Assisting in Reuse of Adaptive Hypermedia Creator's Models

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Abstract. The design of Adaptive Hypermedia is a difficult task which can be made easier if generic systems and AH creators' models are reused. We address this design problem in the setting of the GLAM platform only made up of generic components. We present a rule-based approach helping an AH creator in reusing its user and domain models to create a specific adaptive hypermedia. This semi-automatic approach takes the creator's models as specialisations of GLAM generic models and requires the creator to express a minimum set of mappings between his models and the generic ones. The process results in a merged model consisting of the generic and the corresponding specific model. This merged model can be used by the adaptation model.

Keywords: adaptive hypermedia, assisting tools, user and domain modelling.

1 Introduction

Although adaptive hypermedia have proved their benefits, particularly in the educational domain [1], authoring an adaptive hypermedia for a particular need is still a difficult task [2]. Some freely available adaptive hypermedia systems, which are, in fact adaptive educational hypermedia systems, like AHA![1], come with an authoring tool but they required to learn how to use the system and it is necessary to adapt the resources to the format used by the system. Some systems [3,4] can translate resources from one particular adaptive system to another one. But, all those systems have developed "ad-hoc" solutions closed to the adaptive systems used and are not applicable to other adaptive systems. If a user wants to use a specific AH system, he needs to translate his models into the specific format understood by the system and to use the vocabulary specific to that system. Furthermore, he also needs to translate all the instantiations of his models (i.e. the resources and their metadata). We think that this task is tedious and time-consuming and we want to avoid it. Our objective is to

[1] http://aha.win.tue.nl/

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allow the creator of an adaptive hypermedia to reuse his models (his vocabulary) and his models' instantiations without any change of format or vocabulary.

We are currently working on the GLAM platform [5] defined for an entire class of adaptive hypermedia systems. The platform is made of a generic adaptation model relying on generic user and domain models. Specific systems can be obtained by specializing the GLAM generic user and domain models. The main steps of the approach that we propose are the following: (1) Specification, by the AH creator, of equivalence and specialization mappings between classes of the generic and the specific models, merging the whole generic GLAM model and the mapped classes of the specific model (together with the associated mapping links) in order to obtain a new model. (2) Automatic computation of additional mappings between the classes. (3) Automatic computation of mappings between relations and properties. (4) Validation by the AH creator of the deductions made by the system.

In this paper, we focus on step 3, steps 1, 2 and 4 are detailed in [6]. In section 2, we describe the structural knowledge applicable to whatever the model is (user or domain model) to deduce automatically mappings between relation and properties. As the models are expressed in OWL[2], structural knowledge has been modelled in a meta-model [6] based on the OWL meta-model. In section 3, we describe inferences made on the knowledge modelled in our meta-model.

2 Structural Knowledge

The exploitation of structural knowledge aims at defining the nature of mapping links between OWL properties which are referred to in this paper by relations because relations (in its usual meaning) and attributes are both represented by properties in OWL. In our approach, the deduction of mappings between relations is inferred from information characterizing the compatibility of the relations. A mapping between two relations is possible only when the relations are compatible. A mapping may be either a potential or a probable link according to the compatibility information (inferred from mappings between classes and from properties restrictions) associated to the mapped relations. We will note $R_{m,d,j}$ to represent the relation j with the domain d in the model m.

Definition 1. Two relations $R_{s,i,j}$ and $R_{g,k,l}$ are linked by a *potential link* if a mapping is defined between their domain and between their range.

Definition 2. Restrictions relative to two relations $R_{s,i,j}$ and $R_{g,k,l}$ are *compatible* if those relations are linked by a potential link and if:

1. $(Cardinality_{max}(R_{s,i,j}) \leq Cardinality_{max}(R_{g,k,l})$
   and $Cardinality_{min}(R_{s,i,j}) \geq Cardinality_{min}(R_{g,k,l}))$
   or $Cardinality_{value}(R_{s,i,j}) = Cardinality_{value}(R_{g,k,l})$.

or

2. $R_{s,i,j}$ and $R_{g,k,l}$ are both functional or not (resp. inverse functional or not) or $R_{s,i,j}$ is functional (resp. inverse functional) and $R_{g,k,l}$ is not.

[2] http://www.w3.org/TR/owl-features/

Definition 3. Two relations $R_{s,i,j}$ and $R_{g,k,l}$ are linked by a *probable link* if they are linked by a potential link and if their restrictions are compatible.

Probable links can be either equivalence or specialization links according to the nature of mapping between the classes corresponding to the range and according to the restrictions associated to the relations.

Definition 4. A probable link between $R_{s,i,j}$ and $R_{g,k,l}$ is an *equivalence probable link* if the two ranges are linked by an equivalence relation and if they have the same restrictions.

Definition 5. A probable link between $R_{s,i,j}$ and $R_{g,k,l}$ is a *specialization probable link* if a mapping is defined between their range but the restrictions on $R_{s,i,j}$ are stronger than those on $R_{g,k,l}$ or if they have the same restrictions but the $R_{s,i,j}$ range is a subcategory of the $R_{g,k,l}$ range.

3 Deduction Rules

In this section, we give the rules, expressed in SWRL[3], to deduce mappings between relations of the generic and specific models. The rules derive from the definitions given in section 2 and are based on the proposed meta-model.

Deducing a potential mapping. The rule inferring a potential mapping derives directly from Definition 1. It uses mappings between a class of the generic model and one of the specific model.

Deducing compatible restrictions. We defined 9 rules which group all cases where a relation of the generic model Pg and one of the specific model Ps are linked by a potential link and have compatible restrictions. For example the rule deducing compatible functional properties is

```
potentialLinkedProperties(?Pg,?Ps) ^ functional(?Pg,false) ^
functional(?Ps,false) → sameFunctionality(?Pg,?Ps) ^
compatibleFunctionality(?Pg,?Ps)
```

Deducing a probable mapping. The rule inferring a probable mapping derives directly from Definition 3.

```
potentiallyLinkedProperties(?Pg,?Ps) ^
compatibleRestriction(?Pg,?Ps)
→probablyLinkedProperties(?Pg,?Ps)
```

Two kinds of probable mappings are distinguished. A rule arising directly from Definition 4 allows deducing an equivalence probable mapping link. The deduction of a specialization probable mapping link can be expressed by the following formula: *Probable link* $\wedge$ (*Restrictive range* $\vee$ *restrictive functional* $\vee$ *restrictive inverse functional* $\vee$ *restrictive cardinality).* As the disjunction operator doesn't exist in SWRL, here is one of these four rules needed to deduce a specialization probable link:

```
probablyLinkedProperties(?Ps,?Pg) ^ range(?Pg,?Rg) ^
range(?Ps,?Rs) ^ mapping(?Rg,?Rs)
→probablySubProperties(?Pg,?Ps)
```

[3] http://www.w3.org/Submission/SWRL/

Deducing an inconsistent mapping. Inconsistencies relate to potential mappings and derive directly from restrictions. We defined 5 rules which group all cases where a relation of the generic model is more restrictive than the potential one mapped with.

4 Conclusion and Future Work

We have proposed a solution enabling the user to create an adaptive hypermedia with the GLAM system re-using his own models and consequently his own resources and their metadata. In this paper, we detailed the automatic deduction step of mappings and potential inconsistencies between relation and properties of the two models. This step is based on specified mappings between classes and on additional mappings automatically deduced. Then the AH creator has only to validate the system proposals. We have implemented a prototype using the Protégé platform and its plug in: OWL Protégé, SWRL Tab and SWRLJessTab, it has allowed us to make some experiments in which we have personally played the role of an AH creator.

We now intend to complete the implementation in integrating the developed components and to design an ergonomic IHM. It can also be interesting to consider the relations between the adaptation rules and the user and domain model. We envision an extension enabling AH creators to interact with the adaptation model. Finally, our solution is based on the use of OWL to express the models and it is not dependent on the use of GLAM, so we plan to apply it to other systems.

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