

Exercises – Phylogenetics

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<https://gi.cebitec.uni-bielefeld.de/Teaching/2018summer/Phylogenetik>

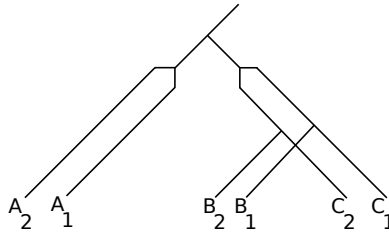
Exercise Sheet 2 — 19.04.2018

Due: 26.04.2018

Task 1 Gene and species trees.

(2 points)

- (a) Give all pairs of paralog and ortholog genes.



- (b) Find out the meaning of *xenolog*. Draw a picture and explain the term.

Task 2 Gene tree / species tree reconciliation.

(3 points)

Consider the following gene tree G and species tree S .

$$G = ((g_4, g_5)g_2, (g_6, g_7)g_3)g_1;$$
$$S = (A, (B, C)n_2)n_1;$$

Let g_4 be present in species A . Genes g_5 and g_6 are in B and gene g_7 is found in C .

- (a) Draw G and S . Label the internal nodes and leaves. Furthermore label the leaves of G with the corresponding names of the species.
- (b) Calculate $\gamma(g_1)$, $\gamma(g_2)$ and $\gamma(g_3)$. Calculate the $M(\cdot)$ for every node (including the leaves) in G and draw the matching arrows (lecture notes: Figure 2.6) from G to S . Decide for every internal node whether it corresponds to a duplication or speciation.
- (c) Draw the resulting scenario (similar to Figure 2.5 (right) in the lecture notes).

Hint The scenario might include deletions.

Task 3 Last common ancestor.

(2 points)

Consider a rooted tree $G = (V, E)$. Write an algorithm in *pseudo code* that determines the *last common ancestor* $LCA(u, v)$ for two given nodes U and V . What is the asymptotic worst case running time of your algorithm?

Hint: You can find examples for pseudo code in the lecture notes (page 13, 22/23, 28, 35, 36 etc.)

Don't get confused! *lowest* and *last/least common ancestor* are basically the same. In phylogenetics, the term *last/least common ancestor* is more common since we're looking at the evolutionary time of events. However, if you think about vertices and trees in graph theory, the term *lowest common ancestor* is used since there is no time involved in the analysis. Luckily, the abbreviations of the words are the same.