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Training for crisis decision making – An approach based on plan adaptation

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ABSTRACT

The human ability to take the right decisions is very important in real world critical situations. An interesting problem always worth being investigated concerns how to teach decision making skills to humans. The real nature of taking decisions is extremely difficult to describe in detail and, as a consequence, training it according to fixed protocols is also challenging. This is because it comes out as a combination of natural talent, competence from previous experience, ability to quick reasoning, leadership, resilience to stress, and so on. We have addressed this problem while building a new learning environment to train crisis decision makers.

The environment, called PANDORA, is grounded on Artificial Intelligence planning techniques known as "timeline-based". This technology is used to create and manipulate segments of lesson's content over time. Planning a lesson corresponds to logically organize events over time that are then rendered in front of trainees during the lesson's actual enactment. This paper shows how the machinery of continuous plan adaptation is functional to create variety and novelty in the lessons thus engaging the trainees during the teaching interaction. In particular, it shows the different uses of plan adaptation to take into account the basic reactivity of the trainees, the background deductions from user modeling, and the mixed-initiative interactions guided by the trainer.

1. Introduction

This paper presents an intelligent support system, based on Artificial Intelligence (AI) techniques aimed to facilitate *training of decision makers* in crisis scenarios. Specifically, the context of work is the management of crisis situations by *strategic decision makers*. Effective crisis management is a key requirement to prevent an emergency from becoming a disaster. Crisis events of different nature (e.g., policing and terrorism events, extreme weather, earthquakes, electrical power plant failure, water supply failure, pandemics, epidemics, containment conditions, breakdown of automated control systems, central services, etc.) appear to occur more and more frequently and public expectation for an effective and immediate response grows at a similar pace.

In order to manage these critical circumstances, there is a tremendous necessity to have effective *leadership* in place. Nevertheless, the ambiguity, urgency and high risk associated with crisis situations posits some constraint on the leadership capabilities. For example, given the need for an almost immediate and of course effective response to a crisis, there is little time to acquire and process effectively all the information that decision makers would wish to have available to them. As a consequence, they are required to assess information and make critical decisions under tremendous *psychological stress and physical demands* [1,2], often caused by the difficulty of operating in a context where losses, including both human lives and critical resources, continue to rise until such time as the response can get ahead of the developing crisis. In fact in these circumstances, an important component of the decision making also depends on personal human behavior and the ability to cope with the stress inherent within the challenge presented when operating in traumatic circumstances, particularly when unexpected consequences may also arise.

Within this context *decision making* largely depends on an effective *training*. A great amount of investment is being devoted to the development of training procedures to increase the capability of crisis managers to deal with emergency situations. Among the others, one of the most effective way to improve decision making ability is ensured by *experiential learning*, that is learning by "living the crisis conditions and the possible consequences of the taken decisions". Obviously, this type of learning can be very expensive and difficult to organize.

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This paper describes our effort to exploit AI technology in order to build an intelligent system able to support this type of learning, by reproducing a near-real training environment at affordable costs, allowing the decision makers to "live the crisis situations and exercise in taking decisions" in a simulated environment, thus minimizing the risk of failures in real circumstances.

More specifically, the PANDORA project[1] produced an intelligent system able to simulate all the dynamic elements usually contained in an entire disaster scenario within a training room setting that emulates an engaging, true-life environment. The system is able to present different evolving crisis scenarios, customized to meet specific training needs according to the knowledge and experience levels among the participating students and propose critical decision points to the class of trainees, also registering their decisions and the relative consequences for subsequent analysis.

A key aspect in PANDORA is the use of AI technology to create realistic consequence responses to the decisions taken by trainees thus reproducing realistic situations and facilitating the development of a comprehensive range of decision making skills based on "lived experiences". Additionally, the idea underpinning PANDORA is to take account of human behaviors, perceived stress and individual personalities in order to adapt training sessions to specific attitude and states of individuals.

Central to the PANDORA system is an original use of the timeline-based planning technology [3]. This AI-based technology has been used to both represent a lesson and to build user models on the base of which it is possible to personalize the learning experience.

1.1. Plan of the paper

Section 2 presents the main challenges surrounding the training of decision makers at the strategic level and the basic idea underlying our system. Section 3 shortly introduces the AI timeline-based representation and planning and introduces its use in PANDORA. Section 4 focuses on the added value obtained by using planning to support decision making and reproduce personalized training paths. Particular attention is given to the task of continuous plan adaptation. Section 5 presents first a complete session of usage in order to show the main functionalities of the system and then describes an evaluation made with real crisis managers and the obtained results. Section 6 analyzes similar works in the literature discussing their main difference with respect to ours, while Section 7 ends the paper.

2. Teaching strategic crisis decision makers

Training for crisis decision making strictly depends on the type of leaders we are considering. Specifically, three distinctly different levels of decision making exist each presenting different challenges, all of which are relevant for the crisis management.

More specifically, at the **operational level** we have the operational or **bronze level commanders**, people operating within the detailed area of a crisis situation who perform practical activities and actions, and whose results are monitored and communicated to higher levels.

At the **tactical or silver level** decision makers, who are located close to but not within affected areas of the crisis, are responsible for translating high level strategic decisions into actions by allocating tasks and resources down to the bronze level.

The **strategic or gold level** commanders identify the key issues of a critical situation and prioritize required activity from a detached, and sufficiently high, level of abstraction. Strategies for resolving the crisis are also decided and then communicated to the lower levels for their detailed specification and implementation.

Most of the state-of-the-art training (or decision) support systems and simulators are aimed at the operational or tactical levels. On the contrary, the PANDORA system is specifically targeted towards strategic level decision makers.

2.1. The reference problem: teaching crisis managers

Among the main objectives for gold commanders during a crisis are: protection of human life and, as far as possible, property; alleviation of suffering; support for the continuity of everyday activity; the restoration of disrupted services at the earliest opportunity; upholding the rule of law and the democratic process.

In this light, decision making at the strategic level is mainly unstructured and not describable in terms of programmed or fixed procedures, being mainly related to the novelty and unpredictability of a catastrophic event.

One approach to decision making promotes the need for a creative decision making process to identify and construct potential courses of action in response to an identified developing situation. These possibilities are then filtered and reduced to a set of feasible options. The process is gradually refined until alternatives are decided between and a specific (best or least worse) course of action is to be chosen that will be adopted to achieve the identified strategic aim.

To develop such an ability, training plays a fundamental role. At the strategic level, training aims to teach decision-makers to focus on the possible consequences of their actions. It also teaches the value of integrating and testing the compatibility of plans and the need to work in collaboration with other organizations and between different nations, to promote continuity of efforts and to have a well-defined focus.

Additional challenges arise from the need to foster quick decision making in *stressful* conditions and the need to encourage creative thinking to devise workable strategies to deal with uncommon situations. Overall the following specific requirements for the PANDORA system emerged: (a) *Support cooperative decision making*: it has become clear immediately how important it is to train gold commanders to take key decisions jointly in collaborative working conditions; (b) *Training personalization*: the role of personalized teaching has been underscored even within a group decision making context; and (c) *Mixed-initiative interaction*: the need to have a tool that empower the trainer to adapt and adjust the training session in real time also became a crucial requirement. In the next section we describe the general idea we have conceived to build a training system able to solve this reference problem, highlighting the "intelligent components" that are based on the timeline-based technology.

2.2. The PANDORA approach

In order to conceive an effective solution for the system design we worked in strict collaboration with the Cabinet Office Emergency Planning College[2] (EPC), an official training organization that delivers Cabinet Office-approved emergency planning and crisis management training. EPC provides a central forum for knowledge-sharing and focus on multi-agency working, disseminating best practice nationally and internationally to enhance worldwide resilience against natural disasters, major incidents and malicious attack. As the end user representative in the PANDORA consortium, EPC shared its long-lasting experience in providing a wide range of dynamic and diverse training courses, as well as real-time simulation exercises, transferring its knowledge in the training domain

[1] http://www.pandoraproject.eu/.

[2] http://www.epcollege.com/.