**User modeling: Changing machine decisions**

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**Abstract**

In the resent year’s information system have made considerable progress especially in user modeling research, particularly in the last few years, user application expand their domain from the personal computer to smart phone, tablet computers and home devices (TV, cable modem, streamers…). Today the need for adaptive application with advance abilities to respond to user action is become necessary organ. Adaptive application need to recognize the user obtain his data, stored is data in dynamic data base, predict his next move and respond and react at the same. The adaptive application must be intelligent, understand user need find his flavor and recommend for his a proper way. In this lecture review we will we review previous work that has addressed similar issues and consider some challenges that are presented by the design of adaptive application.

**1.Introduction**

User modeling has made considerable progress during the last decade, particularly in the last few years, user application expand their domain from the personal computer to smart phone, tablet computers and home devices (TV, cable modem, streamers…) this arrivals of those domain change our live cause them to become digital them ever . today application become cross platform and cross devices , therefore the need to adaptive software is increase every day , software today are need to know every changes in their users , learn and analyze user changes in fast way through variety of information sources.

The classic user modeling approach consider the complex of the model itself, some researchers are working on creating ubiquitous user modeling [“**Advances in Ubiquitous user modeling - Revised selected paper ”, springer 2009**] for improving the basic design of user model systems on the aspect of data bases, high level design, deployment, software structure,ontology design etc…

The mission of those researches is to contribute dynamic data base that needed in UM systems, but additional essential approach is the software adaption.

According to Alfred Kobsa “User modeling research has spread into many disciplines which are concerned with the development of computer systems that are to be used by heterogeneous user populations. These fields include:

* 1. Human-Computer Interaction.
  2. Intelligent Interfaces.
  3. Adaptive Interfaces.
  4. Cognitive Engineering.
  5. Intelligent Information Retrieval.
  6. Intelligent Tutoring .
  7. Active and Passive Help Systems.
  8. Guidance Systems .
  9. Hypertext Systems and Expert Systems.”

[ “**User Modeling:Recent Work, Prospects and Hazards**”,1993]

Adaption of software is the key for managing a dynamic application how reflects and respond to user behavior.

Therefore some we can catalog them to tree crude type:

1. Application with dynamic data base founded on anthology which “knows” all user stereotypes.
2. Adaptive application with learning abilities.
3. Combination of 1 & 2.

In this lecture review will focus on the adaptive aspect, we examine if software can analyze itself by user behavior, change her code, structure, data base and software follows.

**2.Know your user**

Recognition of user by application it’s the first step for adaptive software need overcome.

The meaning of recognition covers these fields:

1. **User identification –** adaptive application need to identify her user according to the base identification parameters , according to Kobsa [“**User Modeling:Recent Work, Prospects and Hazards”,**1993] the identification process must fulfill tree tasks:

* **User subgroup identification.** – Application must containing data base on users subgroups and to identify this subgroup from expected user population.
* **Identification of key characteristics. –** Each subgroups has is unique characteristics (for example in music subgroup have characteristics as music type (rock,pop,juzz ….) ), the adaptive application need to draw relevant data for the identification process (without those characteristics computer system couldn’t identify the user )
* ***Representation in (hierarchically ordered) stereotypes*** – The application-relevant characteristics of the identified user groups must be formalized in an appropriate representation system. The collection of all represented characteristics of a user subgroup is called a **stereotype** for this subgroup. The stereotype represent the order of characteristics by those stereotype , we can contribute to our application the ability of analyze user identification

1. **User prior knowledge -** today most users had prior knowledge, some are first time users with minimum background knowledge while some are more experience, but even so adaptive application must obtain relevant past knowledge, filter it and analyze. This process is complex and not homogeneous. Developers must adapt their program to the user knowledge, save relevant data and use it when the application obliged to use it.

**3. Arrange your data**

Since most the user model data is not hard coded, and it can change form user to user, the adaptive application must been establish generic data structure that can handled dynamic code changes, use different data bases and add new model characteristics.

This aspect has been research by many agents:

**3.1** Shlomo Berkovsky ,Dominikus Heckman and Tsvi kuflik[“**Addressing challenges of Ubiquitous user model :between mediation and semantic integration”,** 2009] have been working on integrated system between semantic standardization of user model and build hybrid system - in their research they suggest to create internal semantic language combine with generic dynamic structure, with the ability to change according to language interrupter.

**3.2** Other approach is to creating a collective software with the ability to collect data from different applications or for the web Francesca carmagnole [“**Handling semantic heterogeneity in interoperable distributed user models”,** 2009] insinuating to used semantic language between application and servers for data exchange.

**3.3** k.vab der skuijs and G- j houben[**“automatic generation of semantic metadata as basis for user modeling and adapation”**,2009] take this approach even further more by creating frameworks with internal ontology base on semantic command language this frameworks will establish metadata for each object in the user model with the ability to read/write is metadata .

**3.4** Federica cena and Roberto Furnanri[“**a model for feature base user model interoperability on the web”,2009**] suggest on using web data collector for finding requested data ,in their approach they suggest to used SOA (service oriented architecture) for creating dialog frameworks between application/servers Although this API approach is more healthy of using semantic language since it’s can spare misunderstand between applications , it’s hard to obtain foreign frameworks in each application , it’s also obliged web interface.

3.5 There few researches who suggest complex structure for user model – not all of them suitable for the adaptive approach.

António Constantino Martins, Luíz Faria, Carlos Vaz de Carvalho and Eurico Carrapatoso [“**User Modeling in Adaptive Hypermedia Educational Systems**”,2008] summarize from kobsa (2001), Brusilovsky (2001) ,carrilho (2004), Benyon (1993) and Vassileva (1998) a generic approach for designing adaptive user model . in their paper they concentrate on educational system but they mention and used the concept of DDD and DID a structural design guideline for creating adaptive application :

**3.5.1 Domain Dependent Data (DDD) –**

The components of the Domain Dependent Data correspond to the Domain Model with a three-level functionality.

• Task level, with the objectives / competences of the domain that the user will have to master. In this case, the objectives or intermediate objectives can be altered according to the evolution of the user changes process.

• Logical Level, which describes the user knowledge of the domain and is updated during the user task and changes .

• Physical Level that registers and infers the profile of the user knowledge.

**3.5.2 The Domain Independent Data (DID) –**

are composed of two elements: the Psychological Model and the Generic Model of the user Profile, with an explicit representation (Kobsa, 2001). The psychological data are related with the cognitive and affective aspects of the user. Some studies have demonstrated that the difference between the cognitive capacities and personality aspects affects the quality of some models or styles of interaction (Kobsa, 2001; Carrilho, 2004).

These data are more permanent which allows the system to know beforehand which are the 196 characteristics that it must adapt to. (Benyon, 1993, Vassileva, 1998). The data related to the user interests, common knowledge and background are kept in the Generic Model of the Student Profile.”

The **DID** include following aspects: (Benyon, 1993; Kobsa, 2001; Carrilho, 2004):

• Initial user knowledge.

• Objective and plans.

• Cognitive capacities.

• Learning styes.

• Preferences.

• Age and type of User (Kobsa, 1997).

• Cognitive style (affective, impulsive, etc.) personality aspects (introverted, extroverted, etc.) (Laroussi, 2001).

This two main guideline are suggestion for obtaining flexible structure with the ability of adjusting user changes in the user mode.

**4 Predict user actions**

As you obtain user knowledge and storage his data, you need predict is next plans and actions, this is the key element in adaptive software, a good prediction can case for good software respond while bad prediction can case for bad respond ,software crashes and user frustration.

In the resent years much emphasis has been recently put on the recognition of users plans where a plan is a sequence of user actions that achieve a certain goal.

Adaptive application need Plan recognition element which observe user input action and try to determine the all user possible plans.

According to Kobsa **[“User Modeling:Recent Work, Prospects and Hazards”,1993]** basic algorithm will not sufficient for prediction ,for good prediction the adaptive application need advance algorithm combination for the following reasons :

“1 .it is often unclear when the user commences a new plan.

2 . Actions and short action sequences may often be part of more than one plan.

3. Users may interrupt or suspend the execution of their current plans (for various

reasons, such as when issuing the ‘date’ command or when replying to an email message which they just received);

4. there is often more than one action sequence for achieving a (sub-)goal (i.e., there can be variations of user plans).”

Kobsa summarize two kind of technique for handling user prediction:

**4.1 Plan libraries -** in the approach all possible user plan already coded in pre-stored libraries, the user input action sequence will compare with the pre-stored libraries application respond will according to matching library.

**4.2 Plan construction-** in this approach the application constructs the reaction according to user input action sequence, in this approach the adaptive need complex algorithm with combine libraries which generate new follow when new user plan arrive.

**4.2.1 Constructing plan reaction**

For construction new reaction we need strong algorithm that will have the ability to “learn” the user , there for the answer for creating adaptive and learning algorithm can be found in the machine learning.

**4.3 Machine learning**

According to Avrim Blum**[“Machine Learning Theory”,]** “this field seeks to understand at a precise mathematical level what capabilities and information are fundamentally needed to learn different kinds of tasks successfully, and to understand the basic algorithmic principles involved in getting computers to learn from data and to improve performance with feedback.” <להכניס קשר >

**4.3.1 Machine Learning for User Modeling**

The aspect of machine learning is mentioned in few researcher, GEOFFREY I.WEBB, MICHAEL J. PAZZANI and DANIEL BILLSUS[“**Machine Learning for User Modeling”,2001**]have been concluded critical issues for finding a good algorithm in your user modeling:

1. **The need for large data sets** – like we mention before it’s hard to predict user behavior from few observation, the main reason for bad prediction its machine abilities for finding the ‘correct’ answer. Most machine learning algorithms are base on past users knowledge, if the data sets will be poor it’s will represent only few of user population. Therefore when the adaptive applications need to predict any user action it’s must base on large user facts and estimate the action according to population expectancy. Even more important it’s to change the prediction when the population changes her opinion, the prediction need to be consistent with most pupation and to be update according to it.
   * Other approach is to initialize liberties with data and to make ‘correction’ from the user.
   * There is also to open source approach to let the user to determine the ‘correct’ data like wiki and them to use on this data.
   * There is repetition approach - it is possible to structure the task so that a learned model need not exactly replicate the user's decision.
2. **The need for labeled data –**in section 3 we mention the importance of dynamitic storage data, we also mention to build ontology in your data base for saving user data, but for sorting and saving user data we need to label this data according to the user preference. We can archive this task in three approaches :
   * Require the user to explicitly label the data - in this approach the user will be ask for his opinion for labeling the current data for example: Pandora is web radio website with the preferences abilities, this website try to indentify user preferences and to play music according to user flavor, when the user listen to played song he can press thumbs up (or down) according to his ‘taste’, the application is building his flavor according to his feedback.
   * Infer the labels from the user's behavior – in this approaches the adaptive application will need to follow and documented any user action, the user model them need to scan if there is any changes in his action and label according his action. For example in Gmail site Is connected to the Google search site , usually when user is search item in Google site Google servers save all is search tasks for future relevant adverting.
   * Use a small initial body of labeled examples to infer labels for a larger body of examples which is then used to train the learning algorithm This technique is related to the information retrieval method of pseudo-feedback (Kwok and Chan, 1998) in which first the system find documents similar to the user's query and then it finds documents similar to the retrieved documents.
3. **Concept Drift** -The concept drift means that the statistical properties of the target variable, which the model is trying to predict, change over time in unforeseen ways. This causes problems because the predictions become less accurate as the times passes.
4. **Research of Concept Drift in user modeling**

As researchers have begun to take the importance of concept drift for user modeling applications into account, a few initial solutions have emerged in the literature. A straightforward approach is simply to place less weight on older obser- vations of the user (for example, Webb and Kuzmycz, 1996). However, there is some evidence that the effectiveness of this simple approach is constrained (Webb et al.,1997). Klinkenberg and Renz (1998) explore windowing techniques similar to ideas proposed by Widmer and Kubat (1996) in the context of Information Retrieval. The central idea is to limit training data to an adjustable time window, where the window size depends on observed indicators such as sudden changes in term distributions. Chiu and Webb (1998) have studied the induction of dual user models as an approach for handling concept drift in the context of student modeling. In general, user modeling is a task with inherent temporal characteristics. We can assume recently collected user data to reflect the current knowledge, preferences or abilities of a user more accurately than data from previous time periods. However, restricting models to recent data can lead to overly specific models, i.e. models that classify instances that are similar to recently collected data with high precision, but perform poorly on instances that deviate from data used to induce the model. To overcome this problem, Chiu and Webb use a dual model that classifies instances by first consulting a model trained on recent data, and delegating classification to a model trained over a longer time period if the recent model is unable to make a prediction with sufficient confidence. Billsus and Pazzani (1999) propose a related idea for personalized recommendation of news stories. A nearest-neighbor text classification algorithm built from recent observations forms a short-term model of the user's interests in daily news stories. In cases where the short-term model cannot make a prediction with sufficient confidence, classification is delegated to a more general classifier based on observations collected over a longer period of time. This architecture allows a system to adjust to interest changes rapidly, without sacrificing the potential benefits of data collection over longer time periods. Furthermore, this system tries to automatically anticipate a special case of concept drift: news stories that are presented to the user are assumed to directly affect the user's information need. As a result, the system tries to prevent presenting similar information multiple times, as it is assumed that a certain piece of information is only interesting once, and that the concept of what is considered interesting drifts at that time. While a start has been made on tackling this challenging problem, this is an area in which more progress is required if user modeling is to realize its full potential.

**5. Summarize**

In this lecturer review we reviewed resent researches made in the user modeling especially adaptive applications.

We concluded that constructing adaptive application is a Cyclic process who