A Case-Based Approach to Adaptive Hypermedia Navigation

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ABSTRACT

Hypermedia, with its combination of multimedia and non-linear organization of links among informative nodes, provides a highly interactive environment. In structured domains such as Web-based Educational Systems, the complexity of the learning domain often requires a large set of learning nodes and conceptual interrelationships that can cause several issues, e.g.: lack of comprehension, disorientation and inefficacious learning strategies. In this article we propose a new approach to guided navigation in hypermedia-based domains, suitable for helping users in structured and complex learning environments such as cultural heritage domains. Our proposal draws inspiration from the Case-Based Reasoning paradigm associated with a hypermedia structural analysis. In particular, our presentation highlights the use of a hybrid architecture for Adaptive Navigation Support, where the indexing problem of the case-based reasoner is solved by way of a sub-symbolic approach. A case study in the Neo-Realist Italian Cinema domain is discussed along with a formal and controlled evaluation that proves the advantages of the proposed approach.

Keywords: Educatonal IS; Human/Computer Interaction; Hypermedia Technologies; User Needs; Web-Based Training

MOTIVATIONS AND GOALS

Long distance learning via electronic media supplied by a wide range of universities, publishers and other private companies is quickly spreading as an effective way to transfer knowledge and skills to people. Internet, with its vast amount of information and open technologies, is helping developing Web-based Educational Systems (WBES), such as E-learning or Web-based Educational Hypermedia Systems (WBEHS).

In particular, WBEHS are basically a set of didactic contents available via browser, e.g., HTML pages, featuring text, still and moving pictures together with sound; data is encoded for rapid access and, typically, the user can explore the available information at will, following links to each learning component. Paradoxically, the hallmark of such systems, i.e., their ability to put vast amounts of information at users' fingertips, has turned out to be their weak point. It is easy to get lost in hyperspace

when the user is navigating through WBEHS of a significant size. Moreover, an excess of information makes hard for the user to find the more profitable information to use. With respect to hypermedia systems used as learning aids, users can even loose sight of their objectives (learning a topic, defining a term, etc.) when the system becomes overly complex; they can even feel the frustration of spending more time trying to make the system work than achieving their personal goals. For these reasons, the need for adaptive navigation support has been received much attention from research community, developing several techniques, e.g.: *Direct Guidance*, *Link Ordering*, *Link Hiding, Link Annotation* and *Link Generation* (see for example (Brusilovsky & Millan, 2007) for a review of these techniques).

In this article we propose a model of adaptive navigation support for WBEHS navigation, particularly suited for educational applications in closed corpus learning domains, such as *Museums Guides* (Zancanaro, Kuflik, Boger, Goren-Bar & Goldwasser, 2007; Vinga, 2006) and *Information Kiosks* (Fink, Kobsa & Nill, 1998), and its implementation in the HYPERCASE system. The proposed approach is primarily based on the *Case-Based Reasoning* (CBR) paradigm (Pal, Aha & Gupta, 2006) and on a hypermedia structural analysis. HYPERCASE offers a series of navigation help tools that can dynamically detect the presumed learning goal of the user and, if and when needed, subsequently help him/her find the desired path relating to his/her learning aims. The help system is based on a hybrid architecture, consisting of a sub-symbolic module embedded in a case-based reasoner. The type of help offered by the system is displayed to the user by means of a *Map Adaptation* technique, based on a hypermedia structural analysis, a slight variation of the proposal reported in (Botafogo, Rivlin & Shneiderman, 1992). The project described here is based on a particular philosophy: "give the user maximum navigation freedom with the minimum of intrusive help". Thus, the system design specifies that there should be no intervention unless overly requested by the user

himself. Behind this hypermedia philosophy lies our belief in the "constructivist" view to learning (Duffy & Knuth, 1990; Jonansen, Mayers & McAleese, 1993; Willis, 2000) and in the paradigm of "self-directed" education (see, for example, (Stanton & Baber, 1992)). These ideas contrast with the "dogmatic view of knowledge" and the fundamentally authoritative approach to learning found in highly directive multimedia systems especially of the educational variety.

The domain of interest, chosen as a case study is "Italian Neo-Realist Cinema" and some controlled experiment were performed to evaluate the system by means of a non-parametric statistics.

This article is structured as follows: next section describes the CBR approach to guided navigation, with a particular emphasis on the hybrid solution we opted for. After the complete architecture of the HYPERCASE system is presented, where, first of all, is described the hypermedia system on Italian Neo-Realist; next, the structural analysis of the hypermedia is presented, along with the *Map Adaptation* method, based on the above-mentioned analysis by means the system supplies the requested help to the user. Subsequently our work focuses on the experimental evaluation of the system, where we report the experimental plan, the statistical method used, the statistical conclusions obtained from the analysis of the data gathered from the experiment and, finally, the research conclusions. A comparison with other related work presented in the literature is set forth while in the concluding section our considerations are summarized together with touches on possible future developments.

Case-Based Navigation Model

Given a WBEHS, the user may be offered different navigation possibilities, the main one being unassisted or free navigation. It is the usual method and involves non-linear access to information contained in the hypermedia nodes without any kind of help or guidance supplied by the system. It is a known fact that, with this

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