A Taxonomy of Web Personalization

Completed Research Paper

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ABSTRACT

Web personalization has become an important way to provide individualized user experiences. As a fragmented use of the term "Web personalization" and a lack of a common framework potentially hinder the establishment of a cumulative body of research, we develop a taxonomy of Web personalization. Bringing together research from information systems, computer science, and marketing, we develop a taxonomy focusing on the meta-characteristics *user modeling* (with the dimensions *type of data*, *acquisition method*, and *life span of data*) and *system adaptation* (with the dimensions *object*, *volatility*, *scope*, and *control of adaptation*). We demonstrate an application of our taxonomy by analyzing a sample of articles published in premier information systems journals and present some exemplary use cases to demonstrate how the taxonomy could be applied in practical contexts.

Keywords

Web personalization, User modeling, System adaptation, Classification, Taxonomy

INTRODUCTION

Recognizing the importance of individual differences, scholars and practitioners are placing increasing focus on personalization (Riemer and Totz, 2003). As customers value products or services that reflect their personalities, organizations are attempting to provide personalized products, services, and marketing messages to reach ever smaller customer segments (Montgomery and Smith, 2009). For example, companies such as Amazon.com personalize their Web pages to provide product recommendations based on browsing and purchase history, or the news site CNN highlights articles recommended by one's acquaintances. In sum, personalization is becoming increasingly important, and a clear understanding of the effectiveness of Web personalization is needed (Tam and Ho, 2006). However, definitions of Web personalization vary, and researchers often examine different aspects of personalization (Sunikka and Bragge, 2008). As different types of data about a user are more or less useful for different types of personalization, a guiding framework to classify the different types of data that can be used for Web personalization or to classify the different ways in which the interfaces can be personalized can help to derive theoretically based recommendations for Web personalization.

To this end, we seek to develop a taxonomy of Web personalization to aid in classifying the current body of knowledge and aid researchers in extending the body of knowledge by providing a classification scheme to help identify new research directions. In the next section, we will present a brief introduction of Web personalization, before developing a taxonomy and discussing how it could be applied to inform extant and future research.

WEB PERSONALIZATION

The topic of Web personalization has attracted researchers from various disciplines, including marketing, information systems, and computer science, each focusing on different aspects of the concept (Sunikka and Bragge, 2008). Thus, the usage of the term has become very fragmented, even within specific domains. For example, in marketing, terms ranging from profiling and segmentation to mass customization and one-to-one marketing fall under the umbrella of personalization (Vesanen and Raulas, 2006).

As the focus of this paper is on Web personalization, concepts such as (typically product-focused) mass customization can inform the taxonomy, but are beyond the scope of our study. Common definitions of Web personalization center around the modification of websites so as to provide a tailored Web experience to individual users (see Table 1 for sample definitions). Using Mobasher, Cooley, and Srivastava's (2000) definition as a basis, we define Web personalization as "any action that tailors the Web experience to a particular user".

Reference*	Definition
Mobasher et al. (2000), p. 143	"[Any] action that tailors the Web experience to a particular user, or set of users."
Wu, Im, Tremaine, Instone, and Turoff (2003), p. 2	"[The] adjustment and modification of all aspects of a website that are displayed to a user in order to match that users [*sic*] needs and wants."
Tam and Ho (2006), pp. 866-867	"[The] process of adapting web content to meet the specific needs of users and to maximize business opportunities […]."

*Listed chronologically

Table 1. Sample Definitions of Web Personalization

As Web personalization involves both the website (which triggers the action) and the particular user, Riemer and Totz (2003) have argued for distinguishing between the inputs (i.e., data gathering/acquisition) and the outputs (i.e., different forms of adaptation of the interface) of the personalization process. In the area of interactive marketing, Vesanen and Raulas (2006) proposed that personalization consists of a series of linked phases: data about a customer are gathered during interactions with the customer; such data can be used to create a customer profile, which helps to create customized marketing output to communicate with the customer (see Figure 1(a)). Analogously, in the context of Web personalization, data about a user can be used to develop a user model (often used for system adaptation by adaptive systems, Brusilovsky, 1996), which in turn helps to personalize/adapt the website (see Figure 1(b)). Consequently, the user data as well as the ways in which interfaces can be adapted are crucial to our taxonomy.

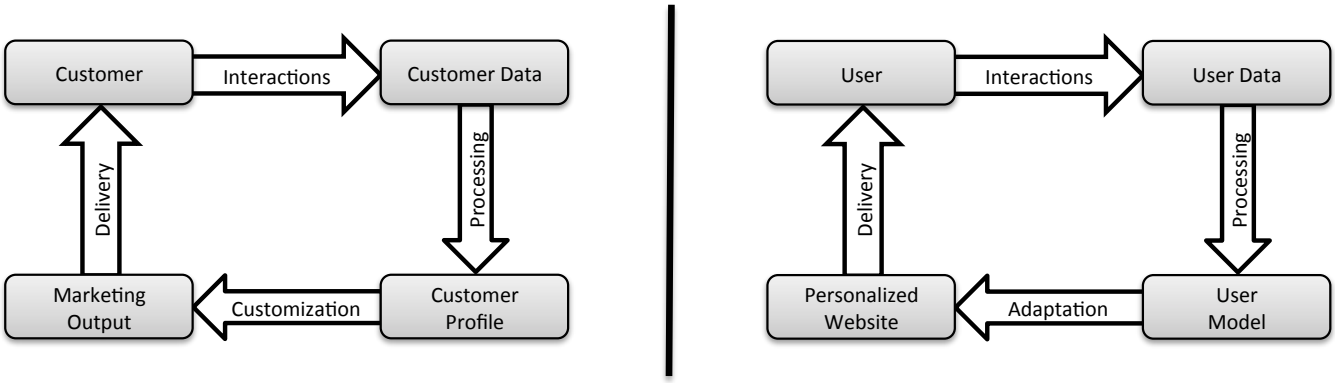

Figure 1. a) The Process of Personalization (Vesanen and Raulas, 2006); b) Adapted Process Model of Web Personalization

METHODOLOGY

Taxonomies are often used in science for classifying different objects or elements into groups or dimensions. Further, taxonomies help to describe and to understand complex problem spaces by providing a conceptual framework (Bailey, 1994), typically consisting of several dimensions, each of which containing at least two mutually exclusive and collectively exhaustive characteristics (Nickerson, Muntermann, Varshney, and Isaac, 2009).

Following Nickerson et al.'s (2009) framework for developing taxonomies in the IS discipline, we used an iterative process to examine subsets of objects with several characteristics. Consequently, we first identified meta-characteristics describing the purpose and serving as basis for the taxonomy. We then examined a subset of objects to be classified, and searched for general characteristics of these objects, before grouping mutually exclusive characteristics into different dimensions. Given this process' iterative nature, the taxonomy can be revised or amended in every step (Nickerson et al., 2009).

TAXONOMY

Given the importance of creating a user model and adapting the website for personalization purposes, the meta-characteristics *user modeling* and *system adaptation* are guiding our taxonomy development. A literature review of user modeling and system adaptation resulted in seven dimensions describing these meta-characteristics (Figure 2). We briefly introduce the meta-characteristics and their dimensions in the following sections.

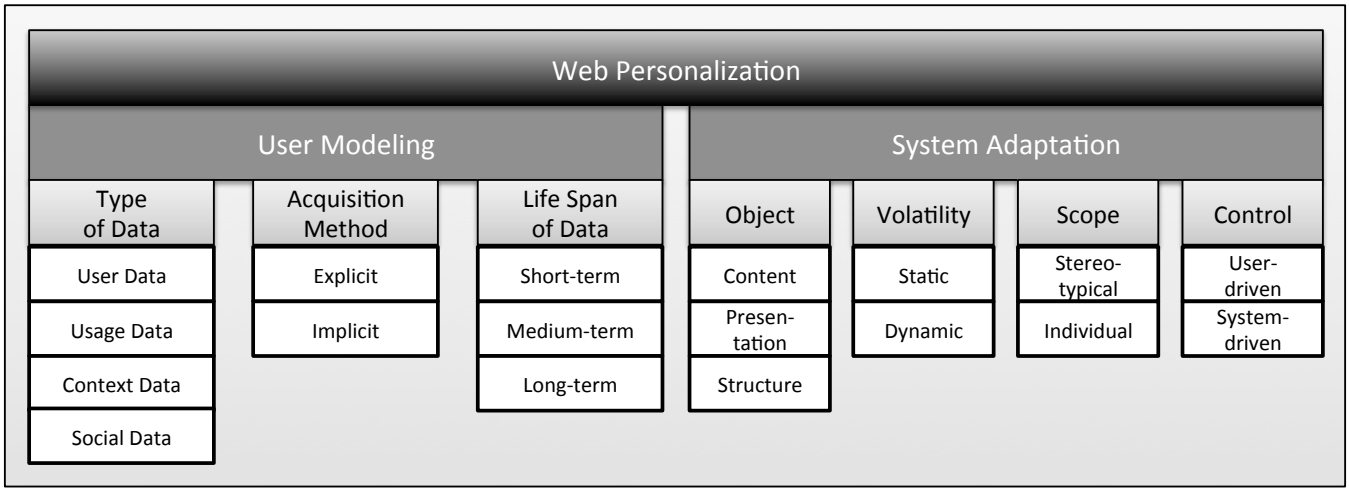

Figure 2. Meta-Characteristics, Dimensions and Characteristics of Web Personalization

User Modeling

By definition, data about the user is essential for Web personalization. The process of constructing a user model (i.e., "the knowledge about the user, either explicitly or implicitly encoded, that is used by the system to improve the interaction"; Kass and Finin, 1988, p. 6), is generally referred to as user modeling (Brusilovsky, 1996). Given that interactions with a system are typically context dependent, user models have evolved from focusing on (relatively) static aspects (e.g., gender or age) towards focusing on dynamic aspects, taking into account information about current interactions, dynamic preferences, psychological states, and so on (see Hothi and Hall, 1998; Tam and Ho, 2006).

A review of the literature related to users modeling resulted in the dimensions *type of data*, *acquisition method*, and *life span of data* (see Figure 2). Next, we will discuss these dimensions and their characteristics in more detail, and will provide examples illustrating each dimension and the corresponding characteristics.

Type of Data

As user modeling is primarily concerned with knowledge about the user (Kass and Finin, 1988), and the level of detail largely determines the potential for personalization (Brusilovsky, 1996), this dimension is concerned with different *types of data* that can be gathered about a user. Commonly, researchers distinguish between user data, usage data, and context data (see, e.g., Kobsa, Koenemann, and Pohl, 2001). Recently, social data (like friends and interactions with them) has become another important data source (Abel, Gao, Houben, and Tao, 2011; Park, Huh, Oh, and Han, 2012):

- User data: Data describing a user's personal characteristics. User data may be provided by the user (e.g., demographics provided during registration) or must be inferred (e.g., beliefs, goals, motivations, knowledge, experience, preferences, etc., Brusilovsky, 1996; Daniels, 1986).
- Usage data: Data describing a user's behavior. As data about users' characteristics may not be readily available, or people are not able to accurately respond to questions about certain personality constructs (Rich, 1979), usage (or behavioral) data (e.g., clickstream or mouse movement data) can serve as an additional important input into the personalization process (Moe and Fader, 2004; Montgomery, Li, Srinivasan, and Liechty, 2004; Padmanabhan, Zheng, and Kimbrough, 2006).
- Context data: Data about a user's environment. In addition to user and usage data, a user's context also offers (or necessitates) opportunities for personalization. For example, websites might be personalized based on the user's device

(e.g., desktop computer versus mobile device), usage context (e.g., shopping, social networking, or information seeking), or geographic location (Kobsa et al., 2001).

- Social data: Data about a user's social contacts. With the rise of social media, social data has become another important source of information. As people interact with friends and acquaintances in social networks or generate own content (e.g., in Blogs or Wikis), data about the connections and about the contacts' behavior or preferences can serve as another valuable data source (Abel et al., 2011; Park et al., 2012).

The online retailer Amazon.com provides a good example of including different types of data in the dynamic personalization process; when a user visits Amazon.com, a variety of user, usage, context, and social data are captured in order to present the user a personalized site with products matching the user's individual needs. The company further recommends products based on user characteristics (e.g., gender) or geographic location to registered users. More sophisticated methods like collaborative filtering may be used to infer a consumer's psychological traits and states by tracking the user's real-time behavior.

Acquisition Method

Whereas some types of data may need to be acquired explicitly, other types can be acquired implicitly (Chin, 1993; Kass, 1991), and the specific data type often predetermines the acquisition method.

- Explicit: Data is frequently explicitly acquired during registration processes or by asking visitors to create user profiles. In such cases, users voluntarily provide various data that can be used for Web personalization. Another common way of explicitly acquiring user data is the use of recommendation agents, which can help to elicit a user's goals or preferences (Wang and Benbasat, 2007).
- Implicit: Companies can also implicitly acquire data and infer user data by monitoring their behavior (especially if users cannot be asked about specific user data, e.g. due to their inability to express themselves). Such data are not explicitly provided by the user, but gathered implicitly from data streams like browsing behavior or clickstream data, and can complement explicitly gathered data (Mobasher et al., 2000; Mulvenna, Anand, and Büchner, 2000).

Especially when focusing on dynamic Web personalization, implicit data may serve as a powerful data source, providing almost an endless stream that often springs up in time, and mostly refers to a specific situation. Therefore, evaluating implicit data can enable a system to react dynamically to a user's situation (Tam and Ho, 2005). Web analytics companies like Omniture (www.omniture.com) or Personyze (www.personyze.com) specialize in tracking users' behavior to provide vendors information about each specific user. Using such information, companies may take action by presenting individualized offers or by helping users in the navigation process.

Life Span of Data

The *life span of the data* largely determines the extent of Web personalization. Short-term data like emotions both enable and require other ways of adaptation than long-term data like gender. In the first case, a system has to react dynamically (e.g., by providing support with the help of a popup). In the second case, a system needs to be adapted just once (e.g., women are presented other content than men). Being aware of differences in the data's life span, several authors suggest distinguishing between short-term, medium-term und long term data (Daniels, 1986; Rich, 1979, 1983):

- Short-term: Data that may change frequently, like emotions or behavior.
- Medium-term: Data that are more stable but may change over time, like experience.
- Long-term: Data that are very robust over time and are unlikely to change, like gender.

Different life span of data leads to different possibilities of adaptation. Whereas short-term data offer possibilities to react spontaneously and dynamically, long-term data are often used for relatively static adaptation. For example, in Hong Kong, the restaurant review site OpenRice.com provides a different user interface based on the visitor's language (as a proxy for culture), but presents advertising based on short-term usage data.

System Adaptation

Derived from the Adapted Process Model of Web Personalization (Figure 1b), the second meta-characteristic of our taxonomy is *system adaptation*, i.e., the adaptation of (parts of) websites to each individual user's needs (Brusilovsky, 1996). Whereas traditionally, websites used a 'one-size-fits-all' approach, adaptation is used to serve each user (represented by a

user model) with an individual interface or content (Brusilovsky, 2001). In contrast to customization (e.g., of one's desktop background), which is performed by the user, adaptation is performed by the system (Cöner, 2003). In particular, some researchers distinguish between adaptive and adaptable systems, based on who controls the adaption (Fischer, 2001; Oppermann, 1994). Our review of the literature related to system adaptation resulted in four different dimensions, namely *object*, *volatility*, *scope*, and *control of adaptation*.

Object of Adaptation

The first dimension of the taxonomy refers to the *object of adaptation*. In order to support a user, Web personalization may take place either by adapting the content, presentation or structure (Brusilovsky, 1996; Kobsa et al., 2001):

- Content: Depending on the user's situation, demographics, or context, the user may be served with certain information in order to match his or her personal needs.
- Presentation: The same information/content can be presented in different ways (e.g., textual or pictorial presentation).
- Structure: Personalized information on a website can be structured differently (e.g., by presenting a different hyperlink/navigation structure).

Examples for differences in the object of adaptation abound; for example, Amazon presents customers who have bought a specific product X another product Y, based on purchases similar customers have made, or websites designed for an Asian target group may be designed more colorful than for Western users. Similarly, Webster and Ahuja (2006) have shown differential effects for different Web navigation systems.

Volatility of Adaptation

The *volatility of the adaptation* refers to the timing and duration of the adaptation. Some systems may use a relatively static approach, and ask the user once (e.g., about long-term data like gender) and adapt the interface accordingly. Other systems may use a dynamic approach, and change their interface automatically and continuously to each user's needs depending on the current situation (e.g., if the system recognizes a certain behavior of the user, it may react spontaneously by providing support) (Daniels, 1986; Kobsa et al., 2001).

- Static: In this case, the website is adapted once the session is started and remains relatively stable during that session.
- Dynamic: In this case, the website adapts dynamically to the users current situation, which may change during one session. In other words, the adaptation is performed continuously, depending on the user's interaction behavior.

Recently, computer games have made use of dynamic personalization. Traditionally, games provided several levels of difficulty, which can be regarded as a relatively static adaptation, as the game's difficulty is predetermined by the "level" the gamer currently plays. In contrast, some recent games continuously analyze the gamer's behavior and performance, and dynamically adapt the level of difficulty to keep the player engaged in the game (see, e.g., Tijs, Brokken, and Ijsselsteijn, 2008).

Scope of Adaptation

The *scope of adaptation* defines to whom a website is personalized. On a wider scope, the stereotypical or "canonical" (Rich, 1979, 1983) adaptation treats each user as an instantiation of a certain stereotype (e.g., gender) and performs an adaptation on that basis (which might be often static, see above). In the case of an individual adaptation, each adaptation is performed based on the specific situation/behavior of each individual user (Brusilovsky, 1996; Daniels, 1986):

- Stereotypical: The adaptation is standardized based on a typical user (i.e., stereotype).
- Individual: The adaptation is performed based on each individual user's specific interaction/situation.

In marketing, customers are commonly segmented into economically viable segments (i.e., groups of stereotypes), so as to enable better targeting of advertising messages. Similarly, a website's visitors can be grouped into stereotypes (often based on user data, such as gender, age, or context data like geographic location). Users belonging to the same stereotype are typically presented the same individualized adaptation of content, presentation, or structure (see above). For example, online retailers may present women or men different content on their websites, or news pages present regional news based on the users' IP addresses. Individual adaptation often works on the basis of behavioral or usage data, enabling the system to dynamically react to individual users (e.g., the system may provide a chat client to aid users in the interaction).

Control of Adaptation

The last dimension of the taxonomy is concerned with who is in *control of the adaptation*. In adaptable systems, the adaptation of some parts of an interface is fully under control of the user and allows for user-driven adaptation; in adaptive systems, the adaptation is fully controlled by the system, automatically presenting an interface that (ideally) provides the best fit for the user, based on some gathered data (e.g. gender or domain experience) (Fischer, 2001; Oppermann, 1994). These two characteristics are extreme manifestations of adaptation control; real system environments may use a combination of both approaches for different aspects of a website.

- User-driven: In this case, the user is in control of the adaptation, and can control how and when a system is adapted, or which aspects of the interface should be personalized and which not. Depending on the complexity of the system, experience may be necessary for successful user-driven adaptation.
- System-driven: In this case, the system decides automatically when and what to adapt; based on various different types of data (e.g., usage or context data), the system personalizes the interface to the user's needs. Given the automatic (and typically transparent) nature of the personalization process, the personalization process is effortless for the user.

The different ways of controlling the adaptation are for example implemented in some e-learning environments. For example, Peter et al. (2010) provide an overview of e-learning systems that are either able to automatically adapt the content presentation to the user by inferring learning styles from the users' behavior (system-driven adaptation) or the user is in control of the adaptation (e.g., the frequency of recapitulations).

Applying the Taxonomy

To provide an initial demonstration of how this taxonomy could be applied, we used the taxonomy for two different purposes: a) as a classification scheme for research articles and b) as a tool for building and describing exemplary use cases derived from the taxonomy. To demonstrate that the taxonomy might be used as a classification scheme for research articles, we classified a small sample of research papers published in the two premier information systems journals, *MIS Quarterly* and *Information Systems Research.* Using the keywords *Web personalization*, *personalization*, *adaptive systems*, *system adaptation*, *website design*, *interface design*, *website usability*, *recommendation systems*, and *user-centered design*, we identified nine papers to be used for illustration purposes (see Table 2). We found that most papers only focused on subsets of the dimensions of Web personalization identified in this taxonomy. For example, while considering various dimensions of user modeling, several papers only (explicitly) mentioned few aspects of system adaptation. Further, some of the studies did not specifically limit their focus on one individual characteristic of a dimension, but rather discussed the dimensions in more general terms. Yet, it stands to reason that focusing on the different characteristics of a dimension can help to discover important boundary conditions. In addition, being explicit about the dimension and characteristics examined can help further a cumulative body of research of Web personalization.

To further demonstrate the applicability of the taxonomy, we present three different use cases that can be described using the taxonomy. Specifically, we selected gender, emotion, and experience as three exemplary user characteristics that are important for interface design and may necessitate different adaptations:

(1) Personalization based on gender: an online retailer offering products such as clothing might present each gender a different user interface. The taxonomy suggests that gender, a typical long-term data type, can be gathered explicitly (during registration process) or even implicitly (e.g., based on clickstream data; see Park, Yoon, and Lee, 2009). The scope of adaptation is likely stereotypical (to gender) and the volatility of adaptation static, as the object (e.g., content) needs to be adapted just once (as soon as the system knows the user's gender.

(2) Personalization based on emotions: online retailers might be interested in inferring users' (negative) emotions (typically having a short life span), so as to aid the users in case of problems. Researchers have shown that emotions can be acquainted implicitly (e.g., by usage data like mouse cursor movements, see Maehr, 2005). The scope of adaptation might be individual, and can encompass dynamically (volatility of adaptation) presenting next appropriate steps in the shopping process (object of adaptation: structure) in order to help the user overcome situations that can lead to negative emotions.

(3) Personalization based on experience: especially for complex products (e.g., custom-built computers), users might be overwhelmed by having to select a variety of parameters, depending on their individual domain experience (typically having a medium life span). The level of experience could be acquired directly by asking; the adaptation of the interface might be static (e.g., inexperienced users can be aided by a need-based interface; see Randall, Terwiesch, and Ulrich, 2007); the scope is in this case stereotypical, and the system controls the type of interface

being presented, which can differ in terms of structure (object of adaptation; e.g., less complex, need-based interface).

Reference*	User Modeling									System Adaptation								
	Type of Data				Acquisition Method		Life Span of Data			Object			Volatility		Scope		Control	
	User	Usage	Context	Social	Explicit	Implicit	Short	Medium	Long	Content	Presentation	Structure	Static	Dynamic	Stereotype	Individual	User	System
Albert, Goes, and Gupta (2004) (Website analysis and design)	X	X	X		X	X	X	X	X	X		X						
Tam and Ho (2005) (Web personalization, persuasion)		X				X	X			X				X		X		X
Komiak and Benbasat (2006) (Trust, e-commerce, adaptation)	X				X			X				X	X					
Padmanabhan et al. (2006) (Data mining, eCRM)	X	X				X	X											
Tam and Ho (2006) (Processing goal, content relevance)		X				X	X			X	X			X		X		X
Webster and Ahuja (2006) (E-commerce, navigation structure)			X			X	X					X		X				X
Jiang and Benbasat (2007) (Product presentation, complexity)	X				X			X			X		X					X
Cyr; Head, Larios, and Pen (2009) (Image appeal, website design)	X				X						X		X		X			
Park et al. (2012) (Customer profile, social network)	X			X		X		X										
*Listed chronologically																		

Table 2. Applying the Taxonomy of Web Personalization to Research Papers

CONCLUSION

As personalization has become increasingly important in various fields ranging from marketing to information systems, researchers and practitioners are interested in Web personalization. While there has been a growing body of research on Web personalization, the lack of a common framework potentially hinders the establishment of a cumulative body of research. In this study, we developed a taxonomy of Web personalization, focusing on the meta-characteristics *user modeling* and *system adaptation*. An application of the taxonomy to a sample of published research articles shows that frequently, authors are unspecific or silent about certain dimensions of Web personalization. Needless to say, this taxonomy, limited by the constraints of a conference paper, can only serve as a first step toward building a common framework, and is likely to evolve as capabilities enabled by technologies evolve. Nevertheless, we believe that this taxonomy can help discover important boundary conditions of research studies, help build a cumulative body of research, and help to provide detailed recommendations for practitioners seeking ways to optimize Web personalization by enabling the discussion of theories and findings in light of the specific dimensions and characteristics.

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