Dynamics in Transition Mental Activity

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Abstract

The scene is set now for computer modelers to take over and highlight the shape and accessibility of the reactive mental sites.

Until recently, attempts to model artificial agents had to take account of every functional unit in every architecture.

The dynamics of mental states events is crucial to design agents because we need to rethink the role of mental states when tuning behaviours. Tiny changes to the shapes of these states make a big difference to what agents do, and only by inspecting how states interact we may find the most suitable structures and mechanisms for the mental activities.

The paper presents how dynamics in transition mental states to agents' behaviour results from a set of properties and laws governing combinations of mental states. These agents can have mental states (beliefs, desires, intentions, expectations) and the activities of these mental states occur in the context of an agent architecture. This architecture, called SEM (Society of Mental States), is a nest of four sub-agents built around beliefs, desires, intentions and expectations.

The characteristics of such agents are defined from the beginning as a basic set of desires, expectations, actions and beliefs,which is also made of strategies to interact with other agents and the world, as well. The interactions of such agents are the result of their mental states' dynamics and their actions, as we show in the paper. Namely, in order to have a pair of agents with tutor and learner behaviours it is only necessary to specify their mental states.

By inspecting the basic machinery of mental states it is possible understand how the relationships among mind and behaviour work [9] and therefore re-design better agents. The whole idea behind this mental choreography is based upon the interactions of two major spaces, the one of mental states and the one of agent architectures.

We know, for example, that among the key components of the mental states of an agent are attributes such as situation, unsatisfaction, uncertainty or urgency, which act as infons of the Situation Theory [8] to assemble particular types with the help of certain laws and controls [4]. Tiny changes of these ingredients can make a big difference to what they do, a different reaction begins to take place, or perhaps the process shuts down completely.

The definition of these mental states in the context of SEM architecture[3] is based upon the Theory of Situations [1,8]. We argue that the ontological commitment of Situation Theory makes it very adequate for the agents' theory and also very promising to the development of actions' theory as pointed by Cohen and Levesque[1990]. In order to program agents we adopt the computational model to this theory as proposed by Nakashima et al. [1988] and discussed by Corrêa and Mendes[1995].

The SEM architecture is a generic architecture of autonomous, deliberative and cognitive agents whose ultimate feature is the following: the agent's specification is made in terms of four mental states, desire, belief, intention and expectation. The agent's behaviour is based on the fact that the only thing the programmer has to do is to specify the agent's mental states. It is also an advantage upon BDI architectures because the inclusion of expectations which enables a bigger flexibility, thoroughness, and more complex behaviours.

The combination chain among these mental states produce other desires, beliefs, expectations and intentions which will cause the agents' actions. These combinations happen dynamically according to the mental states properties presented in Corrêa and Coelho[1997], where a framework is defined to allow other possible mental states beside the ones above stated, and also a higher number of properties.

A previous work applying the SEM architecture on ITS [10] covered the three following situations: 1) a conversation where the agents agree on the knowledge and discuss a method for the solution of the problem; 2) a situation where the agents have distinct knowledge about the problem and have to agree on the knowledge involved in the solution of the problem; 3) a dialogue where one of the agents intends to talk about a specific problem and the other is not interested or does not have the necessary knowledge to co-operate. These three situations allowed us to understand the dynamics that occurs when we run models of mental reactions.

The way the mental states change and interact is carefully controlled, in a similar way to what occurs now with artificial chemical reactions [7]. Our modeling studies showed that it is possible to simulate agent's actions and analyze their behaviours when switching between states. The interplay among a theory, architectures and an agent programming language is responsible for that choreography.

Our approach to specify the architecture of agents based only upon the specification of their mental states, differs from other DAI methods, mostly dependent on functional modules. On the other hand, the SEM architecture was very adequate for this approach because it works on the assumption that an agents' autonomous behaviour in a society comes from their mental states, in particular: beliefs, desires, intentions and expectations.

The use of the Situation Theory enabled a more granular representation of the mental states increasing the power of interaction explanation by promoting a better evaluation of the changes occurred in conversations. This means that the organization of agent dialogues is already implicit.

The key points of this modeling effort are the definition of their mental states and of the causal relationships among these mental states and the agents' actions. The definitions of actions and strategies are modular within this approach, i.e. they may increase their capabilities through gradual programming. The refinement of the mental states specification and their dynamics, as presented in the paper, is a very promising direction for modeling agents and for explaining how and why they interact in a certain way in some world.

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