Exercises – Phylogenetics

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https://gi.cebitec.uni-bielefeld.de/Teaching/2016winter/Phylogenetik

Exercise Sheet 3 — 08.11.2016

Due: 15.11.2016

Task 1 Properties of binary trees. **(2 points)**

Following observation is given in the lecture notes (page 14):

Each unrooted binary tree with $n \geq 2$ leaves has exactly

(a) $(n-2)$ *internal nodes, and*

(b) $(2n-3)$ *edges.*

Proof either observation (a) or (b).
Hint: You can proceed analogously to the proof of the lemma on page 15.

Task 2 Characters and States. **(2 points)**

The four taxa A, B, C and D have the common characters $1, 2$ and 3 with states as specified in the following character state matrix:

	1	2	3
A	ε	x	k
B	β	x	n
C	δ	y	m
D	ε	y	n

Draw all possible binary, unrooted trees that contain the given taxa as leaves. Decide for each character and for each tree whether the character is compatible with regard to the tree.

Is one of the trees a *perfect phylogeny*?

Task 3 Identification of Characters. **(2 points)**

Consider the four species mouse, wasp, hawk and human.
Find at least three characters and their corresponding states with respect to each species in a way that:

(a) a perfect phylogeny does exist.

(b) no perfect phylogeny exists.

Hint: The characters and their states should be chosen in the same way as for the vehicles on page 19 in the lecture notes.

Task 4 Perfect Phylogeny. **(2 points)**

Consider the binary matrix on the right.

(a) Decide whether there exists a perfect phylogeny for the matrix. Use the theorem of Gusfield on page 21 (at the bottom) in the lecture notes.

(b) Discuss the run-time complexity $\mathcal{O}(nm^2)$ of the algorithm that solves the *perfect phylogeny problem* (PPP) according to Gusfield's theorem. Keep in mind that set operations are no constant operations as they have to be performed on a per-element basis.

	1	2	3	4	5
A	0	0	1	0	1
B	1	0	0	1	0
C	0	1	0	1	0
D	0	1	0	0	1
E	1	0	0	1	0