Managing Conflict in Multi-model Adaptive Hypertext

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ABSTRACT

Adaptive hypermedia has the goal of contextualizing the display of a hypertext to suit the user and their situation. A variety of aspects of the context can influence the appropriate adaptation. For knowledge engineering and privacy reasons, systems are moving towards having multiple independent models influencing adaptation. But these multiple models may disagree, resulting in a need for systems to manage the resulting conflicts. This paper presents an approach that combines conflict avoidance, conflict detection, and conflict resolution. This approach is presented within the context of multi-model adaptive spatial hypertext.

Categories and Subject Descriptors

H.5.4 [**Information Interfaces and Presentation**]: Hypertext/ Hypermedia - *architectures, theory, navigation, user issues*

General Terms

Algorithms, Design, Experimentation, Human Factors, Theory

Keywords

Spatial Hypertext, Multiple models, Adaptive, Dynamic.

1. INTRODUCTION

There is a need to personalize the delivery of information in information-rich environments. Thus, research in adaptive hypermedia has focused on customizing the presentation according to a user model that represents significant user characteristics such as goals, knowledge and preferences [1, 2]. Human actions, however, are situated and depend heavily on the particular context. Thus, in addition to the user, it is necessary to take into consideration other relevant factors, such as a user's task or hardware being used. As a result, factors extraneous to the user are often included into the user model. This entangling of factors considerably increases the complexity of the model and the resulting knowledge engineering task. As a result, researchers are investigating mechanisms for adapting hypermedia presentations with the aid of multiple models [4].

A second problem with a using a single adaptation model is concern over its access and control. Users want control of their own user model, calling systems that collect this user data "spyware". Some users want no information about themselves sent to a central or community repository, others allow for anonymized disclosure, and others may allow full disclosure of their user model. These cases result in different possible adaptation methods that are reasonably different user models.

Current multi-model adaptive hypertext systems are designed to function using a fixed, coordinated set of models. This approach is limited in that designers must predict how many models will suffice for any use situation. This can be alleviated by using a variable number of independent models. But independent models can suggest contradictory adaptations. Thus, it is necessary to complement this approach with conflict resolution mechanisms.

Distributed AI provides a number of methods for solving the issue of competing suggestions offered by different mechanisms [3], such as voting or priority based strategies. Most of these approaches try to solve the conflict by disambiguating the situation and computing a unique response. A broader conflict management approach can provide many benefits by reducing the number of conflicts, detecting and identifying the context of conflicts, and by providing a variety of resolution strategies.

2. CONFLICT MANAGEMENT

Conflict management is a process that encompasses three steps: conflict avoidance, conflict detection and conflict resolution. Here we describe these activities in WARP, a multi-model adaptive spatial hypertext system.

2.1 Conflict Avoidance

In multi-model adaptive hypermedia, conflicts occur when different models suggest adaptations that the presentation medium cannot represent simultaneously. For instance one model might suggest emphasizing an object by highlighting it while another model might suggest protecting the object's content by hiding the object. This is a conflict because it is impossible to highlight and hide an object at the same time. Such conflicts can be avoided by having models suggest high-level adaptation methods capable of being expressed through different adaptation techniques. In this example, the system attempts to "emphasize" an object and to "suppress" it's content at the same time. Different techniques can implement the desired methods. Emphasis can be expressed by enlarging the object. Similarly, instead of hiding the object, the content can be suppressed by occluding the text. These adaptation techniques can simultaneously represent both suggestions.

In addition to avoiding conflict, ambiguity in the presentation can be used avoid having to resolve conflicts. In a conflict where one model suggests de-emphasizing an object while another suggests emphasizing it, each "emphasize" could be expressed through different techniques. For instance, the de-emphasize method can shrink the object while the emphasize method can highlight the object. WARP adaptation models produce high-level adaptation methods that are translated into specific adaptation techniques to avoid conflicts when possible and to use ambiguity dependent on the selected conflict resolution strategy.

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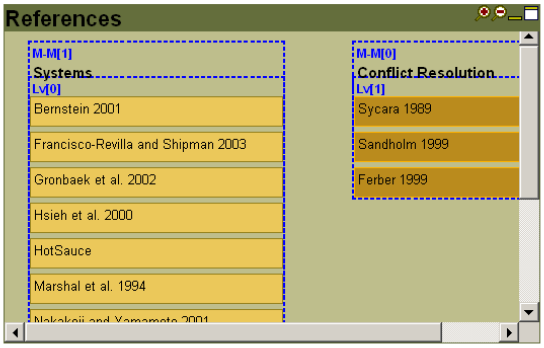

Figure 1. Parsed structure in WARP.

2.2 Conflict Detection

Detecting conflicts when different models make suggestions regarding the same object is easy. However, conflicts are created indirectly as by-products of suggestions regarding different objects. Consider two objects located next to each other. One object is a picture and the second contains text annotating the picture. Hiding the picture is likely to make the text meaningless.

Spatial hypertext's spatial parsers recognize common relationships between objects, such as piles and lists, that can help in detecting indirect conflicts. The parsing process takes a set of objects and groups them into composite objects, which can be part of higher-level composites. Figure 1 shows the unadapted layout and parse of two labelled lists of publications in WARP.

Given the parser's hierarchical structural interpretation, the "context" of a conflict fit into the following categories:

Object conflicts. These conflicts occur when two or more suggestions for the same object oppose each other (e.g. one model suggests hiding an object while another suggests showing it).

Sibling conflicts. These occur when suggestions for an object affect the presentation of another object in the same context (e.g. hiding the picture conflicts with highlighting its annotation).

Parent conflicts. Composites are perceived based on the visual appearance of the objects that make them up. Modifications of a component's visual appearance can affect the parent composite, potentially destroying it. For instance, a list of objects can be broken up into two lists if one object in the middle is hidden.

Parent-child conflicts. These occur when suggestions for a composite conflict with suggestions for its components (e.g. hiding a list conflicts with highlighting objects in the list).

Parent-parent conflicts. Objects may belong to multiple composites. In the case of a vertical list intersecting a horizontal list, the intersecting object is contained in both so highlighting the vertical list conflicts with hiding the horizontal list.

2.3 Conflict Resolution

Depending on the situation, conflicts need to be resolved differently. Conflict resolution strategies include suggestion averaging, prioritizing, voting and market-based schemas. WARP provides default strategies for objects and types of conflicts. Authors and users can override the defaults for the whole document or for individual objects by selecting an alternative.

Conflicts can propagate across object relationships. For example, if an object in a vertical list is enlarged, a sibling conflict might occur between the object and its closest neighbor. If the neighbor

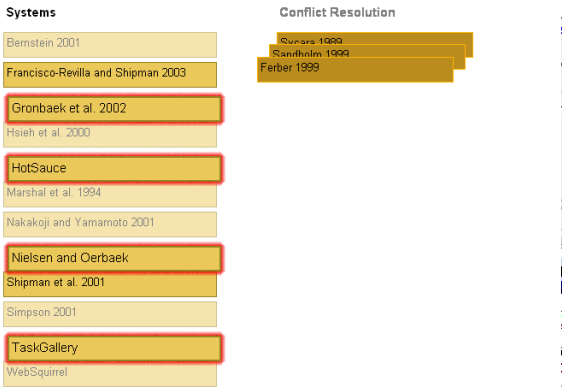

Figure 2. Adapted layout based after conflict resolution.

object is then moved in order to make extra space for the first object, it can cause a new conflict with the next object in the list. WARP resolves conflicts in the following order: object conflicts, parent conflicts, parent-child conflicts, sibling conflicts, and parent-parent conflicts.

Figure 2 shows the results of adapting the lists in Figure 1 using two models: a "writing a paper" task model, and a "preferred references" user model. In this case, the "References" collection (folder) has been removed and its contents moved to the top level. Four references are emphasized using a red glow, two remain the same, and two are de-emphasized by fading them out and reducing their font size. One model suggested emphasizing while the other suggested de-emphasizing the unchanged objects. The conflict was resolved by computing the weighted average of the suggestions. Also, the "Conflict Resolution" references have been piled together due to a parent conflict. The models assessed the relevance of these references as low. In order to maintain some presence of the structure as a whole, the resolution strategy decided to mutate the list into a pile (since piles take less space).

3. CONCLUSIONS

Multi-model adaptive hypertext addresses issues arising due to the complexity of developing single models that represent all relevant aspects of the use context and concerns over control and access to adaptation model content. Systems supporting independent models need to manage conflict among the models. We have explored a combination of conflict avoidance, conflict detection, and conflict resolution within WARP, a multi-model adaptive spatial hypertext. WARP uses the spatial parser to recognize the context of conflicts and takes advantage of the highly expressive nature of spatial hypertext to avoid and resolve conflicts.

4. ACKNOWLEDGMENTS

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