DISTRIBUTED ARTIFICIAL INTELLIGENCE AND MULTI AGENT SYSTEM

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Abstract : As we know Distributed Artificial intelligence and Multi agent systems is an expanding field that blends classical fields like game theory and decentralized control with modern fields like computer science and machine learning. This monograph provides a concise introduction to the subject, covering the theoretical foundations as well as more recent developments in a coherent and readable manner. The text is centered on the concept of an agent as decision maker.

Keywords : Distributed Artificial Intelligence, Multi agent System, Game Theory

Introduction : The modern approach to artificial intelligence (AI) is centered on the concept of a rational agent. An agent is anything that can perceive its environment through sensors and act upon that environment through actuators. An agent that always tries to optimize an appropriate performance measure is called a 'rational agent'. Such a definition of a 'rational agent' is fairly general and can include human agents (having eyes as sensors, hands as actuators), robotic agents (having cameras as sensors, wheels as actuators), or software agents (having a graphical user interface as sensor and as actuator). From this perspective, AI can be regarded as the study of the principles and design of artificial rational agents. However, agents are seldom stand-alone systems. In many situations they coexist and interact with other agents in several different ways. Examples include software agents on the Internet, soccer playing robots (see Fig. 1.1), and many more. Such a system that consists of a group of agents that can potentially interact with each other is called a multi agent system (MAS), and the corresponding sub field of AI that deals with principles and design of multi agent systems is called distributed AI.

Agent Design : It is often the case that the various agents that comprise a MAS are designed in different ways. The different design may involve the hardware, for example soccer robots based on different mechanical platforms, or the software, for example software agents (or 'soft bots') behaviors are of ten called heterogeneous, in contrast to homogeneous agents that are designed in an identical way and have a priori the same capabilities. Agent heterogeneity can affect all functional aspects of an agent from perception to decision making.

Environment : Agents have to deal with environments that can be either static or dynamic(change with time).Most existing AI techniques for single agents have been developed for static environments because these are easier to handle and allow for a more rigorous mathematical treatment. Ina MAS, the mere presence of multiple agents makes the environment appear dynamic from the point of view of each agent.

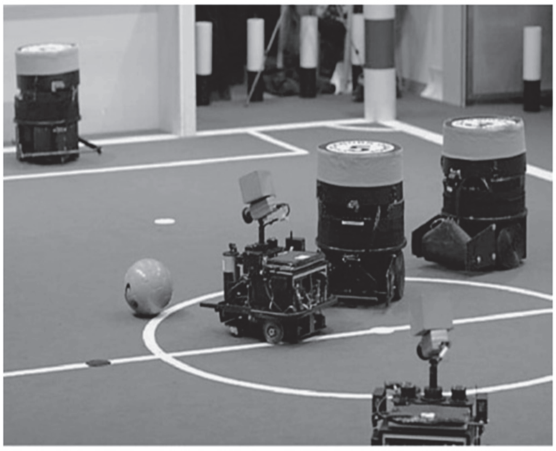

FIGURE 1.1: A robot soccer team is an example of a multi agent system.

This can often be problematic, for instance in the case o concurrently learning agents where non-stable behavior can be observed. There is also the issue of which parts of a dynamic environment an agent should treat as other agents and which not.

Perception : The collective information that reaches the sensors of the agents in MAS is typically distributed: the agents may observe data that differ spatially (appear at different locations), temporally (arrive at different times), or semantically (require different interpretations). The fact that agents may observe different things makes the world partially observable to each agent, which has various consequences in the decision making of the agents. For instance, optimal multi agent planning under partial observability can be an intractable problem. An additional issue is sensor fusion, that is, how the agents can optimally combine their perceptions in order to increase their collective knowledge about the current state.

Control : Contrary to single-agent systems, the control in MAS is typically decentralized. This means that the decision making of each agent lies to a large extent within the agent itself. Decentralized control is preferred over centralized control (that involves a center) for reasons of robustness and fault-tolerance. However, not all MAS protocols can be easily distributed. The general problem of multi agent decision making is the subject of game theory which we will briefly cover .In a collaborative or team MAS where the agents share the same interests, distributed decision making offers asynchronous computation and speedups, but it also has the downside that appropriate coordination mechanisms need to be additionally developed.

Knowledge : In single-agent systems we typically assume that the agent knows its own actions but not necessarily how the world is affected by its actions. In MAS, the levels of knowledge of each agent about the current world state can differ substantially. For example, in a team MAS involving two homogeneous agents, each agent may know the available action set of the other agent, both agents may know (by communication) their current perceptions, or they can infer the intentions of each other based on some shared prior knowledge. On the other hand, an agent that observes an adversarial team of agents will typically be unaware of their action sets and their current perceptions, and might also be unable to infer their plans. In general, in MAS each agent must also consider the knowledge of each other agent in its decision making. Agent knows a fact, every agent knows that every other agent knows this fact, and so on.

Communication : Interaction is often associated with some form of communication. Typically we view communication in MAS as a two way process, where all agents can potentially be senders and receivers of messages. Communication can be used in several cases, for instance, for coordination among cooperative agents or for negotiation among self-interested agents. This additionally raises the issue of what network protocols to use in order for the exchanged information to arrive safely and timely, and what language the agents must speak in order to understand each other (especially, if they are heterogeneous). We will see throughout the book several examples of multi agent protocols involving communication.

Applications : Just as with single-agent systems in traditional AI, it is difficult to anticipate the full range of applications where MASs can be used. Some applications have already appeared, for instance in software engineering where MAS technology has been recognized as a novel and promising

Software building paradigm: a complex software system can be treated as a collection of many small-size autonomous agents, each with its own local functionality and properties, and where interaction among agents enforces total system integrity. Some of the benefits of using MAS technology in large systems are

1. Speedup and efficiency, due to the asynchronous and parallel computation.
2. Robustness and reliability, in the sense that the whole system can undergo a 'graceful degradation' when one or more agents fail.
3. Scalability and flexibility, since it is easy to add new agents to the system.
4. Cost, assuming that an agent is a low-cost unit compared to the whole system.
5. Development and reusability, since it is easier to develop and maintain a modular system than a monolithic one.

A very challenging application domain for MAS technology is the Internet. Today the

Internet has developed into a highly distributed open system where heterogeneous software agents come and go, there are no well established protocols or languages on the 'agent level' (higher than TCP/IP), and the structure of the network itself keeps on changing. In such an environment, MAS technology can be used to develop agents that act on behalf of a user and are able to negotiate with other agents in order to achieve their goals. Electronic commerce and auctions are such examples (Cramton et al., 2006, Noriega and Sierra, 1999). One can also think of applications where agents can be used for distributed data mining and information retrieval (Kowalczyk and Vlassis, 2005, Symeonidis and Mitkas, 2006).

Other applications include sensor networks, where the challenge is to efficiently allocate resources and compute global quantities in a distributed fashion (Lesser et al., 2003, Paskin et al., 2005); social sciences, where MAS technology can be used for studying interactivity and other social phenomena (Conte and Dellarocas, 2001, Gilbert and Doran, 1994); robotics, where typical applications include distributed localization and decision making

(Kok et al., 2005, Roumeliotis and Bekey, 2002); artificial life and computer games, where the challenge is to build agents that exhibit intelligent behavior (Adamatzky andKomosinski,2005, Terzopoulos, 1999).

A recent popular application of MASs is robot soccer, where teams of real or simulated autonomous robots play soccer against each other (Kitano et al., 1997). Robot soccer provides a test bed where MAS algorithms can be tested, and where many real-world characteristics are present: the domain is continuous and dynamic, the behavior of the opponents may be difficult to predict, there is uncertainty in the sensor signals, etc. A related application is robot rescue, where teams of simulated or real robots must explore an unknown environment in order to discover victims, extinguish fires, etc. Both applications are organized by the RoboCup Federation (www.robocup.org).

Gametheory : As we saw an agent will typically be uncertain about the effects of its actions to the environment, and it has to take this uncertainty into account in its decision making. In a multi agent system where many agents take decisions at the same time, an agent will also be uncertain about the decisions of the other participating agents. Clearly, what an agent should do depends on what the other agents will do.

Multi agent decision making is the subject of game theory (Osborne and Rubinstein, 1994). Although originally designed for modeling economical interactions, game theory has developed into an independent field with solid mathematical foundations and many applications. The theory tries to understand the behavior of interacting agents under conditions of uncertainty, and is based on two premises. First, that the participating agents are rational.

Second, that they reason strategically, that is, they take into account the other agents' decisions in their decision making. Depending on the way the agents choose their actions, there are different types of games.

In a strategic game each agent chooses his1 strategy only once at the beginning of the game, and then all agents take their actions simultaneously. In an extensive game the agents are allowed to reconsider their plans during the game, and they may be imperfectly informed about the actions played by the other agents.

Conclusion : The work developed in this paper outlined a concept Distributed AI working with multi agent system using Game theory we study the problem of multi agent decision making where a group of agents coexist in an environment and take simultaneous decisions. We use game theory to analyze.

The problem when we are distributing the AI with multi agent system then we can not only save the time as well as we are saving the money more research is going on.

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