Propositional logic Learning Objects

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Abstract

This paper describes how is possible to design a set of Learning Objects about Semantic Tableaux in Propositional Logic for the subjet of Mathematical Logic of the degree of Engineering in Computer Science. Also, it describes the experience of its use on a Virtual Campus with the students.

Introduction

Within the framework of the Educational Innovation Project entitled "*Didactic Materials for the subject of Mathematical Logic*" of the University Complutense of Madrid, we have generated a set of *Learning Objects* in the subject of "*Mathematical Logic*" for its use by students on a *Virtual Campus*. The learning objects have contents about Semantic Tableaux in Propositional Logic. They are packed according to the IMS Content Package and they can sequence discrete learning activities in a consistent way using the IMS Simple Sequence. Also we have used a Learning Management System to play the Learning Objects.

Learning Objects

Learning Objects are a new design concept for learning content. This proposal responds to the need to reduce to development time [Fri03]. In that sense, a major objective is to transform the creation of resources to an assembly of simpler pieces that can be located either local or remotely, and that may be constructed for heterogeneous platforms. At the structural level [Zey05], a learning object is formed by contents, descriptions of the behaviour for that object, and a set of describing metadata. We have used the learning object implementation of IMS Content Package [Rod03]. The IMS Package consists of two major elements: a special XML file called the IMS Manifest file, describing the content organization and resources in a package, and the physical files being described by the XML. Once a package has been incorporated into a single file for transportation, it is called a Package Interchange File.

Propositional Semantic Tableaux

One goal of our computer-assisted learning project is to investigate the learning principles in the process of designing Learning Objects necessary to understand the main concepts and techniques related to *Semantic Tableaux* in Propositional Logic [Fit90]. It is an intuitive proof procedure [Fit02], closer to the intended semantics, and it is automatable.

The methodological approach considered in this work consists in a stepwise analysis and categorisation of an ordered collection of material from our own experimentation on the course of "*Mathematical Logic*" into understanding the Propositional Semantic Tableaux. In order to develops this material and design Learning Objects, we have applied the following pedagogical principles [Dou01]: Activate students' knowledge, challenge students' thinking, give students an opportunity to express themselves and get feedback on their action, and facilite the comparison by asking explicitly the students to compare the examples and to solve the problems by themselves with their own methods. Following these ideas, our Learning Objects are organized as a 3-session program [Qua03], which provides students to work with a set of files in the PDF format. All the sessions have been initially proved and purchased at the *Virtual Campus* [Sar05] in an estimated time of 1 hour per session, according to the current program and the software resources available for the University course.

Session 1. The "*Theory1.pdf*" file is a brief slide introduction of 25 minutes to the refutation proof procedure of Semantic Tableaux for Propositional Logic. The "*Resume.pdf*" file is then available as an optional add-on. Here's where the student get a summary of the classical *Tableau Expansion Rules* and some useful and practical remarks on the method of Semantic Tableaux. "*Examples.pdf*" covers a collection of typical examples for problem solving using Tableaux in Propositional Logic. Finally, "*Exercises1.pdf*" is a proven step-by-step exercise file that the students must try to solve in an estimated time of 30 minutes. Additionally, the students also have a final review of 5 minutes to discuss their solutions with respect to the "*Solutions1.pdf*" file.

Session 2. "*Appendix.pdf*" begins with a more complicated and motivating example to show the meaning of the two key properties of the method of Semantic Tableaux: *Soundness* and *Completeness*. After approximately 5 minutes, the "*Theory2.pdf*" file provides during 25 minutes the formal notions and results about soundness and completeness and the more useful applications in Propositional Logic: *Testing for Satisfiability* for propositional formulas and the algorithms for conversion to *Disjunctive Normal Form* and *Conjunctive Normal Form*. Proofs of these results are only outlined, but optional and appropiate references are given in the "*References.pdf*" file. In "*Exercises2.pdf*" we give to the student a new step-by-step exercise section of 25 minutes. After this time, the students could check during the last 5 minutes of the session the solucions of their exercises in the "*Solutions2.pdf*" file.

Session 3. The final session of our program will be devoted to examine a possible implementation of Propositional Semantic Tableaux in Prolog following the guidelines given in [Fit90] and "*References.pdf*". We have chosen Prolog as the implementation language because it allows the student to understand a declarative programming language based on Logic with a code that is rather easy to follow. The understanding of Prolog that is necessary is fairly basic. The students must be able to answer in an estimated time of 50 minutes the guided practical and independent exercises presented in "*Exercises3.pdf*". Finally, the last 10 minutes of the session are dedicated to examinate the solutions of the exercises provided in the "*Solutions3.pdf*" file. Optionally, advanced references about similar implementations are set up as references in the "*References.pdf*" file.

Design the Propositional Logic Learning Objects

In order to built a set of Learning Objects from our 3-session program described above, we have used the following elements:
- IEEE LOM for Metadata.
  We tagged the metadata involved for the sessions:
  - General element → Labels: 1.2.Title, 1.3.Language, 1.4.Description, 1.5.Keyword, 1.6.Coverage, 1.7.Structure and 1.8.Aggregation Level.
  - Life Cycle element → Labels: 2.1.Version, 2.3.Status and 2.4.Contribute
  - MetaMetadata element → Labels: 3.2.Contribute, 3.3. Metadata Écheme y 3.4. Language.
  - Technical element → Labels: 4.1.Format
  - Education element → All labels.
  - Righst element → Nothing
  - Relation element → Nothing
  - Annotation element → Nothing
  - Classification element → Nothing
- IMS Simple Sequencing for managing and sequencing the contents.
- The Authoring tool Reload Editor. The Carnegie Mellow version allow to label IMS Metadata and IMS Simple Sequencing, and packaged with IMS Content Package.

Figure 1. Manifest Learning Object Tableaux

Concluding Remarks and Future Work

According to the results and marks obtained in the exams during the course of the project, we can conclude that this initial experience with Learning Objects in the subject of Mathetical Logic has been satisfactory among the students. As future work, our main goal is to build a digital repositorie of Learning Objects about Mathematical Logic using IMS DRI. The students will be able to managed this Learning Objects with a Learning Management System. We have thought about using *Moodle* for this purpose.

References

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