

## Time Series Analysis

Lectures and Tutorials: Annika Betken

2B 2021 – R Assignment

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The purpose of the R Assignment is to have some “hands- on” experience with practical time series analysis.

The exercises may be done in teams of at most two students. Each team is expected to submit a report. It has to be handed in on July 13 the latest. For each exercise, the report should include a short introductory paragraph describing the dataset, a detailed description of the analysis, several plots, the corresponding R Code and a conclusion discussing the results. The report will be graded as satisfactory or unsatisfactory (pass or fail). If the report is not satisfactory, then no final grade is given for the course.

**Exercise 1.** In R read the file “AirPassengers”. It contains the monthly totals of international airline passengers from 1949 to 1960. Assume that for this time series a multiplicative model holds, i.e.  $x_t = m_t s_t w_t$  with  $m_t$  denoting a trend component,  $s_t$  a seasonal component, and  $w_t$  an incidental component, i.e. a stationary stochastic process. To deal with this, consider the transformed time series  $\tilde{x}_t = \log x_t$  and proceed with an additive model assumption. Decompose the time series into trend, seasonal, and incidental component. For this, you may proceed as in the lecture on May 4 on the decomposition of time series. Illustrate and comment on each step of the decomposition. <sup>1</sup>

**Exercise 2.** Eight time series are available for analysis. Of these you have to analyze the Dow Jones index, and one of the other time series (whichever one you like). Alternatively, you may as well analyze the Dow Jones index and another time series data set of your own choice. For this, you may proceed as in the last lecture on June 15 on practical time series analysis.

1. *Dow Jones index.* The file `dowjones.txt` contains data of the weekly averaged Dow Jones index from 1900 to 1989.
2. *University enrollment.* The file `students.txt` contains the number of university students (in thousands) enrolled in the Netherlands from 1935 until 1988. The years 1944, 1972 and 1973 are missing.
3. *Laser intensity.* The file `laser.txt` contains measurement data of the intensity of an infrared laser.

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<sup>1</sup>Source: Box, G. E. P., Jenkins, G. M. and Reinsel, G. C. (2015) *Time Series Analysis: Forecasting and Control*. John Wiley & Sons.

4. *Movie attendance.* The file `movies.txt` lists the number of visitors (in thousands) of the Dutch movie theaters from 1950 to 1994.
5. *Cargo ships.* The file `ships.txt` contains the number of ships (in thousands) active in freighting during 1950 to 1994.
6. *Sugar production.* The file `sugar.txt` lists the annual sugar production in The Netherlands (in thousands of tons) from 1950 to 1993.
7. *Glass furnace.* The file `glass.txt` contains the temperature measured at a point in the cross section of a glass furnace. The file has 1247 data points.
8. *Foetal ECG.* The file `ecg.txt` contains the cutaneous potential recording of one of the components of the ECG of an unborn baby. It has 2500 data points.

A full time series analysis involves the following steps.

1. Plot the data. Inspect the plot visually for preliminary analysis. Center, scale and transform the data as needed.
2. Compute the correlation function and partial correlation coefficients. Remove any trends before doing these computations.
3. Estimate the spectral density function using various window widths. Remove any trends before doing these computations.
4. Estimate a suitable ARMA model for the data, of order not greater than five.
5. Compute, plot, and analyze the residuals for the model you have estimated.