Distributed Simulation Templates for Repast

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Abstract

Many real-world systems involve large numbers of interconnected heterogeneous elements. These complex systems typically exhibit non-linear behavior and emergent properties determining the high level functioning and behavior. Agent-based simulation is a suitable and useful modeling paradigm for the decomposition and study of complex systems.

When, however, the complexity or the number of agents increases, the cost of computational resources become considerable and easily exceed the capabilities of sequential processing systems. Multi-threaded, distributed and grid computing techniques are therefore inevitable to facilitate large-scale real-world simulation of complex systems. This, however, complicates the model development significantly, and can go beyond the capabilities or interests of researchers in complex systems.

In face of these issues, we are developing an integration between the agent simulation toolkit Repast and ProActive, a middleware for multi-threading, parallel and distributed computing. This combination facilitates the design and deployment of distributed agent-based simulations over multiple computational nodes on multi-core machines, local clusters, and grid environments.

Naturally, the distribution/parallelization of computer programs, and thus simulations cannot be fully automatized. Parallelization is a multi-dimensional optimization problem. Two of the major dimensions are the minimalization of communication between nodes, and the balancing of the processing load among the nodes. These are non-trivial issues that require in-depth knowledge about the simulation model. However, general schemas for solutions exists, especially if the priority among the two major dimensions is defined.

Our approach is to focus on the minimalization of communication. We have identified classes of simulations with common agent-to-agent communication templates. We are developing distributed and parallel Repast/ProActive implementations for these templates that can be subclassed and customized for

particular user simulations. The supported templates range from embarrassingly parallel applications and parameter sweeps to full in-run distribution of models, such as cellular automata, static and dynamic (communication) networks, and agents moving in abstract spaces.

The present work is being carried out within the frame of the QosCosGrid (Quasi-Opportunistic Supercomputing for Complex Systems Simulations on the Grid) project funded by the European Commission's 6th Framework Programme. The proposed paper overviews the project's main directions and presents the current status, including working examples and prototypes.