

## Advanced Algorithmic Techniques for Bioinformatics

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### Exercise sheet no. 2 (out: 7 Nov. 2007, in: 14 Nov. 2007)

#### 1. UPGMA.

Given the following ultrametric matrix  $M$ , compute the (unique) ultrametric tree that corresponds to  $M$  using the algorithm UPGMA. Write down each step separately, with the new matrix and the current tree.

	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>
<i>a</i>	0	24	24	24	24
<i>b</i>		0	16	8	8
<i>c</i>			0	16	16
<i>d</i>				0	4
<i>e</i>					0

#### 2. Metrics.

Show that the following holds:

$$\text{3-point-condition} \Rightarrow \text{4-point-condition} \Rightarrow \text{triangle inequality}$$

#### 3. Neighbour Joining.

For the matrix from exercise 1, compute a phylogenetic tree with Neighbour Joining (NJ). (You need to update the  $r_i$ 's and the  $D_{ij}$ 's in each iteration.) Compare the tree with the one you got with UPGMA and discuss the relationship.

#### 4. Perfect Phylogenies.

Decide for each of the following binary matrices whether there exists a perfect phylogeny (proof!) and if so, construct it.

(a)

	1	2	3	4	5
<i>A</i>	1	0	1	0	1
<i>B</i>	0	1	1	1	0
<i>C</i>	0	1	1	0	0
<i>D</i>	1	0	1	0	0
<i>E</i>	0	0	0	0	0

(b)

	1	2	3	4	5
<i>A</i>	1	1	0	0	0
<i>B</i>	0	0	1	1	0
<i>C</i>	1	1	0	1	0
<i>D</i>	0	0	1	0	1
<i>E</i>	0	1	0	1	0