Practice 14 R: GARCH models

1. **White but not IID noise residuals.**

Let us analyze the daily returns of the S&P500:

- library(MASS)
- data(SP500)
- plot(SP500, type="l")
- acf(SP500)
- Box.test(SP500, type="Ljung-Box")

Clearly we have a white noise.

We can compute the mean:

- m<-mean(SP500)
- x<-SP500-m
- plot(x, type="l")
- acf(x)

Of course, we are under the same situation. Note that the series x is not stationary in variance.

But do the following:

- y<-x^2
- plot(y, type="l")
- acf(y)
- Box.test(y, type="Ljung-Box")

What is happening? Note that x is a white noise but y not.

We need a new theory to give structure to this type of processes.

2. Generating ARCH and GARCH models.

```r
a0<-0.25
a1<-0.5
x<-numeric(9999)
x0<-rnorm(1)
for (i in 1:9999){
x0<-rnorm(1,sd=sqrt(a0+a1*x0^2))
x[i]<-x0
}
plot(x, type="l")
```

An alternative system for a GARCH(1,1) is

```r
n<-10000
a0<-0.1
a1<-0.4
b1<-0.2
w<-rnorm(n)
y<-rep(0,n)
h<-rep(0,n)
for(i in 2:n){
h[i]<-a0+a1*(y[i-1]^2)+b1*h[i-1]
y[i]<-w[i]*sqrt(h[i])
}
plot(y, type="l")
acf(y)
acf(y^2)
```

3. Do the same with an ARCH(2).

4. Fitting GARCH models

Now we adjust a GARCH model to SP500 data.

```
library(MASS)

library(tseries)

data(SP500)

plot(SP500, type="l")

x<-SP500-mean(SP500)

plot(x,type="l")

sp<-garch(x, trace=F)

res<-sp$res[-1]

plot(res,type="l")

acf(res)

acf(res^2)

confint(sp)

garch(x,order=c(1,1), trace=F)
```

The instruction "confint" gives the confidence intervals of the parameters of the estimated GARCH model. Tha last instruction gives the estimated parameters.