A Trust Case–Based Model Applied to Agents Collaboration

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INTRODUCTION

The interaction among people as well as the interaction among systems can, at times, be seen from similar perspectives. People and systems construct their relationship network supported by information. People have the ability to retain information about things and, based on that, pursue their requirements. Computational systems can also function in a similar manner; however, this is highly dependent upon how they were created. As time passes, a person may lose contact with someone or develop stronger ties if they see this relationship as favorable. Systems and agents can also cease to relate to other systems or start new relationships, but, for this, actions external to the agent or system may be necessary.

One of the feelings that can bring comfort to interpersonal relationships is trust. Based on this feeling, people allow other people they trust to participate more frequently or intensely in their lives. The relationship between two systems is treated here as collaboration, where each agent, according to its computational purpose, executes operations requested by other agents. Computational systems, however, can have difficulties in evaluating their collaboration with other systems. Quantifying collaboration as appropriate or detrimental can require complex algorithms and several exceptions to a given rule. The proposal presented here suggests the creation of a method which evaluates the relationship between two agents to generate a rating, called *general trust rating*.

All collaborations between agents are unique and generate equally unique results. These results can be seen as a history of the collaboration between agents. This history is rich in information which can be used to underpin the generation of a trust rating. For this, the information has to be stored. The more information that is stored, the more complex the process of extraction has to be. Due to this, a Case-Based Reasoning approach is used to store this information. The collaboration between agents generates a new case in the case database, which comprises the history of this collaboration. Whether this is beneficial or not for the agent can be concluded by reviewing the whole collaboration history. By using the method developed, the correlation of this history can be quantified, generating a trust rating.

This paper presents a method which was developed to quantify the relationship between agents through the generation of a rating. As in human relations, agents may have a high degree of trust in other agents when the relationship is analyzed from a wider perspective. Nevertheless, the agent is likely to have a different trust rating for specific activities due to the environment it is exposed to or to its purpose. In order to allow this differentiation, the proposed method uses case-based reasoning for each collaboration request to find similar previous collaboration. It selects from this base of previous collaboration cases those that were similar to the current demand, generating a situational trust rating for it. The weighting of the situational with the general trust rating allows

evaluating the collaboration considering a particular situation as well as the history of collaboration between the agents.

In the following sections first we present some related work and how the important points are set in the proposed method. Then we illustrate how the method was implemented, where functionalities are separated into modules so as to provide segregation and isolation of these functionalities: we present the tests that were run and the obtained results that corroborate the efficiency of the method. Finally, we present our conclusions and some future work we have planned.

BACKGROUND

Related Work

The conceptual definition of an autonomous agent is understood as being something that perceives its environment through sensors (physical or virtual) and acts upon this environment through effectors (Russel & Norvig, 2003). These effectors can resolve problems or determine actions, acting on the environment to carry out sets of goals or tasks for which they were designed.

A multi-agent system (MAS) consists of a group of agents hosted in an environment where autonomous agents collaborate with other agents for solving problems (Challenger et al., 2016). Agents can be competitive - when an agent attempts to maximize its performance measures over those of other agents - or cooperative, when the agents function in such a manner that they complete their goals and tasks through the knowledge of other agents.

MAS are exploited in several contexts nowadays to provide e-services, as e-Commerce, e-Learning and so on. Those systems are distributed across the internet and are hosted by different companies or structures. Thus, they have a decentralized control and are subject to constant changes during their operational life. The relationship between these systems requires the existence of components that can interact flexibly in dynamic and uncertain environments, with the ability to meet their goals or complete their tasks. (Buccafurri et al., 2014).

In both forms of relationship between agents - cooperative and competitive - it is necessary for the agent to have knowledge of the behavior of those agents with which it has a relationship. This necessity becomes of greater importance when the relationship between the agents occurs in open MAS, given that the differences in structures or controls can impact directly on the task results.

Collaboration Between Agents

The collaboration between agents can be defined as the division of a global task, decomposed into a number of agents' subproblems that can be solved efficiently based on the collaboration of agents (Hsieh & Lin, 2014). This definition makes it possible to understand that collaboration between agents has direct impact on the final result of a task.

Even when two agents have exactly the same purpose and receive exactly the same demand, the outcomes can be different. In addition, since they may have different knowledge, they can be hosted in different structures or have different relationships. It is important that, due to this, collaboration is made between agents that possess the best knowledge, the best performance and also the lowest error rate.

The possibility of interaction between ever wider and more disperse systems has resulted in the creation of numerous models of interaction, such as collaboration (Pynadath & Tambe, 2002) and negotiation (Kraus, 2001). However, the application of these models to open MAS has presented a major challenge; each agent can interact with agents of the same or of other categories. In the literature, various interaction paradigms have been defined. Agents can be competitive if they have conflicting objectives and cooperative otherwise (Barbati, Bruno & Genovese, 2012).

All of the interaction models created presuppose that the relationship between systems will result in a common objective and in the same level of information. Nevertheless, in practice, it is almost impossible to obtain an adequate level

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