

(26 November 2008, 10.00 - 12.00, LRC2)

NOTE: You *do not* hand in your solutions for marking, but you are welcome to discuss them with me at my office hours if you wish. Also, the solutions will be given at the course website on Wednesday, 3rd December.

5.1 Forecasting in time series

5.1.1 Sunspots data

The data of monthly numbers of sunspots recorded from 1964 till 1983 are in the file Sunspots.mtw in STU directory. Download the file and do the following:

- 1 Plot the data and comment on their features. Transform the data if necessary.
- 2 Detrend the (transformed) data using the differencing method.
- 3 Analyze the detrended data, that is, use the sample ACF and the sample PACF to find out what kind of a stationary model may fit best.
- 4 Fit an appropriate model to the differenced data using option **ARIMA** in the **Stat > Time Series** Menu.

Write down the model and explain your notation. Are all the model parameters statistically significant? Are the residuals realizations of uncorrelated WN variables? Make conclusions.

5.1.2 Recife data

Monthly average temperature in Recife (where is it?) in Celsius in years 1953 – 1962 is given in the file RecifeTemp.mtw in STU directory. Download the data and do the following:

- 1 Rename the data as 'x'. Plot the data and comment on their features.
- 2 Detrend the data (use a linear trend in the Trend Analysis option). Store the residuals and the forecasts of 12 'future' values of the trend. Call the residuals 'x-m'.
- 3 Deseasonalize 'x-m' (use the Decomposition option for seasonals only, additive model). Store the 12 values of seasonal effects and the new residuals; call these residuals 'x-m-s'.
- 4 Analyze 'x-m-s', that is use the sample ACF and the sample PACF to find out what kind of a stationary model may fit best.
- 5 Forecast 12 'future' values of 'x-m-s' using option **ARIMA** in the **Stat > Time Series** menu, store the forecasts and their boundaries. Also store the new residuals and call them z. Are the values of z a sample of a White Noise process? Are the model parameters significant?
- 6 Add up the forecasts of trend, seasonal effects and the forecasts of the fitted ARMA model to obtain the forecasts of the temperature for the next 12 months.
- 7 Plot the forecasts of temperature together with the original data as well as the boundaries.

Write down the model and explain your notation. Make conclusions.

5.2 ACF and PACF of a Stationary TS

5.2.1 Classify each of the following models as an ARMA(p,q) process, i.e, find p and q. Express each of the models in B notation and determine whether the model is causal and/or invertible.

(a) $X_t = 0.3X_{t-1} + Z_t$

(b) $X_t = Z_t - 1.3Z_{t-1} + 0.4Z_{t-2}$

(c) $X_t = 0.5X_{t-1} + Z_t - 1.3Z_{t-1} + 0.4Z_{t-2}$

5.2.2 Calculate ACF and PACF for

(a) $X_t = Z_t + 0.7Z_{t-1}$,

(b) $X_t = 0.9X_{t-1} - 0.2X_{t-2} + Z_t$,

where $Z_t \sim \text{WN}(0,1)$ and graph the values of the autocorrelation and partial autocorrelation functions for lag $\tau = 1, \dots, 5$.