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AN INTEGRATED APPROACH TO MISSION ANALYSIS AND MISSION REHEARSAL

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ABSTRACT

Although simulation techniques are widely used to support both mission rehearsal and mission analysis, these two applications tend to be considered as distinctly separate. In this article we argue that integrating them in a unified framework can benefit the end-users of the system (armed forces or police and security forces). We demonstrate this on project EUSAS ("European Urban Simulation of Asymmetric Scenarios") financed by 20 nations under the *Joint Investment Program Force Protection* of the European Defence Agency, where such a unified infrastructure is being developed. We show how a novel approach to integration through behaviour cloning enables the system to capture the operational knowledge of security experts in a non-verbal way. This capability in fact emerges as essential for the operation of the integrated system, and we illustrate how the interplay between the system components for mission analysis and mission rehearsal is realized.

1 PHASES AND ACTIVITIES IN THE EUSAS SYSTEM

The key novel feature of project EUSAS is the combination of mission rehearsal in a highly realistic 3-D cyber environment with mission analysis through behaviour cloning, which enables the system to capture the security expert knowledge in a non-verbal way. Human behaviour is modeled on the basis of latest findings deriving from psychology using the PECS reference model (Schmidt 2002), where the acronym PECS stands for **P***hysical conditions,* **E***motional state,* **C***ognitive capabilities and* **S***ocial status*. High-level scenarios are decomposed into smaller units, dynamic and adaptable micro-scenarios, so each can be associated with a different "optimal" approach or rules of engagement. In this way, the integrated system guarantees that mission rehearsal is consistent with mission analysis and optimizations found in mission analysis can be quickly validated in a new training session.

The activities in the EUSAS system can be broadly grouped in two main operation modes – preparation and regular use – as shown in Figure 1 below. Blue arrows indicate the preparation, light green ones

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the regular use. Red arrows correspond to calibration feedback resulting in agent model adjustments. Preparation and calibration comprise "the training of the system," while the regular use can be viewed as "the training of the trainees." The numbering of the activities in the figure suggests their natural sequence, but there is no hard and fast rule about it, and some activities, e.g. calibration, are actually performed more than once during the full cycle. The full cycle can be repeated as many times as necessary.

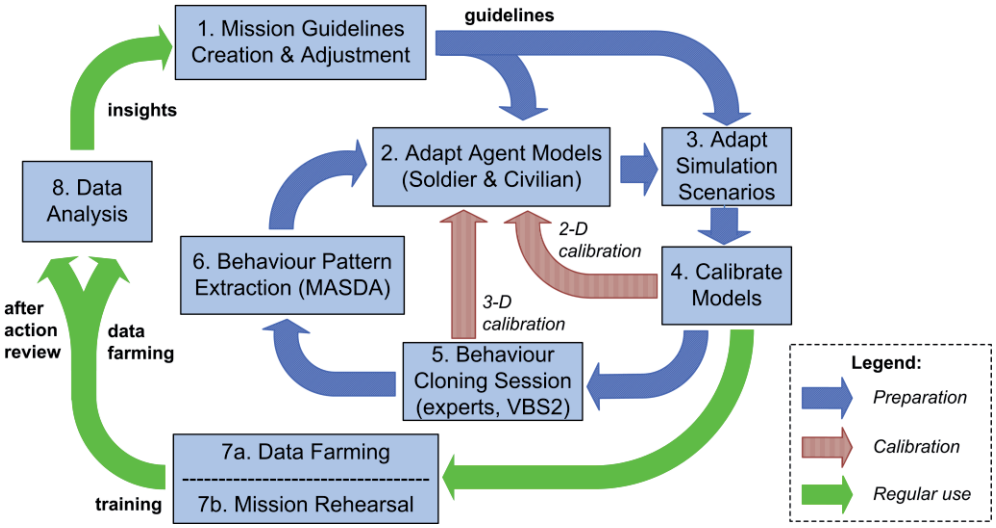

Figure 1: Main phases and activities in the EUSAS system

The process starts with draft mission guidelines to be applied by the security forces in order to cope with specific situations (step 1). Based on the intended training situations, civilian agent models and simulation scenarios are created or adapted (steps 2 & 3). In the next step (4), civilian models are calibrated so that, in step 5, security experts can "play against" the simulated civilians. Once the experts are satisfied that the simulated civilians are realistic and that proper strategies for handling them were found, the logs from such "successful" games are passed to the behaviour cloning algorithm for behaviour pattern extraction (step 6). Behaviour cloning helps define simulated soldier agents (repeat of step 2) and include them in the scenarios (repeat of step 3), so in this way the knowledge of security experts is captured in a non-verbal way. After the calibration of the system with both the civilian and soldier agents simulated (repeat of step 4), data farming (step 7a) is performed in order to verify the robustness of the cloned strategies. This is a condition for using the system for mission rehearsal (step 7b). The evaluation of the results obtained in steps 7a and 7b is performed through various data analysis tools and statistical techniques (step 8). Insights gained through data analysis can, in turn, trigger adjustments to the mission guidelines, and the whole workflow can be repeated as many times as necessary.

ACKNOWLEDGMENTS

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