Exploring the Macroscopic Properties of Complex Systems

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Studying the emergent macroscopic properties of complex systems can be a very complicated task requiring an enormous number of calculations. For some complex systems, the number of calculations necessary for a study may be prohibitive to run on a single PC. By design, these calculations can be distributed across a multitude of PC's and performed concurrently. The cluster of PC's may be constructed, using existing communication standards, over-the-counter hardware, and freely available cluster software.

The complex system studied is an ecological food web. Simulations of the food web are carried-out using the multi-agent rule-based modeling package SWARM developed at the Sante Fe Institute (SFI). In this model, there exist many agents for each of the distinct species of an ecological food web. An agent's behavior is characterized by parameters that determine the rules of interaction of its species. Changing any of the parameters of a species may greatly alter the behavior of this complex system. Thus, a vector made from parameters for all of the species determines the overall behavior of the total system.

The emergent macroscopic properties of these complex environmental systems are explored using the parallel genetic algorithm library PGApack developed at Argonne National Laboratory (ANL). The vector of parameters that determine the behavior of the total system may be viewed as the genome of the system. Then, vectors that optimize specific macroscopic properties in complex systems may be found by natural selection. This same software package PGApack can be used in many different areas of complex systems research.

For research purposes, a 12-node cluster of PC's with MPI (Message Passing Interface) architecture is constructed using the OSCAR software package developed at Oak Ridge National Laboratory (ORNL). This software package is installed on top of the Redhat Linux operating system.