Supporting user of information retrieval systems by visualizing the information dialog context

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ABSTRACT
In this paper we present first results for a new approach designing innovative user interfaces for information retrieval systems. The leading thought of this paper is based on the fact that a dialog between user and system during a search process establishes an information dialog context. We introduce a framework for information retrieval systems to handle the activities and sets elaborated within a search process in order to support the user. In this paper we present a prototype tool which provides and visualizes sets of information objects in order to bring users into the position to keep the developed sets within the search process at hand and actively manage them. Finally, a description of a user study and expert interviews and their evaluation results conducted on the basis of the prototypical tool is provided.

Categories and Subject Descriptors
H.3.3 [Information Search and Retrieval]: Search Process; H.3.7 [Digital Libraries]: User Issues

General Terms
Design, Experimentation, Human Factors

Keywords
interactive information retrieval, dialog, information visualization, search process, user interface, framework, prototype, evaluation

1. INTRODUCTION
Information retrieval (IR) is primarily the search for information objects. The number of information objects has grown rapidly in the last years and new working areas for IR have arisen [7]. When we speak about information retrieval, we have to distinguish between two reasons for information search. One need is the quick retrieval of a few special, perhaps known, information objects (known-item-search). The other need is to collect information objects within a search task to solve a problem by alleviating an information deficit. For this case the cognitive load of users rises with the complexity of the search task. From this awareness we have to infer that it is necessary to support this process with innovative and new user interfaces and services. Therefore, users need tools to visualize and manage the whole search task in an easy way. In modern user-centred models (e.g. [1]), the search process is the focus of research. But a search process requires a high degree of readiness for a dialog between system and users, because only an information dialog can determine uncertainties in the interpretation of information objects or changes in the information needs of users [10]. Therefore, [2] and [9] have described the dialog character of search processes in their research. It becomes clear that the information dialog and the resulting information dialog context are important elements in the search process, because they help to substantiate the information need of users and the system can interpret the information need better.

In the following section, we briefly outline the overall idea of our research and introduce a framework for information retrieval and digital libraries systems with visual interfaces. A prototype tool which is based on the new framework will then be introduced. Finally, we describe a first pre-testing experiment, present and discuss its results.

2. FRAMEWORK FOR INFORMATION RETRIEVAL SYSTEMS

2.1 Background
Landwich [5] outlined in his conceptual model, the information retrieval dialog as a cycle driven by information activities. The results of these information activities are therefore, e.g., sets of information objects, visualizations or assessments. These activities and finally result displays including visualizations supporting informational assessments fill our information dialog context, as the basis for portraying the entire search process. It is only possible to develop user interfaces which support users in reducing their expressed uncertain state of information need if the essential activities and sets of information objects of a search task are defined. To support the cognitive abilities of the user, it is reasonable to visualize not only the results of a search, but also the information dialog context in all its facets. In order to de-
fine the dialog, we analyzed in earlier research ([4], [6]) the basic elements of the dialog of IR-systems and introduced a first explicit interactive framework with granular defined activities and sets of information objects.

2.2 Framework

In this section we would like to introduce a framework for IR systems (see figure 1) developed in UML (Unified Modeling Language). With this framework, we are able to manage the information dialog context. It consists of two major parts: the graphical front-end client (user interface) and a set of services in the backend.

The user interface contains three different functional modules. Each module can contain a collection of different tools. Two modules, query and visualization, are main components of many information retrieval systems. The third module, task manager, provides management functionalities for search tasks. With this module the user can define new tasks for each search process or resume a former created task. A defined task is a logical container for the information dialog context. The backend contains three services. The retrieval service manages the received queries and passes the results to the logging service and back to the user interface. The function of the logging service is to collect all explicit and implicit events (activities or sets of information objects) during the search sessions. To process these collected events, we need the context service. This service stores and retrieves events depending on search tasks in the task database and can build logical combinations for the visualization module of the user interface.

With such a framework, we have now full control of all user and system-triggered events and we are able to represent the information dialog context in all its facets. The potential of this framework is significant. We see many aspects for implementations to support users in reducing their expressed uncertain state of information need.

3. SYSTEM DESIGN AND IMPLEMENTATION

To verify the introduced framework, we developed a prototypical visualization which is easy to use. This prototype implements the visualization of the search history in order to bring users in the position to keep the developed sets within the seeking process at hand.

3.1 General Issues

The prototypical tool is integrated in the DAFFODIL framework [3]. It was implemented in Java following the classical Model View Controller paradigm. The underlying retrieval engine is Yahoo\(^1\). A logging service to log all activities and sets of information objects as well as a task manager have already been developed. The context service is currently under development.

3.2 Requirements

As in 2 outlined, the first requirement is a sensible selection of possible sets of information objects to visualize. [6] introduced all possible sets of information objects which already exist or can be created during a search process (see figure 2).

Figure 1: Architectural framework model for IR Systems with dialog-based visual user interfaces

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3.3 Prototypical User Interface Design

The user interface design of the prototype has five different sections providing support functions to the users. Figure 3 displays a screen shot of the prototype and the numbered sections.

In section 1 the user interface offers an input box to formulate the query. All boolean operations known from Yahoo are possible. The search button will initiate the execution of the query. The section beneath (2) is the area to visualize

\[^1\text{http://m.www.yahoo.com/}\]
4. EVALUATION

In recent years, there have been controversial opinions on the topic of evaluation (e.g., [8]). Because this work aims at supporting potentially complex search processes, performance measurement was not considered. Instead, only subjective data were considered an appropriate evaluation method in the first place. To evaluate the users’ perception of the user interface design and underlying support functions, a user study was conducted with a control group which completed a questionnaire. To find a meaningful information visualization technique for the user interface of the prototype, an initial evaluation was carried out. A recent work by [11] took up the specific problem of evaluating interactive information visualization in IR systems. In our evaluation approach, the first phase (evaluating scenario fundamentals) of his introduced process model was carried out.

4.1 Experiment

The underlying hypothesis for this experiment is: Users of IR systems feel supported by the visual presentation of the information dialog context. The hypothesis was divided into four sub-hypotheses and transposed into corresponding questions within a questionnaire. The study used a between-subjects experimental design. The first group performed searches using the prototype tool with the underlying Yahoo engine. The second group performed searches using the standard interface of Yahoo. Both groups had to perform a search motivated by a given topical information task. 10 subjects in group 1 and 8 subjects in group 2 participated in this experiment. Both groups were introduced in the search topic and were then required to perform the task. A questionnaire gathered information and values for this between-subjects experimental design. It was split into 4 sections: Demographic information/experience values, Support, Usability, and Comments. The section usability was split in 3 subsections: Ease of use, Ease of learning and Satisfaction. All assessments were gathered in a 5-point scale with 1=high and 5=low. Group 1 was instructed by practicing with the prototype tool until they were familiar with it. Next, the subjects of group 1 and 2 got detailed instructions about the experiment and the task. It was pointed out in particular that the goal of the tool was to support the whole search process and not only a single query. After that, subjects had to fill out the top part of the questionnaire with demographic information and experience values. Then, they performed the task with a time limit of 60 minutes. Afterwards, subjects had to complete the questionnaire.

4.2 Results

The areas of support and usability were measured by a collection of questions scaled in 5 points. The questions will match with subjective impressions of the subjects. We used the Levene Test ($\alpha = 0.05$) to verify the equality of variances. Depending on the result, we applied the T-Test for the significance of the mean difference between both groups. 15 of 21 variables showed a significant difference between both groups. In Chapter 5, these values will be interpreted in detail.

4.3 Expert Interviews

In this section we report about expert interviews. Three librarians and two natural scientists served as test persons. We assumed that these test persons know and use search tools in their daily work, and that they know several other IIR-Systems. Therefore, we expected that the experts can make profound comments. The experts could use all functions of the prototype tool and had the same training as all other test persons. The topics of the task were chosen individually by the test subjects and were to reflect a current interest. During the evaluation (time was limited to 60 minutes) all experts worked on their individual task. Generally, all experts gave positive feedback. The underlying idea of visualizing and controlling the elaborated sets of information objects was well accepted.

5. DISCUSSION

The results of our experiment demonstrate that the prototypical tool that we designed for search processes appears to have significant advantages over a standard system like
In the following sections, this statement is explained in detail. For the questionnaire section “Support”, in each of our variables, the group testing our prototype significantly outperformed the group using Yahoo, except for one variable. This section describes the main benefit of the prototype system. We have a significant conclusion that a search will not be easier using the prototype. This effect is probably a result of the higher concentration of visualized information and the unknown possibilities to manage the search process which were unknown up to that time. The degree of experience asked in the questionnaire show a high level except for the experience with digital libraries. This indicates a high validity of the assessments made by the subjects and heightens the overall validity of the experiment. For the questionnaire section “Usability” we have very mixed results. Only seven of twelve variables show a significant difference. In each of our variables for the subsections “Ease of use” and “Ease of learning”, the group testing Yahoo outperformed the group using the prototype tool. But all of these differences were lower than one (<1). In the subsection “Satisfaction” we have contradictory results. In each of these variables, the group testing our tool outperformed the group using Yahoo. The prototype tool was new to the subjects, since they had to learn to handle and to interpret the new functions and visualizations, these results are predictable. In consideration of the fact that the values themselves range on a high level and the differences between the groups are low, we can attest a good usability. The comments made in the questionnaire correspond with the identified results. Subjects were positively surprised by the ability to control their whole search and the resulting information objects. Relations between different kinds of sets (e.g. all not visualized information objects) found interest. Different suggestions for improvements were made. All results show a significant benefit in handling the growing information dialog context of a search process with the prototype tool. The section “Support” of the user study and the expert interviews strongly corroborate our hypothesis. The lower values of the variables in the subsections “Ease of use” and “Ease of learning” could probably be interpreted as a higher cognitive imposition. But in the case of many insignificant values and low differences between both groups, these results do not weaken our hypothesis.

6. CONCLUSIONS

In this paper we presented first results for a new approach to an innovative user interface for information retrieval systems. The leading thought bases on the fact that only a dialog between user and system can establish a necessary information context in order to satisfy an information need. From this central thought we introduced a theoretical framework which led us to an enhanced model for information search processes. On basis of the theoretical framework and the model we hypothesized that user of IR systems feel supported by the visual presentation of the information dialog context. To see whether our prototype system would truly support human information seeking better than a standard system like Yahoo, we conducted a user-oriented experiment. The experiment compared the assessments of subjects divided into two groups performing a given search task. We also interviewed experts after they tested the new system. The results of the experiment demonstrate that the user feels significantly supported by the prototype system in values of support and usability. These results speak strongly in favor of the general concept of designing IR systems explicitly to be able to support the management and visualization of the information dialog context. Through this experiment, we feel encouraged to deepen our research. In the next step we will set up an objective experimental model to measure values for the reduction of the cognitive overload. Furthermore we will refine the prototype under the aspect of the results and the made suggestions for improvement. Implementations for the realization of other aspects (see section 2.2) of our framework are planned.