1	2010-02-19	1611968.17	0	39.93	2.514	211.289143	8
3	1	2010-02-26	1409727.59	0	46.63	2.561	211.319643	8
4	1	2010-05-03	1554806.68	0	46.50	2.625	211.350143	8
...	...	...	...	...	...	...	...	
6430	45	2012-09-28	713173.95	0	64.88	3.997	192.013558	8
6431	45	2012-05-10	733455.07	0	64.89	3.985	192.170412	8
6432	45	2012-12-10	734464.36	0	54.47	4.000	192.327265	8
6433	45	2012-10-19	718125.53	0	56.47	3.969	192.330854	8
6434	45	2012-10-26	760281.43	0	58.85	3.882	192.308899	8

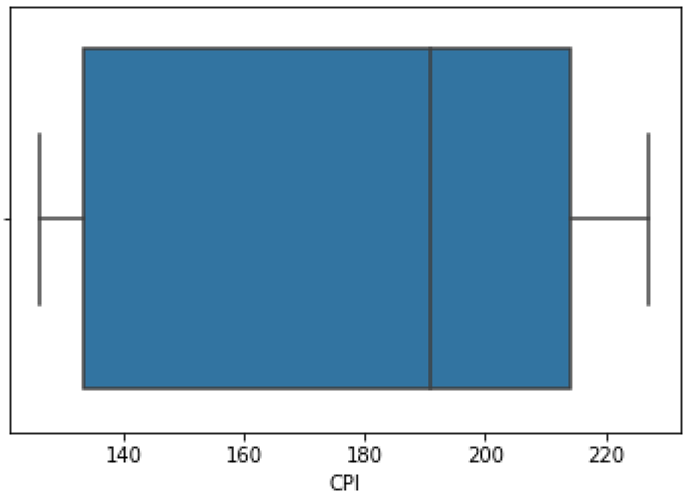
5658 rows × 11 columns

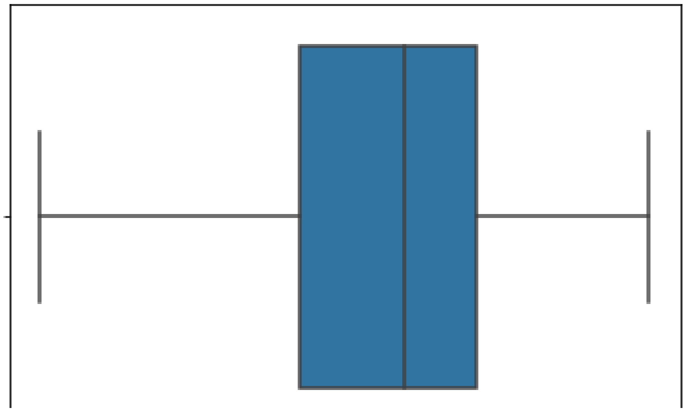
In [63]:

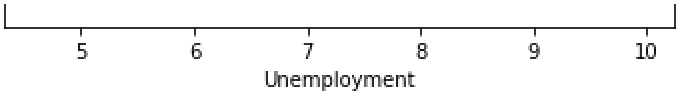
```
# check outliers
fig, axs = plt.subplots(4,figsize=(6,18))
X = data_new[['Temperature','Fuel_Price','CPI','Unemployment']]
for i,column in enumerate(X):
    sns.boxplot(data_new[column], ax=axs[i])
```


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





Build Model

In [64]:

```
# 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
```

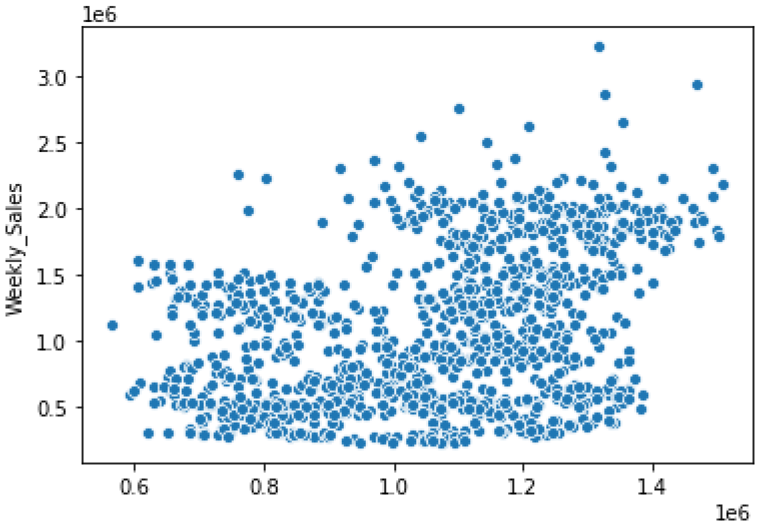
In [65]:

```
# 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)
```

In [66]:

```
# 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: 12.512726429399478
Mean Absolute Error: 445859.2353432851
Mean Squared Error: 279505769725.82086
Root Mean Squared Error: 528683.0522400173
```



# 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);

In [ ]:

In [ ]:

In [ ]: