RTP Exercise Sheet

Series 2

Exercise 2.1

Remove the linear trend by applying backward differencing on timeseries created from the following models:

a) $X_t \sim 0.5t + 1 + U_t$ where $U_t \sim U(-1, 1)$

b) $X_t \sim 2t^2 + 3t - 1 + U_t$ where $U_t \sim U(-200, 200)$

Plot the results. Also compare the length of the different time series and transformations.

R-hints:

```
# create timeseries object
t <- seq(1, 100, length = 100)
data <- 0.5 * t + 1 + runif(100, -1, 1)
ts <- ts(data)

# have a look at
`?`(diff)

# compare lengths of arrays with
length()
```

Exercise 2.2

We reconsider the data set from exercise 1.2 about residential construction in the USA from January 1966 to December 1974.

a) Decompose the time series in trend, seasonal component and remainder using the non-parametric STL method, and plot the results.

b) The special filter $Y_t = \frac{1}{24}(X_{t-6} + 2X_{t_5} + ... + 2X_t + ... + X_{t+6})$ can be used for computing a trend estimate. Plot this, the STL trend and the data in a single plot. What are the differences between the two methods?

c) Try to remove the trend and seasonal effects by computing differences. After removing seasonal effects, choose some linear trend elimination method and plot the outcome.

R-hints:

```r
data.stl <- stl(data, s.window = "periodic")
```

computes the STL decomposition of the time series "data".

```r
weights <- c(rep(1, 10))/10
data.filtertrend <- filter(data, filter = weights, sides = 2)
```

applies a linear filter with ten equal weights of 0.1 on the time series "data".

Exercise 2.3

To test ideas and algorithms, R comes with built-in data sets. The data used in this exercise is called co2 and contains atmospheric concentrations of CO_2 in parts per million. In the R-hints below is shown how to load the data into R.

Use backward differencing on the co2 data to abolish the seasonality effect. Figure out what value for the lag is to choose for an optimum reduction of the seasonality? What happens if you choose other values for the lag?

R-hints:

```r
# load co2 data
data(co2)
plot(co2, main = "co2 data")
```

Exercise 2.4

OPTIONAL: Once again have a look at the co2 data set. In this exercise you should try to decompose the series into trend, seasonality and random parts using a linear additive filter. For the seasonal part, the hints below should help you calculate the means over the same months in different years.

R-hints:

```r
# R-help:
`?`(filter)

# seasonal part:
trend_removed <- series - series.trend
month <- factor(rep(1:12, 39))
seasn.est <- tapply(trend_removed, month, mean, na.rm = TRUE)
```

Disclaimer: Parts of the exercises are adopted from 'Applied Time Series Analysis' course at ETHZ by Marcel Dettling.