Chapter 4.14
Machine Learning Enhancing Adaptivity of Multimodal Mobile Systems

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ABSTRACT

One of the most important features of a mobile device concerns its flexibility and capability to adapt the functionality it provides to the users. However, the main problems of the systems present in literature are their incapability to identify user needs and, more importantly, the insufficient mappings of those needs to available resources/services. In this paper, we present a two-phase construction of the user model: firstly, an initial static user model is built for the user connecting to the system the first time. Then, the model is revised/adjusted by considering the information collected in the logs of the user interaction with the device/context in order to make the model more adequate to the evolving user's interests/preferences/behaviour. The initial model is built by exploiting the stereotype concept, its adjustment is performed exploiting machine learning techniques and particularly, sequence mining and pattern discovery strategies.

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MOTIVATION

The mobile device area is increasing as shown by the variety of the products and services available. Indeed, the user needs require a device able to interact more intelligently. To this concern, one of the most important features of a mobile device concerns its flexibility and capability to adapt the functionality it provides to the users. In particular, an adaptive system might be able to adapt its functionality according to the users' objectives, tasks and interests. However, "Not all humans reason, behave and expect the same when interacting with a device; the interfaces are the same for all users, but not all users are the same" (Jacobs, 2004). Thus, a key process to make a system adaptive is personalization of the access to the information by means of user and context models.

A user model is a representation of a person's attitude, behaviour, preferences and regularities when exploiting some kind of device or moving in a given context. It can describe the user at different levels of granularity and complexity, depending on the amount of resources available and on the specific task it is intended for. Furthermore, a model can represent a whole group of users rather than a single individual: indeed, it is often the case that, independently on their specific preferences and taste, users playing a same role in a system are likely to share common needs and ways of interaction.

The exploitation of user models might be very useful in improving the interaction between the user and the system itself, in order for the latter to adapt more easily and straightforwardly the functionalities it implements to the former. More formally, "A user model is an explicit representation of information regarding a single user or a group of users. This information should be useful for enhancing the interaction between the environment and this user or this group of users. The representation should preferably allow the user model to be interpreted by devices as well as by humans." (Jacobs, 2004).

When building a user model four aspects must be taken into account: description language (that has to be primarily machine-readable, but as an additional desirable feature should be easily interpretable by humans as well), techniques for actually building the models and then exploiting them to relate the (static) information they contain to the specific user and working session at hand (dynamic), and last but not least ways for assessing the actual correctness and suitability of the model itself.

Building user models, however, is a very difficult task, because very often a person's behaviour and preferences vary in time and according to the different environments, situations and objectives (Kaplan et al., 1993; Souchon et al., 2002). Furthermore, the task is made harder when contextual parameters are to be taken into account. For these reasons, automatically learning user models is a hot research topic and many different approaches and techniques have been proposed to accomplish this task (Si et al.,2005; Siewiorek et al.,2003; Randell and Muller, 2000; Liao et al., 2007).

Nevertheless, learning user models is a hard task due to its intrinsic complexity but also to a number of needs to be fulfilled. Even when they are to be learned automatically, the explicitly available knowledge should be easily integrated in the model. Often the model cannot be built before the user exploitation of the system, but must be developed during it by mining the user's interaction log files. Even more difficult, the user can change his/her behavior, causing the model to change in time (a problem known as 'concept drift'). Some environments involve very complex components and features, asking for a more powerful representation language such as first-order logic, that also has the advantage of being easily understood by humans. Finally, the user behavior emerges very often from sequences of actions,