FSPM-P: A general FSPM prototype model for application in crop modelling

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Aim: Many experimental scientists would like to use FSPM but are deterred by the challenge of having to write low-level code. They often have a fair idea of how the model should look like yet have difficulty to convey their ideas to a programmer who, in turn, knows how to *code* but often not how to *model*. Providing a prototype that is easy to parameterize and extensible facilitates, structures, and rationalizes the development process and use of an FSPM, and thus can help make it a more accessible tool.

Initial situation:

- Target group:
  - Scientists who know their experimental system but have no or little programming experience: *how to implement a model?*
  - Developers, who know how to code in an abstract or practical way but have little knowledge of biological systems.
- Common way of modelling:
  - *Ad hoc*
    - Usually starting "from scratch"
    - (initally) no (clear) concept/design
    - Unsystematic

  ➔"Reinventing the wheel"*
  - Extending existing models
    - getting overview of code more difficult

➔

Main features of the Prototype:

- Includes the (meta)knowledge of several models
- Predefined:
  - (Clear) design (software-technical)
  - Model concept: (init → control flow → output …)
- Easy to parameterize, use and extend
- Saves development time
- Makes models comparable
- Facilitates communication between modeller and experimentator

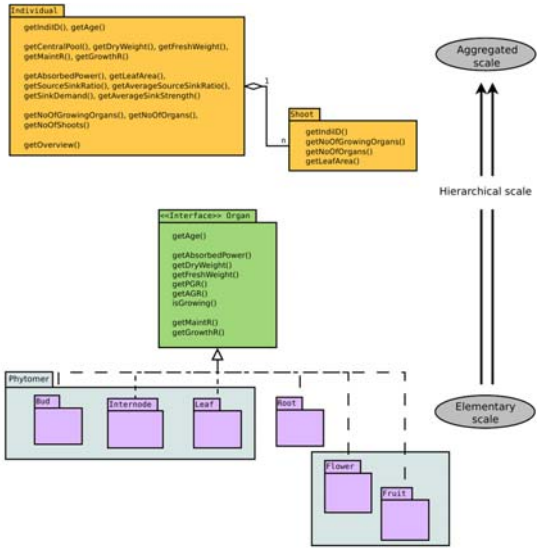
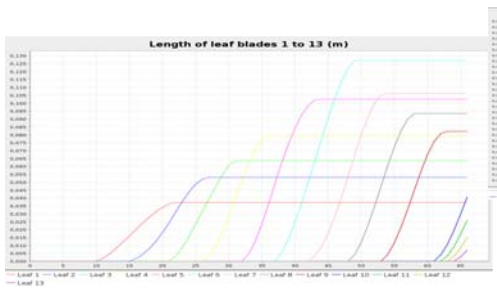
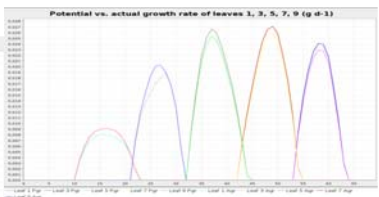


Figure 3: UML class diagram representing the general organs with methods and hierarchical scales within FSPM-P





Figures 1 and 2: Leaf development – Length of leaf blade and potential vs. actual growth rate

Other features:

- Photosynthesis (library of photosynthesis rate models)
- Source-Sink ratio regulates photosynthesis and growth processes
- Light interception (based on a Monte-Carlo radiation model)
- Parameters (mainly environmental)
- Time step hourly or daily
- Selectable manual or time controlled harvest function
- Temperature sensitive, different temperature classes
- Output (about 15 predefined charts and file output), possibility to select and compare individuals in the canopy
- Comprehensive **User manual** (Model description, Building A New Model, Experimental Settings, Measurement protocol, 2D Digital Measurements, Data processing, Results, Templates)

Organ definitions:

- Same organ interface for all organs
- Different hierarchical scales within the plant:
  - Organs: seed, root, bud, leaf, internode, flower, fruit, etc.

    ➔ Organ with predefined state variables and methods representing internal processes: photosynthesis, growth, maintenance and growth respiration
  - Organ aggregations: individual, shoot

    ➔ containing summary functions (e.g. whole-plant or canopy photosynthesis)

Application areas

- Intercropping (two or more crop species growing together)
- Demonstrating a prototype
- Teaching
- Meta-analysis of general crop processes
- Decision support (yield prediction)

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*When *does* it make sense to reinvent the wheel?

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