Exercises – Phylogenetics

Universität Bielefeld, WS 2017/2018,
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https://gi.cebitec.uni-bielefeld.de/Teaching/2017winter/Phylogenetik

Exercise Sheet 1 — 12.10.2017

Due: 19.10.2017

Task 1 **(0 Points)**

Write down your name 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.

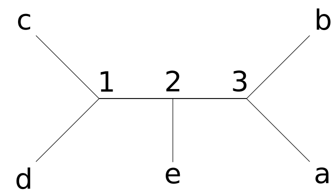
Digit	Parts of proof	
0	(c)⇒(d),	(a)⇒(b)
1	(a)⇒(b),	(e)⇒(f)
2	(c)⇒(d),	(a)⇒(b)
3	(f)⇒(a),	(d)⇒(e)
4	(a)⇒(b),	(e)⇒(f)
5	(d)⇒(e),	(b)⇒(c)
6	(b)⇒(c),	(f)⇒(a)
7	(b)⇒(c),	(f)⇒(a)
8	(d)⇒(e),	(b)⇒(c)
9	(e)⇒(f),	(c)⇒(d)

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 $(i) \Rightarrow (j)$.

Please turn over! Bitte wenden!

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:

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