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ELECTRONIC COURSE UNDER THE THEORY OF ALGORITHMS AS AN ELEMENT OF INTELLECTUAL ADAPTIVE SYSTEM OF TRAINING

Abstract: In the article, questions of creation of an electronic course under the theory of algorithms and data structures as an element of intellectual adaptive system of training are considered. Use of means of multimedia allows achieving more visualization and clearness of a studied subject, creates friendlier environment for the user, and network technologies give the chance remote access to information resources. Adaptive systems of training are directed on personification of the environment of training, its adjustment for features of individual users. It is suggested one system serving set of users with the various purposes, level of knowledge and experience. Problems of more flexible modeling of the trained environment, adaptation of model to the concrete trainee, creation of nonlinear trajectories of process of training (curriculum sequencing) or instructional planning technology are studied as well.

Key words: applications in subject areas; computer-mediated communication; interactive learning environments; lifelong learning; teaching/learning strategies

1. Introduction

Now there is a variety of qualitative manuals under the theory of the algorithms covering the traditional maintenance of bases of the theory and practice of data structures and algorithms. Many modern textbooks contain in the complete set of CD as electronic support of a course. So, for example, T.Korman's textbook under the theory of algorithms (Kormen, 2009) contains descriptions of classes Java for application of the algorithms resulted in the book. However, the possibilities

given available nowadays by information technology are much wider than traditional linear representation of a teaching material in strict sequence of studied themes. Using means of multimedia allows achieving more visualization and clearness of a studied subject, creates friendlier environment for the user, and network technologies give the chance remote access to information resources. Nevertheless, questions of more flexible modeling of the trained environment, adaptation of model to the concrete trainee, creation of nonlinear trajectories of process of training (curriculum sequencing) or instructional planning technology in many cases remain outside of available training courses under the theory of algorithms.

Problems of creation of an electronic course under the theory of algorithms and structures of the data as element of intellectual adaptive system of training are considered in the present article. The structural model of a course, possibility of creation of the adaptive environment of training at its use is considered. The structure is offered and the maintenance of the electronic practical work included in the given course is studied.

2. Electronic course on the theory of algorithms and data structures

2.1. Adaptive systems of training

Adaptive systems of training are directed on personification of the environment of training, its adjustment for features of individual users. Support of adaptive methods in training systems appears rather useful when there is one system serving set of users with the various purposes, level of knowledge and experience. Thus besides adaptation to the separate user it's considered still adaptations to sets of users allocating at computer training three hierarchical levels of adaptation to trainees (Zaiseva, 2003): (1) adaptation to students as categories of users; (2) adaptation to group of students; (3) adaptation to the separate student.

The first level of adaptation provides adaptation to each category of users of computer system of training depending on their requirements and it is usually realized by creation of the special interface for each allocated class. Such approach

is characteristically for any computer systems. In intellectual training systems it is necessary for pupil to give following possibilities: training, examination, exercises, the help and the help information, video lectures and their presentations, different kinds of feedback: questions to the teacher, conference, student's forums, electronic methodical grants, input of comments on a course of employment, etc.

Adaptation to group of students provides adjustment of system depending on the chosen specialty, on an educational program, on an age and a psychological orientation of the person. This level of adaptation is based, first of all, on the decision of two basic questions of didactics: "to learn to what?" and "how to learn?". The answer to the first question defines the training purposes, i.e., volume of necessary knowledge, skills and degree of their development. The decision of the second question of didactics ("how to learn?") causes a choice of methods of the training most suitable to group of pupils and also to ways of representation of the information. A choice of methods of training and ways of representation of the information are stipulated by both age of the trainee and a psychological orientation of its person (orientation to himself, to a problem, to interaction).

2.2. Structural model of an electronic course

The structure of an electronic course is made by following modules:

(1) Basic module - the base of resources – contains teaching materials on all themes including practical tasks, projects, problems, materials of laboratory researches. The module is supplied by the convenient interface for viewing and a choice of educational resources.

(2) Module of monitoring – serves for support of the trainee, carries out training monitoring, provides means of definition of a position of the student for training space. Module contains verifying tasks, tests on the passed theme. The testing program works in an interactive mode representing result of testing on the computer screen directly in the course checking. Formation of tests is carried out on the basis of random sample of both as questions, and an order of answers (in case of the multiple tests). Such way of giving the verifying materials excludes

formal learning only numbers of the right answers and states an adequate estimation of mastering an educational theme. The student has possibility of several attempts of delivery of the test. Thus, results of check, considering also a number of attempts, state an estimation of the student on the given theme. The given estimations being summarized with previous form a current vector of an estimation of the trainee which positions the student on an educational scale.

By results of current check, the system gives out recommendations about the further tactics of training. At a deviation of a trajectory of the trainee from set more than the criterion defined for this stage the system forms correcting vector of educational resources which includes as passed but undigested adequately themes, and an additional material. The additional material contains samples of the decision of the problems, ready algorithms with possibility of step-by-step execution for their best understanding, samples of the executed projects. The given module is structurally connected with the previous module – base of resources.

(3)   Module of total control – serves for a final estimation of degree of mastering the course as the student. The total estimation includes as results of final testing at all course as estimations of the executed tasks, projects according to the curriculum. The total estimation includes the results of final testing received automatically from system, and also an estimation of teachers under the executed tasks and projects. The given module works as an independent component of the previous module and is logically connected with the subsequent module.

(4)   Module of identification of the trainee – serves for registration of users of a training course. Teachers, tutors, students and administration can be users. The system gives the chance formations of educational groups of trainees and group monitoring of training.

(5)   Module of adjustment – is directly connected with the previous module and serves for adjustment of parameters of system. Such adjustment is

carried out from the teacher conducting a training course. The teacher-user of an electronic course has possibility both to set the general group options of training, and to form necessarily individual adapted parameters of system. Group options of a course take into account a category of trainees (a direction of training, a speciality) as the students specializing in the applied mathematics and computer science and as the students of the general natural-scientific directions of training. Individual options carry in many respects the initial character, set initial parameters of trajectories of training. Further the system in many respects itself adapts for the trainee considering its individual abilities to the training, available knowledge base (background). The teacher, nevertheless, can operatively correct the options set initially taking into account results of intermediate estimations that promotes more adequate process of training. Such symbiosis of the automated system of training and the teacher allows to receive better model of the trainee and accordingly to raise efficiency of process of training.

2.3. Possibilities of creation of an adaptive training environment

Among adaptive control facilities we can allocate following ones:

- representation of teaching materials in various sequence taking into account requirements of the trainee; formation of nonlinear trajectories of training;
- adjustment of parameters of the program of interactive testing on the basis of the data of intermediate control of progress;
- organization of educational process in the stage-by-stage image and adjustment of criteria of transition from one stage to another;
- formation of rating system of a gain score of the trainee, adjustment of weight parameters of components of a total estimation.

The electronic course gives the chance studying program themes in a subject "The theory of algorithms and data structures" in a nonlinear order without strict fixation of sequence of a represented educational content. Trainees, proceeding from the requirements or independently or by means of the teacher, can choose

an order of studying course. The tasks, projects carried out in the studying the course are checked by the teacher. He makes necessarily recommendations for choice the further strategy of training. At the same time teacher has possibility of individual or group monitoring of training process. One of the possible schemes of construction of nonlinear model of training is considered below (Fig. 1.). In this scheme the total rating estimation of the student is developed on the base of midterm (intermediate) results and final control.
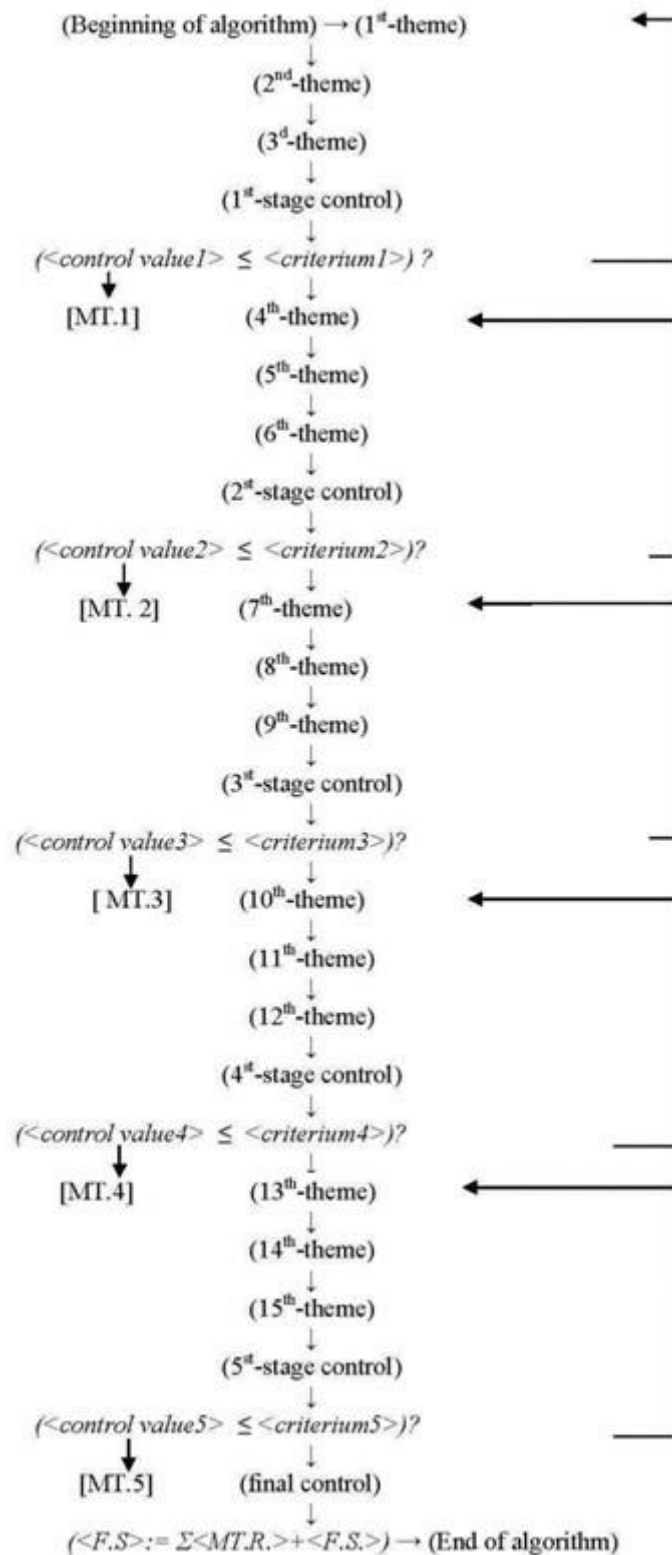
Fig.1. An algorithm of training process trajectory

2.4. The structure and content of the electronic practicum

By working out of an electronic practical work some of algorithms of textbooks (Knuth, Cormen et.al., 2009) have being used. The electronic practical work includes the following sections supporting themes considered in a basic course under the theory of algorithms and data structures:

- basic data types;
- trees;
- basic operations on sets;
- graphs;
- internal sorting;
- external sorting;
- algorithm design techniques

The electronic practical work represents possibility to the student to check up work of algorithms and structures of the data considered in a training course in a real mode. Structurally electronic practical work is a package of the applied programs having the general user interface. Using package programs it is possible to study algorithm work on various sets of the initial data. Thus there is a possibility of research of efficiency of algorithm on these sets including using the best and worst variants of the entrance data. The program gives the chance studying the metric characteristics of algorithm such as quantity of certain operations (cycles, comparisons), speed and volume of demanded memory. The method of the least squares used in an electronic practical work allows receiving a numerical estimation of an error of approximation of speed of algorithm.

Other feature of the given practical work is possibility to provide comparison of work of various algorithms on the same data sets. It allows the student to check up theoretical calculations in practice.

Visualization is one more of important characteristics of the developed software package. It is shown both at studying of various structures of the data,

and at construction of algorithms. Use of multimedia technologies gives the chance to familiarize with the base of the data structures and algorithms "alive".

The electronic practical work is an interactive program where the student has possibility to influence for work of the programs entering into a package. The system of the options developed for this purpose allows varying initial conditions of the program, data sets. In particular, there is a possibility to define a priori the functions of regression defining approximate estimation of speed of algorithms.

Among base structures of the data in an electronic practical work on C++ such structures as "List", "Stacks", "Queues" are realized. Using it is possible to familiarize with work of these structures of the data and base operations in a stage-by-stage mode. In practical tasks offered for independent performance the student has possibility to use realization of these types of the data in the applied programs.

In the section devoted "Trees" electronic realizations of these types of the data and base operations over them are resulted. Students in an interactive mode have possibility to track work of algorithms of detour of a tree.

In an electronic practical work there is also a realization of type of the data "Set", the basic operations over sets. As an example of use of this type of the data program of simple dictionary implementations is resulted.

In the software package there is a program of work with graphs. It is considered both directed and not directed graphs. Algorithms of traversal of such graphs are realized.

Undoubtedly, one of a key section of an electronic practical work is the section concerning sorting. Algorithms of sorting of the given various data structures have an important value in preparation of the competent expert in work with the data. In a practical work various algorithms both internal and external sorting of the data are realized. Programs work in an interactive mode. Tasks for independent work are resulted, thus there is a possibility of checking the work of the program developed by the student. It's checked not only program's

compilation but also correctness of realization of the given algorithm. There is a possibility of reception of average metric characteristics of algorithms as well.

Among methods of working out of algorithms in a practical work some principles of algorithm development such that "Divide and Conquer" are realized.

3. Results and Discussion

Development of an adaptive system of training on the Theory of Algorithms and Data Structures directed on personification of training environment is the main result of research work. System allows representing teaching materials in various sequence of formation of nonlinear trajectories of training. Use of multimedia allows achieving more visualization and clearness of a studied subject, creates friendlier environment for the user, and network technologies give the chance remote access to information resources. System specifies adjustments of parameters of the program of interactive testing. It promotes organizing learning process in the stage-by-stage mode gaining trainee's score.

Other result is the development of the electronic practical work containing sections on Algorithms and Data Structures. It allows trainees checking up work of algorithms using various sets of the initial data; researching efficiency of algorithm on these sets data and metric characteristics of an algorithm. Use of multimedia technologies allows familiarizing with the base of the data structures and algorithms "alive".

Problems of improvement of quality of educational services are in the centre of the reform of educational system of many countries. Thereupon such alternative modes of study as E-learning or Blended learning are rather perspective. Such systems of training are widely applied in the world. As experiment of many countries shows using a correct combination of traditional and electronic modes of study leads to achieve more efficiency of education and training quality.

In this connection the researches connected with development of intellectual adaptive system of training are relevant. Principles considered above for development of an electronical course, particularly, the course on the theory of

algorithms and data structures, can be applied for development of adaptive training systems. Use of such systems for e-learning allows to get a flexible and an effective training system. Such kind of electronical courses consudered above also can be used in distance education.

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