Understanding and Harnessing Self-organization to Engineering

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Self-organization and emergence are phenomena exhibited by dynamical nonlinear systems. In these systems, the overall behaviour cannot be understood, predicted or accounted for by the behaviour exhibited by the parts of the system. Examples of this non-compartimentalization can be found throughout a great variety of diverse environments and disciplines, in animate and innanimate matter; from the group behaviour exhibited by ants to the operation of a laser and the supercondutivity of Josephson junctions.

So how to understand and interact with these systems that cannot be broken down into parts? Nonlinear systems are described by its system variables (which evolve in time) and its control parameters (which determine how the later change in time)[1].

We narrow our focus to understand systems that exhibit rhythmic properties or limit cycles, such as excitable media. Through models that describe the qualitative behaviour of these systems we study self-organization and the interaction between the parts from the engineering perspective, with applications to:

i) electronics: how to design systems with properties such as robustness and emergence? [2,3,4]

ii) systems biology: how to interact with and control living systems? [5,6]

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