A Comprehensive Analysis on Multi Agent Decision Making Systems

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Abstract

Background/Objectives: To analyze and find the decision making systems in multi agent capable of solving complex problems. **Method/Statistical Analysis:** Multi agent systems are the collection of many individual intelligent systems. Decision making is important because a multi agent system consists of many agents that may be homogeneous or heterogeneous. In heterogeneous network agent must trust another agents in the network for sharing of messages. Hence an agent must be capable to make decision towards trusting of neighbor agents. Decision making technique plays an important role to make decision in such a situation. This is one scenario. Multiple scenarios are discussed in this paper towards the decision making capability of multi agent systems. **Findings:** In this research, the study of multi agent system, problem solving and decision making are considered as the two important concepts. Multi agent systems are capable of interacting with different environments like virtual environment or real time environment. In this paper a survey is done towards the decision making capability of multi agent systems. **Applications/Improvements:** The results from this work serve as the motivation to apply the future implementation of multi agent decision making in the complex problem solving.

Keywords: Multi Agent Systems, Decision Making, Environment, Agents, Trust, Problem Solving

1. Introduction

1.1 Multi Agent System

Multi agent system is composed of many intelligent agents capable of interacting with different environments. The agents may be an obstacle, a robot or a human being. The environment may be virtual environment or a real world. The best example is interaction of human in gaming where human is an agent and the gaming application is a virtual environment. Intelligent agents communicate by means of sensors and actuators that they receive information though sensors and reply by means of actuators to the environment. Multi agent systems are capable of solving of complex problems which cannot be done by individual agents[1-3]. Multi agent systems are combination of both heterogeneous and homogeneous systems. Agents in this type of systems have peculiar characteristics. Some agents are independent that they are capable to take decision independently. Some agents have only local view within the system. There are no controlling agents in the multi agent systems. Multi agent systems are important in an organization since different tools are used for software development in IT corporate sectors[4].

All those tools are confined within architecture to support the organization by means of multi agent systems. Information is shared by means of connecting all those agents in a network either globally or locally within an organization.

The environment is classified depending upon many properties such as accessibility, determinism, dynamics, discreteness etc. The classification is made since environment will be depending upon these properties. There may be agents containing entire information about the environment[5-8]. Some information may affect the entire environment or any single change can affect the environment. Some may discuss about the active entities in the environment. Time influencing environment is also present. Multi agent systems have more advantages in terms of feasibility, fault tolerance, time saving, standardization, problem solving capabilities. Multi agent systems are also called as self-organization system[9-11]. There exists coordination among agents without any control agents. An important behaviour of multi agent system is 'pheromones'. Pheromone is a character that an agent leaves information for another agent.

1.2 Decision Making

An important factor to be considered in multi agent system is decision making. Decision making is a technique which has only two answers yes or no. Decision making selects one solution among alternative[12-15]. The solution depends upon certain criteria. Conditions are present to choose certain criteria. If the condition is satisfied then yes will be chosen otherwise an alternative is chosen. It is knowledge based process (cognitive process) since one is chosen among alternatives. Generally problem solving is done first then followed by decision making strategy.

It is believed that information gathered in problem solving helps in decision making. Decision making must be done with proper planning otherwise leads to total failure of the system. Planning is important because decision making depends upon certain condition value. Only when condition is satisfied further proceeding must be carried out. So condition defined must be properly checked for success of the system[16-19]. A system must be designed in such a manner that it have both problem solving and decision making strategies.

Such systems are said to be efficient. When a problem occurs during execution of a system it must be capable of solving it automatically and that problem must be solved by certain condition. In such situation decision making plays an important role.

2. Multi Agent Decision Making System

Since decision making is important for all systems it is needed for multi agent systems too. Decision making are of different types in multi agent systems. Some of them Trust based decision making, collaborative decision making, local decision making approach, decentralised decision making etc[20-23]. In multi agent system many number of agents are present. It may be homogeneous agents or heterogeneous agents. Information is shared among agents within the network. For example - A named agent is not familiar with B named agent but it has to share its information in an authenticated manner. Decision making plays an important role over there. A named agent must decide whether to share its information with neighbour agent or not. Several algorithms, mathematical models are designed for decision making in multi agent system. Some of them are discussed in this paper.

2.1 Trust Decision Making

In this type of decision making, agent within the network must trust the neighbor agent in terms of evidence and confidence provided. Trust is provided by means of sources, provided from previous experience of agents which has already shared information with that agent. If no such experience is present then from third party the information about that agent is gathered[24-26]. Another method of providing trust is comparison of two agents. Confidence is defined by the information provided in terms of trust. Certainty provides correct and complete information. Evidence is a combination of information gathered from sources. The information obtained from experience consists of both positive and negative comments. In system architecture two agents are used namely evidential agent and evaluation agent. Evidential agent collects information from the environment and evaluation agents provide confidential values.

2.2 Graph based Decision Making

In this type of decision making, graphical structures are used to represent the multi agents. In graphical representation, agents are considered as vertices. For example consider a hacker tries to hack a network. Hackers try to attack the nodes which have more benefits. Thus by calculating the weight of each node, benefits of each node can be determined. Weight node may be a server or any

important agent. Once this node has been hacked then information about a particular network can be easily found[27-29]. Generally multi criteria decision making problem have several desired factor like decision maker, alternatives, criteria etc. In multi criteria decision making problem an alternative is chosen that satisfies a set of criteria, then by applying aggregation a best alternative is chosen among them.

A new technique called Fuzzy graph based multi agent decision making (Figure 2) (FGMADM) has been introduced. FGMADM is alternative to GMADM. FGMADM is applicable where graph become uncertain. There are two criteria in FGMADM. First, weights of nodes are known. Secondly, weights are not known. In such case depending upon information known and benefits of nodes weight of nodes can be determined[30-32]. When weight is calculated then overall benefit of plan executed by the hacker can easily identified by FGMADM. A real time example is where in an IT company many projects are assigned and there are three priorities. By applying FGMADM the best project is chosen among the priorities.

3. Open Challenges

Though decision making approaches are made for multi agent systems (Figure 1) still there need optimization for decision making approaches. The existing approach does not provide cent percent efficient result in decision making of multi agent systems[33-35]. An effective decision making approach with optimization must be provided so that fault related to time will not occur. Time and cost efficient decision making approach must be developed to make multi agent system more successful.

4. Motivation

These problems are used to take many optimized techniques in different solutions in an easier manner and also multi agent systems are used to choose the right decision with the helps of using some multi agent techniques for enhancing the performance of a system. Multi agent system consists of agents and environment in which agents are used to perform an intelligent task because it is an intelligent behavior and it used to find an correct decision of any tasks. And agents are used to increase the utility systems. These are the performance of multi agent systems and it helps to motivated us to do the survey on a multi agent systems.
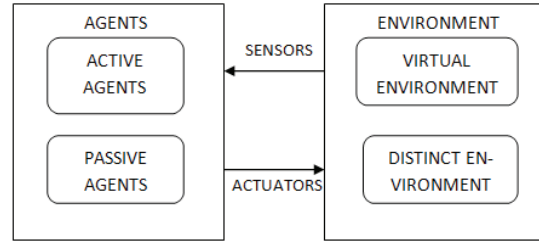

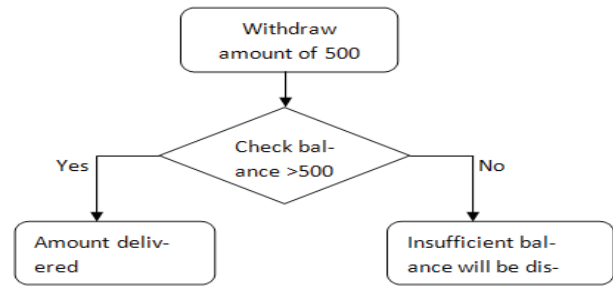**Figure 1.** Interaction of multi agents with environment.

Figure 2. A example decision making strategy.

5. Organization

The remaining content of this paper includes multi agent decision making systems it describes how problems are helps to take decision with the help of multi agent systems. Another section contain open challenges[36] it is used to describe the various problems are solved by using multi agent system concepts. Finally total conclusion of this paper is described in conclusion part.

6. Conclusion

There exist both advantages and disadvantages in traditional decision making approaches. So far framed approaches are good but not much efficient. An efficient methodology must be developed to make faster evaluation of decision making. Among the proposed methods graph based decision making have more advantages and the decision can be made quicker. Trust decision making method also improves confidentiality of agents. With increased confidentiality decision can be made faster.

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