Courses Personalization in an E-learning environment

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Abstract
The E-learning represents the new frontier of education, significantly improving the learning process. In this paper we propose an e-learning model, providing both teachers and students with an open and modular learning environment. We then focus on courses personalization, both in terms of contents and teaching materials, according to each student's needs and capabilities, also taking teacher guidelines into account. To accomplish this, we model courses/lessons as graph nodes, where arcs represent their precedence/succession relationships. We outline a courses generation/presentation engine which allows the creation of personalized learning paths (sub-graph) by extracting lessons, eliminating those known to the student, and arranging them into a tree including all possible paths starting from the student's possessed knowledge towards desired knowledge.

1. Introduction
The new frontier of education and dissemination of knowledge is known as E-learning [1][2][3]. We propose an e-learning model aiming at:
1. providing both teachers and students with an open and modular learning environment, which improve the sharing of courses/teaching materials, as well as distance and collaborative learning;
2. promoting active learning, allowing the construction of courses which are personalized in terms of both contents and teaching materials, selected according to each student's needs and capabilities, also taking teacher guidelines into account.

In this paper, we introduce the learning model that provide courses personalization; indeed, students differ in learning rate, personal capabilities, time availability and owned knowledge, hence the same course must be tailored to each student, or to a group of them (class) sharing some characteristics. Moreover, the teacher adjusts a course to the class, adapting it to the average capability and knowledge of the students and/or modifying the way the lesson is proposed (examples, training, theory, etc.). In this sense, the system should create and propose to the student all the possible paths starting from his previous knowledge and directed towards the desired knowledge (topic of interest), filtering these paths by taking into account both student's and teacher's profiles. The core module of the system is the Engine, which contains the course generation and course presentation sub-modules. The course generation sub-module is devoted to building personalized courses/learning paths: it extracts lessons (respectively, courses) related to the topic requested by a student from the domain database, groups them in order to build the course (resp., learning path), providing each student with the course (learning path) most suited to his needs (coming from his profile), in accordance with precedence-succession relationships. Once courses/learning paths are built, the course presentation sub-module retrieves all the related teaching materials and organizes the way courses are made available.

2. Learning System Architecture
A learning system generally consists of different modules, each performing a given task [4][5][6][7]. Figure 1 shows our proposed learning system, which will be now described.

Fig. 1 – Learning system architecture

The Courses module contains the Domain DataBase (DDB) and Teaching Materials DataBase (TMDB), each with its manager sub-module. DDB contains all Course Units (CUS), each described with a set of properties, as prerequisites, objectives (list of the concepts it concerns),
required time, detail level, etc...
All the CUs, independently of the courses they belong to, are organized in an and/or graph where arcs represent whether one is preliminary to another. Such precedence-succession relationships are established by teachers, and exploited when building courses by composing several related CUs. A CU is actually separated from related teaching materials (slides, documents, videos), that are placed into TMDB, and they are properly arranged by the Course Presentation so that courses can be accessed.
DDB also contains all Course Nodes (CNs), each being a set of lessons properly grouped together. Similarly to CUs, CNs are characterized with a set of properties and arranged into an and/or graph. Precedence-succession relationships represent learning paths.
The DDB manager interacts with the course generation sub-module in the Engine module by providing all CUs and CNs, the course generation sub-module being responsible for grouping lessons/courses in order to build courses/learning paths.
The Profiles module contains all relevant information about teachers and students, stored in corresponding databases, together with their management sub-module. Information concerning each student are for instance his available time, initial knowledge, preferred learning style (practical or theoretical oriented), desired level of difficulty, history (access log files). The teacher profile is used to store educational guidelines provided by each teacher, e.g. which lessons are mandatory, or which learning paths/sub-paths are suggested. The Profile Databases are used by the course generation and course presentation sub-modules when courses/learning paths are generated to tailor their contents (and the related teaching materials).
Engine creates and arranges courses, which are finally attended by students and/or consulted by teachers through corresponding interfaces placed inside the E-learning Interface module as shown in Figure 1; the virtual learning environment can be simply a web site, or it may also integrate different media (e.g. a PC to attend lessons or cell phone text messages for news about courses). The last module is the E-learning Interface, through which:
1. students attend courses, perform exercises and tests, or view and modify their profile.
2. teachers/course creators view and manage their courses, manage teaching materials (also using authoring tools), and view/modify their profile.
3. administrators manage the whole system;

3. Engine

As described in the previous section, the engine module interacts with all the other modules to manage the learning paths; it is divided into two parts: the generation and presentation sub-modules.
The generation sub-module aims at finding all the possible learning paths that will allow the user to acquire the relevant knowledge, starting from the knowledge he already possesses.
The task of the presentation component is to retrieve the material required from the TMDB and, according to the student's preferences, organize the material and send it to the interface module. During the presentation phase the learning path has already been defined and any alternatives have been identified and stored in the system, leaving it up to the user to choose between these alternatives.
The data to build personalized learning paths are the student's aims, and his profile, both supplied to the engine via the interface.
The engine also operates during the insertion of new units, both course nodes and course units. It has the task of checking that the rules concerning the requisites and objectives do not clash with the existing graph, for example by creating circular paths, thus guaranteeing that the information is always consistent.

More details about each module of the proposed learning system, as well as about the engine, can be found in [8].

References