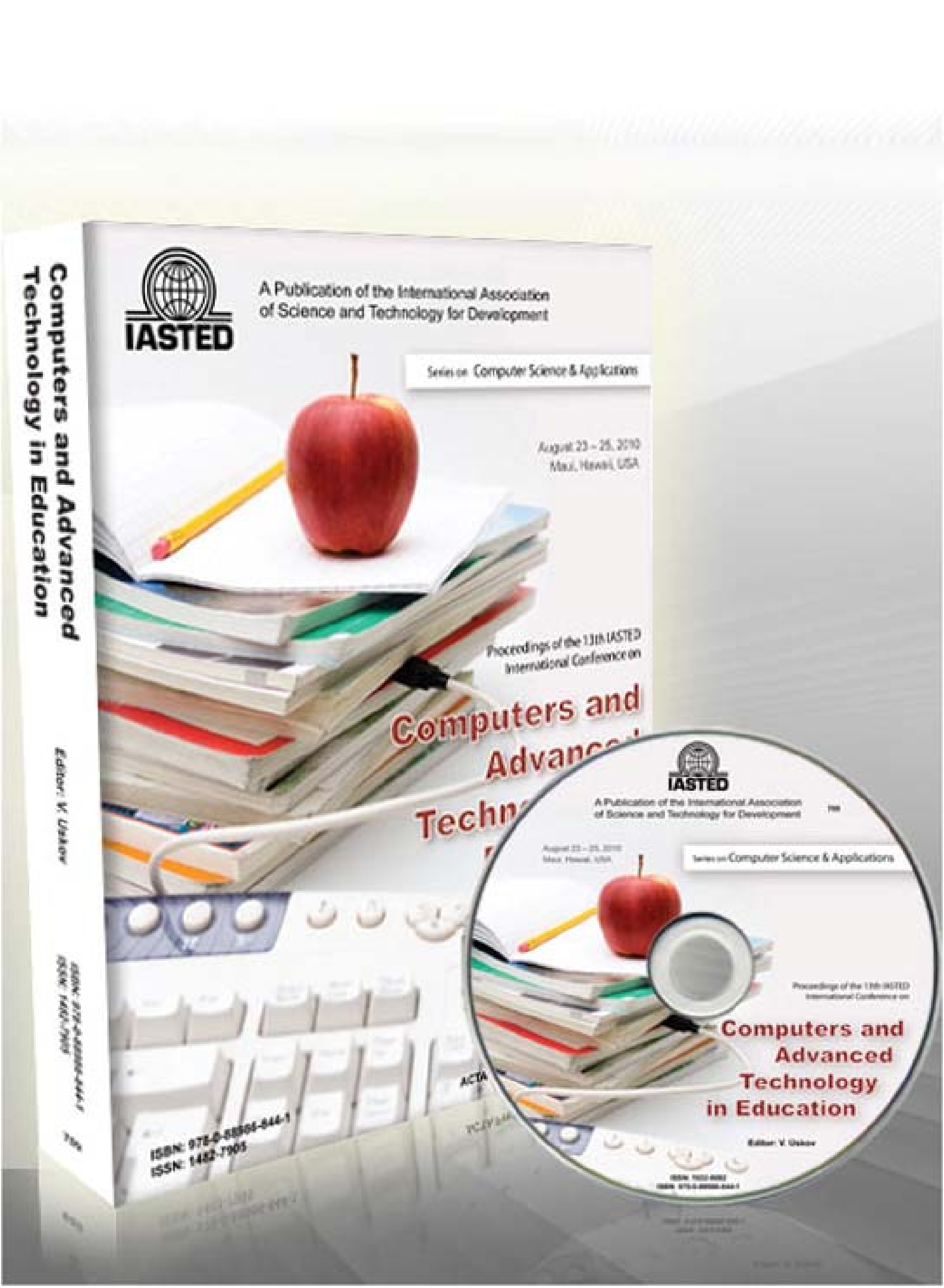
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FOUNDATION OF THE CONSTRUCTION OF MIXED DIAGNOSTIC TESTS IN SYSTEMS FOR QUALITY CONTROL OF EDUCATION

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ABSTRACT
The relevance of computer-based testing of students, as well as the currently existing approaches for the control of knowledge and learning are discussed. Construction of mixed diagnostic tests, representing an optimal combination of unconditional and conditional components, in order to create a telecommunication system for monitoring of students' knowledge is proposed. Authors suggest a technique for construction of optimal mixed diagnostic tests only on the basis of expert knowledge about the subjects under control.

KEY WORDS
Intelligent pattern recognition, decision-making, mixed diagnostic tests, quality control, education, construction

1. Introduction

The growing volume of information in learning process complicates the main task of the teacher: management of training with feedback, which is based on a detailed diagnosis of the knowledge and skills of students, increase of their motivation for learning, as well as identification of the causes of mistakes and development of ways to solve them.
Assistance in efficient solution of this fundamental problem can be provided by use of expert planning, training, diagnostic systems, decision-making support systems, automated training systems, and applied intelligent systems [1].
Objective tests are among the most widely used and well-developed tools in higher education. A classic test is a sequence of reasonably simple questions. Testing components were the first to be implemented and currently are the most well developed interactive components. A comprehensive review of features of technologies for Web-based testing (WBT) is provided in paper [2]. A significant area of development has been in the use of computer-assisted assessment (CAA). Paper [3] provides a list of some of the commonly used CAA systems.
WBT, CAA are well-developed as mechanisms for objective testing (e.g. multiple-choice questions, completion questions, labeling and building questions and true/false questions) and in the collation and analysis of optically-captured data.
Computer testing has several advantages in comparison with traditional forms of control. Automated tests provide quick and objective marks (evaluation) of the quality of knowledge, contributing to increased profitability of education due to savings of teachers' time.
Test systems as software for quality assurance knowledge has long been used in the world education as well as in Russia.
With an appearance of new procedure for accreditation of universities and institutes in Russia the relevance of the development and use of computer testing is enhanced in further. The testing of graduates will diagnose not only their residual knowledge but their skills as well. All of the above require advanced methods of testing.
Russian higher school faces the problem of creating conditions for development of skills to self-education and application of obtained knowledge in practice in the framework of integration in Bologna process. In this work the authors suggest introduction of computer control-training programs for testing in educational process. Without applying the most advanced information technologies (including artificial intelligence methods) process of interaction between teacher and student in the diagnose of gained knowledge can't be qualitatively realized. Development of such systems requires considerable labor, time and cost.
Nowadays Russian Accreditation Agency in the Field of Education conducts an experiment. Since 2005 Federal examination in the field of higher professional education (FEHE) has been introduced to Russian universities. This experiment is based on computer testing of students and their skills to meet the requirements of state educational standards (SES) [4]. Testing students' knowledge is carried out using the Internet (off-line or on-line mode). More than 1,850 universities from 81 regions of the Russian Federation participate in the on-line testing in 2010.

However most developed test systems use rather limited methods in engaging in dialogue with the students, as well as undeveloped systems that explain the work progress steps. Checking the solution by the final result (the answer), or moreover menu-based testing isn't always possible but always primitive.

A set of test questions for each student is generated pseudorandomly (providing that, during the test, questions will be presented to all controlled didactic units (DU)) from an existing database of tests, but their sequence is preassigned. Authors suggest using the so-called mixed diagnostic tests (MDT) [5-14] for test the students. MDT is a new paradigm for building checking and diagnostic tests.

2. Background. Basic Concepts and Definitions. Formulation of Problem

Automaton model for learning and knowledge control was proposed by A.E. Yankovskaya. It has been implemented in the intelligent tutoring system for a) the control of knowledge on linear algebra [8, 9], b) training and control tasks of finding the shortest coverings Boolean matrix [6, 7] and for a number of problems. A distinctive feature of the automaton model is that the assessment by solving the problem depends on the optimal path, following which the solution was obtained.

However in these publications doesn't consider a sequence of requirements to meet the challenges of which also depends significantly on the amount of the assimilated material (didactic units). Note that the order of learning of some sections of disciplines as well as some didactic units within the section is now irrelevant. In most cases, the study and development of subsequent sections of discipline and their teaching units depends on students' knowledge obtained by studying the previous sections of discipline (didactic units).

In the paper [5] author proposed to use mixed diagnostic tests (MDT), which presented a new paradigm of development of intelligent systems which based on test methods of pattern recognition. In this paper MDTs are similar to those introduced in [5] as indifferent to the order of testing the number of sections in the selected discipline. And the order of the remainder of the section of selected discipline is individual for each students group.

Sections of the discipline are associated with grouped characteristic features and didactic units are associate with the characteristic features.

We suggest that test is diagnostic test, if as a result of his passing students access the correct result and detecting test if the only available outcome. After the test students are divided into two classes: relevant and not complying with the SES, as well as the discipline imposed on the test.

Diagnostic test (test) is the set of grouped characteristic features and the characteristic features. Test can to distinguish any pair of objects to different classes respectively.

Unconditional check (diagnostic) test (UCT) is characterized by the simultaneous presentation of all its constituent features of the object (student, discipline) during the decision making.

Conditional check (diagnostic) test (CCT) is characterized by the sequential presentation of features, depending on the value of the previous features.

As described previously mixed diagnostic tests (MDT) present optimal combination of unconditional and conditional components. The term "mixed" was introduced in 1996 [5]. The validity, effectiveness and prospects of mixed tests are associated a) with the possibility of successive extraction of information about the studied object for the conditional component of the mixed test, b) with the advantages of using the unconditional component tests in the construction of decision rules [5, 6], as well as to the appropriateness of mixed test in the organization of intelligent interface (construction questionnaire) [10].

There is an experience of application MDT both in educational sphere, and in practical activities for a number of problem areas.

The greatest application MDT have received in the field of medicine, both at acceptance of diagnostic solutions, and at the organisation of user interface [10-12].

There is a positive experience of application MDT in educational process of medical students (Siberian state medical university, Russia). Optimisation of a choice of revealing of characteristic features, minimization of time expenses for decision-making and revealing of values of characteristic features are observed. It influences on improvement of quality of accepted diagnostic decision-making (solutions).

Unfortunately, methods of testing, which are commonly used in Russia, motivate students poorly on learning of didactic units on which the control of knowledge now is carried out. Usage of MDT allows to raise weak motivation of students and to organize the purposeful approach to mastering of a studied teaching material. It is reached by creation of the telecommunication systems for monitoring of knowledge and its application during a semester.

Formulation of Problem. Educational discipline is parted into some sections, each of which consists of didactic units. It is required to construct a mixed diagnostic test for each discipline and each its section.

3. Construction of Mixed Diagnostic Tests

To monitor students' knowledge various models are used: automata, graph (network, tree).

We have the list of disciplines. Highly qualified specialist must part a lot of sections for each subject into two subsets. The first subset includes the unconditional component of the mixed test, i.e. sections of courses (grouped characteristic features) that are introduced to

students at random sequence. Root node of the search tree is associated with unconditional component of the mixed test. Submission of a grouped characteristic feature of the second subset (conditional component test) depends on what the previous feature was presented at an appropriate level of the search tree MDT. Each branch of the tree represents an admissible sequence of actions to select the section that leads to a sheet. In addition, each sheet associates with the result of the test passage.
It should be noted that the order of features at the same level of the search tree does not matter. Bypass of branches of a search tree is performed in left to right direction.

4. Illustrative Example

We'll give an illustrate example of the construction of mixed diagnostic test for course "Informatics", which takes 200 hours per year (students specialization – Industrial and civil construction).
To construct the MDT we will use the requirements of SES to compulsory minimum content of the educational programs. The main sections of course (grouped characteristic features) are:
1). The concept of information;
2). A general description of the data collection, transmission, processing and accumulation of information;
3). Hardware and software implementation of information processes;
4). Decision models of the functional and computational tasks;
5). Algorithms and programming;
6). High level programming language;
7). Database;
8). The software and programming technology;
9). Computer graphics;
10). Computer practice.
Each grouped characteristic feature contains a different number (from 4 to 8) of didactic units (*characteristic features*).
An unconditional component of MDT includes grouped characteristic features of sections 1-3. Note that grouped of characteristic feature (Section 3) should be divided into two: "3.1. The technical means to implement information processes" and "3.2. Software implementation of information processes".
A conditional constituent of MDT includes grouped characteristic features of 3.2, 4-9, and tests covering sections 6-9, it makes sense to include a diagnostic test in the final stages of testing.
An example of search tree of MDT is given in Fig. 1. The numbers of the course sections are written in tree nodes (represented by rectangles). Subjects assigned with the unconditional component of MDT (sections 1, 2 and 3.1) are listed in the root node of the tree. Transition to knowledge control on course sections which are related to the conditional part of MDT (marked by letters on arcs coming out of the root in Fig. 1) is provided if the object (student) has successfully completed the task on the unconditional component of the diagnostic test (scored at least 50 percent of correct answers).

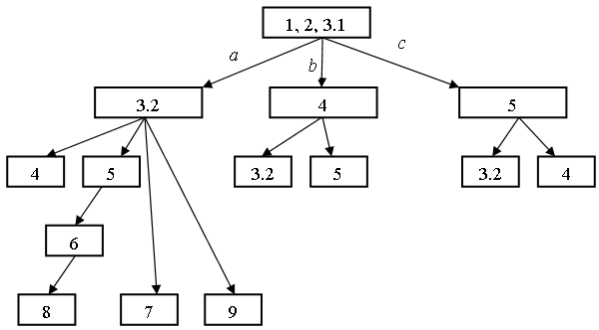

Fig. 1. Example of MDT search tree

At present, a student can skip and return to any of the proposed test items during of FEHE testing. During the construction of MDT such a possibility is excluded and students are invited to explore the section on which the study and development of subsequent sections depends. Full sequence for the section 3.2 is shown in Fig. 1 only. Thereafter the object (student) may proceed to carry out assignments from section 4 or 5. Similarly on tasks for sections 4 and 5 he can proceed to implement the tasks of the sections 3.2 and 5, 3.2 and 4 respectively. One of the possible variants of the conditional part of the test is the following admissible sequence: 3.2, 4, 5, 6, 8, 7, 9. Applied part of course (section 10 isn't shown in Fig. 1) may be indirectly is presented in each of the sections 1-9 as the practical tasks.
For each of the sections the control of knowledge is based on MDT, which was constructed by highly skilled specialists. The unconditional component of MDT includes those sub-sections under consideration, for which the order of study does not matter.

5. Conclusion

The actuality of creation and use of computer testing in the educational process are shown. The major problem facing the high school is improving the quality of education. To solve this problem is proposed to use control system which based on tests of pattern recognition.
The concept of a mixed test consisting of an optimal combination of unconditional and conditional components is introduced. The method and an example of constructing a mixed diagnostic test are given. The proposed method improves the quality of testing by eliminating the possibility of accidental achievement of the correct answer, thereby improving the accuracy of the result.

The purposeful choice of test tasks at monitoring procedure of remainder knowledge of students with usage of MDT allows to reduce time expenses for carrying out of testing and to motivate students on studying of didactic units during their learning.
The proposed new approach can be used to construction intelligent systems that are based on test methods for pattern recognition.
This approach will increase the effectiveness of testing by choosing the shortest ways to get the correct result and exclude the possibility of achieving it at random path. Further development of this approach involves the use of telecommunication systems for monitoring of knowledge (TSMK) based on the MDT. The construction of TSMK is suggested to realize with application of the software tool IMSLOG [15], which based on the logical-combinatorial and logical-combinatorial probabilistic methods [16] of test pattern recognition using graphical (cognitive) means of decision making and explaining, and as the technology for construction of applied intelligent systems based on software tool IMSLOG [15].

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