

# Towards an Integrated Personalization Framework: A Taxonomy and Work Proposals

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**Abstract.** The paper presents a survey of personalization approaches, ranging from personalized web sites to personalized multimedia video programs. One of the main objectives of this work is to find the common concepts that are shared by existing approaches. The proposals are classified according to different dimensions and properties, namely user interaction and content and presentation management. This taxonomy is used as input to our current work on personalization, described in the last part of the paper. The goal is to define a framework for personalization of interactive multimedia content, that will integrate the different dimensions that we are exploring: annotation, personalization of content and several forms of personalization of presentation, namely for interactive television.

## 1 Introduction

Personalization is a pervasive concept in several areas of interactive multimedia, namely web electronic publishing applications. This is caused by the need to adapt the content and presentation style to the preferences of a given user or set of users. There are different techniques for personalization, ranging from the simplest, that allow the user to personalize a web page, by defining its preferred colors or layouts, to the more complex, where the content is built on the fly, according to the profile of the user [10]. The work presented in this paper is an attempt to classify the numerous systems, models and tools for personalization as a way to identify the common characteristics among all these approaches. The main goal is to define a common framework for building personalized interactive multimedia systems that go beyond current web based electronic publishing paradigms. We are currently working on several aspects of personalization namely shared annotation spaces [1], personalization in interactive TV environments [2] and semi-automatic generation of content. The paper is organized as follows. The next section presents the dimensions and categories that were used to characterize the personalization techniques. Section 3 presents a classification of the systems according to the categories presented in the previous section. Section 4 describes our current work on different aspects of personalization, towards

an integrated personalization framework. Finally, the last section presents conclusions and directions for future work.

## 2 Personalization

Personalization in interactive systems can involve adapting the user interface or adapting the content to the needs or preferences of a specific user. In general, personalization of interactive systems considers these two aspects, sometimes simultaneously:

- Personalization of Presentation: allowing to personalize aspects of the user interface, including colors, position of interface items and fonts.
- Personalization of Content: where the content can be adapted to the needs and preferences of different users. For example, for a news on demand system the user would only receive the news about sports, based on a pre-defined profile. The commercials would also be about sports, but could consider the previous purchases of the user.

Considering these two aspects, we tried to characterize the different ways in which personalization is done in interactive systems. Next we present several categories used to classify the systems.

**Content and Presentation Management:** Comparing the normal, non-personalized, content presented to the user, with a personalized version of the same content, we define two main options: **enhancement** and **configuration**.

We define as enhancement all situations where the personalized content has additional material superimposed to the normal or base content. This kind of personalization is typically associated to continuous media, such as audio or video, where personalization may assume the form of video/audio enhancements or annotations. By contrast, configuration is present when the personalized content is adapted for presentation. This may happen when adapting the presentation layout by changing colors, fonts and positions. One example where configuration happens is when the content has to be adapted for presentation: for example color pictures have to be converted to black and white or HTML content has to be converted to WML (for WAP enabled mobile phones). Additional issues arise when a more complex semantic change has to be made. Examples of this are the generation of summaries from video streams [3,8]. In this case rules are necessary for adapting the content. These rules are based on the characteristics of the medium, such as the narrative and aesthetic properties, and the user preferences.

**User Interaction:** Personalization may take many forms, ranging from the explicit definition of a profile to an automatic process of user categorization based on behav-

ioral analysis. We define personalization according to the interaction that is required from the user as:

- **Explicit:** the user is invited to manually state her preferences, by answering questions that are directly related with the content that is being delivered.
- **Implicit:** the user interacts with the system, expressing her level of happiness regarding the content being delivered.

The two options above are also considered in [7]. Finally, we may have a non-interactive approach, were the user profile is collected automatically by data mining behavioral information taken from access logs or from subsidiary systems.

**Group Personalization:** Personalization cannot be seen only in terms of the individual user. Sometimes, we may assume that, specific content may be of interest to all the users from a given geographical area, age, from the same organization, or that share the same main interests.

## 2.1 Annotation as Personalization

In the next paragraphs the classification above is applied to annotation. Our previous work in annotation [1] and additional approaches provide input to this. This paper puts a special emphasis on annotation because it is a very useful and natural way to enhance electronic media, especially if we consider shared annotations. Also, annotation in digital form can change the traditional paradigms of author and reader in electronic publication, by giving an active role to the usually passive reader. Annotation is the most traditional form of personalization. Even before there were digital media solutions, annotations were done by adding personalized content to books and other types of printed materials. Annotated materials enhance the assessment experience and annotations become part of the content. These principles transposed to a digital media, have been addressed not only using textual materials but also in video and television. An annotation in a video can be almost everything: text, sound, a picture or even another video may be quoted as a note. Next, annotation is characterized in terms of the properties defined previously.

**Content and Presentation Management:** Annotated materials are by definition produced by adding new content to a previously existing source. As such, annotations are always enhancements to the original material. When annotations are already present in the system, a form of configuration may happen: the system filters the annotations that are present to the user, accordingly to its implicit or explicit profile.

**User Interaction:** Digital annotations invite the user to an active participation in the personalization process. An explicit form of user interaction will always be coherent to the active role that user has. Non-interactive rules may be difficult to implement in annotation systems, and only applicable to specific systems where the role of the user in the system is well established. In general, user interaction in annotations is explicit.

**Group Personalization:** Shared annotations are very important, enabling collaborative tasks in user communities. The new content added by an individual could be very important to others of the same social or professional group. Shared annotations, constrained or not by security rules, may be presented to groups of users with similar interests.

### 3 Personalization Approaches and Taxonomy

This section presents several personalization approaches that are characterized according to the properties that we defined in the previous sections. The approaches that are presented were chosen to cover the more relevant personalization systems and techniques. The described systems include the possibility to choose multimedia content [4], the generation of personalized hypermedia information [5,6], the automatic construction of multimedia content [7], web site personalization [8,12], video enhancements [9], a personalized TV information system [10] and a personalized library for active learning [13]. Each of the systems is briefly described and then characterized in terms of the properties that were presented in the previous section.

**Personal DJ [4]:** The expected upcoming of new kinds of portable multimedia devices, like the audio wearable computer, will give a new strength to the research efforts in personalized audio. Half way between the user controlled CD player and the DJ mediated radio broadcast, there is the personalization of audio content. User interaction with radio like devices is normally processed using some sort of station/genre selection and in a system like Personal DJ, a fast forward button is used to advance to the next song. This feedback from the user, coupled with some poll information provides a first level of profile adaptation.

- Content and Presentation Management: Configuration. The personalized content is a subset of all the possible content, i.e. music, available for delivery.
- User Interaction: Implicit. This medium is excellent for implicit interaction. The user interaction (advance to the next song) may be used to infer the adequacy of the user profile to his level of "happiness" with the songs being selected.
- Group Personalization: Not described. A system like personal DJ seems to be targeted to individual preferences. Anyway, some sort of genre or mood diversity could be injected in the playlist by observing accepted songs played to users with a similar profile

**HERA [5]:** The authors defend the automatic generation of hypermedia over semi-structured data as a more effective way of delivering information to users as opposed to the approach normally taken in legacy systems based on strongly structured data. The presented system, HERA, accesses collections or libraries of digital semi-structured data and try to derive a hypermedia presentation that is adapted to the users situation. The prime goal is that the derived presentation "adds value" based on knowledge about the data, the user and the application itself. The generation process starts from XML data that represents the query result. This data is then taken by a

"presentation manager", the software responsible for the actual presentation in the user browser.

- Content and presentation management: Enhancement. The main purpose of the system is to provide additional information (enhancements) to an original query result. These additional information results are presented as optional links in the generated hypermedia presentation.
- User interaction: Non interactive. The system builds a presentation based on a query, and this query may be expressed implicitly or in an explicit form. The personalization is performed automatically not involving any form of user interaction.
- Group personalization: Not described.

**PERSIVAL [6]:** PERSIVAL is a system that uses personalization to improve the search capabilities of an healthcare information infrastructure. In healthcare settings, patients may need access to online information that can help them to understand their medical situation while physicians need information that is clinically relevant to an individual patient. A patient or physician query is augmented with important information taken from the patient record and then is processed by a multimedia search engine. The final result takes the form of a multimedia presentation, where textual summarization is produced with references to relevant articles and video data (segmented and presented as a storyboard).

- Content and presentation management: Enhancement. The basic query performed by a patient or physician is augmented and the result is an hypermedia presentation assembled by the system.
- User interaction: Explicit (medical record). This is a domain where explicit interaction works well. The medical record already exists, and contains all the required information the system needs to create a personalization profile.
- Group personalization: Yes. The group personalization features are implicitly present, when the system provides information that is relevant to a group of patients or specialists.

**Personalized TV News programs [7]:** Merialdo et al. discuss personalization in the generation of TV news programs. The construction of customized programs will be an important paradigm in the near future, as a result of the development of Digital Television. TV News is a good candidate for this kind of customization, because it is a very successful type of program and the current broadcast paradigm is very rigid. With personalized news, every user would expect to have a TV news program at a time of his choice, with duration and content that specifically matches this user interests.

- Content and presentation management: Configuration. Some elements are removed from the original presentation (content configuration) and the ordering of topics in the presentation (layout configuration) is automatically performed by the system.
- User interaction: Explicit and implicit. The duration of the program and main aspects of the user profile are explicitly stated by the user. Implicit personalization is used, enabling profile evolution based on user feedback.

- Group personalization: Not described.

**PROTEUS [8]:** PROTEUS is a web site personalizer system that observes the behavior of web visitors and automatically customizes and adapts the site for each mobile visitor. A personalizer may be associated with one web site or situated on a proxy server and adapt many sites. It can also exist on the browser device and serve only one visitor. A web site personalizer can make frequently visited destinations easier to find: highlight content that interests the visitor or elide uninteresting content and structure. The key information behind web site personalizers is that a great deal of information about visitors is readily available in the form of access logs (at the web site or at an intermediary web proxy)

- Content and presentation management: Configuration. The web site personalizer works at the web-site layout level, in order to improve the web site usability. The personalizer may change a link location or highlight content, based essentially in the analysis of access frequency.
- User interaction: Non interactive. Information about the user is obtained through data mining, namely by the analysis of the web server access logs.
- Group personalization: Not described.

**Enhancements in Digital Sports Broadcasts [9]:** In this system, the personalization is viewed as the possibility of enabling custom enhancements in television broadcasts. These enhancements are provided to the user by exploring additional data sources, supplied by the event organizer or by specialized data providers. The personalization of the digital broadcast, rely on the possibility given to the user to accept the enhancements available.

- Content and presentation management: Enhancement. The main broadcast is enhanced with graphical or textual information obtained from additional data sources.
- User interaction: Explicit. The user accepts or rejects the proposed enhancements, having full control over the "visual purity" of the event.
- Group personalization: Not described. The prototype assumes that the same enhancement data is sent to all viewers.

**PTV [10]:** PTV (Personalized Television Listings Service) is an Internet service that provides personalized TV listings content to over 20.000 users in Ireland and Great Britain. The system is based in a content personalization engine named ClixSmart, developed in the department of Computer Science at University College, Dublin. ClixSmart performs two essential tasks: it monitors the online activity of users (from a given website) and automatically constructs profiles for these users. The user profile information is used to personalize a target website by filtering information content for the target user. The ClixSmart personalization manager employs different content filtering strategies: (1) content based filtering and (2) collaborative filtering. A content-based filtering approach seeks to recommend similar items to the items a user liked in the past, while collaborative filtering recommend items that a similar user also liked.

- Content and presentation management: Configuration. The television listing produced for a user is content adapted to its known interests.
- User interaction: Implicit. The system monitors online activity of users and asks them to rate their recommendations when trying to gather information that can help to build or evolve the user profile. At the moment of registration the system tries to sketch the main guidelines of the users profile through some sort of explicit interaction. The explicit user interaction is mainly a bootstrap procedure so user interaction is categorized as implicit.
- Group personalization: Not described. The collaborative filtering approach may include some sort of group recommendation. Recommending an item based on user similarity can be complemented with group recommendation.

**Active Web Museum [12]:** The Active WebMuseum is a user-adapting website, that uses the collection of paintings from the WebMuseum, Paris. In an ideal world a visitor of a museum would enter the museum and then find in the first corridor exactly those items, which he would find most interesting. This approach, that is impossible to implement in a real museum, becomes feasible when a museum's art collection is presented through the web. The web museum uses content-based filtering and collaborative filtering as the main techniques for generating personalized content. The content categorization of a painting is difficult and time consuming. The Web Museum uses automatic content categorization of the digital images, based on color, texture and caption information. Preferences are obtained by inviting users give symbolic ratings to paintings: excellent, good, neutral, bad, and terrible.

- Content and presentation management: Configuration. The museum is essentially the same for all users, the main corridor being a personal view, i.e., it contains the paintings that a given user would find more interesting.
- User interaction: Implicit. The user give ratings to a painting whenever she wants, or when asks for a detailed view of a painting. The user profile is not expressed in an explicit form, but may be inferred from the ratings.
- Group personalization: Not described.

**Active Learning in Digital Libraries [13]:** Active learning is the ability of learners to carry out learning activities in such a way that they will be able to construct knowledge from information sources effectively and efficiently. PIE (Personalized Information Environment) is a framework that provides a set of integrated tools based on individual users requirements and interests with respect to access to library materials. PIE deals with material personalization and collection personalization. Material personalization corresponds to facilities for learners to use library materials according to their individual requirements. Collection personalization captures the learners learning context and interest from the material personalization in order to provide a personalized view of the organization of the digital library.

- Content and presentation management: Mostly enhancement. PIE is composed by several tools, most of them working as annotation managers or performing some sort of personalized query enhancement.
- User interaction: Non interactive. The personalization data is obtained through the analysis of the annotated documents that form the personal library of the user.

The user profile is built based on the documents constructed by the user, using "shallow copy" tools for the different multimedia materials

- Group personalization: Not described.

## 4 Current Work

Currently we are doing work on several personalized information systems, that allow to explore the different dimensions and properties that were characterized above. The most challenging one is to generate new content on the fly, without explicit user interaction. We are working towards this goal but still on intermediate levels. Current paradigms for web based electronic publishing will also evolve in order to accommodate these new dimensions. The traditional roles of the reader and author will be blurred allowing a more active participation from everyone. Current developments are summarized in the next paragraphs.

**Video annotation tools:** Our previous work reported in [1] allows to personalize video based documents. The tool, AntV, provides an interface for adding annotations of different types (text, audio, video) to a given video stream. Each user can have its private set of annotations and can choose if it wants to publish those annotations or not. Our first AntV prototype worked as a standalone application, but more recently we have upgraded it to work and display results on the Web. We are using SMIL (Synchronized Multimedia Integration Language) as the output for the hypermedia documents that combine video and annotations. The personalization characteristics in this system, result from the fact that the user can add its own materials, in the form of annotations and it can generate its own "new" hypermedia documents from the original video and annotations made by different users.

**Personalization in interactive TV environments:** In interactive TV environments the need for personalization is even bigger, given that the TV set is usually shared by different users in the same house. We have made a first experiment on interactive TV personalization [2]. The prototype, named MyTV, is a design for the customization of interactive TV services. It is based on pre-defined templates that can be customized by the user. Although it is a very simple experiment it allows to define the design characteristics that are more important for a given user in an interactive TV environment.

**Semi-automatic content generation:** Generation of content based on the user preferences or choices, allows building customized and personalized information spaces. We are exploring this concept, in two different ways: (1) as a result of the video annotation process, as described above, the original video is combined with the annotation materials resulting in a new video or in a hypermedia document; (2) as a result of applying the user preferences, to multimedia queries. The user specifies the type of preferred content, in terms of topics, durations, media types and the system creates a document that conforms, as much as possible, to that specification.



**Personalization based on user profiles:** Based on standard XML/XSLT technologies for generating content for different types of users and devices, including mobile devices and interactive television, we are building a platform for interfacing user profile information. This platform will be able to handle user information that was gathered automatically or that was introduced by the user. It will work as a gateway between the content personalization system and the various ways to gather information about a user or a set of users.

## 5 Conclusions and Future Work

The work described in this paper helps to characterize the personalization techniques that are currently in use for interactive publishing and distribution systems. This characterization is a first step to integrate the personalization applications that we are developing. The different systems that were surveyed convey distinct aspects of personalization, but have many similarities in the ways that profile information is gathered or personalization is achieved, by configuring content or presentation. Implicit personalization is, in general, the preferred personalization technique although sometimes it is difficult to implement. This happens mainly in the bootstrap process when there is not enough data available. Regarding content and presentation management both techniques (enhancement and configuration) are relevant, depending on the application. Enhancement is mostly used in learning systems and it is a very powerful tool for augmenting existing materials. Configuration is also essential in content presentation systems where the amount of information is immense and it must be tailored and selected to fit the needs of a given user. Group personalization (or shared personalization settings) is not supported by many systems, but it is a helpful technique for managing large numbers of users with similar interests.

Future work on personalization techniques includes the extension of some of the systems that are described in Section 4. This work will be oriented towards the identification of common, reusable software modules that will be shared by the different applications. The objective is to build a software framework that will include automatic and manual personalization tools, personalization of content and personalization of presentation. Personalization of presentation will use current XML based techniques that are commonly used for building electronic publishing systems on the web, combined with modules and interfaces for getting user profile and statistical information. Regarding personalization of content we will continue to work towards the semi-automatic generation of content, based on user preferences and user input, such as annotation. Our ultimate goal is to have a flexible content generation system that provides the information that the user wants, when and where it is needed.

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