

Exercises – Phylogenetics

Universität Bielefeld, SS 2018

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<https://gi.cebitec.uni-bielefeld.de/Teaching/2018summer/Phylogenetik>

Exercise Sheet 9 — 28.06.2018

Due: 05.07.2018

Task 1 Evolutionary Markov Processes.

(3 (+2*) points)

Use your own words to explain three of the five properties an *evolutionary Markov process (EMP)* has by definition. Write 2-5 sentences per property. Do not simply reproduce the formulas.

Earn up to two bonus points by explaining more than three properties.

Task 2 Modeling of Sequence Evolution.

(7 points)

Consider the following model of nucleotide substitution:

$$\pi = \left(\frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4}\right)$$

$$Q = \begin{pmatrix} -5/8 & 3/8 & 1/8 & 1/8 \\ 3/8 & -5/8 & 1/8 & 1/8 \\ 1/8 & 1/8 & -5/8 & 3/8 \\ 1/8 & 1/8 & 3/8 & -5/8 \end{pmatrix}$$

$$P(t) = \begin{pmatrix} 1 - (x + 2y) & x & y & y \\ x & 1 - (x + 2y) & y & y \\ y & y & 1 - (x + 2y) & x \\ y & y & x & 1 - (x + 2y) \end{pmatrix}$$

where

$$x = \frac{1 - 2 \exp(-t) + \exp(-t/2)}{4}, \quad y = \frac{1 - \exp(-t/2)}{4}$$

- How many PAM is the model calibrated to?
- Recalibrate the corresponding matrix to 1 PAM.
(You are **not** supposed to calibrate **both** matrices to 1 PAM.)
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Task 3 Jukes-Cantor Correction.

(3 (+2*) points)

Consider an alignment with length 900 and 45 substitutions (no InDel included). We assume an evolution of the sequences following the Jukes-Cantor model.

- What is the Jukes-Cantor corrected distance d (in PAM) of the sequences?
- How many mutation events occurred approximately?
- For 2 bonus points: Sketch the graph of D with respect to d . Indicate/specify important characteristics of the curve and mark (roughly) the coordinates from (a) and (b).