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# Algorithm for Individual Learning Content Formation in Automated Machine Learning System

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**Abstract:** The study describes the algorithms used in the formation of individual learning content which can be used in machine learning. The algorithm for generating educational content based on the input test procedure, thereby reducing the number of elementary units of knowledge in the educational content. The blocks of knowledge of different semantics in terms of the importance of studying (fundamental, basic and divergent) are used during the process of the formation of educational content. The algorithm-building features for individual learning content formation were determined. The rules of formation of the educational content were developed.

**Key words:** Student's model, adaptive testing, machine learning, educational paths, E-learning systems, automated learning management systems

## INTRODUCTION

The automated individual training management system forms the educational paths based on the personal characteristics of learners and is the promising trend of development of the educational process (Hwang *et al*., 2013; Simonova *et al*., 2011; Jurkov, 2010). The adaptive system of machine learning includes the following components (Lomakin *et al*., 2014): module of analysis of psycho-physiological parameters of a learner, module of formation of the learner's profile, the sub-system of the competencies monitoring, testing rules, rules of the learning content formation, module of analysis of the test tasks quality, the educational program model (Lomakin and Asadullaev, 2013), the learner's model, the model of the automatic control of the educational process, adaptive testing model (Lomakin *et al*., 2012), module of the educational content formation, module of the individual educational paths management and other components required for effective organization of the automated process of management of individual educational paths.

An important factor of the successful use of the machine learning is availability of the tools that are able to from the educational content oriented at each learner by batches.

## MATERIALS AND METHODS

**Procedure:** The studies show the efficiency of use of the individually-oriented machine learning systems (Solovov, 2006; Sokolova, 2011). At that the researchers emphasize the particular relevance of these systems during the process of preparation and enterprise personnel development (Joo *et al*., 2012). Regardless of the area of application of the machine learning system an important issue that remains open is the adaptive support of the learner's navigation within the educational content (Brusilovsky, 2003). The component of the navigation process is the algorithm of formation of individual educational content using the data obtained from the components included in the structure of the machine learning system (Lomakin *et al*., 2014).

## RESULTS AND DISCUSSION

**Main part:** The model of educational program is presented in the form of the graph, the nodes of which are the Elementary Knowledge Units (EKU) belonging to one of the 3 types:

- Basic VB = $\{ebz_i\}$, $i = \overline{1,s}$
- Variative VV = $\{ebz_i\}$, $i = \overline{1,l}$
- Fundamental VF = $\{ebz_i\}$, $i = \overline{1,q}$

Thus, the task of the algorithm of formation of the individual educational component consists in presentation to the learner of the educational content consisting of the combination of the basic, variative and fundamental EKU depending on the individual educational path and specific of the information perception.

By design of the algorithm of formation of individual educational component the following peculiarities shall be

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taken into account $ebz_i \in VB$, $i = \overline{1,s}$ of learners is varied from 3-7; the input testing procedure detects the learner's knowledge in the form of a single question to each EKU; the researcher of the course shall form the volume of the subject content based on the average rate of the material perception by; each EKU shall contain approximately, the same didactic volume of information.

Having taken into account the above-mentioned peculiarities the algorithm of formation of the individual educational content has been designed (Fig. 1). The algorithm of operation of the input testing procedure is presented in Fig. 2. After definition of the complexity level of the test tasks and the ratio of the learner's automation the calculation of the number of the Basic |VBT|, Fundamental |VFT| and Variative |VVT| educational course subject are performed. At that:

$$VBT \subset VB, VFT \subset VFuVVT \subset VV$$

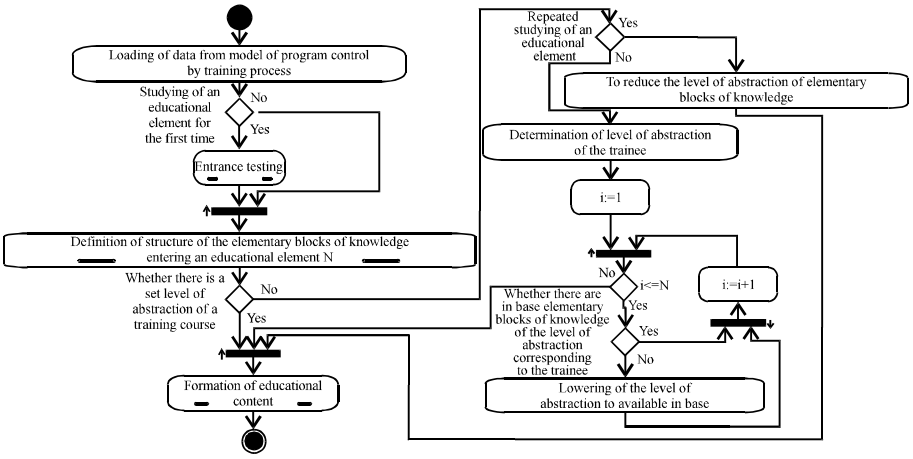


Fig. 1: Algorithm of the process of formation of the individual educational content

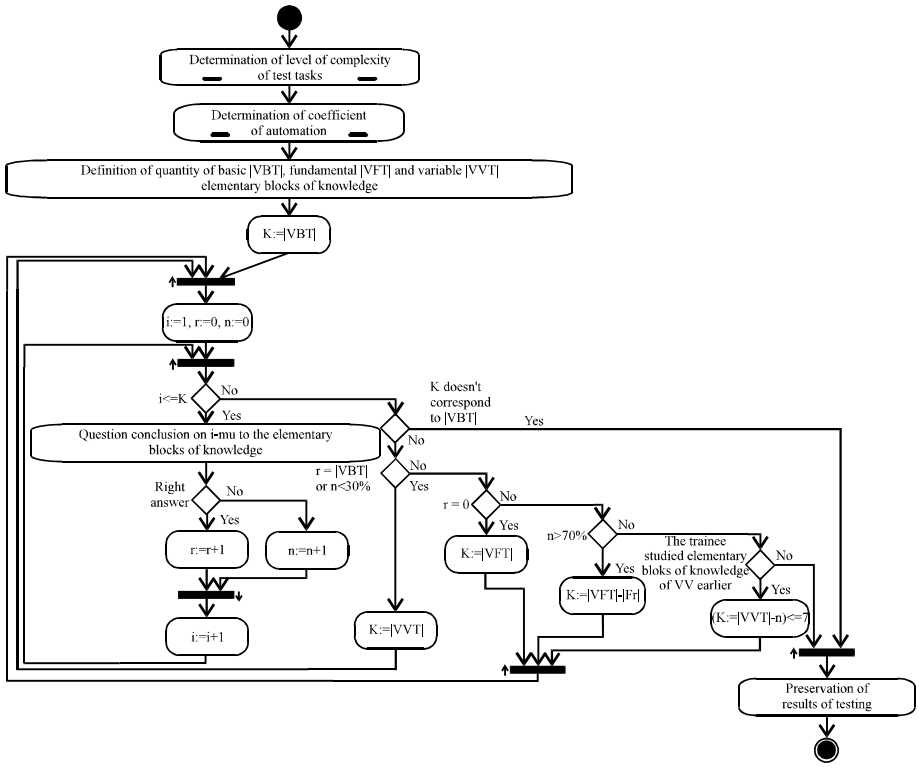


Fig. 2: Algorithm of the input testing procedure

Then testing of the learner by ebz∈VBT is performed whereas the following variables are: K is the number of questions corresponding to the number ebz∈VBT, i is testing cycles counter, r is the answers, n is the number of incorrect answers. Once the answers to all ebz∈VBT have been received the testing of the following conditions is performed.

Of if the questions were not in respect of ebz∈VBT (K does not correspond to ebz∈VBT) the completion of the input testing procedure takes place, otherwise if (r = |VBT|) or (n<30%) (a learner knows ebz∈VBT) then testing in respect of ebz∈VVT (K:=VVT) is performed, otherwise, if r = 0 (a learner does not know either of ebz∈VFT) then testing in respect of ebz∈VFT (K:=|VFT|) is performed, otherwise, if n>70% then testing by ebz∈VFT is performed that are related to ebz∈VBT in respect of which no correct answers were received (K:=|VFT|-|Fr|, where |Fr| is the number of ebz∈VFT relating to ebz∈VBT in respect of which correct answers were received), otherwise, if a learner previously studied ebz∈VVT, then testing by ebz∈VVT shall be performed with account for the fact that the number ebz∈VBT of the incorrect answers and ebz∈VVT shall be either less or equal to 7 ((K:=|VVT|-n)≤7), otherwise, the input testing procedure shall be completed.

Thus, by running the input testing procedure the following set of results RVT may be obtained: a learner does not completely master:

$$ebz_i \in VBT, i = \overline{1,st} \text{ and } ebz_j \in VFT, j = \overline{1,qt}$$

Where:

st = The number of the basic EKU of the subject

qt = The number of the fundamental EKU of the subject; a learner does not completely master

$$ebz_i \in VBT, i = \overline{1,st}$$

and partially masters:

$$ebz_j \in VFT, j = \overline{1,qt - q_1}$$

where, $q_1$ the number ebz∈VFT a learner does not master; a learner does not completely master:

$$ebz_i \in VBT, i = \overline{1,st}$$

but masters:

$$ebz_j \in VFT, j = \overline{1,qt}$$

a learner knows:

$$ebz_i \in VBT, i = \overline{1,g}$$

Where:

$$g < \frac{2 \times st}{3}$$

and knows:

$$ebz_j \in VFT, j = \overline{1,qt - q_2}$$

where, $q_2$ the number ebz∈VFT, referring to the basic EKU to which a learner gave correct answers; a learner knows:

$$ebz_i \in VBT, i = \overline{1,g}$$

and does not master:

$$ebz_j \in VFT, j = \overline{1,qt - q_2}$$

a learner knows:

$$ebz_i \in VBT, i = \overline{1,g_1}$$

Where:

$$g_1 \geq \frac{2 \times st}{3}$$

and does not master:

$$ebz_p \in VVT, p = \overline{1,lt}$$

where, lt the number of variative EKU of the subject; a learner knows:

$$ebz_i \in VBT, i = \overline{1,g_1}$$

and partially masters:

$$ebz_p \in VVT, p = \overline{1,lt - l_1}$$

where, $l_1$ the number ebz∈VVT a learner knows. The results of the input testing and the output value of the model of the program control of the educational process are the ground for formation of the subject content with the use of one of the following methods: VBT, the educational content is formed only from:

$$ebz_i \in VBT, i = \overline{1,st}$$

VBT+VFT, the educational content is formed from:

$$ebz_i \in VBT, i = \overline{1,st}$$

And:

$$ebz_j \in VFT, j = \overline{1,qt}$$

VBT+VVT the educational content is formed from:

$$ebz_i \in VBT, i = \overline{1,st}$$

And:

$$ebz_p \in VVT, p = \overline{1,lt}$$

VVT+VFT, the educational content is formed from:

$$ebz_p \in VVT, p = \overline{1,lt}$$

and:

$$ebz_j \in VFT, j = \overline{1,qt}$$

VVT, the educational content is formed only from:

$$ebz_p \in VVT, p = \overline{1,lt}$$

**Summary:** Thus, the algorithm of formation of the individual educational content has been designed the operation of which is based on the results of the input testing procedure, the adaptive testing procedure and the output data of the model of the program control of the educational process. During the process of individual assembly of educational content the level of the learner's abstraction is taken into account. There was designed the input testing algorithm using the automation ratio and the level of the test task complexity depending on learner's rating.

## CONCLUSION

There was designed the algorithm and determined the peculiarities of formation of the individual educational content. The use of the input testing procedure is especially reasonable at the postgraduate courses since the employees improve the exiting knowledge the initial level of which has to be known by design of the individual training program.

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