

Complex Systems in Bioinformatics SoSe 2025

Exercise 5 [Block II-Assignment 1]

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Deadline: 20 May 2025, before the lecture

The homework should be worked out individually, or in groups of 2 students. Pen & paper exercises (Part a-c of both tasks) 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 (Part d of both tasks).

1. Exercise [4+4+4+4 points]

Consider the system of differential equations

$$\dot{x} = x^2 - y$$

$$\dot{y} = x + y$$

- Determine the nullclines and the steady states.
- Compute the Jacobi matrix of the system and evaluate it at each steady state.
- For each steady state, compute the eigenvalues of the Jacobi matrix and determine the type of the steady state.
- Draw a phase portrait from different initial conditions using a program of your choice (e.g. Python, COPASI).

2. Exercise [4+4+4+4 points]

Consider the system of nonlinear differential equations

$$\dot{x} = x^2 - 1$$

$$\dot{y} = 2y$$

- Determine the nullclines and the steady states.
- Compute the Jacobi matrix of the system and evaluate it at each steady state.
- For each steady state, compute the eigenvalues of the Jacobi matrix and determine the type of the steady state.
- Draw a phase portrait from different initial conditions using a program of your choice (e.g. Python, COPASI).