Content presentation personalisation and media adaptation in tourism web sites using Fuzzy Delphi Method and Fuzzy Cognitive Maps

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ABSTRACT

Web sites become more powerful when they can adjust to their users' needs. Web personalisation refers to adapting both the content and the presentation of web sites, so that to deliver the maximum effect to the user in the most appropriate way. A main objective of web personalisation is to adapt the presentation of the web content in a manner that increases the user's perceived quality. This paper focuses on the applicability of fuzzy logic techniques to content presentation and media adaptation. More specifically, it applies Fuzzy Delphi Method (FDM) and Fuzzy Cognitive Maps (FCMs) in order to highlight the services features that are most preferred by the customer and to adapt presentation media and layout. Fuzzy logic is utilised to deal with the subjectivity inherent in web design choices and in customers' perception of services priorities. FDM is used to capture the experts' knowledge regarding media adaptation with respect to hotel service quality. A prototype that adapts the web site presentation according to customer preferences has been developed and evaluated.

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1. Introduction to web personalisation

Web adaptation and personalisation is a major development towards web services that adapt to users' requirements and increase their satisfaction and loyalty. Adaptation is therefore suggested as a major determinant of e-service quality (Kaynama & Black, 2000; Murugesan & Ramanathan, 2001). The adaptation of web systems includes: adaptive content and recommendation, adaptive navigation and search and adaptive presentation (De Virgilio, Torlone, & Houben, 2006). Web personalisation applies to 'what to offer', i.e. what content to provide, and 'how to offer it', i.e. in what style and format to present the content. Web adaptation can be thought of as a two-task process: content adaptation, which aims at selecting the content that is most relevant to user needs and priorities, and content presentation adaptation, which aims at deciding how to most effectively present the selected content to the user (Bunt, Carenini, & Conati, 2007). Main objectives of web personalisation include (Murugesan & Ramanathan, 2001):

- To personalise web interface and navigation
- To provide personalised information content
- To present web site content in personalised format and layout
- To suggest special offers to selected online customers

- To collect and analyse data and to investigate e-customer behaviour
- To develop a 'human face' for the web.

The term adaptive web site describes sites that manually, semi-automatically or automatically adapt their organisation and presentation according to the visitor's behaviour and characteristics (profile) (Perkowitz & Etzioni, 2000). Many types of online businesses, such as portals and e-catalogues employ adaptive web site technologies. They provide for example, customised local weather reports, favourite links and special offers. Some of them introduce new pages (content), insert, delete or even highlight hyperlinks (navigation) and change the format of specific points in a page (presentation). Some create a different version of the site for each user or for different user groups (Perkowitz & Etzioni, 2000). Another kind of adaptation is reforming and organising the content and its structure. The degree of adaptation depends on the level of automation. Some systems try to predict the user's next page or even his/her interests (Perkowitz & Etzioni, 2000). Personalisation can be offline, for example, when personalised newsletters and e-mails are sent to customers, or online, in which case data analysis and recommendations are carried out in real time. Personalisation in terms of its sophistication can be shallow (for example, addressing a customer by his/her name) or it can be deep, where personalised content, navigation and presentation can provide the foundation for one-to-one marketing. Web personalisation involves three main steps (Murugesan & Ramanathan, 2001):

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(1) User behaviour and profile data collection.
(2) Analysis of user data.
(3) Recommendation of personalised content and personalised presentation.

This paper focuses on content presentation personalisation and media adaptation. It considers four media types (text, icon, photo, and video) and determines the degree of usage for each media type in presenting hotel e-services related content. The paper also aims at adapting the presentation of e-tourism web sites by taking into consideration the preferences of hotel service as perceived by individual customers. It investigates the applicability of fuzzy logic in presentation personalisation and applies the Fuzzy Delphi Method and Fuzzy Cognitive Maps (FCMs) for selecting the most appropriate media, in order to present selected content and to develop adaptive web sites. A prototype system, the *Fuzzy Web Site Adaptation System* (*FWSAS*) is also presented. FWSAS draws on experts' knowledge, regarding the appropriateness of media types, in presenting individual customer hotel services preferences, in order to customise the web sites presentation, according to customers' priorities. FWSAS has been tested for its effectiveness, by analysing the responses of a group of 36 users.

The structure of this paper is as follows: The next section discusses approaches to media selection for presentation personalisation. Next, the paper discusses the adopted methodology and the modelling approach followed by the section, which describes the fuzzy algorithm for personalisation and the architecture of the prototype system. The paper continues with an illustrative example and the evaluation of the prototype. Finally, the last section reviews the benefits of the approach and suggests directions for further research.

2. Content presentation personalisation and media adaptation

Content presentation personalisation is implemented by techniques that are developed based on the content relevance as well as by techniques which are designed to select and adapt the media type, which is the most appropriate for optimal content presentation (Bunt et al., 2007).

It is argued (Pednault, 2000) that personalising the content is not enough for maximum effect, unless the presentation of the content is personalised to meet user needs. Content presentation personalisation techniques try to solve the problem of how to present selected content, based on its relevance, so that the user's attention is drawn to the most relevant information and how to select the most appropriate type of media to deliver the content (Bunt et al., 2007). Techniques based on relevance can be classified into two categories (Bunt et al., 2007):

Priority on focus, i.e. the techniques emphasise the content that is considered as the most relevant to the needs of the current user.

Priorities on context, i.e. the techniques allow or restrict user access to information based on the content relevance to current user priorities.

The priority on focus techniques aim to maximise the user's focus on relevant material, by showing to the user only the content that is considered relevant, and by denying access to non-relevant material. They have been applied mostly in adaptive educational hypermedia (DeBra et al., 2003; Hook, 2000; Melis et al., 2001). However, these techniques suffer from the drawback that the users do not have any control of the adaptation, nor they can recover from a bad adaptation, something that is against human computer interaction principles. The priority on context category includes techniques such as stretchtext, dimming fragments and scaling fragments. All these techniques preserve the presentation context of relevant content by presenting non-relevant material in different

ways, thus allowing the user to have access to non-relevant content, while at the same time distinguishing its presentation from the most relevant content. The *stretchtext* (Bunt et al., 2007) hides less important information when a page is presented to the user, but allows the user to understand, with the use of a header (e.g. placeholder), that hidden information can be revealed at his or her wish, by clicking or placing the mouse on the header of the hidden information. *Dimming* (Boyle & Emcarnacio, 1994) fades the colour of less important information (which however still remains visible to the user), while *scaling* deemphasises by reducing the size of the window containing the presented material (Tsantilas & Schraefel, 2004). *Thumbnail summaries* is another technique that allows the user to see less relevant information by using zoom in and out mechanism to focus on the content. This technique is often used in small screen devices (Lam & Baudisch, 2005).

Media adaptation for content presentation personalisation has been a major research area in presentation personalisation (Zhou, Wen, & Aggarwal, 2005). It addresses the problem of selecting the most appropriate media, i.e. text, graphics, images, video, sound, animation, spoken language for presenting selected content to users in a personalised manner. The optimal exploitation of different media requires a presentation system that can decide which media to use for presentation, as well as determine which combination of media should be used for delivering the best possible effect (Andre & Rist, 1995). Determining a combination of media in presentation is an important goal for presentation personalisation, as media coordination can deliver the selected content more effectively than a single media and also because the strength of a media may compensate for the weakness of another (Andre & Rist, 1995; Zhou et al., 2005). There are five groups of factors that can influence the choice media and they may be considered during presentation media adaptation (Bunt et al., 2007):

User-specific features, which refer to users representation preferences, abilities and accessibility matters. For example, a user may prefer graphical to text presentations.

Information features, which imply that not necessarily all media are equally appropriate for presenting a piece of information. For example, expressing a price tag with text is preferred to the use of sound.

Contextual information pertaining to user environmental conditions, such as noise, light, weather, speed, etc. that may affect presentation quality to the user.

Media constraints, referring to the need to effectively combine media to increase the quality of presentation.

Limitations of technical resources, that relate to device limitations such as screen size, bandwidth, etc.

2.1. Approaches to media adaptation

There are two major approaches for media allocation namely *rule-based* and *optimisation* (Bunt et al., 2007). Rule-based approaches develop rules that model knowledge pertaining to a subset of the factors influencing media adaptation. The optimisation approaches, consider the goal of adaptation and information regarding the factors that may affect media adaptation and then formulate an optimisation problem, in order to specify which media should be used in delivering the best overall result. Rule-based approach is adopted in systems such as that in Ariens, Hivy, and van Mulken (1993), WIP (Andre & Rist, 1995) and COMET (Feiner & McKeown, 1994). The system described in Ariens et al. (1993) adapts media based on characteristics of the content to be presented, the media constraints, the users' interests and the overall goal of the presentation. Ariens et al. (1993) argue for the simplicity of their approach. The WIP system adapts the content presentation by exploiting the characteristics of the information to be displayed and applies meta-rules to decide which media schemes are more