Design patterns for modelling guidelines

Radu Serban[1], Annette ten Teije[1], Mar Marcos[2], Cristina Polo-Conde[2], Kitty Rosenbrand[3], Jolanda Wittenberg[3], Joyce van Croonenborg[3]

[1] Vrije Universiteit Amsterdam, Netherlands
{rserban,annette}@cs.vu.nl
[2] Universitat Jaume I, Spain
Cristina.Polo@sg.uji.es, Mar.Marcos@icc.uji.es
[3] Dutch Institute for Healthcare improvement CBO, The Netherlands
{k.rosenbrand,j.wittenberg,j.vancroonenborg}@cbo.nl

Abstract. It is by now widely accepted that medical guidelines can help to significantly improve the quality of medical care. Unfortunately, constructing the required medical guidelines is a very labour intensive and costly process. The cost of guideline construction would decrease if guidelines could be built from a set of building blocks that can be reused across guidelines. Such reusable building blocks would also result in more standardised guidelines, facilitating their deployment. The goal of this paper is to identify a collection of patterns that can be used as guideline building blocks. We propose two different methods for finding such patterns We compare the collections of patterns obtained through these two methods, and experimentally validate some of the patterns by checking their usability in the actual modelling of a medical guideline for breastcancer treatment.

1 Introduction

In the last decades a lot of effort has been given to guideline development, since medical guidelines can help to significantly improve the quality of medical care. Currently, the National Guideline Clearinghouse (NGC) contains over 1400 guideline summaries. Recently (2002) the Guidelines International Network (G-I-N) was founded, which seeks to improve the quality of health care by promoting systematic development of clinical practice guidelines and their application into practice. Because modelling guidelines is labour intensive, there is a need for reusable components (patterns), which enables a more systematic development of guidelines.

In this short paper, we describe work in progress. In section 2, we propose two different methods for identifying patterns, that can be used as guideline building blocks, a selection of the patterns that we have obtained by these methods, and some observations about the methods and obtained patterns. In section 3, we report on an experiment of modelling and the use of the identified patterns, and

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finally, section 4 concludes. The main contribution of this paper is the set of patterns including their categorisation.

2 Methods and results

In this section we present our results concerning the identification of patterns for constructing guideline models. We present a selection of the identified patterns and present some observations concerning our methods and the identified patterns. First we give a proposal for a categorisation of the obtained patterns.

2.1 Categorisation of patterns

Following the methods to be discussed in later sections, we found a large number of reusable patterns. Therefore it is necessary to categorise them in such a way that modellers can use them during the modelling activity of a guideline.

We use the following categorisation of patterns. We consider *action patterns*, and patterns concerning with *action ordering*. The action patterns are the primitive building blocks, whereas the action ordering are the complex building blocks, since they can be built up from more simple action patterns. The action patterns are subdivided into action associated with context, action associated with time, action associated with conditions, and action associated with a goal. The action ordering patterns describe different orderings between sets of actions. These patterns are divided into sequence of actions, cyclic (repetitive actions), unspecific-order set (no explicit order is given), trials (try an action and, if it does not succeed, try something else), or selection of actions (concerned with the choice of an action). Most of the patterns found using our two methods fit in this categorisation, as depicted in figure 1.

Categroy of pattern	model-driven	guideline-driven
action/plan	-	1
action associated with conditions	3	9
action associated with goals	2	2
action ordering	-	3
cyclic	2	2
sequence of actions	4	2
unspecific-order set	1	1
trials	2	-
selection of actions	2	3
others	4	9
total	20	32

Fig. 1. Categorisation of patterns obtained with model- and guideline-driven approach

2.2 Model-driven approach

In this approach the patterns have been extracted by knowledge engineers from pre-existing Asbru [1] representations of guidelines, hence the name *(Asbru) model-driven*. The patterns has been identified from the Asbru models of jaundice [2] and diabetes [3] guidelines. Consequently, the patterns are concerned with plans, and have often a high degree of complexity.

The following description serves to illustrate the kind of patterns obtained in this way.
Example of pattern: "Sequence of trials, at least the first action must succeed". Try several actions, in the indicated order and possibly with time delays between some of them; at least the first action must succeed. This pattern can be used whenever a precise sequence of steps must be tried in order to achieve certain target value for a particular parameter.

The Asbru solution makes use of a set of plans (one for each step) grouped into a plan of type `sequentially`, enforcing the described order. Concerning the waiting strategy, the (required) first step is the only one to be included in the `wait-for` option. To prevent the high-level plan to complete after the completion of the first step, the option `wait-for-optional-subplans` must be set to yes.

We have identified 20 patterns with potentials for reuse from the Diabetes and Jaundice Asbru models we analysed. Although these patterns are represented in Asbru, they can be described in general terms and hence they can be exploited independently of this particular target language.

Concerning the nature of the patterns, we can distinguish different types of patterns (see fig. 1). Another important observation is that the patterns obtained from existing Asbru models can be rather complex, because of the design efforts of the modeller. These structures are often not explicit in the original guideline texts.

2.3 Guideline-driven approach

In the guideline-driven method we have studied the original text of several guidelines [4, 5, 7] and identified patterns in the guideline text. We looked for general reusable segments of the guideline. After identifying these patterns, we tried to translate them into Asbru patterns The following example is intended as illustration of the kind of patterns obtained with this approach.
Example pattern: "association action-goal" has the following instances:
• Adjuvant hormone therapy for locally advanced breast cancer results in improved survival in the long-term.
• In many patients, radiotherapy achieves good palliation

We found 70 patterns, of which 32 patterns have a counterpart in Asbru, and 38 refer to more general medical aspects that cannot be expressed in Asbru. These patterns are outside the scope of Asbru. For instance, patterns concerning exclusions (ie. "action x should not be part of action y") , rate of success for actions, or support of a hypothesis.

CATEGORY	PATTERN
action/plan	Simple action execution
ass. with conditions	Action along with periodic tests and/or controls
	termination of plan/action
	Monitoring of critical conditions
ass. with goals	Search for treatment, with management of treatment problems
	Management of treatment problems
actions ordering	Ordered action group execution
	Composition of actions
	Actions in parrallel
cyclic	Periodic adjustment of treatment increase of doses of a drug
	Repetitive action with goal specification
sequence	Sequential action composition
	Sequence of actions, none/all of them must succeed necessarily
	Sequence of actions, only applicable ones, any/specific action must succeed
unspecific-order	(Unspecified order) execution of a group of actions
	Unspecified-order set of actions, all of them must succeed
trials	Sequence of two trials
	Series of trials, possibly more than once, a particular action must succeed
	Sequence of trials, at least the first action must succeed
selection	Choice of an action among a list by the user
	Random choice of element from group
	Exclusive alternative branching actions

Fig. 2. Selection of design patterns using the model- and guideline-driven approaches.

2.4 Analysis of approaches

Figure 2 shows a selection of the identified patterns [4]. Although each category contains patterns obtained from both approaches, which may suggest that the patterns they uncover are not very different, there exist differences.

As a general rule, guideline-driven patterns are less specific than model-driven ones, compare, for instance, "action associated with goals" versus "management of treatment problems". As for the level of granularity of the patterns, it differs in general. The guideline-driven patterns cover more generic types of relations, but have a smaller granularity than the relations expressed by the model-driven patterns.

The guideline-driven approach can only expose knowledge which is localized at sentence or paragraph level, while the model-driven approach can capture operational knowledge which is not explicit in the original texts. As result, the patterns obtained through the first approach correspond to complete Asbru fragments and contain medical abstractions, whereas the patterns found with the second one may refer to features broader than Asbru. This makes both approaches complementary to each other.

[4] see [6] for the complete collection of patterns

3 Evaluation of patterns

The evaluation we have performed, which is limited to the evaluation of the patterns obtained via the model-driven approach, has consisted in modelling in Asbru a part of the CBO[5] breast cancer guideline [7], and subsequently studying the degree of reusability of the different patterns.

The number of plans that we have studied amounts to 52. Only two patterns have been reused in those plans Although the reuse percentage is significant –actual reuse in 12 out of the 38 plans, i.e. 31% of cases– neither the variety nor the complexity of the applied patterns is high. One reason to explain the small number of used patterns might be their specificity with respect to Jaundice and/or Diabetes guidelines. The low complexity of used patterns, could be explained by the fact that the modelling has been restricted to chapters dealing with specific parts of the treatment, which makes the reusability of e.g. high-level coordination patterns less likely. Regardless of the above, the reuse of these patterns for 30% of the plans facilitates the modelling task to a great extent.

4 Conclusions

The main conclusion of this ongoing research is that we were able to identify a large number of patterns, that can be used as guideline building blocks. We have used two different methods for finding such patterns: either by observing regularities in the original text of the guidelines (guideline driven), or analyzing regularities in pre-existing formal guideline models (model-driven). In total we identified 52 design patterns for which we found a counter part in a guideline representation language Asbru. Finally, the lesson from the (limited) evaluation we have performed is that the reuse of patterns can facilitate the modelling task, although in practice only few patterns were reused intensively.

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