

MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution
higher education
NORTH CAUCASIAN FEDERAL UNIVERSITY

I APPROVE

Dean of the Faculty of Mathematics
and computer science named after
Professor N.I. Chervyakov,
Candidate of Physical and Mathemat-
ical Sciences, Associate Professor
Grobova T.A.

WORKING PROGRAM OF THE DISCIPLINE

Machine Learning Theory / Теория машинного обучения

Direction of training	02.03.01 Mathematics and Computer Science
Directionality (profile)	Training Program for Electronic Information
Year of commencement of studies	2026
Form of study	full-time
Implemented in a semester	2

Developed by

Candidate of Physical and Mathematical Sci-
ences, Associate Professor of the Department
of Computational Mathematics and Cybernet-
ics
Valueva M.V.

1. The purpose and objectives of mastering the discipline

The purpose of studying the discipline " Machine Learning Theory / Теория машинного обучения " is to develop general professional competence (ОПК-1) and professional competence (ПК-5) in future bachelor's students in the field of study 02.03.01 Mathematics and Computer Science.

Objectives of the discipline :

- developing students' theoretical knowledge and practical skills in the fundamentals of machine learning;
- students' mastery of machine learning tools, models, and methods;
- acquisition of skills as a data scientist and developer of mathematical models, methods and algorithms for data analysis.

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

The discipline "Machine Learning Theory / Теория машинного обучения" refers to the disciplines of the part formed by participants in educational relations.

3. A list of planned learning outcomes for the discipline, correlated with the planned learning outcomes for the educational program

Code, wording competencies	Code, indicator formulation	Planned learning outcomes for the discipline, characterizing the stages of formation of competencies, indicators
ОПК-1. Able to find, formulate and solve current and significant problems in applied and computer mathematics	ID-1 _{ОПК-1} Finds and formulates significant problems of applied and computer mathematics. ID-2 _{ОПК-1} Knows and uses methods for solving significant problems of applied and computer mathematics.	Will be able to identify and formulate significant problems in applied and computer mathematics Able to use methods to solve significant problems in applied and computer mathematics
ПК-5. Able to present and adapt mathematical knowledge, programming methods and information technology in various ways, taking into account the level of the audience	ID-1 _{ПК-5} Assesses the level of preparation of listeners during their public speeches ID-2 _{ПК-5} Adapts the presentation of mathematical knowledge and programming methods to the level of the students	Able to apply machine learning tools, models, and methods to solve professional problems

4. Volume of the academic discipline and forms of control *

Amount of classes: total: 3 credits, 108 academic hours.	OFO, in academic hours
Contact work:	32.00
Lectures/including practical training	0.00
Laboratory work /including practical training	0.00
Practical classes /including practical training	32.00
Independent work	76.00
Forms of control	0.00
Exam 2 semester	-
Credit	-
Credit with grade	-
Coursework	No

* The course involves the use of e-learning and distance learning technologies

5. The content of the discipline, structured by topics (sections) indicating the number of hours and types of classes

No.	Section (topic) of the discipline and brief content	Formed competencies, indicators	full-time education				Forms of ongoing monitoring of academic performance
			Contact work of students with a teacher/of which in the form of practical training, hours			Independent work, hours	
			Lectures	Practical classes	Laboratory work		
1.	Introduction to Machine Learning 1. Types of machine learning tasks 2. Subject and tasks of machine learning and data analysis. 3. Basic principles, objectives and approaches, use in various fields of science and industry. 4. The main stages of the evolution of machine learning algorithms.	ID-2 PC-1		4.0 0		9:00	Defense of practical work
2.	Metric classifiers . 1. Metric classifiers 2. General view of the metric classifier. 3. K-nearest neighbors algorithm. 4. Algorithms for selecting standards.	ID-2 PC-1		4.0 0		9:00	Defense of practical work
3.	Clustering algorithms 1. Clustering algorithms 2. Clustering algorithms with a fixed number of clusters. 3. Density clustering algorithms. 4. Hierarchical clustering.	ID-2 PC-1		4.0 0		9:00	Defense of practical work

4.	Decision trees, linear classifiers . 1. Decision trees 2. Rules and quality analysis (precision, recall). Analysis using the ROC curve. Algorithm for constructing decision trees. Information gain criterion and the Gini criterion. Forests of decision trees. 3. Linear classifiers 4. Perceptron and separating hyperplane. Transition to a higher-dimensional space. Support vector machines	ID-2 PC-1		4.0 0		9:00	Defense of practical work
5.	Neural networks 1. Neural networks and deep learning 2. Logistic regression. 3. Gradient descent. 4. Neural networks and the gradient backpropagation algorithm. 5. Deep learning, convolutions and pooling.	ID-2 PC-1		4.0 0		10:00	Defense of practical work
6.	Regression analysis 1. Regression analysis 2. Linear regression. 3. Polynomial regression. 4. Bias and dispersion. 5. Ridge regression.	ID-2 PC-1		4.0 0		10:00	Defense of practical work
7.	Ensemble methods . 1. Ensemble methods 2. Voting. 3. Bootstrapping. 4. Boosting, adaptive boosting, gradient boosting.	ID-2 PC-1		4.0 0		10:00	Defense of practical work
8.	Stochastic search 1. Stochastic search 2. Monte Carlo search. 3. Simulated annealing algorithm. 4. Genetic algorithm	ID-2 PC-1		4.0 0		10:00	Defense of practical work
	Total for 2nd semester		0.00	32.00		76.00	
	TOTAL		0.00	32.00		76.00	

6. Fund of assessment tools for the discipline

The assessment toolkit (AST) for a course is based on a list of mastered competencies with associated indicators. The AST provides objective monitoring of the achievement of planned learning outcomes. The AST includes:

- description of indicators and criteria for assessing competencies at various stages of their formation, description of assessment scales;
- methodological materials defining the procedures for assessing knowledge, skills, abilities and (or) work experience, characterizing the stages of competence development;
- standard test assignments and other materials necessary for assessing knowledge, skills and the level of mastery of the competencies being developed in the process of mastering the discipline.

FOS is an appendix to this discipline program.

7. Methodological guidelines for students on mastering the discipline

When starting work, each student should take into account the following provisions.

The discipline is structured on a thematic principle, with each topic representing a logically complete section.

Practical work is aimed at acquiring practical experience in the relevant subject area.

Students' independent work is aimed at independent study of additional material, preparation for practical and laboratory classes, and completion of all types of independent work.

To successfully master the discipline, it is necessary complete all types of independent work using the recommended sources of information.

8. Educational, methodological and informational support of the discipline

8.1. List of basic and additional literature required for mastering the discipline

8.1.1. List of main literature:

1. Tatarnikova T. M. Intelligent data analysis: textbook / T. M. Tatarnikova. - Moscow, Vologda: Infra-Engineering, 2024. - 172 p. - ISBN 978-5-9729-1772-3. - Text: electronic // Digital educational resource IPR SMART: [site]. - URL: <https://www.iprbookshop.ru/143351.html>

2. Stepashkina A. S. Numerical methods and machine learning in metrology: textbook / A. S. Stepashkina. - Moscow, Vologda: Infra-Engineering, 2024. - 144 p. - ISBN 978-5-9729-1954-3. - Text: electronic // Digital educational resource IPR SMART: [site]. - URL: <https://www.iprbookshop.ru/143592.html>

8.1.2. List of additional literature:

1. Vasiliev E. P. Intelligent data analysis in decision-making technologies: a tutorial / E. P. Vasiliev, V. I. Oreshkov. - Ryazan: Ryazan State Radio Engineering University, 2023. - 180 p. - ISBN 978-5-7722-0344-6. - Text: electronic // Digital educational resource IPR SMART: [site]. - URL: <https://www.iprbookshop.ru/134854.html>

2. Zamyatin A. V. Intelligent data analysis: a tutorial / A. V. Zamyatin. - Tomsk: Publishing House of Tomsk State University, 2020. - 194 p. - ISBN 978-5-94621-898-6. - Text: electronic // Digital educational resource IPR SMART: [site]. - URL: <https://www.iprbookshop.ru/116889.html>

3. Palmov S. V. Intelligent data analysis: a tutorial / S. V. Palmov. - Samara: Volga Region State University of Telecommunications and Information Technology, 2017. - 127 p. - Text: electronic // Digital educational resource IPR SMART: [website]. - URL: <https://www.iprbookshop.ru/75376.html>

8.2. List of educational and methodological support for independent work of students in the discipline

1. Guidelines for organizing and conducting independent work on the subject "Machine Learning Theory" (electronic version)

2. Guidelines for completing laboratory work on the subject "Machine Learning Theory" (electronic version)

8.3. List of resources of the information and telecommunications network "Internet" necessary for mastering the discipline

- <https://www.kaggle.com/> - an online platform for data science projects
- UCI Machine Learning Repository - repository of datasets for machine learning - <http://archive.ics.uci.edu/ml/>
- Machine Learning Course <https://habr.com/company/ods/blog/322626/>
- A resource dedicated to machine learning, pattern recognition, and data mining. - <http://machinelearning.ru>

9. List of information technologies used in the implementation of the educational process in the discipline, including a list of software and information reference systems

Lectures are delivered using computers and multimedia presentations. During seminars and practical classes, students present presentations they prepared during their independent work hours.

Information reference systems:

Information and reference and information and legal systems used in the study of the discipline:

1.	https://www.kaggle.com/ - an online platform for data science projects
2.	learning datasets - http://archive.ics.uci.edu/ml/
3.	A resource dedicated to machine learning, pattern recognition, and data mining. - http://machinelearning.ru
4.	Machine Learning Course https://habr.com/company/ods/blog/322626/

Software:

1	Alt Workstation 10
2	Alt Workstation K
3	Alt "Server"
4	Operating system: Astra Linux
5	Office software package – P7-Office
6	Intel C++ Studio XE 2013 for Linux OS
7	GNU C++
8	Oracle Java
9	Python

10. Description of the material and technical base necessary for the implementation of the educational process in the discipline

Practical classes	A classroom for conducting classes, equipped with multimedia equipment and technical teaching aids
Independent work	A room for independent student work equipped with computers and the ability to connect to the Internet and access the university's electronic information and educational environment.

11. Features of mastering the discipline by persons with disabilities

Students with disabilities are provided with special textbooks, teaching aids and didactic materials, special technical teaching aids for collective and individual use, the services of an assistant (helper) who provides students with the necessary technical assistance, as well as the services of sign language interpreters and tactile sign language interpreters.

The acquisition of the discipline by students with disabilities can be organized jointly with other students, as well as in separate groups.

The acquisition of the discipline by students with disabilities is carried out taking into account the characteristics of psychophysical development, individual capabilities and health status.

In order to ensure accessibility of higher education under the educational program for individuals with disabilities, the following is provided when mastering the discipline:

1) for persons with visual impairments:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take up a workstation, move around, read and complete assignments, including taking down dictation),

- written assignments, as well as instructions on how to complete them, are written in large print,

- special textbooks, teaching aids and didactic materials (with large print or audio files),

- individual uniform illumination of at least 300 lux,

- if necessary, the student is provided with a magnifying device to complete the assignment;

2) for persons with hearing impairments:

- the presence of an assistant who provides the student with the necessary technical assistance, taking into account individual characteristics (helps to take up a workstation, move around, read and complete assignments, including taking down dictation),

- the availability of sound amplification equipment for collective use is ensured; if necessary, the student is provided with sound amplification equipment for individual use;

- is provided with appropriate sound means for reproducing information;

3) for persons with disabilities who have musculoskeletal disorders (including severe impairments of the motor functions of the upper limbs or the absence of upper limbs):

- written assignments are completed on a computer with specialized software or dictated to an assistant;

- at the student's request, assignments can be completed orally.

12. Features of the implementation of the discipline using distance learning technologies and e-learning

According to Part 1 of Article 16 of Federal Law No. 273-FZ of December 29, 2012, "On Education in the Russian Federation," *e-learning* is defined as the organization of educational activities using information contained in databases and used in the implementation of educational programs, as well as information technologies, technical means, and information and telecommunications networks that facilitate the transmission of said information over communication lines, as well as interaction between students and teaching staff. *Distance learning technologies* are educational technologies implemented primarily using information and telecommunications networks through indirect (remote) interaction between students and teaching staff.

The course may be delivered using distance learning technologies and e-learning, in whole or in part. The components of the course's teaching and methodological kit (the course curriculum, assessment and methodological materials, and assessment forms) implemented using distance learning technologies and e-learning contain instructions for their use.

When organizing educational activities using distance learning technologies and e-learning, asynchronous and synchronous methods of interaction between participants in educational relations may be provided through the Internet information and telecommunications network.

When using distance learning technologies and e-learning, the following is indicated in the curriculum for the discipline:

- methods for implementing interaction between participants in educational relations through the information and telecommunications network "Internet" (VKS - video conferencing, ET - electronic testing);

- links to the electronic information and educational environment of SKFU, to educational platforms and resources of other organizations, to which open access is provided through the information and telecommunications network "Internet";

- for synchronous learning - time of online classes and teachers;

- For asynchronous learning - online course authors.

When organizing midterm assessments using distance learning technologies and e-learning, the Methodological Recommendations for the Use of Technical Means Ensuring the Objectivity of Results during Midterm and State Final Assessments for Higher Education Programs—Bachelor's Degree Programs, Specialist Programs, and Master's Degree Programs Using Distance Learning Technologies—are used (Letter of the Ministry of Education and Science of Russia dated December 7, 2020, No. MN-19/1573-AN "On the Submission of Methodological Recommendations").

The implementation of the course using e-learning and distance learning technologies is carried out using the electronic information and educational environment of SKFU, to which students have access via the information and telecommunications network "Internet", or using the resources of other organizations, including platforms providing services for video conferencing, online meetings and distance learning (MTS-Link), as well as using the capabilities of social networks for communication between students and teachers.

The educational and methodological support for a discipline implemented using e-learning and distance learning technologies includes a work program, educational and methodological manuals or a course of lectures, methodological instructions for the implementation of various types of educational activities of students provided for by the discipline, and other educational and methodological materials posted in the information and educational environment of SKFU, presented in electronic form.