A WEB-BASED COOPERATIVE E-LEARNING ENVIRONMENT FOR MUSICAL HARMONY DOMAIN

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Abstract

This article presents a virtual environment of cooperative Web-based learning to support the teaching of Music, specifically Musical Harmony. Such environment offers support to both semi-distant learning courses and strict distant learning using Internet/Web. The aim of this work is to integrate artificial and human agents in an interactive environment endowed with access to several high quality contents. These contents are available in hypermedia documents and digital library. Our main purpose is to provide learners, teachers, and computer system with opportunities to get productive pedagogical interactions. The computer system is presented here as a society of artificial tutoring agents connected to a digital library and to a hypermedia document.

Key Words

Web-based Learning Environment, Intelligent Tutoring System, Distance Learning, Music Education Multi-agent Systems.

1. Introduction

This article presents a virtual environment of cooperative Web-based learning which adopts a multi-agent approach. The general aim of this work is to integrate artificial and human agents in a rich and well-structured learning environment with strong emphasis on problem-solving activity. To support productive pedagogical interactions with regard to that activity, we have provided the environment with a high quality content and their access mechanisms. Then, this environment intends to provide students with good opportunities of learning, by offering them several ways of interactions with both teachers and computer system.

We have adopted a multiagent approach to design and develop the computer system because music education is, in general, a complex domain demanding many effort on the part of software system designers and developers. This approach has been shown effective to model complex systems.

The computer system, in the proposed learning environment, is represented by a society of tutoring agents. A hypermedia document and a digital library are connected to this society. Human agents may access the contents in these two sources by means of tools embedded in an agent offering a guided and personalised navigation. But, the system also provides human agents with access to the contents in a free way navigation.

This work is part of a broad and innovative research project, that includes a join of two efforts: MATHEMA environment model [1] and a project that aim design and development a digital library of Brazilian Popular Music [2]. Our goal is then to build an interactive environment supporting the cooperative teaching-learning processes, in the context of distance learning, via Internet, as well as presence learning.

The remainder of this paper has been organised as follows. In Section 2 we present aspects related to Music teaching as well as aspects concerning digital libraries. In Section 3 we present the conceptual architecture of the
2. Research Context and Digital Library in Brazilian Popular Music

Although Brazil has a variety in popular music, the professional teaching of national musical traditions has been passed, almost completely, in traditional environments of musical teaching. An elementary historical description of Brazilian professional music teaching that points to social and economical topics of resources application in Music teaching demonstrate the hegemony of the so-called classic music at formal education, which makes the popular music teaching away from the formal environments.

There is a large gap in the production of good didactical material that focus on Brazilian music. Facing this fact, digital and organized contents, that have as main goals the rescue and broadcast of important composers of the Brazilian tradition, bring a very important contribution to the country cultural identity.

On the other hand, the vertiginous enhancement of information available at the Web, mostly multimedia, has generated a considerable demand for tools to access and manipulate them. Specifically, on musical information, despite the many proposals with experimental or commercial aspect, they have frustrated public expectations. It is worth to say that the emphasis in musical bases aim to bring the user’s interest for the digital libraries in order to understand that music interests the audience.

Evidently, The amount of musical material available has followed the general tendency. Nowadays, they are available to computer users around the world and new bases continue to be created and constantly updated. Despite the several works developed in the sense to make tools available to search and to get musical sheet ([3], [4], [5], [6], [7], [8]), there are no satisfactory results that justify its broad use. It happens because they do not necessarily mean natural and effortless accessibility from its users. Actually, this is a reality not only in musical field, but in all and today’s forms of contents available at the Web. To find and filter units of data of interest and insert them in personalized and updated spaces of relevant information represent an even more difficult obstacle faced by users, as well as by those involved in the search of such problems.

How would it be possible to provide users with adequate means to treat volume, dynamics and complexity of this huge universe of data? Digital Libraries have been proposed to find advances on the comprehension of the topics involved in the development of such libraries. In this sense, many works have been developed, particularly at the musical field ([12], [13]). However the warranty of maintaining quality of services is one of the critical points to the digital libraries, as they manipulate large amounts of data, presented in many ways (HTML, XML, text ...). In audio and video applications, this worry is even more critical. How would it be possible to warrant sequences of continuous data as a just-in-time liberation of data fragments? This problem is referenced in the network community and multimedia information as a necessity of QoS (Quality of Service).

It is being developed at the Brasília Catholic University, a project of concept and development of a digital library in the area of Brazilian Popular Music. One of its goals is its use in music distance learning. Technologies for representation and organization of the pattern information are being used, such as Z39.50 and XML, to structure databases (more specifically, music databases) besides operational mechanisms over information (correlation, pattern recognition ...). It is also being investigated the use of software agents, in the aspects of interaction with users, in its activities of information restoring and manipulation, as well as aspects relating to warranty of services of communication, and also with the behaviour of computer networks to answer the demand of data access from digital library servers.

3. Conceptual Architecture of the Proposed System

From the external point of view [15], the conceptual model of this system is organized as shown in Figure 1. It consists of five main entities: human learner, human teacher, Human Experts Society (HES), Society of Artificial Tutoring Agents (SATA), and an Interface Agent. The last one presents the three different interface modules, ensuring the interactions between the three different entities: learner’s interface, teacher’s interface and Hess’s interface.

![Figure 1. General Architecture of MathNet](image-url)
Learner: an active human agent who is interested in learning about certain domain of knowledge. For example, the domain of traditional music harmony.

Teacher: a human agent that plays a facilitator role for promoting assistance to the learner and interacts directly with him.

SATA (Society of Artificial Tutoring Agents): It assures productive interactions with Learner/Teacher. This society represents the multi-agent ITS.

HES (Human Experts Society): works as sources of knowledge to the SATA, being responsible for building and maintaining the tutoring agents from SATA.

Learner’s Interface: this interface allows the communication between the learner and the system. All interactions are achieved through a browser.

Teacher’s Interface: It allows communication between the teacher and the system. As well as the learner interface, it is accomplished through a Web browser.

Expert’s Interface: It assure the communication between HES and SATA.

4. SATA, Hypermedia Document and the Digital Library

In this section, the integration of the society of tutoring agents with the hypermedia document and the digital library is discussed. The general architecture of the system from the inner point of view is presented in Figure 2. Each of the components is explained with details, as follows:

4.1. Society of Artificial Tutoring Agents

This society of agents is built in from a multidimensional view of domain knowledge ([1], [16]), in this case is Musical Harmony. Once established this view, the domain’s partitioning schema is established in several sub domains and, from these, the SATAs tutoring agents are defined.

A multidimensional view is based on the notions of context, depth, and laterality. Context means the multiple representations of domain knowledge, leading to different interpretations. Depth is defined relatively to a context and provides different refined levels in the domain’s description language. Laterality is defined for each pair, involving a context and depth to establish a support knowledge relating to pre-requisites and co-requisites. In Figures 3 and 4, the domain of musical harmony model is defined in terms of context, depth and laterality, based on typical hierarchy in a Music Harmony Course.

The definition of tutoring agents is based on the musical harmony domain modelling, where a tutoring agent is made of a pair <Context, Depth>, we have a society of tutoring agents for each responsible for a certain aspect of domain’s partition in musical harmony. The lateralities are also mapped to support’s tutoring agents. [24]

4.2. Hypermedia Component

The hypermedia document has a structure of a tree, formed with HTML pages. Its modules are made of objects disposed in a hierarchical relation. In the non-guided navigation, the learner has total control of his/her own decision. In the guided navigation, the system determines which is the next document exhibited, based on the learners profile. The mechanism of definition of the next step in a guided navigation, as well as a profile inspection by the apprentice is described in [15]. This component is connected with the tutoring agents.

4.3. Digital Library

It is a repository of musical works, didactic and explained contents that serve as a resource base to agents in guided navigation and as resource base to the learner in a non-guided navigation. This component is also connected to tutoring agents.
5. Illustrative scenario

The figures 4 and 5 illustrate a teaching section in musical harmony domain. In the exercise pointed out in Figure 4, the system asks the learner to determine one harmonic sequence which is valid within the tone C Major. The learner will then fill the chords that are lacking in such a way that is not possible to violate the harmonic field of C Major. The system will then verify the learner’s answer validity by considering the rules of harmonic field and harmonic sequences via interaction of agent society. For example, in this case the Field Harmonic Agent
would be responsible for analyze if exist some chord out of harmonic field of C Major, and then would request Harmonic Sequence Agent to verify if the sequence of chords is in accordance with the Musical Harmony rules.

Figure 4. Exercise proposed by the system

<table>
<thead>
<tr>
<th>Tone: C Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>C - ___ - ___ - ___ - ___ - G7 - C</td>
</tr>
</tbody>
</table>

Figure 5. Learner answer

For instance, the learner could now require from the system a collection of Brazilian popular music which contains such harmonic sequence. Based on digital library the system could return the songs according to a format as in Table 1.

<table>
<thead>
<tr>
<th>Table 1. Query result for Major C sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Song</strong></td>
</tr>
<tr>
<td>A Banda</td>
</tr>
<tr>
<td>Iolanda</td>
</tr>
<tr>
<td>Gente Humilde</td>
</tr>
<tr>
<td>Baby</td>
</tr>
</tbody>
</table>

6. Conclusion

In this article, a virtual environment of cooperative web-based learning is presented and defined to support the learning on music domain, in particular, the Musical Harmony, dealing with the philosophy of a virtual community.

This environment has been implemented using Java Technology and it has been integrated with digital library to provide harmonic sequences for learning users.

Research is being done in a sense to make a Digital Library in Brazilian Popular Music available with index and musical information recovery mechanisms that act independently, as well as integrated to music learning systems.

7. References

[5] K. Lemström (1998) "Retrieving Music – To Index or not to Index". Department of Computer Science, University of Helsinki (Finland).