

# Exercises – Phylogenetics

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

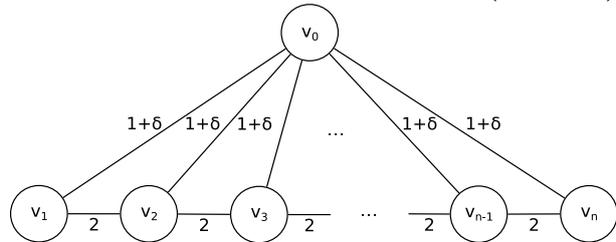
## Exercise Sheet 7 — 23.11.2017

Due: 30.11.2017

### Task 1 Spanning Tree Heuristic: 2-Approximation.

(3 points)

In the lecture notes on page 41, it is shown that the approximation factor of the spanning tree heuristic is at most 2. Use the given graph to show that it is even *tight*, i.e., it has no smaller factor than 2. Terminal nodes should be  $v_1, \dots, v_n$ .



### Task 2 Additive Metric, Ultrametric.

(4 points)

Given the following matrices:

i)	A	B	C	D	E
A	0	5	5	5	2
B		0	1	3	5
C			0	3	5
D				0	5
E					0

ii)	A	B	C	D	E
A	0	9	7	9	7
B		0	5	5	9
C			0	5	7
D				0	9
E					0

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

### Task 3 Properties of Distances.

(2 points)

For every distance function  $d$ , the following relation applies:

$$“d \text{ is additive}” \Rightarrow “d \text{ satisfies the triangle inequality}”$$

Prove this relation by showing: “ $d$  satisfies the four point condition”  $\Rightarrow$  “ $d$  satisfies the triangle inequality.”  
 Hint: The four point condition can be used on three points as well.

### Task 4 Agglomerative Clustering.

(4 points)

	A	B	C	D	E	F
A:	0	2	8	12	18	18
B:		0	4	8	18	18
C:			0	6	18	18
D:				0	8	12
E:					0	10
F:						0

Use the following variants of agglomerative clustering to reconstruct phylogenetic trees from the above matrix.

- (a) Complete linkage clustering.
- (b) UPGMA.

State the corresponding matrix in every intermediate step and write down the final tree. If there are more possibilities, show all of them.

- (c) Compare the results and decide whether the matrix is ultrametric. Explain!