Time series models 2007: Computer exercise I

Deadline: Monday Oct 1

September 20, 2007

A report on this computer exercise should be delivered to Håvard Rue, no later than Monday Oct 1 (unless otherwise agreed upon). Email-submissions is accepted. The assumed program to use is R (see www.r-project.org), but also the one following the book can be used at own risk as I do not use nor support it. Groups no larger than 2, is accepted.

Some hints are given in the end.

1 Problem 1

Do for each of the three models

Model I

$$x_t = \phi x_{t-1} + z_t \tag{1}$$

Model II

$$x_t = z_t + \theta z_{t-1} \tag{2}$$

Model III

$$x_t = \phi x_{t-1} + z_t + \theta z_{t-1} \tag{3}$$

do the following.

1. Chose some appropriate parameters, for example $\phi = \pm 0.9$ and similar with θ. (Make sure you do not chose $\phi = -\theta$; why?)
2. Compute the theoretical ACVF and ACF. (Note that both Model I and II are special cases of Model III.)
3. Sample one short(er) and one long time series

   ```
   x = arima.sim(n, model = list(ar=c(phi),ma=c(theta)))
   ```

   plot them using

   ```
   plot(x)
   ```

4. Compute and plot the ACVF, ACF and PACF, using

   ```
   acf(x,type = "cov")
   acf(x,type = "cor")
   acf(x,type = "partial")
   ```

5. Make a comparison of ACF with the theoretical ACF and the sample paths, for both the short and the long time series. Comment.

6. Confirm by yourself, that for Model I, then PACF is zero at lag larger than 1; and for Model II, the ACF is zero at lag larger than 1. Why is neither the ACF or PACF zero for lag larger than one?

7. Estimate the parameters in the time series model (even though you know what they are), using both the short and long time series, using

   ```
   fit = arima(x, order=c(1,0,1))
   fit
   ```

   for Model III, and "$(1, 0, 0)$" for Model I and "$(0, 0, 1)$" for Model II. Comment.

8. Validate the fitted model, using

   ```
   tsdiag(fit)
   ```

   Explain what each of the three plots are and how they should look if they were "perfect". **Hint:** Reading the help page might help (?tsdiag).

9. Predict future realisations of the time series model, using

   ```
   pred = predict(x, n.ahead = 20)
   pred
   ```

   Add the predictions to the plot of the time-series with 95% prediction interval. Comment.

10. What happen with the predictions far in the future (setting n.ahead to a large value), and why?

You only have to report the investigation for model III. Use model I and model II to experiment with.

2 Problem 2

Fit and validate an ARMA-model to the time-series in the file `http://www.math.ntnu.no/~hrue/Tidsrekkemodel`
Hint: you can read this file into **R** using

```
x = as.ts( scan("tsdata.dat") )
```

(Read the help-page: **?as.ts**)

Hints

- You can create eps- and pdf-copies of your plots as shown on the screen, using commands like

  ```
  library(R.utils) ## once only
  dev.print(pdf,"file.pdf")
  dev.print(eps,"file.eps")
  ```

- Although **acf(x)** plot the ACF, the actual *values* are returned in the functions call;

  ```
  > a = acf(x)
  > names(a)
  [1] "acf"    "type"   "n.used" "lag"    "series" "snames"
  > a$acf[1:10]
   [1] 1.0000000000 0.8912153009 0.7942161702 0.6954640762 0.6218270909
   [6] 0.5633687558 0.5074224632 0.4575082037 0.4140609409 0.3653829956
  ```

  Similarly with the other functions.