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

Deep Learning – 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.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-3 - the ability to develop mathematical models and analyze them when solving problems in the field of professional activity;
- PC-6 - the ability to manage the receipt, storage, transmission, processing of big data.

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-3.3 Develops and analyzes new mathematical models for solving applied problems of professional activity in the field of applied mathematics and informatics.
IPK-6.1 Monitors and evaluates the performance of big data processing.
IPK-6.2 Uses methods and tools for receiving, storing, transmitting, processing big data.
IPK-6.3 Develops proposals to improve the performance of big data processing..

2. Tasks of mastering the discipline

To train students to carry out work on the study of big data using deep learning technologies and develop intelligent systems using the tools of Python, R libraries, public cloud services, evaluate the effectiveness of their work and implement them in applications:

– to train students to identify, form and agree on the requirements for the results of analytical work using deep learning technologies;

– to teach students the principles of planning and organizing analytical work using deep learning technologies;

- to train students to prepare data for analytical work on the study of big data using deep learning methods;

– train students to conduct analytical research and develop applications using deep learning technologies in accordance with customer requirements.

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

Discipline refers 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

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 & Statistics for Data Science", "Introduction to Data Science & Data Mining", "Deep Learning – 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

Section 1. Fundamentals and architectures of deep neural networks
Deep Neural Network Architectures
Section 2. Develop applications that use deep learning
Designing and Deploying Applications Using Deep Neural Networks
Section 3. Practical aspects of training deep neural networks
Methods for improving the efficiency of development and training of deep neural networks
Section 4. Practical Aspects of Sequence Modeling
Deep neural networks for the study of time sequences
Section 5. Practical aspects of using deep neural networks in computer vision
Convolutional Neural Networks and Autoencoders for Solving Computer Vision Problems
Section 6. Practical Aspects of Using Deep Neural Networks in Natural Language Understanding Problems
Using Deep Neural Networks in Natural Language Understanding Problems
Section 7. Deep Generative Models
Generative Adversarial Neural Networks
Section 8. Deep Learning Research
Adaptation of neural network models. Reinforcement training.

9. Ongoing evaluation

Current control is carried out by checking laboratory work in the form of a discussion of the performance of the implemented artificial intelligence systems and the results of their work.

To strengthen the studied material, it is planned to carry out an individual project within hours of independent work. The project can be completed both individually and in a mini-group (2-3 people), provided that the amount of work will also be increased. At the end of the semester, a mini-presentation on the results of the work is presented for each project. The theme of the individual project is related to the theme of the master's degree student. The purpose of the work is the use of deep learning methods in their scientific work.

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

The student makes a presentation and also demonstrates the program code. Questions on the results can be asked by all students of the group, not only by the teacher.

The final grade is set as the arithmetic mean based on the results of control and laboratory work, rounded to the nearest integer.

11. Educational and methodological support

a) Electronic training course on the discipline at the electronic university "Moodle"

Lecture course and practical tasks SQUOT AI 1: Basic concepts of modern artificial intelligence [Electronic resource] / Electronic University - MOODLE. - TSU 2020. - URL: https://moodle.ido.tsu.ru/course/view.php?id =1168 (date of access: 10/15/2020).

Lecture course and practical tasks SQUOT AI 2: Modern tools to support the development of artificial intelligence systems [Electronic resource] / Electronic University -

MOODLE. - TSU 2020. - URL: https://moodle.ido.tsu.ru/course/view.php ?id=1169 (date of access: 10/15/2020).

Lecture course and practical tasks SQUOT AI 3: Development of artificial intelligence applications [Electronic resource] / Electronic University - MOODLE. - TSU 2020. - URL: https://moodle.ido.tsu.ru/course/view.php?id= 11701168 (date of access: 10/15/2020).

Lecture course and practical tasks SQUAT AI 4: Artificial intelligence in cybersecurity problems [Electronic resource] / Electronic University - MOODLE. - TSU 2020. - URL: https://moodle.ido.tsu.ru/course/view.php?id =1171 (date of access: 10/15/2020).

Lecture course and practical tasks SQUOT AI 5: Knowledge acquisition in artificial intelligence systems [Electronic resource] / Electronic University - MOODLE. - TSU 2020. - URL: https://moodle.ido.tsu.ru/course/view.php? id=1172 (date of access: 10/15/2020).

b) Assessment materials of the ongoing evaluation and intermediate certification in the discipline.

12. List of educational literature and Internet resources

a) basic literature:

– Joel Grace. Data Science: Data science from scratch. 2nd edition. ISBN 978-5-9775-6731-2. – St. Petersburg: BHV-Petersburg. 2021.

– Sebastian Raska, Vahid Mirjalili Python and machine learning. ISBN 978-5-907203-57-0. – M.: Dialectics. 2020.

– Ameet V. Joshi Machine Learning and Artificial Intelligence. ISBN 978-3-030-26621-9. – Springer Nature Switzerland AG. 2020

– Denis Rothman Artificial Intelligence by Example. Second Edition. ISBN 978-1-83921-153-9. – Packt Publishing. 2020

– Stuart Russel, Peter Norvig Artificial Intelligence. A Modern Approach. 4th Edition. ISBN: 978-0-13-461099-3. – Hoboken: Pearson. 2021

– Andrew Glassner Deep learning without math. Volume 1. Basics. ISBN 978-5-97060-701-5. – Moscow: DMK Press. 2020

– Andrew Glassner Deep learning without math. Volume 2. Practice ISBN 978-5-97060-767-1. – M.: DMK Press. 2020

– Ian Goodfellow, Joshua Bengio, Aaron Courville Deep Learning. Second color edition, revised. ISBN 978-5-97060-618-6. – Moscow: DMK Press. 2018

– Roman Shirkin Artificial Intelligence. The Complete Beginners' Guide to Artificial Intelligence. ISBN: 9798609154415. – Amazon KDP Printing and Publishing. 2020

– François Chollet Deep Learning with Python. ISBN 978-5-4461-0770-4. – St. Petersburg: St. Petersburg. 2018

13. List of information technologies

a) licensed and freely distributed software:

– Google Colab cloud service, Anaconda package (Python, R), Tensorflow deep learning libraries, Keras, Pytorch, OpenAI services.

14. Logistics

When mastering the discipline, computer classes of the IPMKN TSU are used with access to the resources of the Scientific Library of TSU, including domestic and foreign periodicals and the Internet.

15. Authors information

Aksyonov Sergey Vladimirovich – Ph.D. tech. Sciences, Associate Professor, Department of Theoretical Foundations of Informatics, TSU.