Ministry of Science and Higher Education of the Russian Federation
NATIONAL RESEARCH
TOMSK STATE UNIVERSITY (NR TSU)

Institute of Applied Mathematics and Computer Science

APPROVE:
Director

_____ A. V. Zamyatin

Work program of the discipline

Intelligent Systems - I

in the major of training

01.04.02 Applied mathematics and informatics

Orientation (profile) of training:

Big Data and Data Science

Form of study
full-time

Qualification
Master

Year of admission
2022

Code of discipline in the curriculum: B1.O.05

AGREED:
Head of EP

_____ A.V. Zamyatin

Chairman of the EMC

_____ S.P. Sushchenko

Tomsk – 2022

1. Purpose and planned results of mastering the discipline

The purpose of mastering the discipline is the formation of the following competencies:
- UK-1 - the ability to carry out a critical analysis of problem situations based on a systematic approach, to develop an action strategy;
- GPC-1 - the ability to solve actual problems of fundamental and applied mathematics.
The results of mastering the discipline are the following indicators of the achievement of competencies:
IUK-1.1 Identifies a problem situation, on the basis of a systematic approach, carries out its multifactorial analysis and diagnostics.
IUK-1.2 Carries out the search, selection and systematization of information to determine alternative options for strategic solutions in a problem situation.
IUK-1.3 Suggests and justifies the strategy of action, taking into account the limitations, risks and possible consequences.
IOPC-1.1 Analyzes problems in the field of fundamental and applied mathematics.

2. Tasks of mastering the discipline

– Master the production, semantic and frame models of knowledge representation.
– Learn to apply fuzzy logic algorithms when building expert systems to solve practical problems of professional activity.

3. The place of discipline in the structure of the educational program

Discipline belongs to the mandatory part of the educational program.

4. Semester of mastering and form of intermediate certification in the discipline

First semester, credit with assessment.

5. Entrance requirements for mastering the discipline

For the successful mastering of the discipline, training outcomes are required in the following disciplines: "Mathematics", "Computer Science".

6. Implementation language

English.

7. Scope of discipline

The total labor intensity of the discipline is 6 credits, 216 hours, of which:
- lectures: 20 hours
- laboratory: 44 hours
  including practical training: 0 h.
The volume of independent work of the student is determined by the curriculum.

8. The content of the discipline, structured by topics

Topic 1. Introduction to intelligent systems.
Representation of knowledge in information systems as an element of artificial intelligence and new information technologies. Stages of creating artificial intelligence. Basic concepts and classification of systems based on knowledge. Principles of acquiring knowledge.

Topic 2. Knowledge representation models..
Logical model of knowledge representation and inference rules. Production model of knowledge representation and rules for their processing. Conclusions based on production rules.

Frame model of knowledge representation. Representation of knowledge in the form of a semantic network.

Lab #1
Knowledge representation models.

Topic 3. Architecture and technology of expert systems development.

Introduction to expert systems. The roles of expert, knowledge engineer and user. General description of the architecture of expert systems. Knowledge base, rules, inference engine, user interface. Expert systems development technology.

Topic 4. Fuzzy logic.

Membership function of an element to a fuzzy set. Combining non-integer truth values in fuzzy logic. Weighing evidence. Confidence coefficients. Shortleaf's scheme for determining the degree of confidence in a hypothesis. The likelihood ratio of hypotheses.

Topic 5. Application of fuzzy sets in expert systems.

Operations on fuzzy sets. Eger and Kosko measures for determining the degree of fuzziness of sets. Defuzzification of a fuzzy set. Fuzzifier. Generalized Gaussian function. Defuzzifier. Defuzzification relative to the center of the area. Fuzzy inference rules. Mamdani-Zade fuzzy inference system.

Lab #2
Development of an expert system based on fuzzy inference rules.

9. Ongoing evaluation

The ongoing evaluation of the discipline is carried out by monitoring attendance, conducting tests, tests on lecture material, performing laboratory work, and is recorded in the form of a control point at least once a semester.

10. The procedure for conducting and criteria for evaluating the intermediate certification

The test with an assessment in the fifth semester is carried out in writing by tickets. The ticket contains 3 theoretical questions and one task. The duration of the test is 1.5 hours.

An approximate list of theoretical questions:

1. Describe the production model of knowledge representation.
2. Give a block diagram of the rule interpreter.
3. Describe the frame model of knowledge representation.
4. Describe the semantic model of knowledge representation.
5. Give a block diagram that describes the stages of technology for creating expert systems.
6. Give a block diagram describing the structure of connections between the subsystems of the expert system.
7. Shortleaf's scheme for determining the degree of confidence in the hypothesis.
8. Describe the concept of a cardinal number for a fuzzy set.
9. Describe the Eger measure that characterizes the degree of fuzziness of the set.
10. Describe the entropy measure of the fuzziness of the Kosko set.
11. Describe the generalized Gaussian membership function.
12. Describe the Mamdani-Zade fuzzy inference system.

Task examples:
1 task.
Implement knowledge representation by production rules.
2 Task.
Build a semantic model of knowledge representation.
3 Task.

Implement a frame model of knowledge representation.

The results of the assessment with an assessment are determined by the marks "excellent", "good", "satisfactory", "unsatisfactory".

The current control takes into account the student's performance of laboratory work and answers to questions at colloquia. The points scored are taken into account during the intermediate certification. Grades "excellent", "good", "satisfactory", "unsatisfactory" are given with the number of points scored: 90-100, 70-89, 55-69 and 0-54, respectively

11. Educational and methodological support

a) Electronic training course on the discipline at the electronic university "Moodle" - https://moodle.ido.tsu.ru/course/view.php?id=1396&section=3

b) Estimated materials of the current control and intermediate certification in the discipline.

c) Guidelines for laboratory work.

d) Guidelines for organizing independent work of students.

12. List of educational literature and Internet resources

a) basic literature:

– Spitsyn, V.G., Tsoy Yu.R. Intelligent Systems: Textbook. / V. G. Spitsyn, Yu. R. Tsoy; - Tomsk: Publishing House of TPU, 2012. - 176 p.

– Yasnitsky, L. N. Intelligent systems: textbook / L. N. Yasnitsky. - Moscow: Knowledge Laboratory, 2016. - 224 p.

b) additional literature:

– Rutkovskaya, D. Neural networks, genetic algorithms and fuzzy systems / D. Rutkovskaya, M. Pilinsky, L. Rutkovsky; per. from Polish. I. D. Rudinsky - 2nd ed., stereotype. - Moscow: Hotline-Telecom, 2013. - ISBN 978-5-9912-0320-3. - Text: electronic. - URL: https://znanium.com/catalog/product/414545 (date of access: 08/18/2020).

c) Internet resources:

– http://raai.org/ – Russian Association of Artificial Intelligence.

– http://www.niisi.ru/iont/ni – Russian Association of Neuroinformatics.

– http://ransmv.narod.ru/ – Russian Association of Fuzzy Systems and Soft Computing.– http://www.makhfi.com/KCM_intro.htm – Введение в моделирование знаний.– …

13. List of information technologies

a) licensed and freely distributed software::

– Microsoft Office Standard 2013 Russian: software package. Includes applications: MS Office Word, MS Office Excel, MS Office PowerPoint, MS Office On-eNote, MS Office Publisher, MS Outlook, MS Office Web Apps (Word Excel MS PowerPoint Outlook);

– publicly available cloud technologies (Google Docs, Yandex disk, etc.).

b) information reference systems:

– Electronic catalog of the TSU Scientific Library – http://chamo.lib.tsu.ru/search/query?locale=ru&theme=system

– TSU electronic library (repository) – http://vital.lib.tsu.ru/vital/access/manager/Index

– EBS Lan – http://e.lanbook.com/

– EBS Student Advisor – http://www.studentlibrary.ru/

– Educational platform Urayt – https://urait.ru/

– EBS ZNANIUM.com – https://znanium.com/

– EBS IPRbooks – http://www.iprbookshop.ru/

c) professional databases:
– University Information System RUSSIA – https://uisrussia.msu.ru/

14. Logistics

Halls for lectures.

Classrooms for seminars, individual and group work, ongoing evaluation and intermediate certification.

Classrooms for independent work, equipped with computer technology and access to the Internet, to the electronic information and educational environment and to information reference systems.

Halls for lectures and seminars, individual and group consultations, ongoing evaluation and intermediate certification in a mixed format ("Aktru").

15. Authors information

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