

Using an Ontology for Knowledge Acquisition

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Abstract

We describe an approach to distributed knowledge acquisition using an ontology. The ontology is used to represent and reason about soldier performance. These methods are embedded in an immersive web based knowledge elicitation and analysis system.

Background

Advanced computer simulations are used for training (Haimson, 2005), mission rehearsal, planning, war-gaming, and research, to name a few. Recently, there has been great interest in using simulations to evaluate and analyze systems and technologies for the purpose of decreasing development and testing costs, evaluation of human-machine systems, and on improving system acquisition decisions. As new soldier technologies are being developed, the need for realistic behavior models has increased in order to fully assess the value of these new systems. However, soldier performance data during military operations in urban terrain (MOUT) are very limited. Techniques to obtain MOUT performance data is critically needed for modeling and analysis. Constructive computer models that simulate close combat in MOUT environments require representative human performance data to drive the development of autonomous agents. These agents simulate behavior within the model with the goal of mimicking human decision making activities and allow a better understanding of the relationship between system design, human cognition, and behavior. The inherent problem is significant gaps in data for generating models with enough fidelity for realistic human behavior representations (HBR).

Approach

To support ongoing efforts to improve these models, we sought to identify, develop, and validate techniques to collect and utilize soldier performance data. Simulations only take into account a fraction of the perceptual cues within an environment and a small number of behavior

responses. Using a Cognitive Systems Engineering (CSE) approach, we undertook a comprehensive analysis which utilized literature reviews, knowledge elicitation, subject matter experts (SME), and cognitive engineering techniques to support system design and to generate data in the area of human factors as it relates to soldier performance in the military operational environment. CSE techniques are varied and can include methods that model the knowledge and cognitive activities necessary to perform tasks (e.g., cognitive task analysis, cognitive work analysis, critical decision method), and can utilize different knowledge elicitation techniques (e.g., interviews, questionnaires, etc.) (Shute et. al. 1997; Wray & Laird, 2003). We combined theory and the SME input to develop categories of knowledge which classifies concepts in the domain of interest. Each concept supports the acquisition of relevant knowledge and skills, and maps to levels that indicate how a soldier would perform in a particular situation. The ontology relates relevant aspects of military operations, the environment (e.g., cues and responses) and their impact on performance.

The effort focused on developing an understanding of both the cognitive and physical aspects of an individual soldiers' performance in relation to a set of tasks typical to dismount urban operations. Our work has culminated in a methodology which will enable the collection of relevant data that can be applied to the development of emerging soldier systems and can be utilized by behavioral models. Our approach seeks to capture cognitive phenomena for use in measuring and assessing human cognitive activities and skills. The ontology defines behavioral patterns that constitute the output of these activities in specific operational contexts. In other words, links between behaviors and activities or skills (inferred or explicit) implies a particular cognitive signature, and can be used to generate empirical and realistic human behavior representations. During the ongoing knowledge elicitation process, we are able to update and populate the ontology with actual performance data and use the results to describe the rules for implementing realistic behavior models.

Soldiers participate in a knowledge elicitation process embedded within a web-based tool. They are presented

with complex mission scenarios designed to engage them in the decision-making behaviors of interest. Soldiers' responses to questions about these scenarios produce the behavioral data, which is captured and mapped to knowledge representation structures inside a database. Knowledge elicitation often has its greatest meaning in context, which allows recognition of critical cues, recall of relevant experience, and the compilation of procedural reactions to related events in the environment. The ontology can help provide context for the data we capture with the tool.

Application

The Infantry Warrior Simulation (IWARS) is a high-resolution constructive simulation of individual combatant behaviors to support Research, Development, and Acquisition (RDA) analyses of systems, components, technologies, and associated trade-offs. The fidelity of HBRs and models often impact the results of simulation experiments and analysis. Therefore, it is of great importance that models have an empirical basis. Obtaining data from live exercises or training experiments is too costly and time consuming. Furthermore, the data is limited and inaccessible. We sought to identify knowledge elicitation techniques which were easy to update, reuse, and administer. Another goal was to encode knowledge in a form readily accessible to utilize within HBRs to increase the realism in the behavior of simulation agents relative to actual human performance. This work focused on scientific methods to elicit the data which describes complex human behavior, the ability to automatically transform behavioral data from knowledge elicitation into simulation model inputs, and improvements of algorithms. We summarized the use of an ontology to aid in the classification and utilization of soldier performance data.

Future work includes developing supporting tools to evaluate the ability of our system to provide valid, unbiased soldier performance data. In addition to improving behavior models in virtual and constructive simulations, data can be used to assess performance, provide feedback for training, or support studies in the field of human factors.

References

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