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The potential roles of context-aware computing technology in optimization-based intelligent decision-making

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Abstract

Making effective decisions often depends on having the right information at the right time. Decision support systems were originally designed to help decision makers by automating some of the decision process. Today's decision support systems should take this a step further: making decisions proactively and intelligently by automatically detecting users' contextual data. Context-aware technology-based applications currently only provide limited personalization services that reference the user's context and preferences; these systems do not fully make use of sophisticated decision making capabilities. Hence, this paper describes how decision making and context-aware computing are jointly used to establish context-aware intelligent decision support systems. To incorporate these capabilities, we address a framework of context-aware intelligent intelligent decision support systems (CAIDSS), with the description of the subsystems within.

Keywords: Intelligent decision support system; Proactive computing; Context-aware computing; E-business; Ubiquitous computing; Agent technology; Web service

1. Introduction

A ubiquitous computing service is an augmented conventional e-commerce service: it embodies high levels of embeddedness and mobility, and runs on a wireless network. These characteristics enable the service to be provided anytime, anywhere, to any devices, and over any networks. Moreover, mobile client devices—such as PDAs and cellular phones, which continue to mushroom in popularity—lead future services to be more personalized.

Personalization is the ability to learn the user's preference from personal resources, such as user's profile, history, context and user's evaluation of service results (Geoffrion & Krishnan, 2003a,b). To increase the quality of these personalized services, we propose the following methods. First, researchers have suggested acquiring personal preferences from the users' manual subscriptions to create differentiated or personalized services. In this service, the DSS acquires and stores users' personal profiles and preference in an information repository for future use. Recent web-based personalization services generally follow this approach. In a second approach, service could be discovered and performed in an automated manner: the approach determines the point of service based on a self-reasoning method and performs the service autonomously on behalf of the user. Agent-based technology is used to implement this approach. In the third approach, we consider an agile service that is aware of users' current context data. This approach acquires the user's context data automatically from sensors which are connected with sensory network, and uses this context data to provide the user with relevant, personalized services. This context data could be broadly varied: user's current location, devices currently available, persons who are in the user's neighborhood, schedules, etc. To date, location-based services (LBS) is most commonly suggested by using this approach. As a result, if we integrate these three approaches to by used in personalization services, we anticipate that the quality of services could be increased. However, researchers have seldom proposed this kind of integration, nor have any prototype systems been developed.

Meanwhile, researchers and practitioners continue to develop ways of optimizing electronic commerce implementations. Even though the potential application area is fairly wide, including on-line auctions, dynamic pricing, revenue management, data mining and virtual stock investment (Rey & Quintana, 2001), demonstrating that applying optimization techniques is feasible to service optimization under ubiquitous conditions has been rare, except the algorithmic research of learning user's preference (Geoffrion & Krishnan, 2003a,b). These findings naturally lead us to newly focus on ways to realize optimal personalization services.

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Hence, this paper aims to propose a context-aware technology that contributes to optimal personalization services. We propose context-aware decision making that amends Simon's decision making phase model to suggest a context-aware intelligent decision support system (CAIDSS).

The rest of this paper is organized as follows. Section 2 reviews the notion of context and context-aware computing. The notion of context-aware decision making is proposed in Section 3. According to the characteristics of context-aware decision making, context-aware DSS, a DSS which adopts optimization and context-aware computing technology to support individual decision making is described in Section 4. Implementation idea and potential contributions of context-aware computing technology in decision making support are addressed in Sections 5 and 6. Section 7 concludes the notion of context-aware decision making with further research issues.

2. Context-aware computing

2.1. Optimization techniques and electronic commerce

It has been known that OR/MS and electronic commerce are complementary to each other (Geoffrion & Krishnan, 2003a,b). In particular, optimization techniques contribute to the rational decision making as an infrastructure of electronic commerce such as B2C, B2B, and so on (Geoffrion & Krishnan, 2001). Therefore, optimization methods have been identified as a crucial Internet resource (Fourer & Gox, 2001). The followings are some electronic commerce area where optimization techniques are used.

First, in on-line auction sites, optimization techniques can help derive the optimal number of auctions to administrate and to optimize the auction model, which considers the quota of each auction, etc. (Pinker, Seidmann, & Vakrat, 2003). Peke and Rothkopf addressed how optimization techniques can be used to determine the winner of an auction (Peke & Rothkopf, 2003). Applying game theory to optimize group-buying models has also been discussed (Anad & Aron, 2003).

Second, the optimization of real-time services on the network has been regarded as an important problem (Geoffrion & Krishnan, 2003b). This is the problem of finding the shortest path in least amount of time, subject to the network overload and the location of cashes (Hosanagar, Krishnan, Chuang, & Choudhary, 2003).

Next, Internet-based customer relationships can embed optimization issues. For example, optimization techniques may contribute to minimizing the cost of data collection and analysis in using data mining to acquire useful marketing information (Padmanabhan & Tuzhilin, 2003)

Last, an optimization methodology was proposed to formulate a global optimization model, which shares the information of each participants in an e-supply chain (Swaminathan & Tayur, 2003). Additionally, in an e-supply chain, a variety of coordination mechanisms have been proposed to derive global optimization by resolving the conflicts among participants who are willing to attain their own local optimal solutions (Kwon & Lee, 2002a,b).

Meanwhile, if we turn our focus to mobile or ubiquitous computing services, new research opportunities are emerging that are based on new features of services. Mobile or ubiquitous computing services contain the following additional features in comparison with conventional electronic commerce, which runs on fixed networks. Successful mobile or ubiquitous commerce lies in the realization of their unique characteristics such as mobility, proactivity, embeddedness, context-awareness, as well as the characteristics-business model fit. Characteristics increase the timeliness and promptness of the legacy services, and hence create new service areas as shown in Fig. 1. The dimensions in Fig. 1 are level of ubiquity and decision support orientation. Ubiquity can be simply defined as the state of being everywhere at once with any networks and devices. To do so, the service should be mobile: the users can access to the service via wireless network through portable

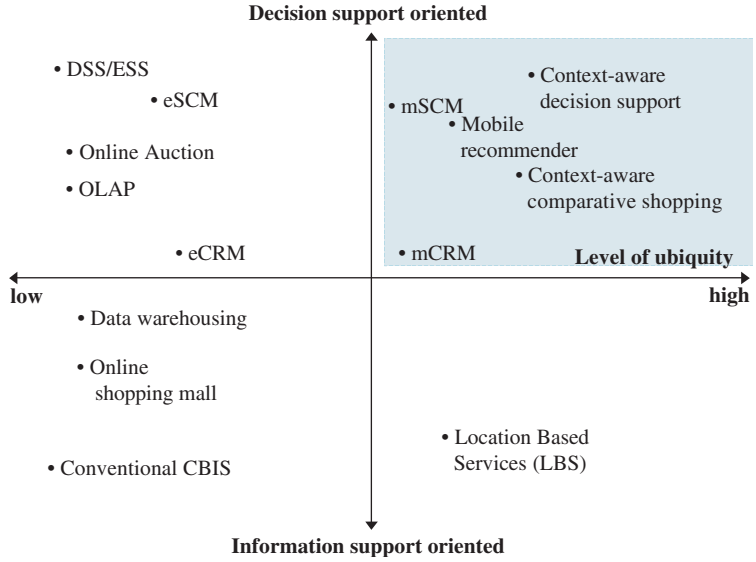

Fig. 1. Service classification.