Mathematics for Systems Biology and Bioinformatics

Lecture Prof. Dr. Thomas Filk

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Exercise sheet no. 4

Submission until 21. Nov 2012 10:00 am in the tutorials

Exercise 6, Sheet 3: Exponential function

a) Show that for a function, with properties $f'(x) = f(x)$ and $f(x_0 = 0) = 1$, the Taylor series at $x_0 = 0$ is $\sum_{n=0}^{N} \frac{x^n}{n!} = \exp(x)$.

b) Proof that the function $f(x) = \sum_{n=0}^{\infty} \frac{x^n}{n!} = \exp(x)$ repeats itself after differentiation.

Homework 5: Bacterial growth (5 Points)

Bacterials grow in a petri dish with enough food, but fixed dish diameter. The population size y at time t is described by the 1-dimensional ordinary differential equation

$$\frac{\mathrm{d}y}{\mathrm{d}t} = ky(G - y) \ . \tag{1}$$

a) Explain the single terms of equation (1) and describe the meaning of the parameters k and G.

b) Solve equation (1), given the initial conditions t_0 and $y(t_0) = y_0$. Focus on a detailed explanation of the single steps of the derivation. Is the solution valid for all values of y, t, y_0, t_0, G and k or are there any (mathematical, biological or logical) restrictions? Sketch the graph of the solution $y(t)$ using different sets of parameters and initial values.

Homework 6: Matrices (5 Points)

Recall some basic rules and laws of matrix calculation.

$$A = \begin{pmatrix} -4 & 7 \\ 1 & 5 \end{pmatrix} \quad B = \begin{pmatrix} 2 & -4 \\ 8 & 7 \end{pmatrix} \quad C = \begin{pmatrix} -2 & 1 \\ -1 & 0 \end{pmatrix}$$

a) Calculate the matrix products

$$AB,\ BA,\ (AB)C,\ A(BC),\ A^TA,\ AA^T,\ (AA)^T$$

b) Calculate the determinant of the matrix H and G:

$$H = \begin{pmatrix} 1 & -2 & 1 \\ 7 & -1 & 0 \\ 8 & 2 & -2 \end{pmatrix} \quad G = \begin{pmatrix} -3 & -2 & 1 \\ -6 & -1 & 2 \\ 9 & 2 & -3 \end{pmatrix}$$

c) Invert the matrix N, such that $N^{-1}N = 1$

$$N = \begin{pmatrix} 1 & 4 & 1 \\ 1 & -1 & 0 \\ 2 & 2 & -2 \end{pmatrix}$$

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