Issues in Designing Physical Agents for Dynamic Real-Time Environments
World Modeling, Planning, Learning, and Communicating

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■ This article discusses a workshop held in conjunction with the Eighteenth International Joint Conference on Artificial Intelligence (IJCAI-03), held in Acapulco, Mexico, on 11 August 2003.

Recent developments in multiagent systems (MAS) have shown promising results in the modeling of autonomous, collaborative behavior between agents in different environments. However, much of the work does not take into account real-time constraints typically associated with many agent applications in addition to the incomplete and dynamic nature of the embedding environments. For example, in environments where a number of agents build teams, and both single-agent and collaborative decisions have to be made, such decisions have to be generated rapidly and in the appropriate time windows to be useful.

The main focus of this workshop was to reevaluate traditional topics used in the agent-based paradigm in the context of real-time constraints and incomplete, dynamic environments. Such topics include world modeling, planning, learning, agent communication, and software architectures. Within this general theme, the aim was to bring together researchers from different communities working with both robots and softbots (for example, RoboCup, cognitive robotics, intelligent autonomous vehicles). The common denominator that these groups share is the pragmatic one of operating in real-time contexts in dynamic environments.

The workshop was well attended and attracted colleagues from many different communities. Thirteen contributions were selected for oral presentation and can roughly be categorized relative to different functions common to general MASs.

Tara Estlin, Rebecca Castano, Robert Anderson, Daniel Gaines, Forest Fisher, and Michele Judd (all from the Jet Propulsion Laboratory [JPL] in Pasadena, California) presented work using the OASIS system, which utilizes techniques from learning and planning for missions to Mars. F. Dylla, A. Ferrein, and G. Lakemeyer (Knowledge-Based System Group, Aachen, Germany) showed how plans can be specified with IPC-GOLOG. The presentation of Cynthia Marling, Mark Tomko, Matthew Gillen, David Alexander, and David Chelberg (The Ohio State University) focused on the use of case-based reasoning for both planning and world modeling. This approach is used to assist physical robotic soccer agents in planning individual moves and strategies. The presentation of M. Bernardine Dias (Carnegie Mellon University [CMU]), Solange Lemai (LAAS/CRNS), and Nicola Muscettola (NASA Ames) focused on reactive behaviors. The hypothesis is that a large control system (IDEA) can be structured as a collection of interacting control agents, each organized around the same fundamental structure. The presentation of Bernhard Nebel (Institut für Informatik) and Yuliya Babovich (University of Texas) discussed goal-converging behavior networks and self-solving planning domains and dealt with both planning and reactive-agent components.

The presentation of Carmel Domshlak (Cornell University) and James H. Lawton (U.S. Air Force Research Laboratory) described an approach to planning with multiagent execution. A model for planning and execution was proposed that treats qualitative and quantitative effects of agents differently. The presentation of Thomas Wagner (University of Brement), Christoph Schlieder (University of Bamberg), and Ubbo Visser (University of Bremen) focused on execution monitoring. The authors proposed the use of qualitative spatial knowledge representation for avoiding obstacles in highly dynamic environments. Their approach is based on an extended panorama. Matthias Fichtner, Axel Grossmann, and Michael Thielscher (Technische Universität Dresden) proposed an approach for intelligent execution monitoring using logical world representation that allows planning and reasoning about world states.

Two papers dealt specifically with

multiagent coordination. The first presentation by Bradley J. Clement and Anthony C. Barrett (Jet Propulsion Laboratory) describes a shared activity coordination (SHAC) framework, which provides a decentralized algorithm for negotiating the scheduling of shared activities. The presentation by Michael Bowling, Brett Browning, Allen Chang, and Manuela Veloso (CMU) introduced the concept of a play as a team plan and combined both reactive and deliberative principles.

Two papers dealt with problems related to prediction. The first presentation by Craig Schlenoff, Raj Madhavan, and Stephen Balakirsky (National Institute of Standards and Technology [NIST]) focused on autonomous vehicle scenarios, where the real-time prediction of objects (obstacles) during on-road navigation is crucial. The presentation by Bernhard Nebel (Albert-Ludwigs-Universität Freiburg) and Yuliya Babovich (University of Texas) focused on goal-converging behavior networks. Here, it was argued that behavior networks converge to given goals regardless of the particular action scheme.

The paper by Kazuhiro Nakadaiy (Honda Research Institute), Daisuke Matsuura (Tokyo Institute of Technology), Hiroshi G. Okuno (Kyoto University), and Hiroaki Kitano (Japan Science and Technology Corporation) dealt with communication. The problem tackled involves a situation where a humanoid robot has to deal with a number of simultaneous talkers. Their approach deals with speech recognition through audio-visual integration.

The workshop attendees consisted of colleagues from universities (Cornell, Freiburg, Kyoto, Aachen, Ohio, CMU, Bremen, Stuttgart, and Dresden), companies (Honda Research, Kitano Symbiotic Systems), and large research organizations (NIST, JPL, National Aeronautics and Space Administration, LAAS/CNRS). Because of the high attendance at the workshop and the broad spectrum of participants, there are plans to continue activities in this area at future AAAI Spring Symposiums and at the European Conference on Artificial Intelligence.[1]

Note

1. www.tzi.de/~visser/ecai04/.

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