L-systems and MTGs: Integrating simulation and formal analysis of architectural plant models.

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Lindenmayer-systems (L-systems) were originally introduced to model the development of relatively simple multicellular organisms, such as algae [Lindenmayer, 1968]. They are now currently used in the modeling of higher plants [Prusinkiewicz et al., 1997]. CPFG [Měch, 1998], developed at the University of Calgary, is a plant simulation program based on the formalism of L-systems. Its distinctive feature is the flexible modeling language that allows the user to specify the architecture of various modular organisms, from filamentous bacteria and algae to herbaceous plants, trees and plant ecosystems. The models produced by CPFG can be descriptive or mechanistic in nature. In the latter case, the user can investigate the impact of physiological and environmental processes on plant development. The results of simulations are visualized as diagrammatic or realistic images of plants.

The formalism of multiscale tree graphs (MTGs) was introduced in 1998 by Godin and Caraglio [Godin and Caraglio, 1998] to represent plant topology at different scales and levels of abstraction, for instance the levels of metamers, growth units, and plant axes. Once represented in the form of an MTG, plant data can be explored using software AMAPmod [Godin et al., 1997] developed at CIRAD. Tools included in AMAPmod make it possible to discover regularities in plant structures, quantify differences between given branching structures, and perform many other analytical tasks [Ferraro and Godin, 2000, Guédon and Costes, 1998]. MTGs may represent experimental data, obtained by measuring plants, and plant structures modeled using simulation programs.

In this work, our goal is to connect both tools to enable an analysis of simulated plants. In our presentation, we will discuss an algorithm for converting plant structures generated with L-systems into the MTG format and an implementation of this algorithm in the modeling program CPFG. The virtual laboratory software (vlab) [Federl and Prusinkiewicz, 1999] is used to integrate CPFG and AMAPmod into a cohesive system for modeling and analyzing plants (*cf.* Figure 1). We will present sample applications of this system, and focus on the assessment of virtual plants in case of the evaluation of modeled inflorescences of Syringa species using a structural comparison with measured inflorescences.

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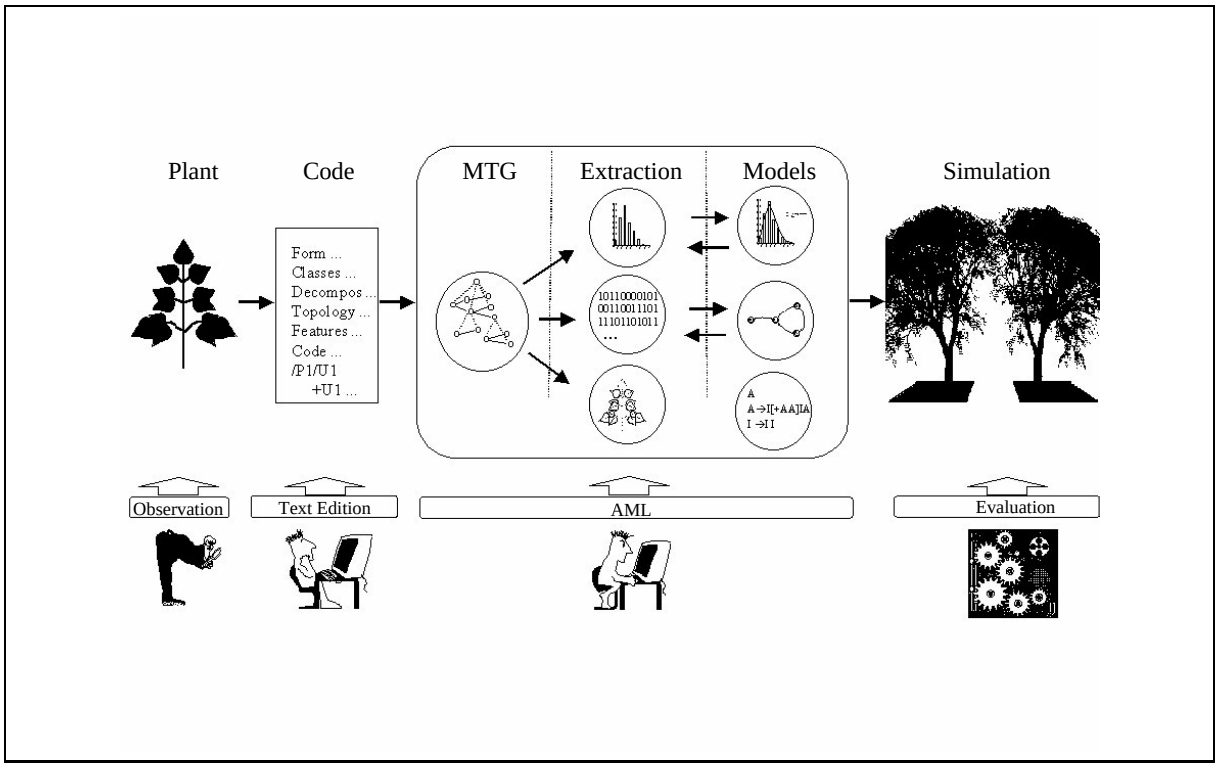

Figure 1: Synoptic of the conection between AMAPmod and CPFG within vlab.

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