Chapter 7.30
Educational Geostimulation

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ABSTRACT

In this work we will describe EGA (educational geosimulation architecture), an architecture for the development of pedagogical tools for training in urban activities based on MABS (multi-agent based simulation), GIS (geographic information systems), and ITS (intelligent tutoring systems). EGA came as a proposal for the lack of appropriate tools for the training of urban activities with high risk and/or high cost. As a case study, EGA was used for the development of a training tool for the area of public safety, the ExpertCop system. ExpertCop is a geosimulator of criminal dynamics in urban environments that aims to train police officers in the activity of preventive policing allocation. ExpertCop intends to induce students to reflect about their actions regarding resources allocation and to understand the relationship between preventive policing and crime.

INTRODUCTION

Simulation aims to represent one phenomenon via another. It is useful to measure, demonstrate, test, evaluate, foresee, and decrease risks and costs. Computational simulation can be considered as experimentation based on a computer model that provides a safe experimental environment for the inquiry of system properties. In educational terms, simulation is important because it allows learning through the possibility of doing (Piaget, 1976). Simulation has proven to be a good teaching tool, especially for complex situations, with high cost and risk. Practical application can be seen in various areas, such as in the aeronautical industry, nuclear industry, space exploration, petrochemical industry, and military research (Roger, 1994).

Multi-Agent paradigm has been widely adopted in the development of complex systems. In

particular, if there are heterogeneous entities or organizations with different (possibly conflicting) goals and proprietary information, then a multi-agent system (MAS) is useful to handle their interactions. A MAS is also appropriate whenever there is a need to represent each entity of the modeled domain individually or if these entities have an intelligent behavior to be modeled.

Social or urban environments are dynamic, non linear, and made of a great number of interacting entities, characterizing a complex system. The use of MAS to simulate social environments has become broadly used (Billari & Prskawetz, 2003; Gilbert & Conte, 1995; Khuwaja, Desmarais, & Cheng, 1996). Aggregating a GIS (geographical information system) to an MAS in the simulation of social or urban environments characterizes geosimulation (Benenson & Torrens, 2004). With the computational development of GIS, bringing precision and realism to simulation (Wu, 2002), multi-agent based simulations (MABS) benefited from them in terms of geographical representation of the areas to be simulated.

Analyzing the existing proposals and tools, and in accordance with Gibbons (Gibbons, Lawless, Anderson, & Duffin, 2001), there are few or even no adequate tools for developing educational computer systems where intelligent agents support the interaction between the simulation model and the user. Despite recent proposals on new models and implementations of instructional layers in simulators (Gibbons et al., 2001; Mann & Batten, 2002), few tools have been created specifically for urban activities, none of them with adequate support to the education process.

This chapter describes the educational geosimulation architecture (EGA), an architecture for training in urban activities based in the synergy among MABS, GIS, and ITS (intelligent tutoring systems) that we consider an optimal and complementary set of technologies for building educational geosimulation. We also describe the ExpertCop system, a training tool developed for the area of public safety based on EGA. ExpertCop is a geosimulator of criminal dynamics in urban environments, which aims to train police officers in the activity of preventive policing allocation. ExpertCop intends to induce students to reflect about their actions regarding resources allocation. Assisting the user, the pedagogical agent aims to define interaction strategies between the student and the geosimulator in order to make simulated phenomena better understood.

This software, based on a police resource allocation plan made by the user, produces simulations of how crime behaves in a certain period of time based on the defined allocation. The goal is to allow a critical analysis by students (police officers) who use the system, allowing them to understand the cause-and-effect relation of their decisions.

With the aim of helping the user to understand the causes and effects of his/her process of allocation, ExpertCop uses an intelligent tutorial agent provided by the architecture endowed with strategies and pedagogical tools that seek to aid the user in understanding the results obtained in the simulation. The agent offers the student a chronological, spatial, and statistical analysis of the results obtained in the simulation. Using a machine learning concept formation algorithm, the agent tries to identify patterns on simulation data, to create concepts representing these patterns, and to elaborate hints to the student about the learned concepts. Moreover, it explores the reasoning process of the domain agents by providing explanations, which help the student to understand simulation events.

ExpertCop was applied in a set of training classes, making it possible to analyze its effectiveness quantitatively as an educational tool.