Chapter 2.31
Mascaret:
A Pedagogical Multi-Agent System for Virtual Environment for Training

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ABSTRACT

This study concerns virtual environments for training in operational conditions. The principal developed idea is that these environments are heterogeneous and open multi-agent systems. The MASCARET model is proposed to organize the interactions between agents and to provide them reactive, cognitive and social abilities to simulate the physical and social environment. The physical environment represents, in a realistic way, the phenomena that learners and teachers have to take into account. The social environment is simulated by agents executing collaborative and adaptive tasks. These agents realize, in team, procedures that they have to adapt to the environment. The users participate to the training environment through their avatar. In this chapter, we explain how we integrated, in MASCARET, models necessary to the creation of intelligent tutoring system. We notably incorporate pedagogical strategies and pedagogical actions. We present pedagogical agents. To validate our model, the SÉCURÉVI application for fire fighters' training is developed.

INTRODUCTION

This study concerns the design of virtual environments for training (VET). We want to immerse learners in their professional environment simulated using virtual reality techniques. This enables them to manipulate the environment so that they can *"learn while doing"*. This idea is driven by the "constructivism" paradigm defined by Piaget (1978) and can find a good implementation in virtual reality techniques as presented by Burdea and Coiffet (1993). Our definition of virtual reality is the one proposed by Tisseau (2001), who proposes to give autonomy to models evolving in the virtual environment by giving them the "triple mediation of senses, decision and action". So, the main developed idea is that virtual environments for training are heterogeneous and open multi-agent systems. Those multi-agent systems (MAS) had been presented by Demazeau (1995) using the *VOWELS* model considering a MAS with four vowels: **A**gent, **E**nvironment, **I**nteraction and **O**rganisation. It also has been use for collaborative work simulation by Clancey (2002). We consider the user of a virtual environment as other autonomous agents because he or she can interact with the environment and with other agents or users in the same way. Then, as Tisseau, we propose to add a last vowel, the letter **U** for **U**ser, in the *VOWELS* model.

Our goal is to provide an agent-based model to create a virtual environment for training (VET) integrating an intelligent tutoring system (ITS) in order to provide students with dedicated tutoring. ITSs are based on four models (Woolf, 1992): domain model (Anderson, 1988), learner model (Self, 1988), pedagogical model (Wenger, 1987) and the interface model (Miller, 1988).

Comparing to STEVE (Rickel & Johnson, 1999), which is a mono-agent system based on a virtual tutor, we propose a multi-agent system where each entity can contribute to the pedagogy. Moreover, pedagogical skills are not imposed by our model; they are viewed as knowledge items

manipulated by agents. These elements provide flexibility and adaptability to our VET. In Lourdeaux, Fuchs and Burkhardt (2001), HAL is a pedagogical agent (based on a pedagogical model) helped by environment-agent and scenario-agent responsible to the detection of the learner actions and intentions. The present work goes further; it takes into account all the ITSs models and both the learner environment (physical and social context) and the pedagogical one are considered as a multi-agent system.

A major issue in multi-agent system is the definition of agents' interactions. In our case, interactions have to be flexible and controlled by pedagogy. Therefore, we propose a model centred on the concept of organisation, which permits to structure these interactions. We show that information about organisation can also structure knowledge upon classical ITS models and thus allows agents to make pedagogical decisions.

After an overview on ITS models, we present our *MASCARET* model (multi-agent system for collaborative adaptive and realistic environment for training). We start by defining a generic model, which is then derived to represent the different types of interaction in our VET. Next we explain how the different models of ITSs are taken into account by pedagogical agents, defining therefore the pedagogical organisation. Finally we briefly present the application of *MASCARET* to a firefighter training environment: *SÉCURÉVI*.

INTELLIGENT TUTORING SYSTEMS

Intelligent tutoring systems (ITS) are computer processing systems for training incorporating communication techniques of knowledge and skills. They were conceived from the combination of interactive learning environments (ILE) and artificial intelligence (AI) techniques. Such systems were developed with the objective to adapt speed and level of the knowledge representation to the student's needs. The system uses an

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