Exercises – Phylogenetics

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

Exercise Sheet 1 — 18.10.2016

Due: 25.10.2016

Task 1 **(0 Points)**

Write down your name and the name of your tutor on each solution. If you have to use multiple sheets, staple them together. This "exercise" applies to every exercise list.

Task 2 Properties of trees. **(2 Points)**

To prove the equivalence of n statements

$$S_1 \Leftrightarrow S_2 \Leftrightarrow \cdots \Leftrightarrow S_n$$

it is sufficient to show:

$$S_1 \Rightarrow S_2 \Rightarrow \cdots \Rightarrow S_n \Rightarrow S_1.$$

By this circular argumentation, we save to show all pairwise equivalence relations.

Let $G = (V, E)$ be a non-directional graph. Apply the above technique to prove that following statements are equivalent.

(a) G is a tree.
(Use the definition of a tree given by the lecture notes.)

(b) Every pair of nodes $\{v_1, v_2\} \in \binom{V}{2}$ is connected by an unique, simple path.

(c) G is minimal connected, i.e., for all $e \in E$: if e is removed, the resulting graph $G' = (V, E \setminus \{e\})$ is not connected.

(d) G is connected and $|E| = |V| - 1$.

(e) G is free of cycles and $|E| = |V| - 1$.

(f) is maximal free of cycles, i.e., for all $e \in \left(\binom{V}{2} \setminus E\right)$: if e is added to E, the resulting graph $G' = (V, E \cup \{e\})$ contains a cycle.

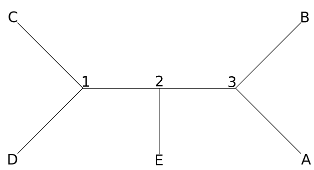
To make that task a little bit easier, we split the steps of the proof according to your students registration number (Matrikelnummer). Take the **last digit** of your registration number and do the two parts of the proof.

Digit	Parts of proof	
0	(a)⇒(b),	(e)⇒(f)
1	(b)⇒(c),	(f)⇒(a)
2	(c)⇒(d),	(a)⇒(b)
3	(d)⇒(e),	(b)⇒(c)
4	(e)⇒(f),	(c)⇒(d)
5	(f)⇒(a),	(d)⇒(e)
6	(a)⇒(b),	(e)⇒(f)
7	(b)⇒(c),	(f)⇒(a)
8	(c)⇒(d),	(a)⇒(b)
9	(d)⇒(e),	(b)⇒(c)

Hint: Some parts are proper for a direct proof, other parts for a proof by contradiction, and sometimes it makes sense to show $\neg(j) \Rightarrow \neg(i)$ instead of $(i) \Rightarrow (j)$.

Task 3 Rooted and unrooted trees. **(2 Points)**

(a) Consider the following tree. Add a new root at the edge `{A,3}`, draw the resulting tree, and give the corresponding NEWICK notation.



(b) Draw the tree to the following NEWICK notation:

(A,(B,((C,D)4,E)3)2)1;