Growth grammars simulating trees — an extension of L-systems incorporating local variables and sensitivity

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Figures

Figure captions

Fig. 1: Structure generation by an example growth grammar.

Fig. 2: Structure generation by a sensitive growth grammar. α is the start string, σ_k is the string which is used by the turtle to create the (plant) structure S_k. Sensitive rules take S_k into account when σ_k is rewritten into σ_{k+1}.

Fig. 3: The shadow-relevant cone of a shoot.

Fig. 4: The centralistic concept (a) and the branch-autonomy concept (b) for carbon allocation in trees. In (a), the assimilates produced by shoot x are distributed to potentially all shoots via the central C-pool. In (b), the assimilates from x can be consumed only by x itself and by shoots belonging to the path from x downwards.

Fig. 5: The relation of local variables to shoots. The local variable x yields 17 when evaluated for shoot a, and 5, when evaluated for shoot b.

Fig. 6: Nine trees with centralistic carbon allocation and light-dependent shoot growth, produced by GROGRA from a sensitive growth grammar. Number of steps: 30 (= 15 growth periods), distance of trees: 450 units, mean heights: 2631 units (corner trees), *resp.* 2778 units (middle trees of side rows), *resp.* 2970 units (central tree); diameter at base: 46.5 units (constant for all trees).

Fig. 7: Nine trees with "branch-autonomy" carbon allocation and light-dependent shoot growth, produced by GROGRA from a sensitive growth grammar. Number of steps: 40 (= 20 growth periods), distance of trees: 200 units, height: 1674 units (constant for all trees), mean diameters at base: 50.4 units (corner trees), *resp.* 43.7 units (middle trees of side rows), *resp.* 19.3 units (central tree). Values are given only for purpose of comparison to each other, no reproduction of quantitative field data was intended in these conceptual models.

Caption for Figure 8 a+b together:

Fig. 8: Comparison of the stem shapes resulting from "branch-autonomy" carbon allocation. (a) Solitary tree, (b) central tree from a group of 9 trees (cf. Fig. 7). Diameters are artificially enlarged with respect to tree height (horizontal axis) but are of the same scale in (a) and (b). Diameters at base: 66.0 units (a), 19.3 units (b); height in both cases: 1674 units.

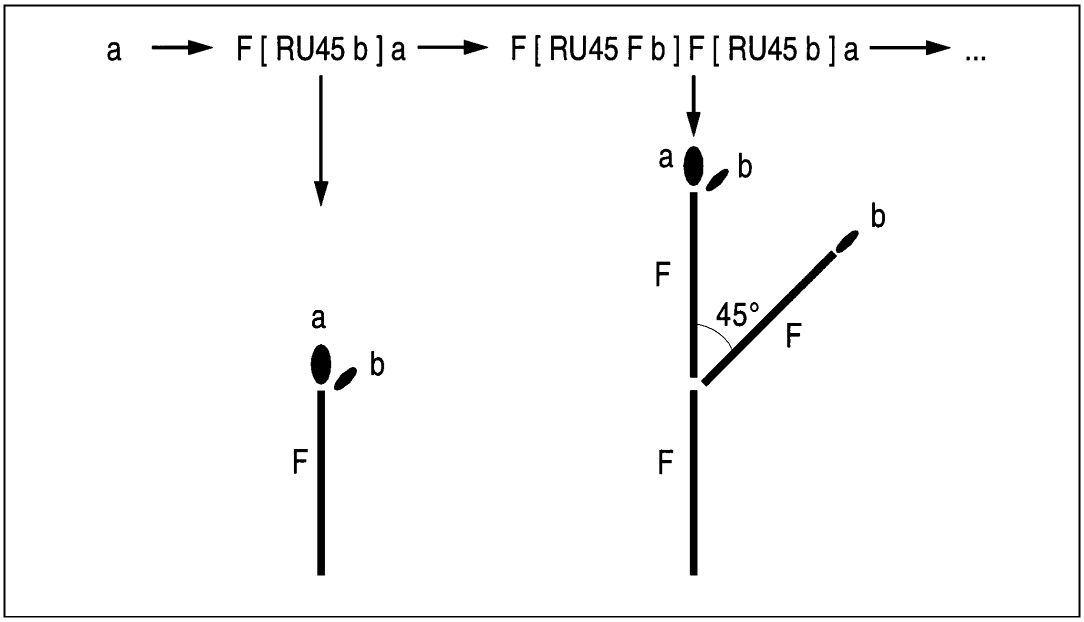


Fig. 1

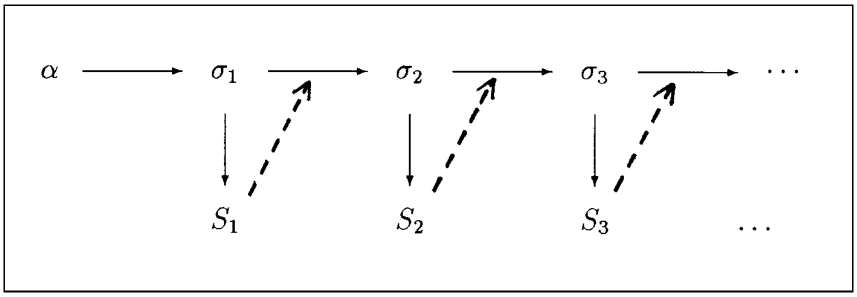


Fig. 2

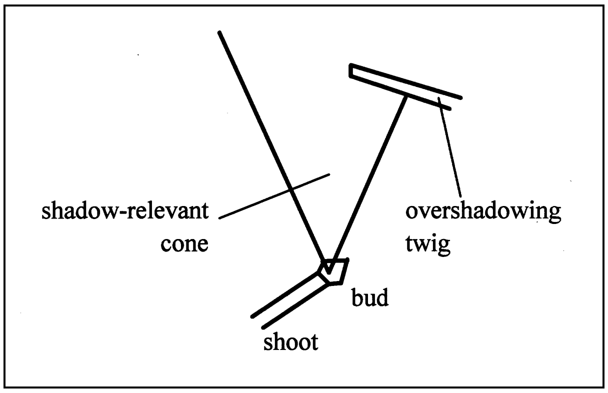


Fig. 3

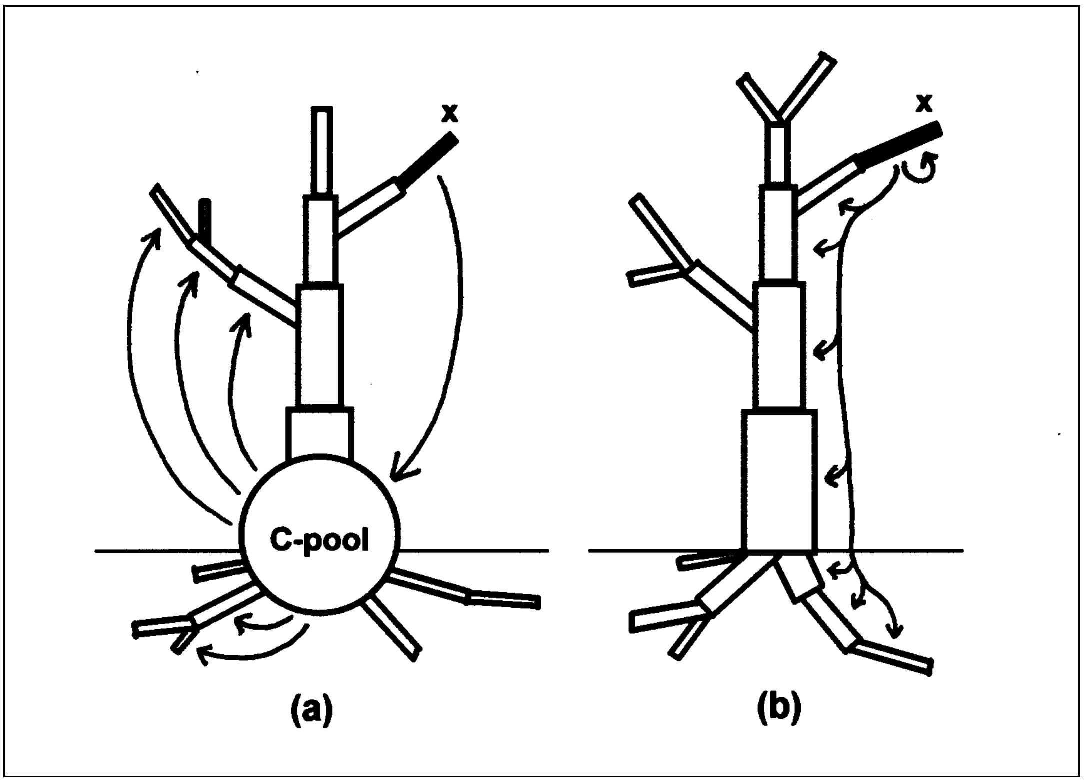


Fig. 4

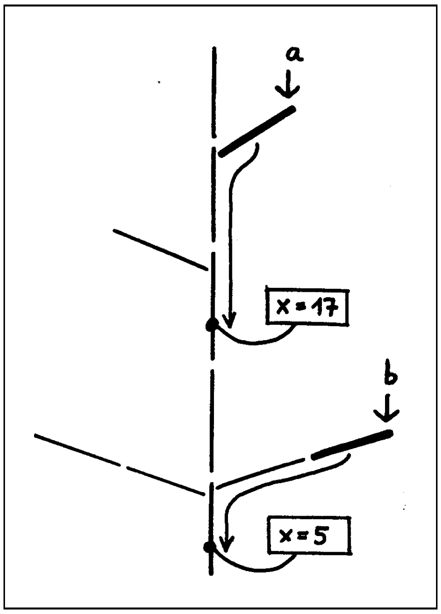


Fig. 5

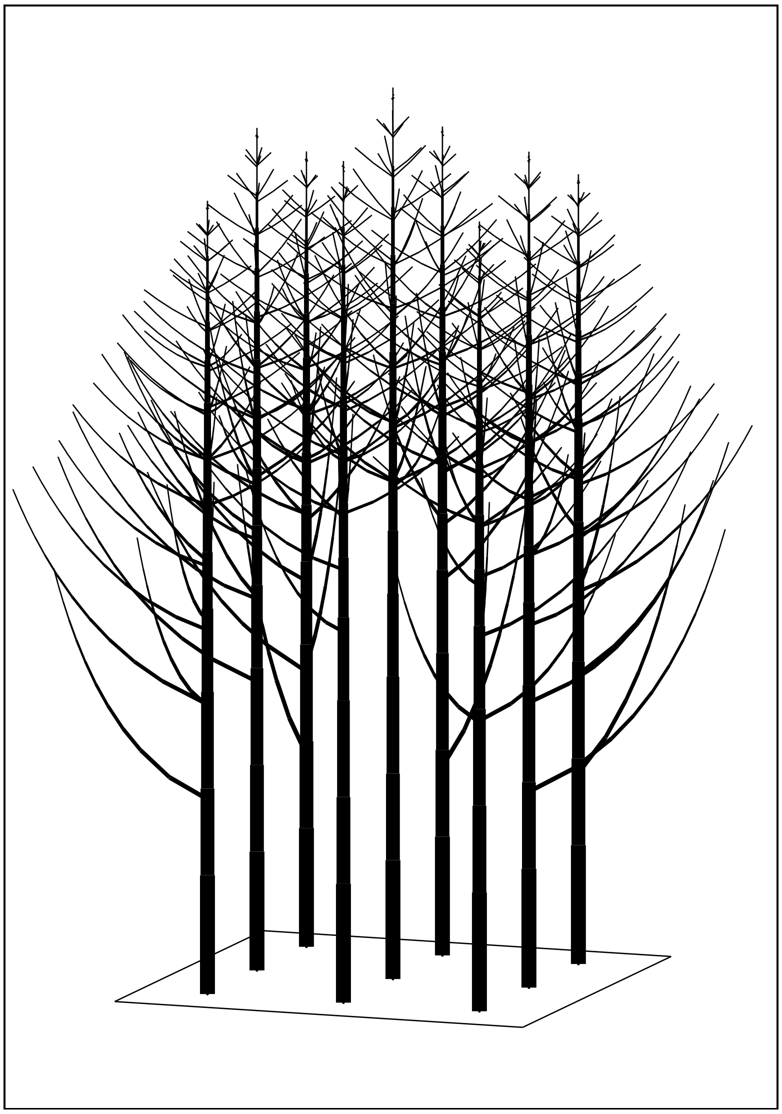


Fig. 6

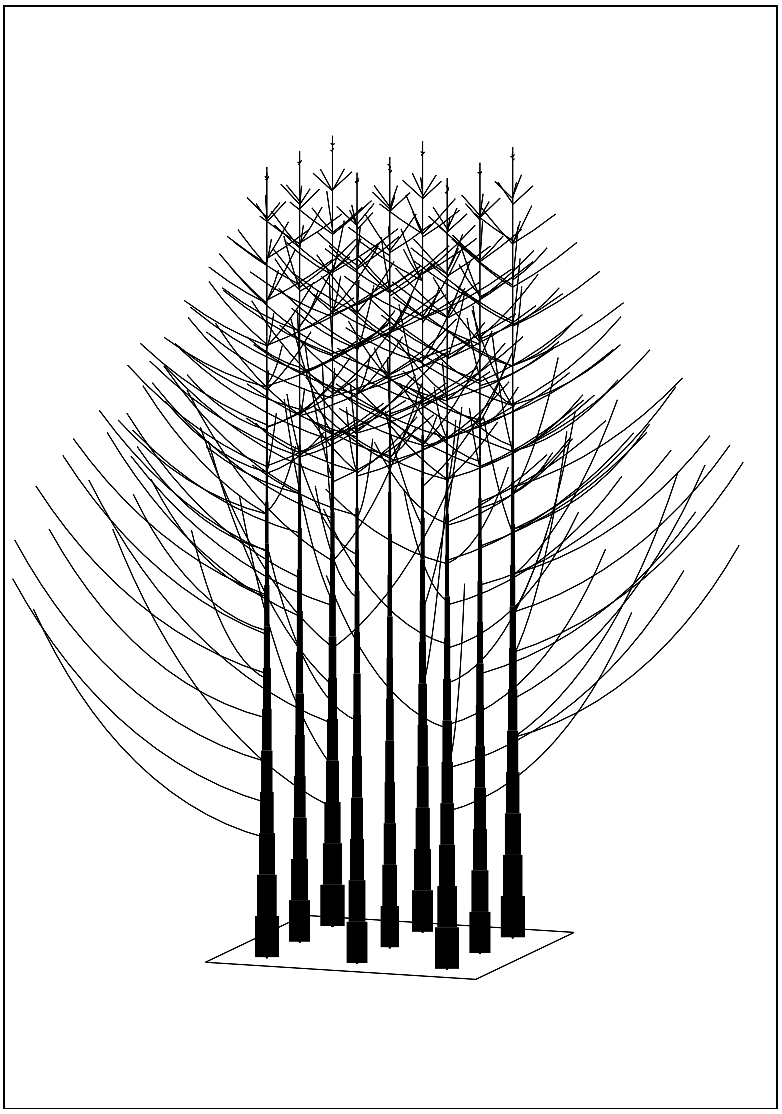
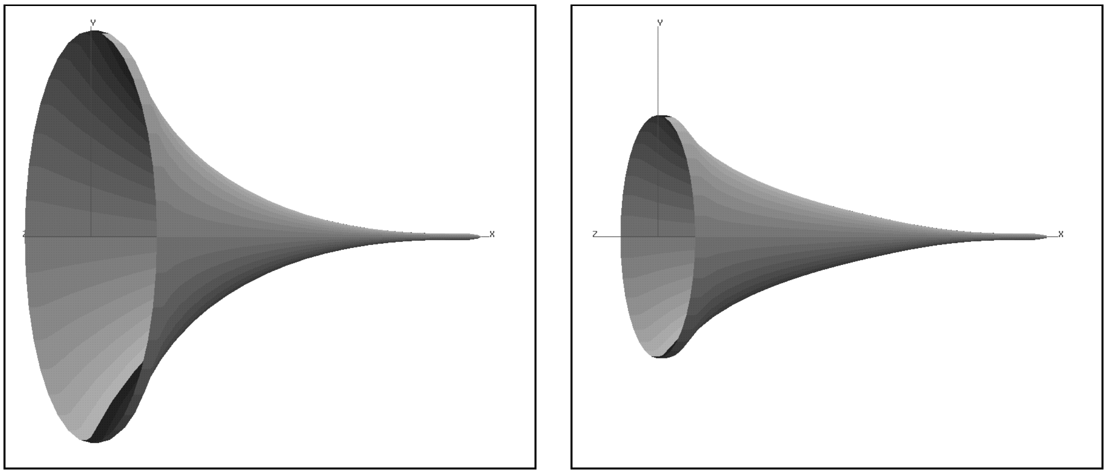


Fig. 7



(a) (b)

Fig. 8