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Multi Agent Systems (MAS): An Intromission

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Abstract—*A multi agent system is one that consists of a number of agents, which interact with one another, typically by exchanging messages through some computer network infrastructure. In the most general case, the agents in a multi agent system will be representing or acting on behalf of users or owners with very different goals and motivations. In order to successfully interact, these agents will thus require the ability to cooperate, coordinate, and negotiate with each other. Multi-agent systems can be used to solve problems that are difficult or impossible for an individual agent or a monolithic system to solve. Intelligence may include some methodic, functional, procedural approach, algorithmic search or reinforcement learning.*

Keywords*: Agent, Interact, Methodic, Procedural Approach, Reinforcement.*

1. INTRODUCTION

In artificial intelligence research, agent-based systems technology has been hailed as a new paradigm for conceptualizing, designing, and implementing software systems. Agents are sophisticated computer programs that act autonomously on behalf of their users, across open and distributed environments, to solve a growing number of complex problems. Increasingly, however, applications require multiple agents that can work together. A multi-agent system (MAS) is a loosely coupled network of software agents that interact to solve problems that are beyond the individual capacities or knowledge of each problem solver.

The multi-agent system concepts appeared recently and it is extremely distributed in all research areas; to solve problems by many agents cooperation. These agents, which have been using for multi-agent system, are defined as an entity; software routine, robot, sensor, process or person, which performs actions, works and makes decision which has defied many attempts to formalize it" Multiagent systems are a new paradigm for understanding and building distributed systems, where it is assumed that the computational components are autonomous: able to control their own behaviour in the furtherance of their own goals. Multi-agent systems can be applied to artificial intelligence. They simplify problem-solving by dividing the necessary knowledge into subunits-to which an independent intelligent agent is associated-and by coordinating the agents' activity.

2. CHARACTERISTICS OF MULTIAGENT SYSTEMS

2.1 Perception

The collective information that reaches the sensors of the agents in a MAS is typically distributed: the agents may observe data that differ spatially temporally, or even semantically .This automatically makes the world state partially observable to each agent, which has various consequences in the decision making of the agents. 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.

2.2 Control

Contrary to single-agent systems, the control in MAS is typically distributed

This means that there is no central process that collects information from each agent and then decides what action each agent should take. The decision making of each agent lies to a large extent within the agent itself. The general problem of multiagent decision making is the subject of game theory. In a cooperative or team MAS, distributed decision making results in asynchronous computation and certain speedups, but it also has the downside that appropriate coordination mechanisms need to be additionally developed. Coordination ensures that the individual decisions of the agents result in good joint decisions for the group.

2.3 Knowledge

In single-agent systems we typically assume that the agent knows its own actions but not necessarily how the world is ejected 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

2.4 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. Moreover, communication additionally raises the issues 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.

3. SPECIAL FACTORS OF MULTI AGENT SYSTEM APPROACH

An MAS has the following factors over a single agent or centralized approach:

- An MAS distributes computational resources and capabilities across a network of interconnected agents. Whereas a centralized system may be plagued by resource limitations, performance bottlenecks, or critical failures, an MAS is decentralized and thus does not suffer from the "single point of failure" problem associated with centralized systems.
- An MAS allows for the interconnection and interoperation of multiple existing legacy systems. By building an agent wrapper around such systems, they can be inporporated into an agent society.
- An MAS models problems in terms of autonomous interacting component-agents, which is proving to be a more natural way of representing task allocation, team planning, user preferences, open environments, and so on.
- An MAS efficiently retrieves, filters, and globally coordinates information from sources that are spatially distributed.
- An MAS provides solutions in situations where expertise is spatially and temporally distributed.
- An MAS enhances overall system performance, specifically along the dimensions of computational efficiency, reliability, extensibility, robustness, maintainability, responsiveness, flexibility, and reuse.

4. INFERENCE FOR MULTI AGENT SYSTEMS

The two major reasons that cause people to study multi agent systems are:

4.1 Technological and Application Needs

Multi agent systems offer a promising and innovative way to understand, manage, and use distributed, large-scale, dynamic, open, and heterogeneous computing and information systems. The Internet is the most prominent example of such systems; other examples are multi-database systems and in-house information systems. Computers and computer applications play an increasingly important and influencing part in our everyday life, as they become more powerful and more tightly connected both with each other through long-range and local-area networks and with humans through user-interfaces. These systems are too complex to be completely characterized and precisely described. As their control becomes more and more decentralized, their components act more and more like "individuals" that deserve attributes like autonomous, rational, intelligent, and so forth rather than just as "parts." Many real world applications, if not most, fall into this class, and they are present in many domains such as scheduling, manufacturing, control, diagnosis and logistics.

4.2 Natural View of Intelligent Systems

Multi agent systems offer a natural way to view and characterize intelligent systems. Intelligence and interaction are deeply and inevitably coupled, and multi agent systems reflect this insight. Natural intelligent systems, like humans, do not function in isolation. Instead, they are at the very least a part of the environment in which they and other intelligent systems operate. Humans interact in various ways and at various levels ,and most of what humans have achieved is a result of interaction.

5. APPLICATIONS AREA OF MULTI AGENT SYSTEM

The main applications for MAS are for telecommunications, data communications ,internet services, and physical agents, such as robots. A group of scientists has specialized in the simulation of agents' societies in the fields of ecology and social sciences. And also used in the field of distributed sensor networks, decision support system, air traffic control or distributed control systems.

5.1 MAS in Distributed Networks Approach

Physical distribution may not be the only reason for a distributed approach. Minsky’s Society of Mind paradigm (Minsky, 1986) suggests the use of a multi-agent system where there is a wide range of reasonably self-contained pieces of functionality that require the use of AI, especially if they run asynchronously, or are distributed or independent in the sense of timing. In this way, a multi-agent approach might be applied to a single robot manipulator taking each joint as an agent or to a single static system with sensors and effectors such as a smart building or a spacecraft.

5.2 MAS in Social sciences

In social sciences, the application of multiagent universes to simulate social phenomena is generally associated with the sociological trend, so-called "individualism", in which the singular individual is considered as the elementary unit or the atom of society. The overlap is, in fact, in the bottom-up approach which characterizes MAS. However, the assimilation between individuals from a society and agents from a multi-agent universe can be misleading. In fact, it is quite possible for social groups and institutions to be considered as agents with their own standards and rules. The agents are directed by constraints or rules that are expressed on a group level, i.e. they are no more than entities that act and are placed in a dynamic environment.

5.3 MAS in social Networks

MAS are developing rapidly in the field of social sciences. Here, we consider that the relationships between people and resources should, in fact, be rephrased as the relationships between people who affect resources. Agents that exchange messages within networks or so-called contact networks can be simulated with MAS. In this way, it is possible to simulate exchanges of information and services as well as contracts and agreements between agents. For example, in the case of irrigated systems, farmer agents can send each other messages so that they know what the water levels are in different plots. They can also ask for or exchange services or addresses. In this way, it has been shown that the evolution of a system can be very sensitive to the structure and dynamics of social networks.

5.4 MAS in Air Traffic

The tasks in Air Traffic Control (ATC) are geographically and functionally distributed. The airspace above the airport areas where take-off, landing and land maneuvers take place is distinguished from the area close to the airport where planes descend and ascend, and from the air terminals for different type of flights. The terminals are in turn divided into geographical sectors that are controlled and regulated by an autonomous *controller*. The airspace above an airport used for take-off, landing and land maneuver is also controlled by a separate system. The geographical and functional distribution and the highly dynamic nature of ATC make it an ideal candidate, with many potential applications that can be modeled with MAS. In addition to the controllers, there are other components that can be modelled as agents, for example aircraft, radar equipments, flight security system, airport information system, and luggage handling system. In ATC aircraft can also be modelled as agents who coordinate their activities with one another. This could be a significant improvement on the present systems were the air traffic is largely centrally controlled from the ground. Active cooperation would also enable automation of many currently uncontrolled areas of flight maneuvers.

5.5 MAS in Road Traffic

Many system components used in road traffic guidance can be made more autonomous and consequently more adaptive, if modelled as agents. Particularly unsatisfactory is the degree of robustness and flexibility of the existing systems, which is basically due to the fact that the number of possible states the network may be in is immensely large and therefore it makes little sense to specify central operation plans. Occurrence of new events leads to consequences that would rapidly change the whole state of the network and as a result the central traffic regulating plans never execute into completion. Currently off-line decision-support systems are used to deal with this problem. Using MAS techniques would lead to a greater flexibility and robustness. The knowledge about the up to date traffic flow and general data can be captured locally by regional/zone agents who control the traffic performance of each region/zone. If an event may have consequences for the areas under the control of the neighboring zones, the corresponding agents can be informed so that they collaboratively adjust and coordinate their plan accordingly. Such a system has the advantage that the regional changes and interferences are considered at regional level and dealt with immediately. Should these events have consequences on any other regions, only the agents in charge of the effected regions must replan their activities. Consequently, the system can much more rapidly react and adapt to the new situations. Instead of an off-line decision support system, using agents this support can be provided on-line. With the increasing awareness of the importance and urgency of environmental considerations in traffic, more ecological traffic routing systems can be imagined. These systems may consist of a network of interconnected stationary and mobile measuring stations, vehicle electricity charging stations. Such a system can be modeled as a multi-agent system where agents communicate and interact to reduce environmental damage.

6. CONCLUSION

Multi-agent systems is one of the landmark technology in computer science, that bring extra conceptual power, new methods and techniques, and that is essentially broaden the spectrum of our computer applications. The technology has the chances to compensate the failures of AI just because this new paradigm shifts from the single intelligent entity model to the multi-intelligent entity one, which is in fact the true model of human intelligence acting. Interaction among agents in MAS is mainly realized by means of communication. Communication may vary from simple forms to sophisticated ones, as the one based on speech act theory. A simple form of communication is that restricted to simple signals, with fixed interpretations and also used this application in various fields of real world.

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