Simulating Coping Processes in Critical Situations - An Agent based Approach

Régis Newo and Klaus-Dieter Althoff

University of Hildesheim, Institute of Computer Sciences,
Laboratory of Intelligent Information Systems
Email: newo|althoff@iis.uni-hildesheim.de

Abstract. How does someone react when he faces a critical situation in his life? In this paper we present an agent-based model for simulating people’s behaviors in those particular situations. Coping strategies are at the heart of our model and we use some strategies developed in the area of psychology. We show the first step of our implementation architecture. We are currently implementing our model by means of a multiagent system approach, realized by distributed knowledge-based systems with a specific focus on case-based reasoning technology.

1 Introduction

In our everyday life, we consistently face situations which pose more or less immense challenges. Examples can be the breakup with a partner, the loss of a job, an illness or even the death of a relative. As different as those challenges can be, the reactions of the persons who are facing the same kind of challenges can be very different as well. The problem consists in finding out, how someone reacts when he/she faces up a given challenge. The problem being a psychological one, there have been many research groups in psychology working in that direction, beginning in the early 1960s [11, 9, 8]. They developed psychological models and paradigms in order to represent and analyze people’s behaviors when he/she faces any serious difficulties. They developed theories, software-based models, and simulation approaches for that purpose. There have been many approaches in the past in order to model and simulate those skills from a psychological point of view. The main drawback of those approaches is that they always follow given guidelines, which are not always adequate to persons.

In this paper, we present an agent-based approach for the representation and simulation of human behaviors in critical situations. For this purpose we developed - in cooperation with Werner Greve (Institute of Psychology, University of Hildesheim1) - the SIMOCOSTS (SIMulation MOdel for COping STrategy Selection) model. In the SIMOCOSTS project we are actually aiming at a threefold goal, namely (1) developing a research software tool for supporting psychologists, who are working on cognitive modeling and learning as roughly described

1 http://www.uni-hildesheim.de/psychologie/mitglieder/werner_greve.htm
above, in their research work, (2) realizing what we call "collaborative multi-
expert-systems" (CoMES; see below) [2], and (3) instantiating the SEASALT
software architecture [4] we developed in our research lab as a first step towards
realizing CoMES. We elaborate in this paper how we intend to implement our
simulation.

In the next section, we will shortly introduce CoMES and SEASALT and discuss
related work. In Section 3, we describe the SIMOCOSTS model, its function-
ality, the developed knowledge representation and processing. The status of its
implementation is elaborated in Section 4. Finally in Section 5 we give a short
outlook on relevant future work.

2 Background and related work

In this section we shortly explain the underlying CoMES approach and its first
instantiation via the SEASALT architecture. Furthermore, we present related
work from the areas of cognitive architectures and coping processes which can
also be found in [12] and [10].

2.1 Collaborative Multi-Expert-Systems

Collaborative Multi-Expert-Systems (CoMES, see also [2]) denote a new research
approach that is both, a continuation of the well-known expert system approach
and a research direction based on the ideas of case factory and knowledge-line [3].
In the knowledge-line concept we systematically apply the software product-line
approach [13] from software engineering to the knowledge of knowledge-based
systems. This enables the necessary "knowledge level modularization" for build-
ing potential variants in the sense of software product-lines. The modularization
can be achieved by making use of multi-agent systems [7, 14] as a basic approach
for knowledge-based systems. An intelligent agent - as a first approximation - is
implemented as a case-based reasoning (CBR) system [1], which, besides case-
specific knowledge, can also include other kinds of knowledge. Each CBR agent
is embedded in a case factory that is responsible for all necessary knowledge pro-
cesses like knowledge inflow, knowledge outflow as well as knowledge analysis.

A Case Factory (CF) is a (virtual) organizational unit that emulates the well-
known experience factory approach [5] from software engineering. Each role
within an experience factory motivates the introduction of one or more soft-
ware agents for carrying out automatable (sub-)tasks more and more independ-
ently. Like the CBR agents, the associated respective CF agents are intended
to learn from experience. For example, they could implement machine learning
techniques for analyzing, evaluating, and maintaining the case base of the CBR
system agent. While many early (and also some current) expert systems had the
problem of acquiring and maintaining their knowledge, the underlying idea in
CoMES is to "develop CoMES where knowledge is produced".
2.2 Sharing experience using an agent based system architecture layout

A first step towards realizing the CoMES approach is the SEASALT (Sharing Experience using an Agent based System Architecture LayouT) architecture [4]. The architecture can be vertically split in two parts (see Figure 1). On the left hand side we have the knowledge provision (i.e. the domain specific knowledge is stored and used for the implemented application in that part). On the right hand side we have the knowledge acquisition (i.e. the needed knowledge is acquired in that part via experts or communities). For the current stage of the SIMOCOSTS project we focus on the knowledge provision part only, mainly because we have to know which knowledge a person needs in order to solve a given problem and how he/she uses it. The knowledge acquisition part will be done by psychologists.

2.3 Psychological Background for Coping Strategies

In one area in psychology, one especially wants to know how people react in particularly stressful situations (also called critical situations). One does not only want to know which reactions result from the fact that the person notices
the critical situation, but also which coping strategies lead to those reactions and which factors affect the choice of the coping strategies.

The coping methods are very important, because it helps us to classify the reaction of the person. One of the most recent theory on coping strategies is from Brandstädter and Greve [6]. It is based on the fact that intentions are a key part of psychological theories of action. Except for knee-jerk or automated behaviors, human actions are motivated by intentions (e.g. start a family). When somebody faces a critical situation (e.g. his/her partner wants to break up), his actual state strongly differs from his goal state (i.e., his intentions). In order to solve the problem, the person essentially can use one of the following three forms of coping processes:

- **Assimilative processes**: the strategy here is to solve the problem by working directly on the actual state. That is, it is an active art to work through a problem, in which the person uses the available resources in a problem oriented way. The available resources can be the person’s own resources or external ones. In our example, the person would try to find a way to convince the partner not to break up.

- **Accommodative processes**: this strategy is used when the person believes he can not change the actual state (i.e. solve the problem) by himself. He then tries to adapt his goal state such that the discrepancy to the actual state can be diminished. In our example, the person could think that being a single is actually better than having a family.

- **Immunizing processes**: in this case, the person just ignores the discrepancy between the actual state and his goals. He can for example perform actions that diminishes the meaning of the discrepancy.

Most of the time, a person does not intentionally apply a given type of process. The person rather just try to find out, which strategy would be the best for him at the moment (depending on his capabilities, environment, etc.). The chosen strategy can then be evaluated to belong to one of the given processes by experts.

### 3 A Simulation Model for Coping Strategies

We present here our model SIMOCOSTS (SIMulation MOdel for COPing STRATEGY Selection), shown in details in Figure 2, for the simulation of process-based problem solving [10]. The model is based on the psychological theories developed by Brandstädter and Greve.

One main difference between our simulation approach and other ones consists in the fact that all the other view the respective persons as normal agents. In our model, each part is represented by an agent. That is, we have agents that can contain further agent, the so called holonian concept. The main parts (agents) of a person include the characteristics of the person and of his environment as well as his coping strategies for critical situations. A detailed description of the model can be found in [10] and [12].
4 An Implementation Architecture for the Simulation of Coping Strategies

The model in the previous view was developed from a psychological point of view and cannot be directly used for an implementation. In this section, we present the implementation architecture of our simulation tool. With our architecture, we aim to represent how we in fact are going to implement our system. The main idea of our architecture is based on the fact that each person has some goals that he wants to achieve. In our scenario, a critical situation occurs when there exist some facts that prevent the person from reaching those goals.

We will implement those goals by using the so-called practical reasoning agents paradigm [15], which is based on the Belief-Desire-Intention (BDI) principle. The main particularity of such agents is that they achieve their goals in two steps. First, they deliberate in order to exactly define what their intentions are, based on the defined goals. Second, in the means-ends reasoning step, they then try to...
find a way to achieve the intentions. The input of our system is a situation (which should judged as critical), and the output contains the computed plan as well as some explanation for the plan. The experts will then use the explanation in order to tune the simulation. Our architecture, presented in Figure 3 consists of three main parts which are elaborated in the next sections.

### 4.1 Knowledge Base

The knowledge base consists of all the general knowledge that can be helpful while loosing the problem. That knowledge include skills, material and/or social environment, etc. We plan to use different case bases for the distinct parts of the general knowledge needed (e.g. skills). The cases in a case base represent the possibilities that we will insert into the system. Those possibilities are needed if we want to simulate different situations. They also represents the new possibilities that will be learned by the system.

### 4.2 The Strategies

In our architecture, the strategies represents the actions (in analogy to BDI agents) that can be used for the computation of the plan in the means-ends reasoning stage. These actions mostly have an impact on the knowledge base defined earlier (e.g. the acquisition of a new skill) as well as on the internal goals (i.e. adaptation of the goals). Both facets need to be taken into account while ”designing” the strategies. We plan to implement those strategies as rules in a case-base reasoning system. Such rules would able to adapt our knowledge base to the new circumstances.
4.3 The (internals) Goals

The initial goals of the person are the initial beliefs of the agents which are used for the computation of the intentions when a critical situation occurs. At any time, each agent wants to fulfill its (long or short term) goals. That means, each agent is responsible for analyzing if its goals are still reachable (i.e. there is no critical situation). This can be done by analyzing each incoming situation and identifying, if there is any conflict with its goal. Since the goals depend on many factors we will implement the goals as cases in a case-base reasoning system. A strategy would either try to adapt the cases in the goal’s case base or adapt the knowledge base such that the facts in the goal’s case base remain or become true.

4.4 Classification of the Architecture

Our Architecture follows the principle of the CoMES approach introduced in Section 2.1 and leans on the SEASALT architecture which we presented in Section 2.2. The important point consist in having a knowledge line in our implementation architecture which contains the three parts presented above. In fact, the knowledge line in our architecture can be seen as all the informations needed to represent a person. We thereby achieve the reusability which is important while developing a knowledge line in terms of CoMES.

We are actually implementing a knowledge base (following the knowledge line approach) for a fixed example, because it is nearly impossible to implement a complete knowledge base for a person. The chosen example is about the break-up of a partner when the person wants to start a family.

5 Conclusion and Outlook

In this paper, we presented an architecture for the implementation of the simulation of coping processes. After the introduction of the CoMES approach and the SEASALT architecture, we presented our SIMOCOSTS model for the simulation of coping strategies. We then presented the architecture that will be used for the implementation of the simulation. Our implementation will be based on two main technologies, namely case base reasoning and multi-agent systems, while following the CoMES approach. Further work include an accurate specification of the knowledge base an its implementation as well as the implementation of strategies and goals for given examples.

References


