Studying long term interactions between plants and their environment

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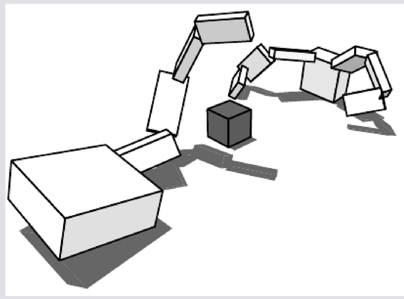
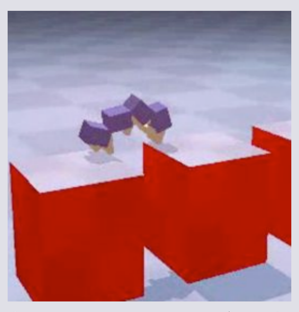
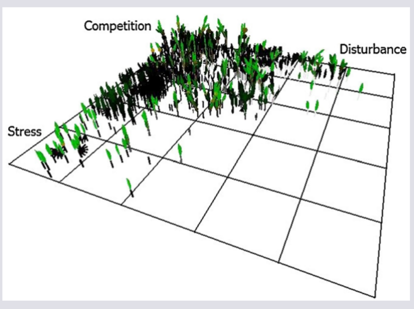
Videos

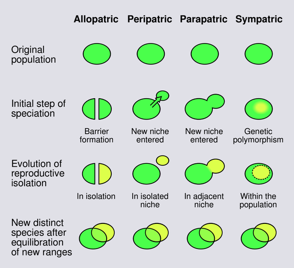
Context


Creature combat from (Sims 1994)


Creature crossing gaps (Lassabe 2008)

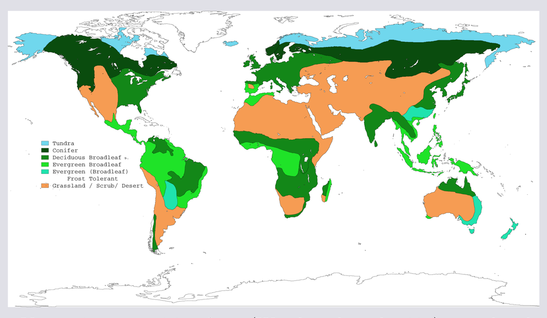


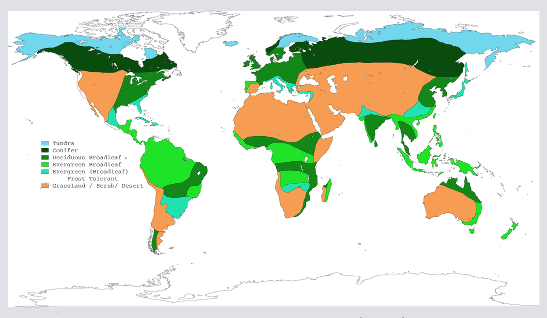
CSR triangle from (Bornhofen et al. 2011)



Speciation processes by (Karonen 2006)

Generating **complex morphologies** for plants embedded in **virtual worlds** has been investigated in a number of publications (e.g. Bornhofen et al. 2011). Yet, much attention is focused on devising models that would perform well in a handful of, mostly hand-made, environments.
It has been shown that **increasing** the **complexity** of the abiotic component drives the population into more **adaptive** and **robust** sections of the phenotypic space (e.g. Canino-koning et al. 2016).
Based on the simulation results found in Woodward et al. 1987, we surmise that heat and hygrometry are sufficient to model **complex interactions** between plants and their environment in a 3D simulation and plan to explore this avenue of research thanks to a **polyvalent mating process and a highly variable simulated 3D world**.

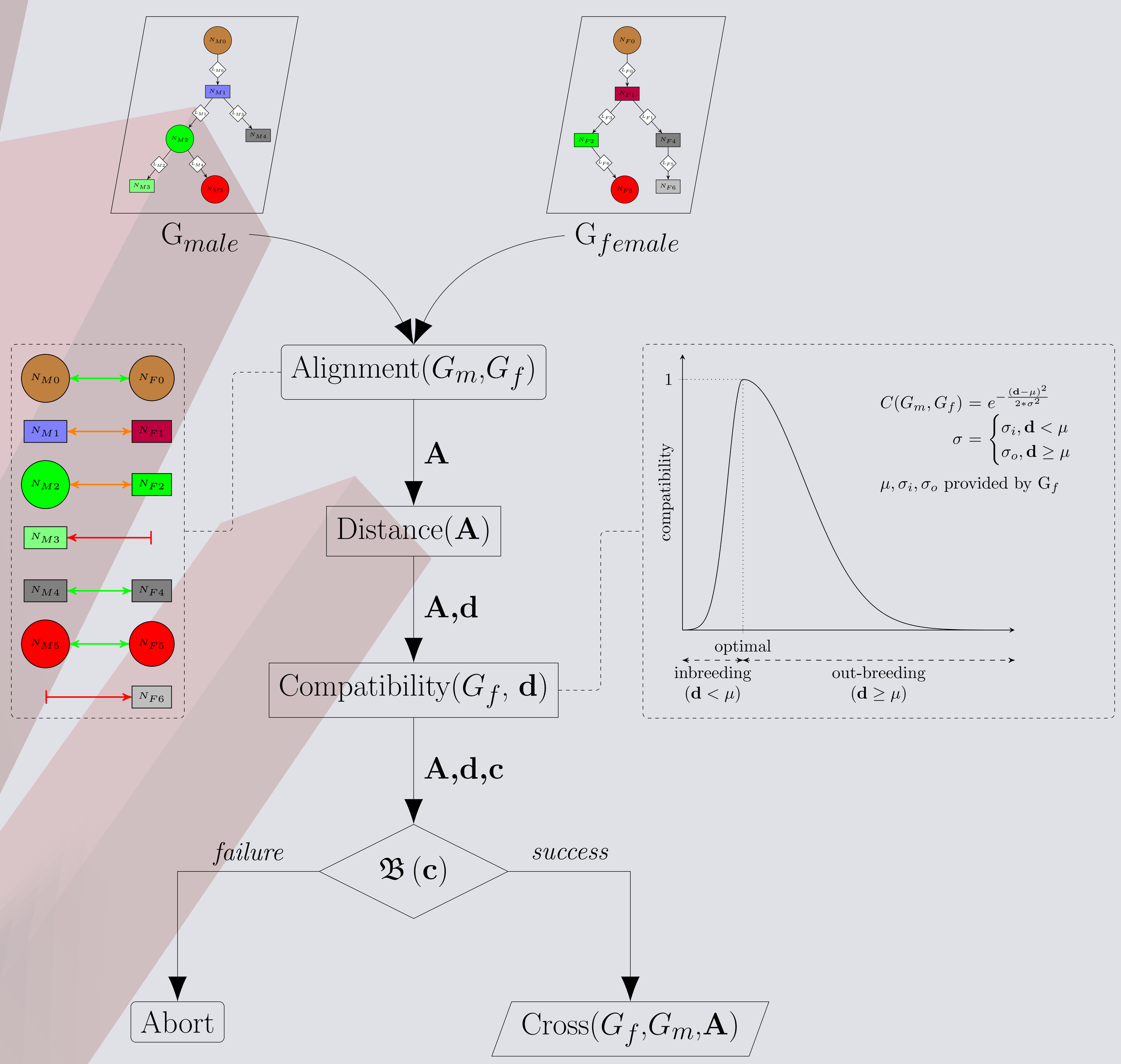

Vegetation repartition from (Woodward et al. 1987) - recolored


Prediction from water and heat data (idem) - recolored

Reproduction

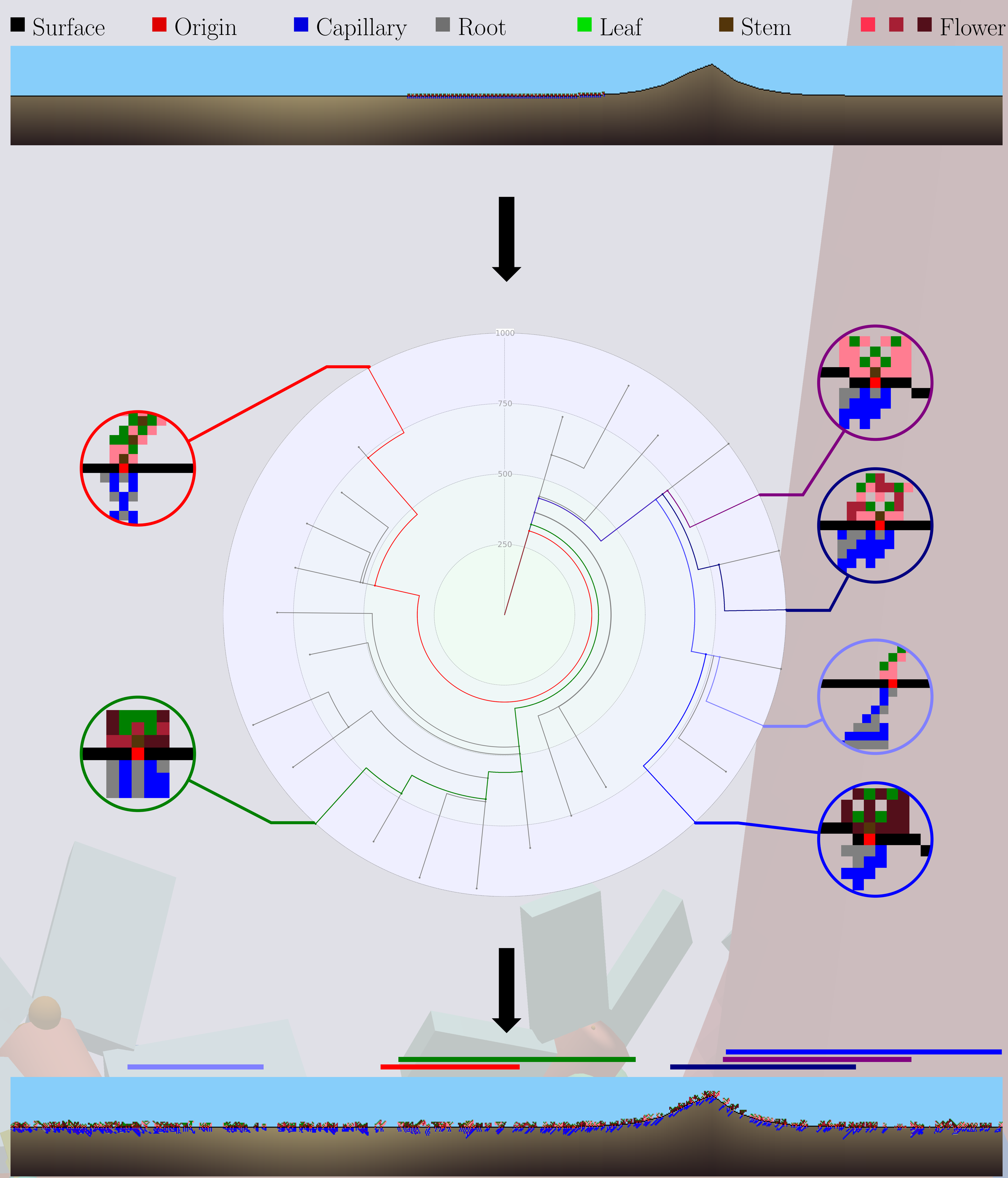
Agnostic bail-out crossover

- Alignment procedure:
  - Topological matching
  - Linear distance computation
  - Straightforward crossover
- Distance metric:
  - Trivial on primitive types
  - Recursive on user types
  - Case-specific for topology
- Compatibility:
  - Provided by the female
  - Handles any genomic size
  - Discerns in/out-breeding



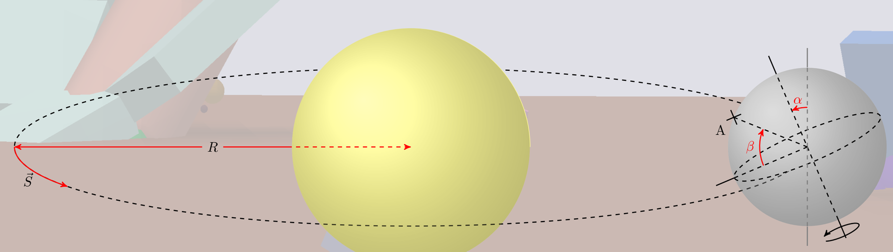
Phylogeny

- Objectives:
  - Validate crossover algorithm
  - Online phylogeny generation
  - Evo. process analysis
- Results:
  - Complete colonization
  - "Hopping" strategy
  - Several speciation forms
- Methods:
  - Cellular automata
  - Soft desert (left)
  - Mountain (right)
  - 50 plants at start

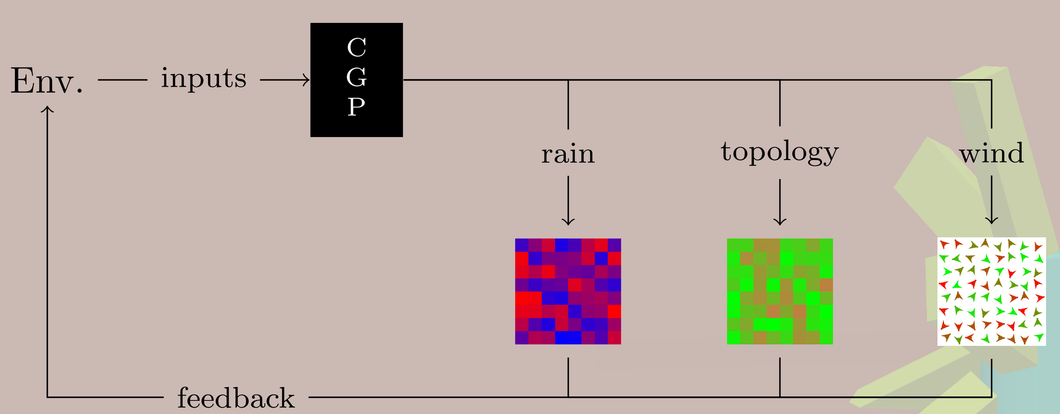


Environment

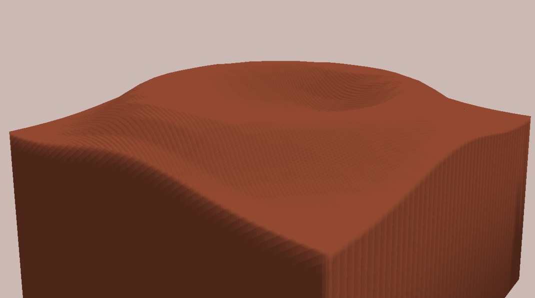
- Simulation divided into voxels
- Each under local, CGP-induced influences
- Additional inter-voxel interactions
- Sun is variable from Earth to Uranus

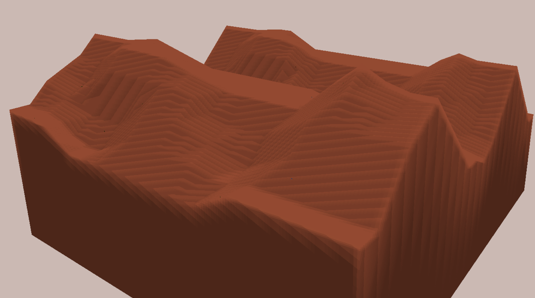


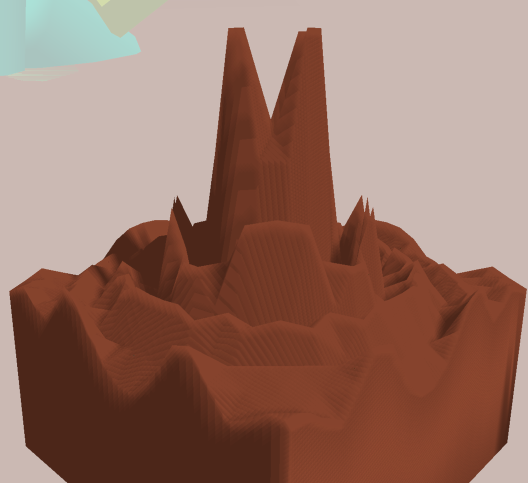
Earth-like conditions: $S = 300j, R = 1000, \alpha = 23°, \beta = 45°$
Uranus south pole would be: $S = 30688j, R = 19218, \alpha = 97.77°, \beta = -90°$



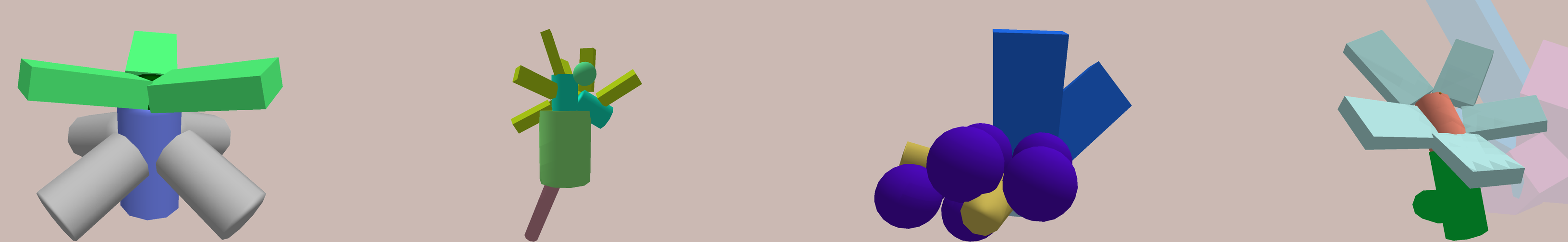
CGP-controlled feedback loop


Volcanoid topology


Mountain range


Chaotic topology (Barad dur)

Future work



- P-Tree calibration
- Corner cases management (hybridism, continuity, ...)
- Longer and wider 2D validations et experiments
- Co-evolving plants and environment
- Integrating 3D simulation with phylogeny
- Challenge of low granularity/large dimensions

References

[1] S. Bornhofen et al. "The evolution of CSR life-history strategies in a plant model with explicit physiology and architecture". In: *Ecological Modelling* 222.1 (2011), pp. 1–10. ISSN: 03043800. DOI: 10.1016/j.ecolmodel.2010.09.014. URL: http://dx.doi.org/10.1016/j.ecolmodel.2010.09.014.
[2] Rosangela Canino-koning et al. "The Evolution of Evolvability : Changing Environments Promote Rapid Adaptation in Digital Organisms". In: (2016).
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[4] Nicolas Lassabe. "Morphogenèse et Evolution de Créatures Artificielles". PhD thesis. 2008.
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[6] F. I. Woodward et al. "Climate and plant distribution at global and local scales". In: *Vegetatio* 69.1-3 (1987), pp. 189–197. ISSN: 00423106. DOI: 10.1007/BF00038700.