"The Study of Fundamental Concepts of Agent and Multi-agent Systems"

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Introduction

The concept of n intelligent agent is a concept that is born from the area of artificial intelligence; in fact, a commonly-accepted definition relates the discipline of artificial intelligence with the analysis and design of autonomous entities capable of exhibiting intelligent behavior. From that perspective, it is assumed that an intelligent agent must be able to perceive its environment, reason about how to achieve its objectives, act towards achieving them through the application of some principle of rationality, and interact with other intelligent agents, being artificial or human [1]. Multi-agent systems are a particular case of a distributed system, and its particularity lies in the fact that the components of the system are autonomous and selfish, seeking to satisfy their own objectives. In addition, these systems also stand out for being open systems without a centralized design [2]. One main reason for the great interest and attention that multi-agent systems have received is that they are seen as an enabling technology for complex applications that require distributed and parallel processing of data and operate autonomously in complex and dynamic domains.

In the area of AI (Artificial Intelligence), agent oriented technology has been introduced a new paradigm for analyzing, designing and developing independent & reusable software components. Agents are sophisticated entities that act autonomously and proactively on behalf of their users. They are used to solve a growing number of complex problems across open and distributed environments [31]. An agent refers to a component of software and/or hardware that is capable of acting in a certain way to accomplish its tasks and/or goal on behalf of its users. Ferber [18] proposes the following definition that something can be called an agent if it is a physical or virtual entity that follows following characteristics.

- An agent is able to act in an environment.
- An agent can communicate with other agents.
- An agent is driven by a group of tendencies.
- An agent has its own resources. .
- An agent is able to perceive its environment (in a limited way).
- An agent has a partial representation of its surrounding environment (and possibly none).
- An agent has skills and offers services.
- An agent may be able to reproduce.
- An agent acts to satisfy its objectives, by taking account of the resources and skills that it possesses, and according to its perception, of its representations and the communications that it receives.

Research Methodologies

Within the framework of artificial intelligence, multi-agent systems have been characterized by offering a possible solution to the development of complex problems with distributed characteristics. When approaching the development of multi-agent systems, there is undoubtedly a significant increase in complexity, as well as the need for adapting existing techniques, or in some situations, developing new techniques and tools. In recent years, different works have appeared trying to propose new processes and techniques for the development of multi-agent systems [3]. The construction of MAS integrates technologies from different areas of knowledge: software engineering techniques to structure the development process; AI techniques to provide systems with the capacity to deal with unexpected situations and to make decisions, and concurrent programming to address task coordination executed on different machines under different scheduling policies. Due to this mix of technologies, the development of MASis complicated. In this sense, during the last few years, there have been different development platforms and tools that provide partial solutions for the modeling and design of agent-based systems [4].

A Multi-agent System (MAS) is a loosely coupled network of software agents. These agents interact to solve problems that are beyond the individual capacities or knowledge of individual problem solver. One of the current factors fostering multi-agent development is the increasing popularity of the Internet. It provides the basis for an open environment where agents interact with each other to reach their individual or shared goals. Agents are autonomous entities capable of carrying out specific tasks by themselves or through cooperation with other agents. The multi-agent system is best suitable for autonomous, loosely-coupled, heterogeneous and distributed systems. Such systems need to interoperate in order to achieve a common goal. Multi-agent systems offer a decentralized model of control. They use message passing mechanisms for communication purposes and are usually implemented from an object-oriented perspective [30]. The term multi-agent system can also be used to describe all types of systems composed of multiple autonomous components displaying the following characteristics [20]:

- Each agent has inadequate capabilities to solve a problem;
- There is no centralized system control; data are decentralized; and
- Computations are asynchronous.

Some of the multi-agent system based applications are education, workflow management, network management, air-traffic control, digital libraries, personal digital assistants, business process engineering, e-mail filtering, information management, data mining, electronic commerce and many more. Agents can share knowledge using any agreed language, within the limitations of the system's communication protocol.

Conclusions

As it has been possible to observe throughout the analysis carried out on the accepted articles, research on MAS continues to provide technological solutions in a wide variety of domains. MAS researchers develop new advances that allow the development of more powerful, flexible, and adapted systems that allow predicting a fruitful future. This Special Issue of Applied Sciences gives us a precise view of the area covering different hot topics. The high number of submissions and the quality of the selected works gives us an idea of the potential of the multi-agent systems area and their excellent health after more than two decades of research. In this way, the main goal of this Special Issue is considered to be more than reached, which has allowed us to extend it to new editions to continue disseminating high-quality works in this area.

Reference

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