

# Gardening Cyber-Physical Systems

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## Introduction

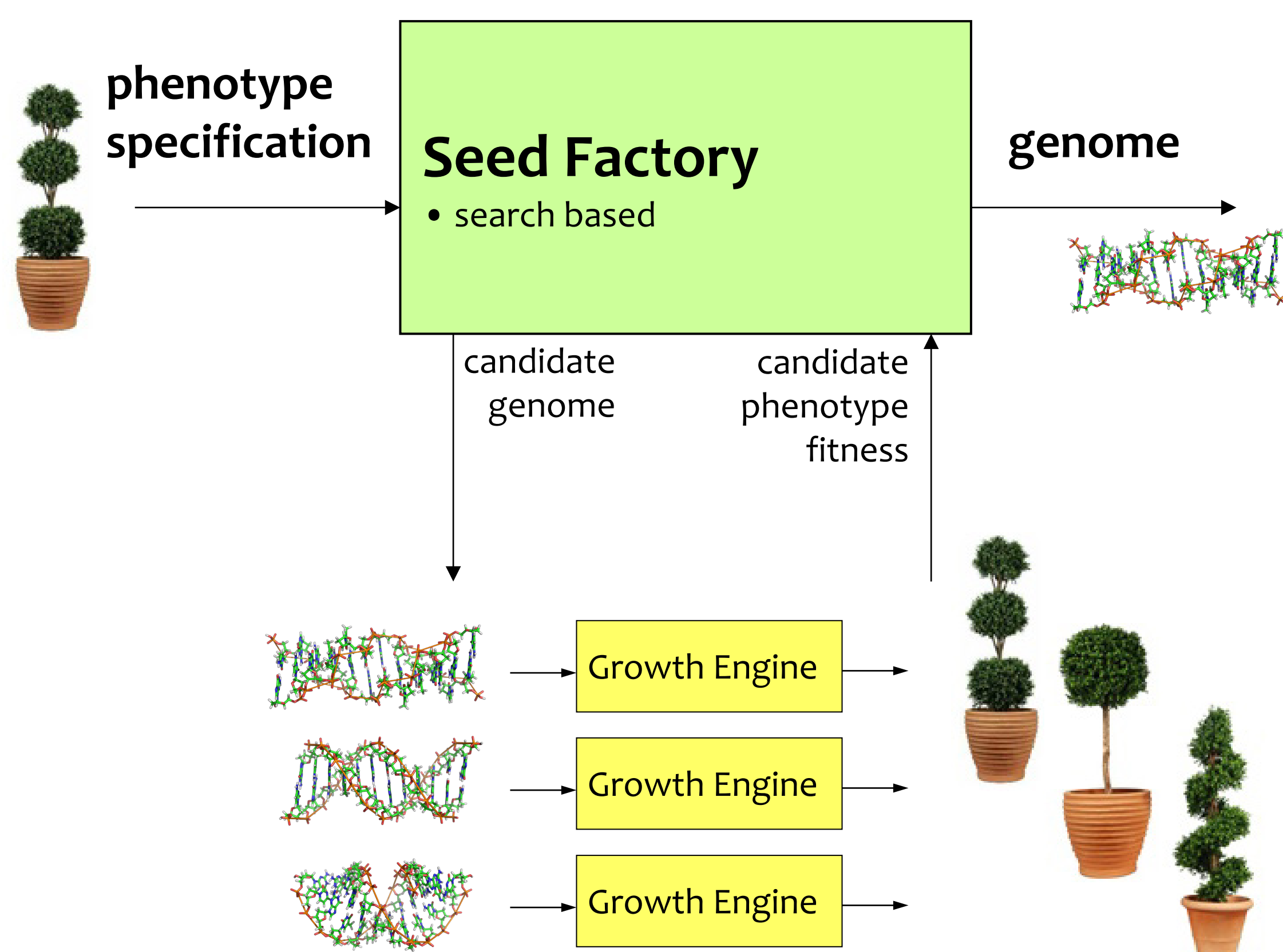
Our vision is of **construction by directed growth**, through gardening macroscopic cyber-physical artefacts formed from a growing, integrated combination of material and virtual subsystems.

Our GRO-CYPHY architecture comprises three major components:

1. a **Seed Factory**, a process for designing specific computational seeds to meet cyber-physical system requirements;
2. a **Growth Engine**, providing the computational processes that grow physical seeds in simulation, and grow virtual seeds into software;
3. a **Computational Garden**, where multiple seeds can be planted and grown in concert, where virtual seeds can be interfaced with embodied growth processes, and where a high-level gardener can shape the whole into complex cyber-physical systems.

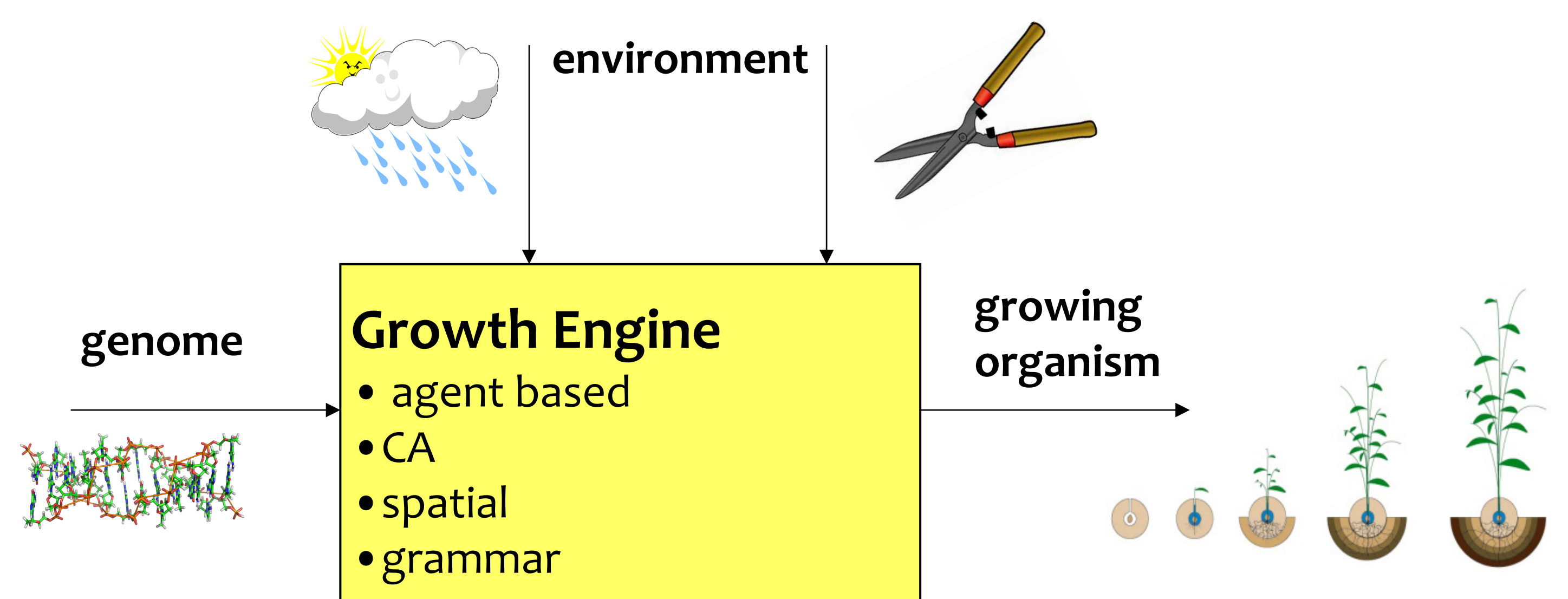
## Seed Factory

High-level phenotype (grown) specifications are input; the search process develops the relevant seeds (subsystem genomes); it uses the Growth Engine to grow candidate seeds into phenotypes, which it evaluates against the specification, and feeds the information back into its search process.



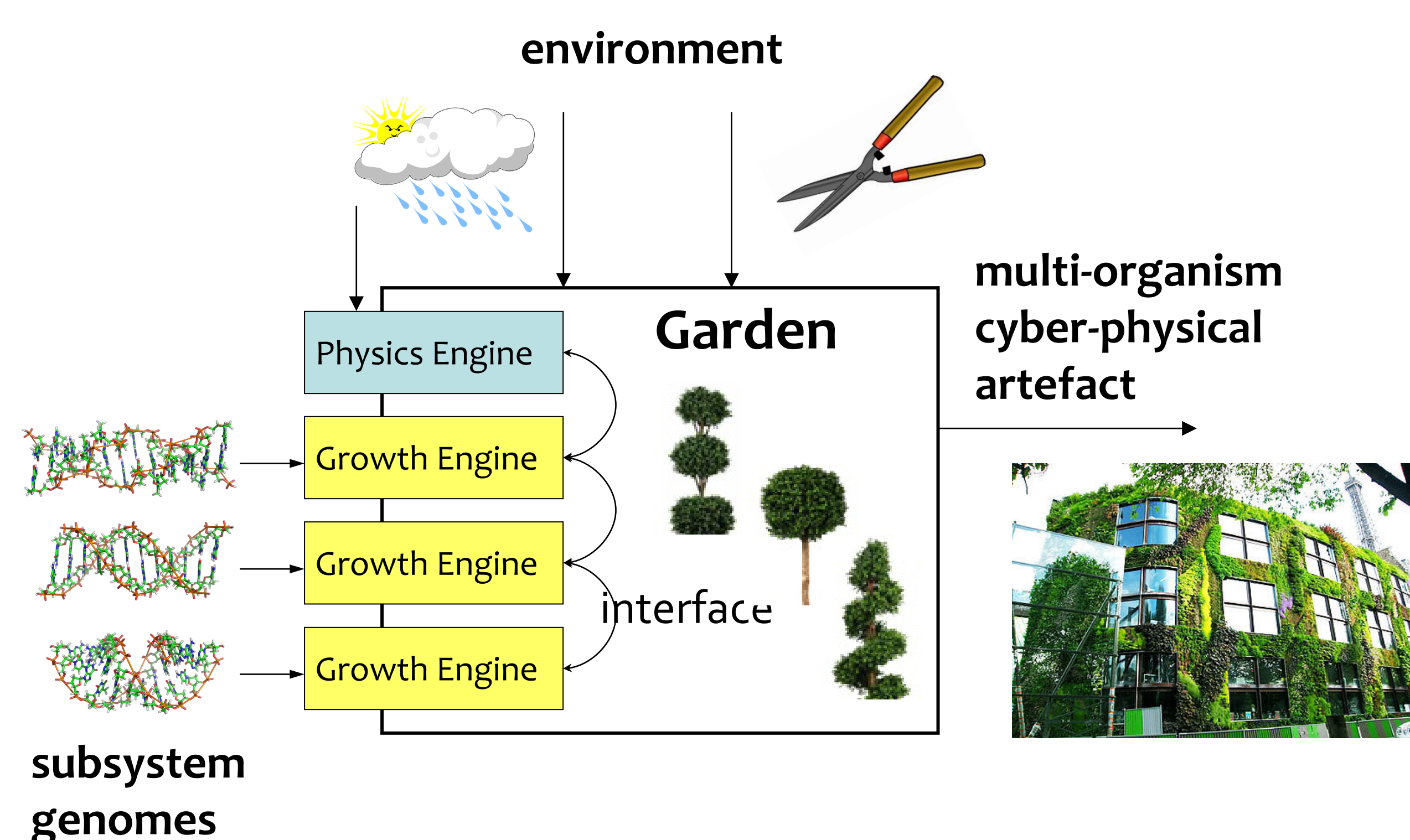
## Growth Engine

A Growth Engine provides the computational mechanisms to grow a seed. This might be required to grow in simulation a seed intended for a physical device, or to grow the seed of a virtual component such as a software control system.



## Computational Garden

The computational garden is where the various seeds are planted and grow together, responding to their environment, into the resultant artefact. The garden provides a high-level metaphor: high-level guiding of a robust complex growing system, rather than low-level engineering of the precise placement of every cell or particle.



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“Skyscraper Garden” © David A. Hardy/www.astroart.org 2012

