CAST for cognitive simulation: An architecture model for tutoring systems based on prototyping

A. Plácido, J. Hernández and F. Martín
Departamento de Informática y Sistemas
Universidad de Las Palmas de Gran Canaria

e-mail: aplacido@halley.dis.ulpgc.es
Campus Universitario de Tafira
35017 - Las Palmas de G.C. Spain

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Systems theory provides a multitude of concepts and methods for problem solving in general. It is thus justified to view CAST as an important component in the construction of support systems for modelling and for problem solving with models [PICH90]. In this paper an architecture model focused on learning cognitives theories, for supporting the behavior simulation of an expert in teaching on problem solving is proposed.

The expert behavior has been previously modelled considering the typical activities in the teaching domain for problem solving in the context of an intelligent tutoring system. The first considered task is to know about the student in order to obtain a model with the most important aspects that condition the tutoring process; and then, to interact with the student applying the most suitable didactic strategies during the tutoring process.

An important aspect in the simulated behavior is the generation and maintaining of student models. Student modelling in intelligent learning environments ensures a tutoring adapted to the learning needs and goals, considering psychological questions underlying learning, teaching and understanding [SLEE83]. The architecture model proposed faces student modelling by the psychological prototyping paradigm.

Student modelling is a critical task because of the lack of knowledge about the student, in particular at the beginning of the tutorial session, making possible the application of inadequate tutoring strategies since the real capabilities of the student are not known. So, the problem is lied in getting a more complete student model at each moment, which can be solved making assumptions based on similarities found among previous students.

In a way, it can be considered that the intelligent tutoring system has to *learn* the student model [GILM88]. In this system, the *learning* of the student model is made by analogies; this skill is based on the transference from previous experience to new situations in order to produce new knowledge structures [GETN83][CARB86]. On the other hand, there are experimental psychological researchs that show the existence of classification effects in the use of the concepts. These classification effects are frecuently used in reasoning [ROSC73][ROSC75]. Starting from the categorial similarity and cognitive economy principles, prototypes of categories that constitute a measure of central tendence of the different relevant attributes for the category are developed [ROSC78][POSN68]. In the system proposed, the retrieval of previous experience for the analogical reasoning is made by prototypes generated from previous students exemplars.

Basing on this theoretical foundations, we propose an intelligent tutoring system architecture that integrates a base of student prototypes. In intellingent tutoring system environment, a prototype can be considered as the representation of the knowledge about the student who is considered as a typical exemplar. The representation of this knowledge is composed by concepts referred to the particular tutoring system domain, as the psychological profile of the student that it represents.

Therefore, the tutoring system must incorporate a subsystem to manage this base of prototypes, connected directly to the subsystem charged with the student modelling. This modeller asks for the prototype searching starting from the initial model, and if the current student can be adjusted to the prototype returned by the management system, the student model is complemented with the returned prototype. Since during the tutorial session, the assumptions can be corroborated or not the system reasoning must be non-monotonic in order to use the student model generated at each moment.

The main functions of the base of prototypes management system are: keeping organized the base of prototypes; providing searches in the base of student prototypes, warranting the recovery of the most resemblance prototype to the knowledge previously modelled by the tutoring system; and finally, the accommodation of the prototypes throughout new students are taught, making more and more complete the stored information.

The management system is able to autorganize itself, allowing the generation of new prototypes and the redefinition of the current ones.

The proposed architecture is composed by four additional modules that interact to reach the aims of this tutoring system: an intelligent interface, which controls the communication in the tutoring system; a tutoring module, which determines the teaching strategy and performs it; an expert module which provides the problems to the student, as well as interpreting his answer; and a modeller with the function of generating the student model by the interaction with the other modules.

The integration of the base of prototypes management system in the architecture of the intelligent tutoring system is a contribution for developing systems for intelligent computer-aided instruction that ensures an effective student modelling and tutoring.

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