PERSONALIZATION OF WEB-BASED INTERFACES FOR HUMANS AND AGENTS, APPLIED TO E-GOVERNMENT PORTALS

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Abstract. *An important part of E-Government is bringing administration closer to citizens. A way for this are webportals, where information and (increasingly in the future) online transactions are possible. To improve the utility of these portals, personalization can be used for presenting more tightly focused information. As customers of such services can be both humans and agents, we present the methods possible for adapting content to both. Necessary aspects of personalization for E-Government portals are identified (both technical and organizational changes necessary) and applied to the methods presented.*

1. Introduction

An important part of E-Government is granting citizens and businesses access to information on administration, proceedings (those they are party to, as well as generally), and probably also transactions, online and not only during office hours but 24 hours a day ([15]). This is usually done through the WWW as it is a universal means of presentation and widely available and known by the largest percentage of the population.

We consider mainly the conventional situation, that a provider offers and transmits information on request after a successful login of a user. But also the ability of pushing information ([1]) to the (previously identified) clients, based or triggered by some events at the servers site, is faced with the aim of personalizing web based interfaces. We also use the term „personalization“ if the user actually is an autonomous agent. In this case personalization refers to specific adaptation to the capabilities or interests of the agent. Therefore whenever we speak of a “user” we include addressing agents as well.

Referring to agents we use the broad characterization of [16]:

> “An agent is an encapsulated computer system that is situated in some environment and that is capable of flexible, autonomous action in that environment in order to meet its designed objectives.”

It is evident, however, that some of the methods, as they are described below, make sense only if the user "behind" (or in front of the webportal) actually is a human being, connected by some client interface.

At least transactions of all possible interactions require identifying the user. If the user is already identified (or recognized as the same visitor as before), the information presented can also be adapted to his needs, further improving the quality of the service. Modifying the content can be done in different ways:

- Adapting the presentation: E. g. for people with disabilities a text-only presentation, larger fonts, special colors, etc. could be provided.
- Adapting the data: For minorities or foreigners, providing information in different languages is an important aspect.
- Adapting the information: Content can be selected according to stated or derived (from various sources) areas of interest.
- Assisting the user: Giving hints on where information possibly of interest can be found, explanations what to type in a form (perhaps in different styles of language for inexperienced and professional users; examples), etc.
- Access through agents ([8]): Beside access by humans, portals should also be accessible through autonomous software (commonly called agents; [9]). In this case personalization is even more important, as recognizing general information as relevant is more complicated and the portal can ease this.

In this article we will therefore take a look at some issues of personalization of webpages with a special view on E-Government portals. The aspects covered include how to adapt the content to individual users (selecting information/data from a larger store), legal issues of personalization (privacy) as well as important aspects of personalization which must be heeded for E-Government portals.

2. Methods of Adapting Content to Users

Several possibilities exist to adapt the content to a user. In most cases a relatively large amount of work is required for classifying the content to personalize, so it can be adapted later to the preferences/interests of users. Often a combination of at least two methods described will need to be used as each has at least one important drawback.

2.1. Questionnaires

The most common way of adapting content is to explicitly ask the user, what he is interested in. Usually this is done by filling out a form on a webpage where interests, dislikes and so on are stated or can be entered. The actual selection of the content is rather easy then, as the category of the data need only be matched to the categories stored with the user's data.

This is the method suited best for agents as recipients. It can explicitly state the information it or (probably: if gained by observation) his owner is interested in (similar to subscribing a service). This is also positive for the server, as he receives a pre-controlled and focused set instead of having to collect data himself.

2.1.1. Advantages

- This method is easiest to implement and requires the least amount of storage and computing time.
- Preferences can be asked for very easily at registration or through a protocol.
- Classes for classifying content are simple to create according to the questions
- Rules for selecting the actual data presented are simple to create.
- Restricted prediction of other interests are possible: If e. g. the user likes A and B, he will probably also like C. Finding these rules can be difficult.
- Personalization is done for the individual user.

2.1.2. Disadvantages

- Personalization is relatively weak as only a limited amount of information on the user is available. Nobody will fill in 10 pages of questionnaires if he is not forced to, especially before he receives any (possible) advantage from it.
- If the user does not take actions for changing his interests, the data stays the same. When his needs change, personalization grows less useful. This method is therefore suited best for creating a profile, but not for updating.
- For useful personalization complex classification is necessary. This means lot of work in advance before users can utilize it.
- Users don’t always disclose their real interests or all of them. In this case personalization is even detrimental.

2.2. Search-Path Shortening

This method of personalization adapts the content to the user by shortening his path through the tree-like structure of a website to the leafs containing information: The more often he clicks on a link, the higher up it will be placed. This can be done either by moving it up in a list or by transporting it to a higher level in the hierarchy. Through this, the information of most interest to a user slowly moves to the top reducing his search-time for consistent requests.

2.2.1. Advantages

- This strategy continually improves itself and therefore automatic adaptation to changing interests of users is achieved.
- Personalization is done according to the real interests of a single individual, without influences from other users or profiles.

- No classification of the data is required and every type of data (e. g. also documents, images, messages, applications) can be personalized.
- No explicit actions by the user are necessary.

2.2.2. Disadvantages

- Personalization takes a longer time to be effective and changes only slowly. Not suited for initializing a user profile, only for slowly updating one.
- Only persons with high usage profit from this, as passers-by see no results.
- No predictions are possible, what might be additionally of interest to the user.
- Users might be irritated if their links continually move around. This is a huge problem for agents, as finding a certain link is even harder for them.
- Usably only if the same or at least similar items are requested repeatedly.

2.3. Collaborative Filtering

Many users rate the content and according to this rating they are divided into separate groups through statistical methods. For personalization the user must rate some selected elements and is sorted into a group by his answers. All the interests of this group are then defined to be also his. In some variations, the user is not sorted into a group, but a single user, who matches his interests best, is selected (a "twin"). Allowing agents to rate information is dangerous, as another layer of possible misunderstandings and inconsistencies is introduced.

2.3.1. Advantages

- No data-classification is needed and all types of content can be included.
- The more persons use personalization and the more they rate, the better it gets for all, resulting in continuous improvement of the personalization.
- Predictions for different areas are possible as long as they are rated by the groups. Also the probability of this being correct can be calculated.
- With only a few rates relatively good personalization is possible, as long as a large user-base is available: excellent suited for initializing a user profile.

2.3.2. Disadvantages

- The algorithms involved are complicated and require a lot of resources.
- Creating groups is the key point but cannot really be predicted. Some groups might be good, but others can consist of different interests.
- A large number of regular users must continually rate items for good results. Even if personalization works well for them they must continue rating. Updates come slowly as large groups change only after many deviating rates.
- Starting is difficult as there is no data available then. Possible solutions for start-up possess low quality.

- Only long-living items can be personalized: E. g. daily news are not of interest any more when there are enough rates to allow personalizing them.
- Personalization for the user is done based on a stereotype: If he does not share a certain interest with his group, this is not reflected in his profile.

2.4. Observing Behavior of Users

This method starts with an unpersonalized page and then observes the users behavior: Where does he click, how long does she remain on certain pages, what words does he search for, from which websites did she come, interactions done with this website, and so on. According to predefined rules from this data the areas of interests of the user are deduced. Afterwards content is selected according to a comparison between its classification and the interests found.

2.4.1. Advantages

- The real interests of the user are found, according to his actions.
- Personalization starts without need for any additional action by the user.
- The content is adapted to the interests of the individual user, not a group.
- Continuous improvement is possible, as long as there are applicable rules.
- Agents behavior is strictly rational and therefore interests are easy to derive.

2.4.2. Disadvantages

- A lot of personal data must be collected (clicks, time, data entered in forms, …) and analyzed afterwards. This clashes with privacy issues.
- Some data can be misleading too: Keeping a specific page opened for a long time simply might refer to a “coffee break” or other work done concurrently.
- Collecting sufficient information for effective personalization is time consuming. It keeps the user busy waiting without an immediate advantage and is therefore usable only for “regular” visitors.
- If the content is already personalized, deducing interests from actions can be rather difficult. Predictions on new areas are not possible.
- Finding the rules, which actions on which elements/classes imply which interests is difficult. Sometimes this can be done only during deployment.
- Content must be classified. The categories for classification might not be complete at that time, so possibly even re-evaluation is necessary.
- Suited for updating user profiles, but not for initializing them: No personalization when beginning.

2.5. Statistical Profiles

For this method only very few general questions are presented to the user, which might be rather different from the content to personalize. According to

very extensive statistical profiles, the user is sorted into a certain category and all empirically found interests of this class are ascribed to him. With respect to agents this works only if they represent their owners directly and have been "fed" with personal information before having been sent on their way.

2.5.1. Advantages

- Only very few questions to the user are needed.
- A very broad spectrum of very detailed interests is associated with users. It is therefore especially suited for initializing user profiles.
- Predictions on completely different areas are possible.

2.5.2. Disadvantages

- Selecting the questions for sorting users is very hard.
- Huge statistical data and much experience is needed for creating classes.
- Nobody conforms to the statistical average: Personalization is done on a broad profile and not the individual. In some areas the profile is wrong, and these might be the interesting ones. Detecting this is impossible in advance.
- Once sorted into a class, no changes are made unless the statistics change.
- No adaptation of the personalization to a single person, but more an adaptation of the user to a class.

2.6. Classification of methods

Some important aspects for classification (and therefore selection for an application) of methods for adapting the content are, whether it is suitable for initializing a user profile and/or it is able to continually (without intervention of users or the operator) update it. Another issue is, whether the method is suited for every content or if there are restrictions for which areas the method can be used. Whether the content is adapted to the individual or a somewhat larger group is presented next. The last column shows whether this method can be employed if the target is an agent. These aspects are shown in the table below for the methods presented (for details see the description above):

Personalization method	**Initializing new profiles**	**Updating old profiles**	**Suitable for every content**	**Individual / Group / Profile**	**Suitable for agents**
Questionnaire	+	-	+	I	+
Search-path Shortening	-	+	+-	I	-
Collaborative Filtering	+	+	-	G	+-
Observing Behavior of Users	-	+	+	I	+-
Statistical Profiles	+	-	+-	P	-

3. Personalization Needs of E-Government Portals

A portal for E-Government should consist of four areas. General information on the portal needs no personalization, except perhaps for help-pages (which can be handled exactly like the next category). Within specific information on legal requirements and procedures, special selections and hints to areas of possible interest are issues when personalizing them. This includes helping decide which forms to fill in, where to go, what to bring, etc. ("wizards"). When sending applications online (filling in forms and sending them directly), personalization can help in automatically filling in parts of forms and collecting additional certifications which are required and available online somewhere. Also merging multiple forms into a single one could be done (identifying prerequisites, consolidating it for presentation, separating it into different forms for different authorities). In the area of online transactions (online applications plus payment and/or receiving answers), personalization is of less importance. Aspects of security and transactional processing require more attention. However, details on payment or secure identification for non-repudiable service can be stored in the same way as data for personalization: both need to be protected. Agents are most useful in this area as they can regularly check for new information or stages of proceedings. Identification/authorization can be securely proved by attribute certificates in this case ([11]).

3.1. Key issues for personalization of E-Government Portals

Several key issues must be taken into account when discussing or implementing personalization for E-Government portals:

- Users possess an extremely broad range of level of knowledge on computers, ranging from absolute novices to experienced professionals. Also, classifying them according to this can be very difficult.
- Personalization must be very reliable: There might be liabilities if wrong advice or hints are given, especially as it is an "official" site. Even if not, bad word of mouth is also an issue if problems occur.
- Users will be extremely unwilling to provide information not already available to public administration. Even then partitioning the data and restricting its use to certain authorities (e. g. internal revenue service only) is important.
- Privacy contains a principle of minimalism: Only this information may be collected and used, which is absolutely necessary for the purpose on hand.
- Data must be kept up to date according to its purpose. This might require continual verification or adjustment with the authoritative source (with the problems of consent to the transmission of data).
- The administration, which is probably the operator of such a portal, is strictly bound to the laws (legal permission needed for actions) and also must ob-

serve the basic civil rights (the latter is less of a problem, as privacy is a basic civil right which also applies between citizens; a notable exception).

- Access to information should also be possible through agents, which is of special utility for companies, which can then automate search for information or preliminary stages of applications, as well as getting alerted on changes of special interest to them. This also allows better integration of the processes of the company with those in the administration.

3.2. Changes required for introducing personalization in existing portals

If an existing portal shall be changed to also include personalization (at least for some part of it), several aspects must be taken into account. These can be either of a more technical or more organizational nature.

From the technical point of view the content as well as the presentation must be divided into several parts. Presentation must be divided into those parts of webpages, which are the same for all users, and those which will be personalized. This task is not that complicated but work-intensive. If presentation is altogether separated from the actual content, also access by agents can be improved, as then the presentation aspect can be omitted. Agents are then able to directly access the (nowadays usually defined in some variant of XML) content ([12]). On the layer of content itself, information must be divided into multiple classes: data which is the same for all users and available to all of them, those parts which may be accessed only by certain persons (e. g. individual information like vaccinations), and the general personalized content everybody might see, but only a part will actually see because it is of interest to them. This is not only a lot of work but also rather difficult. Personal data might obviously be viewed only by the person it is related to, but dividing into general information and information to be personalized is harder. The most difficult aspect here is to categorize the information for different groups, a necessity in many personalization methods: this must be done consistently, even though often multiple persons will be responsible for it.

Another issue is, that for personalization to work the user must be recognized. This can range from recognizing him or her as the same person, who has visited the portal before, up to a reliable identification of the individual (e. g. if applications are accepted or deliveries made). Care must be taken with agents, as it is not the agent which must be identified, but its owner. Especially in companies a single agent might represent different persons over time. To enlarge dissemination also anonymous access should be granted. For personalization of general information, cookies and/or passwords will be sufficient (cookies possess a special problem: advance permission by the user is necessary [2]). If individual data is presented or handled or transactions are done, identification through digital signatures (electronic certificates) is necessary. For legal validity

this is also often a necessity. Care must be taken that identification is mostly automatic, so users are not bothered by complicated and special methods of identifying themselves. They should be recognized in multiple stages (a small contrast to the previous): from anonymous over normal identification (cookies) to reliable identification (el. signatures). This also serves as a reminder to the user, what consequences or importance his acts will have from this point on.

Important to change is also the privacy policy: Tracking users through cookies requires disclosure and consent (in advance; before their use) of them. The data collected must be handled correctly according to privacy laws ([3], [4]). This includes informing the user which data is collected and for what purposes it will be used. In E-Government portals this is of special importance, as parts might be explicitly set in laws, while other uses of data might be deemed politically undesirable, even though their use might be legal. In this context also a special potential of E-Government portals must be discussed: Whether a connection to other databases will be installed or not and which data will be used. In the whole public sector a wide range of information on persons is available and most of it could be used if the person gives consent (see also below).

According to how content for the portal is created and published and which data is available through it, personnel might require special education. How to provide data in a form to be used at all (or at least easier) in the context of personalization is important to reduce additional work for adaptation. Also, a broad supporting base increases the chances for rich content. On the other hand, training will be required what parts might be published and for which groups or persons. This could be only a minor issue when content for the portal is selected by a website management team, as editing and selecting the content is done by them. If e. g. documents of proceedings are also available in a personalized way (only for parties to it), or transactions are included, this approach is no longer possible. Therefore new tools for supporting this task as well as education for the personal is necessary.

In connection with the last issue modifications to the internal processes will probably be required. Deciding which parts of the information collected and produced is available to which users and pertains to which categories is an additional step which must be introduced into the processes. Ideally it would be inserted after each activity, but not all of them are relevant for the outside and only data on few needs to be available immediately. Some information could also be published automatically if the existing software supports it. An example is the state of a proceeding, which could be derived from an existing workflow system. For the process itself, there might also be repercussions: If the view on the process is personalized, it will usually be different from the view the administration has on it. What is one single process with few steps might in reality be a long process with multiple stages involving numerous administrative units. Therefore

mapping between these views are necessary: From the internal perspective to the outside by defining who publishes/provides which data at which stage (and who is responsible for changing the external view if the process itself is modified). Conversely, also a mapping from the external to the internal view is required, e. g. when users interact with the portal or have question pertaining to it (which might be placed by phone or in writing, so the transformation must also be available in this way!). Another issue is, that for improved service processes might be initiated automatically, e. g. reminding a user of some upcoming event or recurring service. Such already exist, but now different methods of alerting are available, e. g. an "upcoming" sign on a personalized webpage and only later an E-Mail. What was previously a one-stage process (sending a letter), now has multiple stages and more complexity because of different available channels.

3.3. Integrating data from different sources

One of the advantages of E-Government portals is, that a huge amount of information is potentially available to be integrated into personalization. However, both legal and technical hurdles must be overcome before. First of all, selection of the content must take place: Which parts are unsuitable for personalization, or are undesirable (political reasons). After this first step, information must be classified according to its potential use: The parts which must not be used because of legal reasons (privacy), those requiring special permission (sensitive data; requiring explicit permission), "ordinary" data, where permission is needed (but can be obtained implicitly), and free data (only indirectly related to persons, or anonymous, like aggregate data, or explicitly permitted/required by law). Only the last class may be used immediately. As there is no connection to a single person, it is usable for personalization only in connection with roles or groups. All other types either require explicit legal permission, must conform to an exceptions in privacy laws, or citizens must give consent. Just using the website will not be sufficiently clear a declaration even if implicit consent is enough. So even if the user is already identified he must be asked for his permission before data may be inspected, transferred or used. If information is used in this way for personalization the administrative unit providing this service will be responsible for observing privacy law ([7]), as it is not a subcontractor working for the other (source of information) unit. This applies even though it might be a service to the origin in some sense (e. g. central government providing a personalized portal for information and/or processes of regional governments).

Resulting from all of this, configuration by the user might get rather complicated: Which parts from which source may be used for which types of personalization or be related to which other information from a different source? This can only be alleviated for those parts where implicit consent is sufficient: A suitable default configuration could be selected and the user asked whether he

agrees to it. Because of the requirement for implicit consent, this question can be formulated rather loosely and in words understandable to the user. For parts requiring explicit consent (sensitive data), this is impossible and clearly defined questions must be asked. A problem in this context is that a standard configuration can be difficult to create: The data cannot be inspected in advance to facilitate it as this is allowed only after obtaining consent. It must be derived either from general rules or according to the already known interests of the person.

It is important to use agents to integrate legacy applications into business processes ([10]) like other databases in this case but also for workflow systems, as this allows graceful transition, respectively results in a system which is rather independent from foreign sources and can be easily adapted to modifications in them. This includes not only changes in the presentation or structure of the data, but also in the processes of acquiring them (protocols).

3.4. Ideas for adapting content

As not all methods of personalization are suitable for E-Government portals, we will investigate which methods could be used for which parts of such portals.

Search path shortening is unsuitable for an E-Government portal, as trees will be rather shallow and changing the order or location would be a huge problem for inexperienced users. Collaborative filtering is only suited for a very small area: If discussion groups or FAQ's are included, these could be automatically classified through ratings according to the (otherwise found) interests of users viewing as well as rating them. Apart from personalization, rating can be used as a feedback for the creators of the content.

In a certain way statistical profiles are important: If a classification was reliably established through other means, predetermined profiles can be used for enriching it. This might be done either through statistical information or legal requirements (e. g. company → corporation taxes). These additional traits should be open to the user so he can remove certain of them he does not want or which are not applicable in his individual case. For optimum service to citizens, explanations why they were selected should be offered (self-explaining system).

Observing the behavior of users is an additional trait which should be used for regular visitors: An example could be a personalized "Hotlist" containing those pages used regularly. Also, changes in the behavior can be taken as hints that some data is no longer valid and need to be updated, removed or marked as "suspect", fulfilling the obligation to assure the correctness of information used.

This leaves questionnaires as the main means of obtaining data for personalization. As many questions as possible should be optional. Improving personalization later on should be available through answering additional questions. Combinations with pre-created profiles and rules (see statistical profiles above)

can further enhance the information on the user. Questionnaires also possess the advantage that information from other sources can rather easily be integrated. Questions are clearly defined, so integrating another database instead of answers results in a relatively easy mapping of it to questions which then need not any longer be presented to the user but could be answered automatically by simple retrieving the data.

4. Conclusions

The success of the Austrian E-Government portal help.gv.at [6] has sparked large interest in similar and improving projects (e. g. [5]). For going on in the same direction, personalization is an important issue and can be rather easily added if transactions are planned or already included. However, in contrast to just providing information there are also problems and drawbacks like legal issues of privacy and reluctance of users to provide personal information. Still, the advantages outweigh the problems and personalization must at least be considered as an (potential) add-on.

Adapting the content is more difficult here than in E-Commerce, as higher standards must be met for correctness (agents: clarity) of classification. Therefore explicit information through questionnaires, enhanced by rules, regulations and statistics should be used for focusing the information to a personal view.

Privacy issues must be addressed when personalization is used, most important through obtaining the permission of the user for gathering, using and transmitting his personal data. Because of legal requirements and as a positive example, absolute and strict adherence to the rules is a necessity. Special care must be taken when integrating data from other source. There is no difference here if agents are introduced as another means of accessing the information.

Providing special services to or through (see e. g. [13]) agents or taking them into consideration can additionally improve quality of the service for citizens and especially for companies. Anyway, some questions arise in this connection which must be solved in the future: How can the interaction between an agent and the portal be done to require least modifications and effort? How to effectively pass areas of interest, whose description might be difficult (transporting also the meaning and the intentions, resulting in a transfer of knowledge)? How must the sources and uses of external information to be integrated be defined, so agents can give consent to the use in place of their owner?

Personalization is therefore a logical step onward in the process of bringing government closer to the citizen, enhancing and in some cases perhaps replacing the need for assistance through personnel, freeing up resources for more non-standard and complicated issues.

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