CIA: Framework for the creation and management of Adaptive Intelligent Courses

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Abstract: This document presents the description of CIA, a Web platform that uses dynamic pages to create and manage virtual courses with Intelligent Tutoring System features that has the next functions: First, they have a tree structure where the course is the root and going down the Learning Objects are found as the leaves. Such structure may be seemed as a text book that is separated in chapters, sub chapters, etc. Second, they perform an intelligent sequencing of the curriculum based on the courses structure and the results of the assessments. Third, they consider the needs and characteristics of the students, adapting the presented content using their learning styles. Forth, they use the LOM metadata standard to describe and manage the Learning Objects that are saved in a repository in order to facilitate the reusability. And fifth, they have tools that contribute to collaborative work as forums and mail exchange.

Keywords: Framework, Virtual Courses, Learning Objects

1. Introduction

The main purpose of this domain-independent framework so called CIA (by its acronym in Spanish corresponding to “Adaptive Intelligent Virtual Courses”) is providing an easy useful tool which allows the creation and management of Intelligent Tutoring Systems-oriented courses (Siemer and Angelides, 1998). Such framework accomplishes the following two requirements: first, it employs standards and follows current guidelines for digital contents; and second, it can be used in extensive way within diverse purpose educational institutions. This last requirement can be accomplished by means of its client-server architecture which allows a simultaneous connection for both professors and students to specific course’s resources.

Even though CIA’s Model and Framework were initially conceived to be used within a university environment (the first two virtual courses which are being built
are addressed to engineering concerns: Programming Foundations and Artificial Intelligence); however, this tool may be used in other kind of educational institutions and formation level, as long as the methodological suggestions which will be described in the following section are followed.

It is important to notice that for the effective use of the CIA’s Framework the objective users of the system must be discriminate: for the students it is necessary that they have a high level of commitment since the courses are actually autonomous and thus the students are those who learn by themselves determining by their own progress a satisfactory conclusion in their learning process. For teachers it is of vital importance that they dedicate a lot of time and effort in designing the course; also in searching and/or creation of Learning Objects and the later monitoring of the active courses. Although, in the teachers part, the two first issues are those which are generally considered as an input barrier since the required time to develop these processes surpass for a lot that to prepare a real course, it is important to recall that this effort is actually performed only once and, the developed course going on indefinitely functioning. In other words, the time teachers employ today building in a course, is the one that they save in the future.

2. Description

In order to perform both a description of the CIA’s Framework, and the model under which it is supported, this section is divided in the following four subsections: in the first, it is explained how the course’s structure must be modeled in CIA; the second and third describe the way of using CIA by teachers and students respectively; and finally, in the fourth section some technical issues are provided.

2.1 CIA’s Courses Structure

In order to build a course in CIA there must be defined the following components which belong to the tree-shaped hierarchical structure proposed by the Domain Model: Course, Learning Basic Unit – LBU, Topics, Instructional Goals – IG, Activities, Learning Objects – LO, Assessments, Basic Concepts – BC, and Pre-requirements. A short description for each of them is:

- Course: they are the most global elements and represent a frame in which the different actors of the teaching/learning process can interact in a direct, instantaneous and ubiquitous way. A course is composed by one or more LBUs.
- LBUs (Learning Basic Units): they are the main elements that the teacher hopes the students learn by carrying out a course. In addition, they can be seen by making an analogy as chapters in a book or real course’s general contents. A LBU is composed of one or several topics.
- Topic: they represent the second level elements in the domain level hierarchy and can be understood by making an analogy as book’s sub-chapters, or the detailed content parts for a real course. A topic posses one or several IGs.
- IGs (Instructional Goals): each one of these elements exhibits the specific intention that a teacher desires his/her students should acquire respect to skills and new knowledge. An IG is attained through the performance of one or several activities which have associated one or several Basic Concepts. In addition a related assessment must exist which purpose is to determine if the specific goal was or not attained.
- Pre-requirement: the pre-requirements of a given course allow defining the “normal” sequence of learning and are established within the proposed model at the IG level. The way through which they are defined is completely flexible so courses could be specified free of them (the whole educational content is available at any time similar to Moodle or other LMS – Learning Management Systems, wherein this feature is indirectly modelled just by means of a schedule), completely sequential (in order to access to IG $k$ it is mandatory to first approve the IG $k-1$, which requires the $k-2$, etc.), or any scheme in agreement with the teacher’s criterion.
- Activity: a set of didactic actions that are performed in order to acquire the required knowledge and to allow the attainment of an IG. An activity is performed using one or several LOs.
- LOs (Learning Objects): they can be defined as the elements used for the instruction or virtual learning of a specific knowledge (Lopez, 2005). In concrete words they are physical files where the domain content of a given course is described and can (should) be exhibited in several formats (text, images, animations, videos, audio, slides, etc.). Each LO must be accompanied by its corresponding metadata in which its characteristics are clearly described such as: title, description, author, kinds of interaction, difficulty, etc. These characteristics are used by the CIA’s framework, making a merge with student’s profiles and other relevant information in order to adapt the deployment of the course domain content through the system interface.
- Assessment: a set of questions among with their corresponding answers that allows defining when a student has attained an IG. It is important to establish that each question must be associated to an unique BC.
- BCs (Basic Concepts): each IG has associated one or several BCs with the purpose that the framework presents to the student, at the moment of performing an IG’s assessment, one or several questions related to this IG, but taking into account that they must cover the whole content, e.g. it must exists at least one question for each BC associated.
2.2 Teachers Interaction

As any user of this kind of educational systems, the first thing that a teacher must do is to register and authenticate through the system’s interface. Once the teacher enters to CIA, he/she can monitor and interact with active courses that has in charge, as well as create new ones or modify the existents. If the teacher decides to choose any of the last two options the interface shown in Figure 1 is exhibited.

Figure 1. Interface for creation and management of virtual courses.

As it is shown in figure 1, on the interface’s left hand side a complete structure of available courses which he/she has in charge using an expandable tree is presented, meanwhile in the right hand side several options are presented depending on which node or kind of element he/she is situated. Thus, for example if a teacher is situated (through a left click) on the course level, a screen will be deployed for the creation of a new course, as exhibited in figure 2. At Topic level, as shown in the figure 3, the corresponding options of modifying (if already entered) and entering a child (an IG) are presented to teacher.
Figure 2. Insertion of a new course

<table>
<thead>
<tr>
<th>Nombre del Curso</th>
<th>Minería de Datos</th>
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<tbody>
<tr>
<td>Objetivo General</td>
<td>El objetivo de este curso es proporcionar al alumno elementos que le permitan entender las principales teorías y prácticas de la emergente área de Minería de</td>
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<td>Create Curso</td>
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Figure 3. Topic modification

<table>
<thead>
<tr>
<th>Nombre del Tema</th>
<th>Historia del Análisis de Datos</th>
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<tbody>
<tr>
<td>Descripción</td>
<td>Bajo la denominación &quot;análisis de datos&quot; se engloba en estadística a un conjunto de métodos descriptivos multidimensionales. Para</td>
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<td>Modificar Tema</td>
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<td></td>
<td>Eliminar Tema</td>
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<tr>
<th>Nombre Of</th>
<th>Objetivo/instruccional 1.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descripción</td>
<td>Lograr que el estudiante comprenda los bases de la Teoría de análisis de datos.</td>
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<td>Create Of</td>
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When continuing going down through the tree structure, if the LO level is reached the teacher can use one of three choices in order to associate a LO to an Activity:

- Search an existent LO within the system repository, using some criterion.
- Search externally to the system (a local or network host, an external device, a remote server, etc.) a LO which has its corresponding metadata in an additional XML file. In the figure 4 an example of this case for a LO located on an ftp server is shown.
- Create a new LO which already has the file. In this case, the system will ask for the information necessary for generating the XML file containing the corresponding metadata, as shown in the figure 5.

![Figure 4. Loading of a LO from a remote server](image1)

![Figure 5. Creation of a LO metadata](image2)
In order to define a set of questions that can be used in an assessment, the teacher must situate himself at the corresponding IO level and select the kind of question that is going to be entered. So far, the kinds of questions taken into account for the platform are: True – False, Multiple choice with only one answer, Multiple choice with multiple answer, Question with free numerical answer, Question with free alphanumerical answer, Matching question (association), Ordering question.

Figure 6 shows an example where a True – False like question is created. In this case, it can be observed that such question is associated to the BC “Datos” and that it has an assessment object. Such object is a file accompanying the question (an image, table, video, etc.)

![Figure 6. Creation of an assessment question](image)

### 2.3 Students interaction

As well as teachers, the students must make a first registration and authentication process, but unlike the formers, apart of the requested personal data (name, last name, age, etc.), they are asked to solve two tests from which the system infers their profiles. One of them is Felder – Silverman test (Felder, 1993), which allows inferring the students learning styles, qualifying them within the following: Global or Sequential, Verbal or Visual, Active or Reflexive, Sensitive or Intuitive. It is important to make clear that the students must consciously fulfill the questionnaire, answering the 44 questions, because the inference done by the system is the one that allows carrying out the content adaptation task.
The second test, known as triad test (De Gregori, 1999; Maclean, 1990) allows knowing the student’s dominant brain (left, right or central). This information is not used for the individual instructional planning, but it does for the group work planning.

Once a user has been logged as a student the framework presents an interface where he may enter in the courses in which he is signed or sign in into the available courses. In the left part of this interface some permanent options are presented and in the right one several contents and options are displayed in a contextual way depending on the actions that student is performing. When a student signs in a specific course, he may go through it and, for each IG, the framework performs a planning of the activities that such student must accomplish, depending obviously on the pre-requirements structure of the course and the student progress. An example of such planning is presented on figure 7.

![Figure 7. Activities planning](image)

At any time students have the chance of checking their progress with regard to courses structure using the table as the one presented in figure 8. There each student may see, at IG level, the description of each one of them, which ones are prerequisites of which others, which ones he already approved, which ones he must review, which ones he must be studying, and which ones he would study later.
Once a student completes the activities that are associated to an IG, the framework plans an evaluation that consists in a form that may have all kind of questions that were mentioned earlier. If the student approves the evaluation, the IGs that are post-requirements of the one associated with such evaluation would be presented to the student as available. Otherwise (if the student disapproves) the framework performs a re-planning in order to reinforce the contents in which student presented knowledge faults.

As a last functional feature of the framework it is important to highlight that it has forums and messaging services with which students may interact among them and with the teacher, exchanging ideas, questions, explanations, etc. In this way the learning/teaching process enriches itself enhancing the experiences interchange.

### 2.4 Technical details

The framework presented on this paper was developed under a client-server architecture using Apache Tomcat 6.0.10 as the pages and servlets manager and MySQL Server 5.0 as DBMS. Doing this, students and teachers may access the framework using a web browser and connecting to the system server. A diagram of the framework general architecture is presented on figure 9.
4. Expected results

At the time of presenting this paper the execution of two pilot courses (one on programming foundations and other in artificial intelligence) has not started yet because, even if the structure of both is already defined according to the parameters described here, their LOs and assessments repositories must be enlarged in order to achieve an effective adaptation according to students individualities. We hope that during 2009 we will have at least one of these courses functioning with a pilot students group.

It is important to highlight that in order to spread this framework, in its installing package, as well as in its website (http://pisis.unalmed.edu.co/CIA), the user manuals for students and teachers may be found.

5. Acknowledgments

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