Network Analysis SS 17
Continuous Modeling

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Deadline: Thursday, 4 May, 10:00 am

1 Exercise

1. Consider the chemical reaction systems

$$2CH_4 \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} C_2H_2 + 3H_2$$

   (a) Give the differential equation models for the system assuming mass action kinetics.

   (b) Implement the model in Copasi. Use the standard values for the concentrations and $k_1 = 0.1$ and $k_{-1} = 0.01$ for the rate laws. Choose reasonable parameters for the time course and plot the concentrations against time.

2. Consider the differential equation $\dot{x} = Ax$ with $A = \begin{pmatrix} 2 & -1 \\ -1 & 2 \end{pmatrix}$

   (a) Compute the eigenvalues of A

   (b) What do the eigenvalues imply for the type of the critical points?

   (c) Draw the phase portraits (including nullclines, direction field and flow) using `Xpp`. Keep track of what you did.

2 Exercise

1. Consider the chemical reaction systems

$$C_3H_8 + 5O_2 \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} 3CO_2 + 4H_2O$$

   (a) Give the differential equation models for the system assuming mass action kinetics.

(b) Implement the model in Copasi. Use the standard values for the concentrations and $k_1 = 0.1$ and $k_{-1} = 0.01$ for the rate laws. Choose reasonable parameters for the time course and plot the concentrations against time.

2. Consider the differential equation $\dot{x} = Ax$ with $A = \begin{pmatrix} 2 & -1 \\ 1 & 1 \end{pmatrix}$

   (a) Compute the eigenvalues of A

   (b) What do the eigenvalues imply for the type of the critical points?

   (c) Draw the phase portraits (including nullclines, direction field and flow) using `Xpp`. Keep track of what you did.

3 Exercise

1. Consider the chemical reaction systems

$$N_2 + 3H_2 \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} 2NH_3$$

   (a) Give the differential equation models for the system assuming mass action kinetics.

   (b) Implement the model in Copasi. Use the standard values for the concentrations and $k_1 = 0.1$ and $k_{-1} = 0.01$ for the rate laws. Choose reasonable parameters for the time course and plot the concentrations against time.

2. Consider the differential equation $\dot{x} = Ax$ with$A = \begin{pmatrix} 2 & 0 \\ 0 & 2 \end{pmatrix}$

   (a) Compute the eigenvalues of A

   (b) What do the eigenvalues imply for the type of the critical points?

   (c) Draw the phase portraits (including nullclines, direction field and flow) using `Xpp`. Keep track of what you did.

4 Exercise

1. Consider the chemical reaction systems

$$E + P \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} C \xrightarrow{k_2} E + Q$$

   (a) Give the differential equation models for the system assuming mass action kinetics.

(b) Implement the model in Copasi. Use the standard values for the concentrations and $k_i = i \cdot 0.1$ and $k_{-1} = 0.01$ for the rate laws. Choose reasonable parameters for the time course and plot the concentrations against time.

2. Consider the differential equation $\dot{x} = Ax$ with $A = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$

   (a) Compute the eigenvalues of A

   (b) What do the eigenvalues imply for the type of the critical points?

   (c) Draw the phase portraits (including nullclines, direction field and flow) using `Xpp`. Keep track of what you did.

Send the solutions for exercise 3 and 4 of your homework until Thursday 4. May, 10:00 am to `Annika.Roehl@fu-berlin.de`