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The Modular Structure of the Adaptive Machine Learning System

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Abstract

The article describes the modular structure of adaptive machine learning system which can form a learning content for each student individually, generate test tasks depending on the results achieved, manage educational trajectory and form the student profile in various aspects. The design features of modern machine learning systems based on individual management of educational trajectories were identified. Machine learning system based on the modular structure proposed can tune to particular subject area flexibly and form the optimal individual educational trajectory.

Keywords: machine learning, educational trajectories, e-learning systems, automated systems of management learning.

Introduction

The development of adaptive machine learning systems, which allow you to manage the individual educational trajectories, is one of the key elements of creating individual-based learning approach [1-4]. The systems of this type are used not only in the educational process, but in the process of advanced studies and retraining of the employees of the organizations also [5]. An important task of the personnel management system for the modern organizations and enterprises is to provide improvement of professional skill continuously in order to maintain competence of the personnel at a level to intensify the manufacturing processes without quality loss of products and services. The machine learning systems allow you to automate the processes of monitoring and management of the personnel reserve based on the availability of information about the knowledge, skills and experience of the staff.

The researchers have distinguished three directions of adaptation to the individual features of the students in terms of availability of adaptive algorithms in the creation of the systems of the machine learning.

The adaptation of the results of the learning process, allowing managing the educational trajectory based on testing knowledge of trainees, has been identified firstly [6]. Secondly, the adaptation, considering psychological and physiological conditions of a student, taking into account the psychological and genetic parameters, as well as the professional experience was found [7]. The third, the adaptation was offered, taking into account the functional state of a learner, which allows to monitor the parameters of the electrocardiogram of the heart, electrodermal resistance, variation pulsometry, keyboard handwriting and the others, based on which it is possible to control individual educational trajectories, maintaining these parameters in the optimal mode for each student [8].

Research Method

Machine learning system is used in order to optimize the management of individual educational trajectories, the achievement of which comes down to two tasks [9]. Firstly, we need to maximize the level of competence of the learner within a limited time on the learning process. Secondly, we need to minimize the time on the learning process while limiting the level of competence of the learner.

Researcher identifies three hierarchical levels according to the degree of adaptation of machine learning systems [10]: adaptation to the audience as a group of users, that is adaptation to each category according to their needs ; adaptation to a group of students, depending on the chosen educational program, age and psychological orientation of the person ; adaptation to the individual listener, which can use different methods. In this case, one of the main issues is the procedure of adaptive testing, which allows us to identify the knowledge of students with minimal errors efficiently [11].

The following tasks have been identified and structured by us for constructing the structure of adaptive machine learning system: the formation of educational and methodological materials, depending on the individual features of the students, testing the psychological and physiological peculiarities, the initial testing, adaptive testing in accordance with the learning outcomes, taking into account the complexity of the test questions and rating of a trainee, management of individual educational trajectory, formation of individual student's profile with the ability to obtain information in the various sections, adjustment of the training program.

Solving these problems will help to individualize the learning process using the machine learning systems.

Research model

On the basis of the synthesis of the requirements for tasks, which modern adaptive learning machine should decide, its modular structure was designed by us (figure 1).

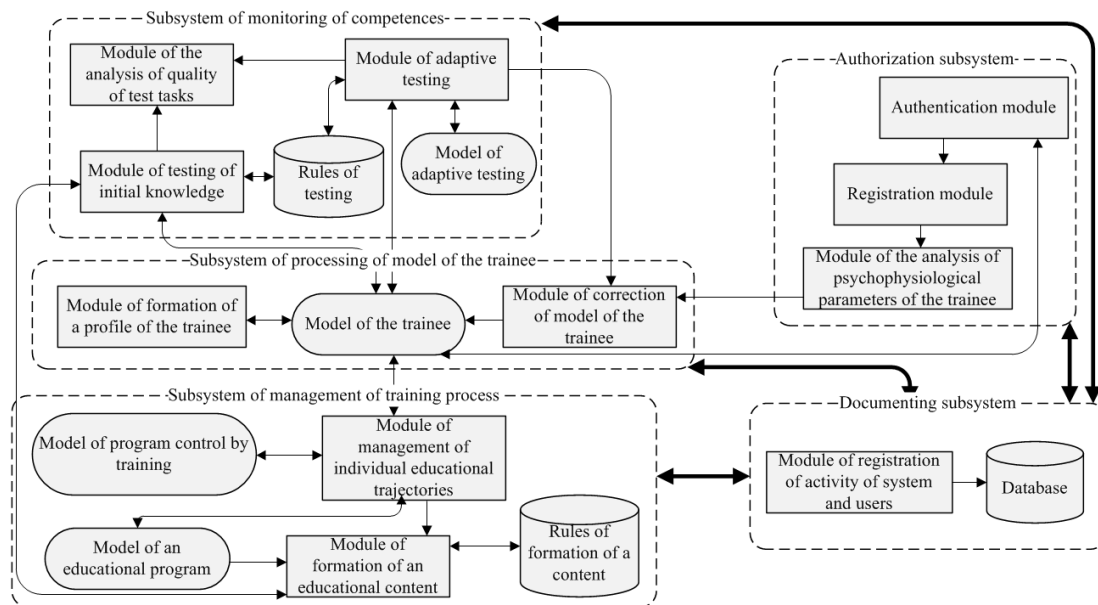


Figure 1. – The modular structure of adaptive machine learning system

All subsystems are interconnected through the channels of information exchange (the dashed line) by means of the documenting subsystem. The following components are included into the modular structure:

- the documenting subsystem intended for processing requests of subsystems to the database by means of which the integration and synchronization of operation of the subsystems was realized. The module of registration of activity of the system and users, as well as database are a part of the subsystem.
- the authorization subsystem provides a process for user to interact with the system, providing it the intuitive interface and features available, depending on his or her rights. The subsystem includes in its composition:
 - 1) the authentication module designed for determining the registered user and providing interface interaction with the system, depending on its individual settings. In addition, the results of training are restored in the system since the last session. An informational message about the end of the planned period of implementation of various control measures may appear to the user at the same time ;
 - 2) registration module initiates the registration procedure in a system that assigns a status to the listener and he takes the initial test, which determines the individual psychological and physiological features, recorded by the model of the trainee ;
 - 3) The module of the analysis of psychophysiological parameters of the trainee defines the individual physiological parameters, recorded by the model of the trainee.
- The subsystem of processing of the model of the trainee, which implements the adjustment of the model parameters and provides data to the subsystems, includes the following components:

- 1) the module of formation of a profile of the trainee analyzes the data about the potential possibilities of the student in various kinds of professional and scientific activities ;
- 2) the model of the trainee, contains information about the psycho-physiological characteristics and learning outcomes with associated parameters and reflects the individual features ;
- 3) the module of correction of the model of the trainee monitors the changes of learning outcomes in order to override the parameters of the model.
- the subsystem of monitoring of competences is designed to determine the degree of mastering elements of the training program, includes the following components:
 - 1) the rules of testing, reflecting the peculiarities of the adaptive procedure and the initial test ;
 - 2) the model of adaptive testing is a discrete structure of the testing process, based on the definition of the complexity of tests depending on the rating of the trainee ;
 - 3) the module of the analysis of quality of test tasks analyzes the answers of users and calculates the parameters of reliability, validity and differentiating ability of tests ;
 - 4) the module of testing of initial knowledge identifies the student's knowledge of educational material that they have to learn ;
 - 5) the module of adaptive testing identifies the student's knowledge of relevant content based on the rules of testing, the model of the trainee and the model of adaptive testing.
- the subsystem of management of training process is designed to manage the individual educational trajectories, depending on the results achieved, includes the following components:
 - 1) the model of an educational program ;
 - 2) the model of program control by training implements the listener's transfer between the elements of the educational program depending on the results of the adaptive testing and the model of the trainee ;
 - 3) the module of formation of an educational content composes the content of the training topic in a rational form for the individual perception ;
 - 4) the rules of the formation of a content are presented in the form of production rules ;
 - 5) the module of management of individual educational trajectories carries out the functions the student's transfer to the next element of the educational program based on the parameters of the model of the trainee, the model of program control by training and the module of adaptive testing.

Conclusions

The analysis of the specific tools and training methods has shown that algorithms and models of individualization are not used sufficiently in modern machine learning techniques, although machine learning implements an effective management of individual educational trajectories of the students. The study of approaches of the construction of machine learning systems has revealed the need to include the

educational programs and learning management software in the control loop of the model of the trainee.

During the analysis of the existing mathematical models of the trainees we revealed that the main share of the modern machine learning systems uses subject of the model of the trainee that reflects the results of learning only, without consideration of the psycho-physiological features.

We carried out a synthesis of the functional requirements for an adaptive machine learning system. We have developed the modular structure of the adaptive machine learning systems consisting of subsystems and modules that implement a set of individual process-oriented learning.

Thus, we developed the modular structure of the adaptive machine learning system, which is adaptable to the particular subject area. Subsystems, modules and models that make up the system, form a complete set of functions to ensure an effective management process individual educational trajectories of the students. The developed system can be effectively used in the educational process, and in the process of training and retraining of the employees.

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