Predicting Metro Interstate Traffic Volume: A Time Series Forecasting Approach with ARIMA

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DSC680: Applied Data Science

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Dataset: https://archive.ics.uci.edu/ml/datasets/Metro+Interstate+Traffic+Volume

Import and View Data

In [1]:

```
# Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
```

In [2]:

```
# import dataset and preview
df = pd.read_csv("Potential_Datasets/Metro_Interstate_Traffic_Volume.csv.gz", compressi
df.head()
```

Out[2]:

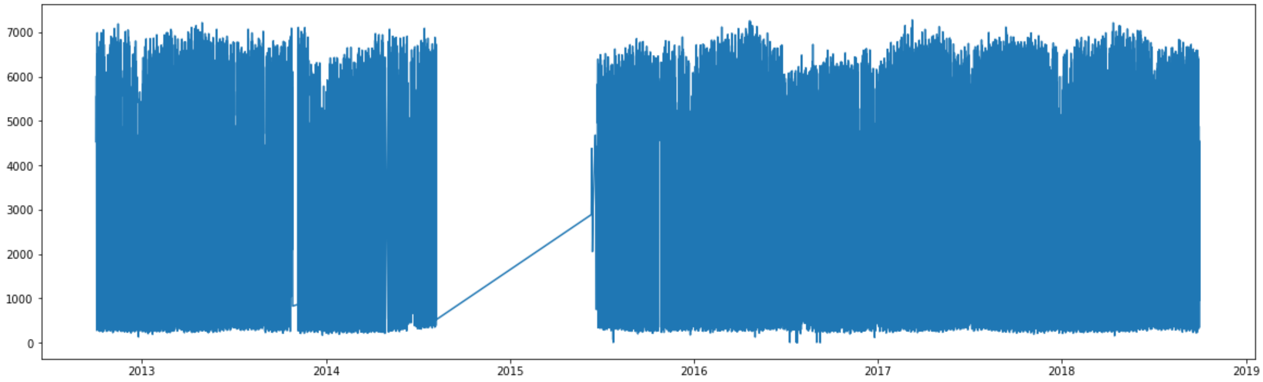
	holiday	temp	rain_1h	snow_1h	clouds_all	weather_main	weather_description	date_time	traffic_v
0	None	288.28	0.0	0.0	40	Clouds	scattered clouds	2012-10-02 09:00:00	
1	None	289.36	0.0	0.0	75	Clouds	broken clouds	2012-10-02 10:00:00	
2	None	289.58	0.0	0.0	90	Clouds	overcast clouds	2012-10-02 11:00:00	
3	None	290.13	0.0	0.0	90	Clouds	overcast clouds	2012-10-02 12:00:00	
4	None	291.14	0.0	0.0	75	Clouds	broken clouds	2012-10-02 13:00:00	

In [3]:

```
# Let's make sure 'date' is actually a date in pandas
df["date_time"] = pd.to_datetime(df["date_time"])
```

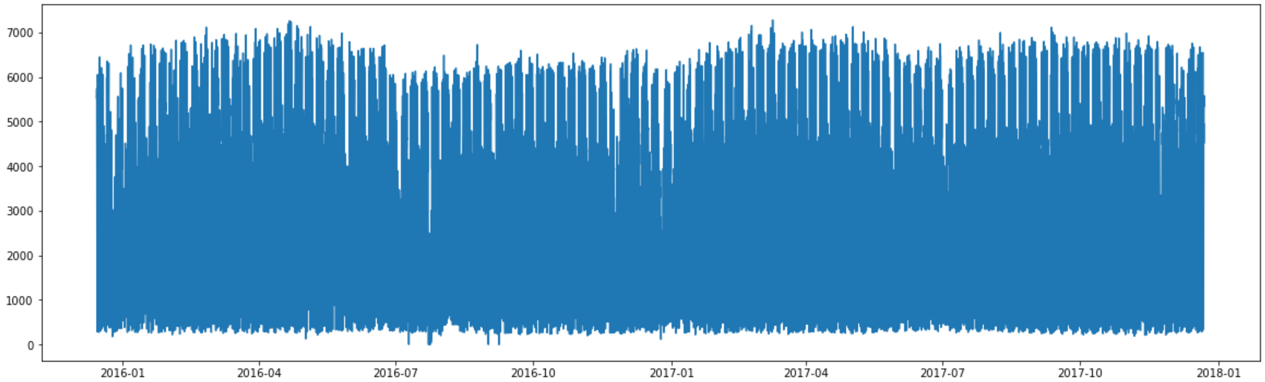
In [4]:

```
# plot the dataset
fig, ax = plt.subplots(figsize=(20, 6))
ax.plot(df["date_time"], df["traffic_volume"]);
```



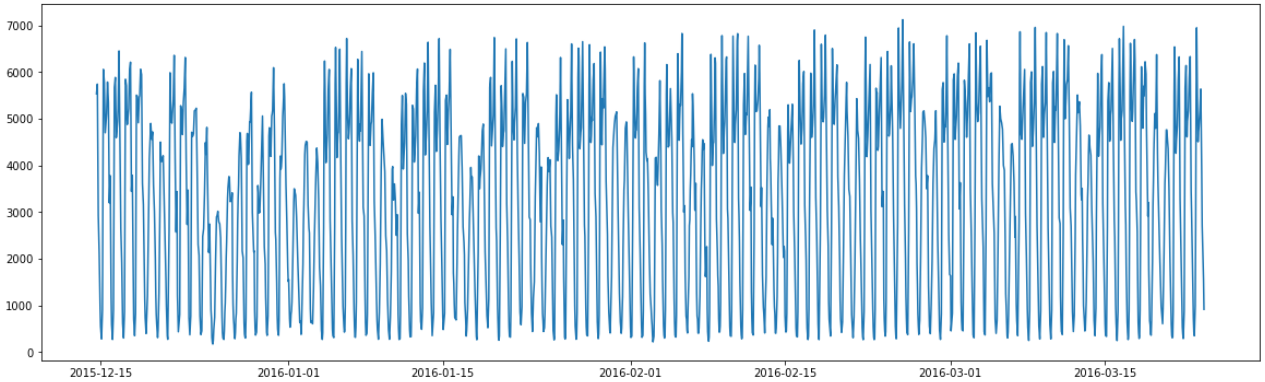
In [5]:

```
# plot the dataset
fig, ax = plt.subplots(figsize=(20, 6))
ax.plot(df["date_time"][20000:40000], df["traffic_volume"][20000:40000]);
```



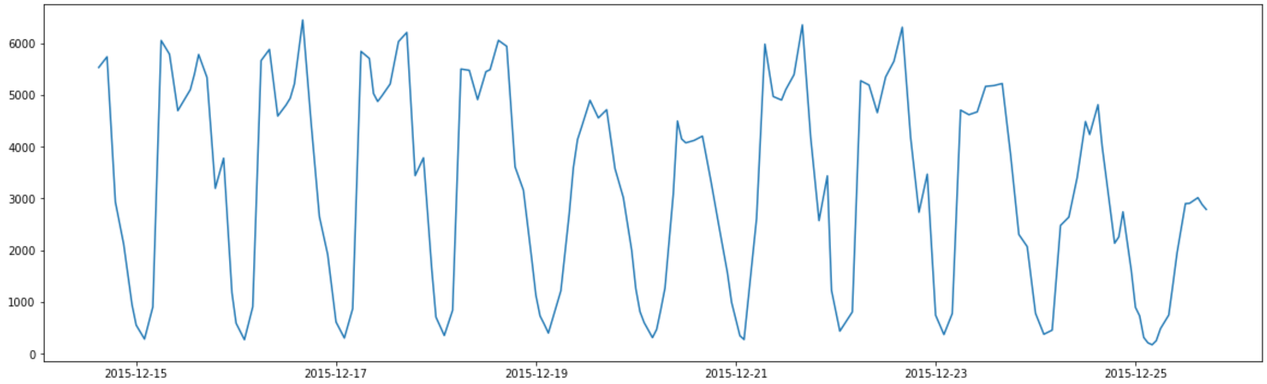
In [6]:

```
# plot the dataset
fig, ax = plt.subplots(figsize=(20, 6))
ax.plot(df["date_time"][20000:22000], df["traffic_volume"][20000:22000]);
```



In [7]:

```
# plot the dataset
fig, ax = plt.subplots(figsize=(20, 6))
ax.plot(df["date_time"][20000:20200], df["traffic_volume"][20000:20200]);
```



Clean Dataset

In [8]:

```
# drop data prior to 2015 - 07
df_complete = df[df["date_time"] > '2015-07-01 09:00:00']
```

In [9]:

```
df_complete.shape
```

Out[9]:

```
(32038, 9)
```

In [10]:

```
# set index
df_complete2 = df_complete.set_index('date_time')
df_complete2.index = pd.DatetimeIndex(df_complete2.index).to_period('H')
```

In [11]:

```
# drop variables
target_df = df_complete['traffic_volume']
target_df.head()
```

Out[11]:

```
16166    4273
16167    4469
16168    4625
16169    4462
16170    4996
Name: traffic_volume, dtype: int64
```

Checking Stationarity with Augmented Dicky-Fuller Test

https://analyticsindiamag.com/complete-guide-to-dickey-fuller-test-in-time-series-analysis/

In [12]:

```
from statsmodels.tsa.stattools import adfuller
```

In [13]:

```
series = target_df.values
```

In [14]:

```
# ADF Test
result = adfuller(series, autolag='AIC')
```

In [15]:

```
# cite source here: https://analyticsindiamag.com/complete-guide-to-dickey-fuller-test-

print('ADF Statistic: %f' % result[0])

print('p-value: %f' % result[1])

print('Critical Values:')

for key, value in result[4].items():
    print('\t%s: %.3f' % (key, value))
if result[0] < result[4]["5%"]:
    print ("Reject Ho - Time Series is Stationary")
else:
    print ("Failed to Reject Ho - Time Series is Non-Stationary")
```

```
ADF Statistic: -21.926192
p-value: 0.000000
Critical Values:
        1%: -3.431
        5%: -2.862
        10%: -2.567
Reject Ho - Time Series is Stationary
```

Determining Parameters (p,d,q)

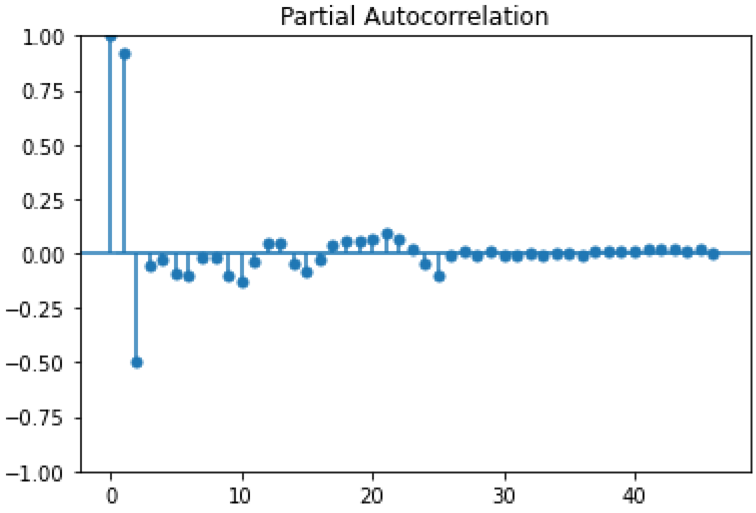
We know d=0 because the time series is stationary.

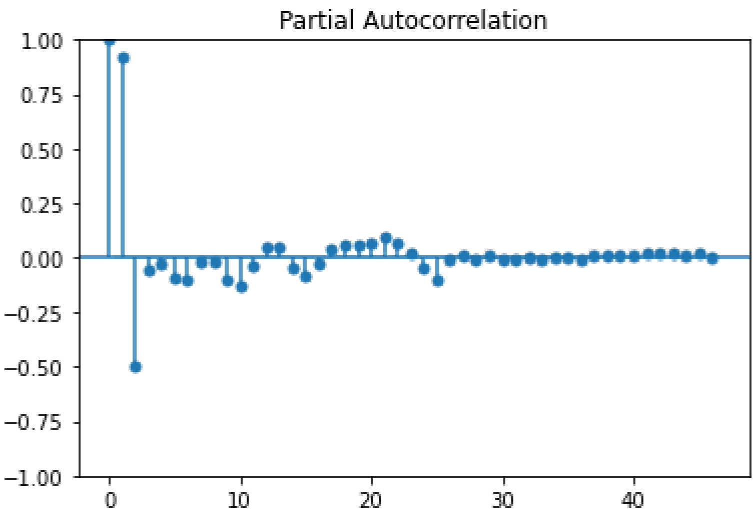
In [16]:

```
# Finding p (AR Term)
plot_pacf(series)
```

```
C:\Users\karli\AppData\Roaming\Python\Python39\site-packages\statsmodels\graphics\tsaplo
ts.py:348: FutureWarning: The default method 'yw' can produce PACF values outside of the
[-1,1] interval. After 0.13, the default will change tounadjusted Yule-Walker ('ywm'). Y
ou can use this method now by setting method='ywm'.
  warnings.warn(
```

Out[16]:





Auto ARIMA

In [17]:

```
! pip install pmdarima --user
```

```
Requirement already satisfied: pmdarima in c:\users\karli\appdata\roaming\python\python3
9\site-packages (2.0.3)
Requirement already satisfied: Cython!=0.29.18,!=0.29.31,>=0.29 in c:\programdata\anacon
da3\lib\site-packages (from pmdarima) (0.29.24)
Requirement already satisfied: joblib>=0.11 in c:\users\karli\appdata\roaming\python\pyt
hon39\site-packages (from pmdarima) (1.2.0)
Requirement already satisfied: numpy>=1.21.2 in c:\users\karli\appdata\roaming\python\py
thon39\site-packages (from pmdarima) (1.22.4)
Requirement already satisfied: statsmodels>=0.13.2 in c:\users\karli\appdata\roaming\pyt
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Requirement already satisfied: setuptools!=50.0.0,>=38.6.0 in c:\programdata\anaconda3\l
ib\site-packages (from pmdarima) (58.0.4)
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Requirement already satisfied: scipy>=1.3.2 in c:\programdata\anaconda3\lib\site-package
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Requirement already satisfied: python-dateutil>=2.7.3 in c:\programdata\anaconda3\lib\si
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Requirement already satisfied: six>=1.5 in c:\programdata\anaconda3\lib\site-packages (f
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Requirement already satisfied: threadpoolctl>=2.0.0 in c:\programdata\anaconda3\lib\site
-packages (from scikit-learn>=0.22->pmdarima) (2.2.0)
Requirement already satisfied: packaging>=21.3 in c:\users\karli\appdata\roaming\python
\python39\site-packages (from statsmodels>=0.13.2->pmdarima) (23.1)
Requirement already satisfied: patsy>=0.5.2 in c:\programdata\anaconda3\lib\site-package
s (from statsmodels>=0.13.2->pmdarima) (0.5.2)
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```

```
WARNING: Ignoring invalid distribution -equests (c:\programdata\anaconda3\lib\site-packa
ges)
```

In [18]:

```
from pmdarima.arima import auto_arima
```

In [19]:

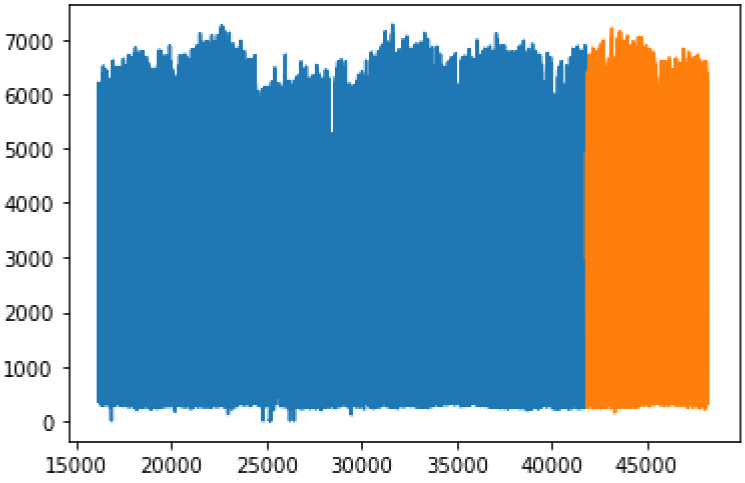
```
# train and test split
train_size = int(len(target_df) * 0.8)
train = target_df[:train_size]
test = target_df[train_size:]
```

In [20]:

```
train.plot()
test.plot()
```

Out[20]:

```
<AxesSubplot:>
```



In [21]:

```
arima_model = auto_arima(train, trace=True, information_criterion='bic', max_order = 5)
```

```
Performing stepwise search to minimize bic
 ARIMA(2,0,2)(0,0,0)[0] intercept   : BIC=409019.857, Time=3.69 sec
 ARIMA(0,0,0)(0,0,0)[0] intercept   : BIC=461602.504, Time=0.29 sec
 ARIMA(1,0,0)(0,0,0)[0] intercept   : BIC=415718.150, Time=0.64 sec
 ARIMA(0,0,1)(0,0,0)[0] intercept   : BIC=435734.986, Time=4.36 sec
 ARIMA(0,0,0)(0,0,0)[0]             : BIC=495255.962, Time=0.17 sec
 ARIMA(1,0,2)(0,0,0)[0] intercept   : BIC=409756.291, Time=2.91 sec
 ARIMA(2,0,1)(0,0,0)[0] intercept   : BIC=409026.840, Time=3.11 sec
 ARIMA(3,0,2)(0,0,0)[0] intercept   : BIC=408968.620, Time=13.62 sec
 ARIMA(3,0,1)(0,0,0)[0] intercept   : BIC=409009.407, Time=6.50 sec
 ARIMA(4,0,2)(0,0,0)[0] intercept   : BIC=408904.955, Time=24.20 sec
 ARIMA(4,0,1)(0,0,0)[0] intercept   : BIC=408990.616, Time=8.81 sec
 ARIMA(5,0,2)(0,0,0)[0] intercept   : BIC=408307.740, Time=39.89 sec
 ARIMA(5,0,1)(0,0,0)[0] intercept   : BIC=408794.236, Time=12.31 sec
 ARIMA(5,0,3)(0,0,0)[0] intercept   : BIC=408604.551, Time=40.86 sec
 ARIMA(4,0,3)(0,0,0)[0] intercept   : BIC=408766.504, Time=30.91 sec
 ARIMA(5,0,2)(0,0,0)[0]             : BIC=410777.842, Time=18.99 sec

Best model:  ARIMA(5,0,2)(0,0,0)[0] intercept
Total fit time: 211.328 seconds
```

In [22]:

```
arima_model.summary()
```

Out[22]:

SARIMAX Results

Dep. Variable:	y	**No. Observations:**	25630
Model:	SARIMAX(5, 0, 2)	**Log Likelihood**	-204108.188
Date:	Sun, 07 May 2023	**AIC**	408234.376
Time:	11:52:31	**BIC**	408307.740
Sample:	0	**HQIC**	408258.093
	- 25630		
Covariance Type:	opg		

	coef	**std err**	**z**	**P>|z|**	**[0.025**	**0.975]**
intercept	548.2602	16.349	33.534	0.000	516.216	580.304
ar.L1	1.8325	0.010	187.205	0.000	1.813	1.852
ar.L2	-1.9355	0.019	-101.544	0.000	-1.973	-1.898
ar.L3	1.2753	0.019	67.209	0.000	1.238	1.313
ar.L4	-0.2299	0.012	-19.206	0.000	-0.253	-0.206
ar.L5	-0.1175	0.006	-20.842	0.000	-0.129	-0.106
ma.L1	-0.5065	0.009	-56.699	0.000	-0.524	-0.489
ma.L2	0.8779	0.009	100.832	0.000	0.861	0.895
sigma2	4.883e+05	3010.923	162.182	0.000	4.82e+05	4.94e+05

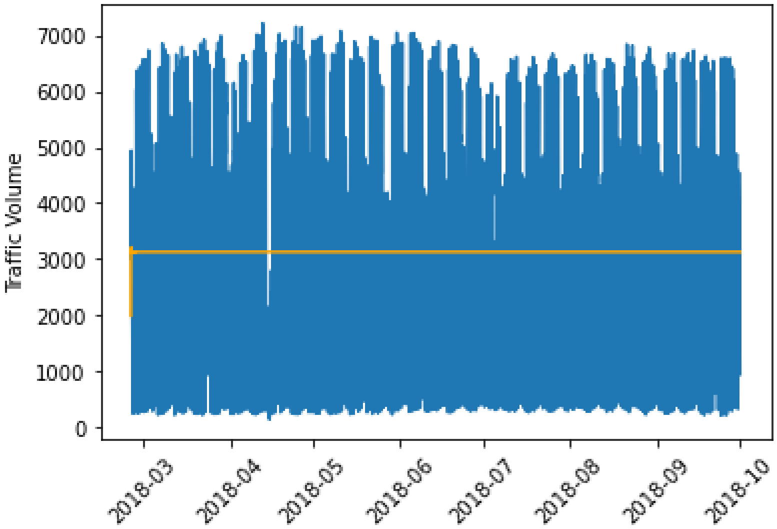
Ljung-Box (L1) (Q):	5.85	**Jarque-Bera (JB):**	39939.19
Prob(Q):	0.02	**Prob(JB):**	0.00
Heteroskedasticity (H):	0.51	**Skew:**	0.73
Prob(H) (two-sided):	0.00	**Kurtosis:**	8.94

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).

In [28]:

```
test_plot = df_complete[train_size:]
plt.plot(test_plot['date_time'], test)
plt.plot(test_plot['date_time'], arima_model.predict(n_periods=test.shape[0]), color='o
plt.xticks(rotation=45)
plt.ylabel('Traffic Volume')
plt.show()
```

```
C:\Users\karli\AppData\Roaming\Python\Python39\site-packages\statsmodels\tsa\base\tsa_mo
del.py:834: ValueWarning: No supported index is available. Prediction results will be gi
ven with an integer index beginning at `start`.
  return get_prediction_index(
```



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