Personalized Navigation in the Semantic Web ⋆

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Abstract. Effective navigation and information retrieval is difficult and time consuming due to the increasing size of hyperspace. The introduction of the semantic web allows us to enhance traditional search methods with semantic search capabilities that take advantage of machine readable semantic information ideally stored in an ontology. Nevertheless issues concerning the user-friendly construction of search queries and a simple yet effective presentation of search results must still be addressed. The proposed approach takes advantage of adaptive hypermedia in an enhanced faceted browser capable of dynamically adapting the set of available facets with additional support for data retrieval from an ontology and adaptive annotation of search results.

1 Introduction

By definition, navigation is the process of following links and browsing web pages. At present, navigation is necessary because it is not (yet) normally possible to satisfy all user needs on a single web page or on the first visited web page. Generally speaking, user needs can be classified into the following types (see [1]):

- Informational, when the user seeks information
- Navigational, when the user seeks a starting point for further browsing
- Transactional, when the user wants to perform an action

In order to fulfill either type of need a user typically first enters a query into a search engine to find a list of the most relevant pages. Next, he selects the most promising links and initiates a navigation session that involves the browsing of the selected web pages. If the respective need cannot be satisfied, the user modifies the original query and starts from the beginning.

Several studies have shown that the recursion rate of navigation is roughly 60% (see [5]) and describes the number of repeatedly visited pages to the total number of visited pages. Furthermore, the shift from the use of closed and relatively small information spaces towards large, open and ever growing information spaces is bound to further escalate this problem. Perhaps a good example of such an open information space is the domain of job offers on the Internet.

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Problems and issues. We intend to address several contemporary navigation problems with the proposed approach. These include the navigation in open and relatively large information spaces, which is too time consuming and often results in the "lost in hyperspace" syndrome that occurs when users loose track of their position in hyperspace due to insufficient navigation aids or because the hyperspace is "too large".

While the problems of effective searching and information retrieval in these spaces can be addressed by semantic search (see [4],[7]) this requires the use of more complex queries than full-text search. As a result, new user-friendly ways of query construction and simple yet effective methods for the presentation of search results must be employed. Adaptive hypermedia technologies (see [2]) can be used to make it easy for users to read and understand the results and allow them to quickly choose the most promising ones for further navigation.

Proposed approach. We propose the use of a faceted browser[1] as a viable solution for the aforementioned problems. While we are primarily interested in large information spaces with many similar instances represented by a domain ontology with semantic markup (e.g., OWL), the proposed approach should also be applicable to other areas.

The faceted browser is based on a classification ontology that describes important aspects of instances from a domain ontology, which are then used to define restrictions on the instances. The user can reduce the total number of displayed instances by enabling one or more restrictions thus decreasing the size of the visible information space. Individual restrictions can be further combined to form complex restrictions allowing the user to perform more precise queries.

The advantages of ontologies are twofold. First, it is easier to create a classification ontology from a domain ontology than from unstructured data and it should also be possible to automate this process. Second, reasoning on ontologies allows us to perform "more complex" queries with higher quality results.

Large information spaces and additional data obtained by reasoning on ontologies would result in too much information thus overloading the user with information. To address this issue we propose personalization and user adaptation as means of reducing information overload by focusing on current user needs and goals defined by a user model.

2 Further research

Based on the initial outline there are three major areas of research that we intend to explore. The most interesting are the facets, their dynamic generation from a domain ontology and their adaptation based on a user model. Also interesting are the possibilities of presentation and simple processing of search results and instances from the ontology e.g. by means of adaptive annotation techniques.

[1] Use of Faceted Classification,
http://www.webdesignpractices.com/navigation/facets.html (2.2.2006)

Lastly, a visual representation of the navigation history in the form of a (hyper)graph appears to have some potential in improving the users understanding of hyperspace.

While all three of these areas are likely to use a user model as the primary source of adaptation, it appears to be an interesting research prospect to evaluate the usability of the observed user navigation and history data as an additional source of adaptation.

2.1 Facets

Adaptation of predefined facets. The adaptation of predefined facets includes adaptive navigation techniques like reordering, hiding (see [2]) and the presentation of facets and restrictions in these facets. An interesting aspect of meta-data navigation and presentation is the fact that facet contents can be presented as enumerated lists or as graphs created by OWL visualization tools.

For example, in the case of the job offer ontology, if a user was interested in high paying jobs with specific experience requirements, the facets including these restrictions would be displayed first. Less important facets or restrictions that are assumed to be irrelevant would be either shown later or completely hidden.

Dynamic facet generation. Dynamic generation of facets goes one step beyond simple adaptation as described above. Ideally it will be able to create new facets and the respective restrictions at run time based on the knowledge contained in the domain ontology and in the user model. This feature would also improve on the usability of the faceted browser with different domain ontologies which would thus not require extensive manual definition of facets.

If we consider the previous example and assume that a facet for experience level requirements was not yet defined, dynamic facet generation would be able to create a new facet definition if experience levels were present in the domain ontology. This facet would then be displayed together with the salary and experience requirements facets in the top part of the facet list.

Advanced query mode. The selection of individual restrictions in facets is transformed into a query that is executed on an ontological database. In simple query mode, exactly one restriction per facet can be selected and all facets are combined by the logical AND function resulting in relatively simple queries.

With the proposed advanced query mode we plan to enable the user to create and execute more complex queries with multiple restrictions per facet thus giving him options for a more precise description of the desired instances. We also plan support for other facet combination functions than the implicitly used AND function. The logical OR function and braces "(", ")" appear to be the most obvious alternatives, but others might prove to be just as interesting.

If we extend the above example with a user who wants a job either in the U.S. or in Canada, the advanced mode allows him to select both USA and Canada as restrictions in one facet Region and combine them with the OR function.

2.2 Presentation and processing

The result of a search performed by a faceted browser is normally an unordered list of instances that satisfy the search criteria. This however is not ideal for effective evaluation of the search results by the user. Additional means for processing of the search results are necessary to improve usability. We intend to add simple ordering of search results as well as support for more complex external sorting tools and several adaptive views with different levels of detail (see [3]). The possibility to compare the attributes of the selected instances (search results) also seems to be good for improving usability.

While sorting can only display the rating of instances with regard to one attribute or a combination of attributes (a single composite attribute), a user will often be interested in several attributes. The use of adaptive annotation techniques (see [2]) to present these attributes appears to be a promising direction for further research.

For example, in the domain of job offers background color can indicate how well a user satisfies the requirements of the employer, an emoticon can indicate how well a job offer satisfies user criteria, while the job offers are ordered in descending order based on the offered salary. A traffic light signal can indicate a composite suitability rating of a job offer based on a heuristic function or the overall rating of the employing company by previous applicants.

2.3 Enhanced faceted browser

So far we were primarily concerned with the features and functionality of a faceted browser. From a users standpoint however, the usability of a tool is not only defined by the array of available functions but also by the usability of its graphical user interface. While this concerns a somewhat different area of research we designed an initial outline of a user interface for an enhanced faceted browser (see Figure 1).

3 Summary

We proposed an enhanced faceted browser as a solution for several navigation and search related problems. Our current (basic) implementation of a faceted browser supports the use of simple search queries in conjunction with an ontological database and the browsing of search results (job offer instances). To evaluate the usability of the browser and the viability of the proposed concept as well as to gain feedback from sample users we will test the browser in the domain of job offers within the scope of a larger project conducted at the Slovak University of Technology (see [6]).

Further work will include enhancements to facets – more predefined facets, their adaptive reordering and hiding and dynamic facet generation based on a user model and domain ontology. We will also explore the possibilities and usefulness of more complex queries. Enhancements to the presentation of search results will include simple processing options – comparing, sorting, highlighting, views and support for adaptive annotation based on a user model.

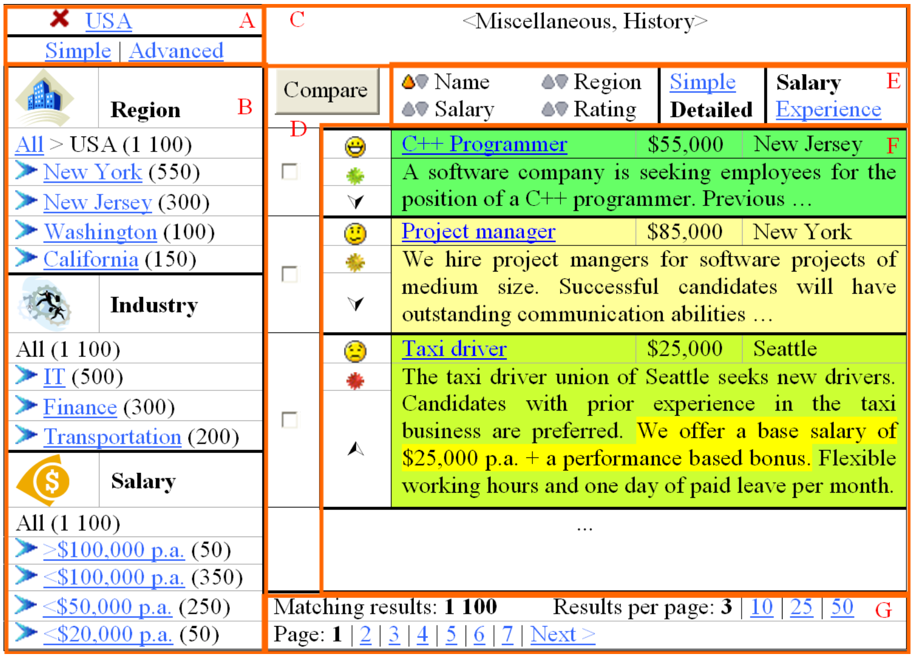

Fig. 1. A sample user interface of an enhanced faceted browser. Areas A shows the currently selected restrictions, area B contains the available set of facets (Region, Industry, Salary) and restrictions. Area C contains miscellaneous data, like navigation or query history and additional settings. Area D is used to compare a set of instances while area E allows the user to sort instances, change views or highlighting options. Area F displays individual instances (search results) and depicts instance data enriched with adaptive annotation techniques (emoticons, background color, traffic lights). Area G serves for navigation between different results pages.

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