Modern Methods of Knowledge Engineering for the Development of Medical Information Systems

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Abstract: To avoid the problem of knowledge acquisition bottleneck a process oriented method for knowledge acquisition was developed. The approach is based on so called scenarios. A scenario describes a certain step within the decision process to be elicited from the medical expert. By using scenario techniques the knowledge engineer is able to represent the elicited knowledge in a way that give both experts control over the whole acquisition process.

Key-Words: Knowledge Acquisition, Process, Model, Medicine

1 Introduction

Knowledge acquisition within medical domains is a complex process. This is caused by the features of medical knowledge: Besides incompleteness, uncertainty and vagueness medical knowledge of a certain domain is highly connected with other medical domains and has an increasing modification rate. Various techniques for knowledge elicitation are reported in literature [1], [2]. The known approaches for modeling [3], [4], [5], [6] the elicited knowledge increase the quality of the knowledge acquisition process. The traceability between models, stability toward changes in the domain, maintainability of the knowledge base can be understood as quality criterions. These are reasons for using comprehensive methods for knowledge acquisition [7].

The introduced methodical approach uses knowledge-solving scenarios as a basic concept to meet these demands.

2 Methods

Starting from the special data situation in intensive care the approach was initially developed for this field and includes the following steps:

- Orientation
- Elicitation of problem-solving scenarios (short: scenarios)
- Structuring and interpretation of scenarios
- Identification and elicitation of concepts and their relations
- Elicitation of domain specific knowledge and explanation knowledge.

The prerequisite for the elicitation of the domain specific knowledge is the elicitation of scenarios which implicitly includes problem-solving knowledge. Scenarios allow a general view of the problem domain. They can be understood as the top-level structures within a domain. Scenarios describe how a problem can be solved by a human expert as problem solver as well as the necessary resources. Within a certain scenario a problem is treated and solved in a typical way.

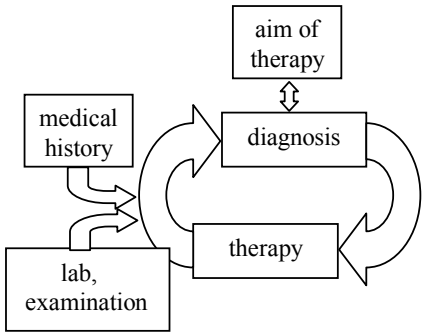

Figure 1: Sequences of diagnosis and therapy: a circular process

The process of diagnosis and therapy can be understood as circular process (figure 1), which consists of single scenarios. For coarse structuring of these process existing scenarios will be made visible by the use of interviews. By doing this, in this first step the essential relations of the whole process are depicted.

The following analysis of the coarse structure allows a detailed description of the scenarios and its relations. The structuring and description process is done by using object-oriented methods of modeling [8].

Concepts and its relations are used to describe the process steps within a scenario. Concepts are defined by investigating the expert's usage taking under

consideration existing ontological structures.
According to the situation different elicitation techniques are used to acquire the solving steps for refining a scenario. The description of the completed scenario is done by the use of object-oriented methods and the ontology defined before.

3 Results

The procedure described above was applied to a restricted domain of intensive care, the traumatic brain injury. First, the medical experts introduced the problem domain. During the following interviews the experts gave a step by step description of what is done in case of traumatic brain injury. Of course, there are many parallel steps. These first interview protocols have been structured into three main scenarios: (1) Primary Care, (2) Emergency Room and (3) Intensive Care (see figure 2). Each scenario is composed of other scenarios. The central element of each scenario is the patients state, described by various parameters. The aim of each scenario is to decide whether a concrete parameter has a physiological value. If not, the scenario describes how to solve this problem.

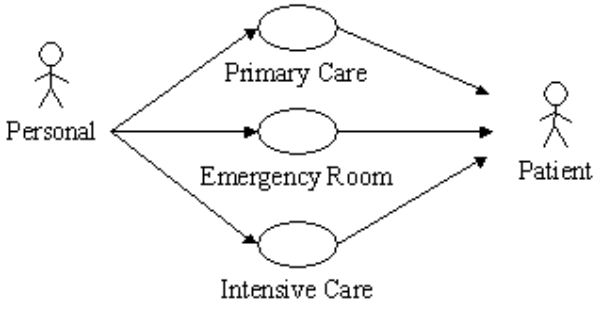

Figure2: The coarse structured three-step process of treatment of traumatic brain injury

The scenario description was the starting point for searching and defining domain specific concepts and its relations. Afterwards the scenario refinement followed in the way described above.

By recording the expert's problem-solving behaviour all elements of the problem-solving strategy are registered.

4 Discussion

The advantage of the approach is that scenarios are intelligible to all as well as usable in a versatile way during all stages of the acquisition process. They adopt the communication role between medical expert and knowledge engineer. By using scenario techniques the knowledge engineer is able to represent the elicited knowledge in the expert's language. For this reason, immediate feedback between both experts is possible and, as a consequence the misunderstanding rate decreases dramatically. Both medical expert and knowledge engineer get control over the whole process to be elicited in an early stage of knowledge acquisition. The representation form of scenarios allows formalization for further knowledge processing.
In comparison with other approaches it can be shown that the procedure described above is able to close the methodical gap between knowledge elicitation and knowledge modeling.

5 Conclusions

The presented approach for knowledge elicitation and modeling is based on the expert's decision process. The proposed projection of decision processes to scenarios allows transparent references to the decision process. These process-oriented and expert centred approach allows the minimization of knowledge leaks during the different stages of knowledge acquisition. The method can be used for an analytical access to the decision process. The approach described above is usable in a flexible way for a wide range of different problem domains.

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