Integrating Online Social Networks with E-Commerce: A CBR Approach

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Abstract

Integrating online social networks (OSN) with e-commerce is a part of Enterprise 2.0 and social media and is of significance for development of e-commerce and online social networking services. However, how to integrate online social networks including Facebook with e-commerce is still a big issue for companies. Case based reasoning (CBR) has a number of successful applications in e-commerce and web services. This article examines how to integrate OSN with e-commerce, how to integrate CBR with e-commerce and how to integrate CBR with OSN. This article also proposes a CBR architecture for integrating online social networks with e-commerce using CBR as an intelligent intermediary. One of the research findings indicates that the principle of CBR is a useful marketing strategy for integrating e-commerce and OSN. The approach proposed in this research will facilitate the development of e-commerce, Enterprise 3.0 and online social networking services.

Keywords

Online social network (OSN), e-commerce, case-based reasoning (CBR), Enterprise 2.0, social media.

INTRODUCTION

In the past two decades we have experienced e-commerce from start via mature to smarter e-commerce (Schneider, 2011, pp. 2-5; Turban & Volonino, 2011, p. 223). The dramatic development of social media in general and online social networking in particular in the past decade provides huge potential and challenges for e-commerce. The potential for e-commerce is that social media provides new avenues for communication and interaction between e-commerce companies and customers (Zhivov, Scheepers, Stockdale, 2011). The challenge for e-commerce is how to integrate online social networking services with e-commerce, which is a part of Enterprise 2.0 and social media (Lai, 2010). The work by Zhivov, Scheeper and Stockdale (2011) addresses the way Facebook facilitates online communities in television fandom sites. Through the use of case studies, they concluded that using social media to build online communities, to which they can promote goods and services, is a potential marketing strategy for television and film companies. However, the unsuccessful initial public offering (IPO) of Facebook can be considered a challenge for online social networking service companies (CBS News, 2012). This implies that how to integrate online social networking services with e-commerce remains a significant issue for researchers in the area of social media, enterprises, e-commerce and information systems.

As an intelligent technique, case-based reasoning (CBR) solves problems through analysis of previously solved cases, either by finding an exact solution to a previously solved problem or by adapting one or more past solutions (Sun, Finnie, & Yearwood, 2010). The most similar set of cases to the current problem will be extracted from the case base (Sun & Finnie, 2004). CBR has found a number of successful applications in e-commerce and Web services (Sun & Finnie, 2004), especially in search, retrieval (Smyth, Briggs, & Coyle, 2009), discovery, brokering, composition and recommendation (Kanawati & Malek, 2007) of e-commerce and Web services (Sun, Finnie, & Yearwood, 2010). For example, Sun and Finnie built the correspondence between CBR cycle and e-commerce activities (Sun & Finnie, 2005). Ladner et al (2008) used a case-based classifier for

Web services discovery. CBR has been also applied to social media including OSN. For example, Smyth and his colleagues developed a CBR system, HeyStaks (http://www.heystaks.com), for sharing search experiences (Kanawati & Malek, 2007) and facilitating collaboration and interaction among the users in an online search community (Smyth, Briggs, & Coyle, 2009). However, how to use CBR to integrate OSN with e-commerce remains unresolved.

This article will address the above issues by examining how to integrate OSN with e-commerce, how to integrate CBR with e-commerce, how to integrate CBR with OSN, and proposing a unified CBR architecture for integrating online social networking services with e-commerce. To this end, the remainder of this article is organised as follows: After providing a background for this research, this article examines how to integrate OSN with e-commerce. This article looks at case-based reasoning from a logical and intelligent system perspective and then examines how to integrate CBR with e-commerce, and how to integrate CBR with OSN respectively. This article also proposes a unified CBR architecture for integrating online social networking services with e-commerce in which CBR is an intelligent intermediary. After briefly looking at some related work, the final section ends this article with some concluding remarks and future work.

BACKGROUND

This section provides background information on e-commerce, OSN, and case based reasoning (CBR) and briefly incorporates them in integrating OSN with e-commerce.

E-commerce is defined as the process of buying, selling, transferring, or exchanging products, services or information via the public Internet or private networks (Turban & Volonino, 2011, p. 158). More generally, e-commerce refers to all business activities that use Internet technologies (Schneider, 2011, p. 6). The business activities include not only the above-mentioned buying, selling, transferring, or exchanging products, services or information, but also all the activities of supporting them such as e-marketing, e-supply chain management and e-customer relations management etc (Schneider, 2011; Turban & Volonino, 2011). Internet technologies include the Internet, the Web and other technologies such as wireless transmission on mobile phone networks (Schneider, 2011, p. 4). Enterprise 2.0 refers to Web 2.0 technologies used for some business or organisational purpose. The goal of Enterprise 2.0 is to promote increased collaboration, information sharing, and knowledge exchange among employees, consultants, and company partners using Web 2.0 technologies (Turban & Volonino, 2011, p. 235).

An online community is defined as an aggregation of Internet users who form webs of personal relationships (Spaulding, 2010). An online community can also be defined as a cyberspace supported by software (information technology) through providing mass communication, interaction and relationship building that meets functional, psychological, social and hedonic needs of its members in the community (Zhivov, Scheepers, Stockdale, 2011). An online social networking service is a website where individuals, who are defined by a profile, can interact with others (Turban & Volonino, 2011, p. 223). Online social networking services or websites create and represent a special type of online community and are the dominant form of online community (Turban & Volonino, 2011, p. 230). Social media encompasses all Web 2.0 applications including OSN. Web 2.0 is the second generation of Internet-based services that let people collaborate and create information online in perceived new ways such as social networking services, wikis, and blogs (Turban & Volonino, 2011). Social media emphasises creation, sharing and exchange of information (e.g. photos, texts, and messages), thoughts, opinions and experiences (e.g. comments, opinions, ratings and playing games) among individual users (Smyth, Briggs, & Coyle, 2009; Kaplan & Haenlein, 2010). In online communities, the Web users can express themselves by posting blogs or experiences or photos, interact with each other, share information and multimedia, and establish their social networks (Lu, Zhao, & Wang, 2010). Facebook is selected in this paper as the example of online social networks or online communities, because it is the most populous online community, and its success will verify the success of integrating online social networks with e-commerce in the near future. Further, we prefer the friending relationship used by Facebook, people "friend" one another to gain access to information (Turban & Volonino, 2011, p. 223), taking into account the principle of CBR.

Case-based reasoning (CBR) is a reasoning paradigm based on previous experiences or cases; that is, a CBR system solves new problems by adapting solutions that were used to successfully solve old problems (Sun & Finnie, 2004). The principle of CBR is "similar problems have similar solutions" (Sun & Finnie, 2004). CBR can be modelled using a CBR cycle which consists of case repartition, case retrieval, case reuse, case revision, and case retention (Sun & Finnie, 2004). CBR provides customers with past experiences and supports their decision making in workflow management (Weber, Wild, & Breu, 2004), e-commerce (Sun & Finnie, 2004), and Web services (Sun, Finnie, & Yearwood, 2010).

It should be noted that the term online community is preferred, although virtual community is used by many researchers (Spaulding, 2010; Zhivov, Scheepers & Stockdate, 2001). The terms online social networking

websites, online social networking services, and online social networks (OSN) are used interchangeably (Turban & Volonino, 2011, p. 223). We understand that only using Facebook as the example of OSN might not hold for common and distinct other forms of online social networking models, for instance, Twitter and QQ (Kim, Jeong, & Lee, 2010). We will mitigate this issue in the future work.

INTEGRATING ONLNE SOCIAL NETWORKS WITH E-COMMERCE

Online social networking services have developed dramatically in the past decade (Messinger, Stroulia, & Lyons, 2009; Kim, Jeong, & Lee, 2010). Facebook.com, as one of the leaders in the social media or online social networking services, has revolutionised how online communities are formed (Zhivov, Scheepers, Stockdale, 2011), how information is shared and exchanged in an online community, and how to join and live in an online community. All these basic functions have been shared by popular online social networking websites such as QQ Zone (www.qq.com), and Renren (www.renren.com) as well as Twitter (twitter.com).

Integrating OSN with e-commerce, which can be called social commerce (Lai, 2010), has recently drawn increasing attention in the communities of both e-commerce and online social networking services. For example, Lai (2010) discusses social media and its effects on emerging social commerce and finds that the profit of online social networking sites is mostly generated from e-commerce business opportunities, because users tend to purchase products or services recommended by other users or friends. Lu, et al (2010) claims that many online social networking service companies and e-commerce companies have already built their own communities and provided their community members with transaction functions such as buying and selling goods and services, or provided improvement to their existing services (Lu, Zhao, & Wang, 2010). E-commerce businesses hope to present their companies in online social networking websites based on the assumption that online communities can be leveraged to provide access to consumers and consumer data (Spaulding, 2010). For example, ABC (http://www.abc.net.au) has a presence in Facebook, so does Harvard University (http://www.harvard.edu) in order to promote their companies. The simple presence of their business, like traditional online presence, is not enough. Alternatively, an online social networking service company such as Facebook hopes to be a part of the e-commerce business process. For example, Facebook has created a platform for business to create a presence and provide tools for targeted online advertising. Facebook also provides a pay-per-click advertising system for targeted advertising (Spaulding, 2010).

Online communities can directly support most e-commerce activities to some extent (Spaulding, 2010). For example, customer behaviours of online purchasing, which are a part of e-marketing, have been affected in many online communities owing to information exchange, interests sharing and ubiquitous online advertising. Everyone in online communities has been affected by various online advertisements and then has inadvertently or unintentionally supported e-commerce. However, different online communities have different influences on integrating OSN with e-commerce. Based on the research of Armstrong and Hagel (1996), there are four main types of online communities: transaction-oriented, interest-oriented, relationship-oriented, and fantasy-oriented online communities (also see (Lu, Zhao, & Wang, 2010) and (Kannan, Chang, & Whinston, 2000)).

Transaction-oriented online communities aim to bring sellers and buyers together and focus on transaction needs, where the members can get business transaction information (Spaulding, 2010; Lu, Zhao, & Wang, 2010). From an e-commerce perspective, transactions can be classified into business to business (B2B) e-commerce transaction, business to customer (B2C) e-commerce transaction, and customer to customer (C2C) e-commerce transaction (Schneider, 2011, pp. 5-7). Therefore, transaction-oriented online communities are the main online communities of e-commerce. eBay.com, amazon.com and alibaba.com facilitate buying and selling online in transaction-oriented online communities, and have been successful in e-commerce activities. Alibaba.com already has its own online community, which aims to provide a platform for sharing business (transaction) information and "finding friends through doing business" (http://club.china.alibaba.com). However, integrating OSN with e-commerce has not yet been as successful as B2B and B2C transactions in e-commerce.

Interest-oriented online communities gather users around a common theme or interest such as information sharing, and experience dissemination (Spaulding, 2010). Users can post their blogs, photos, messages, update files and discuss a specific topic in this type of online community. Facebook has been successful in this type of online community. However, Facebook, like other online social networking services, has not found the secret of successfully integrating OSN with e-commerce owing to the well-known IPO issues (CBS News, 2012).

Relationship-oriented online communities generally focus on real-life relationships such as family, friends and classmates (as a part of Facebook) or business relations (linkedIn.com) (Spaulding, 2010). People with similar experiences come together and form meaningful personal relationships in this type of online community (Lu, Zhao, & Wang, 2010). How to integrate OSN with e-commerce is still a big issue for this type of online community, like interest-oriented online communities.

Fantasy-oriented online communities gather users around a common entertainment such as online games (Lu, Zhao, & Wang, 2010). Second Life (secondlife.com) belongs to this category. Residents of Second Life are allowed to play out their fantasies in these communities (Spaulding, 2010). The residents hope to explore the environment, share experiences with others, meet people, make friends and engage in commercial activities in Second Life (Messinger, Stroulia, & Lyons, 2009). The integration of OSN with e-commerce is also an issue for this type of online community because of fierce competition among online social networking services.

Spaulding (2010) discusses each of the above four types of online communities in terms of product development, marketing, sales and product support of e-commerce activities. No online social networking services or websites including Facebook.com have incorporated all the above four different types of online communities in their services or websites, although Facebook.com has included the last three types of online communities and is attempting to include transaction-oriented online community and is pursuing an all-inclusive website (Sutter, 2012). Therefore, integrating OSN with e-commerce is still a significant issue for both e-commerce companies and online social networking companies in facing the opportunity and challenge of Web 3.0 and Enterprise 3.0, which are the next generation of Web 2.0 and Enterprise 2.0 respectively.

CASE BASED REASONING

This section looks at case-based reasoning (CBR) from a logical and intelligent systems perspective. This is the basis for examining how to integrate CBR with e-commerce and how to integrate CBR with OSN.

Case-based reasoning is, first of all, a kind of reasoning derived from its name, and is related to logical reasoning. Furthermore, CBR is a reasoning paradigm based on previous experiences or cases; that is, a CBR system solves new problems by adapting solutions that were used to solve old problems (Sun & Finnie, 2005). Therefore, we call CBR the form of experience-based reasoning at a general level, briefly,

$$\text{CBR} := \text{Experience} - \text{based reasoning} \tag{1}$$

In business activities, it is usually true that "Two cars with similar quality features have similar prices" (Sun & Finnie, 2004, 2010). This is a kind of experience-based reasoning which is, essentially, a kind of similarity-based reasoning. In other words, similarity-based reasoning can be considered as a special and operational form of experience-based reasoning. Therefore, CBR can be considered as a kind of similarity-based reasoning from a logical viewpoint.

$$\text{CBR} := \text{Similarity} - \text{based reasoning} \tag{2}$$

Similar to the inference engine (IE) and knowledge base in expert systems (ES), one can also use CBR engine (CBRE) (Smyth, Briggs, & Coyle, 2009) and a case base (CB) to denote a CBR system (CBRS); that is,

$$\text{CBRS} := \text{CB} + \text{CBRE} \tag{3}$$

where the CBRE performs similarity-based reasoning, whereas the inference engine in ESs performs traditional deductive reasoning. One of the most important inference rules for deductive reasoning is modus ponens (Sun & Finnie, 2004, 2010):

$$\frac{P,\ P \to Q}{\therefore Q} \tag{4}$$

The inference rule for similarity-based reasoning can be considered as generalized modus ponens (Sun, Han, & Dong, 2008)

$$\frac{P', P \to Q}{\therefore\ Q'} \tag{5}$$

Therefore the CBRE solves a new problem P' by adapting the solution Q that was used to solve the old problem P to Q' based on Equation (5). In other words, the CBRE is a mechanism for performing similarity-based reasoning.

CBR is not only a simple similarity-based reasoning, but is a kind of process reasoning, which is a more complex reasoning paradigm that is usually used in intelligent systems (Sun & Finnie, 2004, 2010). A typical reasoning in CBR, also named as the CBR cycle, mainly consists of (case) Repartition, Retrieve, Reuse, Revise and Retain. Each of these five components is a complex process. For example, case retrieval is a complex operation in the case base. Furthermore, case retrieval and case adaptation are two main stages in CBR, in which similarity-based reasoning plays an important role although case retrieval and case adaptation are based on different similarity-based reasoning models. In fact, case base repartition and building is also based on similarity

based reasoning. Thus, CBR is a process reasoning, in which similarity based reasoning dominates each of main stages of CBR; that is, case base building, case retrieval, and case adaptation (Sun & Finnie, 2005).

The general architecture of a CBR system is shown in Figure 1 (Sun, Finnie, & Yearwood, 2010). The system architecture of the CBR system mainly consists of an interface agent, a case base (CB), a CB manager and a CBR engine (CBRE). The interface agent consists of some kinds of natural language processing systems that allow the user to interact with the CBR system (Sun, Finnie, & Yearwood, 2010). The CB consists of all the cases in e-commerce of an enterprise or the cases that an individual experienced in e-commerce transactions or online communities (Smyth, Briggs, & Coyle, 2009) that the CBR system collects periodically and new e-commerce cases (or online social networking cases) encountered when the system is running. The CB manager is responsible for case repartition, retrieval, reuse, revise and retention which are collectively known as the CBR cycle (Sun & Finnie, 2004, 2010). Different from other existing research on CBR with applications (Smyth, Briggs, & Coyle, 2009), we consider case repartition, retrieval, reuse, revise and retention in the CBR cycle as the tasks of the CB manager, because the data base manager is responsible of data retrieval, reuse, revise and retention. The CBRE consists of the mechanism for manipulating the cases in CB to infer a case that can be used to solve a new problem of a user based on the CBR principle: similar problems have similar solutions. The function of the CBRE is similar to the inference engine of any knowledge based systems (KBSs) including expert systems (Russell & Norvig, 2010, pp. 234-235).
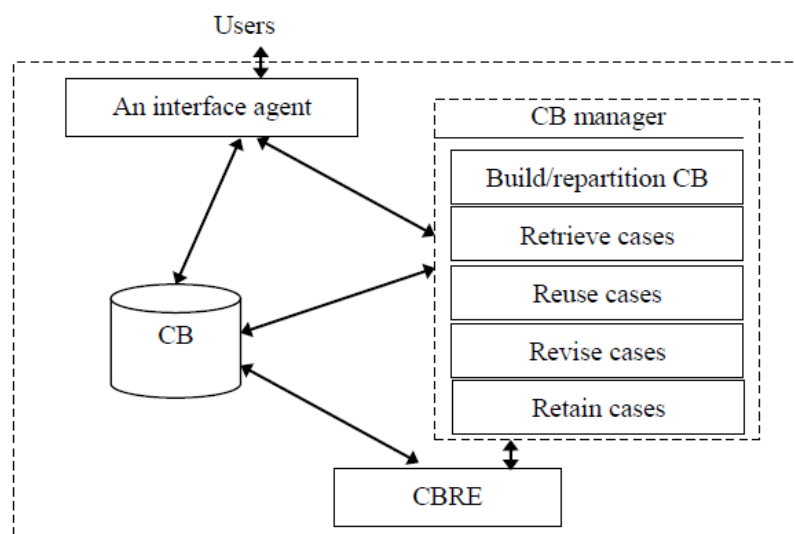

Figure 1. A general architecture of a CBR system after.

It should be noted that many intelligent CBR systems lack either a CBR engine or a CB manager. For example, HeyStaks (http://www.heystaks.com) is a CBR system for social search. However, it has not CB manager as it has not implemented all the functions mentioned in Figure 1 (Smyth, Briggs, & Coyle, 2009). The interrelationship of CBR systems with database systems and KBSs are blurred without a CB manager or a CBR engine. Furthermore, based on the research of (Zhu, Hsu, Nagalingam, & Geng, 2011), more than 60% of the CBR systems have only realised the Equation (4), only a few CBR systems have realised Equation (5).

INTEGRATING CBR WITH E-COMMERCE

CBR has drawn increasing attention in developing Web-based intelligent systems (Sun & Finnie, 2004, 2010). Several Web-based systems that use CBR are already in existence. For example, WEBSELL is an intelligent sales assistant for the WWW, which uses case-based retrieval and case-based recommendation (Cunningham, Bergmann, & Schmitt, 2001). A characteristic of these applications is that they involve implementations of existing CBR technology in a Web context: the client has a remote dialogue through the browser with the CBR application at the server side (Sun & Finnie, 2005). Based on this idea, this section reviews a general model for Web-based CBR systems. In this model, each client has its own case base (i.e. Client CB) and a browser based interface at the front-end that connects to the server at the back-end (Smyth, Briggs, & Coyle, 2009); all the case base processing is performed at the back-end. In the client/server architecture (Turban & Volonino, 2011) the CBR engine is downloaded to the client side, to allow for the later stages of processing to be performed.

The details of the operation of this Web-based CBR system can be explained in the context of e-commerce (Sun & Finnie, 2005). The interface allows a customer to describe his/her demands p'. This is normalised into a partial case description (which is really a problem description) that is passed to the CBR front-end as a Query context (for brevity, it is still p'). Initially, this will be passed to the CBR back-end to find matching cases satisfying $c = (p, s)$ and p is similar to p'. If too many potential matches are found the CBR engine will identify which feature of the problem descriptions in the matched cases is the most discriminating. This is then passed to the user interface as a Refining Question, which is still denoted as p'. This process is known as demand adaptation or problem adaptation (Sun & Finnie, 2005). The response to this request for extra information, which is the result of carrying the demand adaptation, is passed to the back-end as a refined Query context, which is still p', for brevity. This process continues until such time as the Query context is sufficiently discriminating. At this point, matching cases are passed to the user interface as a product or service recommendation.

In this process, as the Query context is refined, the set of potentially matching cases reduces, for example, $c_1, c_2, \ldots, c_n$, where $c_i = (p_i, s_i)$ and p_i is similar to p', $i = 1,2,\ldots,n$, are reduced to $c_1, c_2, \ldots, c_m$, where $m < n$. The advantage of the proposed model is that once this set is sufficiently small it can be passed to the front-end where processing can be completed without further interaction across the network. The decision as to when precisely to do this depends on the size of the cases and the response time across the network. To our knowledge, when a person uses e-Bay or Google search, she or he normally asks if the retrieved results satisfy $m < 100$.

However, from the viewpoint of CBR, the above process has not completely realised Equation (5) in an explicit way, because it only realised case retrieval and problem (demand) adaptation, this is also true for the existing web-based CBR systems for e-commerce. Furthermore, since the end of last century, the relationship between the CBR cycle and e-commerce applications based on CBR has been addressed by several research projects and in some publications such as WEBSELL (Cunningham, Bergmann, & Schmitt, 2001). A relationship between the traditional CBR cycle and the logical model of the CBR cycle and their correspondence to the application areas of CBR in e-commerce can be found in the work of Sun and Finnie (2005).

The principle of CBR, similar problems have similar solutions, has been used in many existing e-commerce systems although there are no explicit declarations by corresponding e-commerce companies. For example, amazon.com has a famous e-commerce system for selling books online (Schneider, 2011, p. 2). This system has been successful in using the principle of CBR in the following way: We search book on "Information Systems", written as p', then we obtain 38,517 results (as on 1 July 2012), written as $c_1, c_2, \ldots, c_n$, where $c_i = (p_i, s_i)$ and p_i is similar to p', $i = 1,2,\ldots,n$, and $n = 38,517$. We have to refine our search by adding "Business" to "Information Systems", because it is similar to "Information Systems", we obtained $n = 4,472$. This number is still too large to read through. We have to refine our search once again by using "Business Driven Information Systems" and we obtained $n = 3$. So far, we realised 1) p' is similar to p (i.e. "Information Systems" is similar to "Business Driven Information Systems") in $c = (p, s)$ where s is the book of Business Driven Information Systems written by Paige Baltzan and published in 2011, further, we click this book and obtain detailed information on this book and buy it online, that is, s. So far, we have realised Equation (4) completely and (5) partially, where $s = s'$. At the same time, we also find that there are a few books, written as $s_1, s_2, \ldots, s_m$, where is $m = 17$, recommended by amazon.com under the tag "*Customers Who Bought This Item Also Bought*", which has logically applied the principle of CBR in the following way. If we buy the book s' and $s_1, s_2, \ldots, s_m$, where s' is similar to s_i, $i \in \{1,2,\ldots,m\}$, then we would also like to buy s_i, $i \in \{1,2,\ldots,m\}$. Yes, we buy one of them online and realise Equation (5). This also implies that the principle of CBR is an important marketing strategy.

INTEGRATING CBR WITH ONLNE SOCIAL NETWORKS

The principle of CBR, similar problems have similar solutions, has also been adopted in online social networking sites such as Facebook.com, although there are no explicit declaration by this company. For example, Facebook uses "likes" to provide its community members with an efficient way to share information. "Like" is the term used by Facebook for becoming a member of a page. "Likes" is used by a team to show the members who "like" this page "have a positive opinion about the post or page made by a friend, member or page moderator" (Zhivov, Scheepers, Stockdale, 2011). More generally, assume that f_1 and f_2 are two members in the Facebook community, g is a description of a good or service, for example, g can be an online game, a photo, a movie, a video program, and a posted comment, $\sim$ is a similarity relation or metric, then if f_1 likes g and f_2 likes g, then f_1 is similar to f_2 with respect to g. If there are n members in the Facebook community who "like" g. Then they are similar with respect to g and we have

$$F_g = \{f_i | \ f_i \ likes \ g, i \in \{1, 2, \ldots, n\}\} \tag{6}$$

F_g is a subcommunity of the Facebook community. Every member in F_g likes g. Or all the members in F_g share same or similar interests with respect to g and then can discuss and communicate with each other in this subcommunity. This subcommunity is developed based on interests rather than geographic location (Zhivov, Scheepers, Stockdale, 2011).

More generally, Facebook uses friending to develop its community. Friendship is a binary relation. If f_1 and f_2 are friends, then f_1 and f_2 have some common interests. In terms of Facebook, the interests include sharing photos, pages, a piece of information, a post, to name a few. If f_1 and f_2 have the common or similar interests in the Facebook community, then f_1 and f_2 have same or similar behaviours in the Facebook community. That is, assume that $\sim$ is a "friend" relationship, $\approx$ is a similarity metric of behaviours, $b_1 \approx b_2$ means that behaviour, b_1 is similar to b_2. Then we have

$$\text{If } f_1 {\sim} f_2 \text{ then } b_1 \approx b_2 \tag{7}$$

In other words, equation (7) means that people with similar interests have similar behaviours. People with similar interests can be called friends. Then "friends have (online) similar behaviours". This illustrates the application of the CBR principle by online social networking sites such as Facebook. If we limit the mentioned behaviours as online purchasing behaviours, then we have "persons with similar interests have similar purchasing behaviours". The first part of this sentence "persons with similar interests" can be used in subcommunities of the Facebook community. The second part of this sentence, similar purchasing behaviours, can be used in online selling and buying of e-commerce. Therefore, Equation (7) is not only an application of the CBR principle, but also a useful marketing strategy for integrating online social networking with e-commerce. This is one of the reasons why Facebook uses "likes" and "friending" to develop online communities, and then uses these online communities to develop e-commerce or realise business strategies of the company.

INTEGRATING ONLNE SOCIAL NETWORKS WITH E-COMMERCE: A CBR ARCHITECTURE

So far, we have looked at integrating CBR with e-commerce and CBR with OSN and found that the principle of CBR is also an important marketing strategy for e-commerce companies and OSN companies. Let's first provide a motivating example. Assume that R and D are two persons. R bought a car of brand "GW" online a few days ago. R and D are friends in Facebook. D consults with R about what a car he should buy online. R recommends that D should buy the "GW" car brand online because it is cheaper than that sold by brick and mortar car dealers. D decides to buy the "GW" car brand online. This example implies that "friends have similar (online) purchasing behaviours". "Friends have similar (online) purchasing behaviours" is common sense, because many of us like to first seek the recommendations from our friends before we buy a car, a house, a computer, even a suit.

Now we propose a unified CBR architecture for integrating OSN with e-commerce, where CBR is considered as an intelligent intermediary (agent), as shown in Figure 2.

In this architecture, R and D are friends in Facebook. This means that R is similar to D in terms of interests and behaviours. For example, friends in Facebook might play the same computer games, post blogs, discuss the same blogs, watch same video clips and share similar ideas on life, politics, and social activities. This is the reason why friends have similar behaviours in general, and friends have similar purchasing behaviours in particular. "Friends" is a key online social networking strategy of Facebook, which has proved remarkably successful, because "People You May Know" and "add friend" features of Facebook have attracted over 1 billion active users in Facebook (Facebook, 2012). These active users form a huge variety of friendship networks based their own interests and behaviours. One kind of friend networks is featured with "friends have similar (online) purchasing behaviours", which is marketed by both e-commerce and online social networking services such as Facebook. Facebook provides an online platform for identifying friends with similar purchasing behaviours. "Similar (online) purchasing behaviours" have drawn attention in the community of e-commerce. It is "similar (online) purchasing behaviours" that makes e-commerce companies such as eBay (www.ebay.com) and Alibaba (www.alibaba.com) apply e-procurement, e-marketing, e-supply chain management and e-customer relationship management (Schneider, 2011; Turban & Volonino, 2011) more efficiently and effectively.

Further, "friends have similar (online) purchasing behaviours" is an instantiation or application of the principle of CBR, that is, similar problems have similar solutions (Sun & Finnie, 2004, 2010) where we consider the principle of CBR as a template. One CBR template can have a large number of instantiations, each instantiation can correspond to a special application of CBR. In fact, "similar problems have similar solutions" is a general tenet of CBR. When using this tenet, we instantiate it to solve a real-world problem. For example, when integrating CBR with e-commerce, we instantiate this tenet as "similar goods have similar prices" (Sun & Finnie, 2004, 2010, p. 18). When integrating CBR with OSN, we instantiate this tenet as "friends have similar online behaviours". When using CBR to integrate OSN with e-commerce, we instantiate this tenet as "friends

have similar (online) purchasing behaviours". Furthermore, the case reuse of CBR, one of the CBR cycle, can be used for integrating OSN with e-commerce as follows: The solution for one friend in the OSN with a new problem (i.e. a new case) is the reuse of another friend's solution for a similar purchasing problem that encountered in the past (i.e. the old case).

Now we use a true story to illustrate this CBR architecture in some detail, although the names in the story are fabricated. Peter and Kate are Australian. Peter lives in Sydney. Kate lives in Melbourne. Peter and Kate became friends using the functions "People You May Know" and "add friend" of Facebook six months ago. They "friended" each other by sharing information (text, message, photos) and experiences (travel, playing games) and discussing some topics of online purchasing, conversing for a number of hours daily in Facebook. Peter and Kate gradually find that they have similar interests and behaviours in online purchasing. So far, Peter and Kate have identified that friends have similar online behaviours in the Facebook world, and have also realised the principle of CBR: Friends have similar behaviours in the CBR world.

Recently Peter planned to travel Spain. However, Peter did not know where to purchase a cheap air-ticket. Kate told Peter that she just returned from a trip to Spain and used the Great Wall Travel Agency (http://www.youxianwang.com) to purchase a cheaper return air-ticket at $1645.00, much cheaper than the price of the air-ticket available from another travel agent ($2874.00). She also told Peter about the incredible beauty of Spain, and the wonderful places to visit. Then Peter took Kate's advice and booked the air-ticket online to and from Spain for $1688.00. Finally, Peter and Kate have realised that friends have similar purchasing behaviours in the e-commerce world based on the principle of CBR. Peter also reused the case that his friend, Kate, in Facebook successfully used earlier. In fact, Peter also simplified the case retrieval (another of the CBR cycle) by asking his friend in Facebook, and revised the case (another of the CBR cycle) by paying a little more for getting the air-ticket, because "time is money" is important for customers in the e-commerce world.
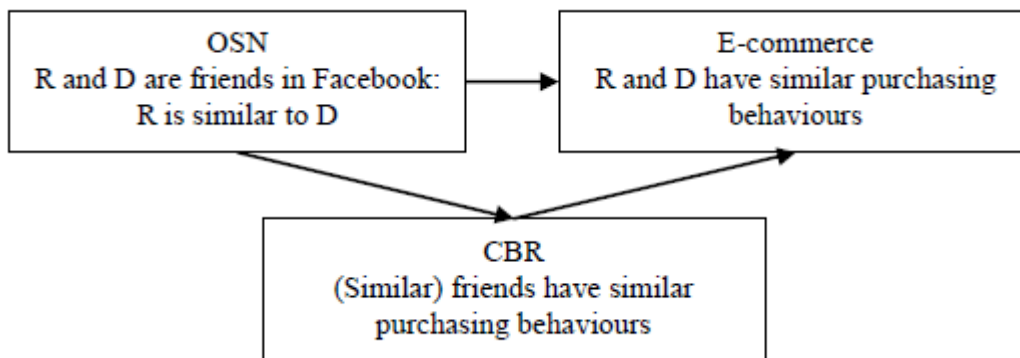
```
┌─────────────────────────────────┐          ┌─────────────────────────────────┐
│            OSN                  │          │         E-commerce              │
│ R and D are friends in Facebook:│ ───────► │ R and D have similar purchasing │
│      R is similar to D          │          │          behaviours             │
└─────────────────────────────────┘          └─────────────────────────────────┘
              │                                            ▲
              └──────────────┐              ┌──────────────┘
                             ▼              │
                   ┌─────────────────────────────┐
                   │            CBR              │
                   │  (Similar) friends have similar │
                   │     purchasing behaviours   │
                   └─────────────────────────────┘
```

Figure 2. A CBR architecture for integrating OSN with e-commerce.

More generally, using the assumption of the previous section, if f_1 and f_2 are friends, and extending Equation (7) which is in the Facebook world, we have

$$\text{If } f_1 {\sim} f_2 \text{ then } ob_1 \approx ob_2 \qquad (8)$$

Where $ob_1 \approx ob_2$ is a special case of $b_1 \approx b_2$, because we limited behaviours as online purchasing behaviours. The Equation (8) means that "Two persons with similar interests have similar online purchasing behaviours". This is the logical basis of any CBR approach for integrating OSN and e-commerce.

RELATED WORK

CBR approaches for integrating OSN with e-commerce can be considered as 1) integrating CBR with e-commerce; and 2) integrating CBR with OSN. In what follows, we review some related work taking into account what we have examined in our research. All the related work motivated us to undertake our research.

Lai (2010) discusses e-commerce in a social media context as social commerce, which uses social media to assist with buying and selling products or services online. In other words, Lai's research aims to integrate e-commerce with social media in general and online social networks in particular. However, Lai's research has not investigated any intelligent techniques.

Spaulding (2010) explored the following two questions: 1) Why do online communities accept certain types of business activities and not others? and 2) which business activities are the best candidates to benefit from participation in online communities? Spaulding's research can be considered as a part of integrating e-commerce with online communities. Spaulding's research presents a limited discussion on online communities and their

corresponding business activities based on the classification of Armstrong and Hagel (1996) rather than considering online social networking. In fact, an online social networking website such as Facebook.com and qq.com covers all the four types of online communities: transaction-oriented, interest-oriented, relationship-oriented, and fantasy-oriented online communities to some extent and faces the challenge: how to integrate online social networking services with e-commerce?

Sun and Finnie (2005) examine how to integrate CBR with e-commerce by building the correspondence between CBR cycle and e-commerce activities. This article developed their research work by arguing that the principle of CBR is an important marketing strategy.

Smyth and his colleagues focus on sharing search experiences and facilitating collaboration among the users in the online search community and developed CBR system HeyStaks (http://www.heystaks.com) (Smyth, Briggs, & Coyle, 2009). They have not discussed how to integrate OSN with e-commerce. Our research emphasises the unified method for integrating OSN with e-commerce using CBR as an intelligent agent (Russell & Norvig, 2010, p. 34).

CONCLUSION

In the past two decades we have experienced e-commerce from start through to mature and currently smarter e-commerce. The dramatic development of social media in general and online social networking services in particular in the recent years provides huge potentials and challenges for e-commerce. Social media including online social networking services has drawn increasing attention as an advanced Web technology for facilitating information sharing and engagement among individuals in online communities. OSN will realise business strategies and revenue models by integrating OSN with e-commerce, as Facebook has been pursuing. This article examined how to integrate OSN with e-commerce, how to integrate CBR with e-commerce, and how to integrate CBR with OSN. This article also proposed a unified CBR architecture for integrating online social networking with e-commerce with CBR as an intelligent intermediary. The research in this article found that the principle of CBR is a useful marketing strategy for integrating e-commerce and OSN. The approach proposed in this research will facilitate the development of e-commerce, Enterprise 3.0, social media and social web services.

Friending as a technological and marketing strategy has been successful in development of Facebook communities. However, how to use friending or friendship networks (Mayer, 2009) to integrate online social network with e-commerce is still an unresolved issue. Therefore, understanding friendship and examining the theory of online social networking services becomes significant for smarter online social networking services and smarter e-commerce. We will address this issue as a part of developing a CBR system for integrating OSN with e-commerce in future work.

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