Exercises – Phylogenetics

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

Exercise List 1 — 20.10.2015

Due to: 27.10.2015

Exercise 1 **(0 Points)**

Write down your name and the name of your tutor on each solution. If you have to use multiple sheets, connect them with a staple. This “exercise” applies to every exercise list.

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

Let there be n statements. You have to show:

$$1 <=> 2 <=> 3 <=> \cdots <=> n-1 <=> n$$

Instead of doing both directions of the proof you can also show:

$$1 => 2 => 3 => \cdots => n => 1$$

Because of this circular argumentation the other direction is saved.
Let's try out this proof technique:

Let $G = (V, E)$ be a non-directional graph. Proof 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 $e \in (\binom{V}{2} \setminus E)$: if e is added to E, the resulting graph $G' = (V, E \cup \{e\})$ contains a cycle.

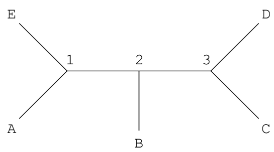
To make that task a little bit easier we split the steps of the proof according to your registration numbers (Matrikelnummer). Take the **last digit** of your registration number and do the two parts of the proof.

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 $(i) \Rightarrow (j)$.

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

Consider this tree:



(a) Add a new root at the edge `{2,B}`, draw the resulting tree and write the corresponding NEWICK notation.

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

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

Exercise 4 NEWICK notation and rooted trees. **(2 Points)**

Draw the trees to the following NEWICK notations:

- ((A,B),C,(D,E));
- (A,((D,B),(E,C)));
- (A,((B,D),(E,C)));
- (((C,E),(B,D)),A);

Point out differences and similarites between the trees.