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Learning of Data Structures and Algorithms Using a Distance Learning Platform

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Abstract

Learning has been considered as a non-trivial human activity because it involves some complex tasks. In distance learning there is an additional complexity due to space and time shift in learning and teaching activities. Computer-based distance learning has an incremental difficulty: the use of technological tools by both learning interaction actors (learner and teacher).

These tools are generally grouped in a platform system that is usually designed and implemented under some common rules: to allow the development of instructional material, to manage synchronous and asynchronous dialogues, etc. Unfortunately, in the design of this kind of platforms, knowledge about technological aspects can get more attention than learner's knowledge acquisition processes or teacher's strategies: the resultant platforms frequently are no flexible systems that do not support the plug-in of tutoring systems. In this paper we describe a system aimed to support computer-based distance learning of data structures and algorithms.

The learner's understanding of this area of Computer Science depends on integration between dynamical visualization and logical reasoning: the presentation of the domain knowledge should put more emphasis on this dynamism. Finally, we discuss about technological feasibility to plug-in our system in a flexible computer-based distance-learning platform being developed.

Keywords

Distance learning; Computer-based learning of data structures and algorithms; Tutorial systems.

Introduction

Nowadays, competitivity makes professionals, from many areas, look forward knowledge and skillful developments. It is sometimes difficult due to their limited schedules and needs of displacement. Distance learning has been an alternative for flexibilization and democratic teaching access because it could eliminate time and distance's barrels.

Teaching has been a difficult activity. In distance education, especially via Internet, we can add other difficulties. According to [Leite, 2000], "*on line education demands a*

specific pedagogical standard development which must profit the actual technological development level in the internet and multimedia area, in order to motivate the students and increase their learning grade". [Leite, 2000] also affirms: "*the developed model to an EAD based on pressed material doesn't seem adequated to the on line environment. Consequently, it doesn't profit the best resources this environment offers*".

The present paper describes a design and an implementation of a computer-based distance learning system concerning data structures and its algorithms. This tool will be integrated to a distance-learning platform (dedicated to several computer science's subjects).

Motivation

It is largely accepted that there is a huge difficulty involving classic teaching of data structures, because the majority of the learners do not have resources to help their apprenticeship about how these structures run. This problem is concerned to the required visual dynamism necessary to understand the logical behavior of structures such as stacks, queues and trees, as well as how the memory is dynamically used. Besides that, these structures are usually implemented with pointers [Szwarcfiter And Markenzon, 1994], a non ordinal conception of understanding.

Static representations tend to limit the learner's understanding, generating gaps that eventually affect other subjects of computer science. Deficiencies in data structures learning may affect the comprehension of databases, for example.

Of course, some learners can achieve a satisfied learning level, despite all the inherent difficulties. It can happen due to teacher's strategies, which usually use graphic representation to do a suitable visualization of the logical behavior of data structures and the associated memory's representation. Even a teacher possessing an ability to draw data representation and having a good strategy to explain it during a lesson, learners will have a poor and static representation of dynamics activities, which is frequently inappropriated to illustrate all executed changes. In fact, only the last structures are effectively transcripted, do not taking in account data structures' changes occurred before the final result.

Generally, only the teacher controls perfectly the technique of construction and manipulation of the data structures and its algorithms. If the learner needs to remember how a particular task was done, then he must ask the teacher about operations and structures. So, it could be necessary to spend a long time with his teacher in order to practice and test his own knowledge.

Concerning distance education, it must be considered some additional complexity due to peculiar characteristics involving space and time. Normally, the learner studies by himself, using the available instructional material. Unfortunately, this material is often static and does not express the inherent dynamism related to this kind of learning. Additionally, this problem could become more accentuated due to the feedback's difficulties, once the teacher is not immediately reachable when necessary. Although there is a possibility of remote interaction between learner/tutor, this difficultly happens in real

time. In other words, dynamic simulations, so necessary to the success of these algorithms and structures understanding, are usually reduced to some specific activities with small periodicity.

In remote learning platforms it is rare to occur synchronous simulations with data structures and its algorithms. The non-monotonic changes, concerning this domain of knowledge, should be taken in account: this could help the comprehension of several stages assumed by a data structure before its final stage of the representation.

Propose

The system proposed here is objected oriented, developed in Java language and uses computational intelligence techniques. It has parameters in order to allow a dynamic connection with a distance education platform: this parametrical abstraction uses uniform diagnostics in order to adapt the platform to the learning context [LIMA, 2000].

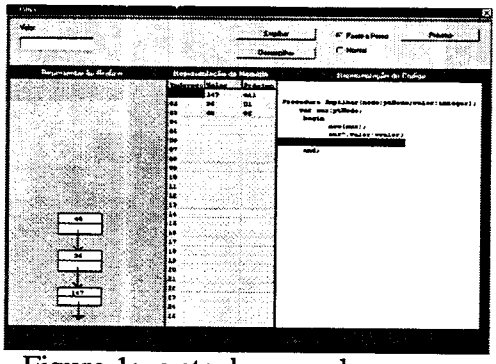

Figure 1: a stack example screen

In this system, learners can create stacks, queues and trees, checking the changes either in their logical structures or in memory's internal organization, verifying several kinds of manipulation on its elements. The system is able to show the initial state of the structure and illustrate, step by step, all changes dynamically occurred. The system is especially able to illustrate all new operations put by the learner, from the beginning to the final state. (figure 1)

Learners can check the algorithms used by the system and could execute them, step by step, via a trace subsystem. They can elaborate their own algorithms and perform tests, identifying, for example, logical errors.

The system also includes a help interactive mechanism, which allows the learner to clarify conceptual doubts concerning data structures and its algorithms.

Although the system is a tool aimed to remote learning, it could also be normally used in presential one. This occurs because the teacher, even using high-level abstractions in classroom, would need to execute an exhaustive number of iterations until the learners achieve a satisfied knowledge level. This repetitive activity of simulation about structures' behavior and its reactions against imposed alterations can be executed by the system, releasing teacher to other activities. The use of the system in presential learning can, in pragmatic terms, help the student's mental representation concerning data structures and algorithms. This could aid the knowledge construction process.

A tutoring system could be seen as a good repository for recording knowledge dynamically. Books and appointments are definitely static materials, which do not represent fairly all the changes imposed to a data structure. Our system allows the application of

operations on these structures as many times as it is necessary. The learner also could check "what" happened with the structure and "how" it happened.

Platform

Our system will be connected to a platform of distance education called ACÁDIA, which offers an apprenticeship environment with friendly interface. The mainly goal of ACÁDIA is to help the learning process, running by a graphical communication in synergy with the contents. This environment was projected and developed in order to motivate the collaboration and the creativity of learners and teachers, transforming them in active agents of the learning process [Brasil and Martins, 2002]. Sites, such as classroom, library, and secretary's room, compose ACÁDIA representing the metaphor of a traditional school. It will be used by others tutoring systems, including ones in development by our research group. These systems embody some domains of Computer Science, such as Design Patterns [Lima and Gandra, 2002] and Objected Oriented approach [Lima et all, 2002].

The ACADIA environment has been developed on a platform named DÉDALUS, which is a flexible framework, which uses a peer-to-peer technology, interacting with federated applications. It allows the construction of connected sites, providing data sharing between them, where available resources on a site may be accessed by the others sites. The approach of distributed computing adopted by DÉDALUS avoids the requirement for robust servers and a large broad band for its utilization [Paiva e Faissal, 2002].

A software engineering research group that is coordinated by professor Carlo E. T. de Oliveira from our University has developed these two platforms.

Conclusion

In the present paper we have showed some problems concerning data structures' understanding and we have proposed a system designed to learning of data structures and its algorithms. In order to minimize the apprenticeship's difficulties, we have demonstrated the importance of the dynamical illustration of interactive visualizations of data structures' logical behavior and the associated changes in the memory, as well as the possibility of checking algorithms used by the system (executing them step by step) and also allowing learners to create and to run their own algorithms.

Through the connection of our tutoring system on a distance-learning platform (ACADIA) we intend to available it to a larger number of learners providing facilities, such as synchronous and asynchronous dialogues, even for learners without technological background. We also emphasized the importance of utilization of DÉDALUS environment in order to allow sharing of resources by several sites, avoiding the need of big servers and a large broad band.

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