Modeling and image understanding for biological development: the case of a plant shoot meristem

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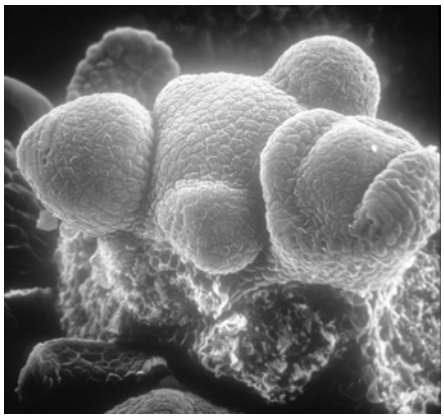
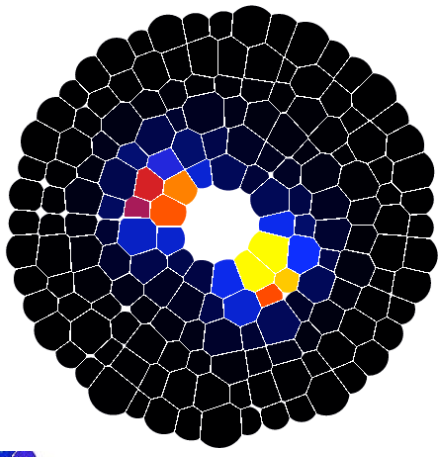
Abstract

The Computable Plant project is a systematic effort to advance the understanding of the shoot apical meristem (SAM) of *Arabidopsis thaliana* through imaging and computational modeling of developmental processes. Interesting and generic mathematical problems arise within the computational approach. For example, to quantify the growth of the SAM and its cell lineages requires tracking multiple features in 3D image sequences; we approach this problem through nonlinear optimization. Also, fitting the resulting data to dynamical models requires a flexible modeling framework for coupled mechanical and regulatory networks. For these problems we develop a mathematical foundation based on the use of a "dynamical grammar" capable of representing discrete-time events such as cell division that change the number of objects and their relationships, as well as continuous-time processes arising from regulatory networks and mechanical interactions. The resulting algorithms are being used to assist experimental research on mechanisms of meristem maintenance and phyllotaxis.

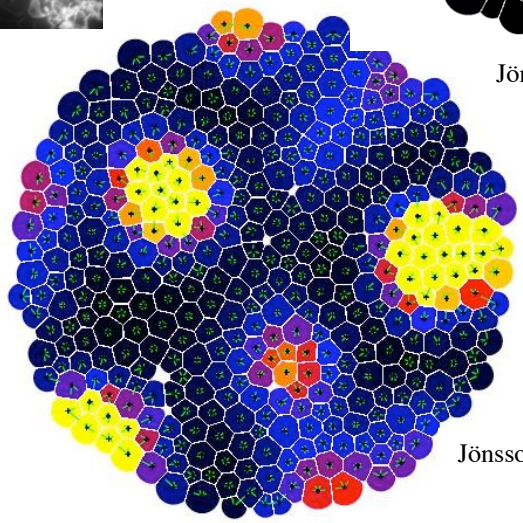
Joint work with Tigran Bacarian, Pierre Baldi, Ashish Bhan, Victoria Gor, Marcus Heisler, Henrik Jönsson, Elliot Meyerowitz, Alex Sadovsky, Bruce Shapiro, and Venu Reddy. Further information available at www.computableplant.org.



Meyerowitz 1997



Jönsson et al. 2004



Jönsson et al. 2004