

A Simple Personalization Layer Improving Relevancy of Web Search

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Abstract— This paper presents an approach to personalized web search that is based on augmenting query with additional keywords extracted from interested person's profile. The profile reflects interested person's interests, past searching experiences etc. It is represented by a set of weighted keywords displayed conveniently as a keyword cloud. Experiments on web search show that our search system can improve relevancy over popular search engines.

Keywords- *Personalized Search, Context Augmented Query, Interested Person's Model, Keyword Cloud, Profile Maintenance.*

I. INTRODUCTION

Volume of digital content on the web increases every day. More and more information is out there. How to retrieve it? One way that has been established over years is to search using some search engine. Even the best search engines, however, no matter how hard they try to cope with the problem of enormous volume of the digital content on the web, return many not relevant or unrelated results and do not return many relevant or related ones. Improving precision or recall or other appropriate quantitative characteristics of the web search is one of the challenges for research.

One obvious weakness of the usual approaches is the volume of input information a search engine receives. It is indeed very difficult to decipher from just a few key words what is the intention of an interested person (IP). Most of the time, there are too many interpretations that are consistent with the list of key words. To identify the interpretation that has been intended by the IP is a very difficult task. Clearly, more information from an IP could prove very helpful.

Some approaches require from an IP more information besides an initial query in form of a usual list of key words. However, asking more from a user, and in particular from an IP, has never been very popular. Therefore collecting any useful information acquired implicitly is an attractive alternative.

In this paper, we investigate how web search can be improved by one particular kind of additional information gathered implicitly from an IP – an information on her interests, as manifested during her previous search experiences. This can be considered part of the search context.

The rest of the paper is structured as follows. In next section, we briefly discuss some related works. Next, we explain our approach to augmented query search. We explain also how IP's profile is formed and maintained. In the following section, we present design of an overall architecture of our proposed approach. Then we give evaluation and results and finally, conclusions and future work.

II. RELATED WORKS

Our idea is to improve web searching by augmenting the query with some additional information that reflects IP's intentions. For example, key words such as jaguar or apple in a query can mean very different things depending on if the IP is interested in cars or zoology, computers or pomology. If we do not want to bother the IP with writing anything besides the original query, and still want to have scope of possible interpretations of the query narrowed, we may take previous searches to extract from it clues pointing at IP's intentions. Therefore, from the wealth of related works, we do not discuss those favouring explicit IP feedback, but rather concentrate on those limited to implicit feedback (Shen, 2005; Teevan, 2005). Of course, all such approaches attempt to contribute to personalization of search. In (Micarelli, 2007), several important user personalization approaches and techniques developed for the Web search domain are presented.

One concept used here is context. Context can be thought of as all the circumstances, the data and information that are somehow relevant to the event or

fact. Another definition says that it is the words or word phrases that give the sense of a word or phrase. An obvious weakness of both of them is that they are too vague. In relation to web search, Lawrence (2000) describes the context of a query as for example, the education, interests, and previous experience of a user, along with information about the current request. The concept of context can be taken here – perhaps not too literally - to mean words describing IP's sphere of interest. Later we return to the question how to acquire such words. Before doing it, let us discuss what options are available for us to use such contextual information.

Several approaches have been taken to using context in web search (Kraft, 2006). Among them, query rewriting, iterative filtering meta-search, rank biasing seem to be dominant.

Query rewriting is based on appending keywords from context to search query as a string and submitting the augmented query to standard search engine. Iterative-filtering meta-search does not augment a query but rather generates many different sub-queries and submits them to several search engines. Upon receiving results, it re-ranks them and aggregates into one set. Rank biasing supposes that a query and context of keywords are sent to modified search engine as a complex query. Having received documents matching query it then re-ranks them by fitness to context. More generally, query preprocessing opens room for context to be a source for query augmentation. A query is seen as a short list of keywords. To rewrite it, we have to identify additional keywords.

The concept of context is quite general and, as we noted earlier, often a loosely defined one. IP's interests, past searching experience etc. can be considered part of it. Our approach adopts this view of context. There are also other views, concentrating more on query itself (Bai, 2008). Still other approaches employ collaboration of IPs (Tvarozek, 2008).

In a sense, web search adjusted in one way or another to a context as determined by the interested person is a personalized search. The other way round, when the IP possesses a personal profile represented in a processable way, e.g. in form of ontology, an ample room opens for personalized web search, too (Sieg, 2007). Our point is, however, that there is a room for improving results of web search even if no concepts of semantic web are employed. It is possible to expand a query in a quite complex way based on personal information (Chirita, 2007).

An approach towards an automatic personalization of web search in which the IP is proposed in (Chirita, 2006). They make use of PC desktop, which is source of a wealth of specific information. Having extracted it, it

allows for an increased quality of user profiling. More specifically, they select personalized query expansion terms for web search using three different desktop oriented approaches: summarizing the entire desktop data, summarizing only the desktop documents relevant to each user query, and applying natural language processing techniques to extract dispersive lexical compounds from relevant desktop resources.

A novel query expansion algorithm is proposed in (Zhu, 2007). Their web search system, acting as a middleware between an IP and a web search engine, is set up on the client machine. It can learn an IP's preference implicitly and then generate the IP profile automatically. When the IP inputs query keywords, more personalized expansion words are generated by their algorithm. These words together with the query keywords are then submitted to a popular search engine such as Baidu or Google. Such a model makes a common search engine personalized, that is, by means of personalized query expansion the search engine can return different search results to different IPs who may input the same keywords.

Some researchers focus their attention to ways of re-ranking results. In (Peng, 2006), IP browsing behavior is source for data mining frequent access patterns. In accordance with user interests mined and feedbacks of IPs, they propose Personalized PageRank for dynamically adjusting the ranking scores of web pages.

There are attempts to employ semantics description languages for representation of IP profiles. (Daoud, 2009) describes a personalized search approach involving a semantic graph-based IP profile issued from ontology. In their work, IP profile refers to the IP interest in a specific search session. It is built using a score propagation that activates a set of semantically related concepts and maintained in the same search session using a graph-based merging scheme. Personalization is achieved by re-ranking the search results of related queries using the user profile.

A possible approach to augmenting an individual IP's profile is by using data from other IPs. (Teevan, 2009) studied whether groups of people can be used to improve relevancy, or in general quality of search. They explore the similarity of query selection, desktop information, and explicit relevance judgments across people grouped in different ways. As could be expected, some groupings provide valuable insight into what members consider relevant to queries related to the group focus. On the other hand, it can be difficult to identify valuable groups implicitly.

III. APPROACH

Our assumption is to use a usual search engine. As a consequence, we do not have the option to alter the way a query is processed inside the search engine. We can focus on either pre-processing the query or post-processing the search results or both. Since we attempt to identify additional words narrowing the possible sphere of interpretations consistent with IP's intention, a natural place to use them is in pre-processing the query. However, we should keep an eye also on the option of using the context to some kind of post-processing the results, e.g. for re-ranking them.

We propose a quite simple way of augmenting a query. Query is extended by one or more keywords from an IP's profile consisting of a set of weighted keywords. Before coming to the specifics of our approach how to form an IP's profile, we should like to mention a simple

idea we propose for representing it. We represent IP's profile by a keyword cloud. It is a way of visualizing a set of weighted words. It can be used also for visualizing IP's interests. It makes easy to assess relative importance of any word in the profile.

Our approach to improving web search through incorporating some words from IP's profile is based on the following idea. We propose to form a combination of a usual search engine and a dedicated search engine. Search query is augmented by additional key words from IP's profile such that they reflect IP's interest that is relatively stable over time. The augmented query is submitted to any usual search engine. The only requirement is that the search engine returns results decorated with key words describing the particular document. For example, Yahoo offers additional service to retrieve also keywords along with results (see in Fig. 1). These keywords describe result more accurately.

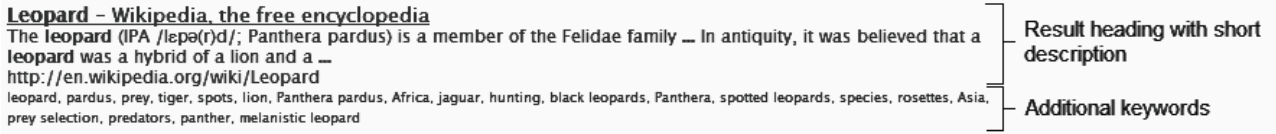


Fig. 1. Yahoo result row

Search process itself takes place in three phases. In the first phase, a regular search performed by Yahoo returns a list of results each decorated with additional keywords. Subsequently, for each hit (or the first m hits) the system determines whether each keyword is included in the IP's profile. Also, we identify number of search engine hits, where the profile keyword was found. At the end of this phase we can generalize retrieved data as follows in Table 1.

Table 1: Retrieved data generalisation

Keyword	Weight	Number of hits where the word occurred
word ₁	i ₁	p ₁
...		
word _k	i _k	p _k
...		
word _k	i _k	p _k

In the next phase, for each word_k, we calculate the ρ_k index according to formula (1)

$$\frac{p_k}{P} \cdot \lambda + \frac{i_k}{avg(i)} \cdot (1 - \lambda) = \rho_k \quad (1)$$

where $\frac{p_k}{P} \cdot \lambda$ represents natural context of the search engine. It is appropriate that we prosper from results found by the search engine and include keyword occurrence number into overall relevancy. The component $\frac{i_k}{avg(i)} \cdot (1 - \lambda)$ represents a context of the IP's profile. Parameter λ (in the range of 0 to 1) serves to determine relative weight of common search engine context and IP's profile context. By properly adjusting the parameter, we shift focus either on the former or the latter context. ρ_k index serves to sort keywords by relevance. Subsequently, several top ranked keywords will be used to enhance the query, resulting in a rewritten query. In the last phase, the search is re-run with a rewritten query. Results of this re-run are displayed to the IP.

IV. PROFILE UPDATING

Processing already a few queries typically results in changing IP's profile. Some keywords get their weights strengthened, some weakened. We should bear in mind that typically, new keywords are inserted in the profile, too. Conversely, we need a way to get a keyword out from the profile. Otherwise, the profile would grow bigger and bigger. We propose to normalize the profile. This maintenance is performed according to this pseudo code:

```

If ( avg(i) > γ OR K > γ ) then {
  if ( ik < δ ) then {
    remove wordk from users profile
  } else {

$$i_k = \frac{i_k}{avg(i)}$$

  }
}

```

Fig. 2: Profile maintenance

Keywords that are less important than the limit value δ are deleted from the profile. This cleans the profile, purging incidental interactions of the IP with the search system. To prevent purging some potentially useful keyword from the profile only because it has been inserted just before the maintenance step, keyword weight is changed to average value. This implies that a new word will be added to the profile with an average weight. However, it is obviously necessary to choose appropriately the parameter δ . Moreover, it is possible to control growing weights too much by reducing the value of parameter α . To determine the threshold of maintenance launch, the parameter γ needs to be adjusted.

V. OUTLINE OF MYFIND ARCHITECTURE

Based on our proposed method of personalized web search, we developed a working prototype of a system for web search that implements the method. Here we present an outline of architecture of our system called MyFind. There are three fundamental players or components of the system: the IP, the usual search engine and our Finder machine.

The system automatically augments search query with a set of keywords that are selected from the IP's profile and correspond with IP's interests. After the usual search engine perform search and returns results,

MyFind suggests to IP a set of keywords that can be added to the original query, aiming at restricting and/refocusing the set of search results. MyFind builds a profile of the IP by monitoring the interaction. In it, IP's feedback is essentially given by clicks on results. In such a way – it is hypothesized – IP singles out some results that are of more interest than the remaining ones.

As shown in Fig. 3, the Finder machine has 3 major components:

- (1) Keyword Selection module for terms retrieval from Yahoo search engine respecting IP's query.
- (2) Query Modification module automatically augments IP's query with terms from IP's profile.

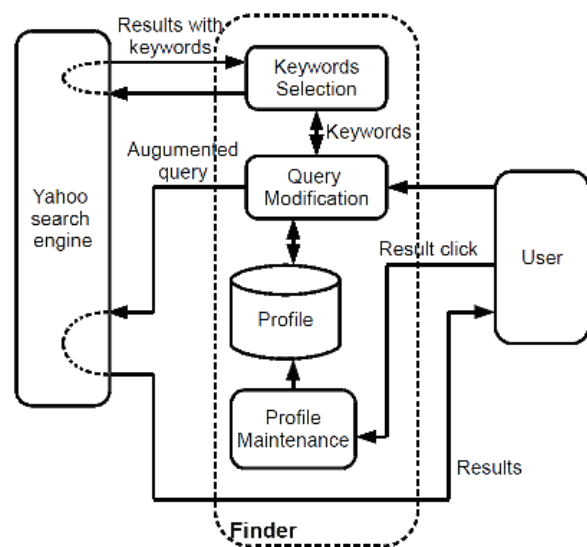


Fig. 3: System architecture

- (3) Profile Maintenance models IP's profiles reflecting IP's interaction with the system.

MyFind architecture is in some aspects similar to other attempts to personalized web search, e.g. profile maintenance and query modification are common in these systems, cf. (Koutrika, 2005; Salamanca, 2008). From a more detailed view, however, their approach to e.g., query modification (i.e., by disambiguation) is different from ours. The other way around, our approach introduces a distinct layer, Finder, as a kind of middleware (cf., Kawsar, 2006) between an usual search engine and an IP. This is a certain improvement over usual architectural solutions of similar systems.

VI. EVALUATION AND RESULTS

The key data in our approach is the IP's profile. If it becomes overcrowded with too many general words,

the results will be even less precise. Otherwise, there is a chance to achieve quite interesting results.

One experiment aimed at comparing results returned by our myFind and an usual search engine (google). IP formulated the query "armstrong music". Both the usual search engine and myFind returned lists of results, out of which we took top 30 ranked results from both lists and marked each returned result for relevance. As Table 2 shows, myFind results are better than google results achieving an improvement of 46%.

Table 2: Precision at top 30 documents

	Relevant documents	Relevant percentage
Google	12 / 30	40%
myFind	26 / 30	86%

In another experiment, IP formulated query "Herbie Hancock YouTube" with the intent to get references to videos with Herbie Hancock playing. myFind augmented the query with the following words: "jazz", "John Coltrane", "Miles Davis". As a consequence, results from myFind included those referring to pages where Herbie Hancock plays with Miles Davis or John Coltrane [Fig. 4]. myFind found these musicians in the IP's profile and noticed they have high weights. myFind evaluated that they can be linked together. Both these simple experiments are just samples of a more extensive experimenting with our system. There were several different IPs involved. myFind was gradually developing their profiles, displaying it as a keyword cloud. In many cases, myFind's performance has been found impressive: "How could myFind know this is what I am interested in?" Of course, in some other cases the performance has been less impressive.

The screenshot shows a search interface with a search bar containing "herbie hancock youtube". Below the search bar, there are two columns of search results. The left column is titled "myFind" and the right column is titled "theirFind - yahoo search".

myFind results:

- YouTube - Miles Davis et John Coltrane - So what**: Miles Davis Coltrane music jazz. URL. Embed. Customize. Loading... 10:59. Herbie Hancock Quintet (VSOP) - So What. 188,703 views. sukapura. Added. 4:28 ...
- YouTube - MILES DAVIS & JOHN COLTRANE - SO WHAT**: MILES DAVIS, JOHN COLTRANE, PAUL CHAMBERS, GIL EVANS, ETC. SO WATH ... 4:47. Miles Davis - Herbie Hancock - Wayne Shorter ... 200,930 views. moresoc63. Added ...
- Miles Davis & John Coltrane - Kind of blue - AOL Video**: Miles Dewey Davis III (May 26, 1926 September 28, 1991) was an American jazz trumpeter, bandleader, ...
- Tour by Brecker, Hancock and Hargrove salutes John Coltrane, Miles Davis >>** Tour ... the births of jazz legends John Coltrane [tickets] and Miles Davis [tickets] ...
- John Coltrane & Miles Davis - Yahoo! Music**: YouTube 1-3 of 25 videos. Prev | Next. Miles davis et john ... Herbie Hancock. Horace Silver. Miles Davis Quintet. Max Roach. Oliver Nelson. Lester Young ...
- Herbie Hancock - Wikipedia, the free encyclopedia**: Herbert Jeffrey "Herbie" Hancock (born April 12, 1940) is a jazz pianist and composer. ... Kelly, and studied recordings by Miles Davis, John Coltrane and Lee Morgan. ...
- Herbie Hancock Videos - vtap mobile videos**: Related Topics. Miles Davis. Chick Corea. John Coltrane. Watermelon Man. Chameleon. Cantaloupe Island ... quintet Hancock helped redefine the role of a jazz ...
- Miles Davis Quintet - Yahoo! Music**: Ron Carter, Miles Davis, Herbie Hancock, Wayne Shorter, Tony Williams... John Coltrane. Freddie Hubbard. Art Blakey & The Jazz Messengers. Wynton Marsalis ...
- Miles Davis & John Coltrane mp3s, Miles Davis & John Coltrane music**: ... the sessions, Feldman was replaced by Herbie Hancock and Butler by Tony Williams. ... Miles Davis at Fillmore East (1971) Grammy nomination for Best Jazz ...
- Herbie Hancock - SoundUnwound**

theirFind - yahoo search results:

- YouTube - herbie hancock rockit**: 9:10. Herbie Hancock - Jazz Fusion Canteloupe Island. 685,714 views. jesuschristopher ... Join YouTube for a free account, or sign in if you are already a member. ...
- YouTube - Herbie Hancock "Watermelon Man"**: From the 1973 album "Headhunters"; here's Herbie Hancock with "Watermelon Man"; Sampled by "Super Cat"; Dolly My Baby; Cool J ...
- YouTube: Herbie Hancock**: YouTube Videos matching query: Herbie Hancock ... YouTube: Herbie Hancock / 177 Views. About this Topic. Created Jun 18, 2008 by timetube ...
- Herbie Hancock Solo - Google Videos - YouTube MySpace Video - Noolmusic.com**: Herbie Hancock Solo - Google Videos - Noolmusic.com ... Herbie Hancock YouTube Videos, MySpace Video. Miles Davis Herbie Hancock Tony Williams And Wayne Shorter ...
- Herbie Hancock - MICKEY.TV**: 世界の動画を一括検索 - YouTube すべてのサイト [お知らせ] 知ってたアニメ動画プレイヤー. Herbie Hancockの動画検索結果 3570件中 1 - 18件目 ... Herbie Hancock live in Shibuya Tokyo Japan ...
- herbie hancock - AOL Video**: Watch herbie hancock videos free online at AOL Video. ... Channel: YouTube. 04:30 "Herbie Hancock: Possibilities" - DVD Clip 01 Herbie Ha ...
- So What - Herbie Hancock Quintet (Vsop) Live - AOL Video**: So What - Herbie Hancock Quintet (Vsop) Live Video on AOL Video - Herbie Hancock, Wayne Shorter, Ron ... Wallace Roney, Tony Williams. Channel: YouTube ...
- Herbie Hancock Jack DeJohnette Christian McBride - YouTube Videos**: Herbie Hancock Jack DeJohnette Christian McBride - YouTube Videos - Noolmusic.com ... Herbie Hancock : 1 - 10 11 - 20 21 - 30 31 - 40 41 - 50 51 - 60 61 - 70 ...
- Herbie Videos - Metacafe**: Herbie Hancock - Chameleon (Live) 16-Aug-06 ... Rated 4.35 12,237 Views 0 Comments Affiliate Video: YouTube. herbie hancock rockit ...
- Herbie Hancock Videos - vtap mobile videos**: Herbie Hancock (Wikipedia.org) ... Sorry it cuts off at 10 minutes, but that's all YouTube will allow. Also, this came off ...

Fig 4. Search results for query "Herbie Hancock YouTube".

VII. CONCLUSIONS AND FUTURE WORK

In this paper we studied how to improve search relevance by considering IP's profile. This, of course,

has been studied by many in the past, but it remains a research topic currently. Our approach is based on a simple idea, but it is capable of noteworthy improvement. We have created a separate layer Finder

that is positioned in the middle between a usual search engine and an IP. This middleware receives information from both sides and processes them for the benefit of the IP. From the usual search engine, Finder makes use of the service that some search engines provide, i.e. they decorate results with key words. From the IP, Finder records her interests as expressed by clicks on results. Finder is thus able to create and maintain IP's profile. We developed a specific method for maintaining the IP's profile. The whole approach is very simple but it is capable of achieving some, sometimes even a significant improvement over a usual search engine.

In our approach, IP profile is being updated on the fly. This reflects the basic observation that IP's interests and preferences change over time and most approaches include one way of updating IP profile or another. However, as (Luxenburger, 2008) point out, IP interests change over time, an IP sometimes works on very different categories of tasks within a short timespan, and history based personalization may impede an IP's desire of discovering new topics. They proposed a selective personalization strategy to cope with the problem.

Several possible lines of research emerge if we venture to challenge the current methods of personalization. Our Finder is already currently capable of serving many IPs, maintaining their profiles. Contrary to individual level, where IPs are not very keen to provide explicit feedback, at a group level IPs seem to enjoy social networking and are willing to provide necessary input to form it. Further research should be aimed at ways of utilizing interests expressed by similar individuals, whatever the definition of similarity may be.

However, the potential of social networking may generate new concepts. If the networked individuals realize that sharing their interests, recommendations or preferences may improve quality of their individual search results, there will be a room for introducing new concepts, e.g. interested collective person whose profile is outcome of their interaction.

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