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Authors

Koenderink, Jan
Richards, Whitman

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Multi-Level Cellular Automata: a platform for understanding perceptual and social dynamics

Jan Koenderink

Delft University of Technology

Whitman Richards

Mass. Inst. of Technology

Abstract: Social and biological systems consist of many levels, typically hierarchically arranged, with different mechanisms and rules for organizing information and decision-making at each level. This multi-level flow of information processing is obvious in perceptual systems, where simple feature elements are aggregated into more complex groupings using Gestalt-like associations. Likewise, in social domains, we find that rules governing individual acts for cooperative activities, for example, are quite different from those of a government that enforces laws for businesses. In both cases these different rules are distinctive to their own level. Yet, because adjacent levels interact, one level can influence outcomes in neighboring levels. For a system to be stable, these outcomes must in some manner be made harmonious, otherwise chaos is likely. We illustrate the behavioral dynamics of such multi-level systems using a simplified three layer framework consisting of agents (individuals or feature elements), groups (factions or Gestalt groupings) and a governing authority (a Federation or a dominating model class). Keywords: dynamical systems; cellular automata; multi-level cognition; social structures; perceptual information processing