Supporting Exploratory Search in User Interface

Ilkka Kiistala
Department of Computer Science
University of Helsinki
ilkka.kiistala@helsinki.fi

Tuire Peurala
Department of Computer Science
University of Helsinki
tuire.peurala@helsinki.fi

ABSTRACT
Here we'll describe the content of our essay.

Author Keywords
Exploratory Search; Information Retrieval; User Modeling.

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

General Terms
Human Factors; Design; Measurement.

INTRODUCTION
In this literature review we introduce the problem of exploratory search and some solutions for the problem. We cover three techniques that help the user in succeeding in his exploratory search task efficiently. We explain what exploratory search is and what distinguishes it from other information retrieval tasks.

To build a good system where machine and a human cooperate to perform a task it is important to take into account some significant characteristics of people [18]. User model is built of these characteristics and traditionally it has been a model of a typical user [18].

In reality often the users vary so much that a traditional user model is insufficient and there is a need for a user model of an individual.

Define ES

[23]: In order to accomodate to differing needs of users or usergroups over time, a system may use one of three basic approaches. System is called adaptive if it alters it structure, functionality or interface on the basis of a user model generated from *implicit* user input. Adaptable systems use *explicit user input* and need user's active participation. Personalized system is a hybrid of the two aforementioned.

In the following chapter we introduce basic concepts, solutions and systems that we found exploring the literature. In the Discussion chapter we summarize our findings and point out what is missing and what we expect from future research. The Conclusion chapter summarizes our findings.

LITERATURE REVIEW
(User Modeling) [18], [5]

Exploratory Search
(Ilkka)

Introduction to exploratory search. [14], [29], [22]

The user interface of an exploratory search system should be designed to fulfill the needs of most of its users. More information on what works and doesn't work can usually be collected from system evaluations.

However, evaluating exploratory search systems is difficult, because users have different starting positions. Their knowledge of the domain varies, they are interested in different aspects of the topic and they have previously encountered different information. [13]

Exploratory search tasks can be characterized as either learning oriented or investigative and they have common aspects like uncertainty, ambiguity and discovery distinguishing them from look-up oriented tasks [12].

User Modeling
(Tuire)

To build a good system where machine and a human cooperate to perform a task it is important to take into account some significant characteristics of people [18]. User models are built of these characteristics and are used to adapt the system toward the user.

User models can be categorized in a three dimensional space (IMAGE?), where the axes are: single model vs. collection of models, explicitly specified models vs. models inferred by the system on the basis of user behaviour and long-term vs. short-term user models [18]. These three dichtomies are explained further in this chapter. There are also other differences on user models like the model lifecycle; in a system where there is only a single model it can be permanently embedded with the system but in the case where there are models for each individual user the model is built on the fly. This and many other differences follow from aforementioned three axes and are not distinguished as categorizing user models [18].

The *single model vs. collection of models* dichtomy [18] has on it's other end the single model of single user. The single user is called the canonical user and is actually not a real person at all but a modelled stereotypical user of the system. Traditional user models have been constructed by collecting

Second draft

data on an average user on various tasks and environments [18]. An example of a canonical user model is Fitt's law that suggests that the speed on which the user operates the machine can be increased by increasing the size of targets the user must hit. The major weakness of these kind of models is that they assume that all the users constitute a homogenous set. In most cases for the majority of users the system is better adapted to them that would be without any adaptation, but it isn't likely the best system that could be produced [18]. In the other end of this dichtomy is the collection of models of individual users. These users are real and the facts to build the individual model are gathered usually from the interaction of the user with the system. When choosing whether to use a canonical or individual user models one should think if the canonical model is sufficient or is the user community too heterogenous for it to be useful enough [18]. The decision on this axis influences the other aspects of user modeling. If one user model is used then it has to be designed only once and the system doesn't have to prepare for incorrect or conflicting user model information as the case is on the latter option.

The way how the user model is specified forms the second dichtomy mapping the user modeling techniques; *explicit vs. implicit models* [18]. On the explicit side the model is specified explicitly either by the system designer or by the users themselves. User model may be formed by letting the user modify the system but this leaves a lot on the hand of the user and fits badly to systems that expect to have lot of users that use the system only once or twice. Explicit user modeling can be done also by asking questions directly from the users but one problem with this is that users can't always answer on what the system needs to know. On the other end of the axis models are formed more subtly, they are inferred by the system only on the basis of user's behaviour. Implicit user models are built by gathering information of the user when the user interacts with the system. When constructing the user model implicitly the system must have some way of distinguishing incorrect information and resolving conflicts between gathered information.

In order to adapt soundly to the user the system must have wide variety of information about the user. The information might be ranging from short-term facts like the last query the user performed to more long-term facts like the level of mathematical sophistication of the user. This forms the third dichtomy: *long-term vs, short term user models* [18]. Long-term models can be built in the course of series of interactions between the system and the user and they might be used for example in a bookstore application to recommend books of certain genre for the user. Short-term user models could be built by gathering recent queries to build a model of the user's search goal. Short term user model is needed to respond to a situation where a user would need differentsearch results for searching with keyword Java after searching programming stuff or after the user has been searching beaches in Indonesia

In order to accomodate to differing needs of users or user-groups over time, a system may use one of three basic approaches [23]. System is called *adaptive* if it alters it structure, functionality or interface on the basis of a user model generated from implicit user input. *Adaptable* systems use explicit user input and need user's active participation. *Personalized system* is a hybrid of the two aforementioned. In personalized systems the output or appearance differs for every user or user group in every context [23]. The adapted output has the potential to be of great benefit for users; it is geared towards the user's preferences, behaviour or needs and it can make interaction easier and a lot more fruitful.

(oli: Personalization) Individualization of user models, Adaptive/Adaptable User Interfaces, intelligent user interfaces [2], [4], [1]

[23]: The evaluation of a personalized system is problematic because it is unclear if the results gathered from a few individuals who all used system personalized for them can be generalized to entire population of users.

[23]: The writers are researchers at University of Twente, Netherlands. They took a look at scientific articles about user-centered evaluation (UCE) studies of adaptive and adaptable systems. The articles they reviewed are from 2007 and before. They reviewed 63 studies. Of the systems in the studies, 37 % were adaptive, 27 % adaptable and the rest, 36 %, were both adaptive and adaptable. As a result of their literature review, they have modeled a process that can be used in evaluating a personalized system. The model they present, the iterative design process for a personalized system, has four phases based on how ready the system is. Based on their findings in the studies they reviewed, they connect the most useful methods to use and most appropriate variables to investigate in each phase. Overall, the article notes that the current UCE practice of personalized systems was found to be sloppy at times. They found that some of the questionnaires they reviewed were poorly designed and suggest that all the questionnaire data and log data as well should be made available so that a reader can judge the quality of the study. One reason they mention for low quality evaluations is that most evaluators of personalized systems are computer scientists and not specialized in evaluation.

Including adaptive elements in the user interface might increase the workload of the user. When users had two alternative interfaces to a menu, an adapted one and a full one, there was cognitive overhead in 1) having to decide which features to include in the personalized interface and 2) having to figure out a menu item was missing and that changing to the full interface would make it appear in the menu again [2].

(Kun tiedetn kyttjst jotain... jatketaan Solutions-kohtaan)

In the following subsections we cover three different solutions that support exploratory search: faceted search, relevance feedback and query expansion.

Faceted search

Information seekers often express a desire for a user interface that organizes search results into meaningful groups, in order to help make sense of the results and to help decide what to do next [7]. There two ways of grouping search results; clustering and hierarchical faceted categories. Clustering is grouping of items based on some similarity and is fully automated process. It is good for clarifying a vague query but the clustering algorithms aren't yet perfect and the clustering can be unpredicted [7]. Category system is a set of labels that are organized to mirror the domain. Hierarchical faceted categories are a set of hierarchical categories that each represent a different dimension. Categories are usually created manually but can be partly automated.

[12]:The writers had done a user experiment to find out what the searchers are looking at in a faceted search UI. The test participants were university students and the system of interest was a library system. As a result of the eyetracker test the writers found out that participants looked a lot at the facets and 47,4% of the eye movement was between facets, breadcrums summarising the selected facets and the result list. In an interview the participants told they used facets to help organize their view on the topic domain and select sub-topics for further investigation. Of these results the researchers deduced that the facets played an important role in the exploratory search process. The article summarizes related study on faceted search and exploratory search and has many interesting leads on articles for our essay topic.

Exploratory search is a complex information seeking task and to support this it has become accepted to use faceted search or categorized overviews [12]. Structured metadata is used to provide the user with an overview of the results and clickable categories. With this UI approach the user doesn't have to reformulate the query to narrow and browse the results. Faceted search is used in practice in library catalogs, web search, online shopping and other domains [12]. Faceted search enables the user to change fluidly between search and browsing and searchers with partially defined or changing information needs can use the overview to understand the knowledge domain and refine their needs. It has been shown that when using faceted search the users explored their results more broadly than without facets and felt more organized about their searches. Still though the faceted search interfaces make the search more efficient the subjects don't always prefer it [12].

- System examples

Relevance feedback

(also User Modeling) The goal of user modeling for a search system is to model a user's information need. The obvious source of information is the query. But as the queries tend to be quite short, especially when using a mobile device, the search words may not be a very accurate source of information for the user's information need. Much more data is available if user is given the opportunity to give feedback on the search results. This *relevance feedback* has been found to improve retrieval accuracy [19]. This, however, requires extra effort from the users and users are reluctant to make extra effort [8]. As [20] shows, user action data can be used to improve the search results without the extra effort. They collected all the actions the user did and used them to update the user model. This user model was used in customizing the ranking which the results were based on. - System examples

Query expansion

- System examples

DISCUSSION

In the Discussion chapter we summarize our findings and point out what is missing and what we expect from future research.

CONCLUSION

Goal, solution summary

Our goal was to explore the field of Exploratory Search and User Modeling. We found several articles that have some contribution to the topic.

Summary of results and their reliability

We found that: - Usage - Success - Failures

How much is it used in the real world, really?

Research impact - What has the research brought into software development?

REFERENCES

1. Brusilovsky, P. Methods and techniques of adaptive hypermedia. *User Modelling and User-Adapted Interaction 6*, 2-3 (1996), 87–129.
2. Bunt, A., Conati, C., and McGrenere, J. What role can adaptive support play in an adaptable system? In *Proceedings of the 9th international conference on Intelligent user interfaces*, ACM (2004), 117–124.
3. Dillon, A., and Watson, C. User analysis in hci the historical lessons from individual differences research. *International Journal of Human-Computer Studies 45*, 6 (12 1996), 619–637.
4. Findlater, L., and McGrenere, J. A comparison of static, adaptive, and adaptable menus. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, ACM (2004), 89–96.
5. Fischer, G. User modeling in human–computer interaction. *User modeling and user-adapted interaction 11*, 1-2 (2001), 65–86.
6. Hearst, M., Elliott, A., English, J., Sinha, R., Swearingen, K., and Yee, K.-P. Finding the flow in website search. *Communications of the ACM 45*, 9 (2002), 42–49.
7. Hearst, M. A. Clustering versus faceted categories for information exploration. *Communications of the ACM 49*, 4 (2006), 59–61.
8. Kelly, D., and Teevan, J. Implicit feedback for inferring user preference: A bibliography. *SIGIR Forum 37*, 2 (2003), 18–28.
9. Kobsa, A. Generic user modeling systems. vol. 11 (2001), 49–63.
10. Kobsa, A. *Generic user modeling systems*, vol. 4321 LNCS of *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. 2007.

11. Kuhlthau, C. C. Inside the search process: Information seeking from the user's perspective. *JASIS 42*, 5 (1991), 361–371.

12. Kules, B., Capra, R., Banta, M., and Sierra, T. What do exploratory searchers look at in a faceted search interface? In *Proceedings of the ACM/IEEE Joint Conference on Digital Libraries* (2009), 313–322.

13. Kules, B., and Shneiderman, B. Users can change their web search tactics: Design guidelines for categorized overviews. *Information Processing and Management 44*, 2 (2008), 463–484.

14. Marchionini, G. Exploratory search: From finding to understanding. vol. 49 (2006), 41–46.

15. O'Connor, B., Krieger, M., and Ahn, D. Tweetmotif: Exploratory search and topic summarization for twitter. *Proceedings of ICWSM* (2010), 2–3.

16. Pazzani, M., and Billsus, D. Learning and revising user profiles: The identification of interesting web sites. *Machine Learning 27*, 3 (1997), 313–331.

17. Pu, H. ., Chuang, S. ., and Yang, C. Subject categorization of query terms for exploring web users' search interests. *Journal of the American Society for Information Science and Technology 53*, 8 (2002), 617–630.

18. Rich, E. Users are individuals: individualizing user models. *International Journal of Human-Computer Studies 51*, 2 (8 1999), 323–338.

19. Salton, G., and Buckley, C. Improving retrieval performance by relevance feedback. *Journal of the American Society for Information Science 41*, 4 (1990), 288–297.

20. Shen, X., Tan, B., and Zhai, C. Implicit user modeling for personalized search (2005). 824–831.

21. Sugiyama, K., Hatano, K., and Yoshikawa, M. Adaptive web search based on user profile constructed without any effort from users (2004). 675–684.

22. Tvarožek, M. Exploratory search in the adaptive social semantic web. *Information Sciences and Technologies Bulletin of the ACM Slovakia 3*, 1 (2011), 42–51.

23. Van Velsen, L., Van Der Geest, T., Klaassen, R., and Steehouder, M. User-centered evaluation of adaptive and adaptable systems: a literature review. *Knowledge Engineering Review 23*, 3 (2008), 261.

24. Wei, B., Liu, J., Zheng, Q., Zhang, W., Fu, X., and Feng, B. A survey of faceted search. *Journal of Web Engineering 12*, 1-2 (2013), 041–064.

25. White, R. W., Bennett, P. N., and Dumais, S. T. Predicting short-term interests using activity-based search context. In *Proceedings of the 19th ACM international conference on Information and knowledge management*, ACM (2010), 1009–1018.

26. White, R. W., Drucker, S. M., Marchionini, G., Hearst, M., and Schraefel, M. C. Exploratory search and hci: Designing and evaluating interfaces to support exploratory search interaction. In *Conference on Human Factors in Computing Systems - Proceedings* (2007), 2877–2880.

27. White, R. W., Kules, B., and Drucker, S. M. Supporting exploratory search, introduction, special issue, communications of the acm. *Communications of the ACM 49*, 4 (2006), 36–39.

28. White, R. W., Marchionini, G., and Muresan, G. Evaluating exploratory search systems. introduction to special topic issue of information processing and management. *Information Processing and Management 44*, 2 (2008), 433–436.

29. White, R. W., and Roth, R. A. Exploratory search: Beyond the query-response paradigm. *Synthesis Lectures on Information Concepts, Retrieval, and Services 1*, 1 (2009), 1–98.