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 - II

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.P.V.08

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 apparatus of genetic algorithms for solving optimization and approximation problems.

– Learn to apply neural network algorithms to solve problems of classification and forecasting.

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

Discipline belongs to the part of the educational program formed by the participants of educational relations.

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

Third semester, credit.

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", "Intelligent systems-I".

6. Implementation language

English.

7. Scope of discipline

The total labor intensity of the discipline is 3 credits, 108 hours, of which:
- lectures: 10 hours
- laboratory: 20 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 6. Genetic algorithm.

Biological basis for the emergence of the genetic algorithm. Problems solved using a genetic algorithm. Stages of the genetic algorithm. Integer and real coding of information. Formation of the initial population. Population estimation. Selection types. Crossing and formation of a new generation. The destructive power of crossover. Mutation. Duration of population evolution.

Topic 7. Setting the parameters of the genetic algorithm.

The main parameters of the genetic algorithm and the relationship between them. Canonical genetic algorithm. Determination of the number of optimized variables encoded in the chromosome. Determination of the criterion for evaluating individuals in the form of an objective function. Setting the encoding method and parameters of the genetic algorithm. An example of the operation of a genetic algorithm. Problems in the operation of the genetic algorithm and ways to eliminate them. Recommendations for the software implementation of the genetic algorithm.

Lab #3

Application of a genetic algorithm for solving optimization and approximation problems.

Topic 8. Artificial neural networks.

The concept of neural network systems. Biological neural networks. Formal neuron. Artificial neural networks (ANN). Rules for the representation of knowledge in ANN. Hebb's rule. Learning algorithm based on error corretion. Supervised learning, reinforcement learning, unsupervised learning.

Topic 9. Practical application of artificial neural networks.

Method for solving the problem of constructing a neural network model of an unknown system. Principles of functioning of the block diagram of non-linear forecasting. Rosenblatt perceptron learning algorithm. Backpropagation algorithm. An example of the operation and training of a neural network. Software implementation.

Lab #4

Application of artificial neural networks for solving problems of classification and forecasting.

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 theoretical questions. The duration of the test is 1.5 hours.

An approximate list of theoretical questions:

1 Give a block diagram of the operation of the genetic algorithm.

2. Describe the concepts of integer and real coding.

3. Describe how the one-point, two-point, and uniform crossover operators work for integer encoding.

4. Describe the principle of two-point, arithmetic and BLX crossover operators for real coding.

5. Give a block diagram of the functioning of a formal neuron.

6. Describe the types of neuron activation functions.

7. Describe the 4 rules for representing knowledge in a neural network.

8. Describe learning based on error correction.

9. Describe supervised learning of a neural network.

10. Describe reinforcement learning for a neural network.

11. Give a block diagram for solving the system identification problem and describe the principles of its functioning.

12. Describe the error backpropagation algorithm.

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. The "pass" rating is given when the score is 55-100.

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

Spitsyn Vladimir Grigorievich, Doctor of Technical Sciences, Professor, Department of Theoretical Foundations of Informatics, Institute of Applied Mathematics and Computer Science TSU, Professor