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Analysis of programs for operational and systems analysis

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Abstract: This paper deals with the selection and comparison of programs that students could use when preparing semester papers in the subject of Operational and Systems Analysis. The analysis consists of a comparison of work in selected software based on selected criteria, such as the availability of programs for students, the language in which the programs are written, the time spent on preparing individual assignments and the correctness of their results. The final part evaluates the benefits of the paper and the selection of the most suitable programs for individual types of tasks.

Keywords: operational analysis, system analysis, mathematical method, program

1 INTRODUCTION

Linear programming is a mathematical method for solving problems that allows managers to make optimal decisions. Linear programming is a part of mathematical programming and therefore also of operational analysis, which deals with solving decision-making problems that involve determining the sizes of the implementation of processes that are or may be taking place in a given system [1-6]. It allows converting real processes into mathematical models and using a mathematical approach to subsequently solve them. In general, we can characterize these problems as having to determine the optimal value of a linear function on the set of solutions of a system of linear equations and inequalities. Many practical problems lead to problems of this type. A manufacturer produces several types of products. He has a certain amount of various means of production at his disposal, for example, raw materials, working time, wages, and production equipment. The manufacturer knows how much of the *i*-th means is necessary to produce one *j*-th product. He also knows what the profit is from selling a unit quantity of individual products. The task

is to design and plan production so that the manufacturer, with given capacities of means, produces exactly such quantities of goods that maximize profit. The quantity of chemical substances whose content in the required mixture interests us is given [7]. We also know the proportion of these chemical substances in the semi-finished products (raw materials) that we have available for preparing the given mixture. We know the minimum (or maximum) quantities of individual chemical substances that a unit quantity of the required mixture should contain. The prices for unit quantities of the given semi-finished products are also given. The task is to determine what quantities of the semi-finished products that we have available need to mix to obtain the required mixture at minimal cost. In the subject of Operations and Systems Analysis, students are introduced to the basic concepts of systems science and a systems approach to solving complex problems as part of their semester papers. Semester papers are focused on solving practical decision-making problems using mathematical models and methods within linear programming tasks. In the past, students used the *WinQSB* program for calculations and visualization of results, which is no longer supported. The program was available only in the computer labs of the *Department of Industrial Engineering*. This often resulted in time-consuming work on assignments during exercises. Therefore, we decided to look for free programs that are available to students at any time as a replacement [8-10]. The programs are differentiated, meaning that we use different programs for different types of tasks. They are all freely available, which results in certain necessary requirements, such as the need for registration or the need to use a certain time-limited trial version, which is free. The individual software programs are divided into three groups according to the type of tasks for which they are intended, namely the solution of *Linear Programming* 1 tasks, network graph tasks and the associated creation of *Gantt charts*.

Názov	Logo	Typ úlohy	Link - prepojenie
Simplex Tode	SIMPLEXOVÁ METODA	OVP	https://www.mdpi.com
AtoZmath	AtoZmath.com	OVP, RP, OZ	https://cbom.atozmath.com/CBOM/Simplex.aspx?q=sm
Zweigmedia	Finite mathematics & Applied calculus Simplex method tool: v 2.0	OVP, RP, OZ	https://www.zweigmedia.com/simplex/simplex.php?lang=en
MathsTools	MathsTools	OVP, PR, OZ	https://www.mathstools.com/section/main/simplex_online_calculator#.XrartKgzZPb
Creately	creately	Sieťové grafy	https://creately.com/
MS Project		Sieťové grafy, Ganttov diagram	[-]
Tom's Planner	TOM'S PLANNER	Ganttov diagram	https://www.tomsplanner.com/
Easy Project	easy PROJECT	Ganttov diagram	https://www.easyproject.cz/

Fig. 1. Analyzed programs

More detailed analyses of the work in individual programs are included in point 3. The main comparison criteria (Fig. 1) include the correctness of the results, the availability of the software, the working environment, and the possibilities of saving and exporting the results. Programs for network graph tasks are intended for a sample display of pre-calculated results using software. The output of the analyzed programs is therefore a finished network graph or *Gantt chart* [11-13].

2 PROGRAM ATOZMATH

The software is freely available without the need to download or install. It is shown in Fig. 2. To work in it, registration or entering personal data is not required. The program is in *English*. Working in it is slightly difficult, some explanation is needed. The program allows changing the sign of the objective function. This means that it can also calculate tasks on the optimal mixture and optimal cutting plan. After entering the structural conditions and the objective function, we work out the results using the Find button.

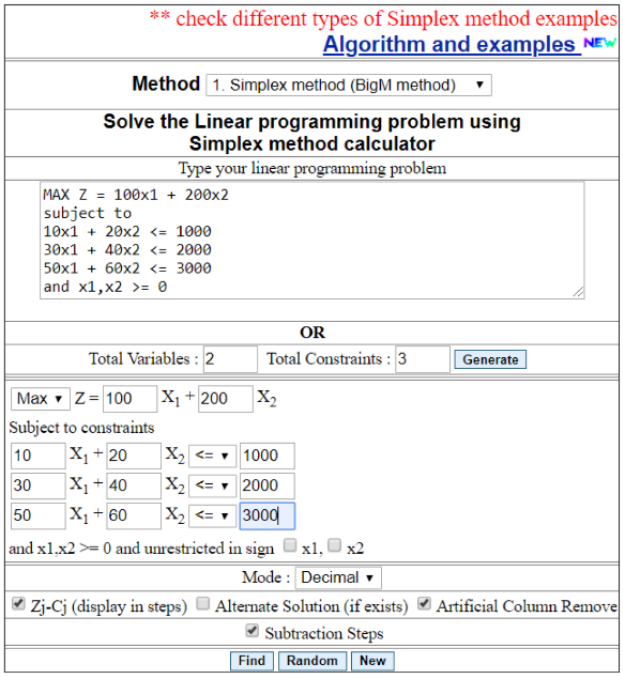

Fig. 2. Program *AtoZmath* [6]

The results are displayed in three steps, each of which requires confirmation and a 15-second wait. The website interface also offers a number of unwanted advertisements, which do not affect the functionality, only the aesthetics. The program offers several methods of calculating *Simplex algorithms*, which can be seen in Fig. 3.

The results from program *AtoZmath* are shown in Fig. 4.

We will reach the result of the graphical solution after the third step and a short time interval. When

changing the parameters of the variable display, we must also go through all three steps of displaying the results again. The resulting solution is shown in Fig. 5.

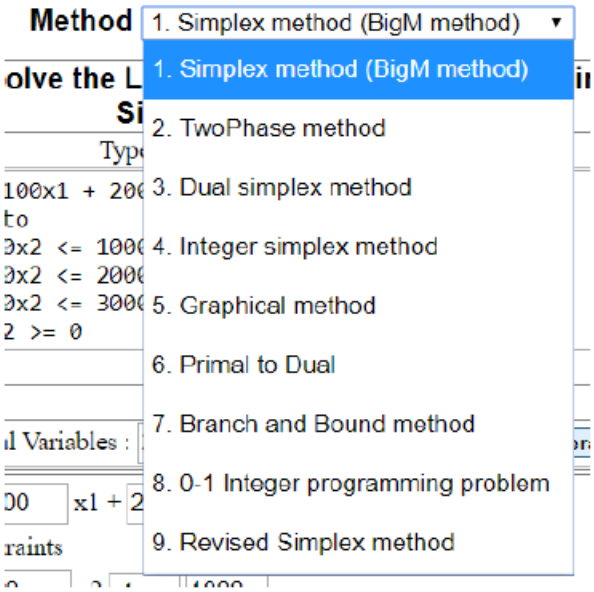

Fig. 3. Calculation methods [6]

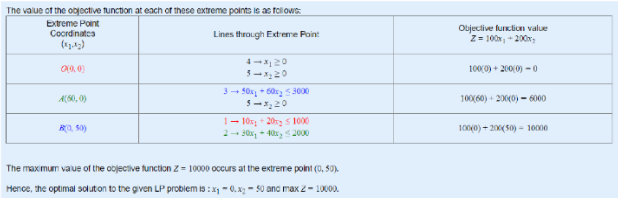

Fig. 4. The first version of *AtoZmath* results [6]

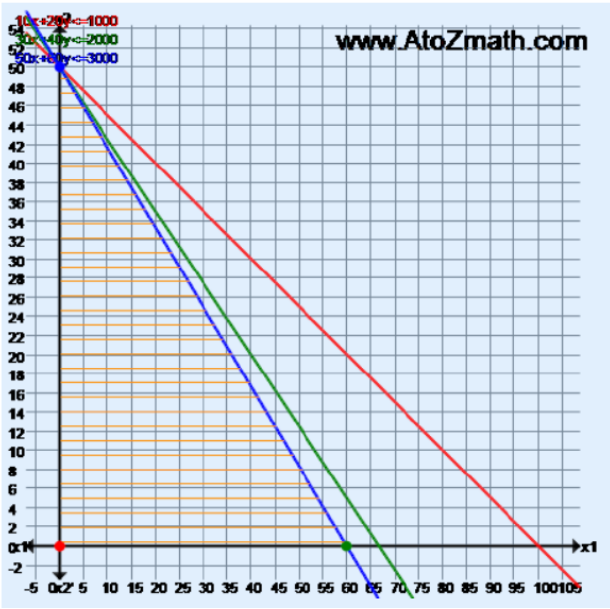

Fig. 5. Graphical solution of *AtoZmath*

3 CONCLUSION

I will evaluate the work in individual programs according to the following criteria correctness of results and output, language, length of work availability of programs, advantages and disadvantages.

The correctness of the result is the most important for the assignment. All the programs I compared offered the correct result, so I will focus on the output of the results. This means whether the results are clear and whether they can be used in semester papers without modification. The length of the work represents the time spent in a given program. This criterion includes not only the length of work necessary to develop the assigned example, but also the time needed to understand and navigate the environment of the selected software. The criterion of program availability includes all the necessary steps that are necessary to be able to work in the program. Some programs are available anytime and anywhere for free and without registration, while others require registration or entering an email address.

The programs being compared are freely available on the Internet without the need for registration or entering personal data. All four found the correct result, but *Simplex Tode* can only calculate tasks on the optimal production plan. Nevertheless, its great advantages are a simple working environment, *Czech* language and short time of work in it. All software generate results in the form of tables with the optimal solution. The *AtoZmath* program also offers a graphical method of solving tasks. Therefore, I recommend using the graphical solution for all three types of linear programming tasks using the *AtoZmath* program. For solving using the Simplex method, I choose the *MathsTools* software for all types of tasks and the Simplex Tode program for tasks on the optimal production plan.

For assignments on network graphs, I recommend the *Creately program*. Working with it is very simple and fast. The creation of a network graph itself ideally takes half an hour and the resulting output can be easily exported directly into a semester paper. Using this software, we can create a sample network graph in a relatively short time. However, it should be added that registration and entering an email address are required to work with it.

For creating *Gantt charts*, I definitely recommend the *Tom's Planner program*. The software is directly designed for creating *Gantt charts*, so it provides everything you need for their creation. Creating a chart is very easy and we also have the option of adding a number of other options, such as adding a description, creating a legend and highlighting the critical path. The result of the work is a clear *Gantt chart* that can be easily exported.

On the other hand, I find the work in *Easy Project* to be lengthy and demanding. The software is mainly designed for working within broad corporate projects. Nevertheless, it can also be used for study purposes

and can create a satisfactory, but less clear *Gantt chart*. For both programs, it is necessary to register.

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REFERENCES

[1] ANTONIUK, I. - SVITEK, R. - KRAJCOVIC, M. - FURMANNOVA, B. (2021). *Methodology of design and optimization of internal logistics in the concept of Industry 4.0*. In: Transportation Research Procedia, 55, 503-509.

[2] BUCKOVA, M. - GASO, M. - PEKARCIKOVA, M. (2020): *Reverse logistic*. In: InvEnt 2020: Industrial engineering - Invention for enterprise - proceedings. Bielsko-Biała: Wydawnictwo Akademii Techniczno-Humnistycznej.

[3] BURGANOVA, N. - GRZNAR, P. - MOZOL, S. (2020): *Design of logistics system in production*. In: Technologie, procesy i systemy produkcyjne. Bielsko-Biala: Wydawnictwo naukowe Akademii techniczno-humanistycznej w Bielsku-Białej, p. 11-18, ISBN 978-83-66249-56-1.

[4] VAVRIK, V. - FUSKO, M. - BUČKOVÁ, M. - GASO, M. - FURMANNOVÁ, B. - STAFFENOVA, K. (2022): *Designing of machine backups in reconfigurable manufacturing systems*. In: Applied Sciences, Vol. 12, No. 5, p. 1-27, ISSN 2076-3417.

[5] FILIPOVA, I. - DULINA, L. - BIGOSOVA, E. - PLINTA, D. (2021): *Modern Possibilities of Patient Transport Aids*. In: Transcom, Virtual conference 26 May - 28 May, Transportation Research Procedia, 55, pp. 510-517.

[6] SUKALOVA, V. - STOFKOVA, Z. - STOFKOVA, J. (2022): *Human Resource Management in Sustainable Development*. In: Sustainability, Vol. 14, No. 21, 14258.

[7] BEREŽNÝ, Š. - KRAVECOVÁ, D. (2012): Lineárne programovanie. [online]. [cit. 2019-12-20].

[8] GANTTOV DIAGRAM (2016): [online]. [cit. 2019-11-15]. Available on: https://managementmania.com/sk/ganttov-diagram-gantt-chart

[9] LINEÁRNE PROGRAMOVANIE 1 (2019): [online]. 2019, [cit. 2019-11-21]. Available on: http://www.fbi.uniza.sk/ktvi/leitner/2_predmety/OA/Semester/P03_LP_modely,%20graficke%20riesenie.pdf

[10] TOMA, V. (2008): *Základy lineárneho programovania*. [online], [cit. 2019-11-22].

[11] SLAMKOVÁ, E. - CAJCHANOVÁ, O. - CHROMJAKOVÁ, F. (1998): *Operačná a systémová analýza*. 1. vyd. Žilina: Žilinská univerzita v Žiline, 181 p., ISBN 80-7100-467.

[12] MÁCA, J. - Leitner, B. (1999): *Operačná analýza*. *I. diel*. 1. vyd. Žilina: Žilinská univerzita v Žiline, 181 p., ISBN 80-88829-39-9.

[13] SLAMKOVÁ, E. (1990): *Operačná a systémová analýza: Návody na cvičenia*. Bratislava: Alfa, vydavateľstvo technickej a ekonomickej literatúry, 177 p., ISBN 80-0500-2017.