Relatório Técnico

Núcleo de Computação Eletrônica

Modeling Computer-Based Distance Learning Platforms

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NCE - 07/02

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Abstract

Pragmatic problems in computer-based distance learning platforms concern generally the correct use of technological tools. These problems have technical solutions and do not represent the most important preoccupation in a platform design phase: even a repetitive utilization of the platform could become their naïf users very familiar with its functionalities. Theoretical problems, in contrast, are more complex because they involve learner's cognitive gains and requirements of dynamic and independent decisions. The dichotomy *cognitive gain x punctual learner's Socratic reasoning* is a good example of this complexity. So, it is important to represent the dynamical knowledge and reasoning involved in learner's cognitive parameters (i.e., learner's abilities and features such as mental representations, knowledge acquisitions, use of inferences, heuristics, deductive or inductive reasoning etc.).

The diagnosis of these parameters (that are naturally fluctuating in a platform during a learning activity) is crucial to provide dynamic inference processes and interpretation of information in order to generate data and metadata to the platform.

This paper aims theoretical supports for computer-based distance learning platforms. We discuss about the design of this kind of platform, which uses uniform and diagnosis processes in order to generate dynamical data and metadata. These data are used to extract new multi-sensorial knowledge to be integrated or then to perform an interoperational search of common knowledge resident on online learning platforms: the status from this knowledge should to shift from a platonic methodology -where the objects are independent from the discuss- to an intuitionist methodology -where the objects are represented as the result of a mental construction-. We affirm that a platform based on these theoretical supports allows a safer learning process.

Keywords
Computer-based distance learning platform, uniform diagnosis, knowledge modeling.

Introduction

Since the sprouting of CAI (computer-aided instruction) systems and authoring languages, computer scientist and education scientists are doing researches together in order to transform *the computer* in a *teacher*. Intelligent Tutoring Systems (ITS), for example, were a great hope to computer-based learning. These systems were referenced as a solution to the problem of forming and training peoples in several areas of the knowledge. Unfortunately, ITS were not a plausible solution: some scientists have quickly perceived that the problem of reasoning representation is more complex than the one they initially imagined. The recent communicational and informational technology (CIT) could be seen as the biggest impulse made in the last years to effective computer-based learning. We are actually heading a group of researchers interested in the use of CITs in computer-based distance learning, more specifically concerning theoretical supports for platforms authorizing a dynamical behavior.

A functional characteristic resident in most computer-based distance learning platforms concerns to a three-faces pyramidal structure: technological tools aimed to the *elaboration of instructional materials*, technological tools aimed to the *management of the use* of these materials and additional tools facilities aimed to the *management of administrative and academic features.* Some of those platforms designed under IMS (IMS, 2002) specifications have showed -in recent versions- characteristics concerning data interpretation. Unfortunately, the perspective of interpretative and dynamical behavior is frequently rare in actual platform designs (Crespo, S., et al). In fact, it represents a new investigation aspect that combines some techniques used by others areas: data mining, computational intelligence, logic etc.

The pursued goal in this context is to avoid the *freezing* of actions and data fluctuating into the platform during real time utilizations. Of course, a distance-learning platform should not be a simple repository of instructional materials with an imbricate composition of technological tools aimed to guide, *nec plus ultra*, the use of these materials.

Uniform Diagnosis

The present paper aims theoretical supports for computer-based distance learning platforms. We suggest that a learning process be modeled by parametrical-dynamic subsystems, which the central task is to help and to drive the learning through the several events (these events could eventually be obtained by the processing of multi-sensitive tokens of knowledge). These events could also be preset or not: using for instance peer-to-peer interoperating or punctual established strategies. A technique able to activate a chain of events, without loss of context, concerns the use of uniform diagnosis processes, which could become activation parameters used by learning subsystems.

To perform these activations and drive the learning the model of the platform must consider some logical requirements that allow dynamical behavior. We chose here the programming problem resolution paradox as a metaphor in order to illustrate the use of recursive subsystems generating uniform diagnosis (of course, we delimitate our actual discourse by the Socratic problem class).

The learner-driving assessment of a platform relies upon a convergence: for such a platform an additional contextual interaction must not forever delay the learning process (Barril, P., et al, 1996). Such a platform must provide uniform diagnosis in order to drive remote interactions with the user: the learner's acquisition knowledge can be simulated as a compilation of knowledge, but, in this context, it could be also necessary to compile knowledge for the learning process. Theoretical foundations for this kind of platform must foresee adjusts in these levels of compilation, to which we propose recursive subsystem generating uniform diagnosis.

An important feature of those parametrical-dynamic subsystems concerns the synchronization of several kinds of processes occurring into the platform during a remote use: it requires an articulation of knowledge tokens, and the general model could be seen as an abstract representation of all survivor data and metadata with regards to a learning process lifecycle. References in the general model could be common to every active token of knowledge piloted by uniform diagnosis subsystems.

Of course, diagnosis must be generalized and classified in order to obey the model, and one is lead to articulate the expertise in levels of knowledge being utilized. For instance, under a classical logic viewpoint, the meaning of a token of knowledge is externally defined by a collection of interpretations; under an intuitionist logic viewpoint[1], the meaning of a token of knowledge is internally defined by rules: the difference between both viewpoints matches to the one between denotational and operational semantics. For remote-learning knowledge construction, one must set the strategies of interaction by an external description, but one must also use the internal approach to verify its construction and diagnosis the status of the interaction.

[1] To define semantics for intuitionist logic, one does not assign to each sentence a truth-value, but proofs instead. Given a sentence, the question an intuitionistic logician asks to himself is not "is this sentence true?" but "what does a proof of it means?" For an intuitionist, the proof of a sentence is a program of a mental construct for showing the sentence is obvious. This constructive feature explains why intuitionistic formalism has more application to computer science than classical one. As a matter of fact, the intuitionistic definition of proof describes exactly the problem frame for diagnosis in computer-based distance learning platforms. Let us note that intuitionistic logic is a bit peculiar. Specially, the negation of a statement means the original statement has no proof and describes an unsolvable problem. The double negation means "this statement has a proof" and so is not equivalent to the original. This allows an interpretation of classical prepositional logic into intuitionistic logic. Constructive methods such as recursive realizability make it possible to extend specification as type paradigm to the simpler classical logic and to give denotational semantics.

An Example of a Dynamic Diagnostic

The following example illustrates the elaboration of dynamic diagnosis in a computer-based remote lesson of computer programming: the learner must solve a table-ordering problem proposed by the instructional material. The two following solutions are referenced to a learning drive subsystem and to the active diagnosis processes (fig. 1). Real references of utilization could be or elaborated by the learner or preset in the construction of the instructional material or yet acquired by platform subsystems. In the second solution of the figure there is an additional loop structure; the first solution has a decreasing loop structure. The parametrical recursive subsystem concerning the active event could be authorized by dynamic characterizations of these solutions (Lima, C., 2000). The first solution has as dynamical diagnosis the following characterization:

```
i←1;
while i<n do
 ini j←i+1;
  while j<=n do
   ini if A[j]<A[i] then
        ini temp←A[j];
            A[j]←A[i];
            A[i]←temp
        end; j←j+1;
   end; i←i+1;
end;
```

```
i←1;
while i<n do
 ini j←i+1;
  while (j>i) e (A[j]<A[j-1]) do
   ini temp←A[j];
        A[j]←A[j-1];
        A[j-1]←temp;
         j←j-1
    end; i←i+1;
end;
```

Figure 1: Referenced solutions for the ordering of the table A.

$$I\,(i):\ \forall j,\ j < i,\ \forall k,\ k < i,\ (j < k \Rightarrow A[j] \leq A[k])$$

The second referenced solution has as dynamical diagnosis the following characterization:

$$I\,(i):\ \forall j,\ j < i,\ \forall k,\ k < i,\ (j < k \Rightarrow A[j] \leq A[k]) \wedge \forall j,\ j < i,\ \forall k\ (i \leq k \Rightarrow A[j] \leq A[k])$$

A General Model

The difficulty of modeling dynamical diagnosis processes illustrates the complexity of remote knowledge management. For parametrical subsystems performing an interoperational peer-to-peer fetching one of the most interesting research problem concerns the epistemological status of the tokens of knowledge activated during a platform event. This status oscillates between a platonic methodology, where these tokens already exists independently of the interaction contents, and a intuitionistic methodology, where these tokens are built as result from a dynamic event in the platform (LIMA, C, 1999). We recognize that the general model must look for the equilibrium between these two approaches.

Some intern platform function requirements could impose a limitation of parameterization of diagnosis process that requires immediate execution of remote processes. Heuristics of event instantiation could be added to the general model in order to do synchronous changes from modal to causal events. For instance, let a genetic graph with supporter tokens of knowledge and structured knowledge designing two axes of a general model abstraction. The elementary tokens of knowledge of the graph are not differentiable and could be seen as strategic knowledge forming the intersection of the three axes (fig. 2).

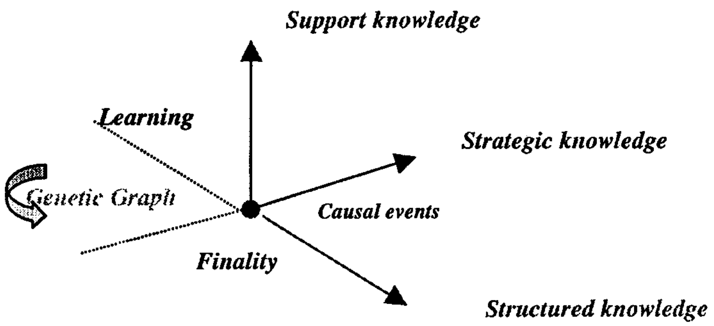

Figure 2: A genetic graph general model

The tokens of knowledge following the three axes are not completely independents: in some cases it could be required some active redundancies in the model in order to establish an eventual causality of the domain been learned. For instance, modal events could be dynamically interpreted and transformed in causal instantiations by the use of remote and heuristic parameters. These synchronous events can be foreseen in the platform design phase by providing specialized, but it is not so trivial and some dynamic adjusts could be necessary in order to do not slow infinitely both the interaction and the active uniform diagnosis process.

The illustration above shows that the general model must pay attention to an actual abstract differentiation under criteria of learning, causality, and finality. However it must be noticed that diagnostics produced by subsystems using those dynamic tokens of knowledge could be collated (and eventually filtered) before their transformation in dynamic parameters.

]The knowledge conservation in real-time changes of parameters among diagnosis subsystems illustrates the necessity of a complete theory describing the platform model. Of course, even a human managing the activation of tokens of knowledge (fixed or context dependent) does not have both a global event description and the control of the knowledge management (Romanczuck-Requile et al). A local representation of a compilation and an additional conceptualization can imposes coherence and fullness restrictions for the descriptions of abstract knowledge modeling processes. It is important to note that an abstraction of a recursive subsystem should be seen, in this context, as a partial compilation process. Of course we do not deny that in most learning interactions reference results from exteriorization of a mental representation, and diagnosis subsystems should be able to describe each step of the elaboration of common references. This model could foresee this elaboration via, for example, the development of reification processes.

Conclusions

In this paper we discussed about theoretical supports for computer-based distance learning platforms. We have proposed the use of uniform diagnosis as a mechanism to generate dynamical data and metadata. These data could be used to extract multi-sensorial knowledge. We showed that the three-faces pyramidal structure of actual platforms could become the platform a simple repository of instructional material, and then it is necessary a general model to support the platform as a dynamic learning environment. We used an intuitionistic logic viewpoint in order to solve the problem of modal events eventually appearing in a remote use of a platform. We exemplified the elaboration of uniform diagnosis by an example that uses the programming problem resolution paradox. We also proposed a general model based on the abstraction of token of knowledge in a genetic graph, and we demonstrated that synchronous events can be foreseen in our model by the design of specialized tools.

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