Studying the long term interactions between plants and their environment

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Generating complex morphologies for plants embedded in virtual worlds has been investigated in a number of publications (e.g. Bornhofen and Lattaud (2008)). 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 and Williams (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 world.

Reproduction

The reproduction scheme of these individuals should exhibit both robustness and versatility. The former implies that crossing attempts between disparate genotypes should not be followed through while the latter links directly to the unbounded nature of our graphtal-based genomes where no assumptions can be made on neither the topology nor size.

We devised a bail-out crossover which begins with a straightforward alignment procedure on both genomes to highlight the topological discrepancies. A *distance metric* is then computed for each pair of similar links based on the differences between their internal data. Integrating over all links provides a global metric for the topological and functional distinctions in the mating pair which is used by the female genome to derive a *compatibility value* based on its reproduction parameters for the optimal distance and in/out-breed tolerance.

This compatibility can be interpreted as the success rate of the synapsis process and ensures that actual mating can only occur inside the self-defined speciation borders.

Evolving environments

Yet, an emergent speciation process needs to be steered by a competitive setting where selective pressures come in different sizes and shapes.

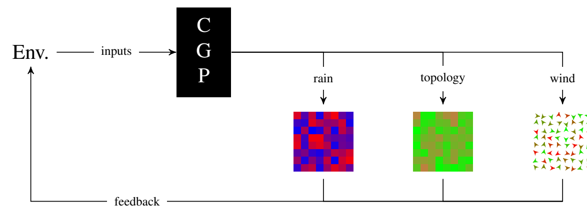

Figure 1: CGP-controlled feedback loop

This is tackled, in part, by a parametric sun trajectory where, in addition to the day/year length, the latitude and declination can be set to specific values (e.g. 45/23 for earth's European region or -90/97 for Uranus' south pole).

In addition, the terrain is subdivided into voxels each subjected to variations computed by a CGP function1. From the current local values (hygrometry, topology, wind), sun's angular positions and cell's local coordinates, new environmental conditions can be determined autonomously.

Conclusion

Coupling an autonomous speciation scheme with a CGP-driven highly dynamic environment paves the way to studying evolutionary trends of complex ecosystems. Indeed, preliminary simulations already show the capability of our reproduction method to correctly segregate between heterogeneous species.

On a broader scale, the system could be customized into exploring specific interaction schemes including but not limited to human deforestation, robustness of endemic systems or long-term impact of overcrowding.

References

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