<table>
<tr><td>Subject code:
F.3(1)</td><td colspan="3">Subject name: Artificial Intelligence</td></tr>
<tr><td>Study load:
5 ECTS</td><td>Load of contact hours: 60</td><td>Study semester:
Autumn</td><td>Assessment:
5-points grade credit</td></tr>
<tr><td>Objectives:</td><td colspan="3">The goal of the course is to study the theoretical foundations and principles of building information systems based on the representation, storage and processing of knowledge that implement intellectual knowledge output</td></tr>
<tr><td>Course outline:</td><td colspan="3">Topics covered:

1 Formal models for the representation of knowledge in artificial intelligence.
2 Predicate calculus and logical programming for AI problems' solution.
3 Problem solving through search, state space search strategies.
4 Uncertain knowledge and reasoning in conditions of uncertainty.
5 Pattern recognition methods in the development of intelligent information systems.
6 Expert assessment and methods for processing expert assessments.
7 Ontological modeling of the semantics of the knowledge subject area.
8 Multi-agent Intelligent Systems.
9 Planning tasks in AI.
10 Natural Language Analysis.

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 concepts and modern theories of the artificial intelligence development;
2 – critically analyse and evaluate principles of building decision support systems, expert systems and natural language information processing systems;
3 – critically analyse and evaluate architectures of the formal models for the representation of knowledge in artificial intelligence.
4 – critically analyse and evaluate modern theories of constructing artificial intelligence systems that implement a fuzzy conclusion on incomplete and unreliable knowledge;
5 – develop application of intelligent information technology;
6 – program in Prolog, Python, NetLogo.</td></tr>
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Assessment Methods:	Assessment is split into two parts: test on lectures, individual tasks on labs, including 10 mandatory presentations (60% of points), and individual project at the end of the course (40% of points).
Teacher(s):	Veronika Garshina
Prerequisite subject(s):	It requires prior knowledge of computer science, programming, discrete mathematics, probability theory, models and methods of decision making.
Compulsory Literature:	Russell S. Artificial Intelligence: A Modern Approach / S. Russell, P.Norvig / - M .: Williams, 2006.-1408 p. Lugger, J.F. Artificial Intelligence: Strategies and Methods for Solving Complex Problems / J.F. Lugger. / - M.: Williams, 2003.- 864 p. Joshi, Practice. Artificial intelligence with examples in Python. - SPb. : LLC "Dialectics", 2019.- 448 p. Sergienko M.A. Development of expert systems in the CLIPS language: textbook. allowance / Sergienko M.A., Garshina V.V. / - Voronezh, VSU Publishing House, 2014. Ledeneva T.M., Tatarkin D.S., Tarasova A. C. Fundamentals of fuzzy modeling in MatLab: Textbook. allowance. Voronezh: Publishing and Printing Center of Voronezh State University, 2006., 51 p.
Replacement Literature:	Allemang, Dean Semantic web for the working ontologist modeling in RDF, RDFS and OWL / Dean Allemang, James A. Hendler-, 2-nd. Ed. - Elsevier Inc., 2011. Martin O. M. Bayesian analysis in Python - M.: DMK Press, 2020. - 340 p . Deepti Chopra, Nisheeth Joshi, Iti Mathur Mastering Natural Language Processing with Python. : Packt Publishing, 2016.
Participation requirements:	Lower limit of lectures attendance is 70%, each assessment and individual presentation must be presented by the end of the course
Independent work:	1. Prolog Syntax. Output Management in Prolog. Denial, clipping, search with return - backtracking. 2. Search management and its implementation in the state space in Prolog (depth, width search). State space search management: recursive search Sample search. 3. Heuristic search algorithms using the example of algorithm A *. 4. Development of intelligent systems based on fuzzy knowledge - Bayesian network-based trust mode and influence diagrams in the Hugin Expert system. 5. Modeling fuzzy inference and fuzzy control of technical systems in MATLAB (module Toolbox fuzzy logic Matlab) 6. Recognition system development based on a naive Bayes classifier. 7. Methods for measuring the degree of the objects influence: ranking, pairwise comparison, direct assessment. Methods of the expert groups' assessment analysis. 8. Development of the domain ontology (Protege). Resource Description Framework (RDF). SPARQL, SWRL rules.

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<tr><td></td><td>9. Applying a multi-agent approach to resource management tasks, modeling the behavior of complex information systems. Development of models in the NetLogo.
10. Planning tasks in AI. DPS and planning for multiple agents. Morphological, syntactic and semantic parsing for natural language (Python, NLTK).
11. TextMining, recognition of the named entities (Python, NLTK).
12. Classification and clustering of texts. Sentiment analysis (Python, NLTK).
13. Individual presentations of final projects</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>90-100 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 artificial intelligence (AI). Topics of modern research in the field of AI. Formal models for the representation of knowledge in artificial intelligence: production, frames, conceptual graphs and network models.</td></tr>
<tr><td>2) Date 2</td><td>Lecture 2
Classroom presentation: Predicate calculus and logical programming for AI problems solution. The basic principles of declarative programming. Language of logical programming - Prolog.</td></tr>
<tr><td>3) Date 3</td><td>Lab 1
Lab: Prolog Syntax. Output Management in Prolog. Denial, clipping, search with return - backtracking.
Homework: learning language documentation</td></tr>
<tr><td>4) Date 4</td><td>Lab 2
Students’ presentations: Individual lab task</td></tr>
<tr><td>5) Date 5</td><td>Lecture 3
Classroom presentation: Problem solving through search, state space search strategies with the example in Prolog.</td></tr>
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6) Date 6	**Lab 3** Lab: Search management and its implementation in the state space in Prolog (depth, width search). State space search management: recursive search Sample search. Homework: the study of search algorithms in the state space. Students' presentations: Individual lab task.
7) Date 7	**Lab 4** Lab: Heuristic search algorithms using the example of algorithm A *. Students' presentations: Individual lab task.
8) Date 8	**Lecture 4** Classroom presentation: Uncertain knowledge and reasoning in the conditions of uncertainty. Bayesian network-based trust mode.
9) Date 9	**Lab 5** Lab: Development of intelligent systems based on fuzzy knowledge - Bayesian network-based trust mode and influence diagrams in the Hugin Expert system. Homework: learning the interface of the Hugin Expert system.
10) Date 10	**Lab 6** Students' presentations: Individual lab task
11) Date 11	**Lecture 5** Classroom presentation: Representation of fuzzy knowledge based on the apparatus of fuzzy sets. The basic principles of the implementation of fuzzy inference and fuzzy control.
12) Date 12	**Lab 7** Lab: Modeling fuzzy inference and fuzzy control of technical systems in MATLAB (module Toolbox fuzzy logic Matlab) Homework: to study the documentation of Toolbox fuzzy logic module in Matlab.
13) Date 13	**Lab 8** Students' presentations: Individual lab task
14) Date 14	**Lecture 6** Classroom presentation: Pattern recognition methods in the development of intelligent information systems.
15) Date 15	**Lab 9** Lab: Recognition system development based on a naive Bayes classifier
16) Date 16	**Lab 10** Students' presentations: Individual lab task
17) Date 17	**Lecture 7** Classroom presentation: Expert assessment and methods for processing expert assessments.
18) Date 18	**Lab 11** Lab: Methods for measuring the degree of the objects' influence: ranking, pairwise comparison, direct assessment. Methods of the expert groups' assessment analysis. Students' presentations: Individual lab task.
19) Date 19	**Lecture 8** Classroom presentation: Ontological modeling of the semantics of the subject area of knowledge.
20) Date 20	**Lab 12**

	Lab: Development of the domain ontology (Protege). Resource Description Framework (RDF). SPARQL, SWRL rules. Homework: the study of GUI Protege, learning language documentation
21) Date 21	**Lab 13** Students' presentations: Individual lab task
22) Date 22	**Lecture 9** Classroom presentation: Multi-agent Intelligent Systems.
23) Date 23	**Lab 14** Lab: Applying a multi-agent approach to resource management tasks, modeling the behavior of complex information systems. Developing models in NetLogo. Homework: learning language documentation
24) Date 24	**Lab 15** Lab: Planning tasks in AI. DPS and Planning for multiple agents
25) Date 25	**Lab 16** Students' presentations: Individual lab task
26) Date 26	**Lecture 10** Classroom presentation: Natural Language Analysis.
27) Date 27	**Lab 17** Lab: Morphological, syntactic and semantic parsing for natural language (Python, NLTK) Homework: learning language documentation
28) Date 28	**Lab 18** Lab: TextMining, named entities recognition (Python, NLTK) Homework: learning documentation
29) Date 29	**Lab 19** Lab: Classification and clustering of texts. Sentiment analysis (Python, NLTK). Homework: learning documentation
30) Date 30	**Lab 20** Students' presentations: Individual lab task and Final lab test