CP2403 - Project – Part 2 – Time Series Analysis

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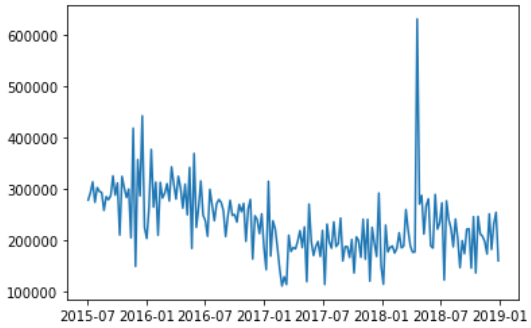
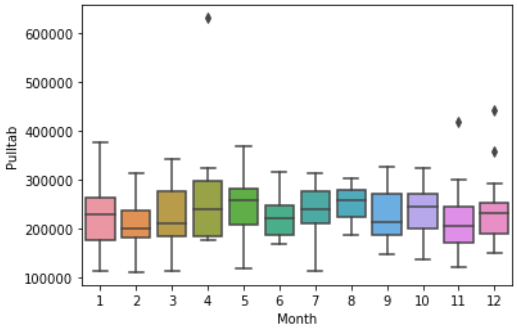
1: Time Series Plot

Figure 1: Line plot of raw time series data. The lottery values used for this time series analysis were the "Pulltab" column. At first glance, the time series does not appear to be very consistent or stationary.



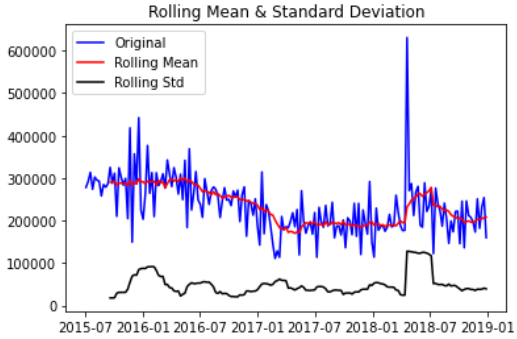
2: Box Plot

Figure 2: Box plot of time series with values grouped by month. This plot shows that the deviation from the mean is fairly large for most months, which could indicate trends and inconsistencies in the time series.



3: Rolling Mean & Standard Deviation Plot of Time Series

Figure 3: Rolling mean and standard deviation plot. In a stationary time series, the rolling mean should not vary, and the standard deviation should resemble a consistent periodic shape. The shape of the red line reveals that this time series may not be stationary.



4: Results of Dickey-Fuller Test of Time Series

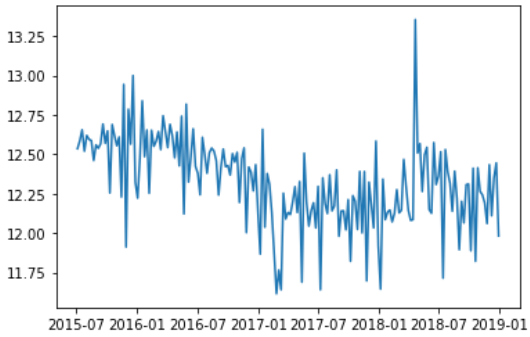
```
Results of Dickey-Fuller Test:
Test Statistic                  -2.387211
p-value                          0.145379
#Lags Used                       4.000000
Number of Observations Used    178.000000
Critical Value (1%)             -3.467632
Critical Value (5%)             -2.877918
Critical Value (10%)            -2.575501
```

H_0: The time series is non-stationary
H_a: The time series is stationary

The Dickey-Fuller stationarity test produces a p-value of 0.145379, which is > 0.05. This indicates that the "Pulltab" time series is non-stationary.

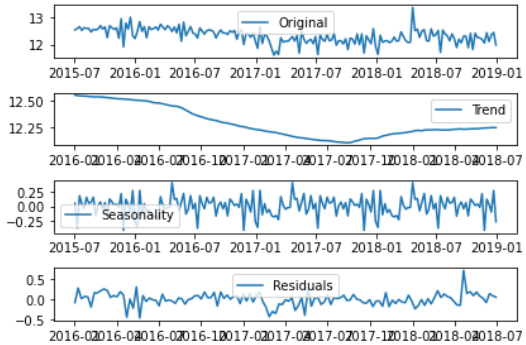
5: Log Plot of Time Series

Figure 4: Log plot of "Pulltab" time series. It appears to closely resemble the raw data, but the variance has been stabilized.



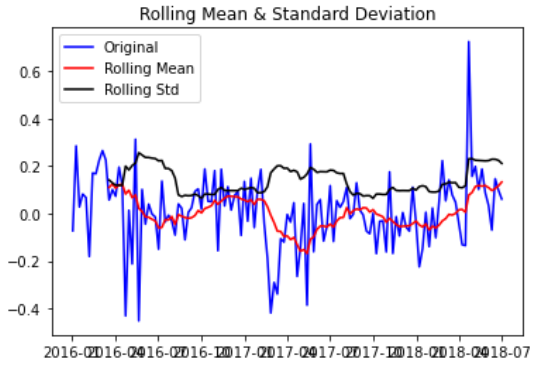
6: Seasonal Decompose plot of Time Series

Figure 5: Decomposition of time series. From these graphs, we can note a decreasing then increasing trend, fairly consistent seasonality, and residuals that resemble the original data points.



7: Rolling Mean & Standard Deviation Plot of Residual

Figure 6: Rolling mean and standard deviation plot of "Residual" part of decomposed time series. The rolling mean and standard deviation fluctuate, but there appears to be less of a significant trend than was present in the raw data.



8: Results of Dickey-Fuller Test of Residual

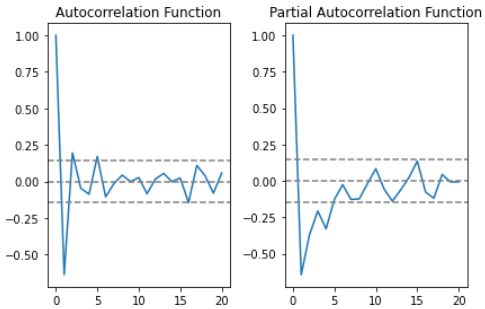
```
Results of Dickey-Fuller Test:
Test Statistic                  -5.602576
p-value                          0.000001
#Lags Used                       1.000000
Number of Observations Used    129.000000
Critical Value (1%)             -3.482088
Critical Value (5%)             -2.884219
Critical Value (10%)            -2.578864
```

H_0: The time series is non-stationary
H_a: The time series is stationary

The Dickey-Fuller stationarity test produces a p-value of 0.000001, which is < 0.05. This indicates that the Residual of the “Pulltab” time series is stationary.

9: ACF and PACF plot

Figure 7: Autocorrelation and Partial Autocorrelation functions. The p and q values for the ARIMA model were obtained from these graphs. On each of the plots, the value where the line crosses the upper confidence interval is closest to 1, so we set p and q to 1.

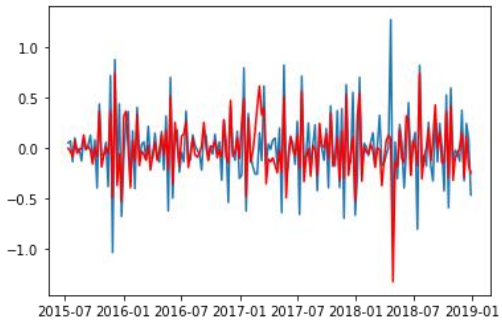


10: p, d and q values

P = 1
D = 1
Q = 1

11: ARIMA Plot

Figure 8: Plot of ARIMA prediction model. The predicted values (red) are extremely close to the actual values (blue), indicating a good fit for the model on the training data.



12: Prediction Plot

Figure 9: Plot of predictions vs actual time series. The predictions appear to reflect the actual values well at the start and end of the time series, but wander in the middle, spiking to an extreme height. This model can be used to predict the future sales of the Iowa lottery to inform business decisions for the institution that owns this data.