# DSC630

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**Week 8 time series Modeling**

using the dataset us_retail_sales.csv to do a time seriea preduction, this data gives the total monthly retail sales in the US from January 1992 until June 2021.

In [ ]:

```
import numpy as np
import pandas as pd

# Loading the data
df = pd.read_csv("us_retail_sales.csv")

df.head()
```

In [26]:

```
# Reshape the date so months are in row.
df2 = pd.melt(df, id_vars=['YEAR'], value_vars=['JAN','FEB','MAR','APR','MAY','JUN','JUL','AUG','SEP','OCT','NOV','DEC'
        var_name='Month', value_name='Sales')
df2.head()
```

Out[26]:

| | YEAR | Month | Sales |
|---|---|---|---|
| **0** | 1992 | JAN | 146925.0 |
| **1** | 1993 | JAN | 157555.0 |
| **2** | 1994 | JAN | 167518.0 |
| **3** | 1995 | JAN | 182413.0 |
| **4** | 1996 | JAN | 189135.0 |

In [27]:

```
# Convert month to ordered numbers.
df2['Month'] = df2['Month'].map({'JAN' :1,'FEB' :2,'MAR' :3, 'APR' :4,'MAY' :5,'JUN' :6,'JUL' :7,'AUG' :8,'SEP' :9,'OCT
df2.head(13)
```

Out[27]:

|  | YEAR | Month | Sales |
|---|---|---|---|
| **0** | 1992 | 1 | 146925.0 |
| **1** | 1993 | 1 | 157555.0 |
| **2** | 1994 | 1 | 167518.0 |
| **3** | 1995 | 1 | 182413.0 |
| **4** | 1996 | 1 | 189135.0 |
| **5** | 1997 | 1 | 202371.0 |
| **6** | 1998 | 1 | 209666.0 |
| **7** | 1999 | 1 | 223997.0 |
| **8** | 2000 | 1 | 243436.0 |
| **9** | 2001 | 1 | 252654.0 |
| **10** | 2002 | 1 | 256307.0 |
| **11** | 2003 | 1 | 267230.0 |
| **12** | 2004 | 1 | 278913.0 |

In [29]:

```
# Sort the year and month in orders.
sorted = df2.sort_values(by = ['YEAR','Month'], ascending = [True, True], na_position = 'first')
sorted.head()
```

Out[29]:

|  | YEAR | Month | Sales |
|---|---|---|---|
| **0** | 1992 | 1 | 146925.0 |
| **30** | 1992 | 2 | 147223.0 |
| **60** | 1992 | 3 | 146805.0 |
| **90** | 1992 | 4 | 148032.0 |
| **120** | 1992 | 5 | 149010.0 |

In [9]:

```
# Check the data type
sorted.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 48 entries, 0 to 47
Data columns (total 3 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   YEAR    48 non-null     int64
 1   Month   48 non-null     int64
 2   Sales   48 non-null     int64
dtypes: int64(3)
memory usage: 1.5 KB
```

In [30]:

```
# Merge the year and month as a date
sorted['Date']= sorted['YEAR'].astype(str) +'-'+ sorted['Month'].astype(str)
```

In [71]:

```
#sorted["Month"] = pd.to_datetime(sorted.Month, errors='coerce').dt.month
#sorted["YEAR"] = pd.to_datetime(sorted.YEAR, errors='coerce').dt.year
#sorted['YEAR'] = pd.to_datetime(sorted['YEAR'], format='%Y')
#sorted['Month'] = pd.to_datetime(sorted['Month'], format='%m')
```

In [21]:

```
#sorted.head(2)
```

Out[21]:

|  | YEAR | Month | Sales | date |
|---|---|---|---|---|
| **0** | 1992 | 1 | 146925 | 1992-1 |
| **4** | 1992 | 2 | 147223 | 1992-2 |

In [32]:

```
# Convert Date into datetime format
sorted['Date']= pd.to_datetime(sorted['Date'])
```

In [33]:

```
sorted.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 360 entries, 0 to 359
Data columns (total 4 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   YEAR    360 non-null    int64
 1   Month   360 non-null    int64
 2   Sales   354 non-null    float64
 3   Date    360 non-null    datetime64[ns]
dtypes: datetime64[ns](1), float64(1), int64(2)
memory usage: 14.1 KB
```

In [42]:

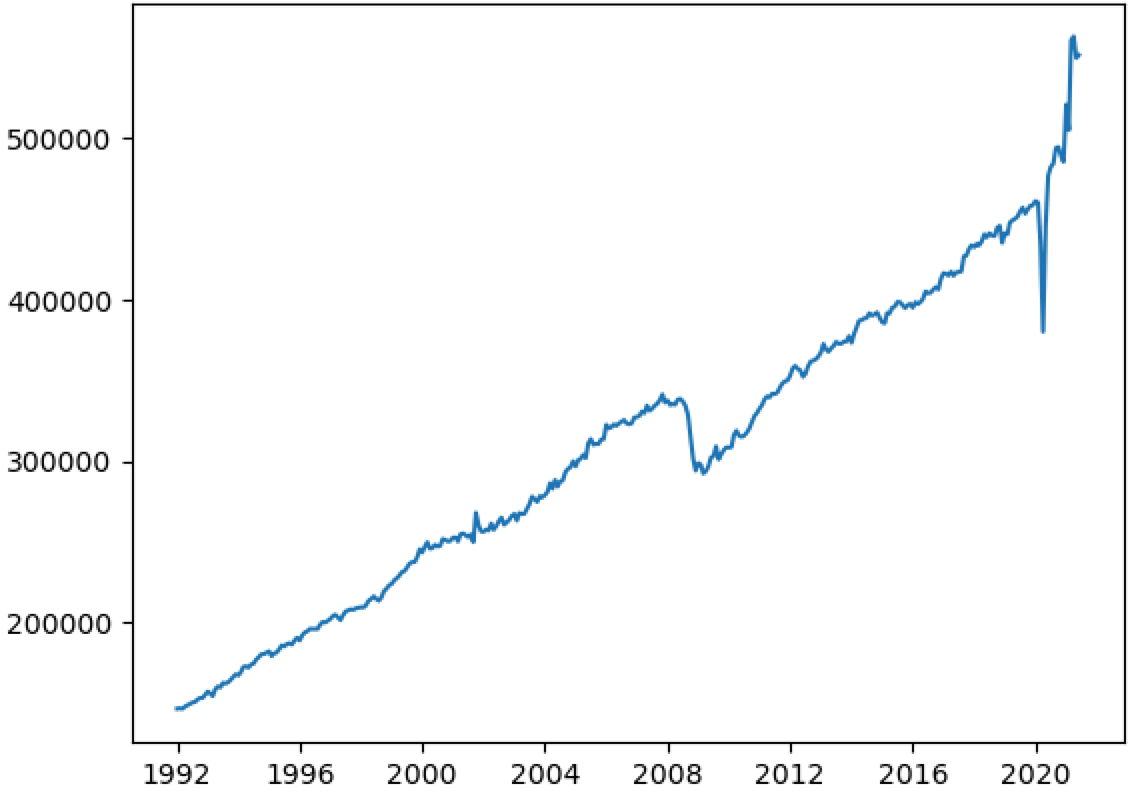
```
# Create a new dataframe with Date and Sales only.
clean =sorted[['Sales','Date']]
clean.head(4)
clean.shape
```

Out[42]:

```
(360, 2)
```

In [114…

```
# Check the overall trend of sales to spot anything abnormal

import matplotlib.pyplot as plt

plt.plot(clean['Date'], clean['Sales'])  # Plot the chart
plt.show()
print('There are 2 abnormal sales varaitions, at end of 2008 and Apr-2020, plus, the sales growth rate at 2021 are also
```



```
There are 2 abnormal sales varaitions, at end of 2008 and Apr-2020, plus, the sales growth rate at 2021 are also unprec
edented.
```

In [74]:

```
# Since I only has one column to process, direct split the data into train and test set
x = clean.Sales
train = x[:342]
test = x[342:354]
print(train.size, test.size)
```

```
342 12
```

In [62]:

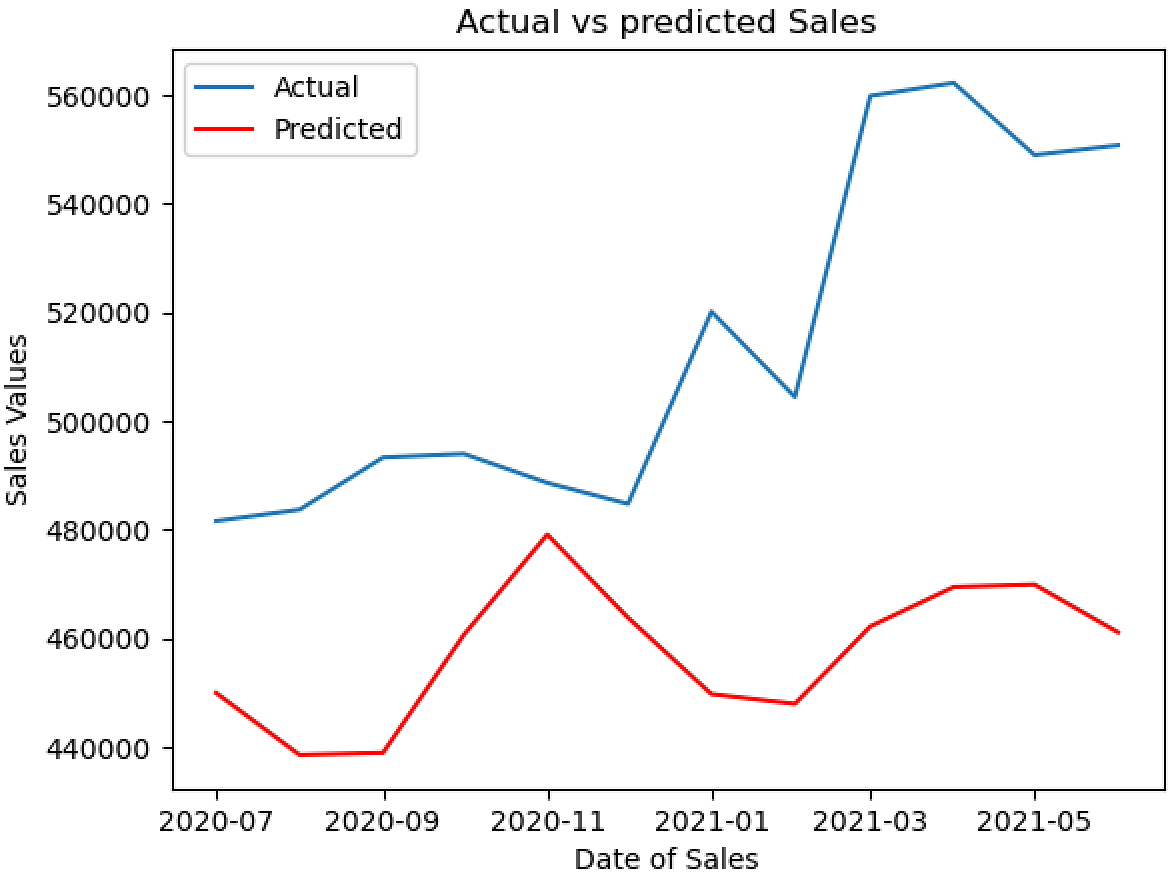
```
#Using AR model

#Suspend the warning
import warnings
warnings.filterwarnings('ignore')

from statsmodels.tsa.ar_model import AutoReg
from sklearn.metrics import mean_squared_error

res = AutoReg(train, lags = 10).fit()
```

In [89]:

```
# Predict the sales from July-2020 to June-2021
predictions = res.predict(start=343, end=354)
```

In [115…

```
# Visualize the prediction vs the actual sales.
truevalue= x[342:354]
plt.plot(clean.Date[342:354],truevalue, label = "Actual")
plt.plot(clean.Date[342:354],predictions, label ='Predicted', color='red')
plt.legend()
plt.xlabel("Date of Sales")
plt.ylabel("Sales Values")
plt.title("Actual vs predicted Sales")
plt.show()
```



In [116…

```
#Calculate R2, RMSE, and MAE on predictions

import sklearn.metrics as metrics
test_r2 = metrics.r2_score(truevalue, predictions)
test_mae = metrics.mean_absolute_error(truevalue, predictions)
test_mse = metrics.mean_squared_error(truevalue, predictions)
test_rmse = np.sqrt(test_mse)


print('prediction RSME value is:', test_rmse)
```

```
prediction RSME value is: 63378.83236300476
```

**Conclusion:**

the RSME is very big. so the model did not work very well. From Charts above, the model did predict the trend but the values were off quite a bit. I think the big abnormal sales dip in April-2020 and unprecedented sales growth in 2021 impact the development of model negatively.

Resource: The dataset is provided by Bellevue university for use in DSC630 class.