Exercises – Phylogenetics

Universität Bielefeld, SS 2019
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https://gi.cebitec.uni-bielefeld.de/Teaching/2019summer/Phylogenetik

Exercise Sheet 1 — 04.04.2019

Due: 11.04.2019

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 do not need to show *all* pairwise equivalence relations.

Let $G = (V, E)$ be a undirected 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 a unique, simple path.

(c) G is minimally 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 acyclic and $|E| = |V| - 1$.

(f) G is maximally acyclic, 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.

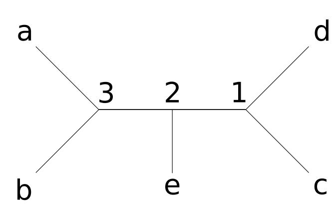
To make that task a little bit easier, we split the steps of the proof according to your students registration number (Matrikelnummer). Take the **last digit** of your registration number and do the two parts of the proof.

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 `{b,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;