Freie Universität Berlin
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1. Assignment
Complex Systems for Bioinformaticians
SS 2025

Deadline: April 22, 12:00 (**before** the lecture)

The homework should be worked out individually, or in groups of 2 students. Pen & paper excercises should be handed at the designated deadline. Each solution sheet must contain the names and 'Matrikulationnummer' of all group members and the name of the group. Please staple all sheets.
Programming exercises must be submitted via Whiteboard.

Homework 1 (Modelling (pen & paper), 2+1+2 points)
You saw the following depiction of a reaction network model and would like to use this model in a research project of your own.

$$\begin{aligned} R_1 : X_1 &\longrightarrow X_3 + X_4 \\ R_2 : \varnothing &\longrightarrow X_2 \\ R_3 : X_3 + X_4 &\longrightarrow \varnothing \qquad (1) \\ R_4 : X_2 + X_2 &\longrightarrow X_1 \qquad (2) \end{aligned}$$

a) Decompose it into its stoichiometric matrix and propensity function vector (= vector of *deterministic* reaction rate functions). X_1, X_2, X_3, X_4 are the systems variables. $\varnothing$ symbols denotes the elimination of molecules or the emergence of a molecule "from nothing" (from the boundary of the system).
b) State the order of each reaction R_1 – R_4.
c) Write down the corresponding ODE system.

Homework 2 (Modelling (pen & paper), 2 points)
You have used the following ODE-system in your research:

$$\begin{aligned} \frac{\mathrm{d}}{\mathrm{d}t}x_1 &= -k_1 \cdot x_1 \cdot x_2 \qquad (3) \\ \frac{\mathrm{d}}{\mathrm{d}t}x_2 &= -k_1 \cdot x_1 \cdot x_2 + k_2 + k_3 \cdot x_3^2 \\ \frac{\mathrm{d}}{\mathrm{d}t}x_3 &= -k_3 \cdot x_3^2 \end{aligned}$$

Write down the stoichiometric matrix and rate functions $r_1, \ldots$. Then, depict the corresponding reaction network (analogous to the reaction network in **Homework 1**).

Good luck!