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# ソーシャルネットワークにおけるエキスパートモデルと探索手法

Expert Finding in Social Networks

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Recent advances of the Web and ubiquitous environment enable users to accumulate and share their experiences. Since humans usually also take others' experiences into account for decision making, an intriguing extension of this idea is to assist users in the sharing of such experiences. One important issue in sharing experience is to select relevant sharing partners who have appropriate knowledge and information on current specific topics. We propose a method which employs the user profile and social structure of a Web community in order to find sharing partners who have appropriate expertise and are likely to be able to reply to a request. We addressed the issue in the scenario from the actual social network service for sharing recipes. Utilizing the user information and social structure from the existing Web community, we implemented and operate the community mining system which locates relevant and socially close experts for information seekers.

## 1. Introduction

Human decision making usually takes not only the decision maker's personal experiences into account, but also experiences and opinions of other persons. This behavior can be supported by a personal assistant, which has access to experiences of people known to the user. Actually, the recent Web communities such as blogs and social network services provides huge collections of experiences which could be exploited for realizing such support. In addition to the Web communities, recent development of ubiquitous technologies also enable users to share experiences by automatically capturing and recording their actions. The data from ubiquitous environments may be recorded in a way easy to process by machines, therefore it can also be exploited for ubiquitous user support (e.g., recommenders, teaching systems) beneficial for recipients of such experiences.

Although large amount of user experiences from the Web and the ubiquitous environments are currently available, there is still the question of *whose* experiences should be applied for support. Candidates can be found in various places, for instance, in the user's previous contacts, among people physically nearby, or on the Web. Their count might be large, which suggests to support the user explicitly in this selection problem. Here, we propose to exploit that people interested in some domain are frequently organized in a Web-based community—which might hold for the candidates as well. Thus, an analysis of a candidate's social relationships within a community matching the user's problem is a promising way of not only estimating expertise—but also of the candidate's will to assist the user.

In this paper, aiming at helping a user find relevant sharing partners of experiences, we propose the method for mining Web communities. In particular we address the issue of finding experts from the Web community who have appropriate knowledge and information on specific topics. We focus on the scenario from the actual social network service for sharing recipes. Utilizing the user information and social structure from the existing Web community, we implemented and operate the community mining system which locates relevant and socially close experts for information seekers.

In the next Section 2, we compare our approach with related research. We continue in Section 3 with a description of our example scenario. Then, in Section 4 we explain in details about the proposed method to find experts in the Web community. Finally, we conclude the paper with an outlook on future work in Section 5.

## 2. Related Work

One of the central questions addressed in this paper is how to find relevant sharing partners of experiences, who might be able to answer a given information need. This issue is closely related to the recommendation community members in social matching systems (cf. [Terveen 05]). For instance, an expertise recommender [McDonald 00] may help members of an organization to locate other members who have specific expertise. Such expertise finders have been explored in a series of studies [Streeter 88, Ackerman 03]. Here, systems such as Referral Web [Kautz 97], ER [McDonald 00], and MARS [Yu 03] leveraged social networks as a means of finding people.

Most of these expert finding systems mainly focus on specific domains within organizations. However, there is a growing interest in exploiting ubiquitous information for this task: recent research has shown that social networks and communities could also be obtained from the sensor information [Hope 06]. In addition, due to the popularity of blogging and social network services, a tremendous amount of sharing-related information is becoming available online. Thus, the task of expert finding now becomes the problem not only for specific users but also for every single end user. Thereby, the research question which should be newly ad-

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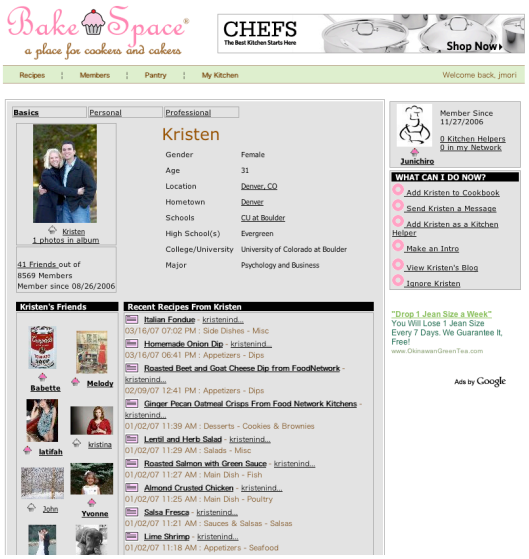


図 1: Bakespace.

dressed in this area is how to find appropriate sharing partners for end users by using the ubiquitous information and other information from the Web.

Social visualization systems (e.g., [Smith 01, Freeman 00]) offer rich graphical representations of a community's social activity to support a user in finding someone to communicate with. However, most social visualizations only highlight personal contacts or represent the exchange of information. They rarely address the issue of finding appropriate users for a given information need. Reputation systems such as ebay and expertise finders highlight users who may be reliable or experts in general in a domain, which is of interest for our system, but recommendations are usually the result of algorithms which are due to their complexity hidden from the user. Consequently, those mechanisms cannot be controlled and influenced by the user. Therefore, with respect to the variety of situations in which the user may need community members' experiences in our case, we researched on flexible ways to allow the user to specify which kinds of persons are likely to be of interest in these particular situations.

## 3. Example Scenario: Finding Experts in Recipe Sharing

There currently exist many online communities aiming at information sharing on the Web, where users can share their interests, maintain their relationships and communicate with each other. Among recent online communities, social networking services (SNSs) have received much attention on the Web. SNSs enable users to register their friends. Therein, the users can create their contents such as profiles and Blogs and communicate with their friends. One important feature on SNSs is information sharing because information on SNSs such as private profiles, photos, and Blogs are neither completely open nor closed: they can

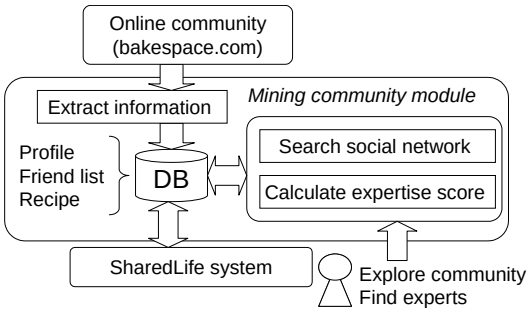


図 2: System Overview of Mining Community Module.

be shared loosely among user's friends, colleagues and acquaintances with elaborate access control. For sharing various information, several SNSs have increasingly emerged targeting niche communities such as music, medical, cooking, and business communities.

Recipe information is one of actively shared experiences in these SNSs. Users are eager to share their recipes and try to find relevant sharing partners. Recipe often involves complex constraints such as availability of ingredients, food allergies, dietary rules, and religious food preferences. Thus, finding relevant experts are important for the users. However, it is difficult for the users to find experts from the SNSs just by looking at each Web page. For example, suppose one user is looking for someone to ask advices about vegetarian foods and recipes. The user has to manually check who is creating vegetarian recipes from the recipe list. Even if the user could find a right expert to ask advices, the user is not sure whether the expert is socially close and therefore is likely to answer the question.

In order to address this issue of finding experts in the Web community for sharing recipes, we focus on BakeSpace (Fig. 1) [*1] which is a Web community that combines recipe sharing with comprehensive social networking. Users on BakeSpace can create their profiles and blogs, make new friend and share recipes with other users. In the following, we will explain in details about how to mine the Bakespace community and find appropriate experts who could be potential sharing partners.

## 4. Expert Finding in Social Networks

### 4.1 System Overview

Figure 2 show an overview of the proposed system for mining community (mining community module). This mining community module works as an external add-on module of existing Web communities. The system first extracts information from external online communities by processing html pages. In our example, the system extract user profiles, friend lists, and recipe information from BakeSpace. Extracted information are stored in the database of mining community module. When the system receives a query from a user who tries to find experts, the system searches the user's social network on BakeSpace and compute the

∗1 http://bakespace.com

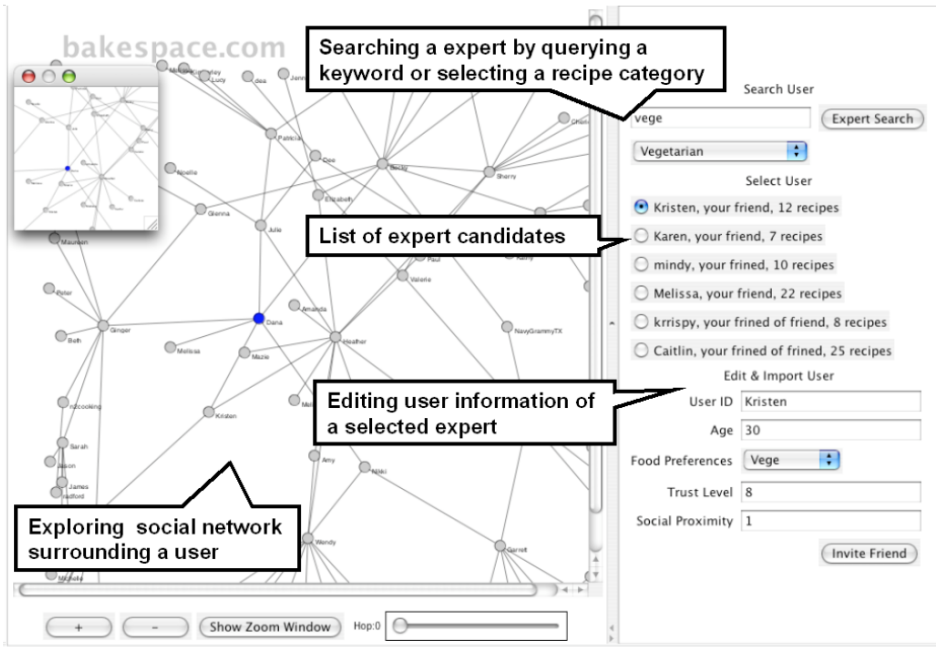


図 3: User Interface of Mining Community Module.

expertise of neighboring users. The expertise is scored according to relevancy to the given query. Finally the system returns the list of expert candidates and shows the referral chain which is a network path from the user to the expert.

Now we go in details about our method to find experts. In our example scenario, a user is not familiar with vegetarian foods and recipes therefore she would like to find an expert who could share some useful experience about vegetarian stuff and answer some questions. In addition she would like to find someone who is socially close to her (e.g., a friend of a friend) so that she can easily contact a expert. To achieve these goals, we now address following two questions: (1) Who are the experts on a certain topic (Expert Model) and (2) How the experts can be accessed (Search Social Networks).

### 4.2 Expert Model

Our expert model is based on probabilistic language model [Balog 06] which has been successfully applied in many Information Retrieval tasks. In our expert finding task, when the system is given a topic $q$ (e.g. a recipe category such as meat and vegetable), it returns a list of candidate experts which are ranked according to their expertise on $q$. For this, we calculate the probability $p(u|q)$ that a candidate $u$ is an expert given the query topic $q$. And we rank the candidates according to this probability. The top candidates are deemed the most probable experts for the given query. Using the Bayes' Theorem, we compute the probability $p(u|q)$ as

$$p(u|q) = \frac{p(q|u)p(u)}{p(q)},$$

where $p(u)$ is the probability of a candidate and $p(q)$ is the probability of a query and $p(q|u)$ the probability of the query given the candidate. $p(u)$ is estimated as the number of recipes that a candidate $u$ has created in Bakespace. $p(q)$ is estimated as the number of recipes that are categorized into a recipe category $q$ (Bakespace provides recipe categories and every recipe is categorized into one of the categories). $p(q|u)$ is estimated as the number of recipes that are created by a candidate $u$ and categorized into a recipe category $q$.

### 4.3 Search Social Networks

To find a expert who is socially close to a user, the system searches his or her social network. Following the classic study by Travers and Milgram about the "small world" and "six degree of separation" [Milgram 67], several studies have addressed the methods for searching social networks, which can also be adapted to locating experts. Adamic proposes best connected search (BCS) algorithm which makes use of the skewed degree distribution of many networks [Adamic 05]. Breadth First Search (BFS) searches a user's ego centric network by starting from ego and expanding its search to neighboring nodes along with the network paths. Because BFS has the strength of finding the target closest to the source, which matches our requirement to find socially close experts, we employ BFS for searching social networks.

Searching social networks according to BFS, we also consider the network centrality of a expert. In social network analysis (SNA) several ways to measure centrality for sociological interpretation of network structure have been proposed [Freeman 79]. The simplest measure, called degree-

ness, is to count the number of links that each node has. We employ this degreeness to estimate the accessibility to a expert. Here, our assumption is that if a expert has less links, he or she can be more accessible than other experts who have many links therefore are overloaded with many seekers. In summary our algorithm of searching social network find a expert $e$ in the list of expert candidates such that

$$\arg\min_{e} path(e)\ degreeness(e),$$

where $path(e)$ is the length of network path from a user to a expert $e$ and $degreeness(e)$ is the degree centrality of a expert $e$.

Figure 3 shows the user interface of our mining community module. A user can find experts by querying keywords or choosing recipe categories. The system returns the list of expert candidates and some evidence such as the link to expert's page in Bakespace and the number of recipes. After selecting the expert, the user can see additional information about the expert and contact the expert.

Using the interface, a user can explore his or her social network. Visualising the social network help the user contact a expert by providing the referral chain which is a network path from the user to the expert. This can also be used by the user both to assess the credibility of the expert and as a source of people who might introduce the seeker to the expert. As for supporting the user to communicate with the experts, the user can use the message system in the site or other external interaction means such as emails and Instant Messengers.

## 5. Conclusion and Future Work

Recent advances of the Web and ubiquitous environment enable users to accumulate and share their experiences. By sharing such augmented personal memories, users can be supported in exchanging opinions, guiding others, or just telling stories One important issue in sharing experience is to select relevant sharing partners who have appropriate knowledge and information on current specific topics. In this paper, we reported about our ongoing research efforts towards expert finding in social networks. Our method employs the user profile and social structure of a Web community in order to find sharing partners who have appropriate expertise and are likely to be able to reply to a request. We addressed the issue in the scenario from the actual social network service for sharing recipes. Utilizing the user information and social structure from the existing Web community, we showed our implementation of community mining system which locates relevant and socially close experts for information seekers.

In the future, we will extend the presented work in ubiquitous environments. Social relations among users are currently available not only from the Web information but also ubiquitous information such as location data. Our approach for finding experts in social networks could be applied to help a user find relevant sharing partners of experiences in ubiquitous environments

## Acknowledgements

This research is supported by the German Ministry of Education and Research respectively under grant 01 IW F03 (project SharedLife).

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