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D14.3 The role of Adaptivity & Personalization technologies in e-Participation

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Abstract: The present booklet provides a thorough coverage of the technology of adaptivity and personalization and its potential role within the Demonet project. More specifically, it explains the notions of adaptivity and personalization, presents the enabling technologies of the field, lists the research groups that conduct research in the area and describes the current applications of the technology as well as its potential application in e-participation.

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Executive Summary

Adaptivity and personalization is a research topic spanning several application areas. These technologies are commonly used to overcome the overflow of information and service providers adopt them in order to acquire a better knowledge of their end-users and optimize their service offerings. The present booklet aims to investigate the potential of adaptivity and personalization principles and technologies when applied to the eParticipation field and more specifically, to eParticipation websites. The booklet is organized in six chapters.

Chapter 1 introduces the need and scope of adaptivity and personalization in the context of modern information systems, as the major problems addressed by these technologies are discussed.

Chapter 2 provides a general understanding of adaptivity and personalization technologies, including the definition and clarification of commonly used terms as well as the theoretical description of models and techniques that are used for personalizing the user experience. The possible targets for adaptation and adaptation mechanisms are presented, providing insights about what can be adapted and how, respectively.

Chapter 3 identifies the research landscape of adaptivity and personalization, by investigating the main research efforts of individuals and organizations worldwide. An overview about research organizations that are active in this area is provided while at the same time practices and tools that can form the basis for sketching potential application scenarios for e-participation are described.

Chapter 4 presents applications of the technologies, which can be considered more in line with the e-participation aims and scope. Examples of applications in the domain of education, business and commerce, electronic news services and e-government, provide useful insights, ideas and lessons learned that should be taken into account when applications in the e-participation area are considered.

To our knowledge there is not application in the convergence between personalization and e-participation to date. For this reason, after a comprehensive understanding of the scope of research, of the research landscape and of the application aspects of adaptivity and personalization, that are provided through chapters 1-4, the chapter 5 investigates potential application scenarios of these technologies in the context of policy engagement and active participation of citizens in democratic decision-making. The application scenarios are presented per participation area (cf. D5.1), in which adaptivity and personalization could come into consideration. More specifically application scenarios for the following participation areas have been identified: information provision, community building, consultation, deliberation, mediation, spatial planning and campaigning.

In the last chapter we sketch some conclusions by discussing the two-fold impact of adaptivity and personalized technologies in e-participation.

1 Introduction

As the World Wide Web matures, it makes leaps forward in both size and complexity. In this expanding environment, the needs and interests of individual users become buried under the sheer weight of possible viewing choices. Beside the problem of finding interesting information on the web, users experience big problems in navigating through the content of a web portal, especially regarding the efficiency of that process.

One major problem is the lost-in-hyperspace one: In the rich link structure of a portal, users can easily get overwhelmed and become unable to navigate effectively. There is a growing body of empirical evidence to suggest that users tend to make poor decisions in traditional systems as the navigational freedom given to the user leads to comprehension and orientation difficulties in the sense that users may become spatially disoriented, lose sight of objectives, skip important content, choose not to answer questions, look for stimulating rather than informative material or simply use the navigational features unwisely [32].

The second major problem is the one-size-fits-all: Websites provide (from the user's point of view) relatively static content and are viewed by diverse users. This may cause difficulty for those who have less background; also it can be redundant for those who already know the information; and be uninteresting for others. In other words, since the user population is relatively diverse, traditional static applications suffer from an inability to satisfy the heterogeneous needs of the many users [32].

In order to cope with these problems, there is a demand for intelligent tools and structures which can make navigation of the sites easier for users and maximize the quality and completeness of their experience. To counter this, there has been a rise in research in adaptive websites and personalization, a combination of data mining, machine learning, user modelling, Human Computer Interaction (HCI), optimization theory and graph theory which seeks to sift through the tides of possible information and provide users with a high-quality stream of information.

In respect to e-participation, where a number of citizens with different needs and expectations is addressed, adaptivity and personalization can help to structure the complex area thereby creating a new way in which citizens engage in the discourse with politicians and governments.

In the following sections, we provide a detailed description of the concept and technology of adaptivity and personalization, covering the state of the art about the theory, models and techniques of adaptive and personalized systems. We provide an overview of key research groups in the field and investigate the application of adaptivity and personalization in various domains. We conclude by describing potential future application scenarios of adaptivity and personalization in e-participation, that enable the technology to advance its application domain.

2 Theory Models & Techniques

Web sites are increasingly adapted towards their users by a variety of dynamic techniques, providing improved personalization for the individual. An overall description of the technology of adaptivity and personalization is provided in this chapter. Before introducing the models and techniques used for personalizing the user experience, we briefly define the terms adaptivity and personalization, we try to resolve the confusion usually made between various terms which are used in this research area and we highlight the major research challenges.

The state of the art in the area of adaptivity and personalization that is provided in this chapter as well as the review of the related research groups, which is included in the following one, both serve as input for chapter 5 where application scenarios of the technology in the domain of e-participation are investigated.

2.1 Theory

2.1.1 Definition of Adaptivity

Adaptivity is a particular functionality that alleviates navigational difficulties by distinguishing between interactions of different users within the information space. Adaptive Systems employ adaptivity by manipulating the link structure or by altering the presentation of information, based on a basis of a dynamic understanding of the individual user, represented in a user model [32].

An adaptive hypermedia system is a hypermedia system which reflects some features of the user in the user model and apply this model to adapt various visible and functional aspects of the system to the user [28], [13]. A system can be classified as an Adaptive Hypermedia one if it is based on hypermedia, has an explicit user-model representing certain characteristics of the user, has a domain model which is a set of relationships between knowledge elements in the information space, and is capable of modifying some visible or functional part of the system based on the information maintained in the user-model [28], [13], [16].

Such a system should have the ability to recognize users and events, to reason about, and plan for the future. Therefore, creating adaptive websites requires server-side functionality for user modelling and for the adaptive generation of (HTML) pages. The broadest definition of an adaptive website is a website which changes based on the way it is used [45]. Changes can take on many forms, as they may either be immediate (as in the case of recommendation systems) or gradual (as in the case of systems which suggest changes to a website administrator).

2.1.2 Definition of Personalization

A relatively new research area, very closely related with adaptive web systems is web personalization. Web personalization has a more extended scope than adaptive hypermedia, exploring adaptive content selection and

adaptive recommendation based on modelling user interests and it is primarily used in the e-business application domain [32].

As is often the case with a good marketing buzzword, the term personalization is used rather loosely [20]. It has come to stand for an ultimate goal of customer relationship management by businesses, supporting for example one-to-one marketing. It has also come to mean delivery of information of high relevance to an individual, in the context of receiving from a large body of information only the part that is of interest to an individual or a group of individuals [81].

In [81] personalization is defined as delivering to a group of individuals relevant information that is retrieved, transformed, and/or deduced from information sources, while authors of [32] state that, web personalization refers to the whole process of collecting, classifying and analyzing Web data, and determining based on these the actions that should be performed so that the user is presented with personalized information.

In summary, personalisation takes place between one or several “providers” of personalised “offerings” and one or several “consumers”. Personalised “offerings” include content (such as Web pages and links), product and service recommendations (such as for books, CDs, and travel packages), e-mail, information searches, dynamic prices, and products for individual consumers (such as custom CDs).

2.1.3 Adaptable vs Adaptive Systems

One important aspect of personalized and adaptive systems is how the information that is used in order to build the user model is acquired. To this end, we distinguish between adaptable and adaptive portals. Adaptive web sites are not the same as adaptable ones, although both kinds of sites seek to customize the user's visit.

A portal is merely adaptable if the way it performs or behaves changes based on explicit information, such as a user profile. This profile will not vary over time unless the user explicitly changes it. In other words adaptability, also referenced as customization, occurs when the user can configure an interface and can create a profile manually, adding and removing elements in the profile [9]. The control of the look and/or content of the site are explicit and user-driven; i.e. the user is involved actively in the process and has direct control [10]. Portal Web sites such as Yahoo.com and iWon.com are adaptable; they allow users with Yahoo or iWon accounts to choose how information is displayed on their personal view of the Web site. For example, Yahoo users can choose the types of news that they would like on their my.yahoo.com page [80].

On the other hand, a portal is considered adaptive if it changes based on implicitly discovered information, such as an analysis of the way it is used. The user model is updated during the browsing process. The site monitors the user's browsing behaviour (and in particular the pages that are visited) in order to create a user model representing the user's interests and knowledge. In other words the web site is customized by unobtrusively observing the user's actions [25], [50]. In adaptive systems the user is seen as being passive, or at least somewhat less in control [9].

The obvious limitation implicit in explicit personalization techniques, is that they do not take into account that the visitor's interests and needs might change during the exploration and might demand a reconfiguration of the system [10].

2.1.4 Challenges

The environment in which an adaptive web system operates presents certain challenges which impact their feasibility and performance. In the following we present the most interesting ones.

Impact on User Experience

When adaptation takes place, there are by definition some changes which are made to the website, perhaps to the content of the pages, the structure of the site or the links which are presented to the user. Since the website is changing, it is important to consider the impact that making such a change would have on the user's experience, and avoid or modify changes in light of how the experience should be maintained. For example, in a website which has a highly visual layout, the addition or removal of links may have a disastrous effect on that layout; even the modification of the colour of the links or the augmentation of link icons might confuse the user as to what links they had visited already as opposed to which links they have yet to visit [14]. In another case, while there may be a large number of links which are deemed relevant to a particular user, some subset of these must be chosen to avoid overwhelming the user and putting them back into the "lost-in-hyperspace" situation. In yet another example, the adaptation of content may confuse or disorient a user, as the location of familiar items may be radically altered based on the system's perceived shift of interests.

Another challenge concerning interfaces that are unique to each user is that there is no longer a common interface that we can assume all have seen, and in fact, it may become harder for people to help each other when they have questions about an adaptive web site [38].

To counteract the user's sense of powerlessness, adaptive web sites should explicitly demonstrate that they are still learning about the user and can be trained to work with the user [80]. Users are more likely to trust an agent that demonstrates that it is learning and are more open or feel more positive towards an adaptive web site that they know is working to adjust to them [48].

As a general rule, an adaptive system should provide relevant but not critical information [49]. This will alleviate the negative impact that an adaptive system may have to user experience. Amazon.com is a good example of this requirement. It recommends products for the user to browse, but these recommendations are not a crucial part of the user's visit to the web site. The user can ignore the recommendations and still get full functionality from the site.

Changing Interests

While different users may have different interests, a single user's interests also may change over time such as short time interest under a certain situation and long-time interest which reflects the real interest of a user [53]. Some users may want information about a specific topic after they explore different kinds of information. On the other hand, some users may need wider background knowledge after they study a specific topic. Along with the changes of the environment, a user's interest in a particular area may wax and wane. These and other reasons may cause changes in a user's interests, which may happen abruptly and rapidly (concept shift) or gradually and slowly (concept drift) [43]. Ideally, adaptive web systems should be able to adapt to such interest changes.

Additionally, a user's interests may not simply change, but things which interested a user in the past may become interests again at some future point. So, in addition to some form of interest forgetting, which represents a shift over time, there is also the idea of interest remembering, where old interests may reappear [41].

Poor Modelling

Poor user modelling may lead to poor adaptations on a web site. Since the system is trying to draw conclusions and common features from a less-than precise body of information, it will on occasion have considerable difficulty in reaching accurate or even at all correct generalizations. This happens when the system, while trying to make decisions based on its perception of the user, tries to make more or bigger decisions than its understanding of the user really allows.

Another problem related with poor user modelling is that the system may not be able to distinguish between a deliberate user choice and a mistake [4]. For example at Amazon.com, a user might purchase a book not at all to her taste as a gift for someone else, yet the web site might persist in recommending similar books because it thought that she liked it [80]. These incorrect assumptions could lead to inappropriate adaptation [4].

If there is no way to inspect the decision process made in reaching conclusions and potentially correcting them, there could be disastrous results, with the system generating entirely inappropriate suggestions, as in the case of Amazon described above or as in the case of a TiVo gone wild in [84].

Privacy

Adaptive systems which capture information about users in order to build a profile about them can be viewed as an impingement on personal privacy by some users which are sensitive about sharing personal information with anyone. User modelling requires data collection, which leads to the possibility that the information may be misused [4]. This issue is a social one and not a technological one, but does imply that the results of a user model that describes a user or group of users should be treated carefully and not casually. Privacy laws may restrict both the

content of personal user data and the methods that may be used for processing them. Furthermore, Web systems normally face customers from all over the world. In this case, the fact, that different countries have different privacy laws, may need to be taken into account in user modelling [40]. A recommended practice is to declare a privacy statement (or disclosure statement) which describes exactly what kind of information is gathered and the policies about how that information is used and shared [9].

2.2 Models and Techniques

There are two major questions that must be taken into account when an adaptive/personalized system or application is considered.

- What can be adapted, meaning which are the targets for adaptation
- Which techniques are used by the system in order to collect user information and create the user profile, which is subsequently used to adapt to the user.

In this section we describe the targets of adaptation, as well as the adaptation techniques that are commonly found in adaptation systems.

2.2.1 Targets for Adaptation

The heart of an adaptive web system is its ability to change in response to the way it is used. This section describes the kinds of changes that such a system may perform. It should be recognized that the content, presentation and links of a web page are closely related, so there is bound to be crossover between these categories.

Content

One of the basic modifications that might be made is to change the content of the web page, based on the model that the system has been able to deduce about the user [40], [14]. Content might be added to or removed, or it might be simply rearranged [29]. These modifications might be done to accomplish several things, including the following:

- **Optional explanations**: Additional explanations might be presented (or removed) to complement a user's presumed background knowledge in the subject [40]. Among the many ways to perform adaptation to text the technique of inserting or removing fragments is the most popular. This is probably due to the fact that this technique is easy to implement. With a fragment a condition can be associated, a Boolean expression on information from the user model, and this condition determines whether a fragment will be shown or not. We distinguish three areas in which this technique is often used:
  - In prerequisite explanations an extra explanation is added for users who need it. A page that uses a technical term or a

name the user has not yet seen may conditionally include a short introduction or explanation for that term or name

- Additional explanations can be given to users who are ready for them. Whereas prerequisite explanations try to compensate for missing knowledge additional explanations take advantage of users' knowledge to offer more in-depth information to users who can understand it
- A special kind of additional explanations are the comparative explanations. This technique refers to a comparison between topics described on different pages. The comparison can only be understood by users who have read both pages. So when visiting one of these pages first, the comparison will not be made, but when visiting the other page the comparison appears

- **Optional detail**: Additional detailed information might be added or removed to pages depending on a user's perceived interest in the topic [40]
- **Personalized recommendations**: Particularly in the ecommerce world, recommendations for offers or products in which the user might be interested may be presented. In other websites, this would include putting links to other conceptually related subsections that the user might find interesting [40]
- **Optional opportunistic hints**: Hints to understanding or discovering information might be added based on the users' interests and on current circumstances [40]
- **Substitution of content**: Depending on the perceived browser capabilities or user interests, content of one type may be replaced with equivalent content of a lesser or greater browser requirement. For example, an image of a map might be replaced with a textual description of the map for users who are visually impaired and using a text reader, or a video might be replaced with a still picture with a link to the video for a user whose actions (or preferences) indicate a low-bandwidth connection [31], [64].

Presentation

In addition to modifying the content of the page, one can also change the way it is presented in order to serve a user. Most of the research on adaptive presentation deals with adaptive text presentation, and even then mostly with canned text presentation (and not natural language generation). In multimedia the selection of a presentation mode or the presentation medium (text, image, video and audio) is most feasible. Automatic adaptation of multimedia content, like in automatic summarization of video or audio, is still very much future work.

Adaptive natural-language generation generates alternative text descriptions for different users [40]. A similar technique can be seen in online page translators such as Altavista's Babel Fish [1]. Figure 1 represents a classification of the techniques for adaptive presentation. In

this section we will provide a detailed description of canned text adaptation, as an example, because it is the area that adaptive presentation research is focussed.

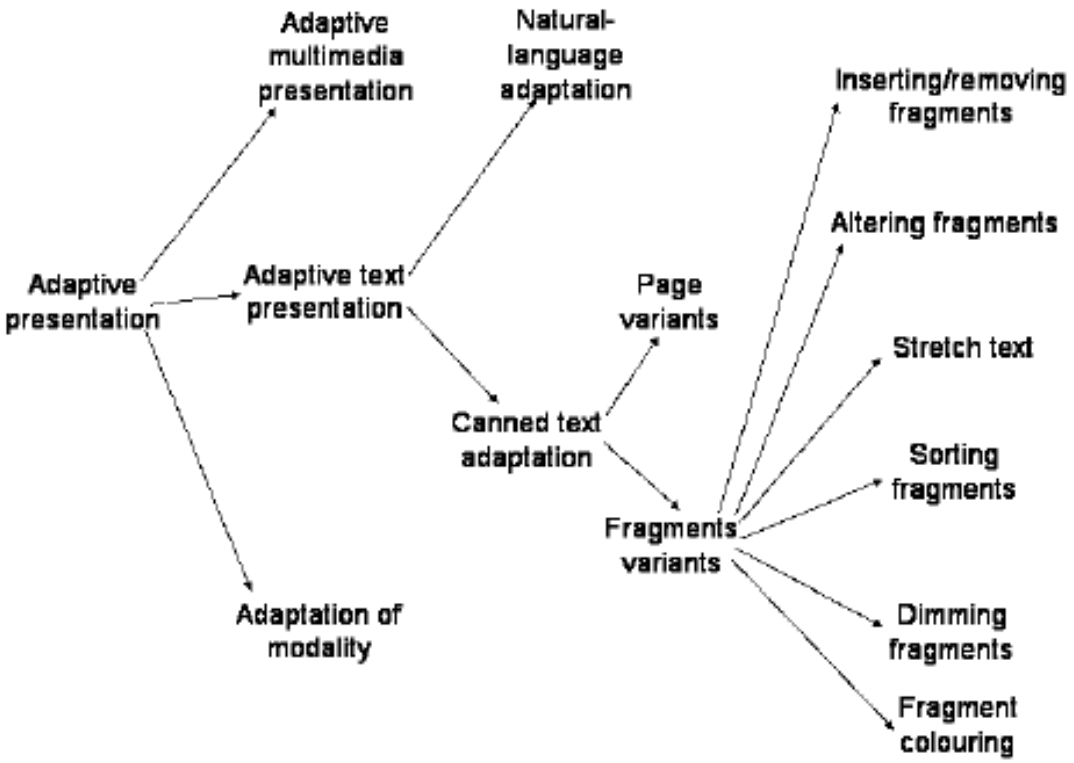

Figure 1: Adaptive presentation techniques

Canned text adaptation consists of the following techniques:

- **Page variants**: Different versions of all possible adaptive variations may be stored in the system, and the particular page selected at run time [40]. One common case where this is done is for multi-lingual websites, where a version for each web page translated into each language is stored, and then selected based on the user's language preference
- **Fragment variants**: Similar to the technique of page variants this technique stores content fragments (or atoms) and selects the appropriate fragments at runtime, assembling them into a static page when needed [40]. This technique can readily be seen for any site which has easily separable atoms of content, such as news sites [3].

The meaning of concrete presentation techniques (cf. most right part of Figure 2) is straightforward. We give just several examples:

- **Inserting or removing fragments**: Among the many ways to perform adaptation to text the technique of inserting or removing fragments is the most popular. This is probably due to the fact that this technique is easy to implement

- **Dimming fragments**: There are many ways in which some information can be emphasized or deemphasized. Less important or urgent information can be presented using a smaller font, in a sidebar, as a footnote, as a pop-up activated when you move the mouse over a tooltip icon, etc.
- **Fragment colouring**: This technique colours fragments to highlight which ones are important and de-emphasize those which are irrelevant. In this case, the content of the pages is the same for all users; this avoids the problem of an incorrect characterization of a user having too negative an impact on their experience [40].

Links

Adaptation of navigation realizes adaptation by changing the links of the system [40], [13]. This adaptation speeds up the search for a particular page and helps to avoid the problem of users lost in hyperspace. There are several techniques to realize adaptation of navigation that are represented in Figure 2.

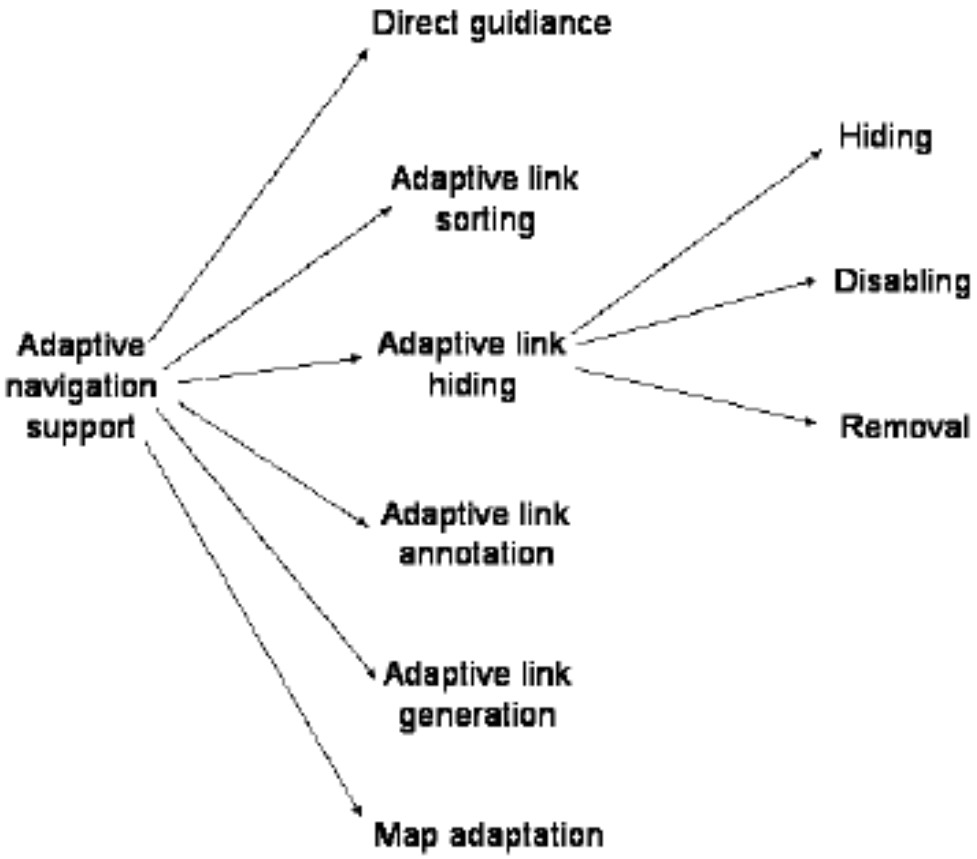

Figure 2: Adaptive link (navigation support) techniques

- **Direct guidance** ([14], [13]): is a technique to offer users a possibility to be guided as in a guided tour. Typically a "next"

button invites you to go to the “next” page. But unlike in a static guided tour the adaptive system determines the destination of that “next” button, so different users may go to a different page when clicking on the “next” button on the same page and when you revisit a page the “next” button on that page may take you to a different page than the previous time (but that can be confusing). Of course direct guidance can also be more subtle. Apart from buttons that clearly lead to a tour other links on a page may also have adaptively determined link destinations. You may have the impression that there is a lot more navigational freedom than is actually the case, because links may not lead to where you think they do

- **Adaptive link sorting**: This technique first selects the most relevant pages based on the users’ interests or goals, then sorts them based on their relevance, finally presenting them to the users as an ordered list of hypertext links. The most relevant link is always presented first, but if the user is not happy with this link for some reason, he or she can try the second and the following suggested links [14], [40]. However, this technology has two problems (i) it is hard to use for indexes and content pages, and (ii) it cannot be used with non-contextual links and maps. The order of links may also change frequently as the user visits pages, possibly contributing to a user’s disorientation [13]
- **Adaptive link hiding guidance** ([14], [13], [40]): means that links that are not considered relevant for the user (at a specific time) are hidden, disabled or removed in some way. Link hiding means that the link anchor cannot be seen as being a link anchor. When the text on a page is black, a black link anchor not underlined, looks just like plain text. If the link is still there many browsers will show a special cursor when the mouse pointer is moved over the anchor. The link can also be disabled [40], meaning that the anchor text is no longer a link anchor. On the web this is easy to realize by removing the anchor tag. However, that performs hiding as well as disabling. It is possible to use font colour and optionally underlining to make the anchor still look like a link anchor, but this is seldom done because it is frustrating for users to see link anchors that do not work as links. Adaptive link removal [14] means that the anchor text (for undesired links) is removed, thereby automatically disabling the link as well. Link removal can easily be done in a list of links, but not in running text because removing words from the text may seriously alter its meaning and also disrupt the reading process (especially if sentences with words removed are no longer valid sentences). When asked in an informal setting a large majority of users has indicated that they preferred links in a list to be annotated or “hidden”, but not removed
- **Adaptive link annotation** ([14], [13], [37], [79]): is the most popular link adaptation technique. It is the least restrictive technique: all the links are accessible. Annotations are used to indicate how interesting the link is for user, at the time of reading the page containing the link. Many systems use some kind of icon in

front of or behind the link anchor to indicate the relevance of the link. Since the Web has been extended with style sheets it has also become possible to use the colour of the link anchor itself as an annotation. This is not without drawbacks: some users are so used to links on the Web being blue or purple that they do not recognize words in other colours as being link anchors

- **Adaptive link generation**: goes one step further and not only generates link destinations but the link anchors as well. There are many ways in which the system can decide to create new links. In open hypermedia all links are always generated. This is done by matching text on a page with a database of links. Adaptive link generation can also be based on the discovery of similarities between (the topics of) pages. This is certainly adaptive if it is done in pages from an open corpus of documents. The list of links that result from a search request in information retrieval or filtering systems is also adaptively generated
- **Map adaptation**: In order to give to the user an idea of the whole hyperspace, and some orientation support regarding where the user is in this space, many applications offer some kind of map. Websites often offer a textual sitemap, mostly because this is easy to generate. A graphical map, preferably based on conceptual relationships rather than link relationships, is a better tool for giving insight into the application's structure. However, maps are often too large to be insightful. A map can adaptively be reduced so that you can still grasp the overall picture. Nodes on the map can also be annotated to indicate relevance, to indicate where the user has gone before, and perhaps even to indicate where other users have gone.

Structure

It is also possible for an adaptive system to modify the long-term structure of the website in a "permanent" fashion, rather than the per-request temporary fashion suggested above. Usually, the final decision to add or remove a page or atom should be ultimately made by some human administrator, but the indication of whether it should be added or dropped can be made by the system. In this way, the adaptive system can be viewed as a tool to help the administrator measure the effectiveness of a website.

Several indications may be given by the system, including:

- **New index pages**: Based on the perceived common viewing patterns of a group of users, the system might suggest new index pages which capture links which serve as a central point to support that group [68]
- **Measurement of use of a set of pages**: By generating statistics about commonly viewed pages and subsets of pages, the administrator will be more informed about whether the viewing pattern matches their expectations. Pages which should be included

in some groups might actually be omitted, indicating that those pages are incorrectly promoted or linked, for example

- **Permanent new link suggestions**: The system might suggest that certain links between pages be made permanent for similar reasons to the suggestion above that they be added for individual page views.

While the adaptation of links might also be seen as the adaptation of the structure of a website, such adaptations are of a short-term time period and have little lasting impact on the website beyond an individual browsing session. Also, normal, short-term adaptations cannot change the form and structure of image maps, which would require a human administrator to accomplish [13].

2.2.2 Adaptation Techniques

The techniques available to collect information about users and the methods used to process such information to create user profiles and provide adapted content, presentation and/or structure, are varied. Most web personalization techniques fall into four major categories: content-based filtering, collaborative filtering, rule-based filtering and web usage mining. A brief description of the aforementioned techniques and methods are provided in this section.

Content-based filtering

Content-based filtering systems recommend items to users (such as content, services, and products) like the ones they preferred in the past. Content-based methods analyze the common features among the items a user has already rated highly. Only the items similar to user's past preferences are then recommended. In other words these systems are solely based on individual users' preferences [27], as they use correlations between the content of the items and the user's preferences in order to build the user model and adapt to the individual user. All of the content-based approaches represent items by the "important" words in the items.

Content-based filtering is a technique that has been used mainly in the context of recommending items such as books, web pages, news, etc. for which informative content descriptors exist [66], [7]. An example of a content-based filtering system is NewsWeeder [44]. In the case of NewsWeeder the user provides active feedback by rating articles on a scale of 1 to 5. The process of building a profile for a user requires the transformation of each article into a bag or words representation, with each token being assigned a weight using some learning method [57]. With this way the content of the article is represented with a set of terms. The system uses then this profile in order to recommend articles to the user. Another example, in the context of an online museum, is the following: if a user shows an interest in paintings of a particular style or period, or by a particular artist, links to other related pictures are presented [10].

Content-based filtering systems build an individual model of user likes and dislikes and use this profile to predict/tailor future interactions with that user. The major disadvantages of this technique are content limitations and over-specialization. The content limitation weakness is related to the fact that the system depends on the availability of content descriptions of the items being recommended [57]. But IR (Information Retrieval) methods that are used for the creation of content descriptions can only be applied to a few kinds of content, such as text and image and furthermore they can only capture certain aspects of the content [33]. Concerning the over-specialization issue, the provided recommendations are merely based on individual user profiles; therefore, users have no chance of exploring new items that are not similar to those items included in their profiles [33]. This lack of serendipity leads to over-specialization.

On the other hand the advantage of this approach is that it can be implemented on the client side, resulting in reduced worries about user privacy [57].

Collaborative filtering

Collaborative filtering systems invite users to rate the objects or divulge their preferences and interests and then return information that is predicted to be of interest to them. These systems make automatic predictions (filtering) about the interests of a user by collecting preferences from many users (collaborating) and then recommend items to the user that people with similar tastes and preferences have liked in the past. The basic idea underlying collaborative systems is that the adaptation is based on the experiences of a population of users, rather than on an individual user profile. This is based on the assumption that users with similar behaviour (e.g., users that rate similar objects) have analogous interests and that those who agreed in the past tend to agree again in the future.

Collaborative filtering systems usually take two steps:

- Look for users who share the same rating patterns with the active user (the user who the prediction is for), i.e. for users that have provided similar feedback to a large number of the items that have been consumed by the active user. This group of users is called the neighbourhood of active user, in collaboration filtering terminology.
- Use the ratings from those like-minded users found in the first step to calculate a prediction for the active user. Items that have been consumed by likeminded users but not by the current user are candidates for recommendation.

A typical example of the use of this technique is Amazon (http://www.amazon.com), which determines a user's interests from previous purchases as well as from ratings given to titles [47]. The user's interests are compared with those of other customers to generate titles that are then recommended during interaction. Other examples of systems that incorporate collaborative filtering techniques are GroupLens [71], Ringo [75] and Net Perceptions [63].

In contrast to content-based filtering, the collaborative filtering technique does not use the actual content of the items for recommendation [33], and hence it overcomes the drawbacks of the content-based filtering that have been mentioned in the previous section. Nevertheless, a collaborative filtering system suffers from two major disadvantages: the new item rating problem and the new user problem. The first problem is related with the system's inability to provide recommendations or predictions for new or recently added items. This inability comes up because of the reliance on the availability of ratings for any item prior to it being recommendable. In other words a user's rating on a new item cannot be compared with the ratings of other users on the same item [62]. The new user problem on the other hand, is related to the fact that a new user needs to rate a number of items before he can start to obtain useful recommendations from the system.

Rule based filtering

Rules-based personalization is the delivery of personalized content based on the subjection of a user's profile to set rules or assumptions [26]. The rules are used to affect the content served to a particular user, based on relationship analysis. Rules-based personalization systems use business logic embedded in conditional (if/then) statements to create content display. Under rules-based personalization, a user's known preferences fulfil certain criteria, and corresponding content is served accordingly. A system administrator typically uses a visual interface to input if/then criteria, specifying each condition and the content which should be recommended in response. These rules can be straightforward and simple, like a single keyword, or balanced and complex (equal weights) using multiple keywords and boolean operators.

For example, association rules could explicitly encode the fact that users who visit two pages may also be likely to be interested in the third related page. More concretely, an interest in albums of Scorpions and Pink Floyd could potentially demonstrate a general interest in rock. Examples of systems that belong to this category are Yahoo!'s personalization engine [52] and Broadvision [12].

This kind of personalisation presupposes the existence of rules, which constitutes an inherent drawback of the specific approach, as manual creation of rules is time-consuming and their creation depends on users knowing in advance the content that interests them. This drawback has been partially outreached by using automatic rule extraction. For instance, geographical locations can be derived from IP-addresses. Such rules can consequently be used when filtering or adding certain elements from or to the set of returned information. On the other hand the primary benefit of this approach lies in its ability to directly link organizational strategy or policy to customer interactions.

Content-based, rule-based, and collaborative filtering may also be used in combination, for deducing more accurate conclusions.

Web usage mining

Web usage mining techniques rely on the application of statistical and data mining methods (e.g. association rule mining, sequential pattern discovery, clustering, and classification) to the web log data, resulting in a set of useful patterns that indicate users' navigational behaviour. These patterns are used in order to predict user behaviour and provide personalized experience while users interact with the Web.

Web server logs provide an abundant collection of data, by recording interactions of users with the website, in other words, by recording the way that the website is used. This collection of data may be described in terms of simple page views, transactions (which are "significant" events, and may combine multiple page views), and sessions (which are a combination of page views or transactions that together represent an individual users' experience) [23]. In addition to the simple sequence of events, information about time of access and frequency of access is also useful. User's interests can be identified from the pages they visit and the amount of time they spend on them. Revisiting a certain page and spending more time on it may be considered for example as an indication of strong interest in that page [45].

A typical example of the use of this technique is the WebPersonalizer system [58]. It provides a list of recommended hypertext links to a user while browsing through a Web site, by relying solely on anonymous usage data provided by web server logs and the hypertext structure of a site. Other noteworthy applications are Alta-Vista, Lycos, WebSift, and SpeedTracer [27], [69].

Web usage mining has several advantages over traditional personalization techniques [61]. For example, it can dynamically develop user profiles from user patterns while reducing the need to explicitly obtain subjective user ratings or registration-based personal preferences, which are prone to biases [77]. With this way the system performance does not degrade over time as the profiles age. Additionally, traditional web personalization techniques, including collaborative or content-based filtering, have the problem of reliance on subject user ratings, which doesn't exist in web usage mining.

On the other hand web usage mining can be problematic when little usage data is available pertaining to some objects or when the site content attributes of site must be integrated into a Web mining framework and used by the recommendation engine in a uniform manner [60], [59].

3 Related research groups and systems

In this chapter research groups that have as primarily area of interest that of adaptivity and personalization are presented. Also a number of implementations of adaptive systems by each research group are given. This information will enable governments to find the experts and expertise they need when developing an e-participation project with personalization and adaptivity issues.

3.1 Information Systems Group - Eindhoven University of Technology

http://www.win.tue.nl/dh/doku.php

The Information Systems Group of the Department of Computing Science of the Eindhoven University of Technology, expertise on technologies that are used to build modern information systems: databases, to store and manage information, and hypermedia, to provide access to the information. Since 1996 the group focuses on adaptive interfaces for multimedia information disclosure. Almost all information sources contain a wealth of information of which each user only wishes to view a small part. Adaptation, or automatic personalisation, must ensure that each user is guided (automatically) to the part that is relevant to him/her. Adaptive hypermedia is studied by the Information Systems Group at both the conceptual and the practical level: the former is done through the study of the Adaptive Hypermedia Application Model (AHAM), the latter through the development of the Adaptive Hypermedia Architecture (AHA), a general-purpose web-based adaptive hypermedia system.

The AHA [11] system is aimed at being a generic adaptive system which can be used for a wide variety of applications. It uses a user model which tracks the level of knowledge of particular concepts and uses that to decide if particular page fragments or links should be displayed, altered, or omitted. Each concept (which can also be described as an interest or preference) has a boolean value, which represents 'understood/ not understood' (or 'interested/not interested', or 'preferred/not preferred'). A user's familiarity with concepts is drawn either from a test (or questionnaire) or by analyzing which pages they have viewed (pages may indicate that by reading them, the user understands a concept).

Pages are divided up into fragments, each wrapped with hidden, commented sections which are surrounded by 'if-then-else' clauses with the concept(s) that must be understood in order to view that section. Entire pages may also have dependencies, which indicate which concepts must be understood in order to view the page at all.

Links are also annotated with some indication of whether it is appropriate for the user to follow them, based on whether the page in an external link, or an internal link to a page with understood dependencies.

The AHA server rewrites all URLs to be redirected to itself. In this way, it controls all interactions with the user. The system has intentionally been

kept simple in order to broaden its applicability and create a standard platform for adaptive systems. However, it is limited by the need to explicitly label and annotate all of the pages over which the system is to have intelligence.

3.2 Text Learning Group - Carnegie Mellon University

http://www.cs.cmu.edu/~TextLearning

The Text Learning group is a research group of the School of Computer Science of CMU (Carnegie Mellon University). Its goal is to develop new machine learning algorithms for text and hypertext data. Applications of these algorithms include information filtering systems for the Internet, and software agents that make decisions based on text information. As part of their work they have developed two adaptive systems: WebWatcher (http://www.cs.cmu.edu/~webwatcher/) and Personal WebWatcher (http://kt.ijs.si/Dunja/pww.html).

WebWatcher [37] is a software agent built into the website of the School of Computer Science of Carnegie Mellon University (CMU). It works as a tour guide for the Web and has three main features:

- It is familiar with the structure of the website, which includes the contents of each web page and links among the pages
- The agent can interact with users using natural language
- It learns by observing the actions of users. The more knowledge about users it has, the higher quality of recommendations it could provide

Once the system is activated on the front-door page of CMU School of Computer Science, some WebWatcher commands are labelled on the top of each web page along with relative links listed at the middle of the page. Also, the hyperlink URL in the original is switched to a new one that points to the WebWatcher server directly. No matter whether the recommended links are chosen or not, the system accompanies the user to next page and watches user's action through user's shoulders to provide recommendations. The recommendations are based upon expertise gained by the system by analyzing user actions, statements of interest, and the set of pages visited. Aside from this, WebWatcher could help users to search relative pages quickly.

WebWatcher performs content and navigation adaptation. It speeds up users' search and helps them to avoid being lost in hyperspace. In addition, it attracts users as well. Studies conducted by the Text Learning Group have suggested that WebWatcher could achieve close to the human level of performance on the rather difficult problem of predicting which link a user will follow given a page and a statement of interest.

While WebWatcher gives tours to many people (over 8,500 thus far), and learns to become a specialist at a particular web site, Personal WebWatcher in contrast, stays with a single user, becoming a specialist in that user's interests. Personal WebWatcher is a "personal" agent that accompanies users from page to page as they browse the web,

highlighting hyperlinks that it believes will be of interest. Its strategy for giving advice is based on feedback from earlier tours.

Personal WebWatcher is mainly inspired by WebWatcher, but unlike WebWatcher, this system is structured to specialize for a particular user, modelling her/his interests. It “watches over the users shoulder'' the similar way WebWatcher does, but it avoids involving the user in its learning process (it doesn't ask the user for any keywords or opinions about pages). It solely records the addresses of pages requested by the user and highlights interesting hyperlinks. In the learning phase (typically during the night), requested pages are analyzed and a model of user interests is generated/updated. This model is used to give advice for hyperlinks on retrieved HTML-pages, requested by and presented to the user via Web browser.

3.3 Intelligent User Interfaces group - University of Torino

http://www.di.unito.it/~seta/index.html

The activities of the Intelligent User Interfaces group of the Department of Computer Science at the University of Torino, concern the design and development of intelligent systems, mainly based on distributed architectures, and exploiting Internet technologies. Particular attention is devoted to the definition and application of advanced techniques for improving the interaction with the users.

One of the most well-known adaptive systems that have been designed and developed by this group is SeAN [3], a server for adaptive news. It is an adaptive system for the personalized access to news servers on the Web. SeAN provides not only personalized news topics that match a user’s interests, but also adaptive detail level of each news item. This capability makes it different from other approaches in the literature.

In SeAN, news items are classified according to an a priori hierarchy of topics, and stored in a news database. Each news item is separated into several complex composite entities, associated with a few attributes that define their components. This structure enables the system to provide a different detail level of information to users with different knowledge and background. Advertisements are stored in an advertisement database and each advertisement has two associated attributes: a target, which is what kind of user it is aimed at; a topic, which is what section of news it is associated.

User profiles are stored in a user database. A user model is divided into four dimensions: interests, expertise, cognitive characteristics, and life style, each of which corresponds to different conceptual characteristics of a user.

Stereotypes are used for initializing the user model for a user. A stereotype profile contains information about its members, which is a set of values for the user features and the probability that a user having this value for this feature matches this stereotype. According to a registration form containing a small set of questions, the system can calculate the probabilities of a new user belonging to different stereotypes by using Bayes’ theorem. Then, based on the characteristics of different

stereotypes and the probabilities that the user may belong to these stereotypes, the system can finally predict the user's characteristics by again using a Bayesian algorithm. The user model is dynamically maintained according to the user's behaviour, based on user modelling update rules pre-set by the system.

Content adaptation is used for providing adaptive news in SeAN. All pages are generated dynamically, including the home page. Users with different interests and expertise may reach different topics with different detail levels. In order to avoid confusing a user by changing the page content, buttons such as "add" and "delete" can be provided for the modification of the choices made by the system. Users may reconstruct their news pages if they like, and these actions explicitly provide useful feedback to the system.

3.4 The Knowledge and Data Engineering Group (KDEG) - Dublin University

http://kdeg.cs.tcd.ie/

Knowledge & Data Engineering Group is a research team of the School of Computer Science and Statistics, of the Ireland's Dublin University. Knowledge driven adaptive systems is one of their major research themes. They examine how knowledge driven techniques and methodologies such as knowledge elicitation, semantic interpretation and knowledge representation can be used in order to support and provide information to adaptive systems. This information is used subsequently by the adaptive systems as input in order to alter the behaviour and appearance of the system.

The group has also pioneered composition tools for constructing adaptive hypermedia and adaptive services, mainly in the e-learning domain and has published heavily in the area of Adaptive Hypermedia composition. A key unique aspect of KDEG's research in this area is its integrated and unified approach to adaptive hypermedia and adaptive service composition, supporting the notion of 'intelligent, active content'. One example is KDEG's Adaptive Course Construction Toolkit (ACCT) [24] which supports the design of adaptive (personalizable) e-learning designs. A second composition tool for adaptive hypermedia is ACT-Sim which supports the composition of adaptive simulations. This adaptive simulation composition environment is being developed as part of the ADAPT project (http://www.empowertheuser.com/), an Ireland project that KDEG participates. Within this project the tool is trialled with the Department of Psychiatry (TCD) to compose adaptive virtual interviews with mentally ill patients. Besides ADAPT, the group has been also involved in EU-funded research projects, associated with its research interests, including iClass (http://www.iclass.info/iclass01.asp), EASEL (ftp://ftp.cordis.europa.eu/pub/ist/docs/ka3/eat/EASEL.pdf) and ELEKTRA (http://www.elektra-project.org/).

3.5 Web Technologies Lab - University of Nottingham

http://www.cs.nott.ac.uk/Research/webtech/

The Web Technologies Lab (WebTech) is a research group within the School of Computer Science and Information Technology at The University of Nottingham, UK. The group is very active in the research areas of adaptive hypermedia and personalization of content, with an emphasis in the e-learning domain. Ongoing work of the group covers the interoperability of adaptive hypermedia systems, as this is now a major stumbling block for widespread use of these systems. Interoperability of authored materials as well as of user models is covered.

The WebTech group has designed and developed WHURLE (Web-based Hierarchical Universal Reactive Learning Environment), an experimental adaptive learning environment and educational content management system. WHURLE is an attempt to address the failings of current static, ill conceived learning environments with one that is pedagogically effective and adaptive to learner needs. It is a hypermedia-rich educational tool, suitable for all subjects, that seeks to address the pedagogical limitations of existing commercial Virtual Learning Environments. A unique feature of WHURLE is that it can change the user model used, as it is not a 'hard-wired' part of the system, but rather a component that can easily be interchanged. WHURLE has been used with many types of students, from secondary schools to those in Higher Education.

3.6 Software Agents Group - MIT

http://agents.media.mit.edu/index.html

The Software Agents Group of the MIT Media Laboratory investigates computer systems to which one can delegate tasks. Software agents differ from conventional software in that they are long-lived, semi-autonomous, proactive, and adaptive. The primary focus of the group is to create software that acts as an assistant to the user rather than a tool, learning from interaction and proactively anticipating the user's needs.

With this goal in mind, the group has designed and developed an agent that acts as a user's assistant in browsing the World Wide Web, Letizia [45]. Letizia's approach is to consider the search for information as a cooperative venture between the human user and an intelligent software agent. Rather than search a pre-indexed portion of the Web according to user-stated keywords, the agent infers interest implicitly from observing user actions and tries to stay just a few steps ahead of the user, searching for immediately accessible links dynamically.

More specifically, Letizia tracks a user's selections in a Web browser and does a "reconnaissance" search to find interesting pages in the neighbourhood of the currently viewed page. In this agent, it is analysis of the user's history that provides the context for anticipating what the user is likely to want next. Letizia shows that there is a valuable role for a software agent in helping the user to identify intersections of past context

(browsing history) with current context (the currently viewed Web page and other pages a few links away from it) [46].

3.7 Personalized Adaptive Web Systems Lab - University of Pittsburgh

http://www2.sis.pitt.edu/~paws/index.html

Personalized Adaptive Web Systems Lab (PAWS Lab) was established in 2004 with support from National Science Foundation and School of Information Sciences (University of Pittsburgh). The goal of the PAWS Lab is development and evaluation of innovative user- and group-adaptive Web-based technologies, systems, and architectures. The Lab currently explores a range of user modelling, adaptation and personalization technologies. The Personalized Adaptive Web Systems Lab is directed by Peter Brusilovsky (http://www2.sis.pitt.edu/~peterb/), a guru in Adaptive Hypermedia, Adaptive Web-based Systems and Adaptive Interfaces with more than 70 publications in this area.

Brusilovsky has been involved in the design and development of more that fifteen adaptive systems, most of them addressing the e-learning domain, including for example InterBook [15], Knowledge Sea [18] and NavEx [83]. The most well known system is ELM-ART [78], an intelligent learning system that can be used in the context of practical Web-based education. ELM-ART is an intelligent interactive educational system, with the aim to support learning programming in LISP. ELM-ART provides all learning material online in the form of an adaptive interactive textbook. Using a combination of an overlay model and an episodic student model, ELM-ART provides adaptive navigation support, course sequencing, individualized diagnosis of student solutions, and example-based problem-solving support. The system demonstrates how some interactive and adaptive educational components can be implemented in WWW context and how multiple components can be naturally integrated together in a single system.

3.8 Human Computer Interaction (HCI) Group - University of Minnesota

http://www.cs.umn.edu/research/research_areas/human_comp_interaction.php

The Human Computer Interaction (HCI) Group belongs to the Department of Computer Science and Engineering (CSE), of the University of Minnesota. Their research focuses on developing more effective methods for humans to interact with and use computer technology. The group specializes in interfaces that help groups of people work together more effectively. Research efforts include developing algorithms and interfaces for handheld devices to aid coordination in space and time, and in applying social science theories from economics and social psychology to the development of community web sites. The group also specializes in recommender systems with a long history in the development and analysis of algorithms, interfaces, and user applications.

Most of the system developed in HCI research group, focus on collaborative filtering and its integration into various applications. An example of such a system is MovieLens [56], a typical collaborative filtering system that collects movie preferences from users and then groups users with similar tastes. Based on the movie ratings expressed by all the users in a group it attempts to predict for each individual their opinion on movies they have not yet seen.

This group has showed very good results concerning the exploitation of their research. John Riedl (http://www-users.cs.umn.edu/~riedl/), a professor of computer science at the University of Minnesota, is a pioneer in commercializing collaborative filtering, as he is the co-founder of Minneapolis-based Net Perceptions Inc (http://www.netperceptions.com). Net Perceptions has developed a toolkit which enables on-line information, product, and service providers to craft personalized experiences for visitors to their sites. An on-line bookstore, for example, can adapt to each user's tastes by providing personalized recommendations and by organizing its content to match the user's preferences.

4 Applications of the technology

We present here the applications of the technology under discussion, which can be considered more in line with the e-participation aims and scope. The investigation of adaptivity and personalization applications forms the basis for sketching potential application scenarios for e-participation, as useful insights, ideas and lessons learned can be obtained. The first and foremost application of adaptive and personalized systems is education, where the navigational freedom of hypermedia was introduced into the area of intelligent tutoring systems. But since then applications in the domain of news' provision, e-commerce and e-government have been realized.

4.1 Education

Adaptive systems are used widely in the education domain in order to alleviate the difficulties of content comprehension and orientation. Adaptation can be defined as providing a different response based on the different characteristics of the receivers of the response. In the education domain and more specifically in an e-learning platform, the receivers are the users (mainly learners and tutors) of the platform who require adaptation to have an efficient learning process based on their individual particularities [73]. The use of adaptive presentation and navigation has proven effective since learners using such systems have demonstrated faster learning, more goal-oriented attitudes and take fewer steps to complete a course [21].

A representative application of adaptivity and personalization in education is the ALFANET (Active Learning For Adaptive interNET) IST Project [73]. The system produced by this EU-funded project allows individuals to have an interactive and adaptive online learning, supported by effective and efficient educational models, bringing them the opportunity to learn on those matters that are relevant to perform and improve their work. Adaptation in ALFANET is not only user-centered, but adaptation based on the context is provided as well [73], while the context of the course is built from the analysis of the interactions done by learners. This system adapts to learners and tutors in three ways:

- Adaptation by the Instructional Design: At design time each course is defined according to an instructional design. At this stage, the author of the course has the opportunity to define different learning routes for different types of users. This type of adaptation is specified at design time
- Adaptation of the Interaction. The system supports user's interactions with recommendations derived from other related users by recommending something that have been useful to other learners with similar learned profiles and in closely related learning situations [72]. In other words ALFANET provides adaptive and personalised educational services to learners by providing them

new information (in terms of dynamically generated web pages) according to the individual and collaborative user's needs

- Adaptation of the Presentation. The user interface is adapted depending on each learner's user model

Another representative application of the technology of adaptivity and personalization in education is the ActiveMath system [54], an innovative third generation e-learning system for school and university level learning as well as for self-study, which offers new ways to learn mathematics. ActiveMath resembles a book that adapts to the goals of the individual learner, to her/his competencies and to how she/he feels, i.e. a book that offers interactive tools to deepen the mathematical knowledge, a book that talks with the learner about her/his achievements and current competencies. The ActiveMath system adapts to the learner and learning context and comprises personalization, student modelling and tool-supported active and exploratory learning.

The approach followed by ActiveMath is based on the fact that every learner is different, and even the same learner will have different goals in different learning sessions. Therefore, the system offers dynamically constructed courses that suit the learners' goals, preferences, and knowledge. The presentation tools of ActiveMath include a course generator and pedagogical rules employed by the course generator [55].

More adaptive education systems, as well as a comparison between them can be found in [17], where an extensive review of these systems is presented.

4.2 Business and Commerce

Several e-commerce Web sites that recommend products or services to customers depending on their behaviour have emerged during the last years. A representative example of such a site is Amazon [2]. When a customer is visiting the part of the electronic catalogue concerning a book of his/her interest, or buys a book, the recommendation engine of Amazon recommends other similar books to him/her. The recommended books are those that are frequently purchased by other customers who purchased the selected book. This feature that is presented to the front end of Amazon's portal through the title "Customers Who Bought This Item Also Bought" is based on collaborative filtering techniques. Another type of personalization offered by Amazon is content-based, as the recommendation of books is based on customer's owned items, i.e. on books that the customer has purchased in the past.

Other Web sites offer similar items or correlated items features to suggest items closely related to those in the shopping cart. Reel.com for example [70], a web site about movies, provides movies recommendations on the information page for each movie. The recommended movies are strongly related with the initial selected movie, in terms of theme, genre, cast, e.t.c. According to the degree of similarity, the "matched" movies are categorized into "close matches" and/or "creative matches." Figure 3

depicts for example the recommendations made by the site, when information about the “The Prestige” movie has been acquired.

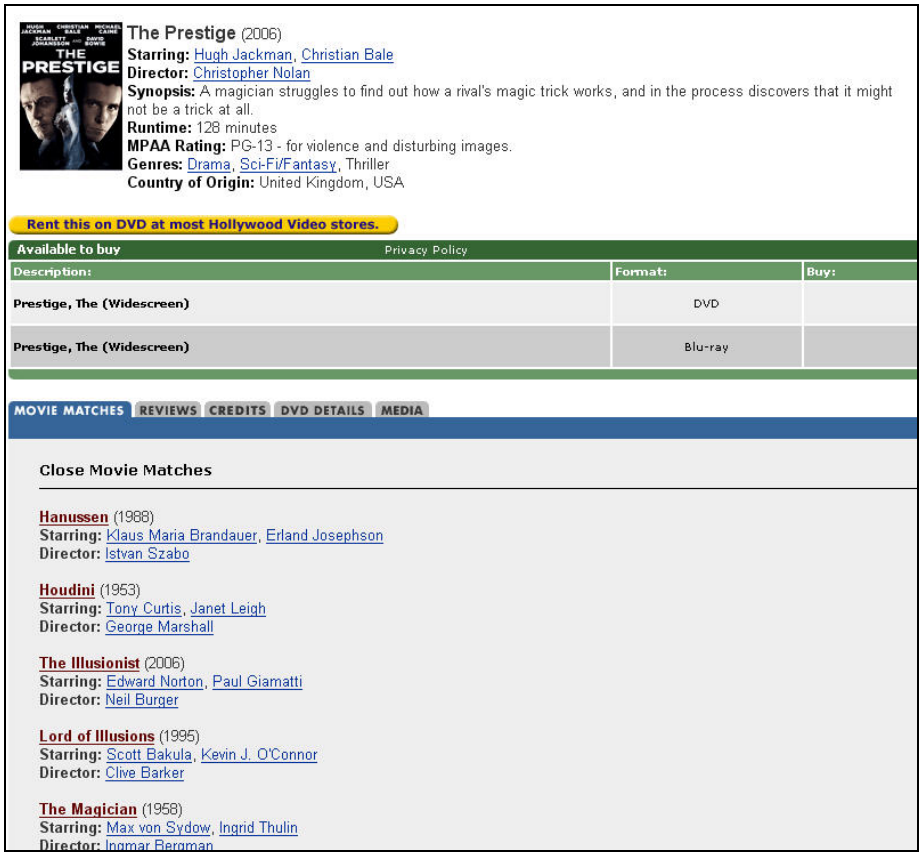

Figure 3: Close Movie Matches on www.real.com

Other examples of commercial products that are adopting personalized features, are Yahoo!’s personalized Web portal [82] and Google Lab’s personalized search [34]. In Yahoo!’s personalized Web portal, users can choose what they want to see, like email, news, weather, stock prices, sports scores, TV and movie listings, and much more. It's like having an assistant to bring you your favourite sections of the newspaper and tell you about your mail and appointments for the day. Google’s personalized search delivers personalized search results based on what users searched for on Google and which sites they have visited. With this way users get more relevant and useful search results and recommendations.

4.3 News

Nowadays, people can spend more time sifting through potential online news, than they do absorbing the material that actually interests them, due to the increasing number of the available information sources (e.g. electronic newspapers, news servers, press agencies). A range of adaptive systems have been used over the last years in order to address the aforementioned problem. These kinds of adaptive systems provide a personalized access to news and help individuals to find the most

interesting or relevant news content. With this way information overload is relieved and individuals can spend their time on news material of interest.

Major search engine like Yahoo and Google provide services (Yahoo! News and Google News respectively), that allow users to customize the news categories to be included on their front page, or to indicate topics of interest, which are then used for personalizing the displayed news. This kind of differentiation of system response based on explicit information, characterize such services as adaptable and not as adaptive (see discussion in section 2.1.3 for the definition of each term).

Typical examples of applications of adaptive systems in the news area are SeAN [3], which has already described in section 3.3, and GroupLens [71]. The latter, recommends newsgroup articles based on ratings of like-minded users, by making use of collaborative filtering techniques. Users are asked to rate every article they read, and correlation techniques are used in order to find similar users. An article is then recommended to a user according to the ratings of his affinity group.

Adaptive news applications have been also developed for mobile and ubiquitous environments. A well-known example of this category is WebClipping2 [19]. The main aim of this system is to deliver to specific users, news articles they consider interesting, in a mobile context, without the need for explicit classifications. It uses a Bayesian classifier to select articles of interest to a specific user, according to his profile, based on keywords matching. The articles are extracted from web pages and displayed in a zoom-able interface-based browser on a PDA. The system monitors the users' reading behaviours, from which it infers their interest in particular articles and updates the profile accordingly, in order to cope with the problem of interests' change.

4.4 E-Government

In most e-Government projects to date, technology was in the centre of the project and not the user, although the user, e.g., the citizen or business person, is the one who shall in the end use all the new and exciting online e-Government services [74]. Since citizens pose different access possibilities, skills and motivation, service delivery should be tailored to the widest possible end-user population, a requirement that is very closely related with the notion of e-participation. Organization of public e-services in a way that serves every citizen individually can drive e-government initiatives into success. This adaptivity means that all citizens have access to the public services in a manner which is enabling and satisfying.

Although some personalization features - like the structuring of portals and services according to the life event approach - can be found in some e-government portals, advanced personalization facilities are lacking and furthermore research efforts in this direction are limited. An interesting approach on the convergence between e-government and personalization research is the system proposed in [35]. This system makes use of personalization and semantic technologies in order to provide a personalized view of legal information/documents to citizens. The main

idea underlying this research is that some legal documents or some of their parts have a limited applicability only to specific classes of citizens. For example, some articles of a tax-related legal document are applicable only to unemployed persons, some to self-employed persons, some others to public servants only and so on. The system provides a personalized version of the legal document to a citizen, containing only articles which are applicable to his/her personal case, by utilization information stored into his/her profile. With this way the system helps citizens to perform search into huge amounts of legal information in a feasible and timely way.

Another example application of adaptivity and personalization technology in the e-government domain is the EU-funded IST project FIT [76]. The overall objective of FIT is to develop, test and validate a self-adaptive e-government framework based on semantic technologies that will ensure that the quality of public services is proactively and continually fitted to the changing preferences and increasing expectations of e-citizens. The FIT project will specify, develop and deploy a holistic framework and supporting tools for an inclusive and personalized e-government, by enabling continual adaptation of the services to the changing needs and preferences of users, through the application of the semantic technologies. Moreover, it will lay a foundation of a self-adaptive e-government, which automatically discovers deficiencies in its functioning and fits itself in order to satisfy ever increasing users' expectations.

Approaches, methods and tools that have been or will be developed in the FIT project that is still running, and will be validated in three e-government portals of three European countries, are a very useful source of ideas for the development of e-participation application scenarios of adaptivity and personalization.

5 E-Participation Application Scenarios of the technology

Adaptivity and personalization technologies appear not to be very much used in e-participation projects to date. Nevertheless, by analysing the "Participation" areas described in the DEMO-net deliverable 5.1, we will provide some possible application scenarios of adaptivity and personalization technologies in e-participation and we will show the significant potential that these technologies can possess to the engagement of citizens, to the strengthen of citizenship and public-involvement at the national, regional, and local levels.

Some of the participation areas (cf. D5.1), in which adaptivity and personalization could come into consideration, are shown in table 1:

e-Participation Area	Description
Information Provision	ICT to structure, represent and manage information in participation contexts
Community Building	ICT to support individuals come together to form communities, to progress shared agendas and to shape and empower such communities.
Consultation	ICT in official initiatives by public or private agencies to allow stakeholders to contribute their opinion, either privately or publicly, on specific issues
Deliberation	ICT to support virtual, small and large-group discussions, allowing reflection and consideration of issues
Mediation	ICT to resolve disputes or conflicts in an online context
Spatial Planning	ICT in urban planning and environmental assessment
Campaigning	ICT in protest, lobbying, petitioning and other forms of collective action (except of election campaigns)

Table 1: Participation areas relevant to adaptivity and personalization

5.1 Information Provision

The information provision participation area is strongly related with the first level of e-participation (e-informing), as it has been defined in D5.2. E-informing aims at providing the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities, solutions as well as in gaining insights of the political systems and the deliberations. Major stakeholders need access to background information and issues on the political agenda, like technical and legalistic information, in order to be able to discuss and participate. This is more relevant to participation exercises that are close to the draft

policy stage, as higher demands on citizens' ability to understand technical and legalistic statements exist in this stage [65].

The necessity to fairly deal with different categories of citizens - belonging to both sides of the digital divide, and having different experience and knowledge - claim for the personalization of the information supplied. For that reason the process of making background information suitable for the target audience is a high priority issue. We have identified three possible e-participation application scenarios of adaptivity and personalization, which are related with information provision.

The first application scenario concerns the provision of personalized views of background downloadable documents based on user profiles. Ideas from e-government applications of the technologies, which have been described in section 4.4 can be incorporated in e-participation scenarios as well. For example legal documents and norms can be adapted and each stakeholder can view versions of these documents containing only articles which are interesting for him/her. This idea can be also adopted for the personalization of other types of documents, like technical documents concerning specific deliberation issues or documents describing the policy formation processes.

The second application scenario concerns adaptive and personalized features of the e-participation site that enable the accessibility and understand-ability of the information presented. User's knowledge, expertise, backgrounds and disabilities can be taken into account in order to personalize the presentation of information:

- Information in different levels of detail can be provided to each citizen according to his knowledge about the topic presented, by making use of text fragments adaptivity.
- Help and support information, about the use of discussion forums should be more detailed for users with little knowledge, while experience users should not be bothered with irrelevant information.
- Linguistic versions of the e-participation site can be adapted to individuals depending on their language understand-ability.
- The font size can be varied based on citizens' vision ability.

Such features will encourage full participation of people with disabilities and will bridge the digital divide by ensuring inclusiveness across a diversity of needs. Furthermore such a use of personalized features and services in e-participation sites facilitates the interaction of citizens with the government, hence improving the access to government as well as the satisfaction of citizens. This has as consequence that citizens are more trusting of the e-participation web site, which in turn leads to loyalty. With this way personalization features foster greater citizen interest and involvement in public issues and indirectly drive citizens to engagement with many e-participation features, like e-deliberation, e-petitioning, e.t.c.

A third application scenario is related with the emerging technology of webcasting. Taking into account the emerging trend that a lot of users

prefer to view rather than read information, multimedia tools such as webcasting can be used by governmental authorities for communicating key messages and involving the public. The role of webcasting in e-participation has been investigated in the eTEN EU funded project eParticipate [30]. In addition to traditional web casts, the system that has been developed in this project provides some advanced features. For example citizens can fully control the movement of cameras and can view a textual summary of a meeting, while personal information on the speakers filmed at events is also given.

We believe that interaction with the public using webcasting would be enhanced if personalization technologies are considered. More specifically two levels of personalization have been identified. In the first level the most relevant and interesting streams could be recommended to each citizen, while personalized streams to each citizen, according to his user profile, can be provided as the second level of personalization.

5.2 Consultation, Deliberation

One of the major activities of consultation and deliberation participation areas, include the expression of citizens opinions on specific themes and issues of the political agenda that are affecting them, through various means such as discussions, surveys and polls. Themes and issues of deliberation and consultation are proposed either by public authorities or by citizens. By applying personalization and adaptivity features in the aforementioned participation areas, the themes/issues of deliberation or consultation can be personalized according to citizens' interests, in terms of recommendations of interesting topics/themes to each individual citizen.

This application of personalization is very important especially in large-scale e-participation sites where the overload of deliberation themes could possible discourage citizens' engagement. In this possible application, attention should be given to inclusion of every citizen that wants to participate in the process. In other words, all possible issues and themes that are subject to consultation and deliberation should be visible to everyone, i.e. recommendations should be viewed as a means to increase the timeliness and usability of the process and not as a way to filter out specific citizens' categories.

Adaptive surveys are another possible application of the technologies under discussion. While surveys can be used in many participation areas, the participation area that is mainly supported by surveys is "consultation", as it has been described in D5.2. Surveys are mainly used to research views, attitudes and experiences of participants and are realized as web-based questionnaires, where the e-participation website shows a list of questions, which users answer and submit their responses online. A common problem with web-based surveys is that users are usually reluctant to participate, especially when the time needed to complete the questionnaire, or the number of questions, increase [36].

This problem can be addressed if the list of questions to be given to each participant is not fixed, but composed dynamically from a predefined set

of questions, or if the list of alternative answers for a single question is adapted based on some criteria. This approach which has been realized for measuring the quality of e-government service in [51], can be also incorporated in the context of consultation e-participation area. Criteria for adaptation may include in this case, user profile data such as participant's interests, geographical information, experience and abilities. With this way not only the response rate increases, but also citizens' feedback is targeted, as each citizen is providing feedback for the consultation topics/questions of the questionnaire that he/she is more knowledgeable and interested. In other words citizens with insight and knowledge in a given topic are getting more in touch with decision makers.

5.3 Community building

Forums can play an important role in public dialogue. Communities are built around a variety of topics and citizens participate by contributing ideas that could be very useful for authorities in order to design their policies and make their decisions. Topics or threads of messages, in discussion forums can be recommended to each citizen, in a personalized way, according to his/her previous engagement in e-participation exercises. For example citizens that have participated heavily in threads where privacy issues in traditional offline advertising are discussed, can be invited to participate in discussions about privacy issues in online information systems, as well. Such invitations can be provided either in terms of recommended links or by using the information push communication paradigm. In the latter case citizens can receive updates and alerts (e.g. newsletters, emails) about new threads concerning a topic of their interest.

5.4 Mediation

Mediation is a form of dispute resolution aiming to assist disputants in reaching an agreement. As adaptivity and personalization techniques provide a personalized view of a domain, based on each participant's experience and expertise, their use could be applied for conflict prevention by unveiling concepts and relations whose ambiguity may lead to misunderstanding or dispute or conflict. More specifically advanced and experienced participants should be provided with a coarse-grained detail about concepts and relations, in contrast to participants that need more explanations and disambiguation, where a fine-grained detail level should be given. With this way a better understanding of concepts and relations could be achieved by all participants and dispute and conflict would be mitigated.

5.5 Spatial planning

A possible application scenario of personalization for national e-participation sites is the personalization of engagement concerning spatial planning, based on geographical profiles of participants. Although this application scenario could be relevant for e-participation sites of an urban,

municipal or prefecture scale, national scale e-participation sites that spread large geographical areas are more appropriate. According to this scenario the e-participation site can take into account geographical and location-based data about participants – like their cities, villages, municipalities, geographical areas of interest or even their position in a mobile context - in order to provide a personalized view of issues and themes that are subject to citizens' engagement. This allows the filtering of irrelevant data, and thus the engagement in the process of spatial planning in made more efficient and usable.

An important risk of opening the spatial planning process to the public, is that some private own corporations that do business in the real estate field, will probably try to affect the political agenda or the final decision, in order to increase their profit. By weighting participants' opinions based on their geographical profile, the aforementioned conflict of interest can be mitigated, as the weights that will be attributed to those directly affected by the project, (e.g. habitants or people with strong relations with a specific geographic area) will be bigger.

5.6 Campaigning

The campaigning participation area refers to an organized effort to influence the decision making process. E-petitioning and e-protesting contribute to such an effort. Online petitions/protests allow citizens to sign in for a petition/protest by adding their name and address online. This participation area could be enhanced if personalization and adaptivity technologies are considered. The number and topic of petitions/protests that a citizen has participated can be used in order to build a citizen profile, which encapsulates his/her political interests. This profile can then be used by personalization techniques, forming the basis for inviting the citizen to participate in other petitions/protests of similar content.

Another important possible application of adaptivity and personalization to the campaigning participation area is related to the adaptation of the back office. Handling of citizens' petitions/protests can be assigned to the most appropriate governmental authority, or to the most appropriate public servant, depending on their knowledge, availability and role. A similar approach has been adopted by the FIT project mentioned in section 4.4, where flexibility and adaptivity of the back office has been increased by extending process models by business rules.

6 Conclusions

Adaptive and personalized systems are used in several application areas where the hyperspace is reasonably large and where a hypermedia application is expected to be used by users with different goals, knowledge and backgrounds. E-participation has the characteristics described above, thus it is an application area where personalization and adaptation techniques and systems can be applied.

The impact of adaptivity and personalized technologies in e-participation is two-fold, having direct as well as indirect results. Direct impacts have mainly a qualitative nature while the nature of indirect impacts is mainly quantitative. On the one hand direct impacts are related with the increase of the quality and completeness of citizens' engagement in the discourse with politicians and governments, as the application of personalized techniques offers higher functionality and an optimized usability to e-participation exercises (which are otherwise mutually exclusive attributes).

On the other hand, the provision of personalised support and services to citizens has as prerequisite the availability of deep knowledge about each individual. In this way by using prior interactions and knowledge with/of citizens, long-term and more stable relationships with them can be built. These stable relationships, as well as the increase of citizens' satisfaction attributed to their personalized experience, can leverage the enlargement of citizens' participation though nationals or municipals e-participation sites.

The applicability of adaptivity and personalization technologies to the area of e-participation has been discussed in the context of possible future application scenarios. E-participation programs can be applied in various levels of public administration, such as in a national or municipal level. The higher the level of public administration that the e-participation program is applied, the more applicable the technologies of adaptivity and personalization are. This is true because of the increasing need to address the "one size fits all" problem in a setting of increased availability of information. In other words the information overload, which is the main problem that the technologies under discussion address, is bigger in national than in municipal level. On the other hand e-participation is an emerging area of research and it has been mainly applied in pilot environments at the municipal level of administration. Considering these, we can conclude that adaptivity and personalization technologies have a very big potential for future large scale e-participation programs.

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