

Lab 4

Gustav Sternelöv

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Assignment 1

a) - Simulate the model

A linear Gaussian state space model is implemented in line with the given instructions. 100 observations are simulated from this model and the obtained states(x) and observations (y) are plotted in figure 1.

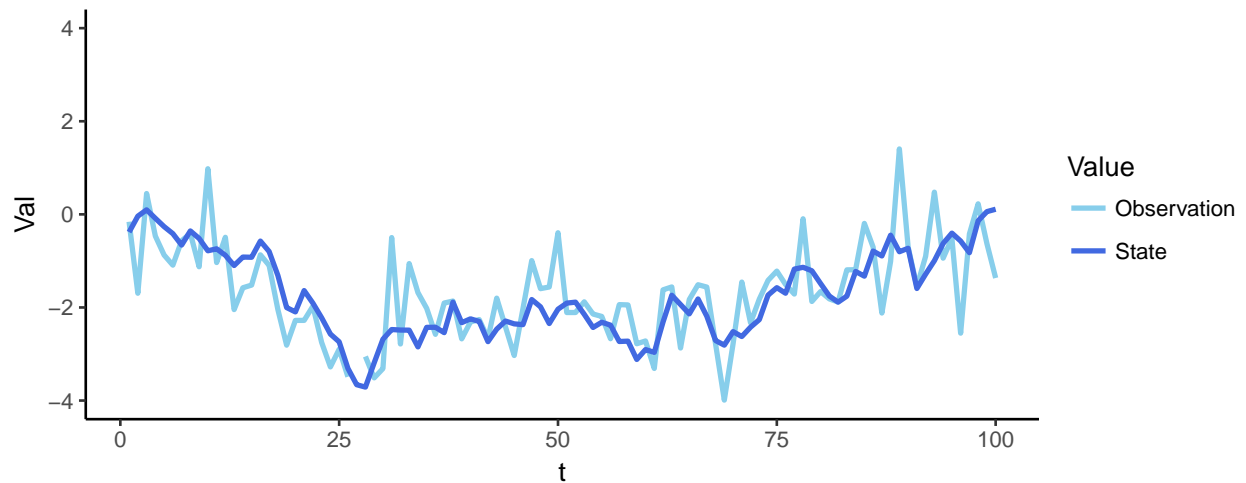


Figure 1

b) - Filtering: Sequential state inference

The point estimates for the Kalman filter and the 0.95 probability bands for the point estimates are plotted together with the states and observations simulated in a).

Kalman filter estimates with 0.95 probability intervals

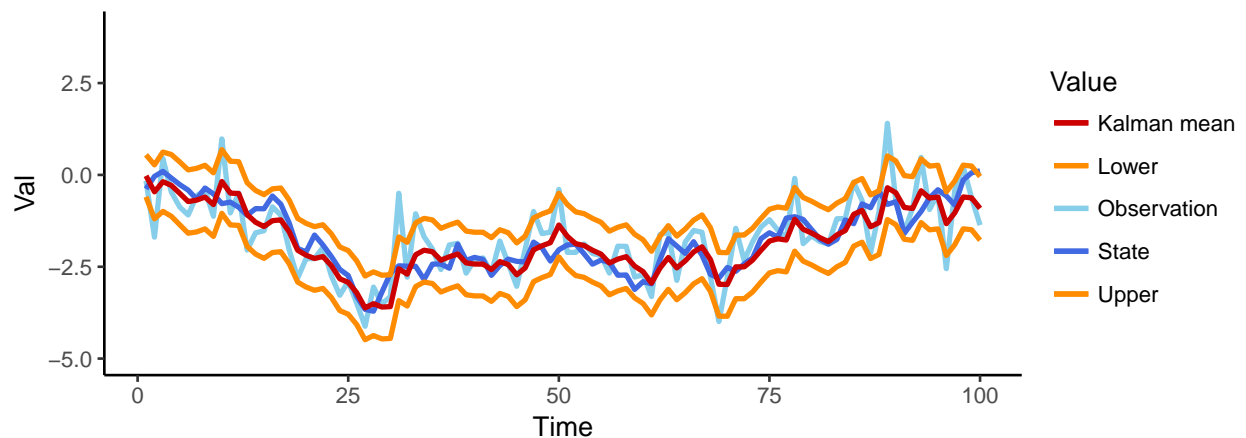


Figure 2

In figure 3 are the Kalman filter estimates and probability intervals obtained by the implemented Kalman algorithm compared to the estimates returned by the *dlmFilter* function from the *dml* package.

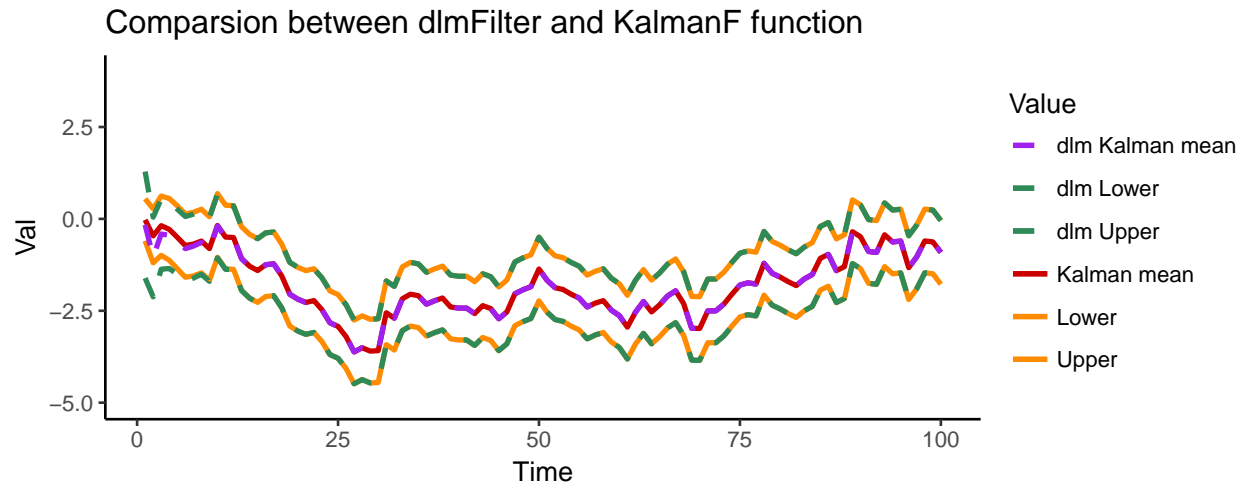


Figure 3

Except for the first values are the point estimates and the probability intervals identical.

c) - Prediction of state and data by simulation

The probability intervals for 5 future states and observations are plotted in figure 2 together with the data plotted in figure 2. The 5 future time steps are simulated 10 000 times and a 0.95 probability interval is given by the quantiles from the sample.

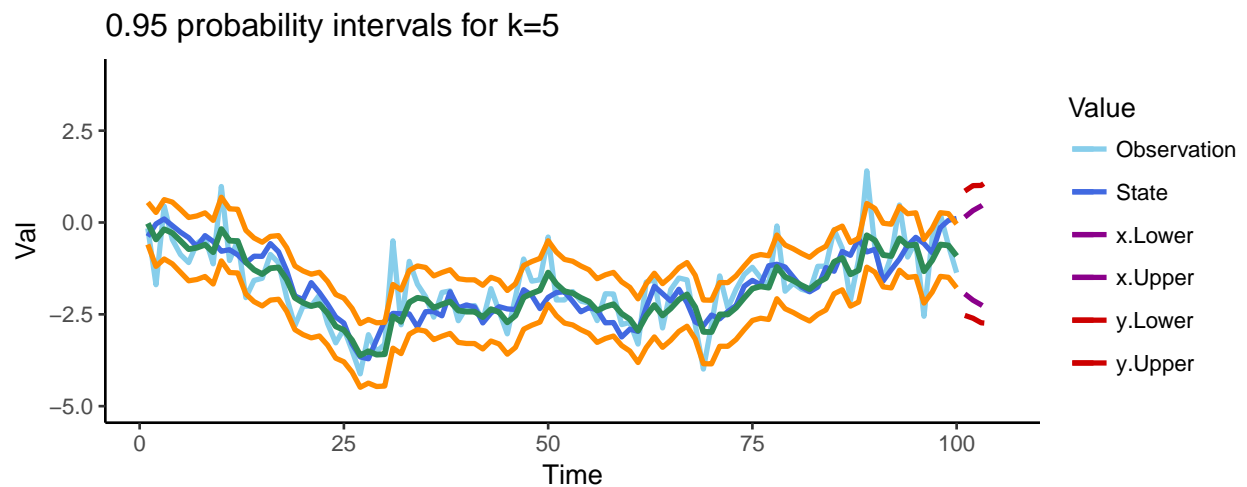


Figure 4

Even though it only is 5 time steps that are predicted it can be seen that the uncertainty grows as the number of steps forward in time increases.

d) - State and model parameter inference

Assignment 2

a) - Estimating the variance components by MLE.

By MLE the following estimates are given for the variance components.

$$\sigma_{\epsilon}^2 = 0.00232745481301804,$$

$$\sigma_{v(1)}^2 = 1.1230781 \times 10^{-5},$$

$$\sigma_{v(2)}^2 = 6.3383481 \times 10^{-4}$$

Should these be $\log()$?

b) - Filtering and smoothing

The filtering and smoothing distribution is computed for α and β . In the figures below are these distributions plotted together with 0.95 probability intervals.

The respective distributions for the alpha parameter are shown in the figures below. As expected, the same pattern is seen in both figures and a more smooth curve is returned for the smoothing distribution.

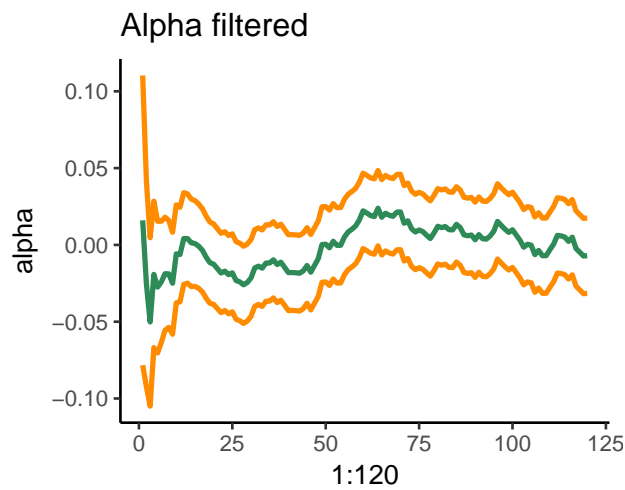


Figure 6

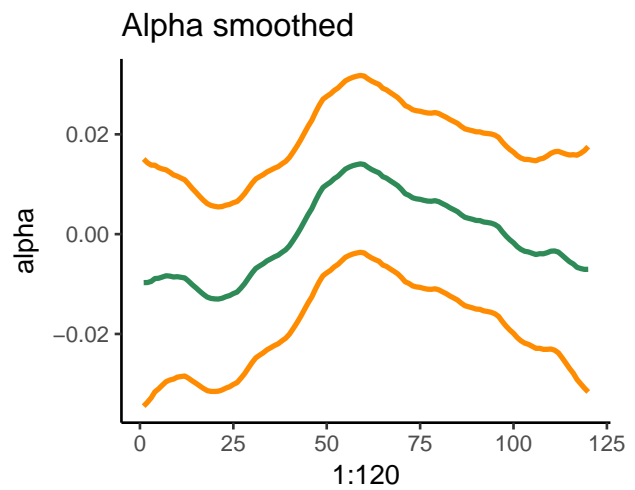


Figure 7

For the beta parameter is the pattern a little bit different for the respective distribution. In figure 9, for the smooth distribution, the value is increasing from around time point 50 and onwards. This pattern was not seen in the figure for the filter distribution.

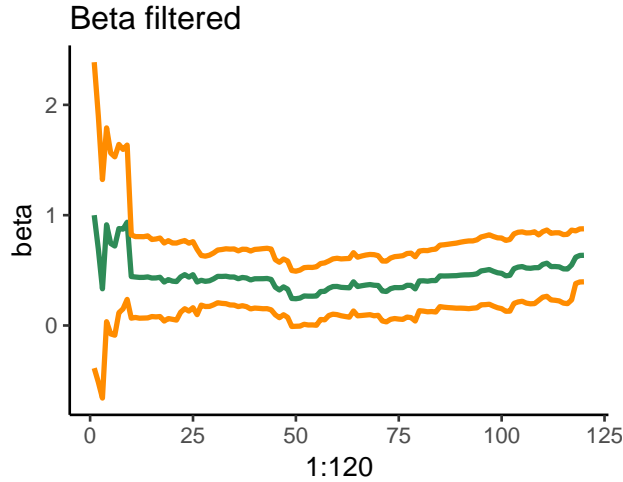


Figure 8

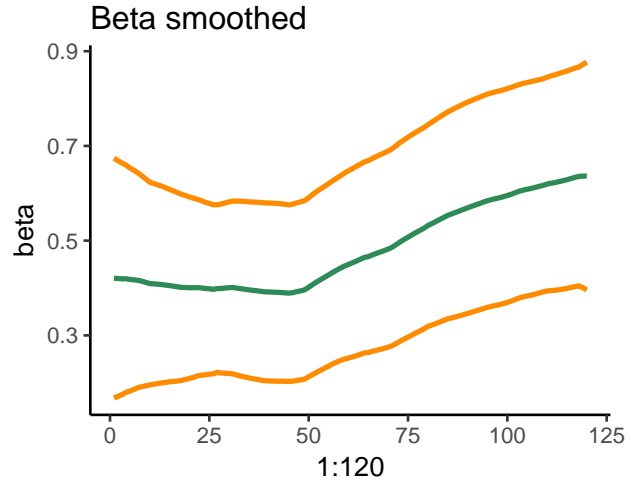


Figure 9

c) - Average sensitivity pre and post 1982 - a retrospective analysis

The retrospective analysis is performed by first computing the smoothing distribution for the time points pre 1982. This is done by only using data for the first 48 observed time steps. Then, the same thing is done once again but for all the data points.

For both samples is then the mean and the standard variance calculated and inserted into the *rmnorm* function. With this function is a sample of size 10 000

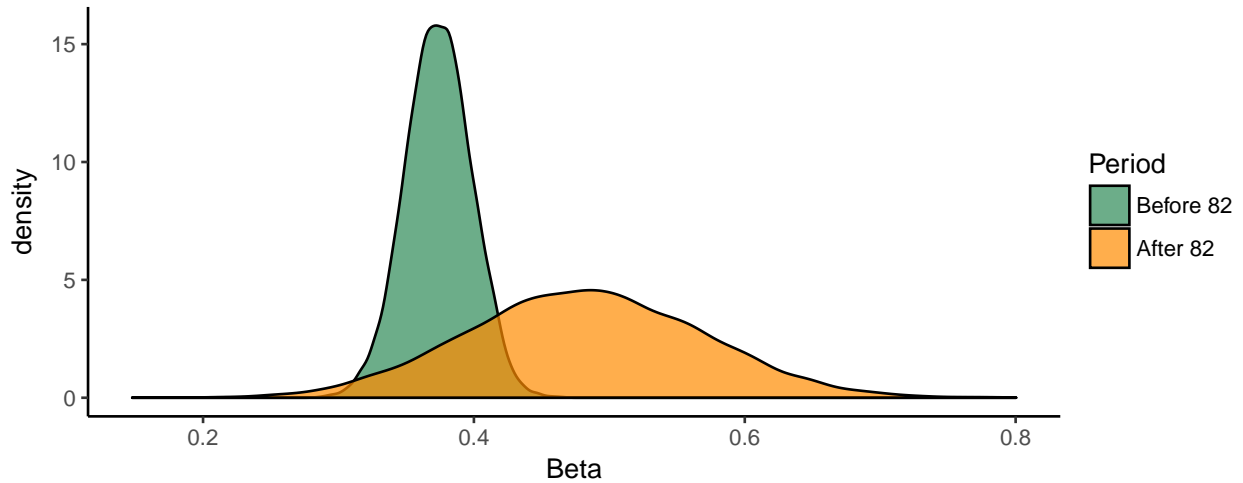


Figure 10

d) - Bayesian inference for the variance components

All of the variance components are unknown parameters that we want to estimate. In order to do bayesian inference on the variance components a possible approach is to analyse the point estimates for each component together with the uncertainty for each point estimate. The result of this approach would be an analysis that consider both the estimated value for each component and the uncertainty for these estimations.