

DOCTORAL (PHD) STUDIES
COURSE UNIT DESCRIPTION

Course unit title	Scientific areas	Faculty	Institute, department
Decision making strategies	Informatics engineering (T 007)	Faculty of Mathematics and Informatics	Institute of Data Science and Digital Technologies

Study method	Number of credits	Study method	Number of credits
Lectures	1 (spring)	Consultations	1
Individual works	4	Seminars	1

Summary
<p>We constantly face with decision making in a variety of areas. Often decisions are made after evaluating various alternatives, taking into account not only one but several criteria. This is called multi-criteria decision making. The first part of the course provides knowledge about multi-criteria decision making, methods used in decision making, and decision support systems. The second part is intended for multi-criteria optimization. The third part deals with decision making, when the decision is made by interpreting the image obtained by visualizing the analyzed data in a certain way. Several basic visualization methods are analyzed. The benefits of visualization for the classification and clustering tasks are explored. Ph.D. students will gain knowledge of multi-criteria decision making, the basic methods used in decision making and the ability to apply them in solving real-life decision making tasks.</p> <p><i>Main topics:</i></p> <ol style="list-style-type: none"> 1. Multi-criteria decision making <ol style="list-style-type: none"> 1.1. Main concepts and tasks 1.2. Methods, used in decision making <ol style="list-style-type: none"> 1.2.1. Pair comparison method 1.2.2. Pareto technologies 1.2.3. Fuzzy technology 1.2.4. ELECTRE method 1.2.5. PROMETHEE method 1.2.6. TOPSIS method 1.3. Decision support systems, principles of their development, examples of systems. 2. Multi-criteria optimization <ol style="list-style-type: none"> 2.1 Formulation of the multi-criteria optimization problem (variables, criteria, objective functions, constraints, role of decision maker) 2.2 Multi-criteria optimization problem solutions (Pareto set, Pareto front, dominance relationships) 2.3 The classification of multi-criteria optimization methods according to the role of the decision maker 2.4 Multi-criteria optimization methods based on decision maker's preferences 2.5 Visualization of the Pareto front 3. Visual decision making <ol style="list-style-type: none"> 3.1 The objectives of the visualization and its benefits in decision making 3.2 Data visualization methods <ol style="list-style-type: none"> 3.2.1 Direct visualization methods (scatter plot matrix, parallel coordinates, Andrews curves, faces of Chernov faces and others)

- 3.2.2 Dimensionality reduction-based methods (principal component analysis, multidimensional scaling)
- 3.2.3 Self-organizing neural networks (maps)
- 3.3 Interpretation of results and decision making
- 3.4 The benefits of visualization in solving the problems of classification and clustering (dendrogram, visualization of the results of the k-mean method)

Practical assignment: to solve decision making and multi-criteria optimization tasks using selected decision support systems; to select a data set, and visualize it using various visualization methods; prepare a report in which the results should be described, conclusions should be drawn.

Main literature

Dzemyda, G.; Kurasova, O.; Žilinskas, J. (2013) Multidimensional Data Visualization: Methods and Applications. Springer, ISBN 978-1-4419-0235-1. doi:10.1007/978-1-4419-0236-8.

Govindan, K., & Jepsen, M. B. (2016). ELECTRE: A comprehensive literature review on methodologies and applications. *European Journal of Operational Research*, 250(1), 1-29.

Behzadian, M., Kazemzadeh, R. B., Albadvi, A., & Aghdasi, M. (2010). PROMETHEE: A comprehensive literature review on methodologies and applications. *European journal of Operational research*, 200(1), 198-215.

Greco, S., Ehrgott, M., & Figueira, J. (2016). Multiple criteria decision analysis: state of the art surveys. *International series in operations research & management science*, 233(2), 35-47.

Emmerich, M. T., & Deutz, A. H. (2018). A tutorial on multiobjective optimization: fundamentals and evolutionary methods. *Natural computing*, 17(3), 585-609.

Liu, Z., Xiao, F., Lin, C. T., Kang, B. H., & Cao, Z. (2019). A generalized golden rule representative value for multiple-criteria decision analysis. *IEEE Transactions on Systems, Man, and Cybernetics: Systems*.

Lecturer(s) (name, surname)	Science degree	Main publications
Gintautas Dzemyda	habil. dr.	http://www.elaba.mb.vu.lt/dmsti/?aut=Gintautas+Dzemyda
Olga Kurasova	dr.	http://www.elaba.mb.vu.lt/dmsti/?aut=Olga+Kurasova
Ernestas Filatovas	dr.	http://www.elaba.mb.vu.lt/dmsti/?aut=Ernestas+Filatovas