

Embryomorphic Systems Meta-Design: Preparing for Self-Assembly, Self-Regulation and Evolution

René Doursat

Institut des Systèmes Complexes, CREA
CNRS & Ecole Polytechnique, 1, rue Descartes, 75005 Paris, France
<http://doursat.free.fr>

Abstract— Exploding growth in the size and complexity of computational systems leads us to gradually replace traditional rigid design and control with decentralization and autonomy. Instead of directly making systems, future hardware and software architects will rather “meta-design” mechanisms of self-assembly, self-regulation and evolution. Natural complex systems, in which numerous small elements form large-scale, adaptive patterns, provide compelling sources of inspiration toward this goal. A new major engineering challenge is thus to artificially reproduce self-organized phenomena that can be at the same time functionally constrained and free to generate novel designs. This work presents an original model of artificial system growth inspired by embryogenesis. A virtual organism is implemented a lattice of cells that proliferate and differentiate locally to form reproducible global shapes. The fate of each cell is guided by the same internal gene regulatory network. Based on these results, a new discipline, *embryomorphic engineering* is proposed to emphasize the need for hyperdistributed architectures and self-organized development as prerequisites for evolutionary innovation.

