INRAe

EXPLORATORY PROJECT

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A new tool for exploring the multi-regulator and multi-scale network controlling plant architecture

Coordination
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Key words
Multi-regulator network
Emergent behaviour
Virtual plant
Online interactive simulation interface

INRAE units involved
IRHS
AGAP Institut

Partnerships
Inria-ENS Lyon
CNRS

Context and challenges

To maintain the agronomic performance of plants in increasingly stressful environments, it is necessary to have a systemic vision of their adaptation mechanisms, particularly their architectural development, i.e. the initiation and development of new organs.

The mechanisms involved in this development are complex. They involve multiple regulators of different types (hormones, nutrients), controlled by different processes and at different scales (local, remote). Numerical models have proven to be effective tools for understanding some of these complex regulations, as they simulate non-intuitive behaviour induced by this complexity. They make it possible to test regulation hypotheses in experiments comparing the behaviour of a real and a virtual plant. Today, there are digital tools for simulating virtual plants, such as the L-Py platform.

However, their effective use for the virtual exploration of regulatory networks at the plant scale requires, on the one hand, facilitating their user-friendliness and interactivity with biologists and, on the other hand, improving the dialogue between biologists and modellers, who work at different scales (mechanisms vs. plant behaviour).

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Metaprogramme
DIGIT-BIO

Goals

The Physioccope project aims to provide an efficient tool for smooth and collaborative interaction between biologists working at different scales through a virtual plant model. The tool will be developed specifically to understand how light regulates bud outgrowth, but it is designed to be used more broadly. The project's objectives are threefold:

1. The integration of the mechanistic network controlling bud outgrowth along an axis into a virtual plant, coded in L-Py;
2. The development of an intuitive tool for interaction and visualisation of this network via the virtual plant, based on the coupling between L-Py and the MorphoNet browser (dedicated to the interaction with morphodynamic structures);
3. The identification of new hypotheses on the bud outgrowth regulation network by comparing the behaviour of the plant between virtual and real experiments.

Research units involved and partnerships

INRAE scientific division	INRAE research units	Expertises
Agronomy and environmental sciences for agroecosystems	IRHS	Expertise provided: Modelling, at the interface between physiology and ecophysiology, of mechanisms regulating plant architecture
Plant biology and breeding	AGAP Institut	Expertise provided: Simulation of architecture and functioning. Distributed computing
External partners		Expertises
Inria-ENS Lyon	RDP	Modelling of plants and molecular networks
CNRS	LIRMM	Data Science for Biology, Interaction and Visualisation of Models