Chapter 17
Models, Methods, and Algorithms for Control over Learning Individual Trajectory

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ABSTRACT
The article discusses models, methods and algorithms of determining student's optimal individual educational trajectory. A new method of controlling the learning trajectory has been developed as a dynamic model of learning trajectory control, which uses score assessment to construct a sequence of studied subjects. In connection with the transition of the educational system to a competence-oriented approach, the problem of learning outcomes assessment and creating an individual learning trajectory of a student has become relevant. Its solution requires the application of modern information technologies.

INTRODUCTION
The third generation of Federal state educational standards of higher professional education (FSES HPE) defines the requirements for the results of mastering the basic educational programs (BEP). According to FSES HPE up to 50% of subjects have a variable character, i.e. depend on the choice of a student. It significantly influences on the results of developing various competencies.

The article discusses models, methods and algorithms of determining student’s optimal individual educational trajectory. A new method of controlling the learning trajectory has been developed as a dynamic model of learning trajectory control, which uses score assessment to construct a sequence of studied subjects.

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APPROACHES TO SOLVE THE PROBLEM OF FORMATION AND SELECTION OF STUDENT’S INDIVIDUAL LEARNING TRAJECTORY

One example of information technologies development to solve problems of assessing the student’s competence is the paper by G. Algazin and O. Chudova (Algazin, & Chudova, 2009), which is based on a hybrid expert system taking into account different types of measurement scales. A hierarchical approach was used to classify the information.

The analysis of the model of educational process organization in terms of individual approach makes it possible to develop a decision support system (DSS). DSS is a set of interrelated programs and data used for analysis of situation, development of alternative solutions and selection of the most acceptable alternative. An example of such DSS is proposed in the work by I. Dobrosotskaya and L. Krakht (Dobrosotskaya, & Krakht, 2009).

DSSs are often used when building individual learning path, because this task can be considered as a discrete multi-criteria problem, creating a significant burden on the decision maker (DMs). In the paper (Gettinger, Kiesling, Stummer, & Vetschera, 2013) three ways of representing data in the DSS were analyzed, including tables, heatmaps and parallel coordinate plots. The data in a DSS are represented both by objective and subjective indicators. In heatmaps each column represents the criterion, and each row represents an alternative. The cell color represents the significance of a criterion for a concrete solution. The criterion with low significance is indicated red, the medium one is indicated yellow, and the high one is indicated green. When using parallel coordinate plots alternatives are depicted as a line connecting points on the corresponding axes. All feasible solutions are superimposed on each other. Therefore, multiple criteria can be displayed, and reducing the load on the DMs.

In the experiment, the authors found out that the sequential structure of the spatial information representation facilitates decision-making provided that the amounts of data are large.

The work by G. Setlak (Setlak, 2008) is of a significant interest for our research. It considered the Neuro-Fuzzy Method for Knowledge Modeling. The model is based on neural networks and artificial intelligence, which can be used to build fuzzy inference systems, aimed at forming an individual learning path of a student.

The fuzzy neural network, used for classification in this paper, has the following features:

- Each neuron represents one fuzzy IF-THEN rule,
- The number of neurons equals to the number of rules in the base of rules,
- Weights of the neurons have an interpretation concerning parameters of the membership functions of the corresponding neuro-fuzzy system.

In (Limongelli, Sciarrone, Temperini, & Vaste, 2010) the author compares various algorithms of curriculum formation: KBS, LS-Plan and IWT. For comparison the following criteria and metrics were used: Overall Effort metrics, Overall Acquired Knowledge metrics and Overall effort metrics. The curriculum was presented as an algorithm or graphs. It was stated that the LS-Plan has the longest distance of educational trajectories and the greatest number of errors, whereas the algorithm IWT generates the shortest path.

We can classify incoming data using the method of hierarchies analysis. An example of this classification is presented in (Sivic, Russell, & Zisserman, 2008) by J. Sivic, B. Russell et al.
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