Preprint of: Joeran Beel and Bela Gipp. Enhancing Information Search by Utilizing Mind Maps. In Proceedings of the 21st ACM Conference on Hyptertext and Hypermedia (HT'10), pages 303–304, Toronto (CA), June 2010. ACM.

Enhancing Search Applications by Utilizing Mind Maps

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ABSTRACT
In this paper we present how sharing and utilizing mind maps could enhance search applications such as document search engines and recommender systems. In addition, we briefly present the first research results which indicate that mind maps can be used to determine document relatedness and therefore can enhance document recommender systems. We also discuss some challenges that information retrieval on mind maps will probably have to overcome.

Categories and Subject Descriptors
H.3.3 [**Information Storage and Retrieval**]: Information Search and Retrieval – *information filtering, retrieval models, search process*

General Terms
Algorithms, Measurement

Keywords
Mind maps, social media, information retrieval, search applications

1. INTRODUCTION
Internet users create and often share various kinds of data, among those include social tags, blog entries and wiki pages. The latest trend is to research how this social data can be used to enhance other applications. For instance, it was researched how social tags could enhance search engines [1] or how data of CVs could be used to create expert systems [2].

A type of data that is often created but rarely shared and – to our knowledge – not utilized for enhancing other applications, are mind maps. In this paper we present ideas how mind maps could be utilized to enhance expert search systems, search query recommender, (academic) search engines and document recommender systems. In the following section, a brief introduction to mind maps is given. Then the ideas are presented, followed by first research results.

2. MIND MAPPING OVERVIEW
Mind maps were originally invented by Tony Buzan in the 1970s [3] and are nowadays used by millions of people for brainstorming, note taking, knowledge management, project management, decision making, literature management and document drafting. Many software tools exist to support the creation of mind maps. The probably most popular ones are *MindManager* with about 1.5 million users [4] and *FreeMind* with about 150,000 downloads a month [5]. Although there must be tens of millions of mind maps on users' computers, only a few thousand are publicly available on the Web on platforms such as *Mappio.com* and *MindMeister.com*.

3. UTILIZATION OF MIND MAPS
We believe that by analysing mind maps on users' computers or on the Web, many applications could be enhanced, namely

- Expert Search Systems
- Search Query Recommender
- (Academic) Search Engines
- Document Recommender Systems

The ideas are described in more detail in the following sections.

3.1 Expert Search Systems
In large enterprises finding the right experts, for instance, for a new project, is a difficult endeavor: The employees' skills need to be known. In first attempts of managing employee skills, databases were used and employees could enter their skills manually. In the last decade much research has been performed on automatically creating skill profiles. Probably the most promising approach is analyzing documents. Based on words contained in the documents the employees' skills are determined. Typical documents being analyzed are emails, visited websites, scholarly articles and documents published in a company's intranet [2]. Mind maps have not been used so far.

Figure 1: Mind Map (Arrows Indicate a Link to a File)

A mind map (see Figure 1) seems well suited for creating a skill profile of its author, as words in a mind map should specify the author's expertise and fields of interest. In contrast to text documents, a mind map probably contains less stop and other irrelevant words. This should facilitate the creation of skill profiles.

HT'10, June 13–16, 2010, Toronto, Ontario, Canada.
ACM 978-1-4503-0041-4/10/06.

3.2 Search Query Recommender

A mind map is a graph and nodes are in hierarchical order and direct relation to each other. Based on mind maps, a search query recommender could make recommendations. In the example (see Figure 1), 'analyze websites' or 'analyze emails' could be recommended to someone searching for 'expert search'.

3.3 (Academic) Search Engines

When searching for documents, usually a keyword is entered and the search engine returns those documents containing the keyword. Various algorithms exist to calculate how relevant a document is for a certain keyword search (e.g. tf-idf and BM25(f)). As an extension, words of 'neighbored' documents can be considered, too [6]. That means, document A could be found for a keyword search even if document A does not contain the keyword, but document B, which is somehow linked to document A. Usually this kind of link analysis is applied to scholarly literature (citations) and websites (hyperlinks). However, it seems likely that the same concept could be applied to mind maps.

If a mind map links to a document, the words of the linking (and parental) node could be assigned to the linked document. Figure 1 illustrates this: The mind map contains a node called 'Expert Search' and child nodes link to documents related to this topic (those nodes with the arrows). However, many of the linked documents do not contain the term 'expert search', but other expressions such as 'expert finder', 'expertise management' or 'skill management'. If search engines would analyze mind maps and treat them as 'neighbored' documents, recall in document retrieval could be increased.

3.4 Document Recommender Systems

One common recommendation approach is to recommend those items which are related to items a user likes. For scholarly literature and websites, relatedness often is determined via citation analysis and hyperlink analysis respectively. The same concept could be applied to mind maps.

The basic idea of what we call 'Link Analysis in Mind Maps' [7]: when two documents A and B are linked by a mind map, document B could be recommended to those users liking document A. This concept could be enhanced with common citation analysis approaches. For instance, if two documents are linked in high proximity, their relatedness can be expected to be higher than two documents linked in lower proximity.

4. RESULTS & DISCUSSION

We conducted an initial experiment in which we researched whether mind maps could be used to determine document relatedness. In the experiment five mind maps were analyzed and five participants were asked to rate the relatedness of documents linked in the mind maps. The results were positive. Those documents linked in the mind maps were significantly more often rated as related than documents randomly shown from a large database to the participants. In particular, those documents that were linked in high proximity in the mind maps were rated very often as highly related. Details will be published in another paper.

Data availability seems to be a challenge that information retrieval on mind maps will have to face. Although millions of people use mind maps, only a few thousand mind maps are publicly available. On our website sciplore.org we offer a special mind mapping software for researchers [8] which analyses the users' mind maps. In the past few weeks, about 11% of all users agreed that we may analyze their mind maps. If 11% of all mind mapping users would agree to let their mind maps being analyzed, millions of mind maps could be used for information retrieval.

Another challenge is the robustness of collected data. All social media platforms do have to cope with spam and fraud as soon as they become successful. There is no reason to assume this would be different if mind maps were used for information retrieval. However, most social media platforms also find a way to cope with fraud and spam. If only mind maps of 'trusted' users were used, serious spam and fraud could, in all probability, be prevented successfully. Trustworthiness of users could also be determined in cooperation with social networks, other community websites or by usage data of mind mapping software.

Overall, we see a good chance that sufficient data can be collected and that spam and fraud can be prevented successfully and, eventually, mind maps will be another source for enhancing applications such as search engines and recommender systems.

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