

Learning in multi-agent systems

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Learning agents acting in a multi agent environment can improve their performance. These agents might decide upon their course of action by learning about other agents with whom they interact. The learning agents can learn about the others' information and rules of behavior. The agents will not need to plan their actions beforehand, each time they are asked to solve the same problem they have already solved or when dealing with similar problems.

Our research focusses in finding learning algorithms for multi agent environments. In particular, we want to develop agents that learn how to cooperate with other agents and learn how to become experts. I am studying these themes in several domains to achieve a more broader understanding of how learning is influenced by different multi-agent domains and thus how learning algorithms can be developed. The research aims at answering the following questions:

1. How do agents learn how to act? I am looking at a teacher-learner model in which the teacher might also play the role of the learner, and the learner might also behave as a teacher. I am investigating two main directions. One direction regards a 2-phase model and we investigate how agents can be trained by other agents and then how they generalize the knowledge they acquired (Goldman & Rosenschein 1995). The second direction focusses on a dynamic learning model in which the agents learn from the others incrementally and also act based on the current knowledge they have.

I am also investigating the behavior of learning agents that are implemented as automata (deterministic and probabilistic). We investigated (Mor, Goldman, & Rosenschein 1995) how one learning agent can decide which action to play while he learns his opponent's strategy. Currently, we are focussing on mutual learning

In both cases, I am looking at reinforcement learning, where the feedback is given to the agents by the

other agents, in contrast to most methods used in reinforcement learning in which the agents receive their feedbacks from the world in which they perform their actions.

2. How do agents learn about information (i.e. understand, share and compose new information)? Currently, I am working on three projects: Musag (Goldman, Langer, & Rosenschein 1996): a system based on four software agents, that learns about concepts by "reading" html documents in the Web. I am currently working on expanding the system to include a group of such systems that will interact in order to learn more about the concepts they are learning, by sharing information they have, with the others. Courtz (Goldman, Mor, & Rosenschein 1996): a software agent dedicated to looking for information about a topic given by a user in a fuzzy way, i.e. the information is not well defined and might have ambiguous meanings. NetNeg (Goldman, Gang, & Rosenschein 1995): a hybrid system built on a neural network module and an agents based module. This agents deal with multi-media information.

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