WAPE - a system for distance learning of programming

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Summary

A challenging research goal is the development of advanced Web-based educational applications that can offer some amount of adaptivity and intelligence. In the paper the WAPE project being under development as an intelligent and adaptive environment for supporting distance learning of programming is presented.

The WAPE system supports users of four types: students, instructors, lecturers and administrators. Users access WAPE through a standard Web-browser, which present HTML-document provided by the HTTP server on the server side. After authorization of the user as a student, the appropriate menu shell is opened. The WAPE system supports the following tree levels of learning process:

(1) when a student learns theoretical material in a specific domain with the help of hypertext textbook,

(2) when the system tests student's conceptual knowledge concerning theoretical material learned,

(3) when a student under the control of the system solves the practical educational problems (projects).

The third level is assumed to be the main one in using the system; in order to learn a course supported by WAPE a student has to perform several individual projects: tasks and exercises.

Any course supported by WAPE is based on a knowledge model which consists of a finite set of concepts and some relations on it. For any concept s a model of a student x includes a grade of knowledge that x has on s. We use four grades which divide all students on experts, advanced students, beginners or novices with respect to s. The student model is used to provide the student x with the most suitable individually planned sequence of concepts to learn and the projects to solve. For example, every time when the student x is going to solve a project the system checks whether all prerequisite concepts are sufficiently known by x. If not, the student x cannot begin to solve the project.

Many adaptive systems detect the fact that the student reads some information to update the estimate of his knowledge. Some of them also include reading time or the sequence of read pages to enhance this estimation. While this is a viable approach, it has the disadvantage that it is difficult to measure the knowledge a student gains by "reading" an HTML page. In contrast we decided to take into account neither the information about visited pages nor the student's path through the hypertext books. Instead we use only the projects (tasks and exercises) and the tests for updating the student knowledge model.

The WAPE system uses three problem solving support technologies: intelligent analysis of student solutions, interactive problem solving support, and example-based problem solving support.

For intelligent analysis of student solutions to every task are assigned a set of program tests and a set of inference rules. The program tests are used to decide whether a program constructed by a student is a correct solution of the task or not, find out what exactly is wrong or incomplete. The inference rules are used to possibly identify which missing or incorrect knowledge may be responsible for the error and to update the student model when the program constructed is an incorrect solution of the project.

Instead of waiting for the final solution of a task, the WAPE system can provide a student with intelligent help on each step of problem solving. The level of help can vary: from signaling about a wrong understanding of the statement of the task, to giving the next suitable learning goal.

Tests are questions that the system uses for testing student's conceptual knowledge concerning theoretical material learned. We use tests of three types (single choice, multiple choice and textual tests) and distinguish three types of tests: verbal, quantitative and analytical questions. All tests which are aimed to check the student's knowledge related to the same concept are grouped into so-called test space which is used for random generation of sequence of tests for concept as a path from an input test to an output test.

One of the main issues in development of advance technology learning environment is a gap between pedagogues and technicians. The WAPE project is aimed to overcome the gap. Lecturers without programming skills will be able to create adaptive educational hypermedia courses supported by the WAPE system.