

## Group HW3

CS 685-001/PPA 784-003/STA 695-001 Fall 2009

Due: September 17th, 2009

For Question 2 through Question 4, please ignore branch lengths in a tree.

**Problem 1** Review all definitions defined in Lectures 4 and 5.

**Problem 2** With three and four leaves how many unlabeled unrooted binary trees are there? How about for rooted binary trees?

With three leaves there is only one unlabeled unrooted tree. With four leaves there are is only one unlabeled unrooted tree. With three leaves there is only one unlabeled rooted tree. With four leaves there are two unlabeled unrooted trees.

**Problem 3** For rooted and unrooted binary trees, how many leaves do there have to be to obtain more than one unlabeled trees? Other words, what is the minimum number of leaves in order to have at least two different (unlabeled) tree topologies for unrooted and rooted trees?

Unrooted: 6, Rooted: 4

We have a tree

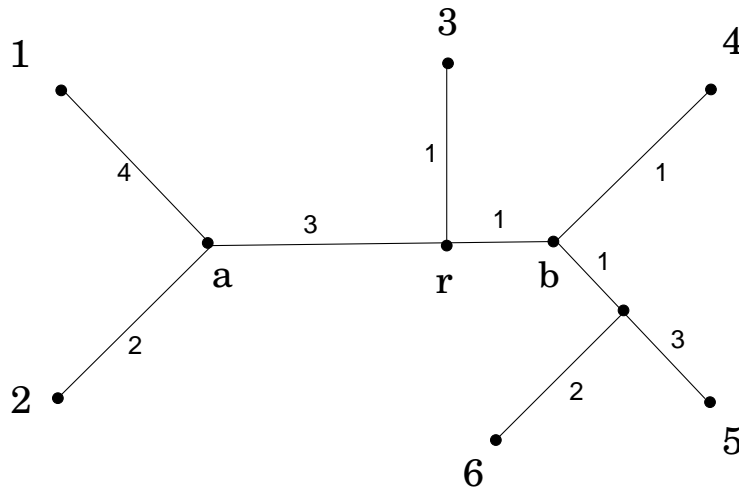
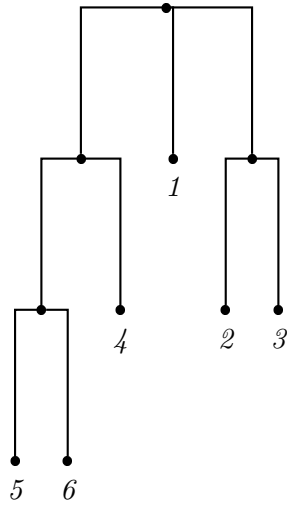
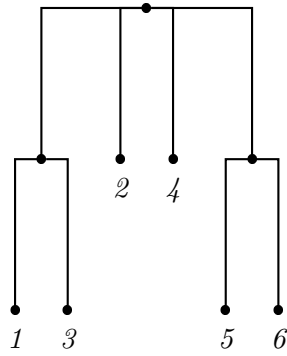


Figure 1: Tree with 6 leaves

**Problem 4** Apply NNI move about the edge between *a* and *r* in Figure 1. Draw all possible trees you can get by this NNI move.



**Problem 5** Write a newick format on the following tree in Figure 1. Then use treeview to see them as cladogram, phylogram and unrooted tree.

**Newick format:**  $((1:4, 2:2):3, 3:1, ((6:2, 5:3):1, 4:1):1);$