Ontology-supported Exploratory Search for Physical Training Exercises

Michael Kotzyba[1], Denis Ponomaryov[2], Thomas Low[1], Marcus Thiel[1], Birte Glimm[2], and Andreas Nürnberger[1]

[1] Data and Knowledge Engineering Group, Otto von Guericke University Magdeburg, Germany <firstname>.<lastname>@ovgu.de
[2] Institute of Artificial Intelligence, University of Ulm, Germany <firstname>.<lastname>@uni-ulm.de

Abstract. In order to provide a qualitative support to the users during a web search, it is important to have access to a multitude of information sources simultaneously. Depending on the available domain expertise, the user can get an overview and insight to different information perspectives and compare the quality of resources. In this work, we present an exploratory search engine that simultaneously accesses internet resources and a local knowledge base given in the form of ontologies. The ontologies are used to define the search context and can be extended during exploration with new information, thus making the search process adaptive and iterative. We demonstrate our system on an example from the fitness domain, where the user searches for physical training exercises on the Web to complete a personal training plan.

1 Introduction

To address the increasing variety of information published on the Web, different techniques have been developed to support users in information retrieval (IR). Index structures allow for searching for arbitrary keywords, query suggestions help the user in formulating the information need, summarizing surrogates and thumbnails facilitate preselection, while personalization helps to increase search performance. With the development of the Semantic Web and the increasing amount of domain-specific ontologies, more advanced techniques for IR have appeared that make use of semantics to support the user during search.

We present an implementation of a search engine, that accesses internet resources and local ontologies simultaneously to support the user during exploratory search, and allows for extending a personal ontology on demand. We illustrate how the system works with a use case from the fitness domain, where a user is creating a training plan using a fitness planner. A user searches for a specific fitness training exercise, because the exercise is not yet listed in the knowledge base of the fitness planner. The general approach, namely to search for missing information to complete a knowledge base and simultaneously use the same knowledge base to support the user, is of course not limited to this scenario. A demonstration video of the application is available at `http://www.dke.ovgu.de/ISWC2015.html`.

2 Related Work

Ontologies are traditionally used to support information retrieval tasks. Crampes and Ranwez [1] discuss strategies and formulate principles of conceptional navigation based on ontologies with the goal of improving navigation in the Web. Yang et al. [2] propose an ontology-based FAQ system, which processes user queries to enhance ranking techniques. Yang and Ho [3] show that user models can be improved by using domain-specific ontologies. The system by Fensel at al. [4] operates with Web resources and employs background ontologies to provide a homogeneous access to information. Keeping in mind the complexity and variety of Web resources, it still cannot be guaranteed that no important information is omitted when using the homogeneous access. In contrast, our approach allows for exploring not only Web resources, but also the content of background ontologies contained in the system, which can be dynamically extended with user-specific knowledge. Thus, we argue that instead of an accumulated, homogenous view, a separated view for the ontological knowledge is required in order to improve search effectiveness and user experience.

3 Ontology-supported Exercise Search

We consider a scenario in which a user interacts with a system designed to provide personal training assistance. The system contains knowledge about the fitness domain which forms the basis for suggestions of training programs to the user. The system stores a list of fitness exercises that can be combined into training programs and is open for updates from external information sources available on the Web. In the demo, we address the situation when a user wants to add a new exercise to the system's knowledge base in order to use it in an individual training program. The user initiates an online search for spine therapy exercises, which is guided by the system knowledge base given as a collection of ontologies. This search can be categorized as exploratory search [5,6], since the user is not sure about a specific exercise to search for, and thus needs support in exploring possible alternatives.

3.1 Ontologies

The core component of the system's knowledge base is the domain ontology. It contains categorized exercises, each of which is provided with textual descriptions such as preparation, execution, and comment. For every exercise, the required fitness equipment, as well as corresponding target and synergist muscle groups are specified, and a link to an animation is provided, which depicts how the exercise is performed. The list exercises in the domain ontology is a subset of exercises published at ExRx.net[1].

[1] ExRx (Exercise Prescription) on the Internet `http://www.exrx.net`

The second component is the user specific ontology, which mimics the domain ontology, but contains only those exercises that have been added to the system during the search process. Initially, the list of exercises in this ontology is empty.

Finally, the third component of the system's knowledge base is the DBpedia ontology [7]. For performance reasons, in our demo this ontology contains a subset of DBpedia derived from the seed concepts "physical exercise" and "physical therapy" and all related entities to the 2nd degree. The subset of the DBpedia ontology consists of 4375 entities.

3.2 Demo Application

To demonstrate the approach of the ontology-supported exploratory search, we have implemented an application for the use case described above. The whole interface is implemented as a Web application. At first, the user can choose available information sources such as Web search APIs, local sources, and ontologies. Furthermore, a color legend specifies possible annotations and their corresponding ontologies.

A schematic illustration of the main search interface is given in Figure 1. The search field is placed at the top. While typing the search query, the system provides suggestions based on the available ontologies. When the query is submitted, the system triggers search in all chosen information sources. Search results retrieved from the ontologies are shown directly below the search input. Here the title and the corresponding super concept of an entity, e.g. for a physical exercise or a DBpedia entity, is shown. On mouse over, a tool-tip with further information such as preparation and execution of the exercise or a general description of the DBpedia entity is faded in.

Web search results are presented in the center of the interface. Each result is accompanied with a title, summarizing text, URL, Web page thumbnail, and a list of annotations. Annotations indicate terms that appear in the content of the Web page and as a concept in one of the ontologies. The annotations are colored in accordance with ontologies, where the concept appears. By hovering over an annotation, the word and its surrounding context on the Web page is shown.

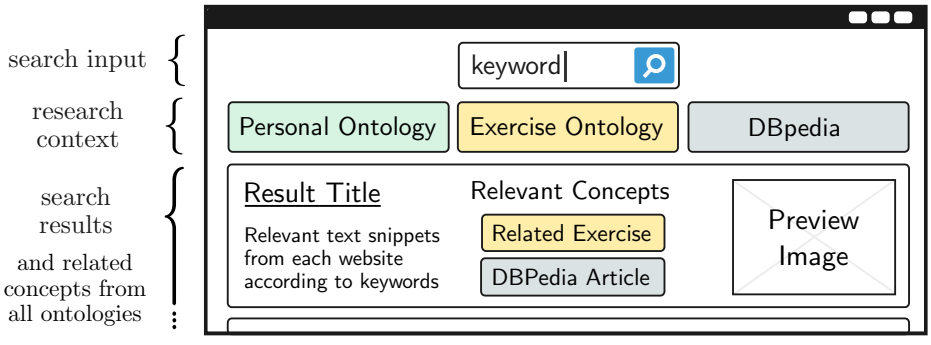

Fig. 1. Main search interface as schematic illustration.

When a Web page is opened, the user can select and transfer information about a relevant physical exercise from the page's content to the system in order to check whether the exercise is already present in one of the ontologies. If the retrieved exercise is new, the user can add it to the personal ontology, e.g. to complete the personal training plan.

4 Conclusions and Future Work

Domain ontologies are a helpful means to support users during a Web search in a specific context. In this work, we presented an approach to search in several information sources, such as ontologies and the Web, simultaneously. For demonstration we have chosen a use case where a user searches for physical training exercises to complete a personal training plan. For future work, a user study to analyze the usage of the different information sources and the process of information extraction can reveal new insights. Furthermore, it is interesting to investigate different methods of extension of the initial domain-specific ontology with information from the search results.

Acknowledgments

This work was done within the Transregional Collaborative Research Centre SFB/TRR 62 "A Companion-Technology for Cognitive Technical Systems" funded by the German Research Foundation. We would like to thank the contributors of ExRx.net for the permission to use a subset of the published exercise library.

References

1. M. Crampes and S. Ranwez. Ontology-supported and Ontology-driven Conceptual Navigation on the World Wide Web, Proc. of the Eleventh ACM on Hypertext and Hypermedia, HYPERTEXT '00, ACM, P. 191–199, 2000.
2. S. Yang, F. Chuang and C. Ho. Ontology-supported FAQ processing and ranking techniques, Journal of Intelligent Information Systems, Vol. 28, Nr. 3, Kluwer Academic Publishers-Plenum Publishers, P. 233–251, 2007.
3. S. Yang and C. Ho. Ontology-supported user models for interface agents, IEEE expert, 1996.
4. D. Fensel, J. Angele, S. Decker, M. Erdmann, H. Schnurr, S. Staab, R. Studer and A. Witt. On2broker: Semantic-Based Access to Information Sources at the WWW, Educational Resources Information Center (ERIC), 1999.
5. G. Marchionini. Exploratory search: from finding to understanding, Communications of the ACM, Vol. 49, ACM, P. 41–46, 2006.
6. T. Gossen, M. Nitsche, S. Haun and A. Nürnberger. Data Exploration for Bisociative Knowledge Discovery: A Brief Overview of Tools and Evaluation Methods, Bisociative Knowledge Discovery, Springer LNCS, P. 287–300, 2012.
7. J. Lehmann, R. Isele, M. Jakob, A. Jentzsch, D. Kontokostas, P. N. Mendes, S. Hellmann, M. Morsey, P. v. Kleef, S. Auer and C. Bizer. DBpedia – A Large-scale, Multilingual Knowledge Base Extracted from Wikipedia, Semantic Web Journal, IOS Press, 2014.