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Using Case-Based Reasoning to New Service Development from User Innovation Community in Mobile Application Services

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***Abstract*—**The emergence of mobile application services and App Store has led to the explosive growth of user innovation, which users voluntarily contribute to. User innovation communities where end users freely reveal innovative ideas and needs with other community members are becoming increasingly influential in this area. However, user's ideas in user innovation community are not enough to be new service opportunity, because some of them can already developed as existing services in App Store. Moreover, the existing services similar to new service opportunity can be significant references to apply analogy to develop service concept. In response, this research proposes Case-Based Reasoning approach to matching the user needs and existing services, identifying unmet opportunistic user needs, and retrieving similar services with opportunity. Due to its intuitive and transparent algorithm, users related to App Store innovation communities can easily employ Case-Based Reasoning based approach to their innovation.

***Keywords*—**App Store, Case-Based Reasoning, Mobile Application Service, User innovation community.

I. Introduction

RECENTLY mobile industry has moved into new landscape. Mobile data traffic has been dramatically growing, driven by new mobile devices and application ("app") services. Mobile devices such as smartphones, smartbooks, and tablet PCs now can provide the environment to connect mobile broadband networks. Also, *mobile app services* which are embodied in such devices have strongly influenced data usage. The *App Store* concept introduced by Apple in July 2008 allows iPhone users to browse and directly download apps from app marketplace. As of September 2012, there were 700,000 iOS apps in the Apple App Store with more than 35 billion download and 670,000 Android apps in Google Play with 25 billion download.

This phenomenon that apps are explosively increased is captured by the notion of *user innovation*, which leverage the end users of an organization's products and services [1]. The platform providers such as Apple and Google offered open application program interface (API) and software development kit (SDK) which can be the source and toolkit for innovation. This facilitated a voluntaristic production mode, users on their own initiative contribute to innovation and development [2]. Thus, users are becoming "*prosumers*"- producers who are also consumers [3][4]. End users have the most experience actually using a firm's services, and are at the intersection of a service's expected use and its actual use. Thus, user innovation has potential to an effective extension of the firm's research and development efforts, which increases the potential number of ideas and/or innovations.

The prosumers shares their knowledge, ideas, and even technologies through *user innovation communities*, rather than develops mobile app services alone. In the user innovation communities, users exchange the feedbacks for services, suggest their new ideas, and evaluate and assist their service development each other. These knowledge base of needs (i.e. this paper considers user's requirements, feedbacks, and ideas as unified term "needs") in user innovation community can be important source of innovation for both firm and user [5]. However, user needs itself are not enough to be new service opportunity, because some of them can already developed as existing services [6]. Also, even though some of needs are unmet by existing services, the existing services similar to them are significant references to apply analogy or benchmarking to develop service concept [7]. Therefore, quite naturally, the features of the existing services should be matched with needs for identifying new service opportunities [8]. However, there lack the attempts to matching various needs in user innovation communities and existing services.

Taken together, this paper applies Case-Based Reasoning (CBR) approach. CBR has been applied as one of the computer-aided creative problem solving methods to developing new product or service based on the existing functions [9][10]. CBR can retrieve existing product or services (solutions) which are most similar to one customer needs (problem). Research on CBR in innovation has emphasized the adaptation phase which reuses and revises retrieved cases [11]. This is in part because design cases can be quite complex and thus design adaptation is especially hard. However, previous research in CBR has not considered the existence of enormous amount of needs. Huge needs data in user innovation communities are incorporated into CBR process. Then, prior phases of adaptation (represent and retrieve) are more important to deal with vast amount of case bases. In response, the purpose of CBR-based approach in this paper is two-fold: identifying new service opportunity and retrieving

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benchmarking services for developing opportunity. The overall process comprises four stages: case collection, case representation, case retrieval, and case adaptation. In case collection, two types of data are utilized: needs database for problem and service database for solution. In case retrieval stage, new service opportunity is identified and existing services which are the closest to opportunity is searched in case base.

The rest of the paper is as follows. Section II describes conceptual background regarding user innovation community and methodological background including case-based reasoning. Section III describes our proposed method to apply through the CBR stages. Section IV presents the conclusions of our work.

II. Background

A. User Innovation Community

User innovation communities are defined as "distributed groups of individuals focused on solving a general problem and/or developing a new solution supported by computer mediated communication" [12]. While user innovation communities are not a new phenomenon [13], advances in information and communication technologies (ICTs) have enabled end users of an organization's products and services to organize and share innovations through the creation of online communities.

In case of App Store, due to the store's open concept, any developer with any expertise can freely create a mobile app service [2]. There are expertise developers who develop the commercial apps but general users who participate to develop free apps that fit to their needs. These developers and users are sharing their knowledge, ideas, and even technologies through user innovation communities. For example, 'XDA developers (http://www.xda-developers.com)' is the biggest world smartphone open source community that deals with Android and Window based apps.

User innovation communities can be divided along the control dimension: user-controlled and organization-controlled [5]. User-controlled innovation communities are communities that form around a central interest or hobby. In this case, firm can strategically position an organization's human resources within user innovation communities to capture knowledge about an innovation [14]. Organization-controlled user innovation communities operate within the formal boundaries of the firm, with the pre-specified goal of developing organization-specific innovations [5]. In this case, firms should internalize the innovation by implementing user innovation communities.

B. Case-Based Reasoning

Case-Based Reasoning (CBR) is a problem-solving approach that relies on past similar cases to find solutions to problems (Kolodner, 1993). The CBR principle is based on an analogy to the human task of "mentally searching for similar situations which happened in the past and reusing the experience gained in those situations" [16]. A CBR system involves the following three core components: (1) a case representation scheme, (2) a similarity metric, and (3) a case-retrieval mechanism (Wu et al., 2006). The CBR process (Fig. 1) can be represented as follows [17]:

1. Represent: Describing the current problem.
2. Retrieve: Searching and retrieving the case(s) most similar to the problem case, according to a predefined similarity measure.
3. Reuse: Evaluating retrieved cases in order to decide if the solution retrieved is applicable to the problem.
4. Revise: Revising (adapting) the solution manually or automatically and validating through feedback from the user.
5. Retain: Adding the confirmed solution with the problem, for future reuse, as a new case in the database.

It is often used in task domains that have no strong theoretical model and where the domain rules are incomplete, poorly defined and inconsistent [15]. In the domain of product design and development, CBR has been applied to retrieve existing product data or product design [18] and support the creation of new product ideas [7][9].

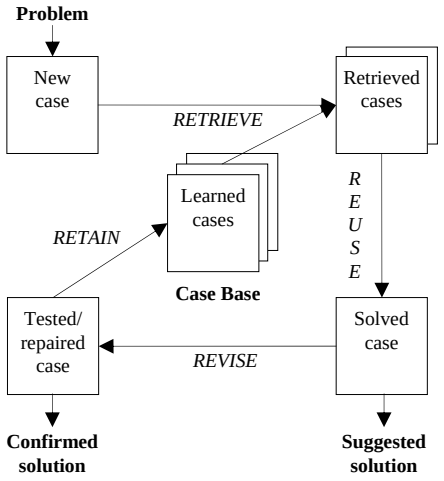

Fig. 1 CBR cycle

III. Proposed Approach

This paper proposes the CBR framework to develop new service concept based on the needs from user innovation community. The case base of solutions is defined as existing services in App Store. On the other hands, a new case of current problem is assumed as the opportunistic problem identified in user innovation community. The unique feature differentiated from general CBR is that a problem (new case) is not given, but selected by matching user's needs with existing service solutions. The requirements and ideas expressed by prosumers in user innovation community are collected as '*needs DB*' and transformed as '*problem base*'. After mapping the closest cases for each needs, the opportunistic needs are selected as '*opportunistic problem*'.

The overall procedure (Fig. 2) consists of four stages: case

collection, case presentation, case retrieval, and case adaptation. Detailed descriptions of these stages are discussed sequentially hereafter.

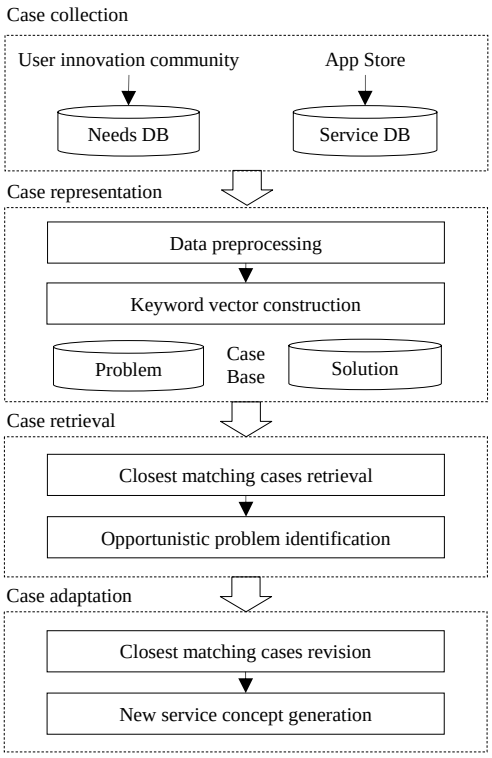

Fig. 2 Proposed approach

A. Case Collection

First of all, two different data are prepared to construct two types of problem base and case base. One is the user needs for a new service gathered from user innovation community, and another is the detailed service information which can be collected from service providers. First, the data source for needs DB can be customer forum or community websites such as Apple Discussions (http://discussion.apple.com), Modmyi (http://modmyi.com/forum/), iPhone Application List (http://iphoneapplicationlist.com), and iPhone Owners (http://www.iphoneowners.com). Second, service DB can be collected from Apple App Store that provides information of apps such as category, last changed date, version, price, size, service provider, detailed description, and reviews. The documents are collected in html files.

B. Case Representation

The CBR needs cases to be represented in structured form such as index, feature vector, hierarchy, and categorization [19]. Since the html documents collected from websites are unstructured form, they should be processed to be structured format. Thus, this paper utilizes "*text mining*" algorithm to construct keyword vector. Text mining, the process of finding interesting patterns, models, directions, trends, or rules from unstructured text, is an automated discovery of knowledge from texts [20]. In text mining, it is assumed that documents in the text format can be featured by keywords, and a keyword vector is the general method of handling large amounts of unstructured text to extract information from structured data.

For instance, a keyword vector is constructed using the common keyword dimensions as shown in Fig. 3. The column represents the keyword dimensions whereas the row denotes each document of the service features and customer needs. The value of each cell in the matrix can be the binary value signifying the existence of keyword (i.e. occurrence) or the number of keyword (i.e. frequency).

	Keyword 1	Keyword 2	...	Keyword n
Needs 1	(1	0	...	5)
Needs 2	(0	1	...	2)
⋮		⋮		
Needs m	(1	2	...	0)
Service 1	(0	1	...	0)
Service 2	(7	3	...	5)
⋮		⋮		
Service k	(2	1	...	0)

Fig. 3 Example of keyword vector

First, data preprocessing is applied to transform html files into text files and eliminate source codes. Second, keyword vectors are constructed for needs DB and service DB. As a result, two types of case base are developed: problem case base and solution case base.

C. Case Retrieval

First, the closest matching cases are retrieved. The CBR system solves a query containing information about problem and returns a list of the 'n' most similar cases ('n' is user defined) or cases with similarity less than a user specified threshold. The similarity between two cases is calculated pairwise between pairs of fields and the most similar cases in a range are searched, using heuristic algorithms. The most general algorithm is nearest neighbor (NN) algorithm [21].

Second, opportunistic problems are identified. All of the user needs are the candidate of new service opportunities. However, some of them are not new service opportunities if the keywords of needs coincide with that of service features because it implies that needs are already satisfied by existing services. On the opposite way, the user needs are identified as the new service opportunities when the service features do not cover them. Therefore, new service opportunities are defined as the user needs which place in the service vacuums which existing services do not exist. In this way, the opportunistic problem is identified.

D. Case Adaptation

The closest matching cases retrieved in third step are arranged according to selected new service opportunity. By applying the analogical thinking to them, the cases are copied

modified and refined. This process can be either manual or automatic work. Consequently, the new service concept can be generated.

IV. Conclusion

This study proposed CBR based approach to exploring and developing new service opportunities. This paper has several contributions to previous research. This research is one of early practical works to utilize the information in user innovation communities. It can help both organization such as Apple and users (developers) in App Store. For organizations, key challenge is how to effectively and efficiently absorb innovations from the community. Since CBR can retrieve, manage and update the learned cases automatically, firms can easily utilize the ideas and needs data in user forums as well as existing service data in App Store. For users, since CBR is transparent and intuitive in terms of how it works, it is easily understood and accepted by users. Retrieved cases can be recommended as the reference of user innovation. Therefore, this can effectively facilitate user innovations based on either their own needs or other user's needs.

However, this research needs future elaboration in terms of methodology. Since this paper suggested only framework, the case study should be conducted. Furthermore, the following issues should be considered. First of all, case revision methodologies such as TRIZ and synectics can be added. Although various previous research has integrated CBR and TRIZ for their synergy for their synergy [22], but the attempts to apply them to service area are scarce. Second, the screening or selecting methodologies can be elaborated. There are various attempts to incorporate screening methods such as fuzzy AHP to retrieve ideas that tend to be more-valued [9]. Finally, the utility of the proposed approach depends largely on extracted keywords. However, the criteria for selecting keywords are rather arbitrary. In spite of the problem of the keyword, this paper assumed that keywords can represent documents for the service features and customer needs quite well. However, derived keywords have various meaning according to circumstances or context. Therefore, ontology-based approach, which considers a context, is expected to be more effective for dealing with this type of data.

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