

Complex Systems in Bioinformatics SoSe 2025

Exercise 6 [Block II-Assignment 2]

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22 May 2025

Deadline: 27 May 2025, before the lecture

The homework should be worked out individually, or in groups of 2 students. Pen & paper exercises should be handed at the designated deadline. Each solution sheet must contain the names and Matrikel No. of all group members and the name of the group. Please staple all sheets. Programming exercises must be submitted via Whiteboard.

1. Exercise [10 points: 1+1+1+3+1+3 points]

Consider the system of differential equations

$$\dot{x} = v_o - k_1 xy^2$$

$$\dot{y} = k_1 xy^2 - k_2 y$$

with the parameters $v_o, k_1, k_2 > 0$ and the variables $x, y \in \mathbb{R}_{\geq 0}$.

- Determine the steady state of the system.
- Derive the Jacobi matrix of the system and give it at steady state.
- Determine the trace and determinant of the Jacobi matrix at steady state.
- Set $k_1 = 1$. Give example parameter combinations (v_o, k_2) that allow for stable focus, stable node, unstable focus, unstable node.
- Which regions does the line $Trace = 0$ separate?
- Implement the model in a program of your choice. Plot at least one time course and phase plane for each of the four possible dynamics; stable focus, stable node, unstable focus, unstable node. (Include your chosen parameters and initial conditions in your solution.)