An agent-based model for consumer-to-business electronic commerce

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Abstract

Electronic commerce has changed the outlook of traditional business trading behavior. It is now common to see business-to-business (B2B), business-to-consumer (B2C) and consumer-to-consumer (C2C) commerce on the Internet. However, another type of model, consumer-to-business (C2B), is seldom found. A possible reason for this phenomenon is transaction cost; to unite a group of candidate buyers' common needs and preferences to buy a product or service is uneasy. Difficulties arise, for example, in how to synthesize individual's preferences into a group's consensus, how to communicate with each other within the group, and how to collectively negotiate with a seller, etc. To establish a successful business model in the electronic market, however, these processes have to be implemented. We address these issues in this paper, and propose a Buyer Collective Purchasing (BCP) model implemented in a multi-agent framework. A prototype system, which uses a laptop computer purchasing case as an example, is created to demonstrate the idea and show how the model works.
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1. Introduction

The explosion of Internet and the ensuing applications in electronic commerce (e-commerce) have permanently changed the outlook of traditional business trading behavior. Different business parties are now made easy to interact through Internet with others to conduct transactions in a more efficient way. Based on the nature of transactions, e-commerce is classified into following types (Turban, Lee, King, & Chung, 1999): business-to-business (B2B), business-to-consumer (B2C), consumer-to-consumer (C2C), consumer-to-business (C2B), non-business e-commerce, and intra-business e-commerce.

Compared to the three frequently mentioned models: B2B, B2C, and C2C, which are now very popular, the progress of the other one (i.e., C2B) is far left behind; it is seldom seen on the Internet. A possible reason for this situation is the high transaction cost. It takes effort to unify

a group of buyers' common needs and preferences and to interact between the buyer's party and the potential venders in order to complete a transaction. Moreover, it is not clear how to do it; there is little research into this problem. For example, how to synthesize individual's needs into a group's consensus? What is the mechanism to communicate with each other within the group? How does the group collectively negotiate with a seller? All these problems need a solution if one wants to create a successful C2B trading model.

Collective purchasing is not new to the traditional business. Friends sometimes invite each other to go to a restaurant for a meal and share the expense. People join a tour to share the expense of transportation, hotels and other expenditure. In these cases, people scarify some of their personal preferences in order to gain benefits from the collectively purchasing behavior. Likewise, can we transfer such consumer behavior to the e-market? If with a suitable model and mechanism, we believe Internet will be an enabler, not an obstacle, to collective purchasing behavior because people there get easier to setup a group with common interests.

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In this paper, we define and propose a model for buyer collective purchasing (BCP) behavior, which consists of a number of steps, each for a specific task, e.g., product description, buyer invitation, needs synthesis, negotiation, etc. A multi-agent architecture is devised to facilitate this job. In the framework, different agents, each assigned with a specific role, cooperate together to support the process. For example, there is an agent for each buyer who participates in collective purchasing to record the buyer's needs and preferences. Similarly, there are agents for sellers to represent their offers to the purchase. An agent is responsible for collecting and synthesizing the buyers' needs. Another plays the role for negotiation. Among these agents, the platform itself supports communication and interaction within the group.

Behind the multi-agent framework, there need algorithms to collect and synthesize the buyers' preferences and to negotiate with sellers. An AHP (Analytic Hierarchy Process) algorithm is devised to synthesize the common needs from the buyer group. Based on the created AHP tree, a one-to-many negotiation algorithm takes place to seek for the best deal from potential sellers that carry products satisfying the group's needs. Based on the proposed BCP model, we implement a prototype system to demonstrate the idea, which uses a laptop computer purchasing case to show how the model works.

The remainder of this paper is organized as follows. Section 2 discusses C2B buying behavior and defines the buyer collective purchasing model. Section 3 implements the model with a multi-agent framework. Preferences synthesis and alternatives ranking are described in Section 4, in which the algorithm of AHP used in this paper is illustrated. Section 5 describes a one-to-many negotiation algorithm that can bargain with several potential sellers simultaneously based on the information given by the constructed AHP-tree. The prototype implementation and demonstration that realize the whole idea are presented in Section 6. Finally, we conclude the paper with future research issues in Section 7.

2. C2B business model

Collective purchasing is sometimes referred to as a buyer coalition formation model (Shehory & Kraus, 1998), in which multiple buyers cooperate together to get a better offer for a specific product (or service). In this model, buyers usually specify multiple items and their valuation on them, and a group leader is elected to divide the group into coalitions and calculates the surplus division among the buyers (Yamamoto & Sycara, 2001). In particular, Tsvetovat and Sycara (2000) divide the buyer coalition process into five stages: (1) negotiation, (2) leader election, (3) coalition formation, (4) payment collection, and (5) execution stages. They give an example of book purchasing in a university and show how the seller provides a volume discount according to the size of the coalitions. In this kind of group

model, what buyers' needs are relatively fixed and different needs are divided into different coalitions.

Another coalition example given by He, Jennings, and Leung (2003) describes a bakery store which receives a large order of iced buns than it can produce. It then seeks to find a partner from the market and negotiates with a number of potential collaborators to get one that best satisfies it in terms and conditions. In this example, the leader has the authority to define the coalition conditions and negotiation right to determine who can join the group.

Although the goal is same, i.e., to group buyers together to get a special discount from a supplier, there are collective purchasing behaviors other than the ones described above. For example, we all have an experience that a group of people sit together to discuss a travel plan including where to go, to stay, and so on. In the group, there is usually no leader but a coordinator who tries to synthesize all proposals to find out a plan that satisfies most of their preferences. Individuals participating in this kind of group are willing to compromise on their preferences to some extent for a common goal. The final outcome is one that satisfies most of their needs and the best offers they can get.

2.1. The buyer collective purchasing model

To differentiate from the buyer coalition formation model introduced above, we here define a more flexible collective purchasing behavior model, called the buyer collective purchasing (BCP) model, which consists of six stages: (1) product description, (2) participant invitation, (3) buyer needs synthesis, (4) merchant brokering, (5) negotiation, and (6) purchase and delivery (Fig. 1). Except some of the steps, i.e., merchant brokering and purchase and delivery, that are in common with many other models (Guttman, Moukas, & Maes, 1998b; He et al., 2003) and will not be further discussed, others are unique and explained in the following.

2.1.1. Product description

Production description is the first stage in the BCP model. In the beginning of the collective purchasing process, there must be someone who has an intention to buy
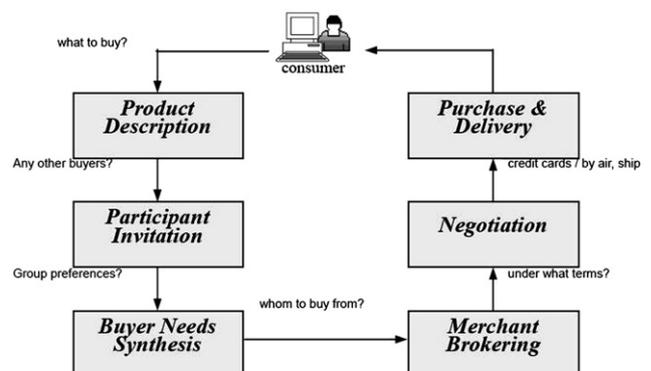

Fig. 1. The buyer collective purchasing (BCP) model.