Refining the Results of Automatic E-Textbook Construction by Clustering

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ABSTRACT

The abundance of knowledge-rich information on the World Wide Web makes compiling an online e-textbook both possible and necessary. In our previous work, we proposed an approach to automatically generate an e-textbook by mining the ranked lists of the search engine. However, the performance of the approach was degraded by Web pages that were relevant but not actually discussing the desired concept. In this article, we extend the previous work by applying a clustering approach before the mining process. The clustering approach serves as a post-processing stage to the original results retrieved by the search engine, and aims to reach an optimum state in which all Web pages assigned to a concept are discussing that exact concept.

Keywords: clustering algorithm; e-textbook; representation model; Web learning

INTRODUCTION

The World Wide Web has evolved into one of the largest information repositories. It now becomes feasible for a learner to access both professional and amateurish information about any interested subject. Professional information often includes compiled online dictionaries and glossaries; course syllabi provided by teachers; tutorials of scientific software; overviews of research areas by faculties from research institutes; and so forth. Discussion boards sometimes offer intuitive descriptions of the interested subjects that are beneficial for students or beginning learners. Both these resources greatly enrich and supplement the existing printed learning material. The abundance of knowledge-rich information makes compiling an online e-textbook both possible and necessary.

The most common way of learning through the Web is by resorting to a search engine to find relevant information. However, search engines are designed to meet the most general requirements for a regular user of the Web information. Use Google (Brin & Page, 1998) as an example. The relevance of a Web page is determined by a mixture of the popularity of the page and textual match between the query and the
document (Chakrabarti, 2002). Despite its worldwide success, the combined ranking strategy still has to face several problems, such as ambiguous terms and spamming. In the case of learning, it becomes even harder for the search engine to satisfy the need of finding instructional information, since the ranking strategy cannot take into account the needs of a particular user group, such as the learners.

Recently, many approaches have been proposed to improve the appearance of Web search engine results. A popular solution is clustering, providing users a more structured means to browse through the search engine results. Clustering mainly aims at solving the ambiguous search term problem. When the search engine is not able to determine what the user’s true intention is, it returns all Web pages that seem relevant to the query. The retrieved results could cover widely different topics. For example, a query for “kingdom” actually referring to biological categories could result in thousands of pages related to the United Kingdom. Clustering these results by their snippets or whole pages is the most commonly used approach to address this problem (Ferragina & Gullí, 2004; Zamir & Etzioni, 1999; Zeng, He, Chen, & Ma, 2004). However, the structure of the hierarchy presented is usually determined on the fly. Cluster names and their organized structure are selected according to the content of the retrieved Web pages and the distribution of different topics within the results. The challenge here is how to select meaningful names and organize them into a sensible hierarchy. Vivisimo is an existing real-life demonstration of this attempt.

The clustering approach works well to meet the needs of a regular user. But when the application is narrowed down to an educational learning assistant, it is possible to provide the learners with more “suitable” Web pages that satisfy their needs in the pursuit of knowledge. Users seeking for educational resources prefer Web pages with a higher quality of content. Such Web pages often satisfy the criterion of being “self-contained,” “descriptive,” and “authoritative” (Chen, Li, Wang, & Jia, 2004). Limited work has been done to distinguish higher quality data from the Web. An important one (Liu, Chin, & Ng, 2003) is where the authors attempt to mine concept definitions of a specific topic on the Web. They rely on an interactive way for the user to choose a topic and the system to automatically discover related salient concepts and descriptive Web pages, which they call informative pages. Liu et al.’s work (2003) not only proposed a practical system that successfully identified informative pages, but also more importantly pointed out a novel task of compiling a book on the Web.

Chen et al. (2004) presented an approach to automatically construct an e-textbook on the Web. They extend Liu et al.’s (2003) work by adding a concept hierarchy that outlines the user-specified topic. In the concept hierarchy, also called a concept tree, each node corresponds to a concept and the ancestor relationship of nodes represents the containing relation of the concepts. The use of the concept tree is essential and benefits the learning experience to a great extent. It is used to gather Web pages that are more likely to be of learning importance, and also readily serves as a table of content for the final e-textbook. The concept tree is easier for the users to understand compared with the cluster hierarchy generated on the fly, thus saves time for browsing. The approach is described concisely in the following:
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