Practice 7R: AR(p) models

1. Simulating AR(p) models:

Do

```
n<-1000
x<-arima.sim(list(ar = c(0.8897, -0.4858), sd = sqrt(0.1796)), n)
plot(x,type="l")
```

We have generated an AR (2) model.

Compute its auto-correlation function doing

```
acf (x)
```

or

```
k<-floor(log(n))
acf (x, k)
```

Try the same exercise with different values of n, different number of parameters and different parameters of the AR(p).

2. Fitting AR(p) models:

Do

```
n<-1000
x<-arima.sim(list(ar = c(0.8897, -0.4858), sd = sqrt(0.1796)), n)
plot(x,type="l")
s1<-arima(x, order=c(2,0,0), method="ML")
s1
```

We obtain an estimation of the AR(2) parameters and the intercept. See the quality of the estimations. Try higher values of n.

Do it several times simulating new series with different parameters.

An alternative method is

```
s2<- ar(x, order.max=2, method="mle")
s2
```

Try order.max= 3.

3. Validation:

Do

- n<-1000
- x<-arima.sim(list(ar = c(0.8897, -0.4858), sd = sqrt(0.1796)), n)
- plot(x,type="l")
- s<-arima(x, order=c(2,0,0), method="ML")
- s
- y<-resid(s)
- plot(y,type="l")
- h<-floor(log(n))
- Box.test(x,lag=h, type=c("Ljung-Box"))
- Box.test(y,lag=h,type=c("Ljung-Box"))

Note that x is not an IID noise and y yes. If the adjustment is correct the series y has to be an IID process. Draw the acf of y.

An alternative method for the last three instructions is

- h<-floor(log(n))
- tsdiag(s,gof.lag=h)

4. Selection of the best AR(p) model:

Do

```
n<-1000
x<-arima.sim(list(ar = c(0.8897, -0.4858), sd = sqrt(0.1796)), n)
plot(x,type="l")
ss1<-ar(x, order.max=3, method="mle")
ss1
```

The instruction selects the best AR between AR(1), AR(2) and AR(3) to fit data x, using Akaike method (we will see this in next lectures). The solution should be an AR(2).

5. A complete analysis with real data:

Do

- x<-LakeHuron
- x

We have the data of yearly level of Lake Huron from years 1875 to 1972.

Graph the series using

- plot (x, ylab="depth", xlab="times")

Do

- lag.plot (x, lag=4, do.lines=F)

These are plots of (x(i-1), x(i)), then (x(i-2), x(i)), and so on. Notice that the linear trend disappears when we increase the lag.

Do

- acf (x)

To fit a model AR(1) to x we do

- s1<-ar(x, order.max=1, method="yw")
- s1

or

- s2<-ar(x, order.max=1, method="mle")
- s2

yw and mle denote different methods of estimation of the parameters. Yw means Yule-Walker and mle means maximum likelihood estimator.

More generally, to fit an AR(p) model to x we do

- s3<-ar(x, method="mle")
- s3

or

- s4<-ar(x, method="yw")
- s4

Compare the results of s3 or s4. Note that both propose an AR(2) with similar parameters.