<table>
<tr><td>Subject code:
F.1(2)</td><td colspan="3">Subject name: Machine Learning</td></tr>
<tr><td>Study load:
5 ECTS</td><td>Load of contact hours: 50</td><td>Study semester:
Spring</td><td>Assessment:
5-point grade credit</td></tr>
<tr><td>Objectives:</td><td colspan="3">The goal of the course - the study of machine learning the basics and the use of advanced software tools for creating data processing algorithms using machine learning methods</td></tr>
<tr><td>Course outline:</td><td colspan="3">Topics covered:

1. Basic concepts and basic approaches of machine learning. Superficial and deep learning
2. Compositional algorithms: bagging and boosting
3. Basic concepts of neural networks. The simplest neural networks
4. Multilayer direct distribution networks (MLP). Algorithm backpropagation
5. Hopfield neural network and its use
6. Networks based on self-organization. Kohonen Map
7. Features and modern technology training deep neural networks. Overview of software tools for developing algorithms using deep neural networks
8. The architecture and training convolution neural network
9. Application of convolution neural networks for classification and segmentation of objects in images
10. Recurrent deep neural networks. LSTM network and its application to the analysis of texts

Contact lessons will be divided into two parts: lectures and labs with individual tasks.</td></tr>
<tr><td>Learning Outcomes:</td><td colspan="3">By the end of the course students (in the terms of knowledge, skills, and attitudes) should be able to:
1 – critically evaluate typical approaches to the construction of information processing algorithms using machine learning methods;
2 – critically evaluate the principles of operation of surface and deep learning algorithms;
3 – critically evaluate the typical architectures of neural networks of various types, the features of their training and application;
4 – develop and program machine learning algorithms in Matlab and Python;
5 – model and research the effectiveness of information processing algorithms using machine learning methods.</td></tr>
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<tr><td>Assessment Methods:</td><td>Assessment is split into two parts: test on lectures, individual tasks on labs, including 9 mandatory presentations (60% of points), and individual project in the end of the course (40% of points).</td></tr>
<tr><td>Teacher(s):</td><td>Alexander Sirota, Elena Mitrofanova</td></tr>
<tr><td>Prerequisite subject(s):</td><td>It requires prior knowledge of computer science, programming, discrete mathematics, probability theory, models and methods of decision making.</td></tr>
<tr><td>Compulsory Literature:</td><td>Sirota, Alexandr Anatolievich. Methods and algorithms for data analysis and their modeling in MATLAB: [study guide] / A.A. Sirota. — St. Petersburg: BHV-Petersburg, 2016 .— 381 p. : ill. - Bibliogr .: p. 371-374 .— Sub. decree: p. 377-381 .— ISBN 978-5-9775-3778-0.
Osovsky S. Neural networks for information processing / trans. from Polish I.D. Rudinsky. - M.: Finance and Statistics, 2002. - 344 p.
Keras: The Python Deep Learning library official documentation [Electronic resource]. - Access mode: https: //keras.io.</td></tr>
<tr><td>Replacement Literature:</td><td>Scholl F. Deep Learning in Python / F. Scholl. Publishing House Peter. - 2018. - 400 p.</td></tr>
<tr><td>Participation requirements:</td><td>Lower limit of lectures attendance is 70%, each assessment and individual presentation must be presented by the end of the course</td></tr>
<tr><td>Independent work:</td><td>1. Developed application using deep neural network in Python
2. Individual presentation of final project</td></tr>
<tr><td>Grading criteria scale or the minimal level necessary for passing the subject:</td><td><table><tr><td>Failed</td><td>< 50 points</td></tr><tr><td>Passed, grade 3</td><td>50-69 points</td></tr><tr><td>Passed, grade 4</td><td>70-89 points</td></tr><tr><td>Passed, grade 5</td><td>>=90 points</td></tr></table>
Ongoing assessment:
Tests: 20 points
Homework reports: 30 points
Presentation: 10 points

Final Project:
Final lab test: 25 points
Final projects demonstration: 15 points</td></tr>
<tr><td>Information about the course:</td><td>Room ___, on ___ at ___</td></tr>
<tr><td>1) Date 1</td><td>Lecture 1
Classroom presentation: Basic concepts and basic approaches of machine learning. Superficial and deep learning</td></tr>
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2) Date 2	**Lab 1** Lab: Studying the properties of the simplest artificial perceptron. Visualization of activation functions Homework: Perform training of a neuron to perform the logical “or” function (using the adapt and train functions) Students presentations: Individual lab task
3) Date 3	**Lecture 2** Classroom presentation: Compositional algorithms: bagging and boosting
4) Date 4	**Lab 2** Lab: Neural network data classifier with linear dividing boundary Homework: Neural network data classifier with linear dividing boundary (gaussian random vectors)
5) Date 5	**Lab 3** Students presentations: Individual lab task
6) Date 6	**Lecture 3** Classroom presentation: Basic concepts of neural networks. The simplest neural networks
7) Date 7	**Lab 4** Lab: Neural network classifier given with a nonlinear dividing boundary Homework: Neural network classifier given with a nonlinear dividing boundary (gaussian random vectors)
8) Date 8	**Lab 5** Students presentations: Individual lab task
9) Date 9	**Lecture 4** Classroom presentation: Multilayer direct distribution networks (MLP). Algorithm backpropagation
10) Date 10	**Lab 6** Lab: Solving algebraic equations using a multilayer perceptron Homework: Develop a program for solving equations of a given type
11) Date 11	**Lab 7** Students presentations: Individual lab task
12) Date 12	**Lecture 5** Classroom presentation: Hopfield neural network and its use Classroom presentation: Networks based on self-organization. Kohonen Map Classroom test: Artificial neural network
13) Date 13	**Lab 8** Lab: Hopfield network and its use as associative memory Homework: Perform Hopfield network testing for various images. To study the effect of the probability of pixel distortion on the quality of restoration of the original image
14) Date 14	**Lab 9** Students presentations: Individual lab task
15) Date 15	**Lab 10** Lab: Kohonen network and its application Homework: Develop a program for solving the problem of clustering of many vectors in the form of clusters arranged accordingly

16) Date 16	**Lab 11** Students presentations: Individual lab task
17) Date 17	**Lecture 6** Classroom presentation: Features and modern technology training deep neural networks. Overview of software tools for developing algorithms using deep neural networks Classroom presentation: The architecture and training convolution neural network
18) Date 18	**Lab 12** Lab: Deep neural networks and their application Homework: Explore the possibilities of a convolutional neural network
19) Date 19	**Lab 13** Students presentations: Individual lab task (1 points)
20) Date 20	**Lab 14** Lab: R-CNN Object Detector Training for Stop Sign Detection Homework: Test a trained R-CNN object detector
21) Date 21	**Lab 15** Students presentations: Individual lab task
22) Date 22	**Lecture 7** Classroom presentation: Application of convolution neural networks for classification and segmentation of objects in images
23) Date 23	**Lab 16** Lab: Handwritten digit recognition using convolutional neural networks in Python with Keras Homework: Develop a program to solve the problem of classifying a source image using a deep convolutional neural network
24) Date 24	**Lecture 8** Classroom presentation: Recurrent deep neural networks. LSTM network and its application to the analysis of texts Classroom test: Deep neural networks
25) Date 25	**Lab 17** Students presentations: Final projects demonstration Students presentations: Final lab test