FUZZY LOGIC IN CREATING ADAPTIVE INTELLIGENT LEARNING

Abstract. the article discusses the relevance and effectiveness of individualization of online learning using information and Internet technologies, the features of a multi-agent approach using fuzzy logic, an analysis of intelligent adaptive learning systems with different types is given, their models, advantages and disadvantages are also given.

Keywords: adaptive learning, intelligent adaptive learning systems, online learning, online learning systems, platforms for online learning, online learning models.

Modern scientific interpretation of adaptive training involves personalization process of learning on the basis of the creation of e-learning courses that take into account boiling individual characteristics of students, including the level of prior knowledge, perception, psychological characteristics, as well as individual goals and objectives of teaching. Adaptive e-learning models are implemented on the basis of several modern approaches and methods: the expert assessment method, the multi-agent approach, the programmed training based on a package of applied programs (traditional approach), methods of fuzzy logic based on the theory of fuzzy sets; inference technologies based on neural network algorithms; intellectual planning, ontological engineering, etc.

Modern adaptive e-learning is currently actively developing in the field of education, relying on knowledge engineering methods used to create educational
information systems, taking into account the behavior and state of knowledge of a person in the learning process.

The method of expert assessments, based on the use of expert information systems, makes it possible to realize the possibility of not pre-setting a sequence of learning steps, since it is built by the information system itself in the process of its functioning. This makes it possible to form for each student a primary individual training plan based on his competence-oriented model, which is based on the analysis of answers to questions from special tests, some of the student’s personal characteristics. Expert training systems (ETS) are capable of performing structural and parametric adaptations, which make it possible to bring the structure and parameters of the student’s model closer to his real «portrait», but the didactic possibilities presented in this case are very limited. The individual training plan is corrected by the ETS based on the results of mapping the student’s current model, based on his learning experience, to the reference model of the course, followed by comparison with fragments of the applied ontology of the course or discipline.

As a tool for constructing expert systems, one can imagine the AT-TECHNOLOGY complex, aimed at developing and using ETS in the educational process for the automated support of a number of academic disciplines. In particular, the accumulated technological and methodological experience of automated maintenance of a significant number of individual models of trainees in these disciplines and the corresponding learning models allows, based on the results of its analysis, to use and develop modern innovations in solving intellectual learning problems using integrated ETS, including web-integrated ETS. Based on the means of the complex, it was possible to implement a certain set of functional tasks characteristic of intelligent teaching technology, including «individual planning of the methodology for studying a specific training course», «intelligent analysis of solutions to educational problems», «intelligent decision support» [1].

In addition, a technology is being developed for the automated construction of integrated ETS, which simultaneously uses the approaches of both knowledge engineering and ontological engineering, intelligent planning and traditional programming [2].
The multi-agent approach makes it possible to implement the possibility of adapting all levels (structural and parametric, control object, learning goals), which makes it possible to control the object - the learner - at all stages of the learning process. The approach is based on building the system as a set of programs (agents). Each agent has its own semantic description of its field of activity (its structure and knowledge), representing an ETS with a traditional structure. In addition to the memory of his activity, an agent also has its own resources to achieve its own goals, has the ability to interact with other agents and resolve conflicts with the goals of other agents to achieve a common goal. This allows you to freely choose those goals of the learning process that are currently pursued by the control subsystem, and in accordance with these goals to choose a standard (represented by the appropriate agent). Compliance with the standard is achieved by the current student model. Thus, for each specific learning task, a certain group of agents is compiled, which indicates a change in the structure and goals of the decisive subsystem, depending on the task [3].

Solving the problem of effective management of e-learning is one of the topical areas of research in the field of further development of educational technologies. The term «e-learning» as the notes A.V. Solovyov [4], successfully integrates in itself a number of concepts in the field of temporary educational technologies, based on widespread use of information and communication technologies (ICT) ... ELearning also understand adaptive intelligent (individualized) training, implemented on the basis of all-round at Menenius multi- and hypermedia, remote access to distributed educational resources based on web technology, with automated control and analysis of learning outcomes and the widespread use of a variety of network interoperability trainees with each other and with the teacher.

The development of information technologies has led to fundamental changes in the everyday and conservative spheres of human life, including education, which can be considered the most important in the life of a modern person. New technologies have fostered new learning opportunities and, as a result, the development of new technologies and methodologies.
The modern level of ICT development allows creating e-learning systems based on the principles of adaptation to the learner. Such systems can be effectively used both for distance learning and for integration into the traditional (full-time) educational process. In accordance with the classification proposed by P.L. Brusilovsky [5] technology adaptation are divided on two categories: firstly, it is adaptable planning training, secondly- adaptive presentation of information and adaptive navigation. In the work of L.V. Zaitseva [6] considers the levels of adaptation in teaching systems: to students as a category of users, to a group of students, to an individual student.

Information technology allows you to move from practicing hundreds of years of group education to individualized. One of the technologies that makes it possible to create conditions for the individual assimilation of material by a student is the technology of adaptive intellectual learning.

«Knowledge is only knowledge when it is acquired by the effort of one’s own thought, and not by memory,» - these are the words of L.N. Tolstoy is the best way to reveal the essence of adaptive learning systems.

Adaptive intelligent training system (AITS) - are systems that are adapted to the person, gender, age, the psychological and cognitive state of the student. In other words, the adaptive system adjusts all elements of the educational system to the student:

– goals;
– content;
– methods, methods, teaching aids;
– forms of organizing the cognitive activity of students;
– diagnostic results.

One of the founders of the application of the adaptive approach in education with the help of information systems is considered G. Pask [7], who defined adaptive learning as a process that continuously adapts to the individual characteristics of a student.

The management of this process is considered as a continuous selection and correction of the learning path depending on the initial input data or on the previous learning history [8].
Adaptability can be considered on several levels, firstly, in relation to the student, and secondly, the subject area. And he and the other types of adaptation is well known [9] and are reduced to the original setting AITS based on initial testing student. A more difficult adaptation option is changing the learning scenarios during the functioning of the IAO. This is necessary in the following cases:

1) when errors are detected by IAO;
2) if necessary, add new learning scenarios;
3) when combining several scenarios;
4) when selecting a thematic selection from the scenario for solving a specific problem.

In all these cases, you can use the algebraic representation of the scenarios with their subsequent division into sub-scenarios. When splitting a script, any correction can be performed on separate sessions.


Often there are three main types of IAOs - providing «passive», «active» and «smart» adaptability. This classification is found in the online dictionaries of European countries on pedagogy and psychology [11].

In systems with «passive adaptability», the main role is assigned to the learner. Based on a set of rules and a parameter, the student himself plans his movement according to the training material and terms. Such systems use simple «if-then» causal schemes.

In AITS with «active adaptability» the system itself determines the trajectory of the student's movement in the educational material based on his answers to test questions. In such systems, active if-then schemes are implemented using programming.

For systems with «active adaptability» can be attributed SmartBook adaptive version of the training course on the basis of e-books from the company by
McGraw-Hill Education. SmartBook - this system to access online from any device through a browser or a mobile application. The system adjusts the learning process for each user, taking into account the pace of the learner, prioritizing learning and focusing on the key concepts of the topic, forcing the user to repeat and memorize unassimilated content. SmartBook from McGraw-Hill integrates with LMS Angel, Blackboard, Canvas, Desire2Learn, Moodle, Pearson Learning Studio, Sakai [12].

Systems with «smart adaptability» include systems that build a learning trajectory based on constantly received data about the student, such as the psychological picture, his preferences, success in mastering the material at each stage, etc. Such a model is implemented using Big Data programming and analytics in Education Learning Analytics.

The main task of Learning Analytics systems is to collect and analyze large amounts of data from online educational systems. Such systems should take into account and analyze the impact of any technical or social aspects and any organizational changes on the educational process. The main functions can also include the comparison of parameters of online courses in the same or different systems [13].

In an example of adaptive systems to «smart adaptability» can lead courses Pearson to MyLab, «personalized» by the algorithm Knewton, which uses analytics study of content by students (about 11 of millions of every day) to build learning algorithms and adapting the material for the needs of each user of the system. To do this, a colossal array of data is used to analyze the success of users who study the same courses along different trajectories, at different rates, using different intermediate tasks. This algorithm created on the basis of these allows you to build for each student his own trajectory of movement through the material, offering individual explanations and tasks. Identifying similarities interest rate, the rate of advance of the educational process and other indicators of different users, the system can recommend the union of in groups for joint study of material [14].

Model systems of adaptive learning in the present time are implemented on the basis of several approaches and methods: the method of expert evaluations of
programmed instruction (traditional approach), methods of fuzzy logic, based on the technology of neural network algorithms, intelligent scheduling and other [15]. The use of fuzzy logic methods in conjunction with traditional methods allows for a better assessment of the student’s test results, taking into account the input metrics and full control of the teacher.

Fuzzy logic and the theory of fuzzy sets for the first time about the limits of American scholar Lutfi Zade: «The more we analyze the real problem, the more uncertain it becomes a solution.» The reason for the emergence of the theory of «fuzzy sets» was the presence of fuzzy reasoning in the description of processes, systems or objects by a person [16]. The human mind, unlike a machine, operates with fuzzy concepts when assessing various situations. Therefore, when making decisions, in conditions of inaccurate information and in the presence of fuzzy goals, the method of fuzzy sets is used.

A fuzzy set is a subset of elements A from E, such that each element is associated with the degree of membership of this element in the set E. The fuzzy set is completely determined by specifying the membership function \( \mu_A(x) \): its domain of definition is E, the range of values is the segment \([0,1]\), where 0 means that the element is not included in the fuzzy set, and 1 describes a fully included element. Values between and indicate elements that are not clearly included. The higher the value of \( \mu_A(x) \), the higher the degree of belonging of an element x from E to a fuzzy set A is estimated [16].

In this article it is considered a way to change the level of difficulty of the course with the use of fuzzy sets. The following fuzzy scale of changes in the level of complexity of the course is proposed: «Decrease», «Leave» and «Increase». At the same time, there can be any number of levels of complexity of the course. The change in the level of difficulty of the course for the student occurs step by step. In the first stage, all students start learning at minimum difficulty.

After the number of lessons set by the teacher has expired, an adaptive system for changing the difficulty is connected. Evaluation of the results occurs at the end of two lessons in a row. If the number of mistakes made is acceptable to increase the level of complexity, then the system transfers it to a more difficult level relative to
the current one. When the number of errors more than a predetermined threshold, the system determines how to change the difficulty of the course the student - to lower or keep the current level. If the error rate is high for three lessons in a row at the lowest difficulty level, the system notifies the student’s administrator or teacher.

In conclusion, it can be noted that the use of fuzzy logic in the development of systems for adapting educational content to a student is justified and has a number of the following advantages over steel options for implementation:

– there is no need to accumulate large statistical data to build an adaptation model, which are necessary for systems built using neural networks;

– the curator can easily make a change in the logic of the system itself by changing the degree of belonging;

– systems based on fuzzy logic can contain a large number of both input and output variables, which allows building educational content of any degree of complexity.

References:


