ATX Traffic Prediction

August 5, 2022

1 Austin Traffic Predictions

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1.1.1 August 5th 2022

An experiment using a SARIMA time-series model to predict what future traffic volumes will look like.

SARIMA Model SARIMA is an acronym for:

- Seasonal
- Autoregressive
- Integrated
- Moving Average

A SARIMA model takes in parameters for each of these sub-models and combines them to make predictions. It is typically written as:
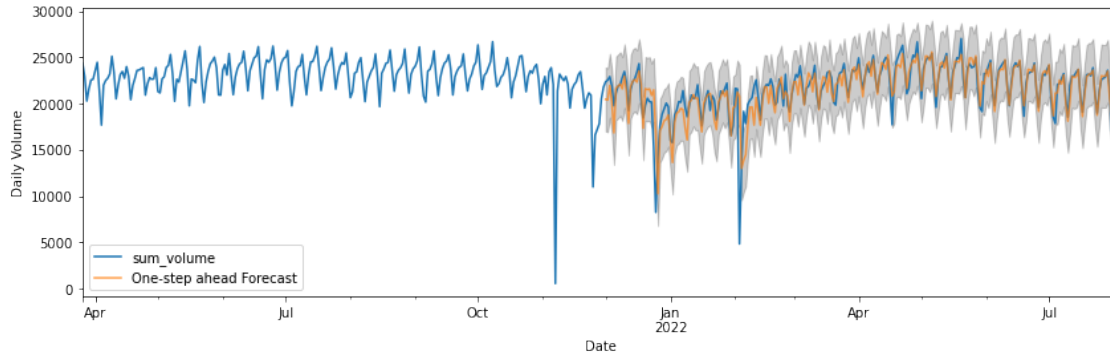
$$SARIMA = (p, d, q) \times (P, D, Q)_s$$

s is the period of the seasonal parameter, in this case we're using **7** to account for the day-of-week effects of traffic.

To pick parameters for SARIMA, we simply do a grid-search of p, d, q, P, D, Q parameters to see which has the best performance in a statistic called AIC.

The most optimal found for grid search in space 0 to 2:

$$SARIMA = (0, 1, 2) \times (0, 2, 2, 7)$$

This produces a pretty good result for the day-ahead prediction:

Data source This data is sourced from the Austin Open Data portal's Camera Traffic Counts dataset.

I've limited this analysis to the "OLTORF ST / 1ST ST" intersection as it has the most complete data.

Drawbacks

- Lack of uniqueness: SARIMA models are not unique, so many different parameters may actually provide similar or identical results.

- Holidays: this model heavily relies on day-of-week seasonality and the larger trend in the moving average, so it will not be able to change its prediction based on a 3-day weekend or Thanksgiving, for example

- Weather: this model doesn't consider the effects of weather apart from the seasonal effects it has on traffic volumes.

```python
[1]:
# Python default library
import warnings

# Third-party libraries
import itertools
import matplotlib.pyplot as plt
import pandas as pd
import plotly.graph_objects as go
import statsmodels.api as sm
from pylab import rcParams
```

Downloading data and transforming it into a datetime index, filling missing dates with zeroes.

```python
[2]: DATA_URL = "https://data.austintexas.gov/resource/sh59-i6y9.csv?
    ↪$select=sum(volume),date_trunc_ymd(read_date)%20as%20date&atd_device_id=7341&$group=date&$o
```

```python
[3]: df = pd.read_csv(DATA_URL,index_col=1)
```

```
[4]: df
```

```
[4]:                        sum_volume
      date
      2022-08-03T00:00:00.000      23364
      2022-08-02T00:00:00.000      22347
      2022-08-01T00:00:00.000      21051
      2022-07-31T00:00:00.000      17029
      2022-07-30T00:00:00.000      21590
      …                             …
      2021-03-30T00:00:00.000      22549
      2021-03-29T00:00:00.000      21590
      2021-03-28T00:00:00.000      20283
      2021-03-27T00:00:00.000      22915
      2021-03-26T00:00:00.000      24339

      [496 rows x 1 columns]
```

```
[5]: df.index = pd.DatetimeIndex(df.index)
     all_days = pd.date_range(df.index.min(), df.index.max(), freq='D')
     df = df.reindex(all_days)
     y = df[['sum_volume']]
     y['sum_volume'] = y['sum_volume'].fillna(0)
```

Plotting seasonal components

```
[21]: rcParams['figure.figsize'] = 18, 8
      decomposition = sm.tsa.seasonal_decompose(y, model='additive')
      fig = decomposition.plot()
      plt.show()
```

```
[22]: p = d = q = range(0, 3)
      pdq = list(itertools.product(p, d, q))
      seasonal_pdq = [(x[0], x[1], x[2], 7) for x in list(itertools.product(p, d, q))]
```

```
[23]: # Grid search of pdq x PDQ parameters
      warnings.filterwarnings("ignore")

      res = []

      for param in pdq:
          for param_seasonal in seasonal_pdq:
              try:
                  mod = sm.tsa.statespace.
       →SARIMAX(y,order=param,seasonal_order=param_seasonal,enforce_stationarity=True,enforce_inver
                  results = mod.fit(disp=0)
                  print('ARIMA{}x{}12 - AIC:{}'.format(param,param_seasonal,results.
       →aic))

                  res.append([param,param_seasonal,results.aic])

              except:
                  continue
```

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[25]:
```python
# best result:
res[0]
```

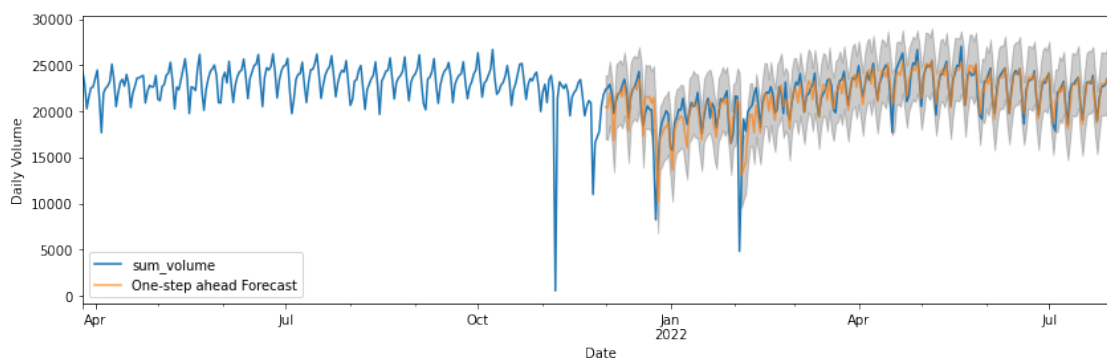[25]: `[(0, 1, 2), (0, 2, 2, 7), 8611.366636552555]`

[6]:
```python
# Fit model to the best parameters
mod = sm.tsa.statespace.
 →SARIMAX(y,order=(0,1,2),seasonal_order=(0,2,2,7),enforce_stationarity=True,enforce_invertib
results = mod.fit(disp=0)
```

[7]:
```python
# One-step ahead chart
pred = results.get_prediction(start=pd.to_datetime('2021-12-01'), dynamic=False)
pred_ci = pred.conf_int()
ax = y['2015':].plot(label='observed')
pred.predicted_mean.plot(ax=ax, label='One-step ahead Forecast', alpha=.7,␣
 →figsize=(14, 4))
ax.fill_between(pred_ci.index,
                pred_ci.iloc[:, 0],
                pred_ci.iloc[:, 1], color='k', alpha=.2)
ax.set_xlabel('Date')
ax.set_ylabel('Daily Volume')
plt.legend()
plt.show()
```

```
[8]:  # Three-week prediction chart
      fig, ax = plt.subplots(figsize=(15, 5))

      y[y.index > '2022-07-01'].plot(ax=ax)

      fcast = results.get_forecast(steps=21).summary_frame()
      ax = fcast['mean'].plot(ax=ax, style='k--')
      ax.fill_between(fcast.index, fcast['mean_ci_lower'], fcast['mean_ci_upper'],␣
       ↪color='k', alpha=0.1)
      ax.set_ylabel('Daily Volume')
      ax.set_xlabel('Date')
      ax.set_title("3-Week Prediction")
      plt.show(ax)
```