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Emergent error correction in distributed controller networks
DAVID GRIFFIN, DAVID PEAK, Utah State University — Sparsely connected networks of sensor/controller-units have been successfully implemented in transportation and electric power systems, factory automation, and robotics applications. Usually, such distributed networks lack a central controller capable of globally coordinating unit activity; the tasks they perform, therefore, have to emerge from dynamics associated with how the units communicate. To investigate physical constraints on such communication, we studied a simple model in which the target task was to convert all controller outputs to the same on/off state in a specified time after start-up. The initial configuration of states in the network was determined by allowing each unit to respond independently to what it sensed (perhaps incorrectly) its environmental input to require. The uniform target configuration was assumed to consist of the unit state that was initially in the majority. The architecture of our network was a square array of units with communication between nearest neighbors only. We found communication rules for synchronously updating controller-unit states (in discrete time steps) that competently performed the target task with high accuracy despite strong initial disagreement between units and random persistence of incorrect unit state. Interestingly, the competent rules asymmetrically interrogate only two of a unit's four nearest neighbors (depending on what its own state is) at each time step. Our goal is to apply insights gained from this study to try to understand the structure and function of controller-like networks found in multicellular biological organisms.

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