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**REVIEW of**
**FOREIGN SCIENTIFIC CONSULTANT**
**on the dissertation work of Fedkin Yevgeniy «Development of models,**
**methods, and algorithms for forming schedules for traditional and distance**
**learning in the universities»,**
**submitted for the degree of Doctor of Philosophy (PhD) under the**
**educational program 8D06101 – Information systems (by industry)**

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The relevance of the research topic of doctoral student Fedkin Yevgeniy is determined by the fact that the task of scheduling classes is one of the important tasks in the management of the educational process in higher education institutions. The specified task has many input parameters and conditions, as well as many restrictions that are imposed on the schedule being compiled, which largely depend on the specific educational institution. As a result, the development of models, methods and algorithms that allow considering the specific of a particular educational institution is a very important factor for research in this area.

In addition, the development of information and communication technologies has introduced such a form of education as distance learning into the educational process. Therefore, the development of methods for scheduling for this form of training, as well as a mixed form (distance and full-time) also determines the relevance of this study.

This scientific study examines the problem of scheduling based on the educational portal of D.Serikbayev named East Kazakhstan Technical University.

The first chapter of this dissertation is an overview. The author examines the methods and algorithms that are used to solve the problem of scheduling classes. In this review, the author of the study considers two groups of methods and algorithms: exact methods that involve a complete search of solutions, and approximate methods that are focused on obtaining an acceptable schedule option for an acceptable working time. Considering these methods and algorithms, the author provides a description of their work, as well as their strengths and weaknesses.

The second chapter of this study describes the construction of a mathematical model of scheduling. This mathematical model includes input and output data. Also, in this model, the author describes the restrictions that are imposed on the schedule. These restrictions are conditionally divided into "hard" and "soft" constraints. Further, the author suggests using a genetic algorithm to solve the problem of scheduling. The proposed variant of the genetic algorithm is based on the use of an individual with a single chromosome, in which the genes represent individual classes in the schedule. As a fitness function for the genetic algorithm, the author proposed a function based on determining the fulfillment of constraints with weighting coefficients for each constraint. Also in this chapter, the author proposes algorithms for the formation of an initial population based on the ordering of academic streams based on their semantic proximity, algorithms for crossing and mutation operators, an algorithm for the formation of a new population and a condition for completing the search. At the end of the chapter,

the author provides a scheme for creating functions to evaluate the implementation of constraints that are imposed on schedules. The proposed scheme has several advantages that reduce the number of required calculations.

In the third part of this dissertation, the author carries out the practical implementation of the proposed model and algorithm for scheduling classes. In this part, the author provides a database schema for storing the source data required for scheduling and provides an implementation of a dynamic library that implements the scheme of the genetic algorithm proposed in the second part. This development is extensible, which allows you to use this development for various educational institutions.

In the fourth part of this study, the author conducts research on the architecture of the educational portal of D. Serikbayev named EKTU to identify the data required for scheduling classes. Based on the analysis, the author identified tables in the database that contain the necessary information and implemented their import into the database for scheduling from the second part. To test the proposed algorithm, the author extracted data for scheduling classes for the 3rd trimester of the 2022-2023 academic year. Based on the data obtained, a computational experiment was performed to evaluate the performance of the proposed algorithm. This experiment has showed that the proposed algorithm has a polynomial dependence on the number of elements in the schedule and that the algorithm for generating the initial population allows you to get a schedule version close to the optimal one, which in total allows you to get a better solution in the cyclic part of the genetic algorithm.

In general, the scientific novelty of this study lies in the application of the genetic algorithm proposed in the second section of the modification based on the fitness function of evaluating the fulfillment of constraints with a weighting factor for each constraint.

As a result of the conducted scientific research, the author obtained the following scientific results with signs of scientific novelty:

- A mathematical model for the schedule of classes is proposed, which includes input and output data, as well as a set of constraints imposed on the schedule, which are conditionally divided into "hard" and "soft" constraints.

- A fitness function is proposed for evaluating the schedule based on the fulfillment of constraints imposed on the schedule, with weighting coefficients. This function evaluates the implementation of "hard" and "soft" constraints. To obtain an optimal schedule of classes, it is necessary to maximize this function in the following order: first by the value for "hard" constraints, then by the value of "soft" constraints.

- An algorithm is proposed for generating an initial population based on clustering of academic streams based on their semantic proximity, followed by sorting the streams and their sequential inclusion in the schedule based on the value of the proposed target function.

- Algorithms for genetic operators of mutation and crossing are proposed. These algorithms allow you to create new schedule options based on the values of the target function.

- An algorithm for the formation of a new generation is proposed based on the values of the target function, values for certain types of constraints and a random sample from the new generation of genetic operators obtained after the application

- A scheme for constructing a function for evaluating the implementation of constraint is proposed, offering a breakdown of the original schedule into schedules by category (group, teacher, audience) and checking the constraints on each individual schedule and subsequent summation of the results obtained. This scheme allows you to speed up the constraint check by saving the previous calculation results.

The practical significance of the results obtained lies in the fact that the proposed solution to the problem of scheduling allows it to be used for scheduling based on the requirements of a particular educational institution. There are also acts on the implementation of the results of this work and an author's certificate for the program for scheduling semester classes for universities.

The main results of this dissertation research are reflected in scientific publications, including publications in journals in the SCOPUS database, in journals recommended by the Committee for Control in Science and Higher Education of the Ministry of Science and High Education of the Republic of Kazakhstan, as well as in the materials of scientific conferences, including those indexed in the SCOPUS database. Also, one monograph «Development of an on-line education model for higher educational institutions of the Republic of Kazakhstan» was published as part of the study.

In general, Fedkin Yevgeniy's dissertation is a completed independent scientific work that meets all the requirements of the Committees for Science and Higher Education of the Ministry of Science and High Education of the Republic of Kazakhstan, and its author deserves to be awarded the degree of Doctor of Philosophy (PhD) under the educational program 8D06101 – Information Systems (by industry).

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