Adaptive Collaboration Based on the E-CARGO Model

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ABSTRACT

Adaptive Collaboration (AC) is essential for maintaining optimal team performance on collaborative tasks. However, little research has discussed AC in multi-agent systems. This paper introduces AC within the context of solving real-world team performance problems using computer-based algorithms. Based on the authors’ previous work on the Environment-Class, Agent, Role, Group, and Object (E-CARGO) model, a theoretical foundation for AC using a simplified model of role-based collaboration (RBC) is proposed. Several parameters that affect team performance are defined and integrated into a theorem, which showed that dynamic role assignment yields better performance than static role assignment. The benefits of implementing AC are further proven by simulating a “future battlefield” of remotely-controlled robotic vehicles; in this scenario, team performance clearly benefits from shifting vehicles (or roles) using a single controller. Related research is also discussed for future studies.

Keywords: Adaptive Collaboration (AC), Agents, Role Assignment, Role-Based Collaboration, Roles

1. INTRODUCTION

Change is an eternal phenomenon of the world. Adaptability is a special property that enables people to sustain themselves in dynamic environments. The often quoted “survival of the fittest” is a phrase which captures this law of nature. Collaboration is required in situations where one individual is unable to accomplish a given task by him/herself. In collaboration, structures, members, relationships among members, and environments are always changing.

To maintain good collaborative performance, high adaptability is required.

In human communities, even though individual interests are emphasized and personal property is protected, we still emphasize team interests through the use of teamwork. That is to say, pursuing the highest team performance is a stronger requirement than pursuing individual interests. The social axiom followed by adaptive collaboration states that every person hopes to become a great member in a great team. For example, to be a member of the National Basketball Association (NBA) team is the ideal scenario for most basketball players in the world, and likewise, to be a member of the National
Hockey League (NHL) team is ideal for most hockey players in the world. After members join a team, their common goal is to maintain the significance of the team. They must adapt to and pursue the highest performance. The team members want to adapt to the team, but in reality the system often does not allow individuals to adapt since they must follow the commands of the team’s management.

With the help of computers, desired adaptability of a team, i.e., desired teamwork, should be easy to achieve. In other words, computer systems should assist people to adapt to the team by pursuing higher team performance in the interests of the initiating individuals (Kerr & Tindale, 2004).

It is essential for a person to be adaptive within a team, since optimal team performance can only be achieved when everybody within the team contributes at their highest potential. Ultimately this will require individuals to adapt and change their existing behavior. This is why traditional research on adaptation focuses on the adaptability of individual agents (de Wilde et al., 2003; Picard & Gleizes, 2003; van Splunteret et al., 2003) and the adaptability of machines to individual users (Atterer et al., 2006; Brusilovsky & Millán, 2007; Fischer, 2001; Gena, 2005; Hou et al., 2007a, 2007b; Jameson, 2003). However, true adaptive collaboration concentrates on the adaptability of the team as a whole.

Team adaptation includes many aspects, such as team structure and individual adaptability. It reflects the ability of the team to work, live, socialize, and compete. Team adaptability is dependent on its organization, structure, culture, and regulations. Many factors affect collaborative performance in a team, such as culture, interests, personalities, health, equipment, hardware resources, benefits, abilities, powers, motivations, and situations. These factors present a big challenge for researchers of man-machine systems and collaborative technologies by making it difficult to optimize team performance in a timely fashion.

Regulating people and agents to gain better team performance is no doubt an essential function of multi-agent systems and adaptive systems (Atterer et al., 2003; Berman et al., 2003). However, there is little research that considers team performance in traditional intelligent systems and multi-agent systems. Adaptive collaborative systems are required to take advantage of the complex interactions of people, agents, and computers in teams. Adaptive Collaboration (AC) is one way to meet this requirement. AC dynamically adjusts teamwork according to changing collaboration situations. An evident phenomenon fostering AC can be observed in basketball or soccer games, where shifting players correctly in time causes a team to win.

Role-Based Collaboration (RBC) is an emerging computational methodology that facilitates an organizational structure, provides orderly system behavior, and consolidates system security for both human and non-human entities that collaborate and coordinate their activities with or within systems (Zhu & Zhou, 2006). The life cycle of RBC includes three major tasks: role negotiation, assignment, and execution. Therefore, role assignment is an important aspect of RBC. It largely affects the efficiency of collaboration and the degree of satisfaction among members involved in collaboration. Adaptive collaboration assumes that agents (members in a team) have the ability to transfer roles.

This paper concentrates on the intersection of the second and third parts during which adaptation often occurs, i.e., role assignment and role execution. The assumption is that the set of agent qualifications for roles is changing. Dynamic role assignment affects role execution from the viewpoint of team performance.

The remainder of this paper is arranged as follows: Section 2 discusses a real-world problem; Section 3 revises the Environment-Class, Agent, Role, Group, and Object (E-CARGO) model in order to formalize the problem of adaptive collaboration; Section 4 specifies team/group performance and related parameters; Section 5 defines the procedure of AC; Sec-
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