Egyptian Informatics Journal (2012) **13**, 191–198

Cairo University

Egyptian Informatics Journal

www.elsevier.com/locate/eij
www.sciencedirect.com

ORIGINAL ARTICLE

Agent-based web search personalization approach using dynamic user profile

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Received 29 April 2012; revised 31 August 2012; accepted 16 September 2012
Available online 25 October 2012

KEYWORDS

Web search personalization;
Dynamic user profile;
Query optimization;
Multi-agent system

Abstract The World Wide Web has become the largest library through the history of the humanity. Having such a huge library made the search process more complex as the syntactic search engines offer an overwhelming amount of search results. Vocabulary problems like polysemy and synonymy can make the search results of traditional search engines irrelevant to users. Such problems trigger a strong need for personalizing the web search results based on user preferences. In this paper, we propose a new multi-agent system based approach for personalizing the web search results. The proposed approach introduces a model to build a user profile from initial and basic information, and maintain it through implicit user feedback to establish a complete, dynamic and up-to-date user profile. In the web search process, the model semantically optimizes the user query in two steps: query optimization using user profile preferences and query optimization using the WordNet ontology. The model builds on the advantages of the current search engines by utilizing them for retrieving the web search results. We present a detailed case study and simulation results evaluation to illustrate how the proposed model works and its expected value in increasing the precision of the traditional search engines and solving the vocabulary problems.

1. Introduction

With the huge amount of information available on the World Wide Web, some Internet users may face information overflow problems, where there are a huge number of hosted documents on the web. The keyword-based search engines are unable to satisfy the user needs during his web search process. Furthermore, these search engines do not address vocabulary problems such as polysemy and synonymy. Polysemy refers to the existence of multiple meanings for a single word. For example, when a user searches for the word "Jaguar", the retrieved results may be related to jaguar as an animal or jaguar as a car brand. Synonymy refers to the existence of multiple words

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Peer review under responsibility of Faculty of Computers and Information, Cairo University.

Production and hosting by Elsevier

1110-8665
http://dx.doi.org/10.1016/j.eij.2012.09.002

with the same meaning. For example, when a user searches for the word "car", all results that are related to another word such as "vehicle" would be neglected although the two words are nearly having the same meaning [1].

Personalization of web search results can solve the mentioned problems by focusing on the most relevant results for the user query combined with his preferences-identified in his user profile. In addition, it reduces the user efforts during the web search process [1]. Recently, several approaches of web search personalization have been proposed. Some of the most successful approaches are based on building a user profile that represents user interests and using it in the web search process [2–5].

In this paper, a new multi-agent system based model called "Web Search Personalizer" is proposed for personalizing the web search results. The multi-agent system (MAS) technique is employed here to enhance the information retrieval precision and recall assessment criteria through building multiple agents for addressing the different personalization issues and phases. Also, using MAS technique, our model gains the advantages of interacting with the current search engines to retrieve and defuse the web search results. In the proposed model, a user profile is built from initial and basic information and maintained through the implicit user feedback extracted by the click-through technique [6–8]. Consequently, the model keeps the user profile complete, dynamic and up-to-date. In addition to keeping an up-to-date user profile, we also propose a semantic query optimization technique based on both query related user profile preferences and the WordNet ontology. WordNet is the largest lexical database containing words grouped into synsets (Synonym Sets) [9].

The rest of this paper is organized as follows: Section 2 reviews some related work. Section 3 describes the proposed model conceptual view, while Section 4 presents the model architecture in details. Section 5 presents a detailed case study and its simulation results evaluation. Finally, the research work presented in this paper is concluded in Section 6.

2. Related work

Different approaches were proposed by researches in the area of web search personalization. Some of these approaches are based on the user's geographical location considering the location factor only [10–12]. In such approaches, the retrieved results are related to the user's language and his demographic attributes, without considering any other user preferences. Although, these approaches may give better results than the traditional search engines, the users in the same geographical area will have the same results even if they have different preferences and interests.

On the other hand, other some approaches re-rank the retrieved search results from the traditional search engines based on the user preferences [13–15]. The main disadvantage of these approaches is that the search process relies on the original search query without taking the user preferences into consideration.

A user feedback can be an important factor to fine-tune the search results, thus another type of approaches employs the user implicit feedback to avoid direct user involvement [6–8]. These approaches rely on the user feedback only, so the search process takes long time and passes through multiple iterations.

Finally, the most famous and effective approaches build a robust user profile from different resources. This profile contains all user preferences, and hence it is used in web search personalization [2,4]. The main disadvantages of these works are either they ignore the vocabulary problems or involve the user in enhancing and maintaining his profile.

To tackle the above-mentioned disadvantages, we propose a multi-agent system based model called "Web Search Personalizer" (WSP) that builds and maintains the user profile automatically. The proposed model also presents a semantic-based optimization method for the user's query. The model uses the user preferences to overcome the polysemy problem, and employs the WordNet ontology to solve the synonymy problem. Moreover, the model updates the user profile through the user implicit feedback.

3. WSP model conceptual view

The main objective of the Web Search Personalizer (WSP) model is to retrieve the best search results that meet the user's preferences using his up-to-date user profile, which is being built and updated regularly. Fig. 1 shows the conceptual view of the WSP model and its interactions with the external entities.

As shown in Fig. 1, the user interacts with the WSP model by entering a user query, which is then semantically optimized to produce an optimized query. The query is optimized based on the user's profile preferences and the query-related synonyms from the WordNet ontology. After that, the optimized query is sent to a set of syntactic search engines for retrieving the related search results, which are then defused to produce the final personalized results. Finally, WSP model extracts the user feedback implicitly by the click-through technique to update the user profile.

In order to build and update the user profile, WSP model interacts with the user to gather the static user profile part and interacts with published resources to gather the dynamic user profile part. The static user profile part represents the basic user information such as username, birth date, location,

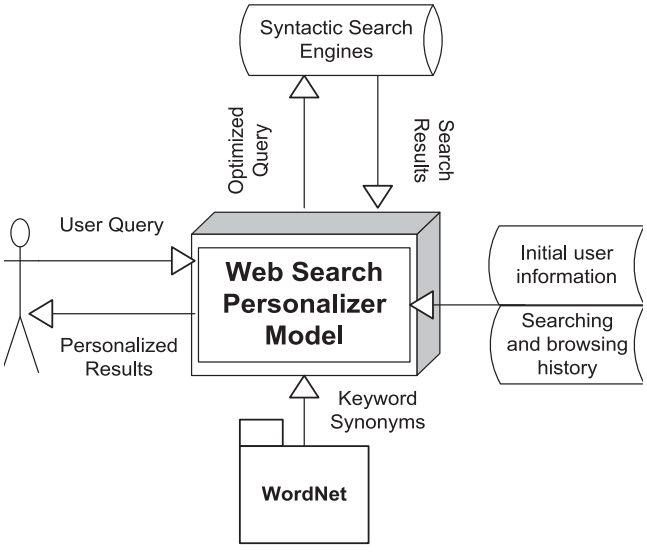

Figure 1 The WSP model conceptual view.