From Agent-Oriented Models to Profile Driven Military Training Scenarios

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Abstract. We propose an approach for creating agent-based "man-in-the-loop" simulation scenarios for training military and paramilitary staff. The approach is based on psychological theories and enables to define small standalone simulation scenarios for a certain context. It considers several types of personality profiles. Each profile is represented as a combination of needs-based personality characteristics. The overall objective of this research is to achieve realistic "man-in-the-loop" military training scenarios where some roles are played by humans and some other roles by software agents.

Keywords. Agent-oriented modeling, military trainings, agent simulations.

1 Introduction

Personality traits are the unique sets of attributes possessed by individuals. In psychology, trait theory is an approach to the study of human personality. Personality generally refers to the character of an individual or his/her permanent behavioral traits [1]. According to recent studies [2], in a military task environment, a very important role for soldiers' situational perception is played by two narrow need-based personality traits: Sensation Seeking and Need for Structure. Sensation seeking is a personality trait defined by the tendency to search for experiences and feelings that are "varied, novel, complex and intense" [3], and by the readiness "to take physical, social, legal, and financial risks for the sake of such experiences" [3]. Personal need for structure is another personality trait defined by a desire for certainty and clarity, and a corresponding aversion to ambiguity [4].

In this paper we propose an agent-oriented modeling approach for designing and conducting military training scenarios. Our approach is based on psychological theories. It considers several types of personality profiles. Each profile is defined in terms of the individual set of skills, such as reaction speed and completeness of activities, and team skills, such as attention on the activities by other team members and helpfulness towards other team members. We also aim to map each profile to the scale of needs-based personality characteristics with Sensation Seeking on one end and Personal need for structure on another [2]. Our objective is to achieve realistic "man-in-

the-loop" military training scenarios where some roles are played by humans and some other roles by software agents.

In our approach, we first represent each training scenario by a set of agent-oriented models described in section 2 and then define for each scenario separately software agents with different psychological profiles, based on the models. The resulting software agents are guided by simple rules that are defined based on the descriptions of the psychological profiles of interest and evaluation criteria for the scenario. The profiles and the corresponding agents differ in the levels of the following criteria: reaction speed, completeness of performing an activity, attention on the activities by other team members, and helpfulness towards other team members. We are interested in the overall emergent behavior of the simulation system consisting of humans and software agents performing the scenario as a whole rather than in mimicking as precisely as possible human behaviors.

2 Agent-oriented modeling

In our approach, training scenarios are defined by agent-oriented modeling (AOM). AOM [5] is a top-down approach for modeling and simulating the behaviors of socio-technical systems. In the problem domain addressed by us, a socio-technical system is a "man-in-the-loop" military training system. In AOM, a problem domain is first conceptualized in terms of the goals to be achieved by a socio-technical system, the roles required for achieving them, and the domain entities embodying the required knowledge. The roles are mapped to the agents playing the roles, the goals – to the activities performed by the agents, and the domain entities – to the items of knowledge held by the agents. Models are considered as abstractions. Appropriately abstracting a system can reduce its complexity for better understanding of the system's particular aspects and their impact on its behavior. The types of models that are relevant for this paper are goal models and role models.

A goal model can be considered as a container of three components: goals, quality goals, and roles [5]. A goal is a representation of a functional requirement of the socio-technical system, that is, a training system. A quality goal, as its name implies, is a non-functional or quality requirement of the system. Goals and quality goals can be further decomposed into smaller related sub-goals and sub-quality goals. Goal models also determine roles that are capacities or positions that are needed to achieve the goals. Role models describe the capacities or positions that are required for achieving the goals.

Fig. 1 represents the training scenario, based on an example from our earlier research [6], by means of a goal model. Goals are represented as parallelograms, quality goals are clouds, and roles are stick figures. The arcs indicate relationships between constructs. The purpose of the scenario is to train evacuation.

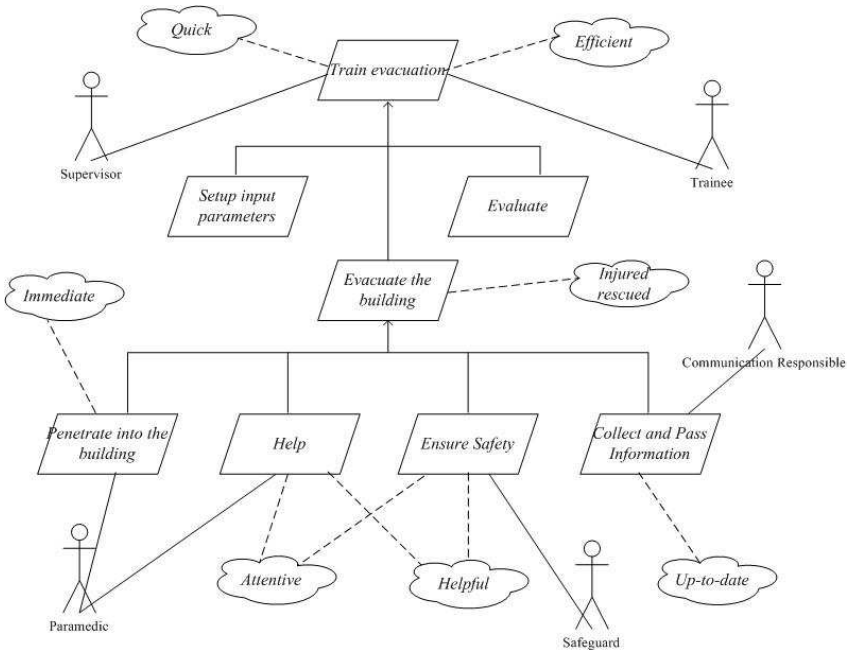

Fig. 1. The high-level motivation model for evacuation training simulation

In our approach, simulations are tuned by quality goals. Our simulation scenario is characterized by such quality goals as Immediate, Attentive, Helpful and Up-to-date – as is illustrated by the lower part of Fig. 1. Both quality goals characterize the behaviors of agents playing the roles Paramedic and Safeguard.

3 Proactive vs. reactive behavior in training scenarios

This section describes how the behaviors of software agents can be defined based on different psychological profiles. Software agents are characterized along the dimension of proactivity vs. reactivity. Acting in advance of a future situation, rather than just reacting, is understood as proactive behavior. In terms of agent's context, according to [7], proactivity can be defined as follows: "agents do not simply act in response to their environment; they are able to exhibit goal-directed behavior by taking the initiative". In case of reactivity, "agents perceive their environment, (which may be the physical world, a user via a graphical user interface, a collection of other agents, the Internet, or perhaps all of these combined), and respond in a timely fashion to changes that occur in it." In the military context, where the responsibilities and constraints of roles are generally well defined by, for example, rules of combat, it is important to build flexible, adaptive leaders with keen understanding and strong decision-making skills. Proactive soldiers and leaders generally do not need to be asked to act, nor do they require detailed instructions.

According to the model of a training scenario represented in Fig. 1, the training exercise is evaluated by the dimensions of speed, efficiency, attentiveness and helpfulness by team members. All of them correspond to the respective quality goals, as can be seen in Fig. 1. Within this paper, we focus on the quality goals of attentiveness and helpfulness by team members because they well correlate with the proactivity of team members [8]. In the training scenario, proactive behavior is particularly required of performers of the roles Paramedic and Safeguard. We therefore focus on these two roles. According to [8], helping behaviors can simply be categorized as reactive helping and proactive helping, whereas reactive helping is triggered by an external request. On the other hand, proactive helping is not initiated by help requests but by the anticipation of others' needs from shared by the agents' knowledge — even if such needs are not directly expressed [9].

According to [10], a quality goal ("soft goal" as the authors term it) is achieved ("satisfied" as the authors describe it) when thresholds of some precise criteria are reached. In psychological training, the achieving of quality goals is characterized by discrete scale from 0 to 3. Based on the criteria, we can define agents playing the roles Paramedic and Safeguard that meet these criteria to a greater or lesser degree. It is done by representing the corresponding agent behaviors by their behavioral rules in Table 1. These rules include a number of undefined in this paper constructs, several of which are concerned with message exchange between agents and situation awareness by agents. The "Request for help" and "Offer help" constructs denote the respective messages sent and received by the agent in focus. The "Assess the situation" construct denotes assessing the situation with respect to performance by other agents. The "Possible problem" construct denotes the situation where *any* other agent has a problem possibly requiring help by other agents. Finally, the "Interaction" construct refers to any interaction between any two agents or an agent and its environment in the training system.

Quality goal / Scale	**0**	**1**	**2**	**3**
Attentive	No behavioral rule	ON RECEIVE Request help THEN Assess the situation	ON RECEIVE THEN Assess the situation ON SEND THEN Assess the situation	ON Interaction THEN Assess the situation
Helpful	No behavioral rule	ON RECEIVE Request help THEN WAIT N Sec.; SEND Request help	ON RECEIVE Request help THEN SEND Offer help	ON Possible problem THEN BROADCAST Offer help

Table 1. Prototypical behavioral rules

According to [8], to help other agents often requires the agent to monitor the performance by other agents. In our approach, we define paying attention through assessing the performance by other relevant agents, relying on the common knowledge by the agents involved. In the training scenario of evacuation under discussion here, this means that an agent playing the role of Safeguard assesses the performance of the agent playing the role of Paramedic and the other way round, based on the shared by these agents situational knowledge. In the second row of Table 1, the behavioral rules corresponding to the quality goal "Helpful" are represented in a similar manner. The most helpful agent is the one that offers help to everyone whenever any of the situation assessments performed by this agent indicates a possible problem with any of the other agents. Attentiveness and helpfulness are separate characteristics that may have different levels for the same agent.

We define for software agents of the training system constants *payingAttention* and *beingHelpful* reflecting the level of attentiveness and helpfulness, respectively. Next, we can define the following logic applied as a part of scenario for achieving the goal "Help" by a software agent playing the Paramedic role:

```
Input the beingHelpful constant
Switch to behavior based on beingHelpful value
    Case 0
          Break // No behavioral rule
    End Case
    Case 1
          If RECEIVE Request help
                WAIT N Sec.
                SEND Request help
          End If
    End Case
    Case 2
          If RECEIVE Request help
                SEND Offer help
          End If
    End Case
    Case 3
          BROADCAST Offer help
    End Case
End Switch
```

4 Conclusions

In this research, an approach for creating agent-based simulation scenarios for training military and paramilitary staff is proposed. The approach is based on psychological theories. Two different needs-based personality characteristics are discussed: Sensation Seeking and Personal Need for Structure. Agent-oriented modeling is used to

define and visualize training scenarios by goal and role models. In the case study, the training exercise is evaluated by the dimensions of speed, efficiency, attentiveness and helpfulness by team members. All of them are characterized by the respective quality goals. The agents are defined based on the criteria proposed for achieving the quality goals. The corresponding agent behaviors are represented by their behavioral rules. According to the previous and current studies on proactive and reactive behaviors in psychological and military contexts, it can be hypothesized that software agents enacting sensation seekers need to be more proactive, while software agents enacting structure preferrers need to be more reactive. In this research, many aspects were not considered, and a number of research problems were left for future research. Among them is a plan to design a system where software agents following different psychological profiles are generated from agent-oriented models. In our future work the hypothesis stated above needs to be tested in real experiments.

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