

# Exercises – Phylogenetics

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

## XMas Sheet – 21.12.2017

All points on this exercise sheet are bonus points.

Doing the exercises is completely voluntary

Due to 11.01.2018

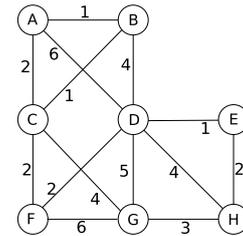
### Task 1 Steiner Trees.

(2 bonus points)

The picture on the right shows an undirected weighted graph. Find a *minimum Steiner tree* with

- (a)  $B, D, F$  and  $H$ , as well as
- (b)  $A, E$  and  $G$

as terminal nodes. Mark all *Steiner nodes* in your solutions.



### Task 2 Additive Metric, Ultrametric.

(4 bonus points)

Given the following matrices:

i)	A	B	C	D	E
A	0	8	8	6	6
B		0	4	8	4
C			0	8	4
D				0	6
E					0

ii)	A	B	C	D	E
A	0	10	10	10	4
B		0	2	6	10
C			0	6	10
D				0	10
E					0

Decide for i) and ii) whether the matrix describes an additive or even an ultrametric. Explain your result.

### Task 3 Pseudocode Perfect Phylogeny.

(2 bonus points)

Write down a pseudo code that solves the *Perfect Phylogeny Problem* by using Gusfield's theorem. The set operations should be written in pseudo code as well.

### Task 4 Ultrametrics.

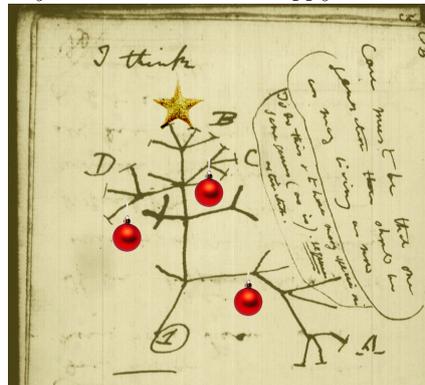
(4 bonus points)

Given a path metric  $d^T$  which states the distances of  $n$  taxa, the following property holds:

If  $d^T$  forms an ultrametric, there are at most  $n - 1$  different entries  $d_{i,j}^T$  for all  $i \neq j$ .

- (a) Justify this statement. (Hint: For each internal node of an ultrametric tree, think about what distances two taxa could have whose LCA is such a node.)
- (b) Find a counterexample of four taxa which shows that the reverse is not true. ("Each path metric with at most  $n - 1$  different entries  $d_{i,j}^T$  for all  $i \neq j$  forms an ultrametric.")

*Merry Christmas and a Happy New Year!*



Darwin's (Christmas) tree