

Time Based Personalization for the Moving User

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Abstract

Unlike desktop users, mobile users are a new and more demanding breed. Technology provided for the first group is often found lacking for the later. Personalization is such an example. The moving user differs from the desktop user in that his handheld device is truly personal. It roams with the user and allows him access to info and services at any given time from anywhere. As the moving user is not limited to a fix place and to a given time period, factors such as time and current experience becomes increasingly important for him. His context is now a function of time and experience and the goal of personalization is to match the local services to this context. In this paper we exploit the importance of time and experience in personalization for the moving user and present a system that anticipates and compensates the time-dependant shifting of user interests.

1. Introduction

Today it is understood that wireless access is not about browsing the Web on your cell phone; it is about providing personalized services that are highly sensitive to the immediate environment and needs (i.e., context) of the moving user. The most recent efforts to support the mobile user focus to the effective ability to access **local** and the most relevant information and services. To effectively aid this task, the solution of personalization and user profiling is often used. Solutions, however, that was well studied and provided for the desktop user proved to be inadequate for the moving user as these two types of users differ in quite fundamental aspects. The one is restricted in a fixed place and for a fixed period of time and his device (i.e. the desktop PC or even laptop) is not generally used as personal assistant. On the other hand the moving user is quite mobile and at any time, place, or situation turns to his mobile device (PDA or mobile phone), the

truly personal device, for access to information and services that are currently relevant to his current needs. Looking a bit deeper in the mobile user's environment one can clearly see that the new factors involved are **time** and current **experience**. In reality, the user's needs, and thus his context, are a function of time and experience. His interest and needs change along with the time and the situation his currently experiencing.

Indeed these factors, timing and experience, can be crucial for the moving user. Imagine the following scenario where a user cruises around at lunch time browsing his favorite content provider through a personalization system. Most likely, the system would provide only the local to him content. However, the provided content, while matching his interest, would not differentiate between restaurant services, fax centers or bookstores in any meaningful way. Thus, if our user was hungry he should first navigate through all the available services find the restaurant services and then invoke them to get the desired information. In this scenario the personalization system ignored a vital piece of information, namely the fact that it is "lunch time". If the system took the **time**, and what time represents into the users day cycle, into consideration it could alter the order of the provided results to display first the restaurant services.

Another interesting, but not thus far utilized, concept is the so called "**user experience**". By "user experience" we mean the activity (or condition) the user is currently experiencing. For example, during normal working days the user experience could be described as "normal day", while when on vacation as the "vacation" experience. Obviously his needs during "normal days" are quite different than during "vacation". Even the day cycle of the user during the various experiences might be different. It is thus, imperative, for the personalization system, to take the changing of activities into consideration. We want to enable, for example, the system to effectively provide, at a specific time, a vacationing user with the nearest bar or pool while when he's back to work with the nearest business center.

Time and user experience clearly defines the moving user's current interests. His context is now a function of time and experience. Given an experience, the time identifies the specific interests of the user during that activity at that particular time. For example, at 8 PM during vacation, open bars and happy hours are of great interest to vacationers while during normal days Pizza restaurants and rent-a-movie places might be of interest instead. The task of a personalization system is to identify and match these dynamically changing interests to the local services.

The moving user is a new breed of users; they differ from the desktop user in that his handheld device is truly personal, constantly complementing his current activities. It roams with the user and allows him access to info and services at any given time from anywhere. We see that timing and user experience are two factors which are quite significant for this type of user and environment. These are new factors to the personalization problem (to our knowledge there is no literature covering them) and are introduced mostly because the needs of the moving users are not limited to the time he is in front of his office PC, but around the clock, all year long, including weekends and vacations.

In this paper we exploit the importance of time and experience in personalization for the moving user and present a system that anticipates and compensates the time-dependant shifting of user interests. We identified which parts of a personalization system are affected (e.g., profile) and how. We clearly show that exploiting time and experience results in an enhanced and more effective personalization system. We demonstrate our findings via an existing system, called mPERSONA [14], which we adapt to include these new factors. As a side effect, this work is also showing how simply and effectively an existing system can be adapted to these new ideas.

The rest of the paper is organized as follows. Section 2 presents the problem of personalization and further elaborates on "time" and "user experience" concepts. Section 3 presents needed design changes, for a personalization system to incorporate time and experience. Section 4, discusses how to support the time and experience based personalization for the moving user. Section 5 presents the implemented prototype, experiments and some performance analysis. Finally, section 6 presents related work and section 7 concludes the paper.

2. The Personalization Problem

The problem of personalization is complex with many aspects and issues that need to be resolved [14].

Some of these issues become even more complicated once viewed from a moving user's perspective. Such issues include, but are not limited to, the following:

- ***What content to present to the user.*** How to decide what to show, using user profiles, using the user history to predict future needs etc. When using user profiles we must address the need for (1) storing the interests of the user in a format that is easy to be used, be updated or *moved*, and (2) relating interests and items based on a semantics level.
- ***How to show the content to the user.*** Many users want to see the same things but the form they want the data presented might be different. *In the wireless environment this also relates to the mobile device used and its specific characteristics.*
- ***How to ensure the user's privacy.*** Every personalizing system needs (and records) information about the habits of each user. This leads to privacy concerns as well as legal issues [1]. It also leads to lack of user trust and could result in the failure of the system due to the avoidance of its use.
- ***How to create a global personalization scheme.*** The user doesn't care if a set of sites can be personalized but that at each one of them he has to repeat the personalization process. *This is especially annoying and cumbersome for moving users, carrying a resource poor mobile device.*

These are the major issues of personalization which could be summarized in the phrase: "***What, how and for everything.***" There are many approaches to personalization [2-14] and each one of them usually focuses on a specific area, whether this is profile creation, machine learning and pattern matching, data and web mining or personalized navigation.

Time, however, as a factor affecting personalization for the moving user is widely missed by all (to our knowledge) efforts to address this problem. An eluding factor indeed, as one should consider the case of having to provide personalization for many, alternating undergoing user activities. A necessity when the focus shifts from the desktop user to the moving one, since when on move the user is more likely to be engaged in many, medium-to-short term, different activities. Thus, the summarizing phrase for the personalization issues for this type of users should actually be: "***When, what, how and for any activity,***" where "when" relates content to time and current experience.

2.1. Time Based Personalization

As already discussed factors, previously undetected, that seem to have significant importance in the

personalization effort are the “timing” and “user experience”. To understand the significance of these factors, one must consider the needs of the mobile user and the effect they may have if exploited. His need for content is not limited to a specific time period. Instead the mobile user browses for content 24 hours a day, 365 days per year. Hence it becomes a reality to have a user where his interests change in an extremely dynamic way. Indeed, just by considering the launch time scenario we see this dramatic shift in his preferences. A shift that becomes even greater when he changes between experiences, such as taking a vacation after a busy and tiresome business week.

The previously mentioned examples show the extend of the positive effect that a personalization system can have, if it considers, among other factors, the time and experience based preference shifts and adapts its results accordingly. Coupled with the limited and resource poor nature of mobile devices it becomes crucial to handle these preference shifts efficiently.

However, this is not easy to implement. In order to be able to tackle these shifts gracefully we need to know what the users preferences are at any given time. When using user profile for storing those preferences we can easily reach a situation where the user profile is too big to handle and thus useless. Especially when dealing with time which is continues. So, as a first step we can divide the day into several time-zones and store user’s preferences per time-zone. Yet the problem still remains as there is too much information which must be handled, most of it just replicated. A way around this is not to store each user preference per time period and user experience but to associate each user’s interest with a set of weights. Doing so allows the dynamic creation of the user profile based on the current time and activity by applying the relevant weight set on his preferences.

Finally another factor that can be introduced in the personalization process when using user experiences is the user age. With the appropriate sociological research or by using collaborative personalization schemes we can suggest default profiles for each new user in the personalization system based on their age group (e.g., teenagers). Afterwards we can have a monitor mechanism that adapts the user profile according to his actions (e.g. if his actions suggests that on vacation he prefers content related to bars versus concerts we can update his profile accordingly).

In this way time based personalization becomes possible. Furthermore, if we take into consideration the shifting preferences of the mobile user, as well as the positive effect that it has on the overall quality of services it becomes crucial, even if it might result in higher computational costs.

3. Incorporating time based personalization

Having in place a personalization system that handles user’s profiles, content description and application of the user’s profiles on that content is the first step towards incorporating time in the personalization process. In detail, such a system should be able to:

- Capture the user’s preference profile, either implicitly (by studying his behavior) or explicitly (by querying him). This behavior could be encapsulated by a single component – the “user profile management” component.
- Capture the user’s device profile. Again, this could be implemented as part of the “user profile management” component.
- Describe the available content. Having a “content description” component suffices.
- Apply the user’s preferences on the description of the content in order to select the desired one. This could be implemented in another component – the “content selection” component.
- Reform and deliver the selected content based on the user’s device profile. One last component – the “content reform” component – would do the job.

Most current personalization approaches (that are profile based) handle just that. Beyond that, personalization systems that are focused on the mobile user just adapt the user’s profile to the local content. Since these original systems don’t consider the concepts introduced by time and experience certain changes to their design are needed. These changes can be either very easy or even impossible to implement depending on the original system design (usually component based systems need the less effort). *The necessary changes affect mainly the selection of the content to be displayed and the user’s profile.*

The user profile must be enhanced in order to contain all the (newly) required/available metadata such time-zones preferences and user experiences. To cover this need, the part of the user profile that holds his preferences must be easily extendible, easy to handle (retrieve or store preferences) and somewhat standardized. Implementing the profile in XML seems to be best way to go about it. Indeed XML gives the necessary extensibility as well as a way to standardize the profile through the incorporation of XML schemas.

As a chained reaction the description of the available content may also need to be enhanced, (e.g. from keywords to a sophisticated ontology). We need better description of the content to be able to make more intelligent decisions. Furthermore, the same XML schema used for the user’s profile could form the basis for the ontology/ies used to describe the content.

4. Designing time based personalization

As already stated we don't need to design a personalization system from scratch in order to use timing factors. Instead we can adjust an existing system. For this purpose we used mPERSONA [14], a system developed in house. The following sections describe the mechanics of the time based personalization and how we incorporated it into the mPERSONA system. Two components are involved (a) the description of the content and (b) the user profile.

4.1. Content description format

In order to have a good description of the provided content ontologies were used. When using ontologies, in essence we define a vocabulary and a structure (using XML schema) for certain content domains. Having in place the vocabulary (which may or may not be common for all content providers) we define the structure of the content description. Two major distinctions are made: content categories/subcategories and content instances.

The content categories describe general characteristics of some content (see figure 4.2: ontology approach). We can categorize content on the type of the provided information e.g. restaurant content, pharmacies content etc. Of course we can continue this categorization with more levels, e.g. we can elaborate on the news content category by introducing the sports or political subcategory. Note that content categories do not describe any actual data generator (e.g. "Paradise Hotel" content page) rather than it groups of similar content pages (e.g. all the pages that contain information on restaurants). A more concrete example is presented in figure 4.2 (ontology approach) where we have the structure of all restaurant services. Each restaurant has a type, categories of food served, location information, optionally some extra services (e.g. delivery), some identifying details and possibly information on average price.

On the other hand content instances provide actual values for content categories. This information is directly linked with a given content page. A paradigm of this is a content page about a Chinese restaurant that provides the value "Chinese" for the content subcategory "restaurantType". Figure 4.1 shows the content description of a category instance: it describes what the "Dragon" Chinese restaurant offers.

Even though the content description format is not directly related with time-based personalization we need to have knowledge of both the category schema (see fig.4.2: ontology approach) and category instance when we incorporate timing factors in the user's

```
<restaurant>
  <restaurantType>Chinese</restaurantType>
  <foodCategory>
    <meat>
      <meatType>Pork</meatType>
      <meatType>Beef</meatType>
    </meat>
    <poultry>
      <poultryType>Chicken</poultryType>
      <poultryType>Duck</poultryType>
    </poultry>
    <seafood>
      <seafoodType>Prowns</seafoodType>
    </seafood>
    <other>
      <otherType>Salads</otherType>
      <otherType>Vegetarian</otherType>
    </other>
  </foodCategory>
  <restaurantLocation>
    <area>Likavitos</area>
    <town>Nicosia</town>
    <province>Nicosia</province>
    <country>Cyprus</country>
  </restaurantLocation>
  <restaurantServices>deliveryAndTakeAway</restaurantServices>
  <links>
    <link address="www.restaurants.com/chinese/restaurant2"/>
  </links>
  <details>
    <serviceName>Dragon Restaurant</serviceName>
    <phones>
      <phone>+35722321321</phone>
    </phones>
  </details>
  <averagePrice>8.50</averagePrice>
</restaurant>
```

Figure 4.1: Content instance description

profile. We need to assign weights to both categories and instances of these categories. To understand this lets compare the keyword approach with this one (see fig 4.2). When using keywords we have a list of all possibly describing words associated with each node without making any distinction as to what they describe. Thus, on our example (fig. 4.2) we can't tell that the word "Chinese" describes the restaurant type (content instance) while the word "Restaurant" gives the content category. On the other hand when using an ontology we know what the content category is ("Restaurant") and we know that the specific node that is described has the "Chinese" restaurantType. This is important as it allows prioritization based on both, the category and the instance of a content node. In this way timing and the user's experience can be

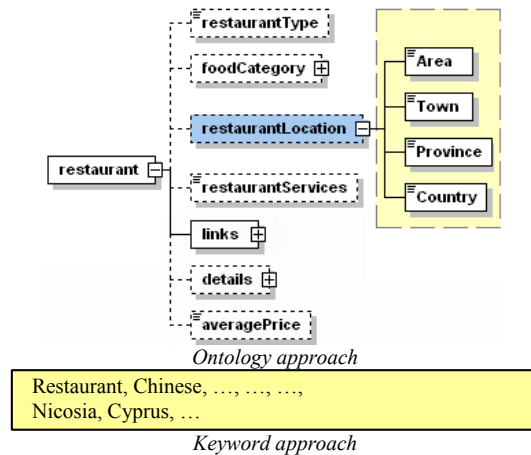


Figure 4.2: Content description for "Restaurant"

used with both of these, thus leading to the case where they can effect the selection of an entire content category (e.g., display or not any restaurant), as well as, the selection of specific instances of a category (e.g., display *only Chinese* restaurants). Of course the timing and experience information will be stored in the user's profile.

4.2. User's theme profile format: Time and Experience factors

In order to be able to match the user's interests with the provided content his preferences must be captured in a similar format as the description of the content. Towards this goal we use an ontology that is very similar to the content description one. So what we see as user's preferences are the same content categories and instances as the ones in the content description, and thus enabling the match between them. However, this only enables us to know if a user is interested in something or not. Figure 4.3 shows such a user profile. In this example we see the part of the profile that expresses the user's interests in restaurants. It denotes what interests our user when looking for restaurants.

We need to assign a weight to each of the user's preferences to differentiate among them. Weights in effect, show how much a user likes or dislikes a specific content category and/or instance. Being able to differentiate among the user's preferences is crucial in time based personalization. To achieve time based personalization we need to know how the user's preferences change over the 24 hour day cycle.

To represent time we suggest dividing the day into different time-zones. This is possible if we study the daily routine of our users and then split it into time-zones based on the user's activities for each period.

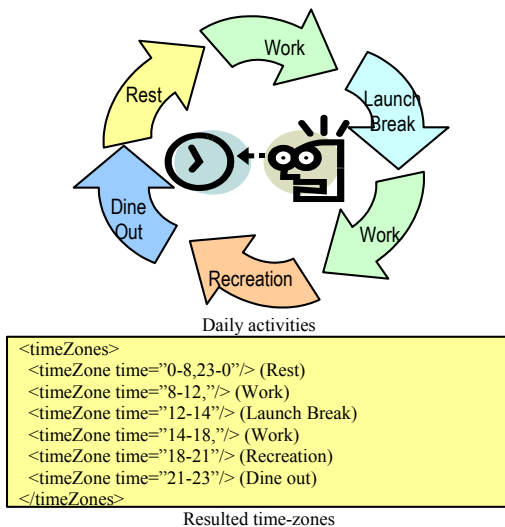


Figure 4.4: Day cycle split into time-zones.

Figure 4.4 shows an example of the daily cycle of a user and how it could be split into different time-zones.

By dividing the day in time-zones, we drastically reduce the possible combinations between time and user's preferences, keeping our design scalable. Having the time-zones on one hand, and the preferences' weights on the other, enables us to capture the required information: we just need to record how the weight of each preference changes over

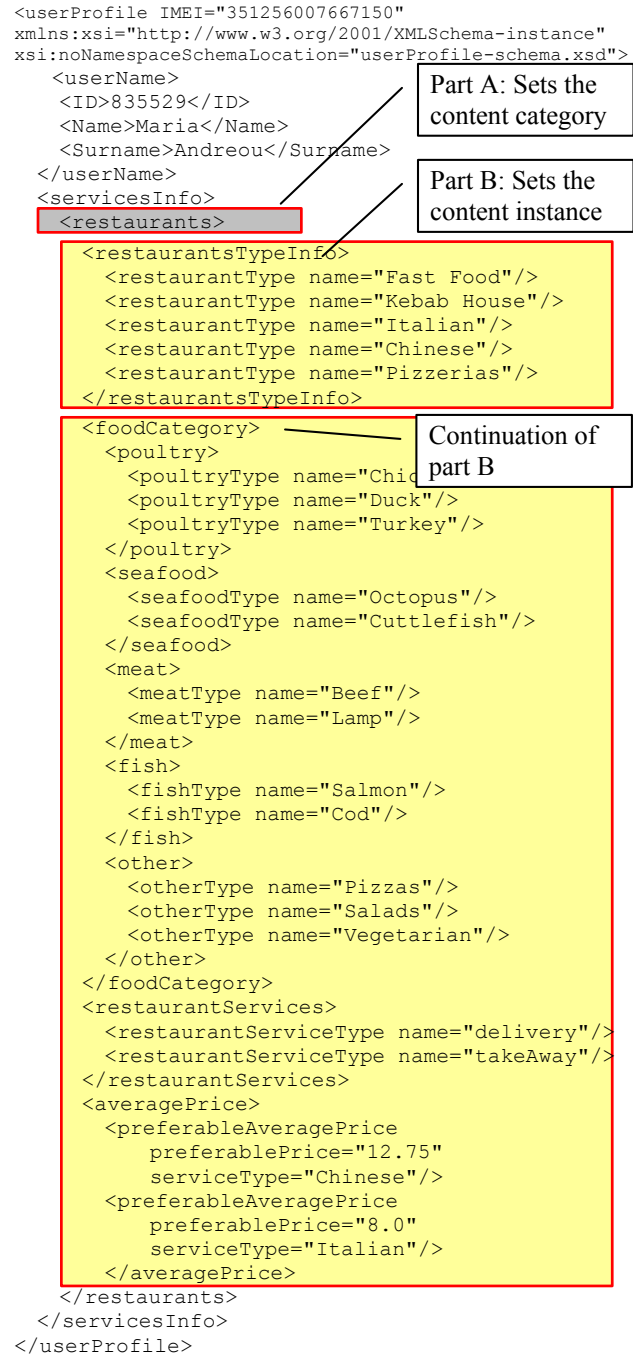


Figure 4.3: User's profile without weights.

each time-zone. Figure 4.5 shows how the user's interest for a given content category (e.g. restaurants) changes during a day. We need one such structure for each and every category in the user's profile. This is added in part A of the normal user profile (see figure 4.3). It basically states that "Restaurants" are of higher interest to the user during 12 to 15 PM than 3 to 6 AM.

The same information can be recorded for the various content instances. Figure 4.6 shows how time affects the user's restaurant preferences in relation with the restaurant type (i.e., cuisine). In this way we know how the user preferences for a specific cuisine change according to a time zone. Note that in figure 4.6 we show weights for both category and instance. Finally, figure 4.6 shows how part B of figure 4.3 (the normal user profile) would be modified to incorporate time and weights. Note that we do not need to repeat all restaurant types in all time zones. Furthermore, common preferences during different time zones lead to the merge of these time zones for the given preferences. When the profile is loaded the merged time zones are split to achieve faster indexing.

User experiences. Using this weighted system enables the user to declare what (and when) something is more important to him. To take this one step further we can repeat the weight association for each user's experience. In that way by just adding another set of weights we can record the user's preferences for a new experience. For example if the user goes on vacation then his experience would be vacation. What changes from his daily experience is the composition of his day cycle. Under the vacation experience the user's profile would have increased weights for content related to recreation and decreased weights for work related content. In effect, integrating the user's experience is like building a user's profile for each of his activities cycles. The difference, however, is that we may exploit the obtained knowledge and that we don't need to store a separate profile. Basically we replicate the weight structure of the normal daily cycle with different values, resulting a dynamically changing user profile that covers all user's activities in a continuous fashion.

4.3. Matching user theme interests with the content description

Since the user profile and the content description are based on the same ontology we achieve improved effectiveness during the content selection. At matching, we compare each content information node (content service) description with the user's profile. The comparison is made on the characteristics between matching categories of the content description and the user's profile for the current time zone. We get the

```
<timeZones>
  <timeZone time="0-3" weight="10"/>
  <timeZone time="3-6" weight="10"/>
  <timeZone time="6-9" weight="10"/>
  <timeZone time="9-12" weight="35"/>
  <timeZone time="12-15" weight="95"/>
  <timeZone time="15-18" weight="20"/>
  <timeZone time="18-21" weight="35"/>
  <timeZone time="21-24" weight="85"/>
</timeZones>
```

Figure 4.5: User's preference weight shifting.

preference weight for each characteristic, from the user profile along with the weight for the given category. The same applies when we have more than one user's experiences. The weight set associated with the current user's experience is loaded. In essence we have a dynamic user profile changing, literally, by the minute. As we see timing and user's experience affect the personalization process (selecting desired content) by allowing the implementation of dynamic user profiles.

The final step in the content selection is the averaging of the retrieved weights and assignment of it as a selection weight to each content node. The results are presented to the user sorted, based on this weight. Nodes with lower weight than a user selected threshold are completely omitted.

Example: Let's consider, for example, that at 19:30 PM the user uses his PDA to get related services. And let's assume, for the sake of simplicity, that our content provider provides only restaurant type of content. The system compares each restaurant (from the provider) with the categories and characteristics from the user's profile. Consider the restaurant described in figure 4.1 and the (part of) profile of figure 4.6. Since in both of them we have the "restaurantType" category the system checks to see if they have matching values. Indeed they have, the value "Chinese" is included in the user's profile for the given time zone. Now it calculates how important this matching element is. For this it takes from the profile the weight of the category "restaurantsTypeByTime" (50), takes the weight of the Chinese "restaurantType" (90) and calculates a rank as follows: $50 \times 90 / 100 = 45$. If the profile contains more

```
<restaurantsTypeByTime categoryWeight="50">
  <timeZone time="0-3">
    <restaurantType name="Fast Food" weight="90"/>
  </timeZone>
  <timeZone time="3-6"></timeZone>
  <timeZone time="6-9"></timeZone>
  <timeZone time="9-12">
    <restaurantType name="Fast Food" weight="90"/>
    <restaurantType name="Cypriot" weight="60"/>
    <restaurantType name="Kebab House" weight="95"/>
  </timeZone>
  <timeZone time="12-15">
    <restaurantType name="Pizzerias" weight="85"/>
  </timeZone>
  <timeZone time="15-18"></timeZone>
  <timeZone time="18-21">
    <restaurantType name="Chinese" weight="90"/>
    <restaurantType name="Mexican" weight="75"/>
  </timeZone>
  <timeZone time="21-24"></timeZone>
</restaurantsTypeByTime>
```

Figure 4.6: User's taste based on time.

matching characteristics then the system will rank them individually as well. That is, in our example if the user profile contained the “foodCategory” characteristic (see figure 4.1 and 4.2) it will similarly rank it and so and so forth. Finally, it averages these ranks and the resulted rank (selection rank) is assigned to that restaurant. The restaurants returned to the user are prioritized/filtered based on their selection rank.

4.4. Manipulating the time based profile

Initially the user is assigned a default profile based on his age group. Age can be used as a clustering factor as users tend to form their interests according to their age group. However since this is not absolute, collaborative filtering, along with direct user input, can be used to fine tune these default profiles. The system can accept weights for characteristics instances in the range -1 to 100. Having the negative value -1 enables the system to completely disregard certain content categories and instances. Keep in mind though, that the system can present even disregarded content if the user asks for it explicitly, revising its previous decision.

Updating of the user profiles is based on user selections. Each time a user selects to view a given content service the system tracks it and updates his profile. In this way we enrich the user’s profile with content elements previously not included (they are added and given an initial weight value). In the case of existing elements, their weights are modified, by either adding or subtracting 1 unit. The system increases the weight for all elements that exist in his profile and the description of the content that the user chose, reducing at the same time the weight of all other elements.

Note that the updating of the user profile extends to cover small shifts detected in the user’s daily routine. This results in the dynamic update of the time intervals that make up the user’s daily activity cycle (recall figure 4.4). This is achieved by checking if the user’s interests in a particular zone are found in higher priority in neighboring time-zone.

5. Prototype and experimentation

Our prototype is derived from mPERSONA system architecture, which combines existing techniques to build personalized portals for the wireless user, but no time or experience was taken into consideration. The architectural components are (Figure 5.1):

- Content description component (Figure 5.1: 2 & 6): maintains the metadata describing the content.
- Content selection component (Fig. 5.1: 1 & 7): it selects the content that will be shown to the user.

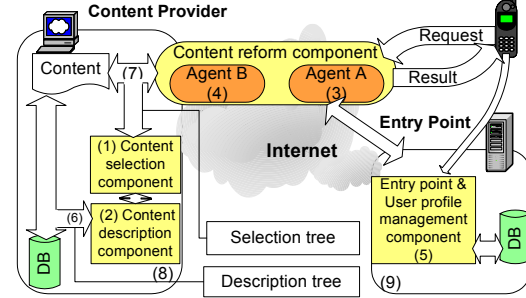


Figure 5.1: The mPERSONA Architecture.

- Content reform component (Fig. 5.1: 3 & 4): reforms and delivers content in the desired form.
- User profile management component (Fig. 5.1: 5): manages user profiles (device and theme profile).

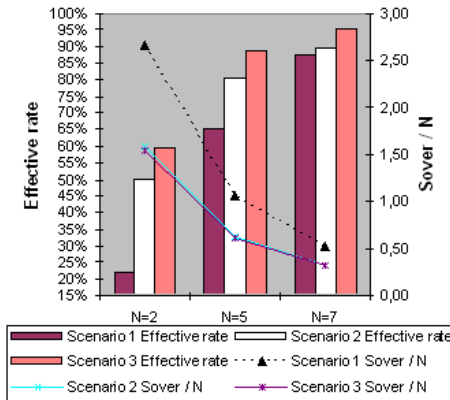
In our current prototype, we chose to focus our attention and experimentation on time and experience factors. Thus, we kept the prototype from our previous work almost intact; we took and adapted only the required components by incorporating time-based personalization. In detail we modified only the content description, content selection and profile management components. Thus, the new prototype uses an updated implementation of the content description component that conforms to the format presented in section 4.1.

Metrics: Having the prototype is only the first step towards the evaluation of our approach as we need to define the appropriate metrics for experimentation. Since our ultimate goal is to prove that time based personalization offers an enhanced and more efficient user experience we need to measure the quality and quantity of the personalization effect. Thus we define “effective rate” as a quantitative metric and “overall success factor” as the qualitative metric. “Effective rate” is the percentage of the times the system was successful in providing what the user wanted. A result is considered successful if the user finds what he wants within the first N provided choices. That is if the user chooses the n^{th} element of a given result, then this result is considered successful if, and only if $n \leq N$. We denote n the “actual success factor” and N the “desired success factor”. Obviously a smaller value of N means higher expectations from the system. Having a high effective rate while keeping the desired success factor low indicates that the personalization process works well and that the users profile accurately provides his interests. The “overall success factor” S_{over} is denoted as the average of the “actual success factor” for all provided results. Lower values mean that the quality of the personalization results is high. The ratio between overall success factor and desired success factor (S_{over}/N) provides an indication if a personalization system

meets the given quality restrictions. Furthermore, keeping N value fixed enables the comparison of the result quality of two (or more) personalization systems.

Experiments: Four different scenarios were tested. In the 1st scenario a set of users requests a predefined set of services without exploiting time and experience. The set is defined by random selection. Which services are selectable is determined based on the high-level user's interests (e.g. likes Chinese restaurants). The users' requests are made during the whole period of a week at 4 different time-zones per day. Scenario 2 is similar to the 1st with the difference that time is used (user's experience is ignored). In the 3rd scenario we repeat the 2nd scenario including user's experience as well. The final scenario examines the case where we provide personalization using a different user's experience from the actual one ("business" experience when his on "vacation"). The test bed used utilized 10 service categories with thirty instances each.

Graph 5.1 is a direct comparison of the 3 first scenarios. We repeated our measurements for the values 2, 5 and 7 as the desired success factor. Since the lower the desired success factor the higher the expectations from the system our results look very promising. Looking at the graph, one can see that the higher the expectations from the system the more benefit we have by incorporating time and experience. Even though our initial results show only 7% to 38% gain (for $N=2$ scenario 3 is by 38% better than scenario 1 while for $N=7$ only 7%) we expect that having more services the gain will be significantly higher due to the number of available choices and the degree of differentiation. Considering the second measurement that shows the ratio between the "overall success factor" (S_{over}) and the "desired success factor" (N) we can see that the 3rd scenario also performs better. Recall that lower values mean better quality results (scenario 3 gives 42% lower values than 1).



Graph 5.1: Comparison of test scenarios

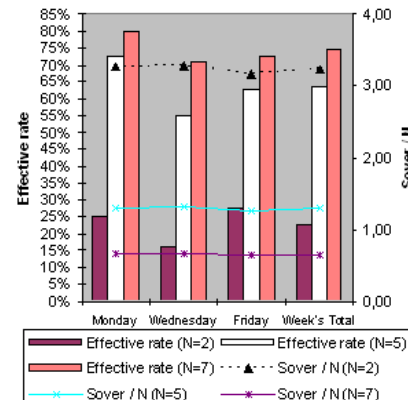
Graph 5.2 shows how important it is to correctly recognize the user's current experience. If we use the wrong user's experience the performance of the system drops dramatically. Especially when having high expectations. Using the wrong experience the system's effective rate is 23% while with the correct one (scenario 3 of graph 5.1) it is 60%, a drop of 37%. We see that in each and every day the system gives bad results. Even the "overall success factor" to "desired success factor" ratio (S_{over}/N) shows a dramatic performance drop (lower values are better) by 110%.

6. Related work

To our knowledge, personalization approaches that focus explicitly on the wireless Internet are quite limited. The widely known work is Internet based and appears within the fixed network. Furthermore it seems that time related factors have been left out from most (to our knowledge all) personalization approaches.

In the wireless Internet we have a couple of interesting approaches. PSE [11] identifies the need to have various profiles that encapsulate data about the users, services, networks and devices. It discusses service adaptation based on the various profiles and identifies service discovery as another problem. [13] presents a clearer approach but with a much narrower scope. It aims to find an efficient way to use Internet directories (e.g. Yahoo!) from PDAs. Personalization is achieved with a subscription scheme that greatly reduces the data volume of the directory and so the data can be stored on the PDA. User preference updates and synchronization are also addressed.

Within the Internet world we have a vast amount of approaches, mostly based on AI concepts. A number of them utilizes static agents. "ARCHIMIDES" [12] is (static) agent based and aims to personalize a web server's content by rearranging the navigation inside the web server's content. Similarly, "Proteus" [2] is a system that creates models for each user (using AI



Graph 5.2: Scenario 4: Using the "wrong" experience

techniques) for the purpose of adjusting the nodes of an Internet site to the needs of that specific user. Other approaches based on static agents are presented in WBI [3] and BASAR [4]. WBI works by using several plugins in order to automate general browsing tasks. BASAR is a similar system that manages and updates the “personal webspace” which is created by the user’s bookmarks. SiteSeer [5] is another system that is based on the user’s bookmarks analysis in order to predict and suggest relevant, possibly interesting Internet sites.

Another interesting approach is the use of “theme profiles” which hold interests of the user. The biggest problem here is the management of this profile. [9] is a subsystem of the SiteSeer services that uses profiling.

Yet another approach is the analysis and modeling of the user in order to predict his future moves. [8] and [10] describe two such systems that incorporate machine learning and artificial intelligence techniques respectively. Modeling the user through rule discovery and validation is another approach. The 1:1Pro [6] system is a representative of this category, and uses data mining techniques to achieve its goal.

An alternative approach is the exploitation of histories in order to reduce the results of information retrieval. Haystack [7] is a system that gathers the transactional history of the user in order to discover knowledge that will be used to limit the results of information retrieval to only the most interesting.

7. Conclusions

Mobile users are a new and more demanding breed of users, significantly different from traditional desktop users. In this paper we have identified factors that until this day were overlooked in the design of personalization systems for this type of users. These factors are related to time. We presented two major factors, timing and user’s experience, showing their importance. We showed that, exploiting timing enables us to capture the shifts of user’s interests based on the time of the day and adapt his preferences accordingly. User experience, takes the concepts introduced by timing one step further. It provides a means to effectively merge many different instance of the user’s profile (one instance for each state of mind, e.g. vacation, work etc.) into one dynamic profile. This dynamic profile can accurately cover the preferences of a user at all times and situations. We have identified which parts of a personalization system is affected by these factors (i.e. profile). We devised appropriate metrics, implemented a prototype and demonstrated the viability of our proposal via experimentation. Our first results show performance gains up to 37%.

8. References

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