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Group Modeling in a Public Space: Methods, Techniques, Experiences

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Abstract :-This paper overviews methods and techniques useful for building group-adaptive systems and presents an experience of building a system to give news adapted to different group of users in a public space . Starting from the analysis of limits of group modelling strategies and of problems to pass from a user modelling to a group modelling approach in the adaptation of system interaction, we suggest an update of the probabilistic group model to improve the interaction of groups of users with devices devoted to show news. In particular, we analyze the way to build a group model useful to improve the adaptation of a system that provides news on a video wall in a public space which is attended from a group of users with common interests.

Key-Words: - Human-Computer Interaction, Ubiquitous computing , User modelling, Group modelling, Adaptive Systems.

1 Introduction

Ubiquitous computing is commonly intended as the possibility to communicate and to compute in every type of environment and context using different devices [1]. The miniaturization of electronic devices, the growing of their connectivity and the decreasing of their cost have determined the develop of this discipline in building systems for the automation of domestic environment (domotic) and public spaces. In particular, the interaction of users with automatic devices in public spaces could be realized using *public kiosks* [2] supplied by:

- *Wall Displays*;
- *Kiosk Displays*: touch-sensitive LCD displays;
- *Mobile Displays*: on personal devices (PDAs, mobile computers, mobile telephones) with different computing power.

The evolution of this type of technology has lead to reach techniques to obtain an interaction of automatic devices adapted to the user and later to the user and to the context (personalized interaction).

From an architecture point of view, the user is moving in an interactive environment and he/she activates a service discovery protocol when he/she is approaching to a particular system access point.. In this case his/her user-model is transferred to his/her personal device (*mobile User Model*) to be managed by a software component able to realize a personalized interaction [3] .

In this paper, we analyze techniques to build a group modelling in a way to make the system interaction sensitive to the requirements and interests of the group of users that are at the time *t* in a public space (*group adapted system).*

In particular, we have planned to build a group adapted system to give news able to capture the attention of users that are moving in a public space. In this case the adaptation has to be realized in a way to present news about particular interests of that particular user group.

Starting from a first naïve categorization of group interests, we have distinguished between *external interests* (new of general type like weather, sport, music, football, cultural events,…) and *internal interests* (specific for the public space where the system is installed). In our case we have tested the system in a public space of the Department of the Computer Science of University of Bari, and the internal interests of students where focused about exams and lessons timetable of the day, administrative information, degree thesis and stages planned by the Department Council, books and scientific magazines available in the library , and so on.

Moreover, in our system we have adopted the following simplifications:

a) Adoption of centralized user models. We have assumed that different user models where pre-loaded in our system. Starting from these user models, we have built our group models.
b) Getting ready a service discovery protocol to obtain a more dynamic answer to the user group interests;
c) The display will show news on the base of a modelling phase of a current group.

2 Group Modelling

A user model is composed by a set of items and values relative to that particular user characteristics (interests, preferences, attitudes, …). Then when a user model is built it is reasonably that there are no contradictions in the evaluation of the values of user-interests items or in the user metrics of the evaluation.

In the case of group modelling, it is necessary to synthesize different user models in a unique group model, then the evaluation of items from the different user could be made on the base of different metrics : for example a user should have used the entire scale of evaluation score and another user should have used only the extreme limits of the score values scale . In a score scale from 1 to 10, the value 7 of the first type of user could be better respect the value 8 given by the second type of user. This means that in the phase of synthesis of different user models in a single group model it is necessary to *normalize* the user evaluations to the range of values effectively used .

For example, let be 6, 4, 7, 5 and 9 (in a range of 0-10) the evaluation scores of a user to a list of interests;

1) the real width of the evaluation score scale is determined by the difference between the maximum and minimum used value, in our case 9-4 is 5;

2) it is calculated the difference between the value of each user evaluation score and the minimum value;

3) this last value is divided by the real width and the result is multiplied with the base of the value scale (that is 10 in our example).

In our example the normalized value of the first score is (6-4)*10/5=4.

2.1. Strategies of Group Modeling

There are many different strategies to synthesize a group model from many user model [4]. All of them need that each user has to evaluate a list of personal preferences with a score. Then, all normalized scores (of each user model) about a single topic are compared with that of other users to obtain a single list of preference scores valid for the group of users.

This is a brief summary of strategies used by different systems :

- ✓ *Utilitarian Strategy - Additive*: it is based on the calculus of the sum of scores of each alternative . Then the values are ordered in a decreasing order respect the previous sum. It is called "*Average Strategy*" because it is equivalent to the calculus of the mean value of each item and to the sorting them in base on new obtained values;
- ✓ *Utilitarian Strategy - Multiplicative*: It is similar to the previous one, but the scores are multiplied . In general, the disadvantage of the Utilitarian Strategy is that, if a user is continuously in a minority position , he/she will be always in unfavourable position, in particular in groups of big dimension . In small groups, on the contrary, the preference evaluation of a single user has a bigger impact (influence) on the final sequence. In particular, the product strategy makes equal zero an item score for which a single user has assigned a value zero);
- ✓ *Least Misery Strategy*: the order criteria is based on the minimum value given to each item, in a decreasing order. In this way the less favourable user can have a big influence to the final result, that in other words the minority can decide for all.. This algorithm is used by **PolyLens** [5], that is a component of **MovieLens**, a system used to suggest movies on the base of inferences made starting from preferences expressed by each user. There is the assumption that if small user groups are satisfied, then all users are satisfied too ;
- ✓ ***Most Pleasure Strategy***: It is like the previous one, but for each alternative there are chose the maximum evaluation score;
- ✓ ***Average without Misery Strategy***: It is similar to the Utilitarian Strategy – Additive, but, if the user evaluation score is less then a minimum predefined value, that alternative is cancelled by the final sequence of interests. This strategy is used by **MusicFx** [6], used in fitness centres to choose music adapted to user groups in different rooms , assuring a minimum degree of satisfaction for each item included in the final list of music songs. The disadvantage is that the less favourable user can eliminate from the list the music pieces that he/she evaluates =0 ;
- ✓ ***Most Respected Person Strategy***: it is choosen a user that decided for all the user of the group the score for each interest.The user is choosen in base on difeerent parameters: the older or the most important in that day, or int that situation or environment, and so on.. It is used in **Intrigue** [7], a system that establishes weights to the user preferences in base to their social status.

There are strategies that emphasize the maximum user satisfaction (Utilitarian Strategy - Additive, Utilitarian Strategy - Moltiplicative, Most Pleasure Strategy e Most Respeted Person Strategy) and strategies that want to avoid un-satisfaction (Least Misery Strategy e Avarage without Misery Strategy). In any case, it is necessary to proceed to the normalization of the user model scores before proceeding to the combination of values.

In general, it is possible to say that there is no strategy useful in every context independently from the environment. On the contrary, the choose of a particular strategy of grouping is a result of a deep context analysis of the public space where the system is used.

2.2. Group modeling strategies limits

To test the approach we have made some hypothesis about the context and the users. We assume that the system can recognize the users near the kiosk, and to collect their profiles. This is an implementation issue that we have solved using a centralize approach. The presence can be revealed using sensors, or wireless system that allow an automatic log-in, or any other system for recognize people.

We also assume that people remaining in front of the display during the visualization of the news are always grouped in the same way. In this first phase we assume that the system is un a public space like an office or a school, where people interacting with the system are not unknown. The group is determined statically by the system at the

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beginning of the interaction. We have planned to realize a dynamic checking and updating of the group determination.

2.3. A probabilistic and weighted strategy

During the evaluation test of the system we wanted to investigate whether contextualizing the interaction of a public kiosk to the people looking at it was effective or not. This kind of situation has a high level of uncertainty, especially regarding the composition of the group of users. The definition of the group is integrated with statistic information gained using a questionnaire, compiled by some student in our department. In this way the preference of users supposed to be in front of the kiosk, in a given period of the day, are used together with that of the users really there. In this way the preference of casual users are taken into account, as well as those of users who can't or don't access the system with a login.

We assume that users are not obliged to log into the system. Moreover we assume that when a user logs in, then after a reasonable short period of time he will log out. So we define *sure* the set of user models t*hat surely are near the kiosk in a certain period of time, eg. They have logged in*. We define *probabilistic* the set of user models of users probably there. The two group are distinct: each user is considered one time. Starting from these considerations we wanted to classify a set of items, previously ranked by users, using another questionnaire.

The two group of users, the *sure* and the *probabilistic are* considered using different weight during the execution of one algorithm of group modeling. These weight are assigned considering the importance we want to give to a group, how many people are logged in, and the percentage of sure user respect on the total of presumed presence.

Let's consider the Utilitarian Strategy – Additive; if we indicate $UM_1, \ldots, UM_N$, the set of sure user models, and $UM_{N+1}, \ldots, UM_{N+M}$,the set of probabilistic user models, in a given time. The weight of a single sure logged user is calculated uniformly as P_{SURE}/N, where P_{SURE} is defined by the system. The weights for the other group can't be uniformly distributed, as people are not only present in a place with the same frequency. Some users are more likely to be in a place at a time than other. The problem is how to determine this frequency f_i. We have split a day into time slice, and we have asked users how long do they averagely stop or pass in the public space of the kiosk, considering the time of the day and the day of the week. This value is called t_i. Using this values we can redistribute the weight between the probabilistic group.

We wanted to calculate the confidence of an item to show. We call UM_i^j the rank of the item j for the user i, normalized considering his preferences. C_j is the confidence of the user preferences for the item j. This is a percentage that shows how much a user like that item; b is the base of the votes Um_i^j;

The average number of minutes that a user *i* spend in the public space is t_i , in the time slice where the algorithm is activated .

The formula to calculate C_j is then:

$$\forall j \in \{1,\ldots,K\}: C_j = \frac{\sum_{i=1}^{N}\left(\frac{UM_i^j}{b} * \frac{P_{CERTO}}{N}\right) + \sum_{i=N+1}^{N+M}\left(\frac{UM_i^j}{b} * \left(\frac{f_i * t_i}{\sum_{m=N+1}^{N+M} f_m * t_m} * P_{INCERTO}\right)\right)}{P_{CERTO} + P_{INCERTO}}$$

where:

$$\forall j \in \{1,\ldots,K\}: C_j = \sum_{i=1}^{M}\left(\frac{UM_i^j}{b} * \frac{f_i * t_i}{\sum_{m=1}^{M} f_m * t_m}\right)$$

with N>0 and M>0. We have to note that UM_i^j/b is the confidence in a range from 0 to 1. If one of the t_i is null its corresponding UM_i does not contribute to the final result. we have to pay attention to the situation where N>0 and M=0; in this case we have to set $P_{PROBABILISTIC}=0$, and $P_{SURE}=1$.

If we consider P_{SURE}/N constant we have the Utilitarian Strategy - Additive without weight. If N=0 and M>0 we have to set $P_{SURE}=0$ and $P_{PROBABILISTIC}=1$.In this case nobody is logged and all user model are inferred starting from the current time slice. This is the method used by the system implemented.

If we assign $C_j=0$ to those values that aren't bigger than a threshold we have the Average without Misery Strategy.

The approximation of the presence of users is based on the time of the day and from a statistic derived from a questionnaire, as well as other system[8][9] in which uncertainty is considered.

3. Architecture of the system

The system is structured as a web application with dynamic pages and support for mobile application. the knowledge bases are XML document. It is implemented using Microsoft Visual Studio .NET 2003 with ASP.NET, and runs on a Internet Information Services (ISS)5.0 web server.

As the application is composed by different modules we have adopted a distributed approach. In this way the system has proved to have faster performance. The system is composed by two web service and a web application (Fig.1).

The first Web Service is called "InterestsLastestNews": it's a service that browse the internet for news regarding a given interest, using the RSS(Really Simple Syndication) Feed technology. RSS is a xml based protocol. Syndication indicated that the information is made for being redistributed from user connected. A RSS feed its a XML file shared by an editor and contains updated news of every kind.

The "GroupModeling" web service is the service that calculate the model of the group , evaluating the single user models of the user connected using the algorithm described in the previous section. The user models are created using the situational statement, from UbisWorld [10];
The Web Application is called "Group Adapted Interaction for News" ("G.A.I.N."). It is an application that starting

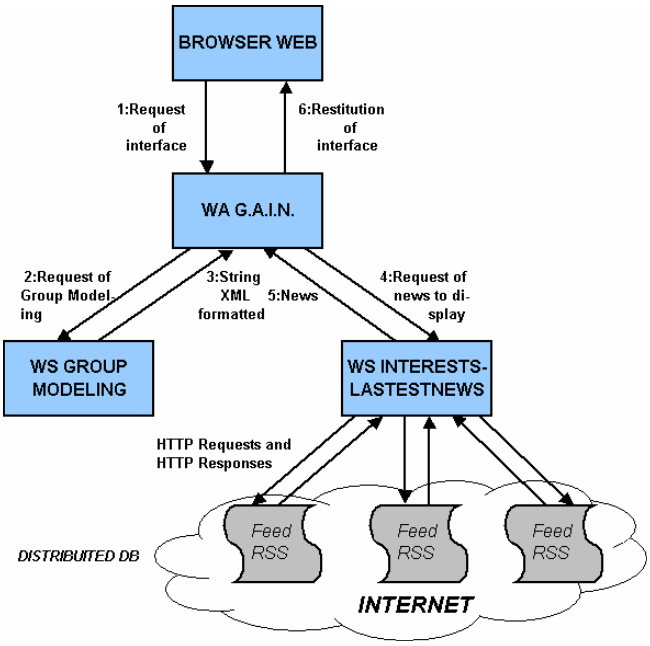

Fig.1. Distributed Computing Environment

from the result of the group modeling web service decide how to adapt the information. It decides how many news of every kind has to be showed. Than it query the InterestsLastestNews web service, receives the result and display the news in the related interface, adapting to different display type and size.

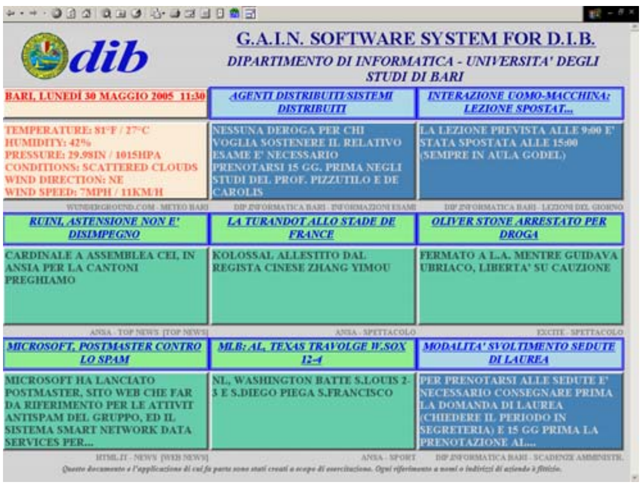

Fig 2. Wall Display

Figure 2, 3 and 4 shows the client interface. Every news is in a different color. Every color identifies a particular interest. The wall display interface (fig 2) updates the news every 60 seconds and there is no interaction with the user.

Fig. 3. Mobile device Display

The mobile display (fig 3) is developed for Handheld pocket PC, and has a textual interface. The user can watch news filtered for his preferences, and touching the display can connect to the page of the news. This kind of interaction is intended for a personal use of the system.

Fig. 4. Kiosk Display

The kiosk display (fig. 4)interface is intended to be used with a touch screen. When user touch one of the news on the left column, the related page is displayed in the other part of the page.

4. Evaluation of the system

The system developed has been tested and evaluated within a user study. We wanted to verify if users like the system, using and not using group modeling strategies. We also asked to testing users if they prefer a personal interaction rather than one based on a group. Another aspect is the contextualization of the system, evaluating if news filtered on the basis of "local" information is effective or not. During the experiments we have verified that the group is not a simple synthesis of the singles, and analyzing the data we have studied how people interact when they have to take a decision together.

The study has been made in three phases. Every experiment has been attended by 10 people. In the first experience we had a uniform distribution of the news, not using group modeling algorithms. This was a control test. The second experience has been done using the 'Average Strategy', calculating the group model using the information collected by a questionnaire. In the third experience we have applied the group modeling algorithm to the user model of the user that had really participate to the experimentation.

We have evaluated the reaction of the single users, using a first personal questionnaire. Then we have asked them to answer the same questionnaire in group.

5. Conclusion

The experiment has demonstrated that the interaction using a group modeling adaptation are promising, because users involved have shown more satisfaction in watching filtered news, rather than not filtered. Moreover during the interaction they were compelled to argue each other about the topics shown into the display. This system shows that an integration between personal and group integration is possible, and users like to be socially involved in discussion about common interests.

The system is flexible enough to be adapted to different context,as the filtering is done on the basis of the user's preferences using questionnaires to investigate what are the most relevant interestsin a given context.The most important result is the fact that a group does not correspond to the sum of its members [11].

Analyzing the questionnaire compiled by the users, we can say that usually in social interaction there is always someone, or a small group, that influencethe other majority. People interacting in a personal mode make different choice than in group. So the group takes decision using the ***Most Respected Person Strategy,*** delegating to this minority the choice. When thw group grows in number this minority grows as well. Starting from this considerations we hava adopted the Average Strategy using weights, so that only a small number of people can influence the decision of the other. This group is composed by the most respected persons of the original group. We have planned to include dynamic learning capabilities to the system, to allow the definition of this groups at run time, modifing the weight associated to a user observing his behaviour during the interaction. This could be interesting in a place with a high variability of people interacting. In the case of a predefined group, such as an office or a home, where the people are always the same, we can use a static determination. The Average strategy without weighting has to be adopted in the case of a real public space. When the most respected person fails the minority group uses the Utilitarian Strategy – Additive, using an average of the preferences of most respected users. However , the system can be extended to experiment other strategies, by implementating new algorithms in the GroupModeling Web Service.

Another future work is the developing the integration of a personal interaction interface to best evaluate the difference between group an single interaction, and the evaluation of the system in envirnment different from our department, to generalize the results.

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