Embryomorphic Architectures

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***Abstract*—** Exploding growth in computational systems forces us to gradually replace rigid design and control with decentralization and autonomy. Information technologies will progress by, instead, "meta-designing" mechanisms of system self-assembly, self-regulation and evolution. Nature offers a great variety of efficient complex systems, particularly biological, in which numerous small elements form large-scale, adaptive patterns. These systems represent a unique type of nonrandom, heterogeneous and reproducible morphogenesis. A new engineering challenge is thus to recreate this self-organization and let it freely generate innovative designs. I present here an original model of multiscale artificial system growth inspired by embryogenesis. A virtual organism is construed as a lattice of cells that proliferate and differentiate locally to form patterned domains and reproducible global shapes. The fate of each cell is guided by the same internal gene regulatory network, while interacting with neighboring cells via molecular signaling and mechanical constraints. 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 artificial evolutionary innovation.