Achieving User Adaptivity in Hyperspace with HyperContext

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Abstract. HyperContext is a framework for adaptive and adaptable hypertext. In any hyperspace, each piece of information (e.g., contained in a document or *node*) is normally juxtaposed by other information via links. Two or more hypertext users may encounter the same document although they may have followed different paths to reach it. Those two users may well describe different aspects of the document as relevant to their needs and requirements. The HyperContext framework allows users to create different *interpretations* of information in *context*, which will also be available to future users. (Work adapted from [6])

1 Background

Adaptive Hypertext Systems (AHSs) [1] fall into two very general categories. We distinguish between domain-specific adaptive hypertext systems, such as AHS-based Intelligent Tutoring Systems (ITSs), and general-purpose AHSs. We cannot, without incurring great expense, as accurately model the user and the domain in general-purpose AHSs as can be achieved in narrow domain-specific ITSs. In HyperContext, a framework for general-purpose AHSs, we monitor the scope of a user's short-term interest through a construct named the *context session*. As long as the user is traversing through hyperspace within the same context session, and has not hyper-leaped out of it, we assume that she is* still searching for the same information, and that she has not yet located it.

In Information Retrieval (IR) systems, a document is frequently represented by a single vector of weighted terms, which may then be used to attempt to satisfy a large number of different requirements (see, for example, [4]). Although users are sometimes able to give relevance feedback [5], this information is normally used to modify the user's query, rather than to modify the document's vector representation. As a result, an IR system used by another user with an identical information need normally cannot take advantage of its previous users' experience to improve its quality of service, whereas a HyperContext hypertext can as its users record how the information they access is relevant to them.

2 HyperContext Overview

Interpretations permit a hyperspace to be partitioned as it is traversed. A context[1] in HyperContext is an arbitrary *container* in which data can be interpreted to acquire meaning. We minimally

[1] We use *context* in a similar way to McCarthy to mean an environment that enables data to be attributed with meaning [3].

associate context with a document and a link source anchor in the document. A document's out-links are associated with interpretations, so the same document in different contexts can have different out-links, or common out-links which have different destinations in each interpretation. This gives us the notion of a *context path*, a sequence of interpretations linked in some context. As a user browses through hyperspace, a node can be *contextually relevant* if it is on the same context path as the user and relevant to a user's interests. Other documents in the hypertext which are relevant to a user are *superficially relevant*. While a user browses through a hyperspace, the interpreted documents accessed on the path of traversal form the user's *context session*. A user browsing through hyperspace may make superficially relevant information contextually relevant by extending a link to it from any node in the context session.

Users searching for information are supported by three Information Retrieval mechanisms: *Traditional Information Retrieval* (TIR), *Information Retrieval-in-Context* (IRC), and *Adaptive Information Discovery* (AID). TIR enables a user to specify a query and presents the user with all relevant interpretations, regardless of context. IRC presents contextually relevant interpretations in response to a user supplied query. AID utilises a *short-term user model* to assimilate a user's short-term interest, based on the context session, and can automatically generate a query on behalf of the user. Superficially relevant information is recommended by AID to the user via "See Also" links. If, following a search, a user hyperleaps to a node containing superficially relevant information she is given the option to make it contextually relevant by extending a link to it from within the current context session, otherwise a new context session is initiated. On the other hand, HyperContext can guide the user to contextually relevant information by recommending links through the hyperspace.

The short-term user model is initialised at the beginning of a new context session. We distinguish between a long-term and a short-term interest. A long-term interest is one which persists across many context sessions, and perhaps lasts for weeks, months, or even years. A short-term interest is transient. It may extend over a small number of context sessions, but it is unusual for it to last for long, although short-term interests can develop into long-term interests. We express the user's short-term interest as a function of the interpretation of documents that the user has seen in the current context session. The user's perceived interest in the current document is represented as a *salient interpretation*. Salient interpretations are combined in the user model according to a weighted *scale of confidence* in the salient interpretation's usefulness in identifying a relevant document.

3 HyperContext Supports Adaptable Hypertext

The HyperContext framework permits a hyperspace to be adapted by its community of users to reflect how the information is actually consumed. Users are able to reuse information, regardless of who authored or "owns" the information, by creating new links between existing nodes. Users are also able to describe the information in the destination node which is relevant to them, to provide an interpretation of the information in the node. Each interpretation of a node is represented by a vector of weighted terms. The parent node containing the link source anchor and the link itself provide the context in which the destination node will be interpreted whenever it is accessed via that link. The interpretations of a node collectively reflect the different ways of describing the information contained in the node.

The interpretations of information are searchable and retrievable through an interface between the HyperContext framework and an external information retrieval system. The HyperContext prototype interfaces with SWISH-E [2], which provides external information indexing and retrieval services to HyperContext. When a user searches for information, HyperContext invokes the external

IR system and retrieves *interpretations* of documents which are relevant to the query. Depending on which search mechanism the user invoked, HyperContext will either present the user with a ranked list of relevant interpretations (TIR), or it will guide the user to a contextually relevant interpretation by recommending links to follow along a context path (IRC). Non-adaptive hypertexts normally cannot guide users to information without the hypertext author having first created a purpose-built trail. On the other hand, adaptive hypertext systems can guide users to relevant information using trails or paths of traversal frequently travelled by previous users. However, in HyperContext we distinguish between contextual relevance and superficial relevance to guide users to relevant information along a context path which other users have previously created.

4 Adapting to the user

A benefit of adaptive hypertext systems is that they are able to automatically or semi-automatically determine a user's interests [1]. In HyperContext we distinguish between a user's short-term interest and her long-term interest. We assume that a user is likely to require greater support in her search for information to satisfy a short-term interest, because she is likely to be unable to accurately represent her information need. We must also detect when the topic of a user's short-term interest has changed, otherwise our representation of the user's interest may be contaminated by no longer relevant information.

We construct a model of the user's short-term interest based on the interpretations of nodes that she has accessed in the context session, assuming that each accessed interpretation in the context session is only partially relevant to her information need (otherwise she would have located the required information and terminated the context session). As an accessed interpretation is considered only partially relevant to the information need, we establish which terms are likely to be relevant and the degree to which they are relevant by deriving a *salient interpretation* of the node. The salient interpretation is derived using a modification to the Rocchio relevance feedback method, which compares the accessed interpretation of a node to all the other interpretations of the same node to establish which terms are likely to best represent the user's interest in the node. A *scale of confidence* is used to weight each salient interpretation of the interpretations accessed during the context session, to reflect HyperContext's confidence in each salient interpretation's ability to contribute information about the user's short-term interest. The weighted salient interpretations are finally combined as a model of the user's short-term interest.

The Adaptive Information Discovery (AID) search mechanism is an autonomous tool which, if active, generates a search query on the user's behalf by extracting terms from the short-term user model. The user can be guided to information that is contextually relevant as well as being presented with a list of superficially relevant "See Also" references.

5 Evaluation and Results

HyperContext was evaluated in 2000 [6]. We automatically selected a series of documents in a number of context paths and then, for each context path, used Adaptive Information Discovery to search for a relevant document. Additionally, a non-adaptive technique was used to create a query to search for a control document for each path. Users were asked to read the documents in an entire context path and then provide relevant judgements for each of the AID-selected and control documents. The AID-selected document was given a higher or equal relevance judgement a statistically significant number of times. The experiments will be repeated in 2003 on a reconstructed implementation of HyperContext.

6 Conclusion

The HyperContext framework is the result of research which crosses the boundaries of the domains of adaptive hypertext, hypertext, user modelling, information retrieval and context. We believe we have contributed to the area of adaptive hypertext by incorporating automatic relevance feedback mechanisms into the derivation of the model of the user's short-term interest. We also believe we have extended research into adaptive hypertext systems by incorporating explicit representations of context into hypertext systems which permits multiple interpretations of the same information to be represented and manipulated to give individual users adaptive navigation support. These conclusions are supported by the experimental results obtained from an implementation of the important adaptive features of the HyperContext framework.

References

1. Brusilovsky, P., 1998. *Methods and Techniques of Adaptive Hypermedia*, in P. Brusilovsky, A. Kobsa, and J. Vassileva (eds), *Adaptive Hypertext and Hypermedia*, Netherlands: Kluwer Academic Publishers, 1-43.
2. Hughes, K., 1994. *SWISH-E: Simple Web Indexing System for Humans – Enhanced*. Current version available at `http://swish-e.org/` (29^{th} June 2003).
3. McCarthy, J., and Buvac, S., 1994. *Formalizing Context (Expanded Notes)*, Technical Note STAN-CS-TN-94-13. Stanford University.
4. Baeza-Yates, R., and Ribeiro-Neto, B., 1999. *Modern Information Retrieval*. USA: ACM Press.
5. Rocchio, J. J., 1971. *Relevance Feedback in Information Retrieval,* in G. Salton (ed.), *The SMART Retrieval System – Experiments in Automatic Document Processing*. Englewood Cliffs, USA: Prentice Hall, Chapter 14.
6. Staff, C. 2001. *HyperContext: A Framework for Adaptive and Adaptable Hypertext*. PhD Thesis. School of Cognitive and Computing Science. University of Sussex.