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Training Crisis Managers with PANDORA

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Abstract. This short paper introduces a novel use of timeline-based planning as the core element of a dynamic training environment for crisis managers called PANDORA. A trainer is provided with a combination of planning and execution functions that allow him/her to maintain and adapt a "lesson plan" as the basis for the interaction between the trainer and a class of trainees. The training session is based on the concept of *Scenario*, that is a set of events and alternatives deployed on a timeline-based system, that shapes an abstract plan proposed to trainees. Throughout a training session a continuous planning, execution, re-planning loop takes place, based around trainer observation of trainees and self-reporting by trainees, which provides analysis of both their behavioral and psychological changes. These, combined with the trainee decisions about what actions to take to manage the crisis, are used to maintain an updated model of each user. In addition the trainer has the ability to directly intervene in a training session to, for example, interject new scenario events. The training session is therefore managed through a combination of automated analysis of trainee behaviour and decisions, coupled with trainer input and direction.

1 INTRODUCTION

When a catastrophic event occurs, it is often human behavior alone that determines the speed and efficacy of the crisis management efforts. Indeed, all too often, shortcomings in the response to the emergency do not stem from the ignorance of procedures but from difficulties resulting from the individual response to the challenge of operating in such a context, particularly when additional unexpected problems arise. Crisis management is of major importance in preventing emergency situations from turning into disasters. The pressure of unexpected circumstances can test the decision making abilities of crisis leaders to the limit. As a consequence, they can be required to assess information and making decisions under significant psychological stress and physical demands, often caused by the difficulty to operate in contexts where consistent losses as well as damages both to human lives and property are occurring. Within this context, training plays a crucial role in preparing crisis managers. Specifically, training for strategic decision making has to foster leaders' ability to anticipate the possible consequences of bad decisions and to come up with creative solutions to problems.

The underlying idea for using planning within PANDORA is connected to the synthesis of a "lesson plan", that is an organized set of lesson's items called *events*, which are given to trainees over a span of time according to a given training strategy. A *user's psychological status* during the training is assessed through psychological self-assessment and physiological measurement, and is then represented by means of similar temporal items so as to insert also these data in a uniform structure and use causal connections between different part of such plan to foster the continuous update of the plan. A natural technology for achieving this task has been identified in the timeline-based planning, an approach to temporal planning which has been mostly applied to the solution of several space planning problems (e.g., [3]). We have synthesized and tested a comprehensive architecture, called the PANDORA-BOX, that makes use of planning in order to model number of domain features. We use planning to compute diversified evolutions of the crisis scenario. These correspond to alternative training paths which help foster creative decision making and thinking by the trainees. This allows us to model and maintain trainees' behavioral patterns according to which aspects of the training can be personalized, as well as to support mixed-initiative interaction between the trainer and the automated learning environment relying on a high level of abstraction for the internal representation.

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2 TRAINING THROUGH TIMELINE-BASED PLANNING

In generic terms, timelines can be seen as functions of time over a finite domain [3]. A single timeline contains a set of *tokens*, described through a predicate holding over a time interval. According to this model, the domain of each timeline depends on the type of events that the same timeline is going to represent. Tokens can be linked to each other through *relations* in order to reduce the permitted values for their constituting parameters and thus reducing the system behavior allowed. These relations, in general, can be represented by a logical combination of linear constraints among token parameters. Finally, we call *compatibility* the logic implication having a predicate signature as an implicant and a logic combination of timeline values and/or relations as implicates. The semantics of this are that each token having the implicant as a signature requires an implicated pattern inside the plan. We call the graph, having tokens as nodes and relations as edges, a *Token Network* and we say that it is consistent iff it respects the set of compatibilities. The token network can be used to represent plans therefore the task of the planner can be reduced to achieve a consistent token network having desired features called *goals*. A more detailed description of the underlying technology is given in [2].

3 INSIDE THE PANDORA-BOX

In PANDORA, temporally related tokens on a *Scenario* timeline are exploited to represent a lesson's content, e.g., different multimedia assets, that overall constitute the crisis plan, which is a collection of different multi-media "messages" that are sent to a group of trainees. Tokens can have consequences in terms of casualties, injuries, involved resources, etc., or they can simply represent information sent to a single trainee. Additionally, all the background information, e.g.,

lesson strategy, trainee classification (user model), evolution of on-field crisis resources, are represented as timelines in order to take advantage of both the uniform representation and the underlying functionalities provided by the technology. All these elements are composed through compatibilities organized so as to decide a proper orchestration of the messages. Trainees receive stimuli and take decisions. Thus, the plan must have the ability to adapt and update itself in response to new information gathered from trainees during the on going lesson. Each action undertaken by trainees is configured as a trigger, which is able to change the current running state of the backbone crisis *Scenario* created by the trainer. Choices are registered by the system as new goals and then responded to by adapting plans and applying corresponding compatibilities in order to ensure token network' consistency.

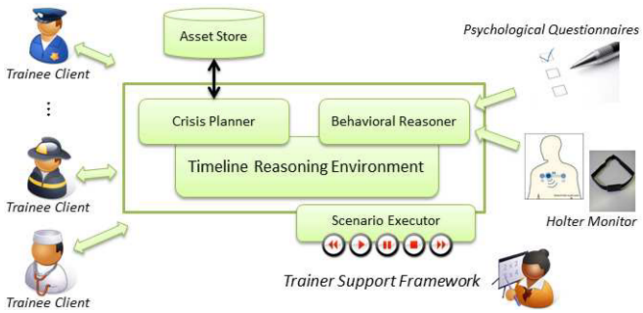

Figure 1. The PANDORA-BOX architecture. The Crisis Planner and the Behavioral Reasoner are the key components that rely on a common timeline-based reasoning environment.

In so doing, the planner makes use of both the domain causality and the psycho-physiological data from single trainees, acquired through psychological questionnaires delivered before and during the training session. This includes a Holter monitor device which is worn by the trainees during training , in order to create a complete and consistent plan at ground level that is ready for execution. The behavioral reasoner controls the *induced stress*[6] which is applied to trainees' timeline that, interacting with the asset store, generates diversified multi media affect to influence the engagement and the cognitive overload of the trainees [1].

In the meantime, the trainer observes what is happening in the class and can intervene in the scenario to influence the trainees either directly, through simulated characters (e.g., simulating missing players decisions) or through chat messages, or indirectly by editing the *Scenario* or posting new goals at the ground planning level. The trainer has the possibility to either observe the lesson flow and simply annotate the abstract plan representation or to more proactively take part in the lesson interrupting it (and/or resuming it) to discuss or explain on specific learning points. A Rewind functionality allows the trainer to move the execution back in time to revert to a crucial decision point in order to provide the trainees to review their decision and take a different path through the scenario.

Figure 1 sketches the PANDORA-BOX architecture. It mainly relies on the following four software components:

1. *Crisis Planner*. This module is responsible for the generation of the "lesson plan" selecting and integrating different media from an asset store. The system animates the scenario in an engaging way and adapts it on a continuous bases to keep pace with both the evolution of the specific group of people under training and their individual performance/status.
2. *Behavioral Reasoner*. This module is responsible for both creating an initial user model of the trainees, through information taken from psychological questionnaires, and maintaining it through a continuous analysis of trainees decisions, psychological assessments and physiological data taken from a Holter monitor during scenario execution.
3. *Trainer Support Framework*. This module provides different functionalities for the trainer to setup and configure the system, in addition to adapting the scenario on the fly. It provides functionalities to set up a "class" and to ensure all the roles in the scenario are filled by asking the PANDORA-BOX to role-play any missing players. The trainer keeps control of the training session by adapting the learning content throughout the execution of the *Scenario*, dynamically adjusting the stimuli based on both his/her experience and observation of the different trainees' actions. Finally, through simple commands, the plan can be executed, paused, resumed and re-wound.
4. *Trainee Clients*. Following a Client-Server architecture, trainees can join a class and participate, also being able to dynamically receive scheduled information, both collectively and an an individual, in the form of videos, maps, decision points, etc. This information is displayed on a Main Communication Window.

An additional module (not shown in the figure) called the *debriefing environment*, records the complete execution of a single lesson (including decisions and annotations) and provides in a post-scenario execution mode, a number of organized facilities for the trainer to use as part of the lesson debrief given the trainees.

[6] This term denotes the fact the the PANDORA system is trying to reproduce stressful and realistic situation by "inducing personalized stress"

4 CONCLUSIONS

The PANDORA environment is able to support a lesson of few hours with a class of trainees who are exposed to a set of stimuli coming from an evolving crisis scenario and customized to their particular needs. The system creates realistic responses to decisions taken by trainees by reproducing believable situations and grounded realistic domain causalities for those decisions. Trainees' behavioral features are also taken into account in order to plan training sessions tailored to individual differences and needs. The timeline representation is the core component of both the crisis simulation and the behavioral reasoner, allowing a continuous loop of planning, execution, and plan adaptation. Finally, the trainer is maintained in the loop so as to support a mixed-initiative training delivery. The project PANDORA-BOX prototype has been intensively tested in a 3 day evaluation session using real strategic level Crisis Managers who were trained at the Emergency Planning College (UK Cabinet Office) in York in February 2012. The sessions involved around 18 real strategic crisis managers and 3 different trainers. The users' reaction has been extremely positive especially with respect to the flexibility offered by the planning technology in creating different courses of actions and *what-if* analysis situation.

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REFERENCES

[1] G. Cortellessa, R. D'Amico, M. Pagani, L. Tiberio, R. De Benedictis, G. Bernardi, and A. Cesta, 'Modeling Users of Crisis Training Environments by Integrating Psychological and Physiological Data', in *IEA/AIE 2011, Part II,*, volume LNAI 6704, pp. 79–88, (2011).

[2] R. De Benedictis and A. Cesta, 'New Reasoning for Timeline Based Planning. An Introduction to J-TRE and its Features', in *Proc. of the 4th Int. Conf. on Agents and Artificial Intelligence*, volume 1, pp. 144–153, (2012).

[3] N. Muscettola, 'HSTS: Integrating Planning and Scheduling', in *Intelligent Scheduling*, ed., Zweben, M. and Fox, M.S., Morgan Kauffmann, (1994).