

**Federal State Autonomous Educational Institution of Higher Education "Moscow  
Institute of Physics and Technology  
(National Research University)"**

**APPROVED**

**Head of the Phystech School of  
Applied Mathematics and  
Informatics**

**A.M. Raygorodskiy**

**Work program of the course (training module)**

<b>course:</b>	Introduction to the Recommendation Systems/Введение в рекомендательные системы
<b>major:</b>	Applied Mathematics and Informatics
<b>specialization:</b>	Modern State of Artificial Intelligence/Современные методы искусственного интеллекта “Pusk” Online and Supplementary Education Centre Chair of Machine Learning and Digital Humanities
<b>term:</b>	1
<b>qualification:</b>	Master

Semester, form of interim assessment: 2 (spring) - Grading test

Academic hours: 15 AH in total, including:

lectures: 0 AH.

seminars: 15 AH.

laboratory practical: 0 AH.

Independent work: 30 AH.

In total: 45 AH, credits in total: 1

Author of the program: R.G. Neychev, senior professor

The program was discussed at the Chair of Machine Learning and Digital Humanities 04.03.2022



### Annotation

There are a lot of different content in the modern world: videos, books, music, articles. However, because of this abundance of information, it is difficult for a person to choose what is interesting to him among many millions of options. Algorithms of recommendation systems are designed to solve such problems. In fact, recommendation systems are used within a huge number of services:

online stores, video hosting, news resources, recommendation feeds, etc. Although this is not always noticeable, but recommendation algorithms have firmly entered our lives. In this kypce we will examineclassik algorithms recomendation, so as matrix factoring, and more modern neural network approaches. Actually reccomended system — pretty applied region, it is important to talk about practical the application of these algorithms and how kak to make it work in prodaction. And also look at the advantages of using different approaches.

## 1. Study objective

### Purpose of the course

- To decompose social processes to identify problematic elements

### Tasks of the course

- Research methods skills in the humanities
- Research methods skills of social, political, economic, and legal analysis
- Ecological and technological risk assessment skills in the social sciences

## 2. List of the planned results of the course (training module), correlated with the planned results of the mastering the educational program

Mastering the discipline is aimed at the formation of the following competencies:

Code and the name of the competence	Competency indicators
UC-3 Able to organise and lead a team, developing a team strategy to achieve a goal	UC-3.1 Organize and coordinate the work of the project stakeholders and help resolve disputes and conflicts
	UC-3.2 Consider the interests, specific behavior, and diversity of opinions of team members/colleagues/counterparties
UC-4 Use modern communication tools in the academic and professional field, including those in a foreign language	UC-4.1 Exchange business information in oral and written forms in Russian and at least one foreign language
	UC-4.3 Present the results of academic and professional activities at various academic events, including international conferences
Pro.C-1 Become part of a professional community and conduct local research under scientific guidance using methods specific to a particular professional setting	Pro.C-1.1 Apply principles of scientific work, methods of data collection and analysis, ways of argumentation; prepare scientific reviews, publications, abstracts, and bibliographies on research topics in Russian and English
Pro.C-2 Understands and is able to apply modern mathematical apparatus and algorithms, the basic laws of natural science, modern programming languages and software; operating systems and networking technologies in research and applied activities	Pro.C-2.1 Demonstrate expert knowledge of research basics in the field of ICTs, philosophy and methodology of science, scientific research methods, and apply skills to use them

## 3. List of the planned results of the course (training module)

As a result of studying the course the student should:

know:

- classical algorithms of recommendations

be able to:



- To identify and formulate current issues and problems in functioning of social systems
- To apply relevant theoretical concepts in the analysis and design of social reality processes
- To decompose social processes to identify problematic elements
- To navigate current social, economic, political, and legal processes

master:

- advantages of using different approaches.

#### 4. Content of the course (training module), structured by topics (sections), indicating the number of allocated academic hours and types of training sessions

##### 4.1. The sections of the course (training module) and the complexity of the types of training sessions

№	Topic (section) of the course	Types of training sessions, including independent work			
		Lectures	Seminars	Laboratory practical	Independent work
1	Introduction, general statement of the problem, basic concepts		3		7
2	Methods based on matrix factorizations		3		5
3	Neural network and content-based recommendations		3		8
4	Training in ranking and evaluating the number of recommendations		3		5
5	Techniques for use in production		3		5
AH in total			15		30
Exam preparation		0 AH.			
Total complexity		45 AH., credits in total 1			

##### 4.2. Content of the course (training module), structured by topics (sections)

Semester: 2 (Spring)

###### 1. Introduction, general statement of the problem, basic concepts

- . Setting the ranking problem.
- . Setting the task of the recommendation.
- . The concept of recommendation systems.

###### 2. Methods based on matrix factorizations

- . Matrix factorization. SVD and LU decomposition.
- . Building a user-item matrix
- . Power method

###### 3. Neural network and content-based recommendations

- The architectures used in the recommendation systems.
- . Working with external text descriptions.
- . Neural collaborative filtering



#### 4. Training in ranking and evaluating the number of recommendations

- . Average precision@k
- . Mean average precision@k
- . Normalized Discounted Cumulative Gain

#### 5. Techniques for use in production

- Highly loaded services
- . Methods of applying recommendations in the case of working with distributed computing

### 5. Description of the material and technical facilities that are necessary for the implementation of the educational process of the course (training module)

A classroom equipped with a media projector and screen. Personal computers with an Internet connection.

### 6. List of the main and additional literature, that is necessary for the course (training module) mastering

#### Main literature

1. Введение в теорию управления системами с распределенными параметрами [Текст] / А. И. Егоров, Л. Н. Знаменская - СПбИзд-во "Лань", 2017
2. Алгоритмы: построение и анализ [Текст] : [учебник для вузов] / Т. Кормен [и др.] ; [пер. с англ. И. В. Красикова и др.] .— 3-е изд. — М. : Вильямс, 2014 .— 1328 с.

#### Additional literature

1. Задачи по программированию. Математическая логика. Теория алгоритмов. Рекурсия. Сортировка. Графы [Текст] : метод. указания к практикуму по курсу "Основы информатики" (для студентов 1 курса) / М-во образования Рос. Федерации, Моск. физ.-техн. ин-т (гос. ун-т), Каф. вычислит. математики ; сост. В. В. Прут .— М. : МФТИ, 2002 .— 32 с.

### 7. List of web resources that are necessary for the course (training module) mastering

1. Principles of social bonds. Voluntary procedural guidelines  
<https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/Translations/2020/Russian-SB-P2020-06-021120.pdf>.
2. Updates on the ICMA website: <https://www.icmagroup.org/green-social-and-sustainability-bonds/>.
3. Gartner Top 10 Strategic Technology Trends For 2020  
<https://www.gartner.com/smarterwithgartner/gartner-top-10-strategic-technology-trends-for-2020>

### 8. List of information technologies used for implementation of the educational process, including a list of software and information reference systems (if necessary)

Multimedia technologies can be employed during lectures and practical lessons, including presentations.

### 9. Guidelines for students to master the course

Successful completion of the course requires independent work by the student. The course syllabus indicates the minimum time required for the student to work on the topic.



**Assessment funds for course (training module)**

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**specialization:** Modern State of Artificial Intelligence/Современные методы искусственного интеллекта  
“Pusk” Online and Supplementary Education Centre  
Chair of Machine Learning and Digital Humanities  
**term:** 1  
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**Author:** R.G. Neychev, senior professor



## 1. Competencies formed during the process of studying the course

Code and the name of the competence	Competency indicators
UC-3 Able to organise and lead a team, developing a team strategy to achieve a goal	UC-3.1 Organize and coordinate the work of the project stakeholders and help resolve disputes and conflicts
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## 2. Competency assessment indicators

As a result of studying the course the student should:

**know:**

- classical algorithms of recommendations

**be able to:**

- To identify and formulate current issues and problems in functioning of social systems
- To apply relevant theoretical concepts in the analysis and design of social reality processes
- To decompose social processes to identify problematic elements
- To navigate current social, economic, political, and legal processes

**master:**

- advantages of using different approaches.

## 3. List of typical control tasks used to evaluate knowledge and skills

In order to control the development of educational material by students, an oral survey is conducted at the beginning of the lesson on the topic of the last lesson.

## 4. Evaluation criteria

- Describe a potential mechanism for ranking items in search results.
- . What matrix decompositions do you know?
- . Describe the method of user-item recommendations.
- . How can we solve the problem of cold start in the recommendations?
- . Give a formal statement of the ranking problem.



Assessment “excellent (10)” is given to a student who has displayed comprehensive, systematic and deep knowledge of the educational program material, has independently performed all the tasks stipulated by the program, has deeply studied the basic and additional literature recommended by the program, has been actively working in the classroom, and understands the basic scientific concepts on studied discipline, who showed creativity and scientific approach in understanding and presenting educational program material, whose answer is characterized by using rich and adequate terms, and by the consistent and logical presentation of the material;

Assessment “excellent (9)” is given to a student who has displayed comprehensive, systematic knowledge of the educational program material, has independently performed all the tasks provided by the program, has deeply mastered the basic literature and is familiar with the additional literature recommended by the program, has been actively working in the classroom, has shown the systematic nature of knowledge on discipline sufficient for further study, as well as the ability to amplify it on one’s own, whose answer is distinguished by the accuracy of the terms used, and the presentation of the material in it is consistent and logical;

Assessment “excellent (8)” is given to a student who has displayed complete knowledge of the educational program material, does not allow significant inaccuracies in his answer, has independently performed all the tasks stipulated by the program, studied the basic literature recommended by the program, worked actively in the classroom, showed systematic character of his knowledge of the discipline, which is sufficient for further study, as well as the ability to amplify it on his own;

Assessment “good (7)” is given to a student who has displayed a sufficiently complete knowledge of the educational program material, does not allow significant inaccuracies in the answer, has independently performed all the tasks provided by the program, studied the basic literature recommended by the program, worked actively in the classroom, showed systematic character of his knowledge of the discipline, which is sufficient for further study, as well as the ability to amplify it on his own;

Assessment “good (6)” is given to a student who has displayed a sufficiently complete knowledge of the educational program material, does not allow significant inaccuracies in his answer, has independently carried out the main tasks stipulated by the program, studied the basic literature recommended by the program, showed systematic character of his knowledge of the discipline, which is sufficient for further study;

Assessment “good (5)” is given to a student who has displayed knowledge of the basic educational program material in the amount necessary for further study and future work in the profession, who while not being sufficiently active in the classroom, has nevertheless independently carried out the main tasks stipulated by the program, mastered the basic literature recommended by the program, made some errors in their implementation and in his answer during the test, but has the necessary knowledge for correcting these errors by himself;

Assessment “satisfactory (4)” is given to a student who has discovered knowledge of the basic educational program material in the amount necessary for further study and future work in the profession, who while not being sufficiently active in the classroom, has nevertheless independently carried out the main tasks stipulated by the program, learned the main literature but allowed some errors in their implementation and in his answer during the test, but has the necessary knowledge for correcting these errors under the guidance of a teacher;

Assessment “satisfactory (3)” is given to a student who has displayed knowledge of the basic educational program material in the amount necessary for further study and future work in the profession, not showed activity in the classroom, independently fulfilled the main tasks envisaged by the program, but allowed errors in their implementation and in the answer during the test, but possessing necessary knowledge for elimination under the guidance of the teacher of the most essential errors;

Assessment “unsatisfactory (2)” is given to a student who showed gaps in knowledge or lack of knowledge on a significant part of the basic educational program material, who has not performed independently the main tasks demanded by the program, made fundamental errors in the fulfillment of the tasks stipulated by the program, who is not able to continue his studies or start professional activities without additional training in the discipline in question;

Assessment “unsatisfactory (1)” is given to a student when there is no answer (refusal to answer), or when the submitted answer does not correspond at all to the essence of the questions contained in the task.

## **5. Methodological materials defining the procedures for the assessment of knowledge, skills, abilities and/or experience**



During differentiated credit the student are allowed to use the program of the discipline.