A Personalization Approach for Problem Management

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Abstract. This paper presents a novel personalization approach for IT service management. We first present a three-layered user profile that represents factual, preferential and transactional information of a user. A key feature of the user profiling is that a new *role* concept is realized in the user profile using fuzzy logic. Second, we emphasize how our user profile can be exploited in a situation in recommending an appropriate IT support group to deal with the given problem. Discussion and future work conclude this paper.

Keywords: personalization, ITSM, user profile, role categorization, recommender system

1 Introduction

The primary goal of IT service management (ITSM)[1] is to serve as a frontline advisor to help clients in solving their problems using accumulated knowledge and abundant experience. Recently, ITSM is changed to a multi-grouped structure based on specific criteria, such as problem-solving responsibility, domain knowledge, experience, and expertise level[2]. In this paper, we representatively call all such groups as *IT support groups (ITSG)* for convenience.

To assist ITSM, various services have been categorized depending on application areas (e.g., incident management, problem management, knowledge management, etc)[3]. One of the most important services impacting IT support organizations can be regarded as *problem management*[3, 4]. The significance of problem management lies in its high proportion of service calls (e.g., 82.2% among all service calls[4]). Problem management can be seen as consecutive tasks of *identifying* problem features encountered, *diagnosing* the problem, and *retrieving* optimal solutions for the problem. One significant challenge of problem management is to improve the client's satisfaction degree, which is typically only about 50-55%[4]. This paper is focused on the problem management aspect of ITSM.

1.1 Research Objective

A practical research area related to the problem management can be found in Case-Base Reasoning (CBR) approach[5, 6]. In CBR, optimal solutions are retrieved based

on the similar problem-solving experience in the past[7]. The basic concept of CBR approach is to derive the optimal solutions by exploiting "*similar remembrance or experience*" of users in the past. However, one common weakness of this approach lies in a limited understanding of the concept of "similar remembrance or experience". It means that most applications using CBR approach are concerning only problem features. In other words, only problem features in the case are considered to make the optimal solutions, ignoring additional information available which can contribute to produce more accurate and satisfactory solutions.

In this paper, our research focus is to identify, conceptualize, and utilize such additional information to overcome that weakness of CBR. Additional information to the problem space is the c*lient space* and the *ITSG space*.

The client space consists of the profiles of clients participating in a given domain, and the ITSG space is composed of the profiles of ITSGs that are responsible for solving problems in the domain. The intuition behind using these two spaces is that by means of utilizing both the profiles of clients and ITSGs, IT support organizations can improve the client's satisfaction and provide more personalized solutions in a consistent way. Therefore, our concern is reduced to the problem of how to identify, conceptualize, and utilize both a client and ITSG profile. An attractive area in terms of this concern is found in *personalization technologies*.

Personalization technologies have been rarely interweaved in ITSM domains[8]. Applying a personalization technology cannot be overlooked, since satisfaction in ITSM is highly dependent on high customization based on personalization information. Personalization can be defined as *"the ability to provide content and services tailored to individuals based on knowledge about their preferences and behavior[9]*." With keeping that definition in mind, we can understand that personalization technologies realize these specific two concerns - (1) designing user profiles and (2) utilizing the user profiles to provide content and services tailored to the clients.

Our primary research objective is to address these two concerns to take advantage of the strength of a personalization technology into the problem management aspect.

2 Personalization in Problem Management

2.1 Augmented User Profiling

One significant issue that needs to be further addressed with respect to user profiling is to identify *reasons* for user actions, e.g., purchasing decision in e-commerce area[10]. To address that issue, a three-layered user profile capturing buying customer behavior is developed, which augments a typical structure of user profiles (i.e., only factual and transactional[8])[10]. The basic idea behind that work is that purchasing behavior of individuals can be uniquely decided on a combination of three categories, i.e., (1) demographics based general customer buying behavior, (2) domain-specific user preferences, (3) and individual transactions of interactions between customer and systems. Being motivated by that user profile structure, our user profile is designed to have a three-layered structure applicable to problem management. The proposed user

profile is a uniform user profile structure for both the client and ITSG, which can conceptualize three different information layers (i.e., factual, preferential, and transactional information related to problem management). These three layers are discussed in the following paragraphs.

2.1.1 Factual Information Representation

The first layer represents factual information that consists of four components, such as user identity (e.g., id, name), company description (e.g., number of employees, software products in use), role characteristics, and role category. The first two components represent domain-independent user information.

The *role* characteristics represent a set of important features about the role of an individual or a target group of users having particular task functions in a given domain. The main reason for deriving such characteristics is to identify either individual users or groups of users who have the same or similar characteristics. These characteristics may be differently composed according to various application domains using important attributes identified by their domain experts. We identify some of potential characteristics that may influence to feature the roles of both the client and ITSG based on the investigation in[4, 11]. Such characteristics are classified into five types (see Fig. 1 (a)) as (1) *demographic* (age, education, task function), (2) *knowledge* (domain knowledge, training), (3) *experience* (current experience, previous experience), (4) *proficiency* (IT speed, skill, problem-solving attitude), and (5) *evaluation* (performance satisfaction [from feedback]).

We derive role categories for users based on the identified role characteristics and maintain such information in the user profile. The aim of deriving the role category is to identify the main roles of the users, and then to provide better information to the both clients and ITSGs to deal with specific problems that the both are concerned with.

The role category is calculated using fuzzy logic which provides a human-like mechanism to imitate human decision cognition. Fuzzy logic is used to reason and aggregate strategy to reach optimal decisions based on practical application knowledge (i.e., rules)[12]. Fuzzy logic has proved quite useful due to its intelligent ability to formalize and manage inexact and vague information[12]. Further, by using fuzzy logic, human experience can be incorporated in a straightforward way, and it is useful in such cases where there is no explicit process model available.

Having motivated the benefits of fuzzy logic, in our system, each role is classified into a pre-defined category for a new user according to a membership value using fuzzy logic. To generate the membership functions, the role characteristics are used in our fuzzy model. Each characteristic is defined by a membership function which helps to take the crisp input values and transform them into certain degrees of memberships.

Fig. 1(a) shows the role types, the role characteristics, and their linguistic terms for membership functions in our fuzzy model. The sample membership functions for input (education) and output (category) are presented in Fig. 1(b), and Fig. 1(c) denotes some of sample fuzzy rules used in the fuzzy logic.

2.1.1 Preferential and Transactional Information Representation

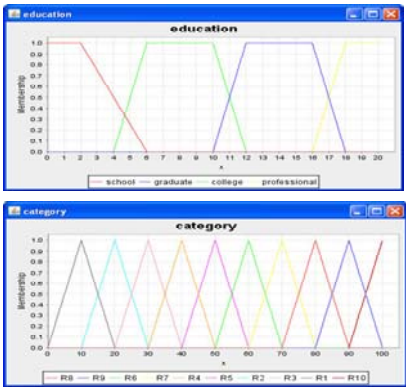
The second layer denotes preferential information which represents the domain-specific features of the problems encountered. This information reveals reasons about

why an individual user or role is deeply related to particular types of problems. Each problem consists of problem identity, problem class, problem attributes (e.g.,

(a)

Types	Role Characteristics	Linguistic Terms
Demographic	Age	young, middle, old
	Education	school, college, graduate, professional
	Task Function	IT_General, IT_Operation, IT_Expert
Knowledge	Domain Knowledge	low, medium, high
	Training	low, medium, high
Experience	Current Experience	novice, medium, senior, expert
	Previous Experience	low, moderate, extensive
Proficiency	IT Speed	low, medium, fast
	Skill	novice, medium, senior, expert
	Problem-Solving Attitude	alone, ordinary, positive, cooperative
Evaluation	Performance Satisfaction	poor, average, good

(b)



(c)

Task Function	Domain Knowledge	Experience	Previous Experience	Education	Training	Skill	IT Speed	Performance Satisfaction	Problem-Solving Attitude	Age	Category
IT_General	Low	Novice	Low	School	Low	Novice	Low	Poor	Alone	Young	R0
IT_Operation	Medium	Medium	Moderate	College	Medium	Medium	Medium	Average	Ordinary	Middle	R1
IT_Expert	High	Senior	Extensive	Graduate	High	Senior	Fast	Poor	Positive	Old	R2
IT_General	Medium	Medium	Extensive	Professional	Low	Expert	Fast	Good	Cooperative	Old	R3

Fig. 1. (a) shows the role types, the role characteristics, and how the role categorization is performed by defining linguistic terms for role characteristics. Two sample membership functions for input (education) and output (category) using the fuzzy logic are shown in (b) and some sample of fuzzy

keywords), the relevance weights of these attributes, and the relevance weight of the problem (i.e., the relative importance over all problems in this layer). The number of components in the second layer corresponds to the number of possible problems that have been encountered. Besides, as the client interacts with ITSGs, the second layer components are increased, aggregated, and updated with the change of the transactional information in the third layer.

The third layer maintains transactional information about how the problems have been handled by certain ITSGs, showing problems encountered, cases retrieved, and the number of problems involved in the cases. In detail, a single transaction consists of ITSG identity that solved the given problem, case identity which contains solutions retrieved to the problem, a set of problem identities that are closely related to the solutions in the case, and 'appropriateness ratio' component. The 'appropriateness ratio' component represents appropriateness value of the given case to the involved problem identities. That is how much the given case is suitable to the related problems. This component is used to update the value of 'performance satisfaction' component in the first layer, and thus to also update the 'role category' component in the first layer. Furthermore, whenever the new transaction occurrs, this new record will be used to update the corresponding instance(s) of related problems in the second layer.

2.2 Utilizing the User Profile

Utilizing the user profile can provide useful benefits to the whole process of problem-solving. As one benefit, we can utilize it in *recommending* an appropriate ITSG who will handle a given problem. The aim is to further process automation for problem-solving by allowing the problem to be dealt by the suitable ITSG. Briefly, our recommendation is divided into three major steps.

First, given a problem by a particular client, we calculate the weightings of associated ITSGs' roles for the client based on their problem-solving experience. The intuition behind this step is that the more a ITSG's role is experienced in handling the problems given by a particular client, the better the ITSG's role will handle a problem given the client in the future. Each weighting indicates a relevance degree of a particular ITSG's role to the client, based on knowledge of how frequently the ITSG's role has handled the problems given by the client. The key idea behind this step is to mimic the paradigm of content-based filtering building on the intuition which is "recommend things like I have liked or preferred in the past"[13]. In other words, we compute the weightings on the basis of a principle that assigning higher weightings if there are ITSGs' roles that have more experience in handling the problem based on the client.

Second, we compute additional weightings of ITSGs' roles for a particular client's role based on feedbacks of the clients who have the same role. The assumption applied in this step is that we would acquire increasingly accurate weightings by taking objective views of similar clients to the given client. The basic idea behind this step is to take advantage of the paradigm of collaborative-based filtering[13]. In other words, we compute the weightings taking into account a set of the 'appropriateness ratio's evaluated by those clients who have the same role with the given client. Therefore, the weightings represent the importance of the suitability about the problem-solving satisfaction of the same role to a particular ITSG's role.

Lastly, the final weightings are computed based on a linear combination of two produced weightings in the previous steps. The ITSG having the highest weighting among them is chosen to solve the problem given by the client.

Two main features of this utilization lie in that we maintain the merits of both content-based and collaborative-based recommendations, and calculate the optimal weightings by utilizing the *roles* in the user profiles, such that we can simplify the calculation process by adopting the role concept.

3 Discussion and Future Work

This paper presented an effective way for incorporating a novel personalization technology into the domain in the problem management of ITSM. We designed a uniform three-layered user profile that conceptualizes both the client and ITSG information related to problem-solving aspect. A major feature of the user profile is that the role characteristics are identified and the role categorization is derived using a fuzzy logic based on such characteristics. Additional beneficial features include building up user profiles in an unobtrusive way by observing the problem-solving

interaction history and providing automatically incremental evolving ability of the user profiles as the user interaction with the system so that the profiles become more accurate and comprehensive. We briefly introduced how to utilize the user profiles in the process of the problem-solving management when recommending an appropriate ITSG to deal with the client's service calls.

In the future, we will explore some of the richer technologies necessary to utilize the user profiles. In particular, to retrieve more accurate and satisfactory solutions, we believe that it is very important to design and develop techniques for an advanced intelligent problem diagnosis and similarity technique that may closely mimic human cognition. Therefore, we will focus on the realization of such issues by incorporating our personalization technology using CBR approach.

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