Computational modeling and image processing approaches to understanding the dynamics of the Arabidopsis thaliana shoot apical meristem

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An integrated effort to advance the understanding of the shoot apical meristem (SAM) of *Arabidopsis thaliana* through computational modeling of developmental processes, is embodied in the Computable Plant project. Interesting and generic mathematical problems arise at each stage of the computational approach. For example, quantifying the growth of the SAM and the lineages of its cells requires tracking multiple features in 3D imagery, which we approach through nonlinear optimization. Fitting the resulting data to a dynamical model requires a coupled mechanical/regulatory network modeling framework. For both the image processing and dynamic modeling we develop a mathematical foundation based on the use of a dynamical "grammar" capable of representing events such as cell division that change the number of objects present and their relationships, as well as continuous-time processes such as regulatory network dynamics and mechanical processes. The resulting computational algorithms are assisting experimental research on mechanisms of meristem maintenance and phyllotaxis.