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Applying case-based reasoning and multi-agent intelligent system to context-aware comparative shopping

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Abstract

Comparative shopping is a promising web service in the field of mobile commerce. This paper aims to propose a context-aware comparative shopping. Multi-agent intelligent architecture is adopted to implement the autonomous negotiation mechanism between buyers and sellers. To automatically estimate user preferences to determine the best purchase, case-based reasoning and negotiation mechanism are utilized. We developed a prototype system and experiment to show the possibility of the mechanism proposed in this paper. We found that our mechanism with multi-agents yields more pay-off, total sales, and wins than the system without those features.

Keywords: Mobile commerce; Comparative shopping; Multi-agent intelligent system; Case-based reasoning; Context-awareness

1. Introduction

The number of users of mobile terminals (phones, PDAs, and communicators) is increasing rapidly. The miniature size of mobile terminals, and that they easily fit into a pocket, makes them an ideal channel for offering personalized and localized services to mobile users. Mobile commerce creates a broad range of new business opportunities for players in the field, such as content and service providers.

One potential business opportunity includes suggesting alternative or comparable products to shoppers, from on- or off-line shops, through mobile devices. In the past, there has not been communication or competition *in real-time* between off-line sellers and on-line sellers. However, if buyers carry their own wireless devices, they can compare products online even when they are shopping at a traditional brick-and-mortar shop. If this kind of ubiquity and "reachabililty" is incorporated, buyers may increase their satisfaction level by making more informed purchases—whether with on- or off-line businesses.

However, only a few web sites are using autonomous agents to negotiate on behalf of their owners, and hence they do not negotiate with buyers. They only provide ads such as product description, price, discount, and warranty condition. There has been substantial research of market-based systems [7,29]. They tried to model an optimization problem for a marketplace consisting of multiple agents in order to calculate optimal equilibrium. Enterprise

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[19], Challenger [5], and WALRAS [6] were such systems. However, as many optimization approaches have encountered, purchasing behavior is hard to quantify. Even though it is possible, creating and changing mathematical models are knowledge-intensive—and hence very costly. To increase customer satisfaction, web sites may dynamically vary products' selling conditions by observing customer preferences and behaviors. For example, some buyers may be prioritizing on price, and others may see warranty services as the more important factor. These lead to the motivation to build an intelligent system that can successfully provide a better proposal enough to sell its own products and at the same time yield a profit for itself. Moreover, the service should be fast enough to influence buyers' decisions before they finish shopping at an off-line shop. As a result, the prompt and adaptive mobile web service requires intelligence and autonomy. These naturally lead us to apply intelligent agent-based systems.

MIT's Media Lab has proposed an excellent approach to agent-based negotiation at point of sale. They combined ideas from electronic commerce and mobile environments in agent-based transaction systems [42]. They extended the Kasbah system [4], letting buyers and sellers create their own agents. When PDA-equipped buyers want to make a purchase, they need to know if there are any other shops which are suggesting better conditions. In this situation, the goal of the system would be to successfully find such on-line shops by communicating with several selling agents and comparative shopping agents on the buyer's behalf.

However, the situation needs to be more generalized to be used in a more realistic setting. First, sellers at the point of sale may be extended from one physical marketplace and multiple on-line marketplaces to multiple physical marketplaces and multiple on-line marketplaces. To do so, the location of the buyer at the point of sale and that of the other off-line shops should be considered. The ''Impulse'' research project is one that enables location-based agent assistance [41]. Secondly, buyers and sellers tend to maximize their own utilities, rather than optimize price level only. Price matters but multi-parameter on-line purchase decision is needed for more sophisticated agent system [23,24]. The negotiation criteria should be augmented from price only to price, quality, brand name, warranty services, etc. Hence, the system must let buyers and sellers create their own profiles. Finally, in comparison to the optimization approach, agents need to be intelligent enough to give sufficiently satisfied suggestions even though utility functions are unknown mathematically.

Hence, the aim of this paper is to propose a context-aware and autonomous system for mobile and comparative shopping that meets the abovementioned requirements. We adopted a multi-agent intelligent system (MAIS) architecture for the following reasons. First, we assume that many selling agents are ready to service according to the request delivered by a negotiator. Secondly, an intelligent agent can contain transaction rules to intelligently and autonomously produce proposals under the delegation of its human owner(s). Next, agent architecture shows widely distributed services very well. Finally, to deal with different buyers' diverse preferences, personalization is needed. Personalization is, to a very limited extent, already available today and an agent system can make it possible. Agent technology has already been used with client/server models and their extensions to build mobile commerce applications [30].

Case-based reasoning (CBR) capability is involved in our prototype since we assume that a user's utility function is hardly represented as a mathematical function. CBR is an AI methodology that provides the foundations of a technology for intelligent systems [15]. The methodology consists of indexing cases, retrieving the best past case from memory, adapting the old solution to conform to the new situation, testing whether the proposed solution is successful, and learning to prohibit solution fails. CBR has been viewed as a technology for automated, intelligent problem solving [37].

We developed a prototype system and experiment to show the possibility of the mechanism proposed in this paper.

The rest of this paper is organized as follows. Section 2 reviews existing research on comparative shopping. In Section 3, we describe our multi-agent framework. The architecture of our purchase advisory system and detail agent behavior algorithm are shown in Section 4. In Section 5, we present a prototype