

# Exercises – Phylogenetics

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<http://wiki.techfak.uni-bielefeld.de/gi/Teaching/2015winter/Phylogenetik>

## Exercise List 3 — 03.11.2015

Due to: 10.11.2015

### Exercise 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

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

Proof this observation.

**Hint:** You can proceed analogously to the proof of the lemma on page 15.

### Exercise 2 Characters and States.

(2 Points)

The four taxa  $A, B, C$  and  $D$  have the common characters 1, 2 and 3. Character 1 has the states  $x, y$  and  $z$ , 2 can occur as  $\beta, \delta$  or  $\varepsilon$  and character 3 as  $a$  or  $b$ . The following matrix gives the specific states of the taxa:

	1	2	3
$A$	$x$	$\beta$	$b$
$B$	$z$	$\varepsilon$	$b$
$C$	$x$	$\varepsilon$	$a$
$D$	$y$	$\delta$	$a$

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

Is one of the tree a *perfect phylogeny*?

### Exercise 3 Perfect Phylogeny.

(4 Points)

Consider the binary matrix on the right.

- Decide whether there exists a perfect phylogeny for the matrix. Use the theorem at page 22 (at the top) in the lecture notes.
- Translate the theorem into pseudo code, that solves the *perfect phylogeny problem* (PPP). The set operations should be written in pseudo code aswell.
- Discuss the run-time complexity  $\mathcal{O}(nm^2)$  (you can use your pseudo code for that).

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