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Information Processing and Management 42 (2006) 1185–1202
INFORMATION PROCESSING & MANAGEMENT
www.elsevier.com/locate/infoproman

Using searcher simulations to redesign a polyrepresentative implicit feedback interface

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Received 27 November 2005; received in revised form 17 February 2006; accepted 17 February 2006

Abstract

Information seeking is traditionally conducted in environments where search results are represented at the user interface by a minimal amount of meta-information such as titles and query-based summaries. The goal of this form of presentation is to give searchers sufficient context to help them make informed interaction decisions without overloading them cognitively. The principle of *polyrepresentation* [Ingwersen, P. (1996). Cognitive perspectives of information retrieval interaction: elements of a cognitive IR theory. *Journal of Documentation 52*, 3–50] suggests that information retrieval (IR) systems should provide and use different cognitive structures during acts of communication to reduce the uncertainty associated with interactive IR. In previous work we have created *content-rich* search interfaces that implement an aspect of polyrepresentative theory, and are capable of displaying multiple representations of the retrieved documents simultaneously at the results interface. Searcher interaction with content-rich interfaces was used as implicit relevance feedback (IRF) to construct modified queries. These interfaces have been shown to be successful in experimentation with human subjects but we do not know whether the information was presented in a way that makes good use of the display space, or positioned most useful components in easily accessible locations, *for use in IRF*. In this article we use simulations of searcher interaction behaviour as design tools to determine the most rational interface design for when IRF is employed. This research forms part of the iterative design of interfaces to proactively support searchers.
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Keywords: Searcher simulations; Interface design; Implicit relevance feedback; Polyrepresentation

1. Introduction

The principle of polyrepresentation (Ingwersen, 1996; Ingwersen & Järvelin, 2005) suggests that representations of different cognitive structures should be offered to searchers, and used by them during their interaction with an information retrieval (IR) system. The cognitive structures around which polyrepresentation is based are manifestations of human cognition, reflection or ideas. In IR they are typically transformations

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doi:10.1016/j.ipm.2006.02.005

generated by a variety of human actors with a variety of *cognitive origins*. Author text, including document titles and their full-text are representations of cognitive structures intended to be communicated. These portions of text have different *functional origins*; they have the same cognitive origin but were created in a different way or for a different purpose.

Polyrepresentative theory has generally been implemented through plausible inference techniques applied on networks of document representations (Turtle & Croft, 1990), or across networks of citations where those who cite documents have unique cognitive structures (Larsen & Ingwersen, 2002). While such research may benefit searchers, more work is needed to investigate the value of polyrepresentative principles in interactive IR (IIR). Belkin, Cool, Croft, and Callan (1993) established that the polyrepresentative extraction of information needs is potentially more effective than eliciting the solitary, isolated query statements gathered by most IR systems. In a similar way, offering thesauri (Jones et al., 1995) and clarification forms (Kelly, Dollu, & Fu, 2005) during query formulation have been shown to lead to more effective query statements. Other techniques, such as relevance feedback (RF) (cf. Salton & Buckley, 1990), where searchers indicate relevant documents to the system, are often under-utilised due to the additional cognitive burden they impose on searchers. Eliciting more expressive information need descriptions from searchers in these ways may improve retrieval but they depend on searchers' ability to explain their information problem, or impede on their search.

This article describes a stage in the development of a prototype search interface based on polyrepresentative principles. Interaction with this interface is used as implicit relevance feedback (IRF) (Kelly & Teevan, 2003) to generate improved query statements that can be used to restructure or recreate search results. In stage one we ran a comparative simulated study to choose the IRF model to underlie the interface (White, Ruthven, Jose, & Van Rijsbergen, 2005b). In stage two we ran a large study with human subjects to determine how interface support for the model we chose should be offered (White, Ruthven, & Jose, 2005a). In the study presented in this article (stage three) we use searcher simulations to help us make decisions about how the interface could be redesigned to make IRF more effective. Interface (re)design is usually based on user involvement in the design process. User-centered design (Rubenstein & Hersh, 1984) is the most commonly adopted approach in IIR research; experimental participants are placed in a reacting role to experimental systems devised to address research questions (Muller, Wildman, & White, 1993). However, user studies can be costly to arrange and run. In this article we demonstrate how simulations of some aspects of searcher behaviour can be used as tools to directly influence interface design decisions, potentially reducing the costs of IIR experimentation. Some of the simulations are tuned using interaction logs from the stage two study, and results are used to inform the construction of the most rational implicit feedback interface (i.e., the interface design deemed most effective when interaction with it is used for IRF).

The prototype interface used in stage two (shown in Fig. 1) takes a searcher-provided query, submits it to a search system, retrieves the top-ranked documents, and extracts and dynamically creates sets of different document representations for presentation to the searcher. The interface implements a progressive revealment strategy where searchers can access an increasing amount of retrieved document content at the interface to help them decide whether they want to view its full-text. They do this by following interactive *relevance paths* between representations created from the same document; interacting with a representation guides the searcher to the next representation in the path or the full-text of the source document. Hovering over some representations with the mouse pointer, or clicking on icons next to others, prompts the interface to highlight the next step in the relevance path. Showing searchers progressively more information about a document to assist relevance assessment has already been used in related work (Paek, Dumais, & Logan, 2004; Zellweger, Regli, Mackinlay, & Chang, 2000). Clicking on the text of a representation takes searchers directly to the source document. The traversal of these paths is used by an IRF model to select terms for query expansion. The model used is based on Jeffrey's rule of conditioning (Jeffrey, 1983), and has been shown in the simulation-based study in stage one to be more effective on our style of interface than other feedback algorithms (White, Jose, Van Rijsbergen, & Ruthven, 2004, 2005b).

To evaluate the components on this interface (i.e., representations and relevance paths) we need a method that is both: capable of providing objective evidence on their effectiveness, and allows us to vary and control how these components are used during the study to test them in a variety of ways. The richness of the potential set of interactions with this interface coupled with the fact that all searcher interaction is regarded as a source of RF, means that searcher simulations that extend the standard Cranfield model (Cleverdon, Mills, & Keen,

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