Guest Editorial: Special Issue on Understanding Complex Evolutionary Systems

IT IS a pleasure to be able to introduce this Special Issue on Understanding Complex Evolutionary Systems. Evolutionary computation research frequently relies on the analysis of the time, and know solutions or measures of the quality of solutions found as metrics for comparing different selection schemes, representations, and operators. While these are important tools, more nuanced tools are helpful even when trying to understand relatively simple evolutionary optimizers, and can be critical when coevolution or multicriteria optimization is being performed. The range of useful tools is broad, including theorems, visualizations, new metrics, and novel analysis techniques. This Special Issue presents six papers that include all of these. The purpose of this Special Issue is to expand our tool set for understanding the behavior of complex evolutionary systems. In the judgement of this writer, it is a good beginning, giving many examples, surveying known techniques, presenting new techniques, and giving many possible next steps.

The paper "*Complex Coevolutionary Dynamics Structural Stability and Finite Population Effects*" presents mathematical results helping to clarify the relationship between finite and infinite population replicator dynamics in evolutionary game theory. It provides tools for understanding when the results of an evolutionary simulation are meaningful and when they might be dominated by noise. "*Visualizing Mutually Nondominating Solution Sets in Many-Objective Optimization*" surveys techniques for visualizing nondominated frontiers and presents new techniques for doing so. The paper also introduces dominance distance, a novel measure for capturing the order relation between different nondominated solutions.

The paper "*Evolved Features For DNA Sequence Classication And Their Fitness Landscapes*" treats the classical problem of feature selection for DNA classification using a novel representation, side effect machines, as a source of features. The fitness landscape on which side effect machines evolved is explored with the goal of comparing and selecting fitness functions. "*Fitness Landscapes of Evolved Apoptotic Cellular Automata*" also performs an analysis of a novel fitness landscape, and surveys tools for fitness landscape analysis and presenting new tools. It uses the tools to resolve extant conjectures about the behavior of single parent techniques, used for controlling the behavior of an evolving population.

In "*Coevolving Game-Playing Agents: Measuring Performance and Intransitivities*," the authors explore the problem of transitivity in the coevolution of game-playing agents. If a cycle of agents can be constructed, each of which can beat the next, then there is a danger of evolution running in circles. The authors make a thorough review of the problem and propose measures of transitivity for evolutionary systems. They demonstrate these measures on the classical game Othello. The paper "*Agent-Case Embeddings for the Analysis of Evolved Systems*" presents a general tool for modeling the space of behaviors and simultaneously the space of problems for agent based systems where the problem the agents are solving has multiple cases. The technique is demonstrated on a variety of problems including game playing agents, virtual robots, and cellular automata. The technique is used to produce taxonomies and visualizations of both agents and problem cases.

The papers in this issue represent a good start on the problem of developing analysis tools for evolving systems. The techniques presented in the issue can be applied to many evolutionary systems and can be generalized to a wider variety of systems. It is earnestly hoped that this Special Issue will seed research into the problem of understanding the behavior and results of complex evolving systems. Finally, if you are looking at a paper copy of the TRANSACTIONS it is worth noting that several of the papers in this issue are in color on-line.

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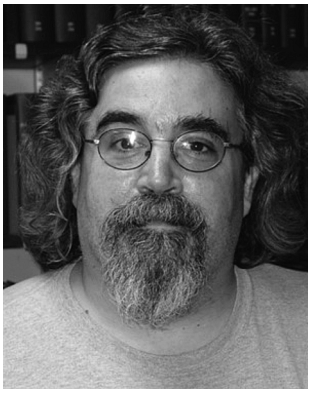

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