How to use the XL version of the plant model GreenLab

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"Modelling of Ecosystems by Tools from Computer Science"

GreenLab

- Functional-structural plant model (FSPM)
- Developed by several teams: Sino-French lab LIAMA (China), Digiplante (INRIA, ECP, France)
- Mathematical formalism
- Versions: deterministic, stochastic, mechanistic, ...
- Softwares: GreenScilab, GreenScilab-Crop, DigiPlante, QingYuan, GLOUPS, AMAPstudio, ... , **GroIMP**

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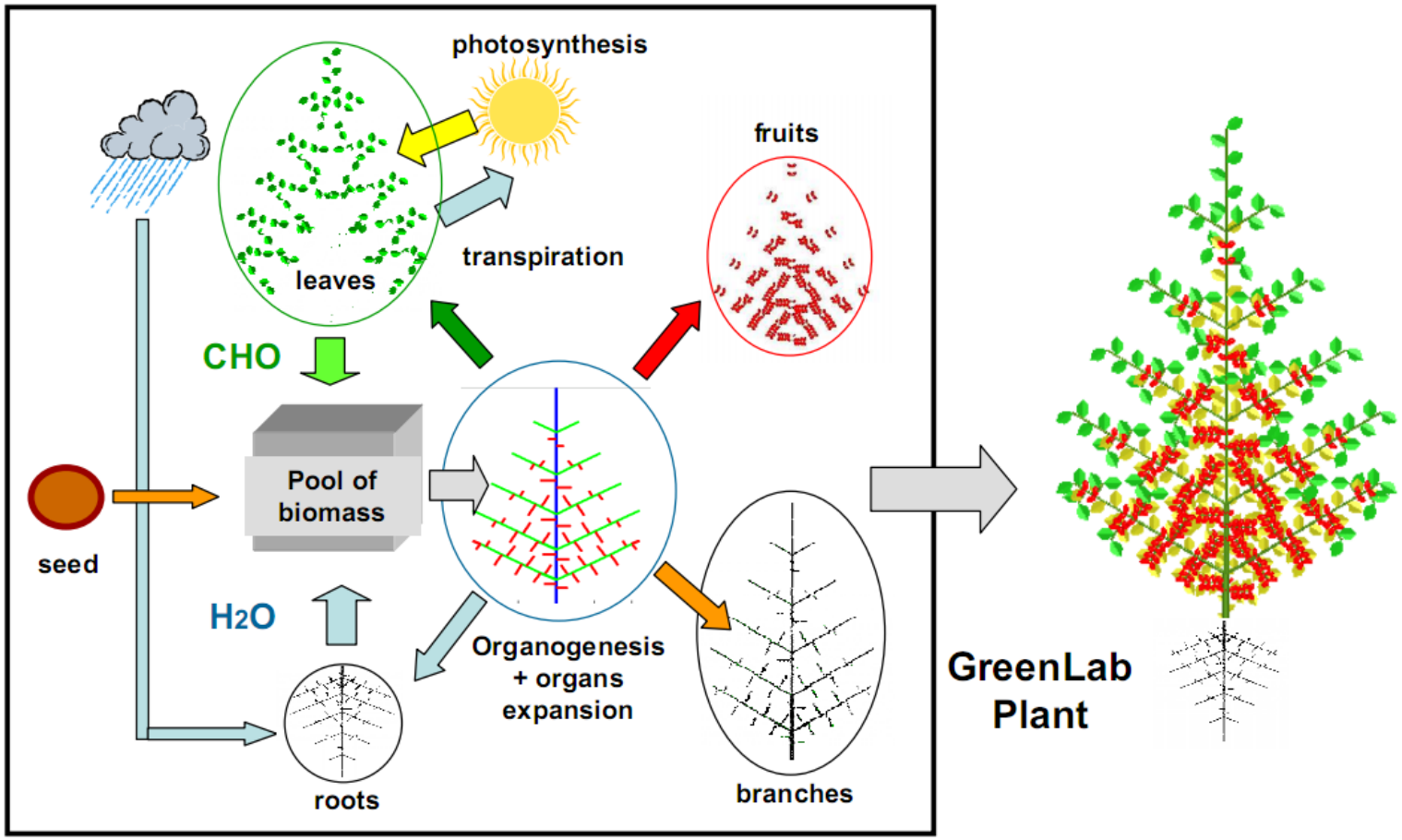
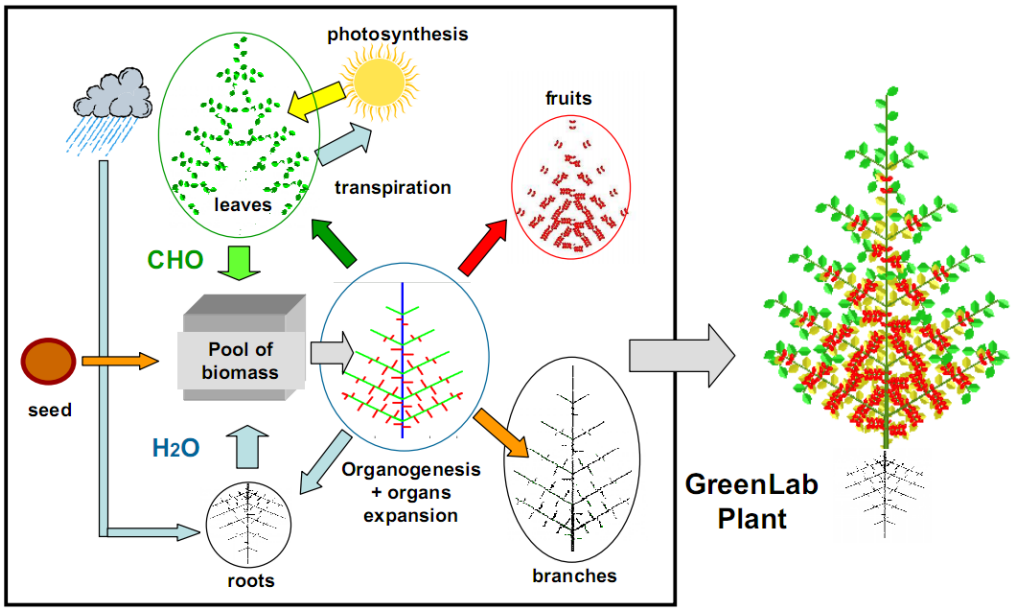
GreenLab - model overview



(Cournède *et al.*, 2006)

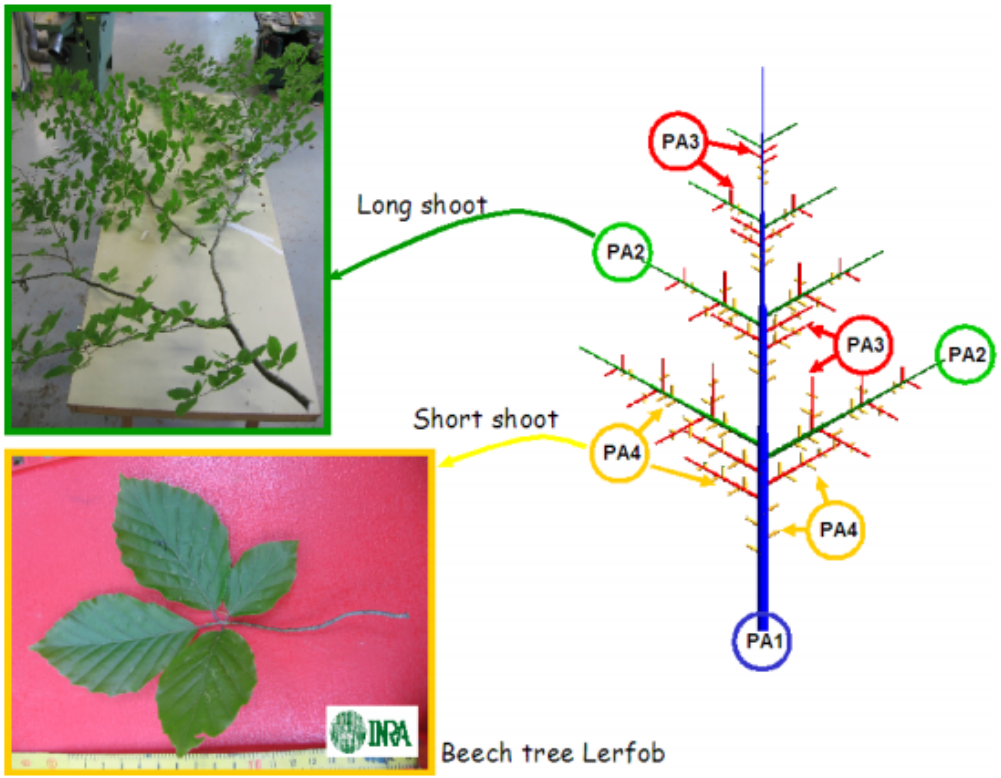
GreenLab - application

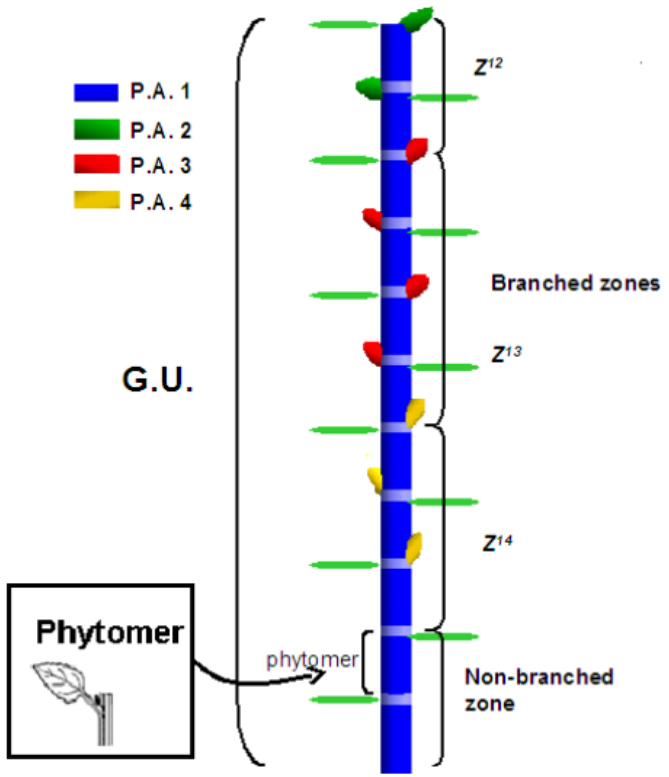


(Cournède *et al.*, 2006)

(Trevezas, Cournède, 2010)

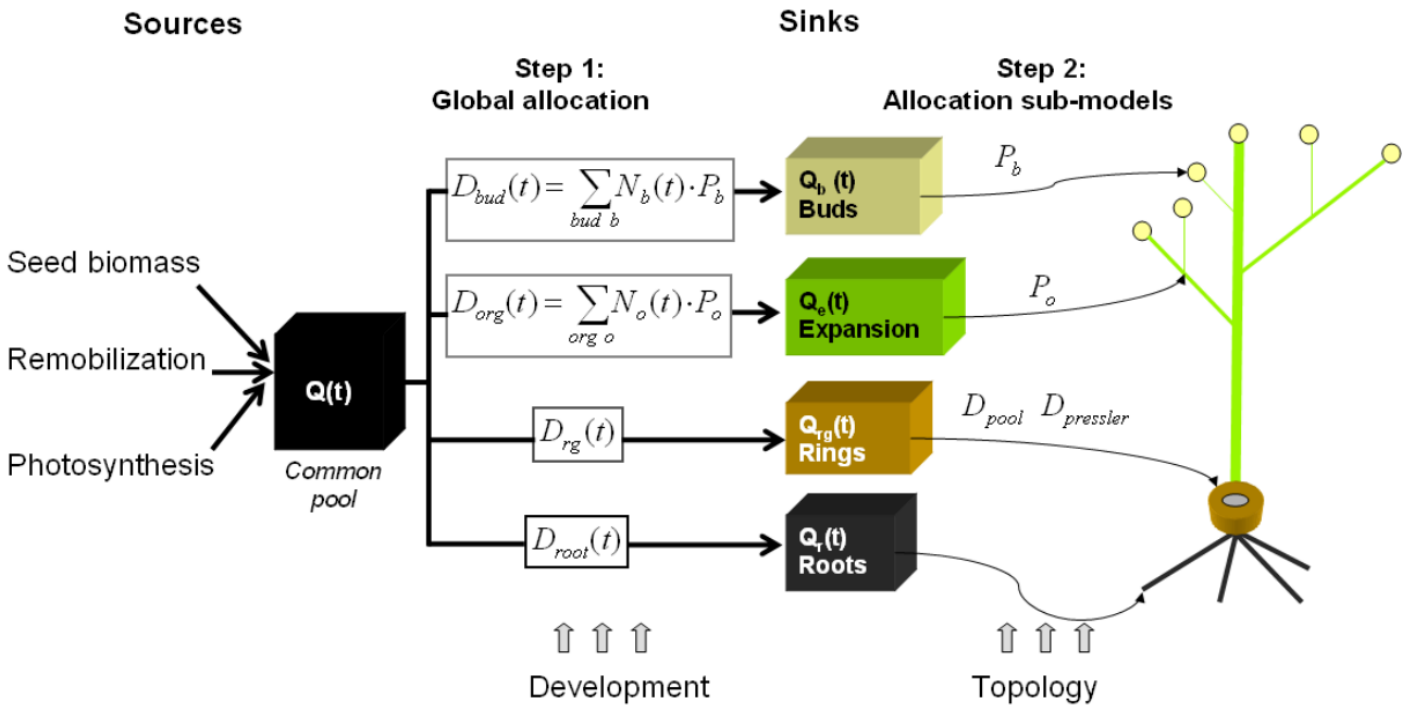
Description of the plant structure





(Letort, 2008)

Physiological processes



(Letort, 2008)

- $Q(t)$ - biomass production at growth cycle t
- $D(t)$ - plant demand at t
- $N(t)$ - number of organs at t, P - sink strength of organs

Model assumptions

- Physiological age (PA) - relates to the degree of differentiation of axes (usually ≤ 5 (6))
- Metamer - basic structural unit of a plant, associated with buds and other organs
- Growth unit - set of metamers developed during one growth cycle
- Time step - growth cycle
- Organ types - Blade, Petiole, Internode, Female, Male, Layer, Root
- GreenScilab v1.0 - reference model

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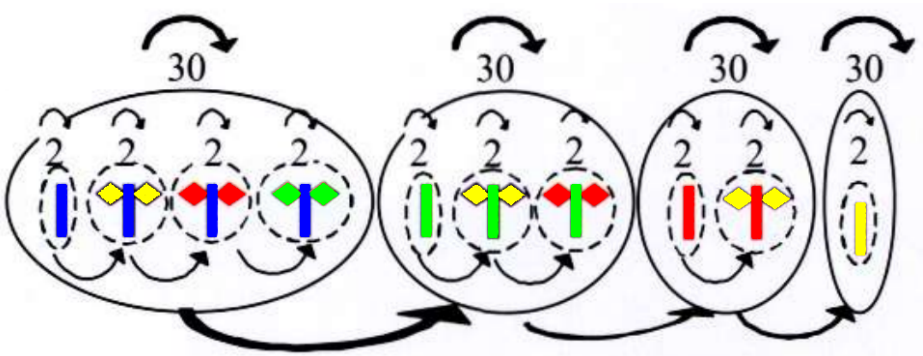
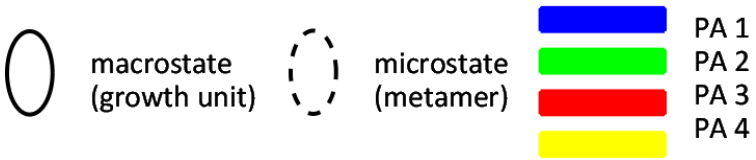
Organogenesis - dual-scale automaton in XL



(Kang *et al.*, 2003, modified)



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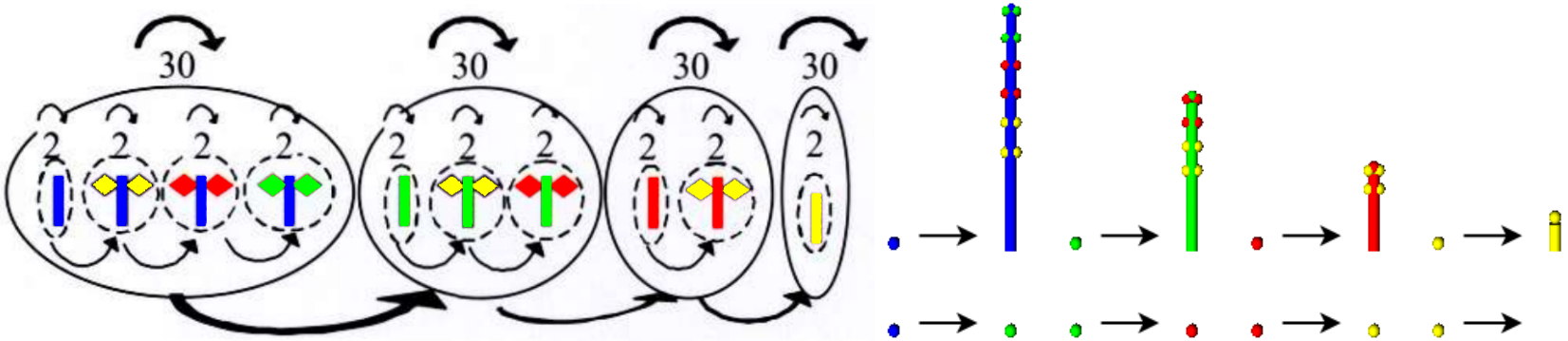

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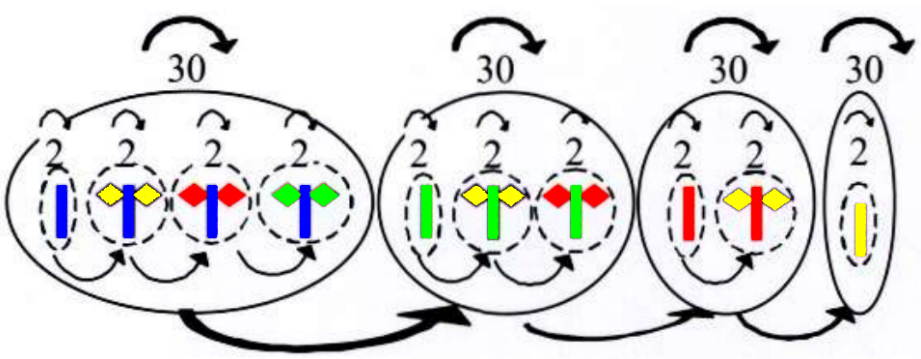
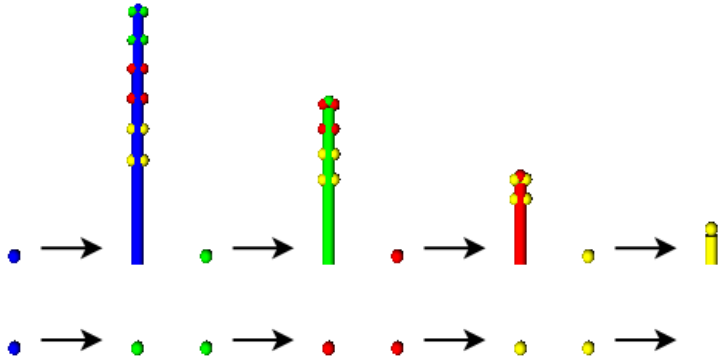
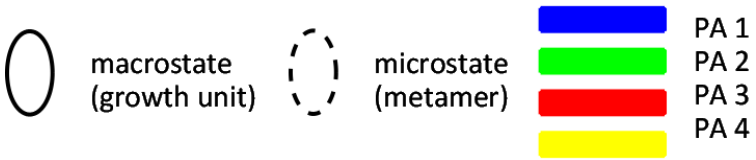




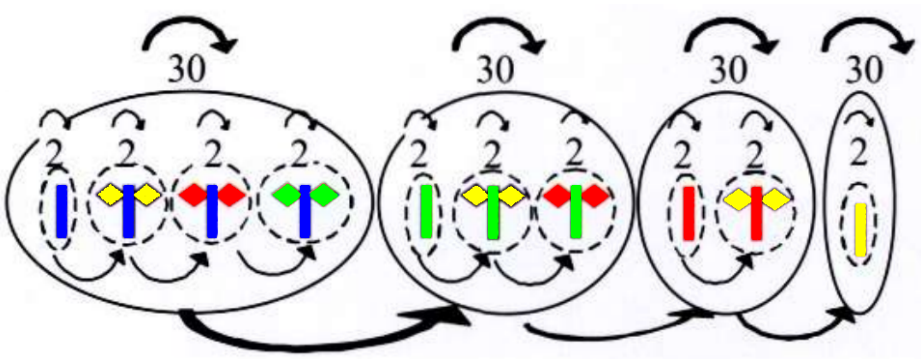
(Kang *et al.*, 2003, modified)

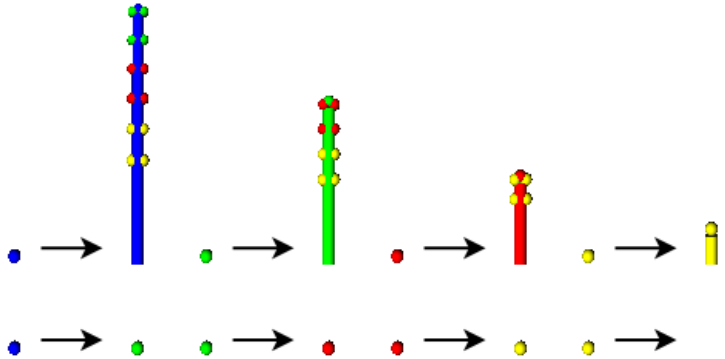


time: 0 (Axiom)

metamers: 0

Organogenesis - dual-scale automaton in XL





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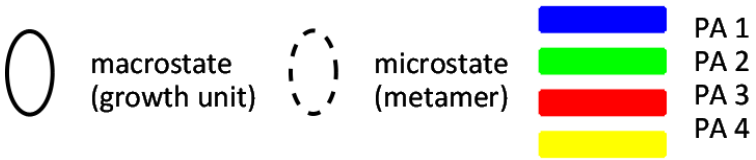
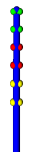
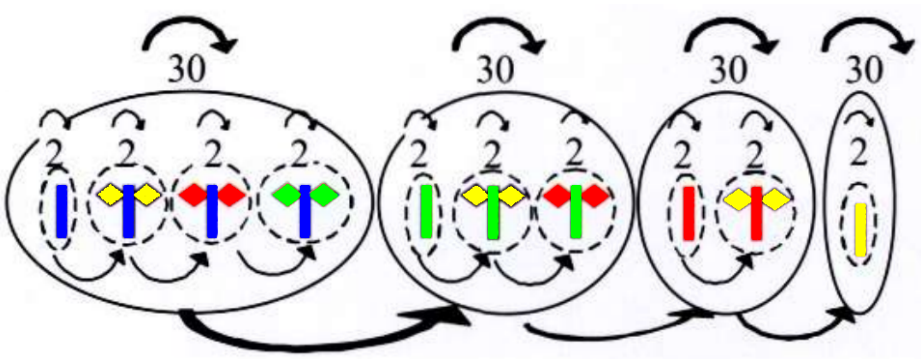


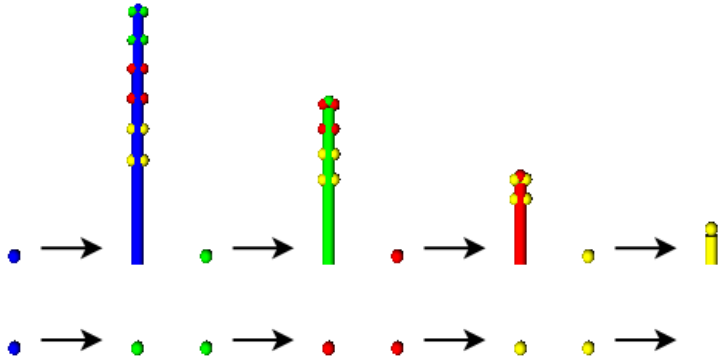


time: 1

metamers: 8

Organogenesis - dual-scale automaton in XL





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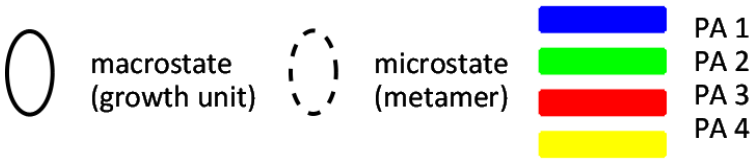
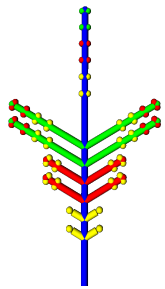
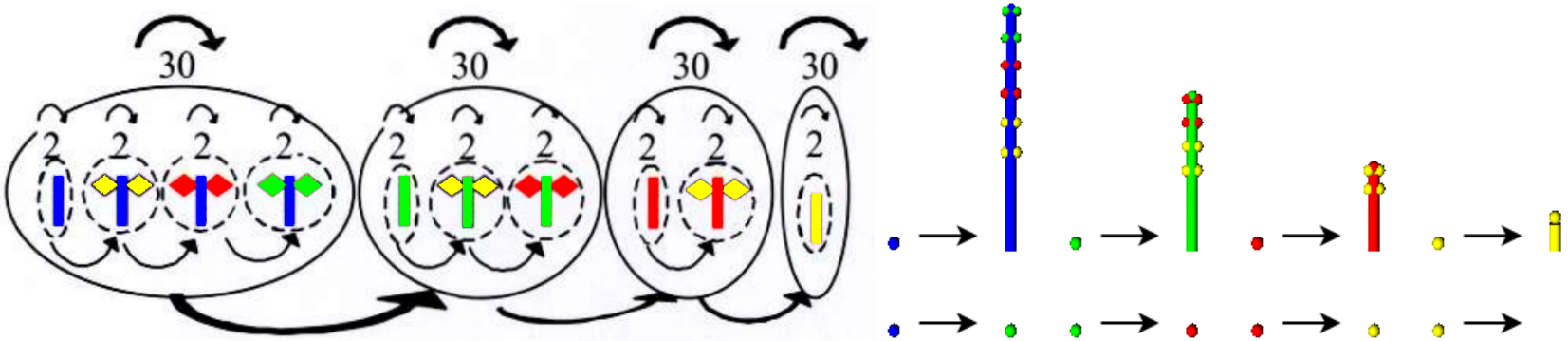




time: 2

metamers: 64

Organogenesis - dual-scale automaton in XL



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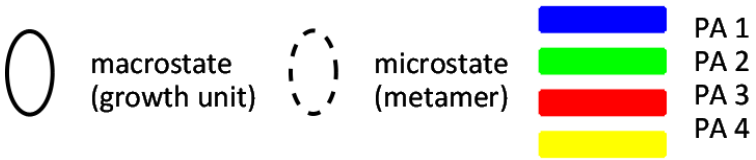
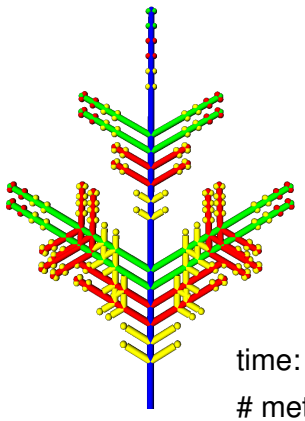
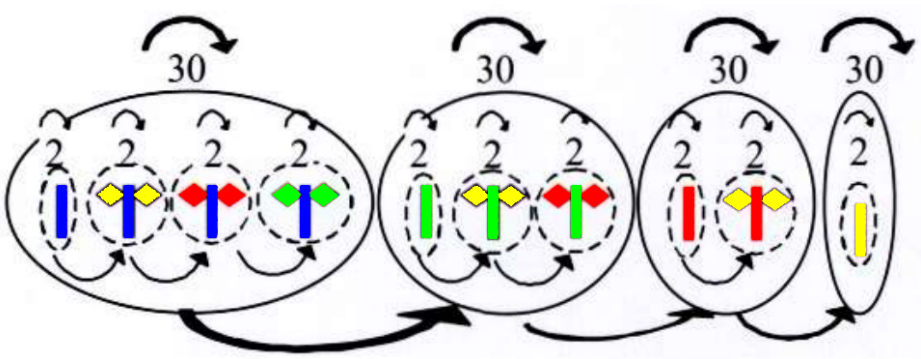


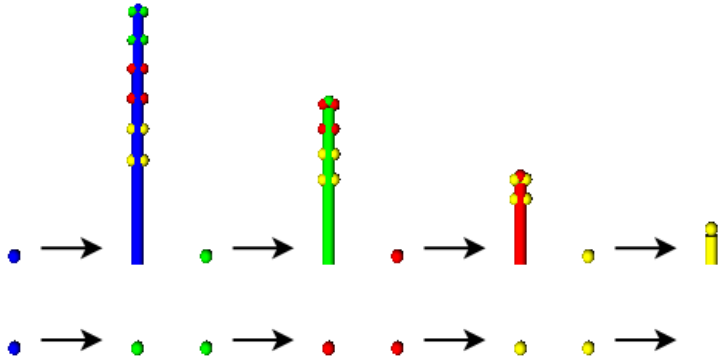


time: 3

metamers: 296

Organogenesis - dual-scale automaton in XL





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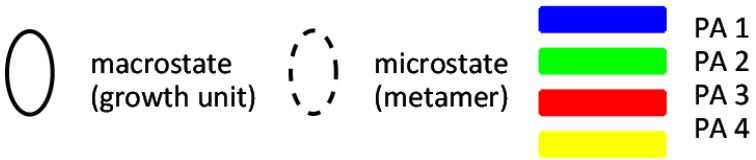
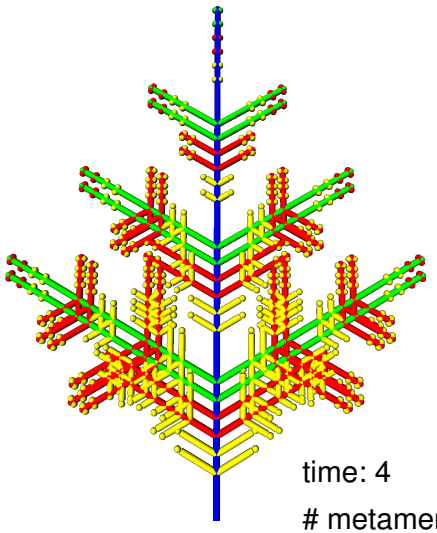
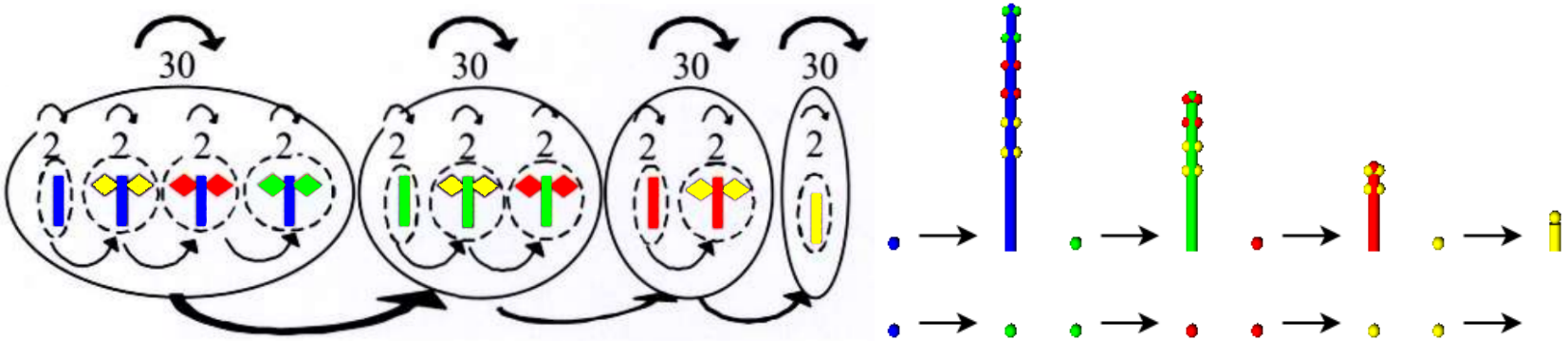




time: 4

metamers: 960

Organogenesis - dual-scale automaton in XL



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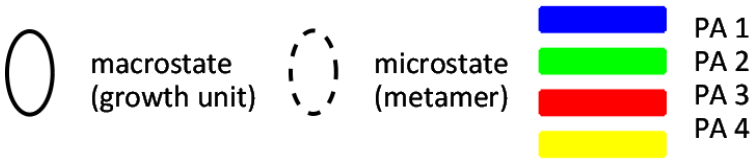
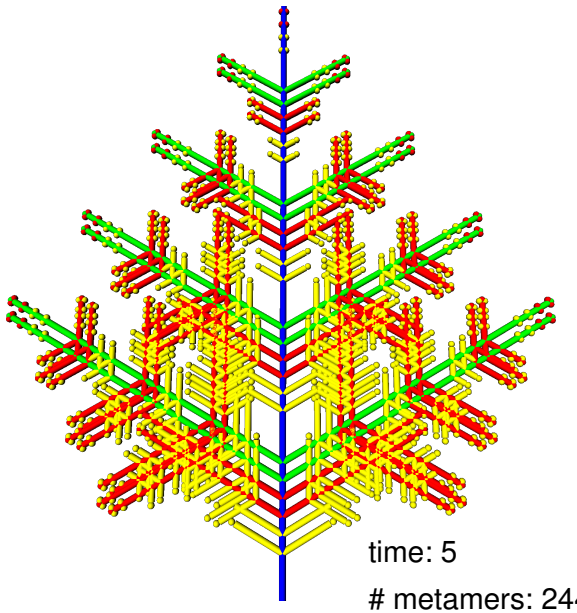
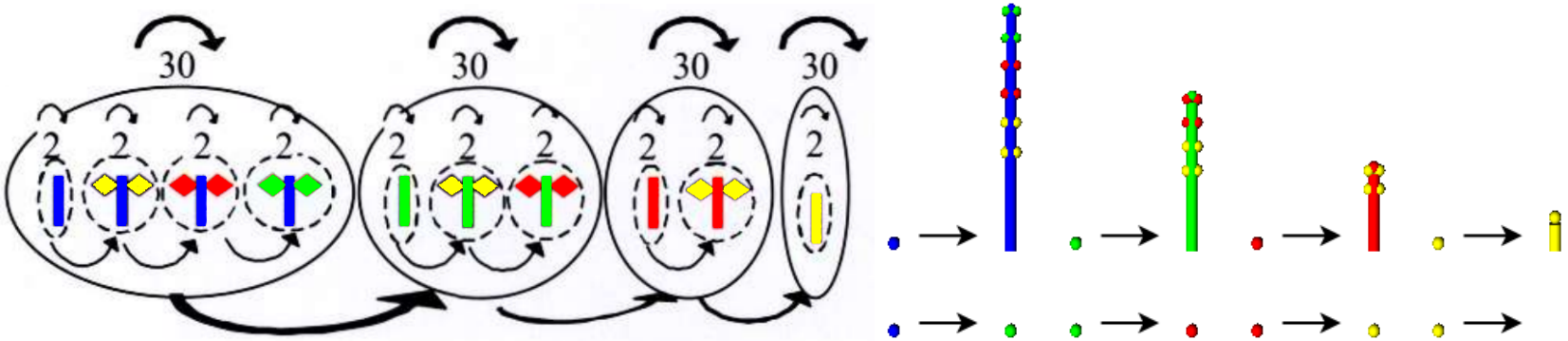




time: 5

metamers: 2440

Organogenesis - dual-scale automaton in XL



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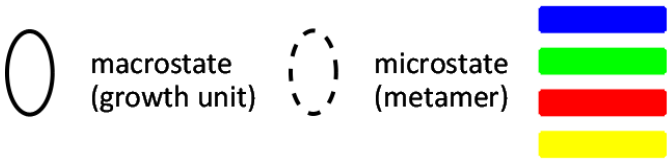

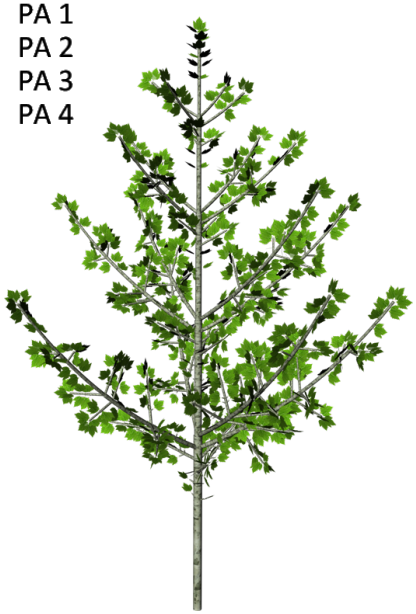

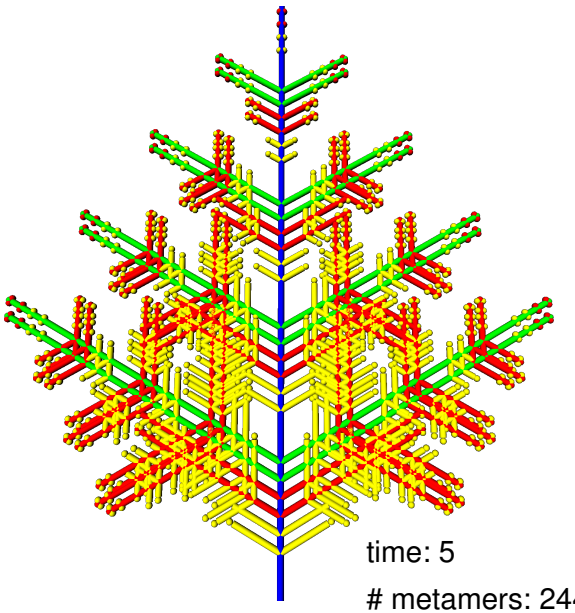

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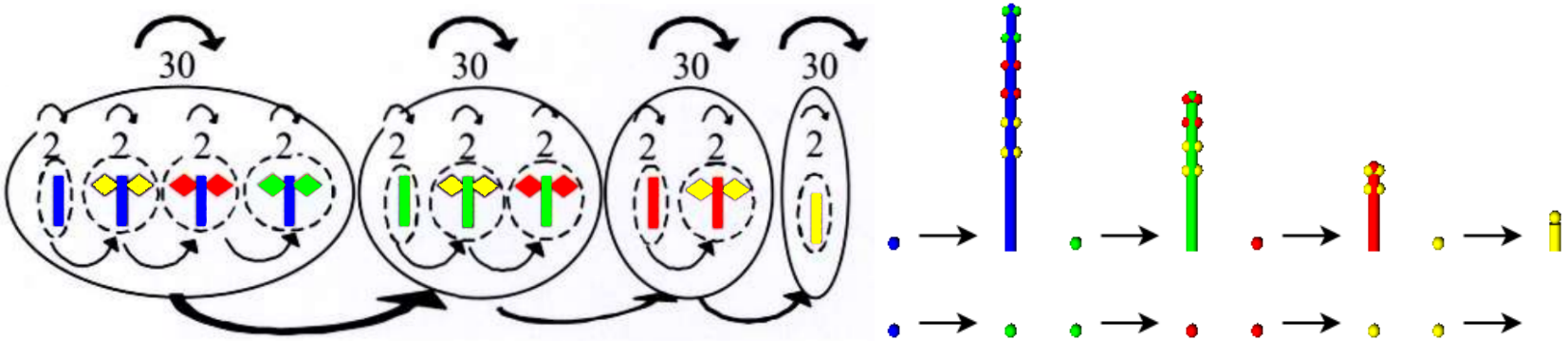

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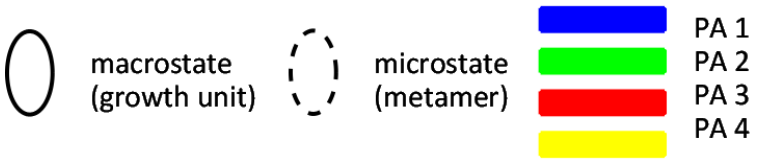
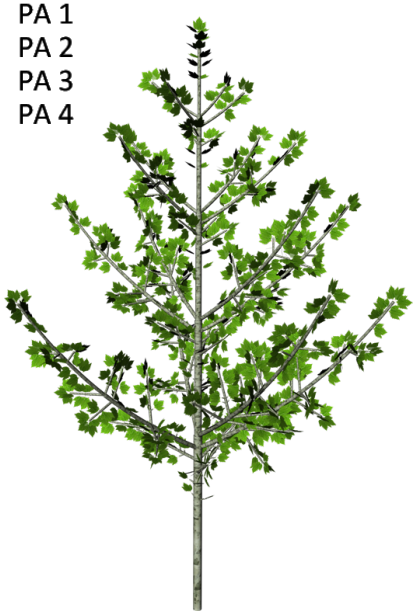
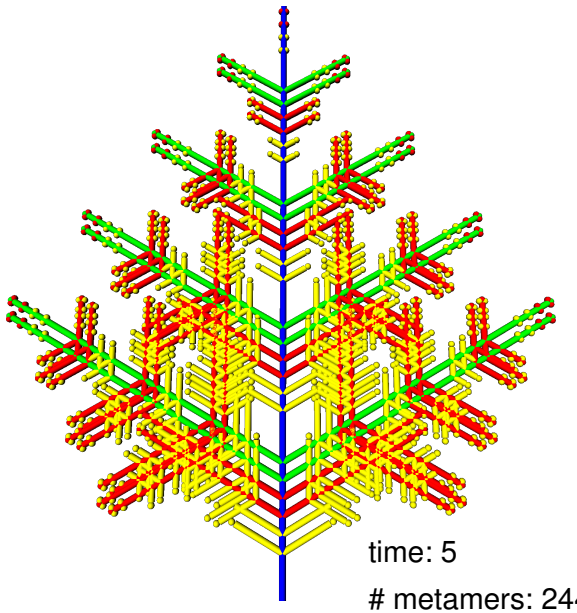


- 1 generic XL rule
- Deterministic and stochastic development

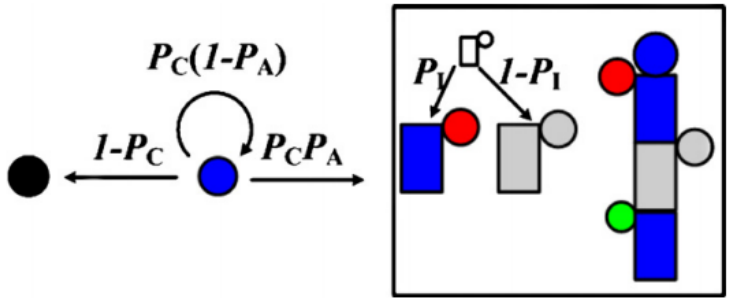




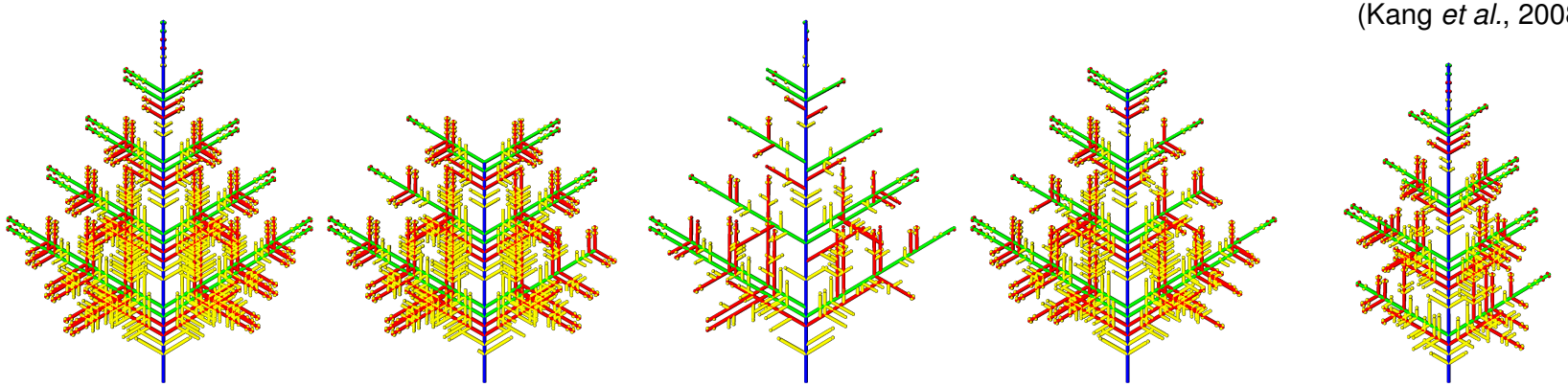
time: 5

metamers: 2440

Stochastic organogenesis



(Kang *et al.*, 2008)



deterministic

survival (bud)

$prob = 0.9$

branching (bud)

$prob = 0.5$

growth (bud)

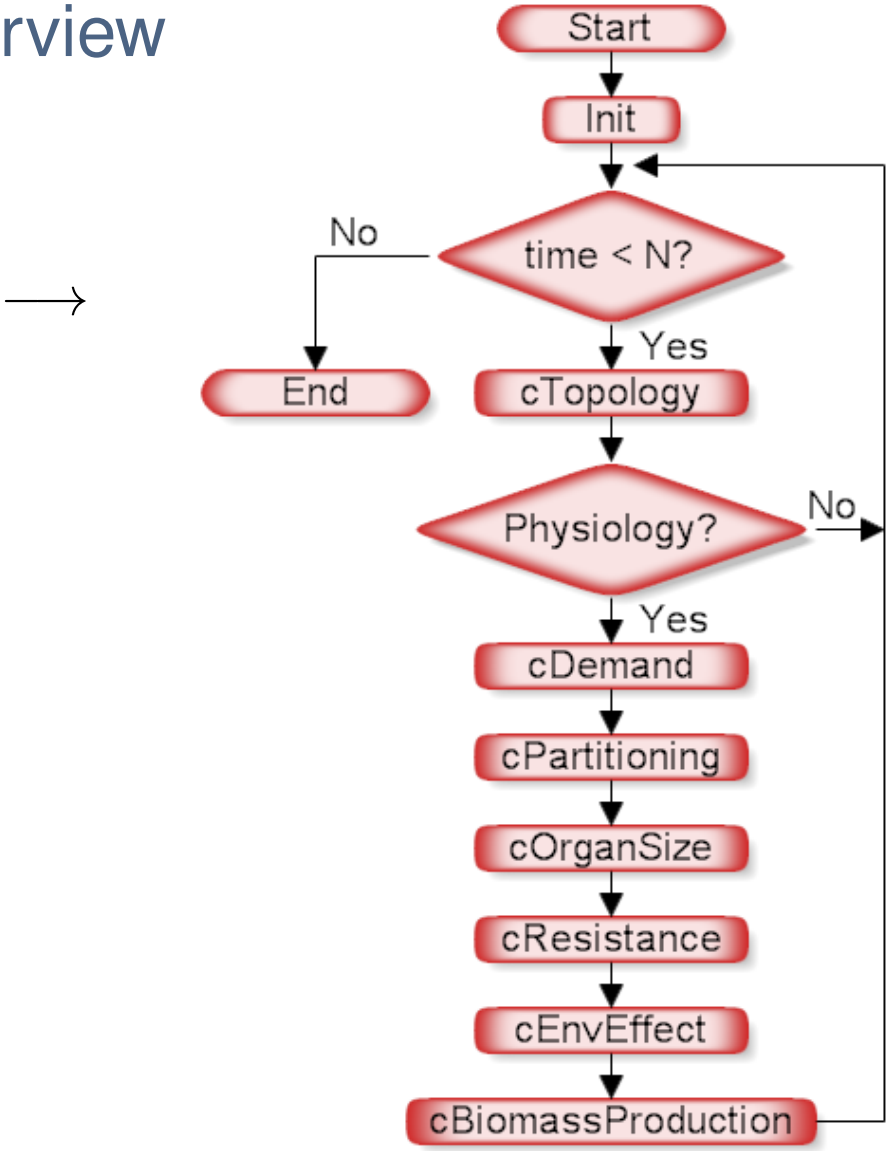
$prob = 0.8$

appearance (metamer)

$prob = 0.8$

GreenLab in XL - model overview

- Code structure (classes)
  - GreenLabModel
  - Parameter
  - ParameterSupplement
  - SinkVariation
  - Organogenesis
  - Demand
  - Partitioning
  - Size
  - Resistance
  - EnvironmentEffect
  - Photosynthesis
  - Chart

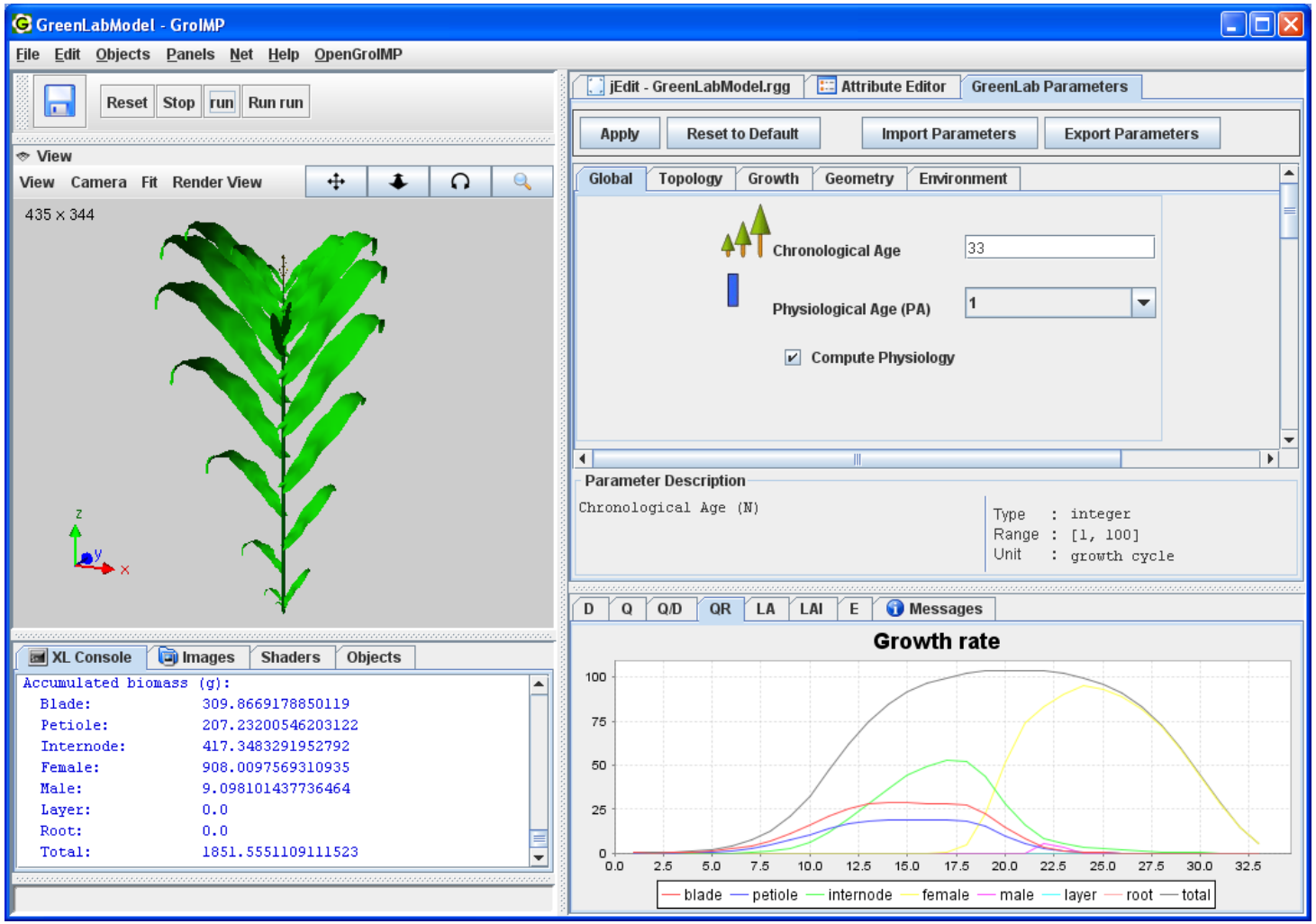


GUI - features

- 5 main tabs: Global, Topology, Growth, Geometry, Environment
- Parameter description window (description, type, unit, range)
- “User-safe” features:
  control of input format and range, unused fields disabled
- Import / export of GreenScilab parameter file (SCI)
- Import filter for SMB shape objects

- Currently no support for parameter estimation!

GUI - imported parameter file (maize.sci)



Demo

GroIMP Menu: File $\rightarrow$ New $\rightarrow$ GreenLab Project