Agent-Based Mining of User Profiles for E-Services

Pasquale De Meo
Università "Mediterranea" di Reggio Calabria, Italy

Giovanni Quattrone
Università "Mediterranea" di Reggio Calabria, Italy

Giorgio Terracina
Università della Calabria, Italy

Domenico Ursino
Università "Mediterranea" di Reggio Calabria, Italy

INTRODUCTION

An electronic service (e-service) can be defined as a collection of network-resident software programs that collaborate for supporting users in both accessing and selecting data and services of their interest present in a provider site. Examples of e-services are e-commerce, e-learning, and e-government applications. E-services are undoubtedly one of the engines presently supporting the Internet revolution (Hull, Benedikt, Christophides & Su, 2003). Indeed, nowadays, a large number and a great variety of providers offer their services also or exclusively via the Internet.

BACKGROUND

In spite of their spectacular development and present relevance, e-services are yet to be considered a stable technology, and various improvements could be considered for them. Many of the present suggestions for bettering them are based on the concept of adaptivity (i.e., the capability to make them more flexible in such a way so as to adapt their offers and behavior to the environment in which they are operating. In this context, systems capable of constructing, maintaining, and exploiting profiles of users accessing e-services appear to be capable of playing a key role in the future.

Both in the past and in the present, various e-service providers exploit (usually rough) user profiles for proposing personalized offers. However, in most cases, the profile construction methodology they adopt presents some problems. Indeed, it often requires a user to spend a certain amount of time for constructing and updating the user's profile; in addition, it stores only information about the proposals that the user claims to be interested in, without considering other ones somehow related to those just provided, possibly interesting the user in the future and what the user did not take into account in the past.

In spite of present user profile managers, generally when accessing an e-service, a user must personally search the proposals of the user's interest through it. As an example, consider the bookstore section of Amazon; whenever a customer looks for a book of interest, the customer must carry out an autonomous personal search of it throughout the pages of the site. We argue that, for improving the effectiveness of e-services, it is necessary to increase the interaction between the provider and the user on the one hand and to construct a rich profile of the user, taking into account the user's desires, interests, and behavior, on the other hand.

In addition, it is necessary to take into account a further important factor. Nowadays, electronic and telecommunications technology is rapidly evolving in such a way to allow cell phones, palmtops, and wireless PDAs to navigate on the Web. These mobile devices do not have the same display or bandwidth capabilities as their desktop counterparts; nonetheless, present e-service providers deliver the same content to all device typologies (*Communications of the ACM*, 2002).

In the past, various approaches have been proposed for handling e-service activities; many of them are agent-based. For example:

- In Terziyan and Vitko (2002), an agent-based framework for managing commercial transactions between a buyer and a seller is proposed. It exploits a user profile that is handled by means of a content-based policy.
- In Garcia, Paternò, and Gil (2002), a multi-agent system called e-CoUSAL, capable of supporting Web-shop activities, is presented. Its activity is

based on the maintenance and the exploitation of user profiles.

- In Lau, Hofstede, and Bruza (2000), WEBS, an agent-based approach for supporting e-commerce activities, is proposed. It exploits probabilistic logic rules for allowing the customer preferences for other products to be deduced.
- Ardissono, et al. (2001) describe SETA, a multi-agent system conceived for developing adaptive Web stores. SETA uses knowledge representation techniques to construct, maintain, and exploit user profiles.
- In Bradley and Smyth (2003), the system CASPER, for handling recruitment services, is proposed. Given a user, CASPER first ranks job advertisements according to an applicant's desires and then recommends job proposals to the applicant on the basis of the applicant's past behavior.
- In Razek, Frasson, and Kaltenbach (2002), a multi-agent prototype for e-learning called CITS (Confidence Intelligent Tutoring Agent) is proposed. The approach of CITS aims at being adaptive and dynamic.
- In Shang, Shi, and Chen (2001), IDEAL (Intelligent Distributed Environment for Active Learning), a multi-agent system for active distance learning, is proposed. In IDEAL, course materials are decomposed into small components called lecturelets. These are XML documents containing JAVA code; they are dynamically assembled to cover course topics according to learner progress.
- In Zaiane (2002), an approach for exploiting Web-mining techniques to build a software agent supporting e-learning activities is presented.

All these systems construct, maintain, and exploit a user profile; therefore, we can consider them adaptive w.r.t. the user; however, to the best of our knowledge, none of them is adaptive w.r.t. the device.

On the other side, in various areas of computer science research, a large variety of approaches adapting their behavior to the device the user is exploiting has been proposed. As an example:

- In Anderson, Domingos, and Weld (2001), a framework called MINPATH, capable of simplifying the browsing activity of a mobile user and taking into account the device the user is exploiting, is presented.
- In Macskassy, Dayanik, and Hirsh (2000), a framework named i-Valets is proposed for allowing a user to visit an information source by using different devices.
- Samaras and Panayiotou (2002) present a flexible agent-based system for providing wireless users with a personalized access to the Internet services.
- In Araniti, De Meo, Iera, and Ursino (2003), a novel XML-based multi-agent system for QoS management in wireless networks is presented.

These approaches are particularly general and interesting; however, to the best of our knowledge, none of them has been conceived for handling e-services.

MAIN THRUST

Challenges to Face

In order to overcome the problems outlined previously, some challenges must be tackled.

First, a user can access many e-services, operating in the same or in different application contexts; a faithful and complete profile of the user can be constructed only by taking into account the user's behavior while accessing all the sites. In other words, it should be possible to construct a unique structure on the user side, storing the user's profile and, therefore, representing the user's behavior while accessing all the sites.

Second, for a given user and e-service provider, it should be possible to compare the profile of the user with the offers of the provider for extracting those proposals that probably will interest the user. Existing techniques for satisfying such a requirement are based mainly on the exploitation of either log files or cookies. Techniques based on log files can register only some information about the actions carried out by the user upon accessing an e-service; however, they cannot match user preferences and e-service proposals. Vice versa, techniques based on cookies are able to carry out a certain, even if primitive, match; however, they need to know and exploit some personal information that a user might consider private.

Third, it should be necessary to overcome the typical one-size-fits-all philosophy of present e-service providers by developing systems capable of adapting their behavior to both the profile of the user and to the characteristics of the device the user is exploiting for accessing them (*Communications of the ACM*, 2002).

System Description

The system we present in this article (called e-service adaptive manager [ESA-Manager]) aims at solving all