Active Experimentation and Computational Reflection for Design and Testing of Cyber-Physical Systems

Kirstie L. Bellman [1], Phyllis R. Nelson [2] and Christopher Landauer [3]

Abstract Cyber-physical systems are being deployed in a wide variety of applications, creating a highly-capable infrastructure of networked ``smart'' systems that utilize coordinated computational and physical resources to perform complicated tasks either autonomously or in cooperation with humans. The design and testing of these systems using current methods, while time-consuming and costly, is not necessarily sufficient to guarantee appropriate and trustworthy behavior, especially under unanticipated operational conditions. Biological systems offer possible examples of strategies for autonomous self-improvement, of which we explore one: active experimentation. The combined use of active experimentation driven by internal processes in the system itself and computational reflection (examining and modifying behavior and structure during operation) is proposed as an approach for developing trustworthy and adaptable complex systems. Examples are provided of implementation of these approaches in our CARS testbed. The potentialfor applying these approaches to improve the performance and trustworthyness of mission-critical systems of systems is explored.

[1] Topcy House Consulting, Thousand Oaks CA, U.S.A. - bellmanhome@yahoo.com

[2] California State Polytechnic University Pomona, Pomona, CA 91768, U.S.A. - prnelson@csupomona.edu

[3] Topcy House Consulting, Thousand Oaks CA, U.S.A. - topcycal@gmail.com