COURSE DESCRIPTION CARD - SYLLABUS

Course name
Artificial Intelligence

Course

Field of study
Computing science

Year/Semester
3/5

Area of study (specialization)

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
24	30	
Tutorials	Projects/seminars	

Number of credit points

4

Lecturers

Responsible for the course/lecturer:
Artur Michalski, Ph.D.

Responsible for the course/lecturer:
Agnieszka Ławrynowicz, Ph.D.

Prerequisites

The student starting this course should have basic knowledge of discrete mathematics, computational logic and set theory, graph theory and declarative programming, theory of algorithms and complex data structures. In addition, they should have the ability to effectively use their knowledge in fields related to IT in solving optimization and decision-making tasks, and the ability to obtain this knowledge from the indicated sources.

Course objective

Provide students with basic knowledge in the field of artificial intelligence by presenting methods such as automatic reasoning, knowledge representation, state space searching, automatic planning and machine learning (including artificial neural networks). Developing students' ability to solve decision and optimization problems using heuristic and non-heuristic methods. Shaping students' skills to choose heuristic methods of solving tasks and symbolic forms of knowledge representation depending on the specificity of the problem.

Course-related learning outcomes

Knowledge

1. The student has theoretically founded knowledge of a knowledge-based systems; can analyze and describe their functioning and understand the scope of their applications
2. The student has basic knowledge of machine learning systems and artificial neural networks
3. The student has systematic knowledge of the principles and methods of solving decision and optimization problems using heuristic and non-heuristic algorithms of the state space search, including methods with resource constraints

Skills

1. The student can identify specific knowledge necessary to perform the task and justify its use in heuristic methods
2. The student is able to develop and implement a solution to a decision-making or optimization problem in terms of the state space search
3. The student can use the method of automatic planning to formulate and solve problem in the field of scheduling problems
4. The student is able to use methods of expert systems and descriptive logics to describe and formalize specific domain knowledge with the use of dedicated programming tools
5. The student is able to assess the suitability of formal methods of knowledge representation and algorithms of artificial intelligence for solving tasks typical for computer science, and can indicate appropriate application areas of both heuristic and non-heuristic methods
6. The student has the ability to practically implement algorithms based on heuristic knowledge in solving programming tasks
7. The student is able to extend his knowledge of the task being performed to a degree enabling him to find effective solution using artificial intelligence methods

Social competences

1. The student understands the need to constantly enrich his knowledge and develop their skills in the area of methods and tools of artificial intelligence
2. The student is aware of the potential role that artificial intelligence systems can play in the transformations of a social and economic nature
3. The student can identify the possibilities of using the known methods of artificial intelligence in the areas of IT applications and development of useful software

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Verification of assumed learning objectives related to lecture: through test at the end of the semester; the test consists of 7-9 open questions with equal marks. Passing threshold: 50% of points

Verification of assumed learning objectives related to laboratory classes: based on implementation of project tasks during the semester: students complete 4 project tasks as part of laboratory classes, for each of the three smaller project tasks, students can receive 20 points, and for a larger project of a computer player for the board strategy game - running throughout the semester - 40 points. Passing threshold: 50% of points

As part of the laboratory classes, it is possible to obtain bonus points for:
- victory in tournament of computer players - additional 10 points of bonus
- contribution to the course development: correction of errors of the software used, development of new, non-trivial tasks, etc. (after consultation with the teacher) - maximum 5 points of bonus

Programme content

1.Introduction: The definition and scope of Artificial Intelligence:
- Short history of AI
- Definition of AI
- Turing test
- Strong and weak AI
- The concept of bounded rationality
- Knowledge representation and search
- Areas of application of AI

2. State space search
- State space and its search as a general model of the problem solving process
- The nature of the state space and the complexity of the solution search process: graphs, cycles, DAGs
- Branching factor and the mechanism of backtracking
- Non-heuristic search methods: breadth-first and depth-first search, depth-limited and iterative deepening search, uniform cost search method
- Heuristic search: climbing algorithm, 'greedy-best-first' algorithm, A* algorithm
- Admissibility, monotonicity and informedness of heuristics
- Searching with resource constraints: IDA* algorithm
- Searching the space of two-player games: min-max rule, horizon effect, cutoff mechanism and alpha-beta algorithm, fail-soft version of the alpha-beta algorithm, methods to improve the alpha-beta algorithm

3. Structural forms of knowledge representation
- Introduction to the problem of knowledge representation
- Review of selected forms of knowledge representation (semantic networks, frames, ontologies)
- Descriptive logics (basics and inference)
- Modeling ontology in OWL

4. Expert systems
- Production rules as a form of knowledge representation
- Rule-based expert system architecture
- Inference in rule-based systems: forward reasoning ('recognize-execute' cycle) and backward reasoning
- Design problems of rule-based expert systems: ambiguity, inconsistency and redundancy in knowledge base
- Advantages and limitations of expert systems: domain knowledge acquisition
- Areas of application of expert systems

5. Machine learning and artificial neural networks
- Artificial neural networks - connectionist model
- Simple perceptron and delta rule
- Multilayer networks and back propagation algorithm
- Network overfitting phenomenon
- Hebb's rule and the Hopfield neural network
- Radial-basis function networks
- Clover's theorem
- Learning radial-basis neural networks: pseudo-inversion method
- Application of artificial neural networks

Teaching methods

1. Lectures: multimedia presentation illustrated with examples
2. Laboratory classes: solving tasks, practical exercise, teamwork

Bibliography

Basic

1. Artificial Intelligence. A Modern Approach, Russell S. J., Norvig P., Prentice Hall, Inc., Upper Saddle River, 1995, (3rd ed.) , 2016.
2. Artificial Intelligence, Second ed., Rich E., Knight K., Mc Graw Hill, Columbus, 1991.
3. Wstęp do sztucznej inteligencji, Mariusz Flasiński, Wydawnictwo Naukowe PWN, Warszawa 2011.

Additional

1. Metody przeszukiwania heurystycznego, t1 , Bolc L., Cytowski J., PWN, Warszawa, 1989.
2. Metody przeszukiwania heurystycznego, t2, Bolc L., Cytowski J., PWN, Warszawa, 1991.
3. Introduction to Artificial Intelligence, Charniak E., Mc Dermot D., Addison Wesley, Boston, 1985.
4. Metody i techniki sztucznej inteligencji, Rutkowski L., PWN, Warszawa, 2009.
5. The Description Logic Handbook: Theory, Implementation and Applications (2nd ed.), F.Baader, D.Calvanese, D.L. McGuinness, D.Nardi, and P.F. Patel-Schneider, Cambridge University Press, New York, 2010.
6. Automated Planning: Theory & Practice, Dana Nau, Malik Ghallab, and Paolo Traverso, Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2004.
7. Uczenie maszynowe z użyciem Scikit-Learn i TensorFlow,Aurélien Géron, Helion, 2018.

Breakdown of average student's workload

	Hours	ECTS
Total workload	104	4,0
Classes requiring direct contact with the teacher	54	2,0
Student's own work (literature studies, preparation for laboratory classes, preparation for tests, project preparation) [1]	50	2,0

[1] delete or add other activities as appropriate