Automated Team Analysis

Taylor Raines, Milind Tambe, Stacy Marsella

Information Sciences Institute and University of Southern California
4676 Admiralty Way, Suite 1001
Marina del Rey, CA 90292, USA
{Raines, Tambe, Marsella}@isi.edu

An interesting problem that AI researchers face today is that of constructing experts that can recognize and analyze team behavior and provide advice to improve it. Team analysis is critical to many areas of research, such as the evaluation of human teams as well as evaluation of alternative designs of synthetic agent teams. In particular, evaluation of synthetic agent teamwork is a critical requirement as agent teams are employed across an increasing range of multi-agent synthetic environments, including such diverse application areas as virtual environments for training, interactive entertainment, multi-robotic space missions, and simulated synthetic air combat. In the RoboCup synthetic agent environment, a research environment based on the team sport of soccer, teamwork among the synthetic player agents is clearly fundamental, and as such makes an excellent test bed for our research.

We have created an agent for analyzing and improving synthetic teams. The agent is built in a bottom-up fashion using little specific domain knowledge. In lieu of extensive domain knowledge, data mining and inductive learning techniques are used in an attempt to isolate the key issues determining the successes or failures of these teams. This approach has been applied to the RoboCup domain, with a current focus on analyzing shots on goal and with future plans for assists, passing, and general teamwork.

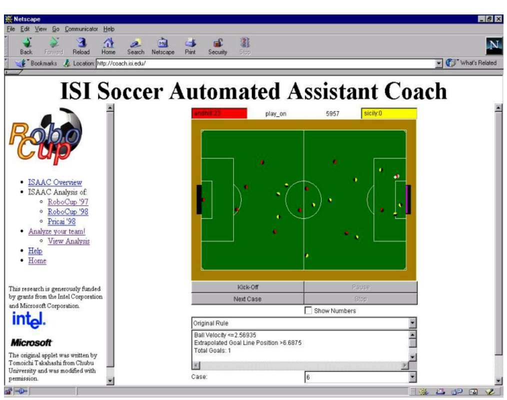

Figure 1: ISAAC online at http://coach.isi.edu

ISAAC is our web-based off-line soccer expert that uses automated analysis to aid in improving a team's behavior (See Figure 1). ISAAC approaches the analysis problem by investigating actions that did not produce the desired result and then classifying the contexts in which failures occurred. Based on that classification, ISAAC recommends changes in behavior to avoid the failures: either the team should perform a different action in that context or should perform the action in a modified context. More specifically, ISAAC's analysis starts with logs of a particular team's games. From the logs, ISAAC extracts interesting behaviors and the outcomes of those behaviors. For instance, shots on goal are interesting behaviors, so ISAAC gathers data on such shots, and whether they succeed. ISAAC then classifies these successes and failures into subclasses with similar contexts. An example subclass might be all shots on goal that fail when an opponent is nearby. Currently, C4.5 is used to induce these subclasses by generating rules that classify the successes and failures of the shooting team.

ISAAC's next step is to formulate suggestions that may improve the team's performance, once again using a knowledge-lean approach. To that end, ISAAC formulates and analyzes perturbations of the rules. Each rule consists of a number of conditions that must be satisfied for the rule to be valid. We define a perturbation to be the rule that results from reversing one condition. The successes and failures governed by the perturbations of a rule are examined to determine which conditions have the most effect in changing the outcome of the original rule, turning a failure into a success.

More recently, ISAAC has been extended to analyze sequences of behaviors, such as sequences of actions (e.g., passes) that lead up to successes or failures. This analysis has revealed that out of the top four teams of RoboCup'97, ISIS is at one extreme with little or no emergent pattern of assists, while CMUnited shows deeper patterns of assists and passing. In analyzing agent behavior in complex multi-agent dynamic environments, the approach of using knowledge poor data-driven analysis techniques combined with human oversight has shown considerable promise.