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■ *Research Paper*

Integrating Web 2.0 with the Case-Based Reasoning Cycle: A Systems Approach

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Traditional case-based reasoning (CBR) research has focused on the theories and heuristics of case representation, retrieval, reuse, revision and retention, while little attention has been paid to the users of CBR systems. In an effort to facilitate and improve the literature related to the CBR cycle as it relates to users, this paper proposes an extended CBR framework which allows users to play a more active role. The extended framework integrates the classical CBR R4-Cycle approach with Web 2.0 technologies such as blogs and RSS (Really Simple Syndication) feeds. The purpose of the extended CBR 2.0 framework is to encourage and enable users to contribute to case retrieval, case revision, case reuse and case retention. This paper also introduces some ideas to deploy Web 2.0 technologies along with CBR systems, with a discussion of the integration of Web 2.0 and CBR systems in systems perspectives. Copyright © 2009 John Wiley & Sons, Ltd.

Keywords case-based reasoning; CBR 2.0; web 2.0; blogs; RSS; systems approach; systems science; systems research

INTRODUCTION

Case-based reasoning (CBR) is an innovative approach to problem solving, which suggests new solutions to new problems by adapting old solutions to those problems (Aamodt and Plaza, 1994). People tend to solve a new problem by finding a similar problem encountered in the past and reusing its solution for the new problem. Then the new problem's solution can be retained for solving future problems. So, when creating a CBR system, one uses a database of problems-with-solutions as an external memory. When encountering a new problem, users can search the CBR system, retrieve a problem situation (in the form of a case) which is similar to the current situation and then adapt its solutions for use in solving the current problem. According to Kolonder (1993), CBR has thus far proven to be an extremely effective approach in solving

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complex problems and has been used in areas such as law, management, business, engineering, health care customer support, sales support, diagnostics and help-desk systems (Li and Xu, 1991; Xu, 1994, 1995a,b, 1996; Hua *et al*., 1996; Watson, 1997, 2003; Li, 1999a, 1999b; Xu and Li, 2000; Yang *et al*., 2006; Luo *et al*., 2007).

Until recently, many CBR systems were complex to use and required a lot of effort to adapt to the needs of users. Such systems were loaded on a local machine and then were run under the individual operating system. These older CBR systems were developed for specialized users, and extensive training and support were required in order for these users to be able to interact with the system. However, stand-alone systems often created issues of inconvenience and high cost for users (Watson and Gardingen, 1999). In recent years, web-based CBR applications, which can be accessed by anyone, anywhere, and at any time, have been implemented. The Web gives users access to CBR systems via common browsers and reduces the complexity of installing and using CBR systems, while also removing time and location constraints. The Web enables the CBR system to be a powerful and accessible tool for users (Toussaint and Cheng, 2006).

In the past five years, the Web has experienced a dramatic change in online communications. It has become much easier to create and publish content to the Web via free web-based services such as RSS (Really Simple Syndication), Blogs (web logs) and Wikis. Users can create and publish content on the internet without the need to know html or other complex software. Some people refer to this change in the nature of information, communication and knowledge as 'Web 2.0', which can be perceived as a second phase of the development of the World Wide Web. As a matter of fact, there has been a lot of controversy regarding the term 'Web 2.0'. Berners–Lee questioned the meaning of the term, and considered that the label of Web 2.0 is unnecessary, since the components of Web 2.0 have existed for a long time (Laningham, 2006). However, Tim O'Reilly argues that although Web 2.0 is an evolution of the original Web, it includes some key ideas that make it different enough from the original web that the term Web 2.0 is needed to differentiate between the two. For example, the new Web 2.0 is more focused on community and information sharing. There is also much debate in existing literatures over how to define Web 2.0. O'Reilly (2005a,b) defined Web 2.0 as 'the network as platform, spanning all connected devices . . .creating network effects through an 'architecture of participation''. Jones (2006) defined Web 2.0 as 'all the Web sites that get their value from the actions of users'.

Regardless of the debate over Web 2.0, in the past three years, more and more users have accepted the term 'Web 2.0'. Web 2.0 has become very popular in both industry and academia, and is increasingly changing the way people learn, work, communicate, collaborate access information and share knowledge. According to a report released in April 2007 (2007), about 120 000 new blogs are created each day and 1.5 million posts are created per day. In addition, people in fields such as business, e-learning and libraries have used Web 2.0 technologies such as Blogs and Wikis to improve their user services and to enhance collaboration with users. Quite a few new terms such as Enterprise 2.0 (McAfee, 2006), Business Intelligence (BI) 2.0 (Spotfire, 2006), E-learning 2.0 (Downes, 2005) and Library 2.0 (Casey, 2005) have been derived from the term Web 2.0 in the past several years.

Some popular Web 2.0 tools include RSS, Blogs, Wikis, Tags, Google Groups and Social Network Service (SNS). RSS allows users to subscribe to a web page and get data updates and notifications as the page content changes. A blog is a web page in diary format that allows users to tell their own stories and get comments from others on their entries. A blog can be easily created by using blog sites such as Blogger.com and Wordpress.com. A wiki is a website that allows collaboration from a group of users which can add, remove, edit and change the content of web pages within the site. As a community-created resource, a wiki can be used as a tool for collaborative learning and knowledge construction (Konieczny, 2007). A wiki can be easily created by using software such as wikispaces.com or mediawiki. Both blogs and wikis can be 'closed' (private, only open to certain users), or

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'open', (everyone on the Internet can have access). Tags are keywords that are associated with information pieces such as video clips or images. They describe an item, thus making that item easier to find. Google groups are created using an online collaboration platform which can be used for question-and-answer sessions between group members. A SNS (social network service) is an online community that specially focused on connecting people. SNS allows a user to create and maintain an online network of close friends or business associates for social and professional reasons (Wan and Zhao, 2007). These are just a few of the Web 2.0 tools that are available.

Although there has been little coverage in the literature of the impact that Web 2.0 is having on CBR, it is conceivable that the Web 2.0 trend could have an impact both on the use of web-based CBR and on research into CBR systems. Based on the concept of Web 2.0, we present the concept of case-based reasoning 2.0 (CBR 2.0). In the past, there had been a change in the way that CBR systems are delivered, now the adoption of Web 2.0 technologies may further influence the roles that users play in case retrieval, reuse, revision and retention. Currently, most existing CBR systems only focus on the retrieval process in CBR and bypass the adaptation task entirely (Leake *et al*., 1995). The aim of case retrieval is to find the old cases that are most similar to the target case. Case adaptation takes those similar cases, and tries to generate a solution that meets the needs of the target case as close as possible (Liao *et al*., 2000). However, as the retrieved case is often not an exact match with the current problem, it is necessary for CBR systems to offer case adaptation support to users (Voss, 1996; Chang *et al*., 2004). Thus, in a manner similar to the way that Web 2.0 is used, we propose that the term 'CBR 2.0' describes this second generation of CBR systems, which are facilitated by the Web platform and which involve both a virtual user community and case adaptation support.

Participation and collaboration are two key characteristics of Web 2.0. Participation and collaboration often lead to collective intelligence, which is a shared or group intelligence that emerges from the collaboration and competition of many individuals (Wikipedia, 2009). Collective intelligence by way of user participation taps a wide range of talent and draws on the social pool of existing knowledge to explore problems with a comparatively low cost. In Web 2.0, users are treated as co-developers. A visitor to the site is not just a user, but is one who helps to develop content for the site. Web 2.0 also emphasizes online collaboration among users. For example, blogs and wikis provide an easy way for users to share knowledge leading to collaboration (Wikipedia, 2007a, 2007b). As we integrate Web 2.0 with CBR, the collaborative characteristics of Web 2.0 provide a powerful tool to improve users' ability to employ CBR systems to solve problems. There is a great potential for Web 2.0 technologies to be used to empower users and to improve users' ability to solve problems by employing the CBR process. As a result, we feel there is a necessity for researching the integration of Web 2.0 and CBR to provide insights into challenges, issues and solutions related to the design, implementation and use of CBR systems.

The reasons for integrating Web 2.0 with CBR include but are not limited to:

(1) deploying Web 2.0 tools along with the CBR system may help to invigorate the CBR case library, which currently faces the challenges of outdated cases and stagnant growth;
(2) forming a virtual user community to facilitate and encourage a culture of participation and collaboration in cases, drawing upon the perspectives and contributions of the user community;
(3) encouraging and enabling a knowledge community of users to share their own views on cases they have used, which will help to improve the quality of the case base;
(4) encouraging and enabling those users to share their knowledge, experience and lessons on the adaptation of cases in general, which will provide new solutions when problem solving. (Specifically, this will aid in determining under which circumstances an adaptation is needed, and in determining how the retrieved solution(s) can be adapted to reflect differences between the new case as

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solved by the user and the original retrieved case(s)); and
(5) encouraging and enabling users to share their experiences in case retrieval, case revision, case reuse and case retention.

CASE-BASED REASONING

CBR has drawn increasing attention over the last 20 years. A large number of successful commercial and industrial CBR applications have been developed and are now in daily use.

When faced with a problem, humans typically assess various situational features presented in the problem, search their memory for past experiences with similar situational features, and seek out similar experiences of peers and colleagues. They then analyse the 'retrieved' experiences and apply the lessons in these experiences to develop new solutions, by relying on the past experience (both their own and others') to solve current problems. In addition, humans, by nature, are storytellers. They often tell stories when sharing experiences with others. CBR models try to reflect this natural process and capture the way that humans store, use and share past experiences. These models include four distinct steps, well-known as the CBR R4-cycle (Aamodt and Plaza, 1994), which summarize the case-based problem solving process:

(1) retrieve the most similar cases from the case library;
(2) reuse the solutions in the cases to solve new problems;
(3) revise or adapt the solution to create a new case; and
(4) retain the current case in the library for future reuse.

Figure 1 depicts this process.

While CBR systems are becoming more common, most studies of CBR have been completed using system-based design research which focuses on functional capability and implementation. CBR research has traditionally focused on the theories and heuristics of case representation, retrieval, reuse, revision and retention. Research on the use of CBR in the form of case libraries is rare (Jonassen and Erdelez, 2005). Little attention has been given to user studies of CBR systems. More research on the impact of user training, users' mental models, system interactions and the ways that users adapt retrieved cases in problem solving is needed (He *et al*., 2008).

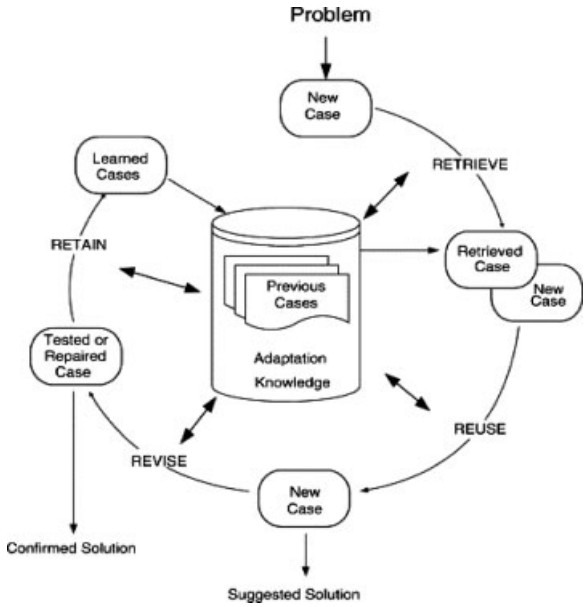

Figure 1 CBR cycle (Aamodt and Plaza, 1994)

In recent years, demands for systems to effectively support and enhance group activities are rapidly increasing due to growing complexities in society and business as well as diversity in user needs (Nishimoto *et al*., 1998). However, most of these ordinary systems are not equipped with facilities to support and/or enhance the creativity of a group as one of its functions (Nishimoto *et al*., 1998). This is also the case for CBR systems. We suggest that one possible reason that many CBR systems are not widely accepted is that the current systems do not provide a social environment for users to communicate with or to get help from others. Most current CBR systems are not equipped with facilities to support group interaction, case sharing and adaptation. It is possible that CBR systems would gain wider acceptance if adequate considerations were given to the interaction

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between the system and the user, and if support were provided to facilitate user collaboration in problem solving and case-base development. A review of literature about CBR systems and applications available on the internet indicates that most CBR systems lack support for social collaboration.

Since problem solving is a social encounter, and since problem solving leads to meaningful learning which often requires collaboration and conversation among people (Jonassen *et al*., 2003), we propose that support should be provided for such collaboration in CBR. When a user accesses a CBR system to solve a problem, he or she may have difficulty in finding the most similar cases to his or her problem situation. If a user encounters a problem outside his or her previous experience, he or she may not know how to adapt or reuse the chosen case for the new problem situation even after the most relevant cases have been found. Providing a social environment in which users can interact with each other may support the adaptation and use of cases from the system. Furthermore, problems of high complexity such as disease assessment and treatment are often assigned to a group of people. Interaction and collaboration among group members become a requirement for solving such problems. Thus, it becomes inevitable for CBR developers to take social communication function into consideration in developing CBR systems. Jonassen and Erdelez (2005) discuss how a case library could grow into communities of practice. As they note:

> Such evolution could be facilitated by addition of interactive modules that allow and encourage users to share comments about how they use case libraries and exchange experiences about how to do it better (p.71).

There are also several common challenges to reusing cases from the CBR case library. Many CBR systems suffer from a lack of user participation and therefore a lack of growth, due to ineffective support for exploring, creating and evolving the cases. Some common issues include:

(1) Sustainability. The cases in the repository become out-of-date as new technologies are developed. A case library must keep growing by integrating new cases into the case base in order to keep users' interest and meet the needs of users, as time goes by.
(2) Case quality. A case in a repository may not adequately describe all of the aspects of a situation, or the information in a case may not be of value to users. It is necessary to get feedback from a community of users in order to improve the content quality of cases and to avoid mistakes.
(3) Case adaptation (Reuse/Revision). Case adaptation can be a very complicated process and can require considerable user expertise (Leake *et al*., 1995). Currently, the CBR community agrees that the best use of CBR is as an advisory system that relies on the user to perform evaluation and adaptation (Pawar *et al*., 2000). As few mechanisms have been devised to help users with solution adaptation based on their own circumstances in literature, it is important to explore the heuristics that can be used to guide users in adapting problem solutions effectively and efficiently.

AN EXTENDED CBR FRAMEWORK

As problem solving often requires collaboration and conversation among people (Jonassen *et al*., 2003), it is not hard to see the contributing value of Web 2.0 to CBR systems. Since Web 2.0 empowers users to share their insights and to make contributions to the case library, this creates an exciting learning opportunity for both users and the case library. We propose that Web 2.0 tools such as blogs, RSS feeds, wikis and discussion groups be considered as enhanced features in developing a CBR system. Figure 2 depicts our proposed CBR 2.0 framework that demonstrates how Web 2.0 technologies can be deployed along with a CBR repository.

According to Topcu *et al*. (2007),

> Integration can be categorized into five kinds: (i) platform, related with framework services; (ii) presentation, concerned with user interaction; (iii) data, using information in the tools;

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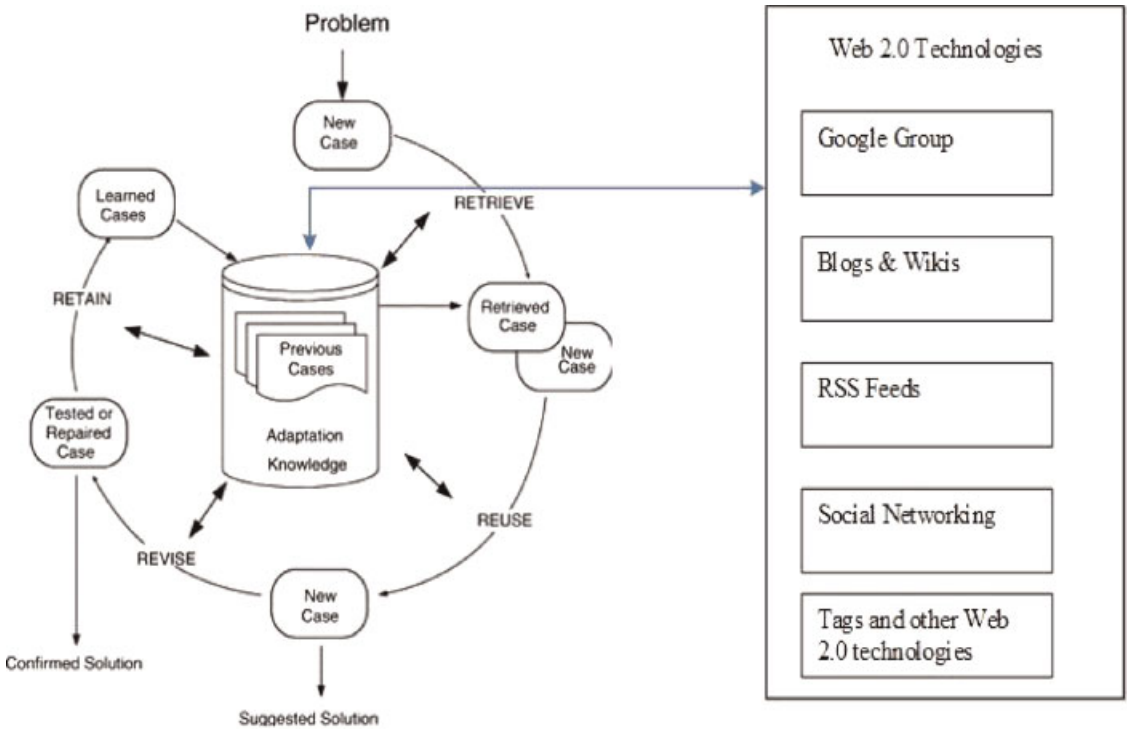

Figure 2 Proposed CBR 2.0 framework (extended from the CBR Cycle)

(iv) control, mechanism for tool communication and interoperation; (v) process, related to roles of tools in the systems (Ian Thomas, 1992; Anthony, 1990). The aim of integration is to transform multiple tools into one useful and flexible environment for building communities and to provide multi-functional services to the users.

The CBR 2.0 framework demonstrates integration in platform level and reuses the existing tools to link together different technologies. It seeks to allow users to play a more active role by participating in the CBR cycle, focusing on case retrieval, reuse, revision and retention. The CBR 2.0 framework can be used to facilitate case use, sharing and adaptation. Based on this framework, deeper levels of integration in presentation, data, control and process level can be further developed.

There are a myriad of ways Web 2.0 can be integrated to support the CBR cycle. Users have the opportunity to choose different Web 2.0 tools and decide the best ones to meet their specific requirements. The following describes some of the ways to use web 2.0 technologies to facilitate the use of CBR systems.

(1) CBR developers can create, store and syndicate custom RSS feeds so that users can be informed about the latest updates, based on preference sets related to their own interests. This can provide methods for more efficient use of the cases in the case library, and also provides an alternative way for cases to be consumed in the case base.
(2) CBR developers can use a wiki system to help collect cases from users. A wiki enables a group to collaboratively develop a case and exchange ideas. Later, these cases can be moved into the CBR case base for indexing and searching.
(3) CBR users can use collaborative tools (such as blogs and Google discussion groups) to build an online community in order to enhance coordinated work or tasks and to facilitate

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problem solving. For example, a user can provide insights on a blog to help another user find the most appropriate cases or alter the retrieved solution(s) to reflect differences between new case and retrieved case(s).

(4) CBR users can participate in ongoing discussions about cases, thus adapting the cases to integrate current ideas and information.

It is also necessary to note that blogs have become a powerful tool for establishing and maintaining online communities. Blogs provide user authentication mechanisms for targeted users to add annotation or comments to the cases they visited in order to benefit the case library and other viewers. This mechanism can effectively prevent the creation of any 'junk feedback' the cases may receive. Furthermore, blogs provide feedback settings which can help to moderate the feedback and reduce inappropriate feedback. Blogs can also be used to set e-mail notifications which are sent to site administrators when any new comment is posted.

SYSTEM PERSPECTIVES FOR INTEGRATING WEB 2.0 AND CBR SYSTEMS

In recent years, there has been a growing interest in viewing information systems as a social technical system (Stanley and Warfield, 2007; Warfield, 1976, 2002, 2006, 2007; Xu, 2000). It is recognized that some information systems might have been technically elegant, but were not ideal from a social standpoint (Xu, 2000). This view takes neglected functions such as communications into consideration and aims to achieve an optimal technical and social system through systems development. From a technical view point, CBR systems and Web 2.0 have different characteristics and can be used as independent systems. However, as Xu (2000) noted:

> Some information system components can operate as independent systems. However, when they are incorporated into a system, their behavior depends on interactions with other systems components. Numerous interactions of different types/characteristics may be involved, such as interactions within a system or a subsystem, interactions between systems and/or subsystems, and interactions between a system and its environment. (Xu, 2000)

Therefore, it is important for us to investigate these interactions if the integration of Web 2.0 and CBR systems is to be employed successfully. In this regard, systems science has provided the potential to help conceptualize these interactions (Warfield, 1976, 2002, 2006, 2007). The following describes our preliminary understanding of these interactions in systems perspective.

To understand these interactions, it is necessary to identify the characteristics of subsystems. Besides the characteristics of participation and collaboration, openness is viewed as another essential characteristic of Web 2.0 (O'Reilly, 2005a,b). Openness means that to be successful we must rely on interactive participation by multiple users to generate new and better solutions to problems. On the other hand, CBR also has three distinctive characteristics. As Althoff, Bergmann and Branting noted,

> Three characteristics of CBR account for its growing popularity. First, CBR can reduce search. Solution reuse is compatible with a wide range of problem-solving methods, so a CBR component can be used in many types of problem-solving system. When similar problems recur, CBR can significantly improve performance. . . .The second characteristic is that CBR permits problem solving even when the underlying domain theory is incomplete. . . . Finally, CBR can facilitate knowledge acquisition. Although human experts can seldom articulate general problem-solving rules, they can often explain the solutions to particular problems. . . . (Althoff *et al*., 2001)

From a functional perspective, both CBR and Web 2.0 technologies can be used to support problem solving or decision making. Depending upon the characteristics of the problem domain and the developer's preference, various forms of case representation can be used (Liao *et al*., 2000). However, a user's attitude and involvement in

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selecting and using a case is often affected by the presentation of a case. When a user dislikes the way a case's information is presented, he or she may choose to stay away regardless of the Web 2.0 features associated with the case. On the contrary, a user friendly presentation of a case can keep users focused and may potentially lead to more user interest. This example demonstrates the effect of CBR on Web 2.0 to some extent. The participation and collaboration properties of Web 2.0 leverage the wisdom of the crowd to analyse problems and various situational issues, retrieve cases from the case base, revise old cases to fit new problems, reuse cases and thus can significantly improve CBR system's performance in solving problems. This performance improvement can be particularly significant for problems of high complexity.

As a result, both Web 2.0 and CBR can complement to each other to some extent from systems perspective. From the user's point of view, integrating Web 2.0 and CBR is especially desirable when dealing with problems of high complexity. With the help of the user community and in consultation with experts in the online community, a number of issues associated with a solution to the problem can be prevented right from the start. With the proposed CBR 2.0 framework in which CBR and Web 2.0 can co-operate and interact with each other, users can benefit from the advantages of CBR and Web 2.0 and be more effective in solving problems. Figure 3 describes the combined characteristics that CBR 2.0 framework may form when Web 2.0 interacts with CBR systems.

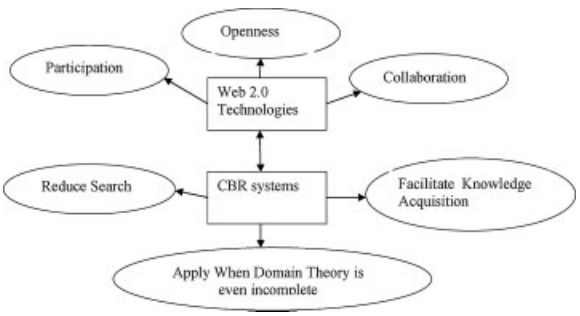

Figure 3 Characteristics of CBR 2.0 framework

In order to integrate Web 2.0 and CBR, CBR system developers need to determine what to store in a case and find an appropriate structure for describing case contents and various Web 2.0 technologies. In general, a case consists of a problem description, a solution description and/or an outcome. We suggest adding a new section named Web 2.0 resources to the case structure. A meta-data section is optional and can be used to include the users' names, time of creation, case source and other referential data (Watanabe *et al.*, 2002). Table 1 shows the representation of our suggested case structure.

Once an appropriate structure for describing case contents and various Web 2.0 technologies is finalized, the CBR system developers can follow the conventional information system development method and practices of software engineering to implement the integrated system. An example of implementation is briefly described as follows. The developer of a CBR repository can add an index item (such as a blog page's URL) to the case structure. When a new case is added to the case base, the blog page's URL will be supplied accordingly. In this way, each case could be linked to a blog page which can be used as a supplemental resource. Similarly, the developer of a CBR repository can add another index item (tags) to the case structure to allow cases to be tagged under multiple terms. Allowing users to tag cases can facilitate the case retrieval and help recall things by context. In addition, an integrated system should allow users get RSS feeds when there are new entries about their case of interest, or about cases on specific topics, and so on. The URL of a RSS feed can be an indexing item in the Web 2.0 resource section as well. Generally speaking, RSS feeds are implemented via XML language and could be

Table 1 Representation of a case for integration of Web 2.0 and CBR

Problem description
Solution description
Outcome description
Web 2.0 resources description
meta-data of the case

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accessed through a RSS icon link on any case page.

It is worthwhile to mention that XML can be very useful in the integration process. XML is a description language that supports meta-data descriptions for particular domains and these meta-descriptions allow applications to interpret data marked up according to this format (Coyle *et al*., 2003). XML is essential for Web 2.0 technologies such as RSS and AJAX (Asynchronous JavaScript and XML) as a group of interrelated web development techniques used to create interactive web applications. Using XML affords many advantages such as ease of transformation, flexibility of presentation and potential to create hybrid systems easily. XML can also be used to represent cases, similarity, adaptation knowledge (Coyle *et al*., 2004) and enable CBR applications to integrate with existing information systems. Several XML-based CBR systems have appeared (Hayes *et al*., 1998; Watson and Gardigen, 1999) over the past few years. Thus, we expect that XML will play an important role in integrating CBR with user-generated content contributed by Web 2.0 and can form the backbone of this integration.

There are some research issues associated with the integration of CBR and Web 2.0. These research issues include but are not limited to:

1. How to implement an efficient method to integrate the generated knowledge from the users into the case base and index the new knowledge for future retrieval? For example, a wiki can be used to collect cases from a group of users. Manually indexing and inputting the wiki cases can be a very time-consuming process. Approaches to automate the case indexing and input are needed.
2. Designing and maintaining integrated systems is challenging (Warfield, 2007; Li *et al*., 2008). As the integrate system becomes more complex than the conventional CBR systems, designing and maintaining such systems will need to become more of a dynamic process (Xu, 2000).
3. How to measure the product and process quality dimension of such integrated systems (Basili and Musa, 1991)? The ultimate quality goal is user satisfaction. In order to support users and to make the user experience as satisfying as possible, models of how users will employ such integrated systems are needed.
4. Efficient data analysis and management strategies need to be employed to take advantage of the massive information that can be contributed by a user community. The uncontrolled nature of Web 2.0 can generate huge amount of chaotic data. Strategies to leverage Web 2.0 to establish an effective collaboration platform are needed.
5. Deeper levels of integration in presentation, data, control and process level need to be further developed (Li *et al*., 2001).

It is important to note that human factors play a very important role in integrating Web 2.0 and CBR systems because the success of the integration of Web 2.0 and CBR depends upon the active involvement and collaboration of users. User input will help to capture new cases from a user community by finding new solutions or improving old cases in the case base. These captured new cases can then be input into the case base for indexing and retrieval. This process provides a new method by which the case base can grow in size. In addition, this process will help reduce the sustainability issue by providing methods for continuous input into the system.

CONCLUSION AND FUTURE RESEARCH

Over the years, many CBR systems and case repositories have fallen into disuse and have been eventually dismantled due to the lack of user participation and therefore the lack of growth in the case base. Web 2.0 provides an excellent platform for collaboration, which can be invaluable in solving problems and making better decisions. Web 2.0 technologies could provide methods to stimulate user participation, to facilitate case adaptation, and to help invigorate these repositories. We believe that deploying Web 2.0 technologies along with CBR systems will provide better support for the R4: case retrieval, case reuse, case revision and case

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retention. CBR system developers could take advantage of tools like RSS, blogs and wikis and other Web 2.0 technologies to support user interaction with such systems.

In this paper, we first introduced CBR and the Web 2.0 technologies. Then we described our concept of CBR 2.0 and proposed an extended framework that can incorporate the Web 2.0 technologies into the field of CBR. We have delineated some ways that Web 2.0 can be integrated with CBR. We note that technologies from Web 2.0 provide opportunities to change the ways that users interact with CBR systems. CBR 2.0 extends the concepts of CBR and integrates Web 2.0 technologies to enhance user input into case retrieval, reuse, revision and retention.

To employ a successful integration of Web 2.0 and CBR systems the application of systems science becomes a necessity (Warfield, 2007). From a research perspective, this paper highlights the need for further research to investigate the complex interactions and relationships between Web 2.0 and CBR systems, and the impact of Web 2.0 technologies in improving the sustainability and quality of CBR case bases. In addition, research is needed to look into the practical effect of the proposed extended CBR cycle in solving real world problems. This paper is also intended to initiate a discussion about formulating comprehensive methodologies and diverse methods to implement the integration of Web 2.0 and CBR systems including deeper levels of integration in presentation, data, control and process level. It is clear that there are many opportunities for in-depth research applying Web 2.0 to CBR systems. Further discussions is needed with other researchers about what the framework of CBR 2.0 should look like, the characteristics of CBR 2.0 Framework, the creation of a formal definition of CBR 2.0 and the creative use of Web 2.0 technologies to facilitate the use and growth of case bases.

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