

Hidden Markov Models - Practical Session 6

Exercise 1: Fitting an HMM to share return data

Let's look at share return data (daily percentage returns) from the Deutsche Bank. We want to analyse the market nervousness using HMMs.

- a) Read the data by

```
returns <- read.csv("http://www.rolandlangrock.com/Misc/deutschebank.csv")$x
```

and do some data exploration (e.g. by plotting the time series, plotting the histogram, looking at summary statistics). Based on that make a first decision about the number of states for the HMM fitting. Also decide which distributions you want to use. What do you expect the N different distributions to look like?

- b) Perform parameter estimation for the HMM you decided to fit and plot the resulting state-dependent distributions in a histogram.

Hints:

1. On lecture slide 145, you can find the likelihood code you need.
2. A good choice of starting values for the means μ_1, μ_2, \dots will be `rep(0,N)`.
3. Don't forget to transform your starting values for each σ .
4. For $N > 2$, the starting values for the t.p.m. are the entries on the off-diagonal. You need $N(N-1)$ entries. You could e.g. set them all to 0.05. Don't forget to transform these values as well before giving them to the likelihood function with `nlm()`.
5. You can extend the number of iterations `nlm()` will do before termination, e.g. to 500, with the argument `iterlim = 500`.
6. Back-transform the parameter estimates given by `nlm()`.
7. Calculate the stationary distribution given the estimated t.p.m. and use these probabilities as weights for the density curves.