A Semantic Wiki for the Engineering of Diagnostic Guideline Knowledge

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ABSTRACT

This paper presents a wiki environment for the modelling of Computer Interpretable Guidelines (CIGs) using the graphical language DiaFlux. We describe a wiki-driven development process using a stepwise formalization and allowing for almost self-acquisition by the domain specialists. The applicability of the approach is demonstrated by a project developing a guideline for sepsis diagnosis and treatment by a collaboration of clinicians.

1. KNOWLEDGE ENGINEERING WITH SEMANTIC WIKIS

Today, Semantic Wikis are used for collaborative ontology development, by providing a flexible, web-based interface to build semantic applications. The main benefit of Semantic Wikis is their possibility to interweave different formalization types of knowledge in the same context. That way, ontological concept definitions are mixed with free text and images within the wiki articles.

In this paper, we introduce the graphical language DiaFlux for modeling of clinical guidelines: The contributions are its simple application for developing decision-support systems, only providing a limited number of intuitive language elements. Due to its simplicity, it is possible to be used by domain specialists and thus eases the application in the knowledge engineering process. To allow for comfortable development of DiaFlux guidelines, we introduce a visual editor integrated into the Semantic Wiki KnowWE [1].

KnowWE provides the possibility to define and maintain ontologies together with strong problem-solving knowledge. Thus, the wiki can be used to collaboratively build decision-support systems. These enhancements require extensions of the standard Semantic Wiki architecture by a task ontology for problem-solving and an adapted reasoning process.

2. CLINICAL GUIDELINE MODELLING

The work presented in this paper is conducted within the project "CliWE - Clinical Wiki Environments"[1]. We investigate languages, tools and methodologies to collaboratively build Computer Interpretable Guidelines (CIG) by domain specialists themselves. The requirement concerning the language is the development of an explicit and executable representation of diagnostic knowledge for active decision-support systems. Furthermore, we create a development process for simple and effective knowledge acquisition by domain specialists. Finally, the completed knowledge bases will be exported into mixed-initiative systems, that cooperate with the clinician during the care process.

Clinical guidelines have shown their benefits by providing standardized treatment based on evidence-based medicine. Many textual guidelines are readily available and also shared through the internet, but rely on the proper application by the clinician during the actual care process. Much effort has been put into the development of formal models for computer-interpretable guidelines. In the variety of CIG models, each has its own focus, e.g. the sharability of guidelines between various institutions or assisting patient care through active decision-support [2]. The focus of the DiaFlux guideline language lies in the executability of the developed models.

For the specification of a clinical guideline, two types of knowledge have to be effectively combined, namely declarative and procedural knowledge. While the declarative part encompasses the facts and their relationships, the procedural one reflects the knowledge about how to perform a task, i.e. deciding which action to take next. DiaFlux guidelines are based on flowcharts. Distinct node types allow, e.g., the conduction of tests, the changing of diagnosis states and calling other DiaFlux guideline as self-contained modules. To express the procedural aspect of the guideline, nodes are connected by edges, which are labeled with conditions. They evaluate the declarative knowledge with respect to the observed findings, e.g. the outcome of a given test or the status of a diagnosis. To obtain the semantics necessary for executability, we rely on an application ontology as an extension to the task ontology of diagnostic problem solving [1]. The application ontology defines the declarative knowledge consisting of findings and their ranges, diagnoses, and treatments.

[1]Funded by Drägerwerk AG & Co. KGaA, Lübeck, Germany, 2009-2012.

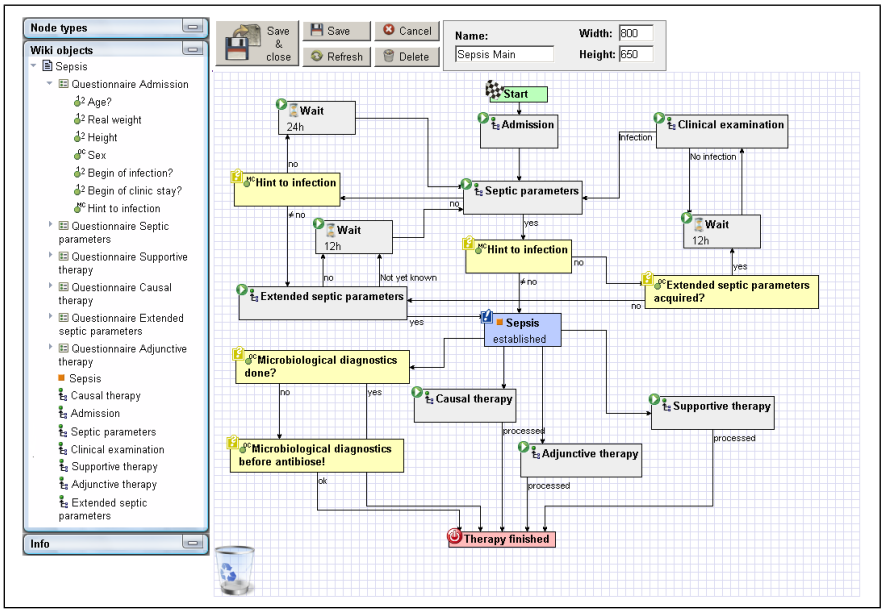

Figure 1: The main module of the sepsis diagnosis and treatment guideline, opened in the visual editor.

An AJAX-based editor for DiaFlux guidelines is integrated into KnowWE. Ontological concepts that are already defined in the wiki's knowledge base can be reused or new ones can be created. The model's source code is encoded in XML and integrated into the corresponding wiki article and saved and versioned together with it. This allows for further documentation of the guideline by tacit knowledge in the article. When the article is displayed in a web browser, the model visualization is rendered.

Collaborative development requires to track the changes of all participants. Therefore, a frequent task is to compare different versions of a wiki article. For DiaFlux guidelines a visual diff is provided, highlighting changes for easy comparison. After creating a knowledge base in the wiki, a test session can directly be started from the wiki. The current state of the guideline throughout the session can be observed, highlighting the traversed pathway through the guideline. This immediate feedback considerably eases the interactive testing of the knowledge base, especially when parallelism or hierarchical structuring are involved.

For the development of DiaFlux models we propose a stepwise formalization process: At first, informal information are collected in wiki articles, e.g. about goals of a protocol. During the next step, a first semi-formal guideline is created using only nodes containing free text and connecting edges. At this stage of formalization, the flowcharts can not be automatically executed, but "manually". For testing purposes the user can explicitly select the pathway through the guideline. The taken pathway is highlighted for easier tracking. The last step is the full formalization into a DiaFlux model and the creation of the application ontology, resulting in an executable knowledge base. By following this process of gradual refinement, the entry barrier for domain specialists is quite low, while knowledge acquisition can start from the beginning.

3. CASE STUDY: SEPSIS MODELLING

In the context of the project "CliWE" we used a prototype of the clinical wiki environment for the development of a guideline covering the diagnosis and therapy of sepsis. Sepsis is a syndrome of a systemic inflammation of the whole body with a high mortality (30 to 60%).

The knowledge base was developed in accordance to the official guideline by the German Sepsis Society. Our formalization of the guideline covers so far the diagnostics and parts of the therapy (cf. Figure 1). It contains about 50 nodes in eight modules with several possible pathways, depending on how the diagnosis can exactly be established and the course of the therapy. Overall, the wiki-based approach showed its applicability and usefulness, as the combination of formal and informal knowledge and its gradual refinement was intensely used during the acquisition of the guideline and according test cases.

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5. REFERENCES

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