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E-Commerce Recommenders: Powerful Tools for E-business

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Introduction

Gathering product information from large electronic catalogs on E-commerce (EC) sites can be a time-consuming and information-overloading process. User personalization, site content customization based upon a user's preferences and interests, is one mechanism of increasing the browsing efficiency of EC sites. Ideally, by increasing product navigation efficiency, EC sites will increase sales.

This article briefly describes the main working objectives and perspectives regarding development of an EC site recommendation system. The article begins with a brief overview of systems. Next, we describe the importance of understanding consumers and their behavior and present a proposal for an agent-based architecture. We conclude with some thoughts about the field. This article is not intended to provide an in-depth explanation of the field, but instead demonstrates how a successful combination of marketing, Knowledge Discovery in Databases (KDD), user modeling, and Human Computer Interaction (HCI) lead to an effective technology in the decision support systems of EC.

Outlining the Recommendation Systems on E-commerce

Recommendation systems suggest products and provide information to consumers to help them decide which items to purchase. Often, it is not possible for humans to make optimal purchasing decisions because there are too many factors involved. Technology can aid decision development by, for example, appropriately chunking information and thus structuring the user's valuation of products and allowing better human analogical reasoning. The recommender in the EC environment acts as a specialized seller for the customer. The recommenders mainly rely on user interfaces, techniques of marketing and large amounts of information about others customers and products to offer the right item to the right customer. The recommenders are the fundamental elements in sustaining usability and site confidence. EC recommenders are gradually becoming powerful tools for EC business.

We classify the large number of recommenders [**12**,**13**] by the kind of information they use and by the way the recommendation system handles that information:

1. **Collaborative-Social-filtering** systems generate recommendations by aggregating consumer preferences. These systems group users based on similarity in behavioral or social patterns. The statistical analysis of data extraction or data mining and knowledge discovery in databases (KDD) techniques (monitoring the behavior of a user over the system, ratings over the products, purchase historical, etc.) builds the recommendation by analogies with many other users. Similarities between users are computed using the user-to-user correlation. This technique finds a set of "nearest neighbors" for each user in order to identify similar liking. Some collaborative filtering systems include Ringo [**14**] or GroupLens [**5**]. The above technique suffers mainly from problem of sparsity due to the need for a large volume of users in relation to the volume of items offered (critical mass) for providing appropriate suggestions.
2. **Content-based-filtering** systems generate suggestions based on the items the user has purchased in the past. These systems use supervised machine learning to induce a classifier to discriminate between interesting or uninteresting products for the user due to her purchase' history. Classifiers may be implemented using many different techniques from artificial intelligence such as neural networks, Bayesian networks, inducted rules, decision tree, etc. The user model is represented by the classifier that allows the system to weight the like or dislike for the item. This information identifies the more weighted items that will be recommended to the user. Some content-based systems also use item-to-

item correlation in order to identify association rules between items, implementing the co-purchase item. Some examples include [8] and [10].

The above technique suffers mainly from the problem of over-specialization because the consumer is driven to purchase the same kinds of items that they have already purchased. This is a problem also for recommending new articles in the store (no consumer has bought this item before).

3. **Knowledge-based** systems are a hybrid between collaborative-filtering and content based systems wherein knowledge about users is linked to knowledge about products. This information is used to reason what meets the user's requirements with the item. The relation between products and clients leads to inferences that build the knowledge in the EC engine. Several papers [1, 13, 4] show the benefits of these systems.

Understanding the Consumer

Understanding and adapting the market to consumer motivation and behavior is a necessity for an EC site's survival. A market succeeds when the product or service is perceived as offering real benefits.

Consumer interaction with EC sites for searching products on-line is a strong decision process. Marketing theories [2] provide the basis for the decision-making process taking into account consumer behavioral issues (**Figure 1**). This process is categorized by three aspects: environmental influences (culture, social class, personal influence, family, and situation), individual differences (consumer resources, motivation and involvement, knowledge, attitudes, personality, lifestyle, and demographics) and psychological processes (information processing, learning, and attitude and behavior change).

Figure 1: Influences on consumer behavior.

The main challenge for consumers navigating an EC Site is information overload. Some sites, like Amazon (**www.amazon.com**) or eBay (**www.ebay.com**), have excellent recommendation systems based on traditional database analysis techniques. These include techniques such as association rules and data mining that are applied based on the top overall sellers on the site, customer demographics, and/or analysis of past buying behaviors [**13**]. There exist different weak points in the present recommender systems. Current systems, even though they allow for personalization ([**6**, **17**]), only do so around technical product attributes. It leaves an important hole in the lack of real personalization and sensibility to the context in the client side.

Personalization Over Context-aware EC Sites

The recommender system of an EC site needs personalization capabilities to fulfill its task. The personalization in this featured model is carried out by context (**Figure 2**). Lieberman defines context as "all that affects the computation except the explicit inputs and outputs [**7**]." In the case of the EC site, the context covers:

- states of the user (e.g., according to the involvement of the consumer)
- the level of risk perception
- the level of expertise about a product category
- states of the products (e.g., according to product value, product complexity)
- states of the computational environment (e.g., interaction according to the user knowledge about the EC Site and the protocols, levels of content hierarchy, etc.

In the same way, the history of user acquisitions, together with the data of user interaction and the contents of the place, endow the context with memory. The history of the user is a fundamental tool in the creation of the context. The recommender system is not only based on the explicit entrance of user's data, but of its integration with the context endowed with the characteristics of personalization. In same way, the results affect not only the recommendation shown to the user, but also apply in the same context.

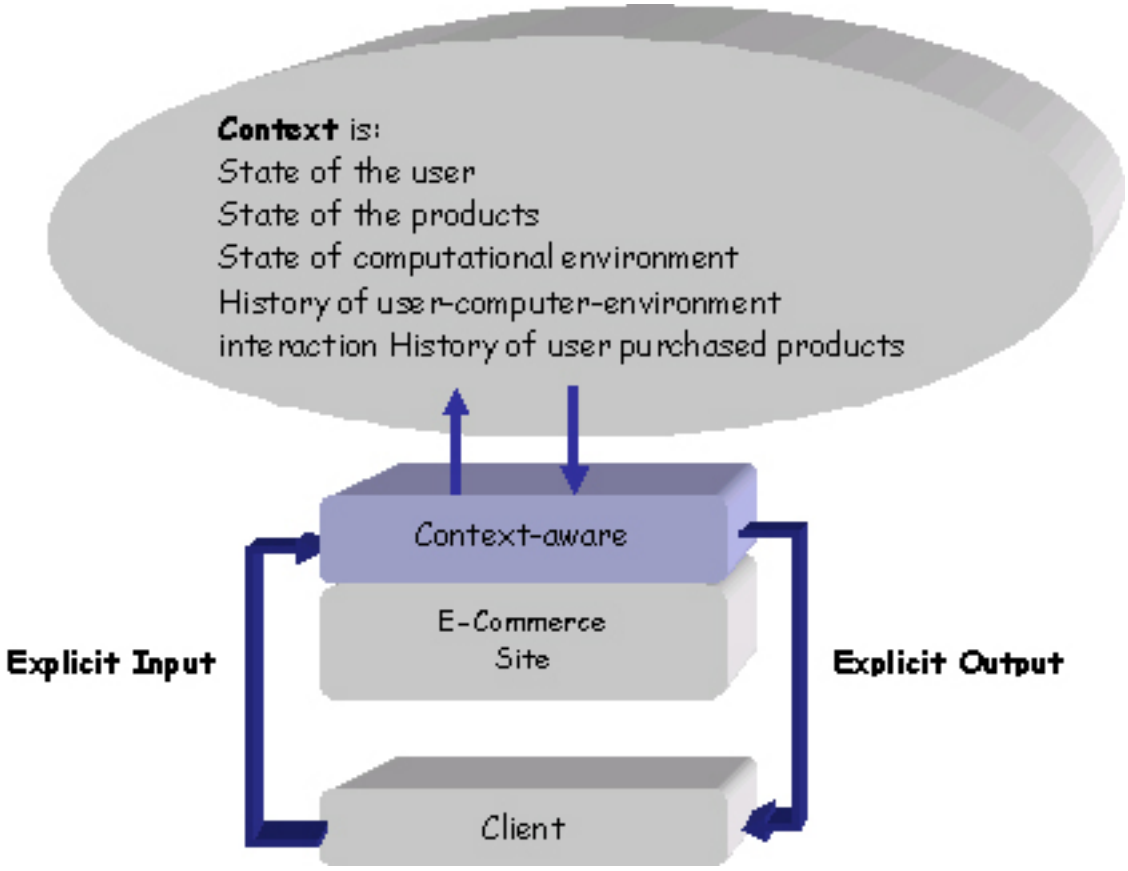

Figure 2: Personalization across context.

Adding context requires a preliminary series of tasks such as:

1. Defining a **product taxonomy** that classifies products into coarse-grained classes and sub-classes. The classification is obtained from different functions as proximity between products and decision-making process weights (repeated problem solving, habitual decision making, etc.). In this way, the items must contain both objective and subjective attributes conferring the taxonomy with elemental differences between similar items. For instance, there are specialized recommenders as movie recommenders (**Moviefinder**, **netflix**, **Movielens**, etc.) and book recommenders (**The Well Bookshop**, **Amazon**, etc.)

2. Defining **initial customer profiles** based on elementary attitudes in consumer behavior. These attitudes are known as behavioral primitives (imitation, opportunism, mistrust, etc.) and drawn together support the information in a consumer ontology [**9**]. The ontology provides the initial prototype models, building the individual consumer model dynamically over them.

The user profile is a structured representation of the user's needs. The retrieval system should act upon one or more goals based on this profile in order to autonomously

pursue the goals posed by the user. This work adds knowledge to both the products and the customers. It allows building the algorithm not only based on technical characteristics but also on the personal context of the customer linked with subjective product attributes. The more the system is able to customize itself, the better the system typically is.

Personalization is fundamental to the e-commerce environment. Pages are generated dynamically by retrieving data from a product database and assembling the result into HTML pages. The syntax and design structure in a retrieved page must facilitate user cognitive operations by taking advantage of proximity between items, co-linearity, containment, and flexible chunking representations.

Toward a Multi-agent System of Recommendation

The economic execution of transactions through the network is now a reality. Relationships between customers and sellers over the Internet are increasing and improving quickly. It is clear that vendors would like to be using their sites as an additional sales channel while also exploiting the Web's micro-marketing and one-to-one marketing potentials [**16**]. To do this, the sites need to maximize the quantity and quality of customer information collected through the electronic medium. They can then model the users through profiles in order to offer better customized offers. Agent-mediated developments provide a suitable technology for the management of the relations among clients and suppliers. Thus, agent-based technology has been one of the most important applications. Herein agents are not limited to activities of information gathering, but can also carry out more complex processes, such as mediating commercial transactions [**15**]. **Figure 3** presents the main agents involved in the recommender system being developed in current research. The need for cooperation and interaction between the modeling agent and the recommender agent is clear. This relationship will be enriched by information the consumer is arranged to interchange with the system through the interface agent. **Multi-agent Systems (MAS)** research is based on a double aim: first, the creation of distributed systems able to perform complex tasks by cooperation and interaction, and second, theoretical and experimental analysis of the mechanisms of self-organization processes that are initiated when autonomous entities interact [**3**]. The intermediary architecture implemented by a MAS is composed of a set of collaborative agents, where the adaptive characteristics are important in interface, behavior, and navigation. The interface agent has the responsibility of dynamically adding and deleting data sources for the user modeling events and also the product repository. This changing

information must be displayed to the user in a structured format which adapts its presentation to the user for a given task, while not overloading the user. A solution to the changing information problem has been proposed in the Data Gardens project [11] that allows a dynamic construction of an interface of visualization.

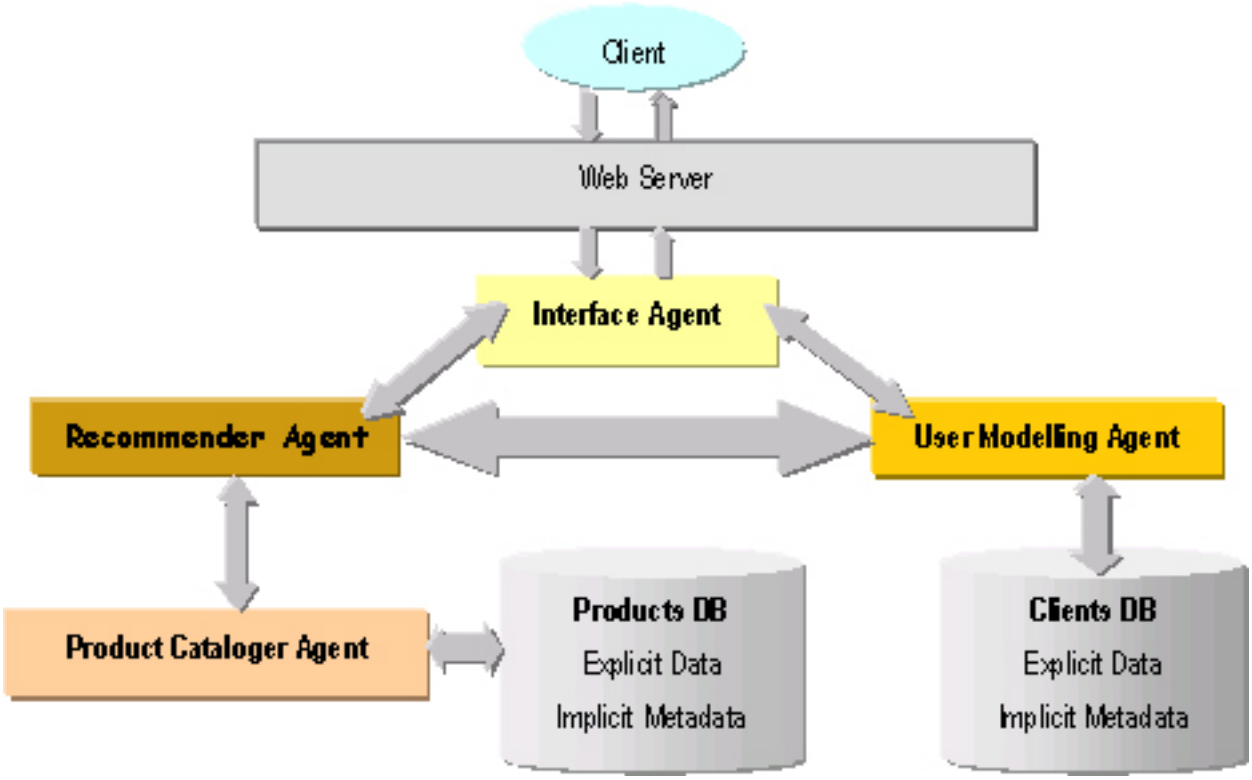

Figure 3: Agent-mediated recommendation system.

The integrated recommender system acts in two aspects:

1. **Direct recommendation** based on a direct request mechanism. In this layer, the user interacts directly with the system that helps him search for the item in a list with the n-articles that most approach his request in relation to his profile. This provides a method to direct marketing.
2. **Pervasive recommendation** as backup to the system of marketing. The advertising system fills in the content over the full page in a personalized way. The system of inner marketing establishes a policy of publicity of each product destined to segments of consumers. This provides a method to cross-sell marketing.

Conclusions

This paper has demonstrated the need for understanding consumer's behavior in order

to facilitate and bring personalized access to the large amount of information EC sites contain. EC sites are attempting to supply the customer with tools for making online shopping an easier process. There are several ways of creating user-recommendations. We believe recommendations can be improved by adding context. To attend to the customer in a personalized way, recommender systems need more than simple product attributes linked with studies in the community sales. This paper points out the context-sensitive agent as the enabling technology with which to present a generic adaptive MAS architecture for the EC site. This architecture is centered on the recommender system. The recommender systems in EC are meeting places where, due to their potential applicability, there are growing research contributions in diverse areas. The need for the development of ontologies, the study of the effects of physical and social presence on consumer experience, and the analysis of consumer behavior in virtual environments, are areas in which the application of cognitive science methods may continue to yield beneficial results for e-commerce technology.

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