Dynamic Generation of Complex Behavior

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Simulation can be an effective training method if the simulation environment is as realistic as possible. An important part of the training for Navy pilots involves flying against computer-controlled agents in simulated tactical scenarios. In order for such a situation to be realistic, the computer-controlled agents must be indistinguishable from human-piloted agents within the simulated environment. The primary goal of the Soar-IFOR project (Jones et al. 1993; Rosenbloom et al. 1994) is to provide such believable agents for flight training simulations.

To achieve this goal, we have constructed the TacAir-Soar system.[1] Developing this system requires us to address a number of core research issues within artificial intelligence, including reasoning about interacting goals, situation interpretation, communication, explanation, planning, learning, natural language understanding and generation, temporal reasoning, and plan recognition.

This report focuses on two particular issues required to function reasonably within the tactical air domain: a system must be able to generate behavior in response to complex goals and situations, and it must be able to do so dynamically, in response to extremely rapid changes in the agent's situation. On the surface, these two capabilities seem to be at odds to each other. Approaches to real-time or reactive behavior have generally not been used within complex domains, and systems that focus on complex goals do not usually do so in real time. Our solution has been to encode knowledge within the Soar production architecture (Rosenbloom et al. 1991) in order to take advantage of state-of-the-art matching algorithms to provide real-time, reactive behavior. In addition, the knowledge is represented at a fine grain size, capturing a deep representation of the first principles involved in the tactical flight domain. This representation allows reactive rules to combine in a fashion that leads to appropriate responses to complex goal and situation combinations.

The current version of TacAir-Soar has been flown in simulated exercises against other computer-controlled agents, as well as human-controlled flight simulators. The agent exhibits a wide variety of complex behaviors, and it meets the real-time requirements of the task. In addition, the agent provides realistic, human-like behavior in a number of tactical scenarios.

[1] This research involves the efforts of John E. Laird, Randolph M. Jones, Paul E. Nielsen, and Frank Koss at the University of Michigan; Paul S. Rosenbloom, Milind Tambe, W. Lewis Johnson, and Karl B. Schwamb at the University of Southern California, Information Sciences Institute; and Jill E. Lehman and Robert Rubinoff at Carnegie Mellon University. The members of BMH, Inc. have also provided invaluable assistance as subject-matter experts. The research is supported by contract N00014-02-K-2015 from the Advanced Systems Technology Office of the Advanced Research Projects Agency and the Naval Research Laboratory.

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