



## Self-organizing Cyber-physical Systems Development with Rough Sets

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The future in the enhancement of cyber-physical system and robotic functionalities lies not only in the mechanical and electronic improvement of the robots' sensors, mobility, stability and kinematics., but also, if not mostly, in their ability to connect to other actors (human, agents, robots, machines, and sensors HARMS). The capability to communicate openly, to coordinate their goals, to optimize the division of labor, to share their intelligence, to be fully aware of the entire situation, and thus to optimize their fully coordinated actions will be necessary. Additionally, the ability for two actors to work together without preference for any specific type of actor, but simple from necessity of capability, is provided by a requirement of indistinguishability, similar to the discernment feature of rough sets.

Once all of these actors can effectively communicate, they can take on group rational decision making, such as choosing which action to take that optimizes a group's effectiveness or utility. Given group decision making, optimized capability-based organization can take place to enable human-like organizational behavior. Similar to human organizations, artificial collections with the capability to organize will exhibit emergent normative behavior. The complexity of this type of system does not necessarily fit into some of the logical conventions of computing. Modeling the vagueness of the real world task environments in which these systems operates calls for an extension of classical theory, especially in the area of indiscernibility and approximation which must occur in real time decision making.



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Prof. Matson was a previous member of the Board on Army Science and Technology for the National Academies of Science, Engineering and Medicine and a member of the Board on Army Research, Development, Test and Evaluation, Systems, Acquisition, and Logistics (BARSL), Assistant Secretary of the Army (Acquisition, Logistics and Technology). He has been an International Faculty Scholar in the Department of Electrical Engineering at Kyung Hee University, Yongin City, Korea, a Visiting Professor with the LISSI, University of Paris Est, Paris, France, Visiting Professor, Department of Computer Science and Engineering, Dongguk University, Seoul, South Korea and in the School of Informatics at Incheon National University in Incheon, South Korea.

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