Modeling Agent Interactions using Common Ground Knowledge from a Joint Activity Theory Perspective

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ABSTRACT
Believability is necessary for agents to establish intimate, real-time collaborations with humans in an interactive game environment. In this paper, the authors model sophisticated interaction patterns to improve believability by adapting Herbert Clark’s joint activity theory. The authors use virtual basketball as an environment, where many communicative scenarios occur and common ground knowledge of collaborative actions such as passing is necessary. The authors have completed preliminary implementation of the agents through the use of a unique computational model based on common ground, and evaluations of basketball simulations have been made with respect to believability scenarios.

Keywords: Agents, Believability, Collaboration, Human-Computer Interaction, Joint Activity Theory, Virtual Environment

1. INTRODUCTION
In the context of cognitive computing, agents represent a vital evaluation tool, allowing us to test theories in the field. If our goal is to use artificial systems to represent human processes, then interactive agents are required. Not only should we consider simulating the internal mechanisms of human logic, but also external expressions. In this case, the goal is to develop embodied conversational agents (ECAs).

Although research into ECAs has been undertaken by numerous researchers, we are still a long way off from realizing agents which behave in a way that is believable to a human. Clearly, this is not a trivial task. When we state that we want agents to be believable, we generally take the definition provided by Bates (1994), who stated that a believable character is “one that provides the illusion of life”. De Rosis et al. (2003) also argue that believable agents act consistently

DOI: 10.4018/ijssci.2013100101
towards its goals, state of mind and personality, while Ortony (2003) also claims that behavioral consistency in similar situations contributes towards believability. These appear to be satisfactory definitions for our use. Also important is the distinction between believability, realism and intelligence. Avradinis, Panayiotopoulos and Anastassakis (2013) argue that realism refers to creating reconstructions of the physical world which are high fidelity, which includes the appearance of agent characters. This differs from believability, where characterization is more important. In terms of intelligence, Loyall (1997) stated that agents need not be intelligent to display believability. An agent’s behavior may be somewhat unintelligent, but if this is consistent with their characterization, then believability is high.

It would appear that we still do not acknowledge ECAs as having the capability to think and reason like a human. On the other hand, consider other forms of virtual characters such as those in movies or video games, which possess qualities that make us believe their intentions and motivations. Of course, the key difference between ECAs and animated characters is the interaction aspect. ECAs are designed for real-time interaction with humans while animated agents are mostly prepared beforehand.

So we are left with two groups of somewhat contrasting agents. Interactive but with low believability (ECAs) and believable but with low interactivity (animated characters). The obvious approach is then to bridge these two factions. Animated agents have the advantage of being able to effectively communicate a mental model of their world. We can observe their world through a screen interface, enabling us to understand their motivations and subsequent behavior. With ECAs, this is not possible so we discover it during interaction. Figure 1 provides a general overview of our research motivation. Our aim is to increase the believability of interactive agents through cognitive communication modeling.

If the goal of cognitive computing is to simulate human internal processes, it needs to be based on a model. While a unified model is unlikely to be suitable for all situations, abstractions are useful. Mathematical models may be useful in some situations but real-world decision-making processes are not geared towards making the most rational or mathematically optimal solution.

Figure 1. Conceptual diagram of state of the research and long-term research goal
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