

Tracing the Formalization Steps of Textual Guidelines

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Abstract. This paper presents a new guideline authoring tool, called *Guideline Markup Tool (GMT)*. It proposes two useful features, which are missing in existing tools. First, it facilitates the translation of a free-text guideline into a formal representation, providing special XML macros. Second, it can be used to create links between the original guideline and its formal representation. Therefore, the *GMT* eases the implementation of clinical guidelines in a formal representation, which can be used in monitoring and therapy planning systems.

1. Introduction

Clinical guidelines are widely used in medicine to standardize medical treatment. Hence, there are currently several ongoing software projects concerning clinical guidelines, for example for visualization, verification, or execution of clinical guidelines. Most clinical guidelines were published as free-text files, such as HTML, which could not be directly used for further processing. Therefore, clinical guidelines have to be translated first into a machine-readable formal representation. For this purpose, *Asbru* [1], a special guideline modeling language, has been developed as part of our *Asgaard* project. Since *Asbru* is intended to cover all aspects of a guideline, it is rather complex, so special tools are needed to facilitate the translation task. Another important issue is the coherence of the two versions of the same guideline – the text and the formal version.

We have developed the *Guideline Markup Tool (GMT)* to address the two abovementioned points: **(1)** to support the translation of clinical guidelines into a guideline modeling language such as *Asbru* and **(2)** to maintain the connection between the original guideline and its formal representation.

1.1 Related Work

Existing guideline authoring tools can be broadly distinguished regarding their intended target group. *AsbruView* [2] has already been developed in the *Asgaard* project to edit and visualize *Asbru* guidelines using special graphical metaphors and is therefore especially suitable for physicians. Whereas *GEM-Cutter* [3], which is comparable to our approach, requires the user to have specific knowledge in the target guideline modeling language (in this case *GEM*).

There are also two quite new projects that combine these two approaches: Both, *Stepper* [4] and *Uruz* (which is part of the *DeGeL* [5] project) divide the translation process into several smaller steps, where the first step could be accomplished by physicians and the remaining steps by knowledge engineers.

The main disadvantage of *GEM-Cutter* compared to the *GMT*, is that it does not provide a linking feature. The web-based guideline tool *Uruz* is too new, so there is currently no detailed information about specific features. Although the developing of the *Stepper* tool is not yet completed, it already looks very promising. It facilitates the formalization process by providing sophisticated transformation rules instead of static macros as in *GMT*.

2. The Idea

The *Guideline Markup Tool* is specifically intended for knowledge engineers who have experiences in understanding clinical guidelines and who are well versed in the target guideline modeling language, in our case this will be primarily *Asbru*.

The *GMT* was designed to provide two new features for the work of knowledge engineers: *links* and *macros* (see Fig. 1).

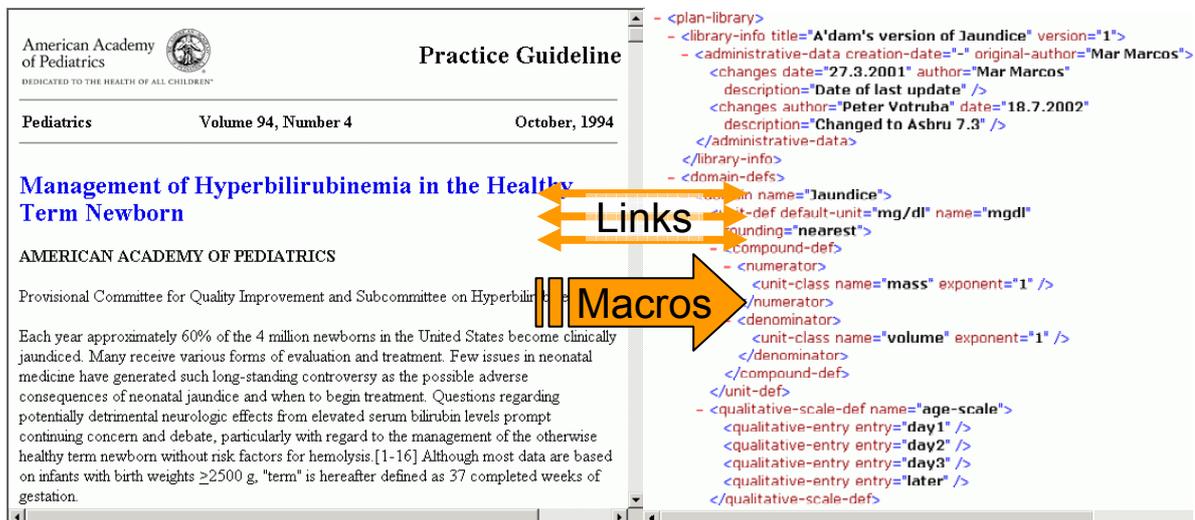


Fig. 1. Overview of the concept behind the *Guideline Markup Tool*

Links are a simple, but useful concept to connect relating parts of two documents. They permit a M:N-relationship between two files, that means that one “link” can have one or more endpoints in each side. If links have been thoroughly inserted during the translation process, they could be used later for several issues:

- *Cross-checking for inconsistencies*: If ambiguities or even errors are found in the formal representation using special tools, they can be retraced to their origin using links.
- *Comprehension of the translation process*: On the one hand, the linking feature may help to find out how a specific text passage has been modeled in the formal representation. On the other hand, it can be used to reveal the reason why a specific element in the formal representation has been chosen.
- *Verify completeness of formal representation*: The *GMT* can be used to verify that all relevant parts of the original guideline have been modeled in the formal representation.
- *Analyze formalization overhead*: During the translation process, usually knowledge is added to the formal representation that has no direct source in the original guideline (implicit knowledge). The *links visualization* feature of the *GMT* can be used to explore, which parts of the formal representation are unlinked and therefore not directly related to parts of the original guideline.

In the new version of the *GMT*, links cannot only be used to establish a connection between an HTML- and an XML-file, but also between two XML files.

The second main feature of the *GMT* are macros. A macro combines one or more XML elements (together with their attributes), which are typical patterns of clinical guideline components. Thereby, macros facilitate the authoring of an XML document, for instance an *Asbru* guideline.

3. The Tool

The *Guideline Markup Tool* has been developed using *Java* to ensure that it runs on most systems. Fig. 2 shows a screenshot of the *GMT* during a typical usage. The user interface is divided into three main parts: two components to view/edit HTML or XML files at the top and the macros part to browse through a macros file at the bottom.

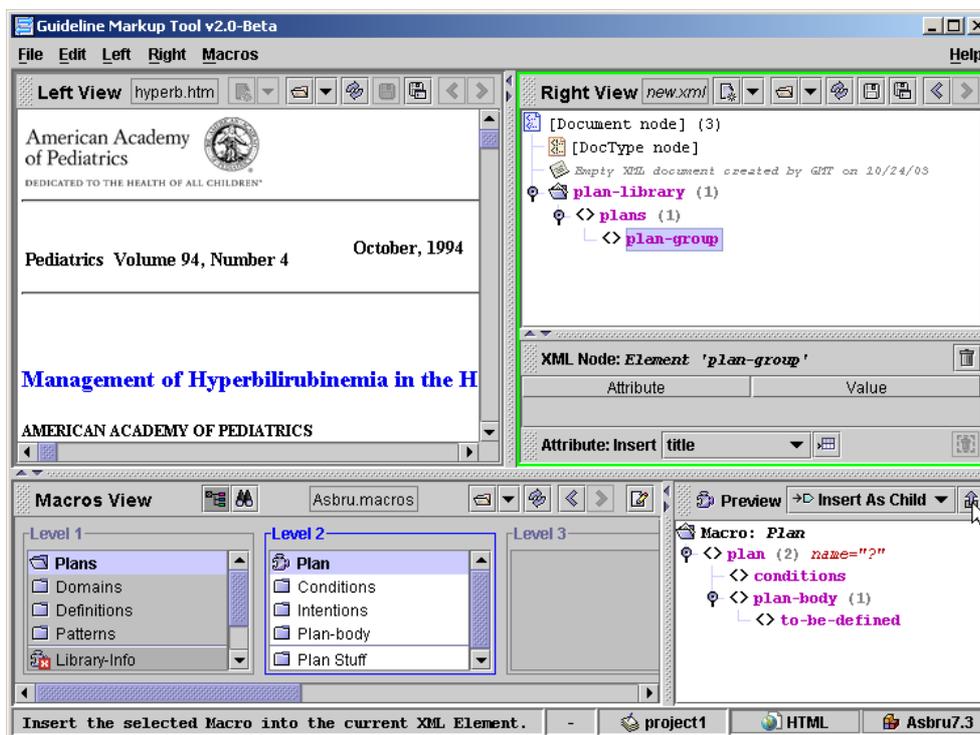


Fig. 2. *Guideline Markup Tool* showing a HTML guideline (jaundice), a newly created *Asbru* XML file and the prototype of an *Asbru* Macros file

3.1 Links

Link endpoints in an XML document are represented using the `gmt-link` element, which will be inserted as child element when creating a new link to an element. To ensure that the `gmt-link` element may be inserted into every possible element of the target XML document, its DTD will be automatically modified to that effect. Link endpoints in an HTML document are accomplished using extended *a*-tags. To retain the connection of corresponding link endpoints, each link gets a unique id number, which will be stored as an attribute at every link endpoint.

Fig. 3 shows a screenshot of the *GMT* demonstrating activation of a link between two XML documents. When clicked on a link endpoint, all endpoints in the other side with the same id number will be highlighted.

To provide a visualization of the distribution of links within an XML document, we have added a feature called *links visualization*. When activated, each element in the XML

view gets colored differently – all link elements get a green background, the elements that belong to a link are colored blue, and the other elements are grey. This feature can be used to find out which parts of an XML document are not linked to the other side.

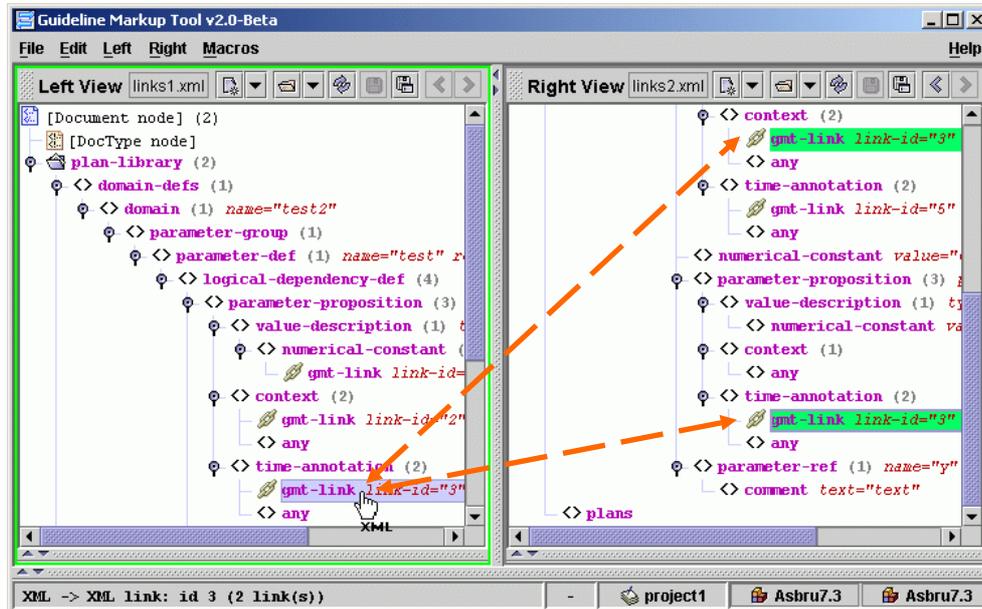
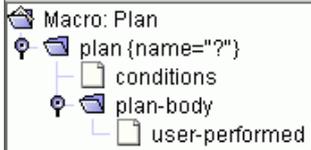


Fig. 3. Guideline Markup Tool demonstrating a link between two XML files

3.2 Macros

To be consequent, macros are defined in XML using a DTD, which we have specifically designed to support any target XML language. We are currently writing a prototype of a macros file for *Asbru* (see Table 1 for an *Asbru* macro). Additionally, we are developing a special macros editor, to facilitate the creation and modification of macros files.

Table 1. Sample macro that can be used to insert a new *Asbru* plan together with two sub-elements (the name of the plan will be asked from the user). The left side shows the source of the macro, while the right side shows a small screenshot of *GMT*'s macro preview and how it would be inserted into the target XML file

Macros File	Result
<pre> <macro name="Plan"> <element-ref name="plan"> <attribute-ref name="name" value="?" /> <element-ref name="conditions"/> <element-ref name="plan-body"> <element-ref name="user-performed"/> </element-ref> </element-ref> </macro> </pre>	 <pre> <plan name="?"> <conditions/> <plan-body> <user-performed/> </plan-body> </plan> </pre>

3.3 Other Features

To enhance the usability, the user should not need to switch to another application while editing an XML document using the *GMT*. Therefore, it includes most of the features of common XML editors, for instance Undo, Copy&Paste and Search. Furthermore, the *GMT* provides some useful features, which cannot be found in conventional XML editors. For detailed descriptions of all implemented features, see [6].

4. Conclusions

We have developed the *Guideline Markup Tool (GMT)* to support the translation of a clinical guideline available as an HTML file into an XML file representing the formal representation of the guideline. Additionally, it can be used to translate one XML file into another, for example an intermediate, semi-formal representation to *Asbru*. For these purposes, the *GMT* provides special XML macros. The second main feature of the *GMT* is the ability to associate two HTML/XML documents using links, which could be very useful to examine the relation of two versions of the same guideline.

These two features – macros and M:N-links between HTML/XML files – make the *GMT* unique among other guideline tools or XML editors.

We performed an evaluation study on the first version of the *GMT* (detailed results can be found in [7]), which showed that we are developing in the right direction and which also led to many ideas for new features.

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References

- [1] Miksch, S.; Shahar, Y.; Johnson, P.: *Asbru: A Task-Specific, Intention-Based, and Time-Oriented Language for Representing Skeletal Plans*. In: Motta, E.; Harmelen, F. v.; Pierret-Golbreich, C.; Filby, I.; Wijngaards, N. (eds.), *7th Workshop on Knowledge Engineering: Methods & Languages (KEMML-97)*, Milton Keynes, UK, 1997.
- [2] Kosara, R.; Miksch, S.: *Metaphors of Movement - A Visualization and User Interface for Time-Oriented, Skeletal Plans*. In: *Artificial Intelligence in Medicine, Special Issue: Information Visualization in Medicine*, pp. 111-131, 22(2), 2001.
- [3] Polvani, K.-A.; Agrawal, A.; Karras, B.; Deshpande, A.; Shiffman, R.: *GEM cutter*, <http://ycmi.med.yale.edu/GEM/>.
- [4] Svátek, V.; Růžička M.: *Step-By-Step Mark-Up of Medical Guideline Documents*, accepted for *International Journal of Medical Informatics*, 2003.
- [5] Shahar, Y.; Young, O.; Shalom, E.; Mayaffit, A.; Moskovitch, R.; Hessian, A.; Galperin, M.: *DeGeL: A Hybrid, Multiple-Ontology Framework for Specification and Retrieval of Clinical Guidelines*. In: Dojat, M.; Keravnou, E.; Barahona, P. (eds.): *Artificial Intelligence in Medicine. Proceedings of the 9th Conference on Artificial Intelligence in Medicine in Europe (AIME 2003)*, Springer, Berlin, 2003.
- [6] Votruba, P.: *Guideline Markup Tool - User Manual*, Vienna University of Technology, Institute of Software Technology and Interactive Systems, Vienna, Technical Report, *Asgaard-TR-2003-2*, 2003.
- [7] Votruba, P.: *Structured Knowledge Acquisition for Asbru*. Master's Thesis, Institute of Software Technology and Interactive Systems, Vienna University of Technology, Vienna, Austria, 2003.