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Data Science 350 – Homework Assignment 8

Assignment:

Perform time series analysis on the data for one of Milk Production, or Ice Cream Production in the CADairyProduction.csv file to answer the following questions

– Q: Is this time series stationary?

– Q: Is there a significant seasonal component?

– For the residual from the STL decomposition of the time series what is the order of the ARMA(p,q) process that best fits?

– Forecast production for 12 months. Report both numeric values and plot the confidence intervals. Are the confidence intervals reasonably small compared to the forecast means? How do the confidence intervals behave as time moves to the future?

Observations:

It's observed that the icecream production time series model is not stationary. It's standard deviation fluctuates over the years of the data set.

There is a significant seasonal component to this time series. This is reflected in Table 3, in the decomposition component 'season'. This makes reasonable sense based on Icecream being more of a hot weather food then a cold weather one. The seasonal component follows the monthly trend of a typical geographic area which has the four seasons.

The order of ARMA best fit for the residual from the STL decomposition is c(2,0,2) or AR(2) MA(2). This is shown in Table 4 below where the AIC value is -11304.

Forecast production of 12 months:

The confidence intervals are reasonably small compared to the forecast means. This can be seen in the Forecast data values table shown in Table 5 below and as well is evident in the Table 5's graph represented by the blue area. It's shape is similar to the prior years. The time series for season components is well behaved. It's expected that a good forecast would be produced by this model. Icecream production peaks in the hotter months of the year and decrease through the colder.

Table 1: Plot of the time series vector of icecream production values

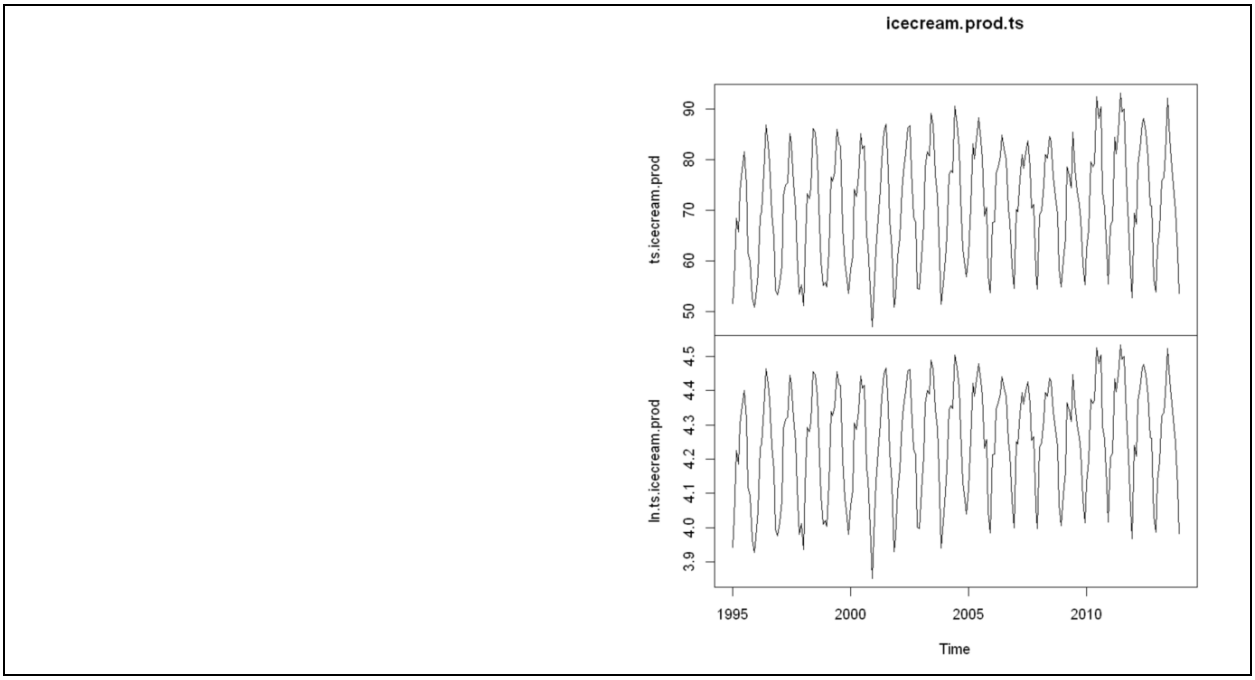

Table 2: Distribution of the icecream production values

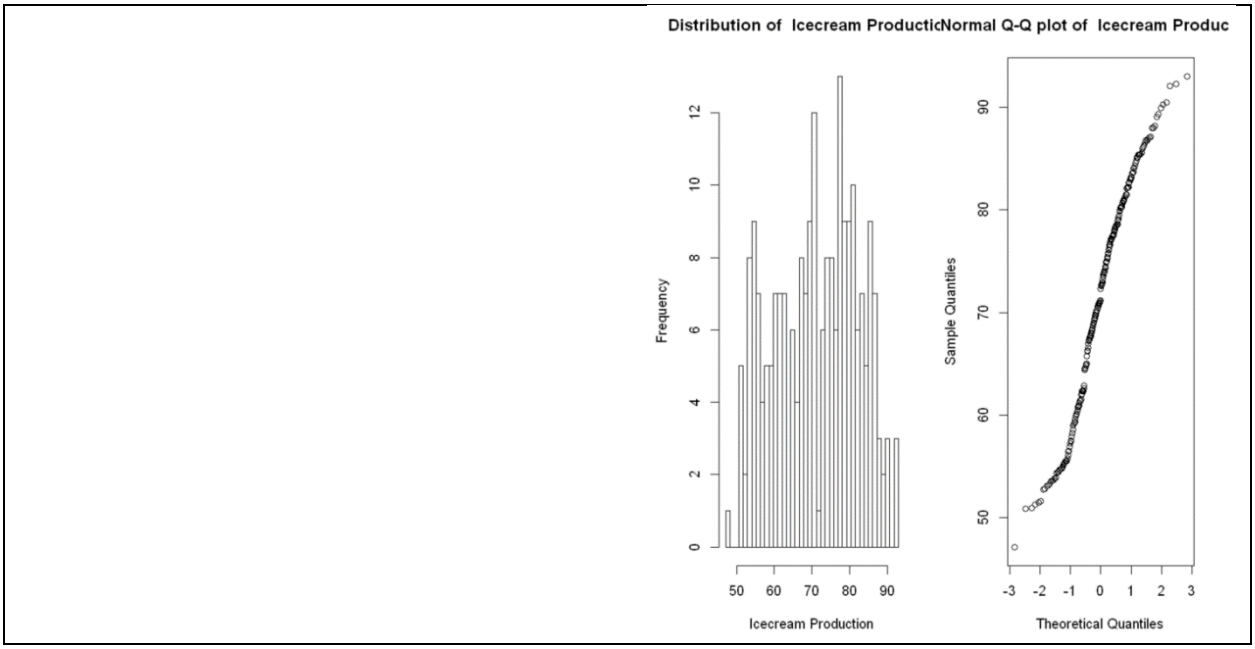

Table 3: Decomposition of the time series icecream production values into components

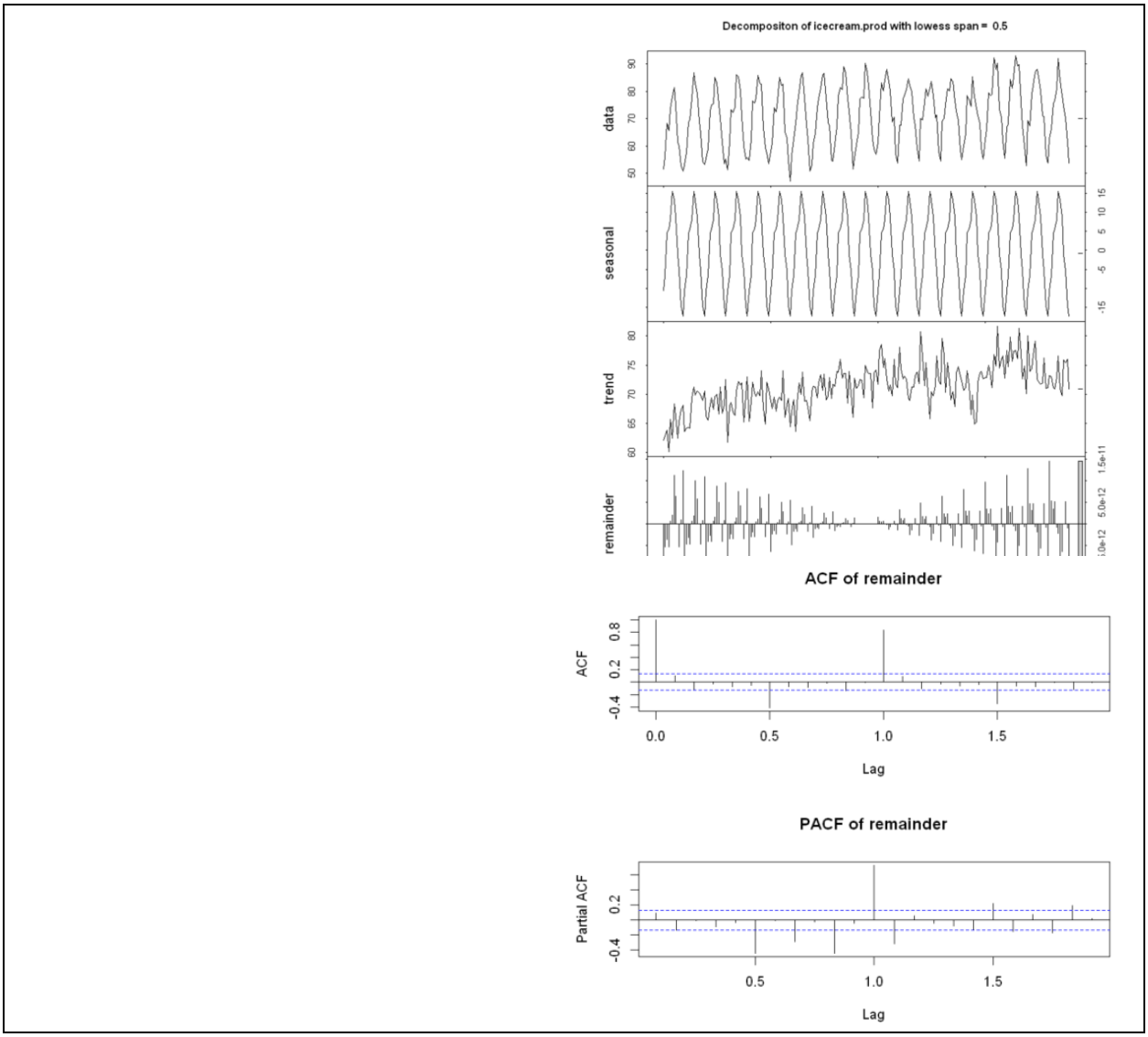

Table 4: ARIMA model of icecream production with ACF and PACF graphs

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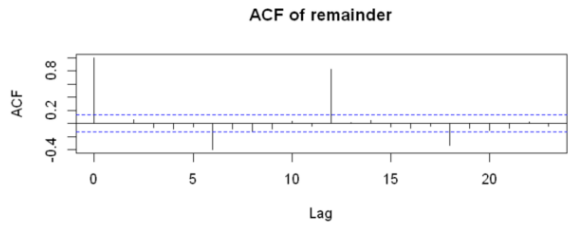
Call:
arima(x = ts, order = order, include.mean = FALSE)

Coefficients:
         ar1     ar2      ma1      ma2
      0.1345  0.3177  -0.1327  -0.7510
s.e.  0.0913  0.0877   0.0542   0.0513

sigma^2 estimated as 1.638e-23:  log likelihood = 5657.12,  aic = -11304.24
```



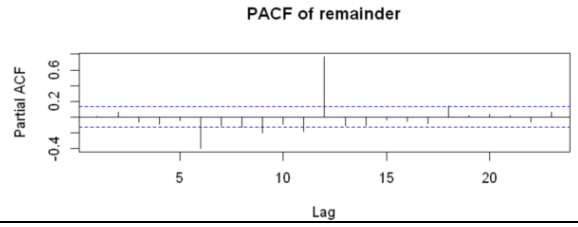


Table 5: Forecast of icecream dairy production for 12 months

The confidence intervals are reasonably small compared to the forecast means. This can be seen in the Forecast data values table.

The time series for season components is well behaved. It's expected that a good forecast would be produced by this model. Icecream production peaks in the hotter months of the year and decrease through the colder.

```
Forecast method: ARIMA(3,0,1)(1,1,2)[12] with drift

Model Information:
Series: ts.icecream.prod
ARIMA(3,0,1)(1,1,2)[12] with drift

Coefficients:
          ar1     ar2     ar3     ma1   sar1     sma1     sma2   drift
      -0.3052  0.2177  0.3482  0.5655  0.026  -0.5470  -0.2335  0.0377
s.e.   0.2020  0.0879  0.0648  0.2203  0.224   0.2184   0.1523  0.0101

sigma^2 estimated as 7.711:  log likelihood=-528.05
AIC=1074.11   AICc=1074.98   BIC=1104.49

Error measures:
                     ME     RMSE      MAE       MPE     MAPE      MASE
Training set 0.09698592 2.652346 2.052637 0.0563378 2.892051 0.7436829
                    ACF1
Training set -0.005397972

Forecasts:
         Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
Jan 2014       63.62479 60.06560 67.18397 58.18148 69.06809
Feb 2014       68.89726 65.21948 72.57504 63.27258 74.52194
Mar 2014       77.71948 74.00891 81.43005 72.04465 83.39431
Apr 2014       79.58273 75.65412 83.51134 73.57444 85.59103
May 2014       82.28689 78.35812 86.21567 76.27835 88.29544
Jun 2014       91.41106 87.45756 95.36456 85.36471 97.45741
Jul 2014       86.60755 82.64092 90.57417 80.54112 92.67397
Aug 2014       82.04068 78.07404 86.00731 75.97423 88.10712
Sep 2014       75.18685 71.21408 79.15963 69.11102 81.26269
Oct 2014       70.61699 66.64395 74.59003 64.54075 76.69323
Nov 2014       61.63109 57.65788 65.60430 55.55458 67.70759
Dec 2014       55.87179 51.89786 59.84571 49.79419 61.94938
```