A UNIFYING APPROACH FOR INTERFACE GENERATION IN ADAPTIVE SYSTEMS

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ABSTRACT
In the context of the « cartable électronique » project, we have developed an adaptive hypermedia, providing the pupils with information on cultural events. We propose a general approach allowing to adapt the information to a given user in a particular context. This adaptation is performed thanks to the user preferences, of course, but also by exploiting the context of use of the system (device, location of the user). The generation of the adapted user interface can be seen as the generation of an adaptive document where the result is obtained through the combination of the adequate fragments of information. Our approach is based on constraints generated from the user preferences and from the context (e.g. depending on the device, some fragments are disabled). An architecture is also presented in which we explain how we adapt the information (selection of what to present – contents and decision on how to present them – display).

KEYWORDS
Adaptive Hypermedia, User Model, Context, Constraints

1. INTRODUCTION
With the evolution of the WWW, several cultural information servers have been developed. However, such systems usually provide the user with static information (www.webcity.fr). The user can therefore be upset by the amount of inadequate information, which may result in not using the system any more. In the context of the "Cartable Electronique" project, we have developed an adaptive hypermedia (Brusilovsky, 2001), allowing the cultural partners to broadcast cultural event advertisements to students (Marty & Vignollet, 2001). By using this service, the pupil will find in his/her electronic schoolbag, the adapted cultural events list. In order to adapt this cultural information, the system must select the adequate events according to the user cultural preferences and present them according to the user display choices. In most adaptive systems, e.g. AHA ! (De Bra & Ruiter, 1999), the approach is user-centred, and the adaptation is thus performed through the user's characteristics and preferences. Furthermore, in these systems, the adaptation rules are either hard-coded, such as in PowerBookmarks (Li & al., 1999), raising the problem of reuse and extension of the software; or they are based on the event-action paradigm, such as in XAHM (Cannataro & Pugliese, 2001), introducing the ending and non determinism issues.

In the adaptation phase, we are faced with the problem of selecting the appropriate information: what is best suited to a given user in a given context? Providing the user with an adequate list of items is closely related to the automated document generation. Several document composition systems use constraints to generate the appropriate documents. These constraints unfortunately only apply to the contents of the document (Boukottaya & al., 2002) and are mainly issued from a user model (Iksal & Garlatti, 2002). Our approach aims at considering constraints more generally, in order to take into account not only the content of the information but also its display; and to use not only the user model, but also the context (device, location, ...) to generate the different constraints.

Our paper is organised as follows: first we describe what can be adapted, the pieces of information on which the adaptation should be performed. In the second section, we explain what can be used to help the adaptation, namely the user model and the context. Sections 3 and 4 detail these data and show how they can
be unified through constraints. Section 5 summarises how the constraints are used to generate the adapted interface.

2. THE DOMAIN DATA

The domain data are constituted from pieces of information (that we call "fragments"). In our example domain, these fragments can be for instance a textual description of an event, pictures of this event, interviews related to this event, etc... The use of fragments, as can be found in other systems (Abrams et al., 1999), offers a large number of adaptation possibilities.

In order to select the appropriate fragments (the best suited fragments according to the constraints), we need to have meta-data on these fragments. For instance, a fragment is aimed at young children; or a fragment is an abstract of an event, ...

Furthermore, we believe that a fragment must be a multi-modal object: to an image representing a film, we propose to associate a textual description summarizing the image and the vocalization of this text. Although these pieces of information are not exactly the same, they are semantically quite close. That is why we represent this example by a unique fragment representing an image of a film; this fragment has three facets corresponding to the three mentioned media. This approach is rich from the adaptation point of view. In traditional systems, when a device cannot display an image, the user is informed that there is information that can't be displayed... In our case, the system will look for another solution, by examining the alternative media of the same fragment. The interface will thus present the user with a short text representing the image. Even if the object is not exactly the same, the user has an idea of what the system wants to transmit. It could be very interesting to study the semantic equivalence of the modalities in different contexts, but this is beyond the scope of this paper.

In our system, the cultural partners are in charge of providing the fragments. When the information exists, they can give different "views" of a fragment (text, image, sound, video). It is also when they provide these fragments that they specify a certain number of meta-data such as the kind of event (cinema, theatre, music) or the target public.

3. USER MODEL AND CONTEXT

We have already mentioned that the adaptive systems need different kinds of data in order to know which information is more appropriate. The first source of such data is the user model. Taking into account the user preferences is now currently admitted in most adaptive systems. This kind of adaptation in adaptive systems is also called personalisation. Other systems, mainly mobile systems, take into account the context in which the human-machine dialogue takes place (Kappel & al., 2003). That includes for instance the location of the user or the device he/she is using. Our goal is to take into account both the user and the context to make our systems as adaptive as possible.

The user model contains the set of information needed by the system in order to adapt the interfaces. This includes the preferences (regarding objects of the domain or interfaces themselves) and the knowledge of the user. The model of the context is formed by characteristics describing a given environment, e.g. the device, the time, the location where the system is used. Both the user model and the context characteristics are useful in obtaining an efficient adaptation of the interfaces submitted to the user.

We can split the characteristics (or attributes) of these models into three types: the fixed attributes, initialised by the administrator when he creates a new user account on the Web site (these attributes are not intended to change); the attributes whose values can be obtained directly through sensors or user inputs; the attributes whose values are inferred by the system (according to the user's actions, we can deduce some user preferences or according to the user location, the system can derive his/her address, etc...). For the attributes belonging to the last category, we can mention that additional data is required, since the information provided by the system is not necessarily true. We thus introduce an uncertainty factor for that purpose (Fuselier, Marty & Vignollet, 2002).
4. UNIFICATION THROUGH CONSTRAINTS

In the previous section, we pointed out that the context can be as important as the user model in obtaining a good adaptation of the interfaces. Our approach aims at unifying the different sources of information allowing the adaptation. For that purpose, we consider that all these data can be represented as constraints on the results to be displayed. Constraints issued from the user model can set some restrictions on the information to be presented; e.g. the user doesn't like classical music. They can also be issued from the context: the user is located in Marseille; it is not possible for him to attend an event in Paris tonight. The constraints can be of different kinds: the constraints having an impact on the selection of the contents (WHAT do we need to present to the user?) and the constraints defining precisely the display of the information (HOW do we present it?). A detailed representation of the constraints can be found in (Fuselier, 2002). Here are some examples of such constraints:

From the user model on the contents:

\[(\text{fragment.type} = \text{cinema}) \land (\text{user.cultural_preferences.cinema.value} > 0.7)\]. This means that we will select all the fragments concerning the cinema as possible fragments to display, when the user likes the cinema. We can observe that the constraint refers both to the meta-data concerning the fragment and to some values of the user model; 0.7 represents a number between 0 and 1 (0: dislikes; 1: likes very much)

From the user model on the display:

\[(\text{image} \in \text{fragment.modality}) \land (\text{user.media_preferences.images.value} > \text{user.media_preferences.text.value})\]. This means that the fragment has an image modality and that the user prefers to see an image when it is possible.

From the context on the display:

\[(\text{terminal.type} = \text{WAP}) \land (\text{text} \in \text{fragment.modality})\]. This means that we will display the text modality of the fragments on WAP devices.

5. ARCHITECTURE OF OUR SYSTEM

The following figure summarises the architecture of our system.

When a new page is to be presented to the user, the initialisation step is to generate the updated constraints according to the current values of the user and the context attributes. The first step is to select the appropriate fragments from the data base of the cultural fragments according to the content constraints (1). Then, we decide on the optimal modality for each selected fragment, also according to the content constraints (2). The problem of display should thus be addressed using the presentation constraints (3). The elements to be displayed and their layout are described in an abstract language. This allows us to translate this into several languages such as HTML, WML or Voice XML (4).
6. CONCLUSION

Our goal is to define a system that can go further than adaptive hypermedia, providing the user with ubiquitous access to services. As is the case in other research, we also aim at improving the access, "at any time, from anywhere, with any media, to everyone and everything" (Kappel, 2003). We also want this access to provide adapted information, in order to suppress the uninteresting information.

Currently, the implementation of a first version of the cultural service works. It includes a simple user model and does not take the context into account. However, a new version is currently being specified including the ideas developed in this paper.

We also want our approach to be as general as possible. That is why we are thinking of another adapted service in the electronic schoolbag: the "homework book", adapted to the student. The homework is displayed according to the group the user belongs to. Additional personal information can also be added to the interface. Interesting constraints exploiting the knowledge of the student can be added (the teacher can decide to give extra work to the students whose knowledge is not sufficient in a given subject).

Adding new services requires the design of a generic user model (or a meta model that allows the extension of an existing user model) and a generic context model. Using constraints allows the systems to adapt the information through a declarative process. Furthermore, our adaptation process operates on a dynamic content while most other systems work on a static content. We believe that the constraints are powerful enough to adapt to other items than the user or the context. For instance, we can also adapt to the providers of cultural information, if they want their logo to appear in the top left-hand corner of each cultural event they organise.

The number of the different constraint sources will thus probably increase and we will be faced with constraint contradictions, e.g. the user does not like images but the cultural partner recommends to display an image for each cultural event. The next challenge will thus be to improve the process of resolving constraint conflicts.

REFERENCES


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