

Exercise Round 6

The deadline of this exercise round is **Thursday February 27th, 2024**. The solutions will be discussed during the exercise session in the T2 lecture hall of Computer Science building starting at 14:15.

The problems should be *solved before the exercise session*. During the session those who have completed the exercises will be asked to present their solutions on the board/screen.

Exercise 1. (Gaussian filter as SLR filter)

Let us again consider the following non-linear state space model from Exercise 1 of Round 4:

$$\begin{aligned}x_k &= x_{k-1} - 0.01 \sin(x_{k-1}) + q_{k-1}, \\y_k &= 0.5 \sin(2 x_k) + r_k,\end{aligned}\tag{1}$$

where q_{k-1} has a variance of 0.01^2 and r_k has a variance of 0.02.

- (a) Write down the prediction equations for the Gaussian filter for this model. Note that technically you can compute the expectation integrals in closed form, but you don't necessarily need to here.
- (b) Write down the equations of the (prior) linearization of the dynamic model and the prediction step of the statistical linear regression filter for this model.
- (c) Show that the equations from (a) and (b) are equivalent.

Exercise 2. (Sigma-point Gaussian and SLR filters)

Let us again consider the model in Equation (1).

- (a) Implement one of the sigma-point filters CKF, UKF, or Gauss-Hermite filter on the model.
- (b) Implement SLR filter (with a separate linearization step) to the model using the same sigma point method.
- (c) Check that the numerical results match exactly.

Exercise 3. (Conditional moments)

Write down the conditional moments for the model in Equation (1).