Innovative Personalization Issues for Providing User-Centric mGovernment Services

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Abstract: *Advances in mGovernment oriented technologies and services are taking place with a considerable speed around the world. As communications and other IT usage becomes an integral part of many people's lives and the available products and services become more varied and capable, users expect to be able to personalize a service to meet their individual needs and preferences. Therefore, due to the heterogeneous users' needs and requirements user profiling could be considered an essential component of personalization systems as a successful step towards the identification of users' preferences. However, could user profiling nowadays be considered complete enough, taking into account all the vital parameters of users' characteristics, in order for these systems to provide them with the most user-centric result? This paper introduces a "new" comprehensive user profiling, incorporating the User Perceptual Preference Characteristics that serves as the core element for filtering raw mGovernment services content.*
Keywords: Multi-channel, eServices, Personalization, User Profiling, mGovernment.

1. Introduction

With the emergence of wireless and mobile technologies, new communication platforms and devices, apart from PC-based Internet access, are now emerging making the delivery of services available through a variety of multi-channel mediums without loosing their integrity or quality of their content (Germanakos P., et al, 2005). Inevitably, this increases user requirements which are now focused upon an "*anytime, anywhere and anyhow*" basis. Moreover, the explosive growth in the size and use of the World Wide Web as well as the complicated nature of most Web structures may lead in orientation difficulties, as users often lose sight of the goal of their inquiry, look for stimulating rather than informative material, or even use the navigational features unwisely. To alleviate such navigational difficulties, researchers have put huge amounts of effort to identify the peculiarities of each user group and design methodologies and systems that could deliver an adapted and personalized web-content.

Challenges therefore ranging not only on adapting to the heterogeneous user needs and user environment issues such as current location and time (Panayiotou C., & Samaras G., 2004), but also on a number of other considerations with respect to multi-channel delivery of the applications concerning multimedia, services, entertainment, commerce etc. To this end, personalization techniques exploit Artificial Intelligence, agent-based, and real-time paradigms to give presentation and navigation solutions to the growing user demands and preferences. To this date, there has not been a concrete definition of personalization. However, the many solutions offering personalisation features meet an abstract common goal: to provide users with what they want or need without expecting them to ask for it explicitly (Mulvenna, M.D., et al., 2000). In addition, a complete definition of personalization should include parameters and contexts such as user intellectuality, mental capabilities, socio-psychological factors, emotional states and attention grapping strategies, since

these could affect the apt collection of users' customization requirements, offering in return the best adaptive environments to the user preferences and demands.

This paper emphasizes on the adaptation of mGovernment services delivery starting with a reference to multi-channel delivery characteristics of user-centric services and the adaptation and personalization considerations with regards to new user requirements and demands. It analyzes the significance and peculiarities of the user profiling for providing a more personalized Web-based result. It further presents a high level architecture for personalizing mGovernment services introducing the "new" comprehensive user profiling that incorporates intrinsic user characteristics such as user perceptual preferences (visual, cognitive and emotional processing parameters), on top of the "traditional" ones (such as name, age, education etc.).

The paper is structured in 7 sections. Section 2 roughly presents multi-channel characteristics for user-centric mGovernment services. Section 3 outlines the user requirements and the personalization problem. Section 4 refers to major adaptation and personalization challenges and constraints. In Section 5 the user profiling characteristics are presented, and in section 6 an overviewed mGovernment personalization architecture is described. Section 7 concludes this paper.

2. Initial Multi-Channel Characteristics for Delivering User-Centric mGovernment Services

"To struggle against the amplification of the digital divide and therefore to think 'user interaction' whatever the age, income, education, experience, and the social condition of the citizen" (Europe's Information Society, 2004).

The specific theme above reveals exactly the need for user-centric mGovernment services development and personalized content delivery. In many ways, the new technology provides greater opportunities for access. However, there are important problems in determining precisely what users want and need, and how to provide Web-based services content in a user-friendly and effective way. User needs are always conditioned by what they already get, or imagine they can get. A channel can change the user perception of a mGovernment application; when users have a free choice between different channels to access an application, they will choose the channel that realizes the highest relative value for them. However, separate development of different channels for a single service (multi-channel delivery) can lead to inconsistencies such as different data formats or interfaces. To overcome the drawbacks of multiple-channel content delivery, the different channels should be integrated and coordinated.

Since successful mGovernment service delivery depends on a vast range of parameters, there is not a single formula to fit all situations. However, there have been reported particular steps (IDA, 2004) that could guide a provider throughout the channel selection process. Moreover, it should be mentioned that the suitability and usefulness of channels depends on a range of factors, out of which technology is only one element. Additional features that could affect the service channels assessment could be: directness, accessibility and inclusion, speed, security and privacy and availability. To realize though their potential value, channels need also to be properly implemented and operated.

The design and implementation complexity is rising significantly with the many channels and their varying capabilities and limitations. Network issues include low bandwidth, unreliable connectivity, lack of processing power, limited interface of wireless devices and user mobility. On the other hand, mobile devices issues include small size, limited processing power, limited memory and storage space, small screens, high latency, and restricted data entry.

3. Extended User Requirements and the Personalization Problem

The user population is not homogeneous, nor should be treated as such. To be able to deliver quality knowledge, mGovernment systems should be tailored to the needs of individual users providing them with personalized and adapted information based on their perceptions, reactions, and demands. Therefore, a serious analysis of user requirements has to be undertaken, documented and examined taking into consideration their multi-application to the various delivery channels and devices. Some of the user (customer) requirements and arguments anticipated could be clearly distinguished into (Germanakos P., et al., 2005): (a) General User Service Requirements (flexibility: anyhow, anytime, anywhere; accessibility; quality; and security), and (b) Requirements for a Friendly and Effective User Interaction (information acquisition; system controllability; navigation; versatility; errors handling; and personalization).

Although one-to-one Web-based service provision may be a functionality of the distant future, user segmentation is a very valuable step in the right direction. User segmentation means that the user population is subdivided, into more or less homogeneous, mutually exclusive subsets of users who share common user profile characteristics. The subdivisions could be based on: Demographic characteristics (i.e. age, gender, urban or rural based, region); socio-economic characteristics (i.e. income, class, sector, channel access); psychographic characteristics (i.e. life style, values, sensitivity to new trends); individual physical and psychological characteristics (i.e. disabilities, attitude, loyalty).

The issue of personalization is a complex one with many aspects and viewpoints that need to be analyzed and resolved. Some of these issues become even more complicated once viewed from a moving user's perspective, in other words when constraints of mobile channels and devices are involved. Such issues include, but are not limited to: What content to present to the user, how to show the content to the user, how to ensure the user's privacy, how to create a global personalization scheme. As clearly viewed, user characteristics and needs, determining user segmentation and thus provision of the adjustable information delivery, differ according to the circumstances and they change over time (Panayiotou C., & Samaras G., 2004).

There are many approaches to address these issues of personalization but usually, each one is focused upon a specific area, i.e. whether this is profile creation, machine learning and pattern matching, data and Web mining or personalized navigation.

4. Adaptation and Personalization Challenges and Constraints

The needs of mobile users differ significantly from those of desktop users. Getting personalized information "*anytime, anywhere and anyhow*" is not an easy task. Researchers and practitioners have to take into account new adaptivity axes along which the personalized design of mobile Web-based content would be built. Such applications should be characterized by flexibility, accessibility, quality and security in a ubiquitous interoperable manner. User interfaces must be friendlier enabling active involvement (information acquisition), giving the control to the user (system controllability), providing easy means of navigation and orientation (navigation), tolerating users' errors, supporting system-based and context-oriented correction of users' errors, and finally enabling customization of multi-media and multi-modal user interfaces to particular user needs (De Bra P., et al, 2004; De Bra P., & Nejdl W., 2004). Intelligent techniques have to be implemented that will enable the development of an open Adaptive Mobile Web (De Bra P., & Nejdl W., 2004), having as fundamental characteristics the directness, high connectivity speed, reliability, availability, context-awareness, broadband connection, interoperability, transparency and scalability, expandability, effectiveness, efficiency, personalization, security and privacy (Lankhorst M.M., et al., 2002; Volokh E., 2000).

The science behind personalization has undergone tremendous changes in recent years while the basic goal of personalization systems was kept the same, to provide users with what they want or need without requiring them to ask for it explicitly. Personalization is the provision of tailored products, Web-based services, Web-based multimedia content, information or information relating to products or services. Since it is a multi-dimensional and complicated area (covering also, recommendation systems, customization, adaptive Web sites, Artificial Intelligence) a universal definition that would cover all its theoretical areas has not been given so far. Nevertheless, most of the definitions that have been given to personalization (Kim W., 2000; Wang J., & Lin J., 2002) are converging to the objective that is expressed on the basis of delivering to a group of individuals relevant information that is retrieved, transformed, and / or deduced from information sources in the format and layout as well as specified time intervals.

5. User Profiling Characteristics – A more Comprehensive Approach

One of the key technical issues in developing personalization applications is the problem of how to construct accurate and comprehensive profiles of individual users and how these can be used to identify a user and describe the user behaviour, especially if they are moving (Adomavicious G., & Tuzhilin A., 1999). According to Merriam- Webster dictionary the term profile means "a representation of something in outline". User profile can be thought of as being a set of data representing the significant features of the user. Its objective is the creation of an information base that contains the preferences, characteristics, and activities of the user. A user profile can be built from a set of keywords that describe the user preferred interest areas compared against information items.

User profiling can either be *static*, when it contains information that rarely or never changes (e.g. demographic information), or *dynamic*, when the data change frequently. Such information is obtained either *explicitly*, using online registration forms and questionnaires resulting in static user profiles, or *implicitly*, by recording the navigational behaviour and / or the preferences of each user. In the case of implicit acquisition of user data, each user can either be regarded as a member of group and take up an aggregate user profile or be addressed individually and take up an individual user profile. The data used for constructing a user profile could be distinguished into: (a) the Data Model which could be classified into the demographic model (which describes who the user is), and the transactional model (which describes what the user does); and (b) the Profile Model which could be further classified into the factual profile (containing specific facts about the user derived from transactional data, including the demographic data, such as "the favourite beer of customer X is Beer A"), and the behavioural profile (modeling the behaviour of the user using conjunctive rules, such as association or classification rules. The use of rules in profiles provides an intuitive, declarative and modular way to describe user behaviour (Adomavicious G., & Tuzhilin A., 1999)). Additionally, in the case of a mobile user, by user needs it is implied both, the thematic preferences (i.e., the traditional notion of profile) as well as the characteristics of their personal device called "device profile". Therefore, here, adaptive personalization is concerned with the negotiation of user requirements and device abilities. As Web developers regard personalization as the best way to filter out unnecessary or irrelevant information for their users, some argue on issues like it may restrict the extent and the variety of information users receive, that people often do not have well-defined preferences, they need to answer detailed questions to personalize their Web pages, that the recommendation process is a black box for end users and so on (Wang J., & Lin J., 2002).

But, could the user profiling be considered complete incorporating only these dimensions? Do the designers and developers of mGovernment applications take into consideration the real users preferences in order to provide them with a really personalized Web-based service content? Many times this is not the case. How can a user profiling be considered complete, and the preferences derived optimized, if it does not contain parameters related to the user perceptual preference characteristics? We could define *User Perceptual Preference Characteristics* as all the critical factors that influence the visual, mental and emotional processes liable of manipulating the newly information received and building upon prior knowledge, that is

different for each user or user group. These characteristics determine the visual attention, cognitive and emotional processing taking place throughout the whole process of accepting an object of perception (stimulus) until the comprehensive response to it (Germanakos P., et al., 2005). In further support of the aforementioned concepts, one cannot disregard the fact that, besides the parameters that constitute the traditional user profile, each user carries his own perceptual and cognitive characteristics that have a significant effect on how information is perceived and processed. Information is encoded in the human brain by triggering electrical connections between neurons, and it is known that the number of synapses that any person activates each time is unique and dependant on many factors, including physiological differences (Graber D.A., 2000). Since early work on the psychological field has shown that research on actual intelligence and learning ability is hampered by too many limitations, there have been a "number of efforts to identify several styles or abilities and dimensions of cognitive and perceptual processing" (McLoughlin C., 1999), which have resulted in what is known as learning and cognitive styles. *Learning and cognitive styles* can be defined as relatively stable strategies, preferences and attitudes that determine an individual's typical modes of perceiving, remembering and solving problems, as well as the consistent ways in which an individual memorizes and retrieves information (Pithers R.T., 2002). Each learning and cognitive style typology defines patterns of common characteristics and implications in order to overcome difficulties that usually occur throughout the procedure of information processing. Therefore, in any knowledge distributing environment, the significance of the fore mentioned users' differences, both physiological and preferential, is distinct and should be taken under consideration when designing such adaptive mGovernment environments.

It is true that nowadays, there are not researches that move towards the consideration of user profiling incorporating optimized parameters taken from the research areas of visual attention processing and cognitive psychology in combination. Some serious attempts have been made though on approaching e-Learning systems (Papanikolaou K.A., et al., 2002; Bra P.D., & Calvi L., 1998; Weber G., & Brusilovsky P., 2001; Mitrovic A., 2002) providing adapted content to the students but most of them are lying to restricted analysis and design methodologies considering particular cognitive learning styles, including Field Independence vs. Field Dependence, Holistic-Analytic, Sensory Preference, Hemispheric Preferences, and Kolb's Learning Style Model (Yuliang L., & Dean G., 1999) applied to identified mental models, such as concept maps, semantic networks, frames, and schemata (Ayersman D.J., & Reed W.M., 1998; Reed W.M., 1996). In order to deal with the diversified students' preferences such systems are matching the instructional materials and teaching styles with the cognitive styles and consequently they are satisfying the whole spectrum of the students' cognitive learning styles by offering a personalized Web-based educational content.

6. An Overviewed mGovernment Personalization Architecture

Based on the abovementioned considerations, a mGovernment personalization architecture is overviewed trying to convey the essence and the peculiarities encapsulated. The current system, depicted in Fig. 1, is composed of a number of interrelated components, as detailed below:

6.1 Entry Point

It is the user access interface of the system. It accepts multi-device (enables the attachment of various devices on the infrastructure, such as mobile phones, PDAs, desktop devices etc. identifying the characteristics of the device and the preferences as well as the location of the user (personalization / location based) and multi-channel (due to the variety of multi-channel delivery i.e. over the Web, telephone, interactive kiosks and so on, this module will identify the different characteristics of the channels) requests. It is directly communicating with the 'Content Filtering' component exchanging multi-purpose data.

6.2 Content Filtering

This component is considered the main link of the 'Entry Point' with the '"New" User Profiling' and the 'Personalization Rules / Mapping' components of the architecture. It actually transmits the data accumulated both directions and it makes the filtering of the content, according to the personalization processing characteristics, delivering the adapted and personalized service. The whole processing varies from security, authentication, user segmentation, service content identification, "new" user profiling characteristics and so forth.

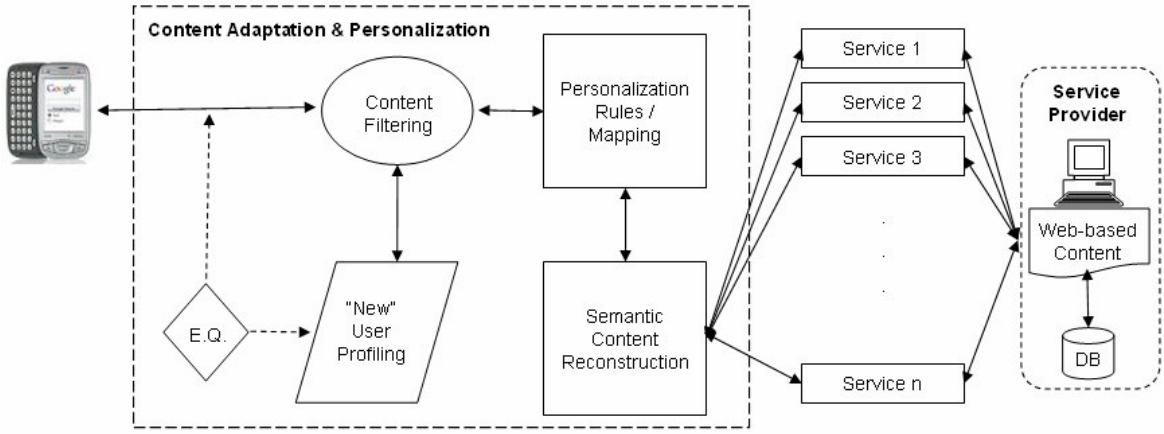

Figure 1. A mGovernment Personalization Architecture

6.3 "New" User Profiling

This is the main component of the architecture and it is called '"New" User Profiling' component. At this component all the requests are processed. It is responsible for the custom tailoring of information to be delivered to the users, taking into consideration their habits and preferences, as well as, for mobile users mostly, their location ("location-based") and time ("time-based") of access. It also keeps the user logs and retrieves data according to user log-on to the system. This component accepts requests from the 'Entry Point' component and after the necessary processing and further communication with the 'Content Filtering' component, either sends information back or communicates with the next component ('Personalization Rules / Mapping') accordingly. This component is comprised of the following two elements:

- *"Traditional" User Profile*: It contains all the information related to the user, necessary for the Web Personalization processing. It is directly related to the User Perceptual Preference Characteristics component and is composed of two elements: (a) User Characteristics: This element is directly related to the Device / Channel Characteristics element and provides the so called "traditional" characteristics of a user: knowledge, goals, background, experience, preferences, activities, demographic information (age, gender), socio-economic information (income, class, sector etc.) and so forth. Both elements are completing the user profiling from the user's point of view; and (b) Device / Channel Characteristics: This element is referring to all the characteristics that referred to the device or channel the user is using and contains information like: Bandwidth, displays, text-writing, connectivity, size, power processing, interface and data entry, memory and storage space, latency (high / low), and battery lifetime. These characteristics are mostly referred to mobile users and are considered important for the formulation of a more integrated user profile, since it determines the technical aspects of it.
- *User Perceptual Preference Characteristics*: This is the new element / dimension of the user profile. It contains all the visual attention and cognitive psychology processes (cognitive and emotional processing parameters) that completes the user preferences and fulfills the user profile. User Perceptual Preference Characteristics could be described as a continuous mental processing starting with the perception of an object in the user's attentional visual field and going through a number of cognitive,

learning and emotional processes giving the actual response to that stimulus, as depicted in Fig. 2, below. As it can be observed, its primary parameters formulate a three-dimensional approach to the problem.

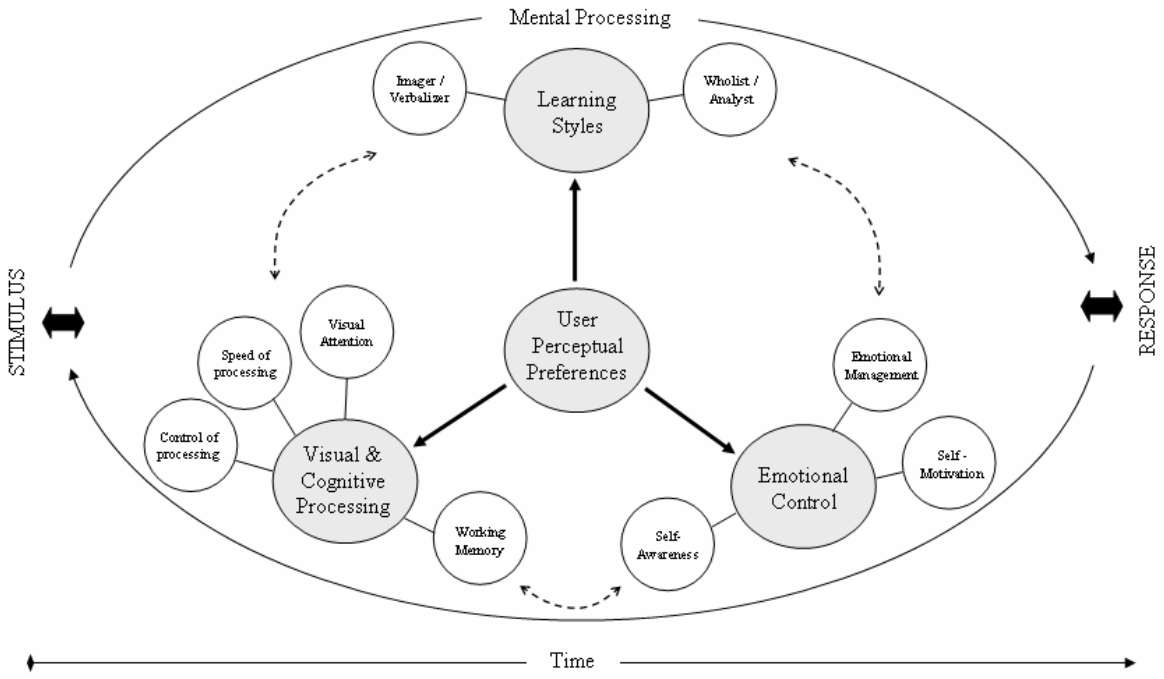

Figure 2. User Perceptual Preference Characteristics

It is considered a vital element of the user profile since it identifies the aspects of the user that is very difficult to be revealed and measured but, however, might determine his / her exact preferences and lead to a more concrete, accurate and optimized user segmentation. It is composed of three dimensions as mentioned above:

(a) *Visual & Cognitive Processing*: From the Visual Processing special emphasis is given to the visual attention that is responsible for the tracking of the user's eye movements and in particular the scanning of his / her eye gaze on the information environment. It is composed of two serial phases: the pre-attentive and the limited-capacity stage. The pre-attentive stage of vision subconsciously defines objects from visual primitives, such as lines, curvature, orientation, color and motion and allows definition of objects in the visual field. When items pass from the pre-attentive stage to the limited-capacity stage, these items are considered as selected. Interpretation of eye movement data is based on the empirically validated assumption that when a person is performing a cognitive task, while watching a display, the location of his / her gaze corresponds to the symbol currently being processed in working memory and, moreover, that the eye naturally focuses on areas that are most likely to be informative (Gulliver S.R., & Ghinea G., 2004). Cognitive Processing parameters could be primarily determined by (i) the control of processing (refers to the processes that identify and register goal-relevant information and block out dominant or appealing but actually irrelevant information), (ii) the speed of processing (refers to the maximum speed at which a given mental act may be efficiently executed), and (iii) the working memory (refers to the processes that enable a person to hold information in an active state while integrating it with other information until the current problem is solved) (Demetriou A., et al., 1993; Demetriou A., & Kazi S., 2001).

(b) *Learning Styles*: They represent the particular set of strengths and preferences that an individual or group of people have in how they take in and process information. A selection of the most appropriate and technologically feasible learning styles are taken into consideration, such as Riding's Cognitive Style Analysis (Verbal-Imager and Wholistic-Analytical), being in a position to identify how users transforms information into knowledge (constructing new cognitive frames).
(c) *Emotional Control (or Emotional Intelligence (EQ))*: The whole emotional processing of a user's interaction with the information space consists of these parameters that could determine his / her emotional control during the response process. It is the most dynamic element of the architecture presupposing its assessment on a constant basis. It describes an ability, capacity, or skill to perceive, assess, and manage the emotions of one's self, of others, and of groups. This is vital so as to determine the level of adaptation (user needs per time interval) during the interaction process.

All the above dimensions have specific characteristics and implications into the information space based on which the personalization rules in the 'Personalization Rules / Mapping' component will be constructed. Suggestively, we present, in Fig. 3, the data – implications diagram of the learning styles chosen:

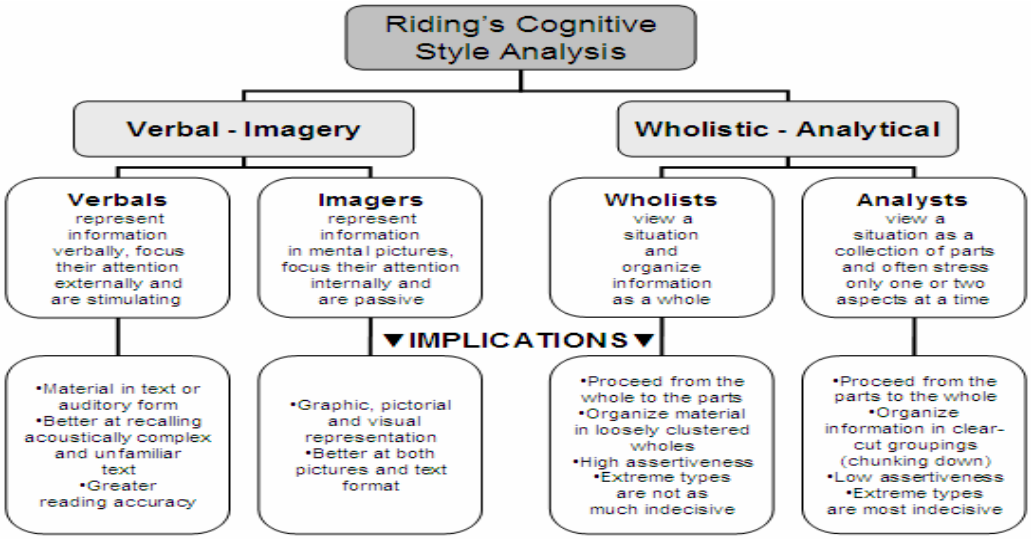

Figure 3. Riding's Learning Styles Characteristics and Implications

6.4 Personalization Rules / Mapping

At this component all the calculations such as the user categorization and mapping, content reconstruction and content adaptation takes place. In order for the current component to run properly Web-based semantic services content is conveyed in the form of metadata from the 'Semantic Content Reconstruction' component. Once the provided content adjusted based on the developed rules to the user characteristics it returns the corresponding adapted and personalized result to the 'Content Filtering' component.

6.5 Semantic Content Reconstruction

This component is based on metadata and it is responsible for describing the content (data) available from the 'Service Provider' (Service 1, Service 2,… Service n). In this way a common understanding of the data, i.e. semantic interoperability, openness, is achieved. The data manipulated by the system is described using metadata that comprises all needed information to unambiguously describe each piece of data and collections of data. This provides semantic interoperability and a human-friendly description of data. This component is also directly related to the 'Personalization Content Reconstruction' component providing the altered Web-based metadata service content. It is consisted of two elements:

- Perceptual Provider Characteristics: It identifies the provider characteristics assigned to the Web-based services content. They are involving all these perceptual elements that the provider has been based for the design of the content.
- Semantic Content Properties: This element performs the identification and metadata description of Web-based services content based on predetermined ontologies. It is implemented in a transparent manner removing data duplication and the problem of data consistency.

6.6 Service Provider

This is the last component of the architecture and is directly connected to the 'Semantic Content Reconstruction' component. It contains transition mechanisms and the databases of Web-based services content as supplied by the provider without been through any further manipulation or alteration.

7. Conclusion

The basic objective of this paper was to introduce a combination of concepts coming from different research areas all of which focusing upon the user. It has been attempted to approach the theoretical considerations and technological parameters that can provide the most comprehensive user profiling, under a common filtering element (User Perceptual Preference Characteristics), supporting the provision of the most apt and optimized user-centric mGovernment service content.

This paper made a reference to the adaptation of Web-based service content delivery investigating multi-channel delivery characteristics of user-centric mGovernment services and the adaptation and personalization considerations with regards to new user requirements and demands. It underpinned the significance of the user profiling introducing the "new" comprehensive user profiling that incorporates intrinsic user characteristics such as user perceptual preferences. It has finally presented an overviewed mGovernment personalization architecture that considers cognitive learning styles as its main personalization filter, in an attempt to provide the user with the most personalized and adapted result.

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