



Syllabus of discipline «Fuzzy Data Processing in Control and Decision Making Systems»

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Expected learning outcomes

As a result of studying the discipline, the student **must know:**

- representation of real-time series and high-frequency data by triangular and trapezoidal fuzzy numbers, main mathematic operators and arithmetic operations in fuzzy data processing;
- types of input data, structure of the intelligent rule base of fuzzy systems, fuzzy rule base properties;
- quality indices of fuzzy systems, activation of MFs for fuzzy rules conclusions, aggregation algorithms in fuzzy data processing, defuzzification algorithms in fuzzy data processing;
- the structures of the fuzzy inference engines of Sugeno-type, Tsukamoto-type and others with fuzzy data processing, fuzzy data processing based on hierarchical structure of fuzzy systems;
- linguistic controllers with fuzzy inference engine of Mamdani-type linguistic controllers with fuzzy inference engine of Sugeno-type;
- structural and parametrical optimization of fuzzy systems (signal processing, control and decision making systems);
- the role of expert evaluation in solving prognosis tasks and problem based on fuzzy approach.

must be able to:

- carry out fuzzy data processing based on fuzzification, aggregation, implication, activation, accumulation, and defuzzification algorithms;
- application of methods for investigations of the impact of aggregation and defuzzification algorithms to quality indices of fuzzy systems;
- fuzzy data processing based on fuzzy inference engine of Mamdani-type, design of Mamdani-type fuzzy systems;
- design of fuzzy controllers based on expert knowledge and control object model;
- reduction of the fuzzy rule base, application of methods of automatic generation and optimization of fuzzy rule base;
- implementation of hesitant fuzzy sets for fuzzy data processing with high level of uncertainty;
- long-time prediction of important events and innovations introducing based on fuzzy Delphi method.

The scope of the discipline: 3 ECTS credits (10 hours of lectures, 20 hours of practice).

Purpose: teaching PhD students the basic principles in fuzzy data processing, types of input data, the structures of the intelligent rule base of fuzzy systems, as well as the development and implementation of fuzzy inference engines of Mamdani-type, Sugeno-type, Tsukamoto-type, and others with fuzzy data processing, and fuzzy controllers based on expert knowledge and control object model. The aim is also to form a system of theoretical knowledge and practical skills on structural and parametrical optimization of fuzzy systems (signal processing, control and decision making systems), implementation of hesitant fuzzy sets for fuzzy data processing with a high level of uncertainty, fuzzy data processing for solving multi-criteria problems with uncertain input data.

The content of the discipline

Topic 1. Transformation of Big Data to fuzzy numbers.

Topic 2. Fuzzy data processing based on fuzzy inference engines with discrete and continuous outputs.

Topic 3. Aggregation and defuzzification algorithms and their impact to quality indices of fuzzy systems.

Topic 4. Fuzzy data processing based on fuzzy inference engine of Mamdanitype.

Topic 5. Fuzzy data processing based on fuzzy inference engines of Sugentotype, Tsukamoto-type and others.

Topic 6. Fuzzy data processing based on hierarchical structure of fuzzy decision-making systems.

Topic 7. Fuzzy data processing for control and decision-making in uncertainty. **Topic 8.** Structural and parametrical optimization of fuzzy systems.

Topic 9. Hesitant fuzzy sets: implementation of hesitant fuzzy sets for fuzzy data processing with high level of uncertainty.

Topic 10. Extrapolation as fuzzy data processing in fuzzy models. Fuzzy Delphi Method for long-time prediction of important events and innovations: distance and similarity of fuzzy numbers.

Topic 11. Methods of fuzzy processing for data classification and multi-criteria decision-making: AHP, TOPSIS, VIKOR, DEMATEL.

Topic 12. The types of fuzzy systems. Fuzzy data processing in neuro-fuzzy models. Fuzzy data processing and fuzzy systems applications: successful examples.

Prerequisites

“Fuzzy Sets Theory and Fuzzy Logic”, “Decision Making Theory”, “Control Systems”

Consequences

The knowledge gained during the discipline can be used in the disciplines or areas "Intelligent decision support systems", "Software intelligent control systems", "Methods of computational intelligence"

Technical support

Practices on the discipline are carried out in computer classes using Microsoft Visual Studio, Java SE, Python, C#

Deadline policy

Works that are submitted in violation of deadlines without good reason are evaluated at a lower grade.

Academic Integrity Policy

Provides independent performance of practices. Write-off (including using mobile devices) is prohibited. The work is not credited in case of detection of plagiarism or writeoff.

Evaluation criteria of laboratory works / practices / individual works / reports / projects

Maximum number of points – a PhD student with high quality independently performed the entire scope of work, answers all questions related to the work performed, and makes additional calculations, for example, using the methods of fuzzy data processing offered to him by the teacher. The teacher has no complaints about the implementation and performance requirements.

70%-99% of the maximum number of points – a PhD student with sufficient quality independently completed all tasks, but in the process he made some mistakes, which, after pointing to them by the teacher, corrected themselves. He answers some questions with a slight error. The additional calculations offered by the teacher make with some complexity. Not all work requirements are met.

40%-69% of the maximum number of points – a PhD student of average quality independently completed all tasks, but did not meet all the requirements for implementation. He answers the question with a slight error. The additional calculations offered by the teacher, for example, using fuzzy methods of decision making makes with insignificant errors. Not all requirements for the design of the work are met.

1% -39% of the maximum number of points – a PhD student performed all the work independently, but the quality of implementation is insufficient (errors in calculations, not all

work requirements are met). The answers to the questions about the work are not entirely clear. There are errors in the answers.

0 points – a PhD student did not perform the entire amount of work, or performed with gross errors. He has problems with calculations by certain methods, does not know the theoretical material, the software implementation does not meet the requirements.