

Документ подписан простой электронной подписью

Информация о владельце:

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MINISTRY OF SCIENCE AND HIGHER EDUCATION OF THE RUSSIAN FEDERATION
Federal State Autonomous Educational Institution of Higher Education
NORTH CAUCASIAN FEDERAL UNIVERSITY

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Ph.D. tech. Sciences, Associate Professor
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WORKING PROGRAM OF THE DISCIPLINE

Fundamentals of Computational Thinking and Artificial Intelligence

Field of study/specialty	11.03.02 Infocommunication technologies and communication systems
Profile/specialization	Intelligent Data Processing in Infocommunication Systems and Networks
Year of commencement of studies	2026
Form of study	full-time
Implemented in a semester	3

Developed by

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1. The purpose and objectives of mastering the discipline (module)

The purpose of the discipline is to develop, in accordance with the educational program, the student's OPK-4 competence.

To achieve this goal, the following objectives are addressed in the course: familiarization with the basic concepts and types of machine learning problems; study of data preparation methods, including cleaning, normalization, and feature engineering; mastering basic supervised learning models, such as linear and logistic regression; mastering stochastic gradient descent as a method for optimizing models; forming an understanding of metrics for assessing the quality of classification and interpreting model results; studying methods for combating overfitting, including regularization and cross-validation; mastering classification algorithms based on the nearest neighbor method and the support vector machine; study of algorithms for constructing decision trees and ensemble models, such as random forest and gradient boosting; familiarity with unsupervised learning methods, including clustering algorithms; mastering methods of dimensionality reduction and data visualization, such as PCA and t-SNE; developing practical skills in tuning models using hyperparameter selection; developing the ability to compare and interpret the results of different models based on objective metrics.

2. The place of the discipline (module) in the structure of the educational program

The discipline belongs to the compulsory part B1 of the curriculum Disciplines (modules) B1.O.13.

3. List of planned learning outcomes for the discipline (module), correlated with the planned learning outcomes for the educational program

Code, formulation of competence	Code, indicator formulation	Planned learning outcomes for the discipline (module), characterizing the stages of formation of competencies, indicators
OPK-4. Able to understand the operating principles of modern information technologies and use them to solve professional problems.	ID-1 OPK-4 uses information and communication technologies to search for the necessary information.	uses information and communication technologies when searching for the necessary information.
	ID-2 OPK-4 designs a solution to a specific project problem, selecting the optimal solution based on current legal regulations and available resources and constraints.	Understands the general principles of operation and architecture of hardware, software and firmware of the administered network; channel protocols,
	ID-3 OPK-4 understands modern interactive software packages and basic methods of processing experimental data, including the use of standard software, general-purpose and special-purpose software packages.	understands modern interactive software systems and basic techniques for processing experimental data, including the use of standard software, general-purpose and special-purpose software packages

	ID-4 OPK-4 uses the capabilities of computing technology and software to solve problems of control and algorithmization of information processing processes.	uses the capabilities of computing technology and software to solve problems of control and algorithmization of information processing processes.
	ID-5 OPK-4 has mastered methods of computer modeling of physical processes in the transmission of information, engineering and computer graphics techniques.	Proficient in methods of computer modeling of physical processes in information transmission, engineering and computer graphics techniques.

4. Volume of the academic discipline (module) 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	No
Laboratory work /including practical training	No
Practical classes /including practical training	32.00/32.00
Independent work	76.00
Forms of control	
Exam	No
Credit	Yes
Credit with grade	No
Coursework	No

* The course (module) requires the use of e-learning and distance learning technologies
(unless otherwise established by the educational standard)

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

No.	Section (topic) of the discipline	Implemented competencies, indicators	Full-time education			Forms of ongoing monitoring of academic performance
			Contact work of students with a teacher, hours		Independent work, hours	
			Lectures	Practical classes		
3rd semester						

1	Introduction to Artificial Intelligence and Machine Learning Basic concepts of AI and ML . Learning approaches. Application areas. Python installation, Jupyter Notebook.	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		2		6	Interview, testing
2	Machine learning tasks and types Supervised and unsupervised learning. Key tasks: classification, regression, clustering, data anomaly detection, dimensionality reduction, reinforcement learning.	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		2		6	Interview.
3	Data preparation and feature engineering ML pipeline. NumPy package basics . Matplotlib package basics . Series and DataFrame data structures in the pandas package . Introduction to exploratory data analysis (EDA). Practical Lesson #1: Fundamentals of Exploratory Data Analysis	OPK -4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		4		6	Interview. Problem solving.
4	Linear regression Loss function. Model and analytical solution. Interpretation of coefficients. Practical lesson #2 Linear Regression	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		4		6	Interview. Problem solving.
5	Stochastic gradient descent The idea of gradient descent. Mini-batches. Updating model parameters.	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4	-	2		4	Interview.
6	Combating Overfitting: Regularization and Cross-Validation	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4	-	2		4	Interview.

	L1 and L2 regularization. Cross-validation. Overfitting and underfitting.	ID-4 OPK4 ID-5 OPK4					
7	Logistic regression Binary classification. Sigmoid. Loss function. Practical lesson No. 3 Logistic regression	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		2		4	Interview. Defense of laboratory work
8	Quality metrics for classification models Error matrix. Accuracy, Precision, Recall, F1, ROC-AUC. Interpretation of results. Practical lesson №4 Quality metrics of classification models	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		2		4	Interview. Defense of laboratory work
9	Nearest neighbors and support vector machines KNN and SVM algorithms. Tuning hyperparameters. Practical lesson #5 Nearest neighbors and support vector machines	OPK -4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		2		4	Defense of laboratory work
10	Decision trees Tree construction algorithms. Partition criteria. Visualization. Practical lesson #6 Decision Trees	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		2		6	Interview. Defense of laboratory work
11	Ensembles of models: random forest and gradient boosting Combining Models. Basics of Random Forest and Gradient Boosting. Comparing Results. Practical lesson #7 Random Forest Practical lesson #8 Gradient Boosting	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4		2		6	Interview. Defense of laboratory work
12	Clustering: Unsupervised Learning K-means algorithms, hierarchical clustering,	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4	-	2		4	Interview. Group creative tasks

	DBSCAN. Clustering evaluation. Elbow (or broken cane) method	ID-4 OPK4 ID-5 OPK4					
13	Dimensionality reduction and data visualization PCA, t-SNE, UMAP. 2D visualization. Application for model analysis and diagnostics.	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4	-	2		6	Interview. Group creative tasks
14	Selection of hyperparameters for models GridSearchCV, RandomizedSearchCV. The influence of parameters on model quality.	OPK-4 ID-1 OPK41 ID-2 OPK4 ID-3 OPK4 ID-4 OPK4 ID-5 OPK4	-	2		10	Interview. Group creative tasks
	TOTAL for the semester			32		76	
	TOTAL			32		76	

6. Fund of assessment tools for the discipline (module)

The assessment toolkit (AST) for a course (module) 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 that define the procedures for assessing knowledge, skills, abilities and (or) work experience that characterize the stages of competencies formation (included in the methodological guidelines for those types of work that are provided for by the curriculum and provide for the assessment of the development of competencies);
- standard assessment tools necessary for assessing knowledge, skills and the level of development of competencies.

FOS is an appendix to this discipline (module) program.

7. Methodological guidelines for students on mastering the discipline

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

The discipline (module) is structured on a thematic principle, each topic is a logically complete section.

The lecture material is devoted to the consideration of key, basic provisions of the courses and the explanation of educational assignments assigned to students for independent work.

Practical classes are held with the aim of consolidating the acquired information and acquiring skills for its application in solving practical problems 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 course, it is necessary to 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 (module)

8.1.1. List of main literature:

1. Bolotsky, A. V. < BR > Operations research and optimization methods Electronic resource / Bolotsky A. V., Kochetkova O. A. - St. Petersburg: Lan, 2020. - 116 p. - ISBN 978-5-8114-4568-4
2. Saraev, P. V. < BR > Machine learning methods Electronic resource: Methodological instructions and assignments for laboratory work on the course / P. V. Saraev. - Lipetsk: Lipetsk State Technical University, EBS ASV, 2017. - 48 p. - The book is in the premium version of the IPR EBS BOOKS . - ISBN 2227-8397
3. Sopov, E. A. Multicriteria neuroevolutionary systems in machine learning and human-machine interaction problems. Electronic resource / Sopov E. A., Ivanov I. A.: monograph. - Krasnoyarsk: SFU, 2019. - 160 p. - ISBN 978-5-7638-3969-2

8.1.2. List of additional literature:

1. Methodological recommendations for practical classes in the discipline "Theory and practice of machine translation": Field of study 45.04.02 Linguistics. Master's program "Translation and Translation Studies". Graduate qualification - master. Form of study - full-time. Curriculum for 2015. Studied in the 3rd semester. - Stavropol: SKFU, 2015. - 9 p.
2. Nedelko, V. M. < BR > Fundamentals of statistical methods of machine learning Electronic resource: Textbook / V. M. Nedelko. - Novosibirsk: Novosibirsk State Technical University, 2010. - 72 p. - The book is in the premium version of the IPR electronic library system BOOKS . - ISBN 978-5-7782-1385-2
3. Rapakov, G. G. < BR > Methods and algorithms of machine learning in making management decisions in the regional system of medical prevention (experience of the Vologda region) Electronic resource / Rapakov G. G., Kasimov R. A.: monograph. - Vologda: Vologda State University, 2014. - 143 p. - ISBN 978-5-87851-548-1

8.2. List of educational and methodological support for independent work of students in a discipline (module)

1. Saraev, P. V. < BR > Machine learning methods Electronic resource: Methodological instructions and assignments for laboratory work on the course / P. V. Saraev. - Lipetsk: Lipetsk State Technical University, EBS ASV, 2017. - 48 p. - The book is in the premium version of the IPR EBS BOOKS . - ISBN 2227-8397

8.3. List of resources of the information and telecommunications network "Internet" required for mastering the discipline (module)

mastering the discipline

1. <http://biblioclub.ru/> – University online library "Biblioclub"
2. <http://github.com> - GitHub web service.
3. <https://code.visualstudio.com/> - the official website of Visual Studio Code.
4. <https://colab.research.google.com> - Google Colab
5. [https:// git - scm . com /](https://git-scm.com/) - the official website of the Git version control system .
6. [https:// www . kaggle . com /](https://www.kaggle.com/) - Kaggle
7. [https:// www . python . org /](https://www.python.org/) - the official website of the Python programming language
8. <http://www.iprbookshop.ru> – EBS “IPRbooks”.
9. [http:// catalog . ncfu . ru / catalog / ncfu](http://catalog.ncfu.ru/catalog/ncfu) - Electronic catalog of NCFU.

9. List of information technologies used in the implementation of the educational process in the discipline (module), 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 <http://github.com> - GitHub web service.
- 2 <https://colab.research.google.com> - Google Colab
- 3 <https://www.kaggle.com/> - Kaggle

Software:

- 1 NVIDIA CUDA version 10.1 and older.
- 2 NVIDIA cuDNN version 7.0 older
- 3 Alt Workstation 10
- 4 Python is a high-level, general-purpose programming language. It is licensed under the Python Software Foundation License, which is perpetual.
- 5 Alt Workstation K
- 6 Office suite - P7-Office
- 7 Alt "Server"
- 8 packages : NumPy, Pandas, Matplotlib, Scikit-Learn, XGBoost, CatBoost, LightGBM, UMAP, PyTorch, OpenCV, transformers
- 9 Git version control system <https://git-scm.com/>. GNU GPL 2 perpetual license.
- 1 Ollama, a software for running large language models . The MIT license is perpetual.
- 0

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

Lecture classes	The classroom is equipped with specialized furniture and technical teaching aids: a short-throw multimedia projector Epson EB-536Wi, a PC Dell OptiPlex3040i3-6100 with Internet connection and access to the EIS, an Acer PD527W projector, an HP LaserJet 3052 MFP, an ASUS K42JC laptop, an HP nx7300 T5600 laptop, a laptop, a portable projector, demonstration equipment and teaching aids (maps, atlases, handouts)
Practical classes	The classroom is equipped with specialized furniture and technical teaching aids: a short-throw multimedia projector Epson EB-536Wi, a PC Dell OptiPlex3040i3-6100 with Internet connection and access to the EIS, an Acer PD527W projector, an HP LaserJet 3052 MFP, an ASUS K42JC laptop, an HP nx7300 T5600 laptop, a laptop, a portable projector, demonstration equipment and teaching aids (maps, atlases, handouts)
Independent work	The classroom is equipped with specialized furniture and technical teaching aids: a short-throw multimedia projector Epson EB-536Wi, a PC Dell OptiPlex3040i3-6100 with Internet connection and access to the EIS, an Acer PD527W projector, an HP LaserJet 3052 MFP, an ASUS K42JC laptop, an HP nx7300 T5600 laptop, a laptop, a portable projector, demonstration equipment and teaching aids (maps, atlases, handouts)

11. Features of mastering the discipline (module) 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 a discipline (module) by students with disabilities can be organized jointly with other students, as well as in separate groups.

The acquisition of a discipline (module) 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 a discipline (module):

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 curriculum for the discipline shall indicate: methods of interaction between participants in educational relations via the Internet (videoconferencing, electronic testing); links to the SKFU electronic information and educational environment, to educational platforms and resources of other organizations that are openly accessible via the Internet; for synchronous learning - the time of online classes and teachers; for asynchronous learning - the authors of online courses.

When organizing midterm assessments using distance learning technologies and e-learning, the Methodological Recommendations for the Application 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 the Russian Federation 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.