

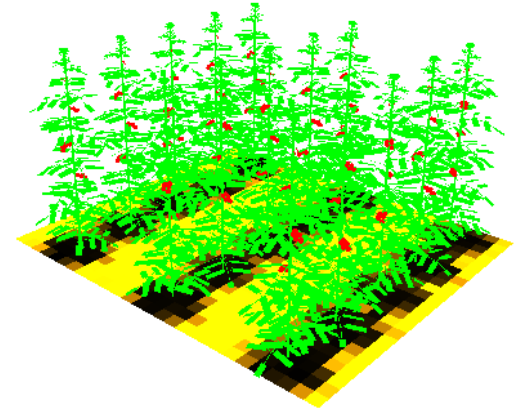
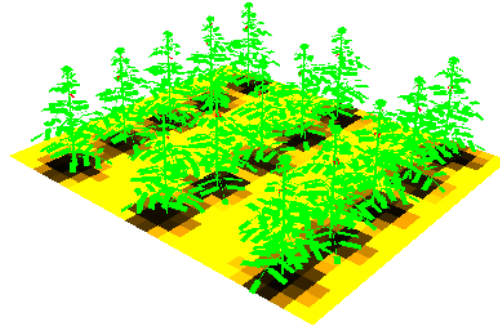
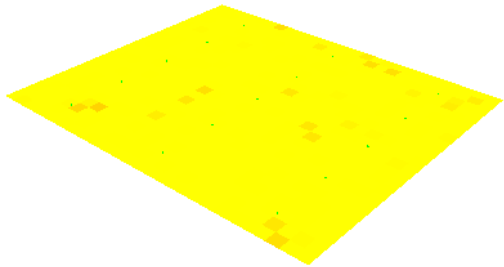
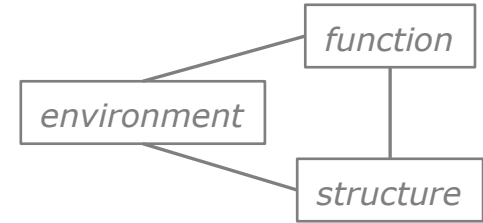
Towards a functional-structural plant (FSP) model

Katarína Smoleňová

FSPM & GroIMP Workshop

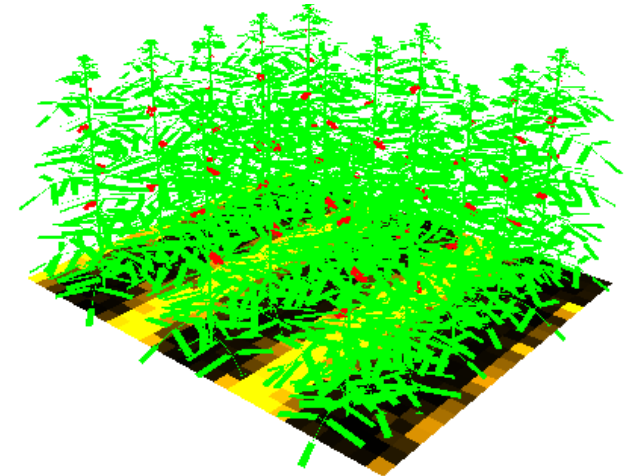
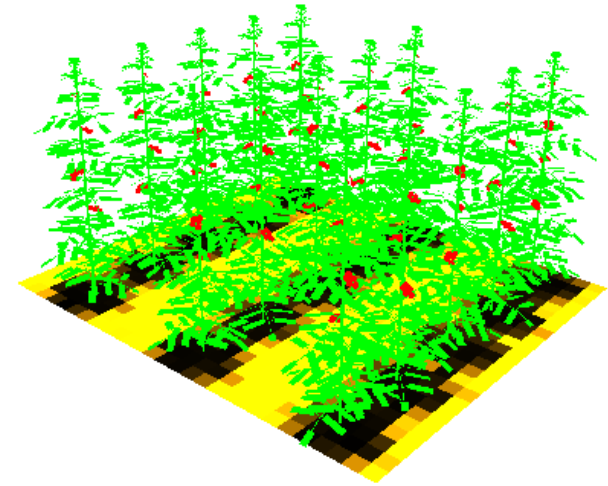
PMBDA 2025, Nanchang, China

November 1, 2025



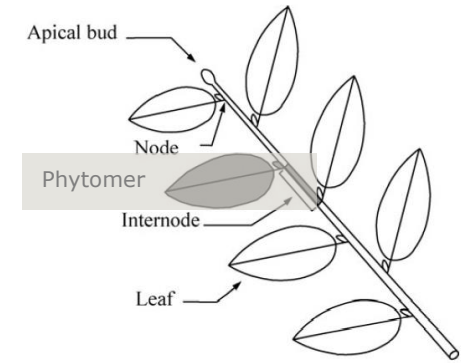
Hands-on example

- Improving our simple tomato model
 - Organ appearance rate
 - Organ extension modelling
 - Light modelling
 - Biomass modelling
 - Plotting simulated outputs
- *In silico* experiments with the model

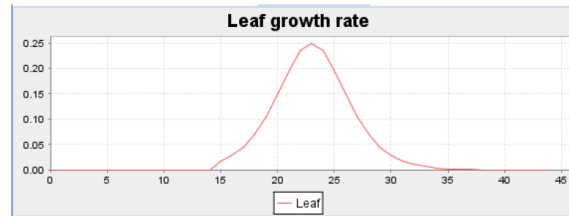
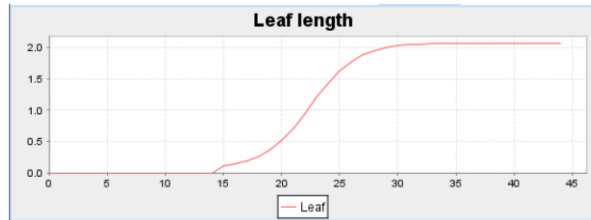


New functionality

- **Phyllochron** - time span between the appearance of new phytomers -> more precise timing of development
- **Organ extension** – gradual increase in size as a function of age; described by a logistic curve



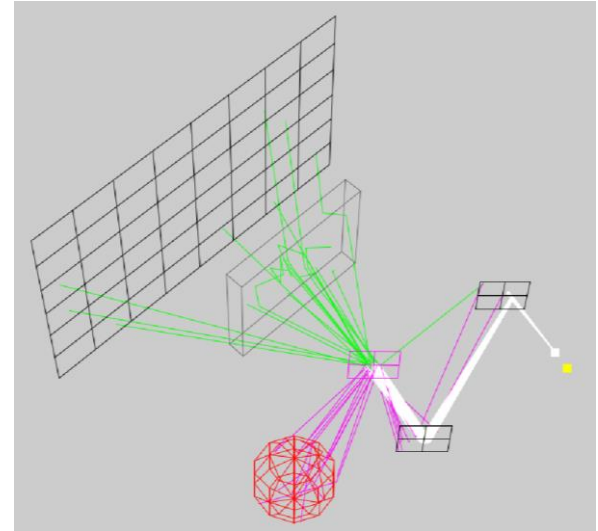
(acc. Barthélémy & Caraglio, 2007)



$$\frac{dW}{dt} = \frac{kW_{\max}e^{(-k(t-t_m))}}{(e^{(-k(t-t_m))} + 1)^2}$$

New functionality (cont.)

- **Light modelling** using a (modified) 3D raytracing approach
- **Light model** calculates how much light is absorbed by each object in the scene
- Material properties of an object (a **shader**) define how much light will be reflected, transmitted, and finally absorbed
- Requires a **light source** in the scene



New functionality (cont.)

- **Biomass production** – calculated using a **photosynthesis** model
- Here, we assume a simple linear relationship between biomass and radiation (*used often in crop models*)
- We will use **absorbed radiation**

$$\text{Biomass} = \text{RUE} \times \text{PAR}$$

RUE – radiation use efficiency

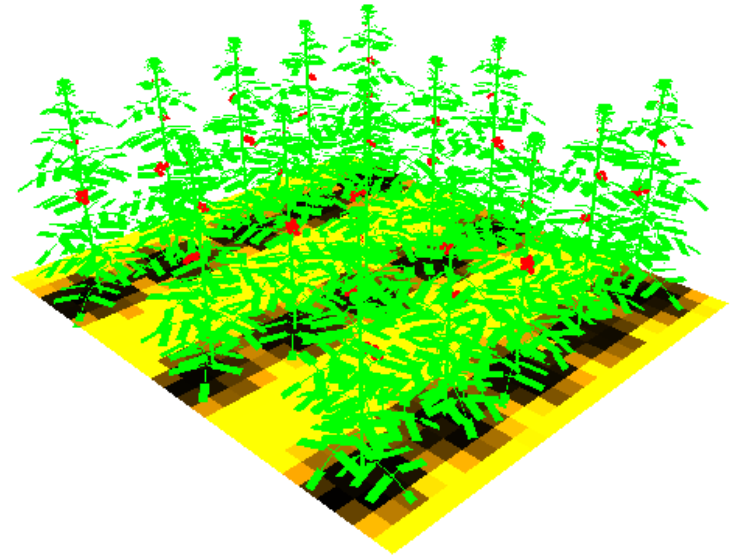
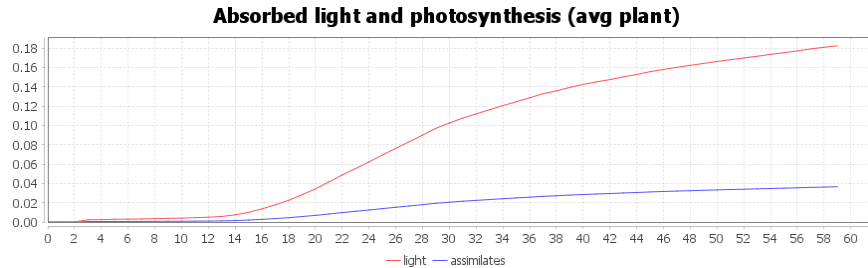
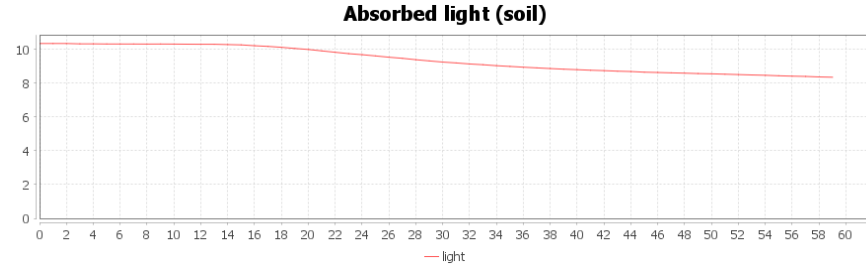
PAR – photosynthetically active radiation



(Hu et al., 2025, COMPAG)

New functionality (cont.)

- Determining how much light arrives at the soil



Try yourself

- **Materials:**

wiki.grogra.de > Workshops > FSPM and GroIMP tutorials at PMA conference 2025

https://wiki.grogra.de/doku.php?id=workshops:tutorial_pma_25:01_saturday

- **Model scenarios** - modify model parameters (in *parameters.rgg*) related to:

- Planting density (NR_ROWS, NR_PLANTS, ROW_DIST, PLANT_DIST)
- Architectural traits: leaf length (MAX_LEAF_LENGTH), leaf angle (LEAF_ANGLE), number of leaflet pairs (NB_LEAFLET_PAIRS), internode length (MAX_INTERNODE_LENGTH)

- **Aim:**
 - 1) less light arriving at the soil (meaning the canopy absorbed more light)
 - 2) increased average plant biomass



wiki.grogra.de



fspm.discourse.group

