Assignment 2

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Analysis and Forecasting of Economic Time Series 2017/2018

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The basic structure for organising data in R is the `data.frame`. However, it has some drawbacks with regard for storing time series data that have a clearly defined order (usually by time). In this assignment sheet we will get acquainted with data structures more convenient for the work with time series.

Problem 1: Dates in R.

a) Create a vector holding the two strings: `'2017-11-09'` and `'2017-08-11'`.

b) Coerce the character vector from a) to class `Date` using the `as.Date` function. Are the strings in an unambiguous date format? Consult the help page for the `strptime` function to find the appropriate format specifiers for `as.Date` (Hint: run `?stptime` in the R console).

c) Create a new character vector from b) that represents the dates in the format `09 November 2017`.

d) Coerce the dates vector to class `numeric` and print the result. What is the meaning of the numeric values that result from the coercion?

e) Convert the numeric representation of the dates vector back to the `Date` class.

f) Create a sequence of dates starting from `01 November 2017` and ending on `17 November 2017` with interval one day. Use the `seq.Date` function.

g) Create a sequence of dates starting on `01 November 2017` and ending on `23 December 2017` with interval one week.

Problem 2: Time series data and the xts package.
The file `bitcoin2017-06-01-2017-11-13.csv` `https://s3.eu-central-1.amazonaws.com/sf-timeseries/data/bitcoin2017-06-01-2017-11-13.csv` contains USD/BTC exchange rates at market close from June 1st 2017 to November 13th 2017.

a) Install and load the `xts` package.

b) Read the data into `R` using the `read.csv` function with `stringsAsFactors = FALSE` argument.

c) Create a `xts` object using the `data.frame` from b).

d) Plot the data with date on the x-axis and the exchange rate on the y-axis.

e) Let y_t denote the exchange rate at time t and y_{t-1} the exchange rate at time $t-1$. Create a scatter-plot for y_t and y_{t-1}. Interpret the plot.

f) Compute the sample mean $\hat{\mu}$, the sample covariances $\hat{\gamma}_0$, $\hat{\gamma}_1$ and sample autocorrelation coefficients $\hat{\rho}_0, \hat{\rho}_1, \hat{\rho}_2$ where:

$$\begin{aligned}\hat{\rho}(\tau) &= \frac{\hat{\gamma}(\tau)}{\hat{\gamma}(0)} \\ \hat{\gamma}(\tau) &= \frac{1}{T}\sum_{t=1}^{T-\tau}(y_t - \hat{\mu})(y_{t+\tau} - \hat{\mu}) \\ \hat{\mu} &= \frac{1}{T}\sum_{t=1}^{T} y_t.\end{aligned}$$

g) Use the `acf` function to plot the autocorrelations against the lag index. Is the result consistent with the interpretation of the scatter-plot in d)?

h) Compute the relative daily change of the exchange rates using $\log(y_t) - \log(y_{t-1})$ and plot the the data.

i) Plot the autocorrelation coefficients and interpret the plot.

Problem 2: First order difference equation.
Consider a dynamic system described by the first order difference equation:

$$y_t = \phi y_{t-1} + w_t, \qquad y_t, w_t \in \mathbb{R}_1, t \in \mathbb{Z}.$$

a) Compute the dynamic multiplier

$$\frac{\partial y_t}{\partial w_t}.$$

b) Compute the dynamic multiplier

$$\frac{\partial y_{t+j}}{\partial w_t}, \quad j \in \mathbb{N}.$$

c) Compute the dynamic multiplier

$$\frac{\partial y_{t+j}}{\partial w_t}, \quad j \in \mathbb{N}.$$

d) Compute the long-term multiplier

$$\lim_{j\to\infty}\left[\frac{\partial y_{t+j}}{\partial w_t}+\frac{\partial y_{t+j}}{\partial w_{t+1}}+\ldots+\frac{\partial y_{t+j}}{\partial w_{t+j}}\right]$$

e) What is the behaviour of the multipliers for $0<\phi<1$, $\phi>1$ and for $\phi=1$?