Studying Complex Adaptive Systems using Molecular Classifier Systems

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Summary. Complex Adaptive Systems (CAS) are dynamical networks of interacting agents occurring in a variety of natural and artificial systems (e.g. cells, societies, stock markets). These complex systems have the ability to adapt, evolve and learn from experience. To study CAS, Holland [1, 2] proposed to employ agent-based systems in which Learning Classifier Systems (LCS) are used to determine the agents behavior and adaptivity. We argue that LCS are limited for the study of CAS: the rule-discovery mechanism is pre-specified and may limit the evolvability of CAS. Secondly, LCS distinguish a demarcation between messages and rules, however operations are reflexive in CAS, e.g. in a cell, an agent (a molecule) may both act as a message (substrate) and as a catalyst (rule). To address these issues, we proposed the Molecular Classifier Systems (MCS.b) [3], a string-based artificial chemistry based on Holland's Broadcast Language. In the MCS.b, no explicit fitness function is specified, moreover no distinction is made between messages and rules. In the context of the ESIGNET project [1], we employ the MCS.b to study a subclass of CAS : Cell Signaling Networks (CSNs) which are complex biochemical networks responsible for coordinating cellular activities. As CSNs occur in cells, these networks must replicate themselves prior to cell division. In this poster we present a series of experiments focusing on the self-replication ability of these CAS.

References

1. J.H. Holland. Exploring the evolution of complexity in signaling networks. *Complexity*, 7(2):34–45, 2002.
2. J.H. Holland. Studying Complex Adaptive Systems. *Journal of Systems Science and Complexity*, 19(1):1–8, 2006.
3. J.Decraene, G.G. Mitchell, B. McMullin. Evolving Artificial Cell Signaling Networks: Perspective and Methods. *Advances in Biologically Inspired Information Systems: Models, Methods, and Tools*, 69:165–184, 2007.

[1] ESIGNET: Evolving Cell Signaling Networks *in silico*, a EU FP6 project - contract no. 12789, http://www.esignet.net