# COURSE UNIT DESCRIPTION

| Course unit title | Course unit code |
|---|---|
| Artificial Intelligence: Classical Principles | **20477** |

| Summary |
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| This course comprises only elements of artificial intelligence (AI) and not the whole variety of AI techniques. Emphasis is on the classical AI, a.k.a. Good Old-Fashioned Artificial Intelligence, GOFAI, https://en.wikipedia.org/wiki/GOFAI. Hence, the course comprises the principles of AI, search methods, and logic-based representations. Machine learning and artificial neural networks are out of scope of this one-semester course. |

| Lecturer(s) | Department |
|---|---|
| **Coordinator:** assoc. prof. Vytautas ČYRAS<br><br>**Other lecturers: -** | Department of Software Engineering<br>Institute of Computer Science<br>Faculty of Mathematics and Informatics<br>Vilnius University |

| Cycle | Type of the course unit |
|---|---|
| 1st (BA) | Non-compulsory |

| Mode of delivery | Semester or period when the course unit is delivered | Language of instruction |
|---|---|---|
| Face-to-face | 5, 6, 7 semester | English |

| Prerequisites |
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| Programming skills in a programming language, for example, C, C#, Java, Pascal, Perl, Python, etc. |

| Number of credits allocated | Student's workload | Contact hours | Individual work |
|---|---|---|---|
| 5 | 130 | 64 | 66 |

**Purpose of the course unit: programme competences to be developed**

To develop competencies and skills in artificial intelligence: to understand the philosophy of AI and the question "Can machines think?". To gain programming skills at creating future intelligent systems, which extend the limits of machine intelligence of the past and use the elements of human intelligence in problem solving.
***Generic competences:*** communication and collaboration, life-long learning, and social responsibility.
***Specific competences:*** knowledge and skills of underlying conceptual basis, software development knowledge and skills, technological and methodological knowledge and skills, and professional competence.

| Learning outcomes of the course unit: students will be able | Teaching and learning methods | Assessment methods |
|---|---|---|
| To understand the fundamental concepts of AI: problem solving by search, backtracking, solver, planner, software agent, the Turing test, etc. | Problem-based teaching, individual reading, writing programs. | Written examination, assignments.<br>Criteria: the quality of programming; accomplishing the assignments in due time – no delay; understanding the subject matter of AI. |
| To program basic techniques of inference: backtrack (depth-first), breadth-first search, forward chaining and backward chaining. | | |
| To understand the essence of AI: differentiating between human intelligence and machine intelligence, extra-logical choice in decision making, e.g., in legal reasoning. | | |

| Course content: breakdown of the topics | Contact hours | | | | | | | Individual work: time and assignments | |
|---|---|---|---|---|---|---|---|---|---|
| | Lectures | Tutorials | Seminars | Practice | Laboratory work (LW) | Praktika | **Contact hours** | **Individual work** | **Assignments** |
| 1. Artificial intelligence (AI): a history, a philosophy, and the hype. Examples of intelligent tasks. AI as a discipline within a classification of computing. The Turing test and interpreting the question "Can machines think?" | 2 | | | 2 | | | **4** | **4** | The Tower of Hanoi puzzle. *Literature*: the course-book (text-book) (Čyras 2021), (Nilsson 2010), (Luger 2009), https://en.wikipedia.org/wiki/Turing_test |
| 2. A system of artificial intelligence: 1) a global data base, 2) a set of production rules, and 3) a control system. Procedure PRODUCTION. Examples: the Tower of Hanoi problem, etc. | 2 | | | 2 | | | **4** | **4** | The Knight's tour program. *Literature*: textbook, (Nilsson 1982; 1998) |
| 3. Procedure BACKTRACK. A problem solving example: the Knight's tour problem. | 2 | | | 2 | | | **4** | **4** | *Literature*: textbook, (Nilsson 1982; 1998) |
| 4. Avoiding loops in labyrinth depth-first search (DFS) with BACKTRACK1, a modified procedure. | 2 | | | 2 | | | **4** | **4** | Programming DFS in a labyrinth. *Literature*: textbook, (Nilsson 1982) |
| 5. The concept of heuristic. Examples in the N-queens problem. | 2 | | | 2 | | | **4** | **4** | *Literature*: textbook, (Nilsson 1982; 1989) |
| 6. Breadth-first search (BFS). The lists OPEN and CLOSED and the shortest path. The types of intelligent agents: reflexive and rational agents. | 2 | | | 2 | | | **4** | **4** | Programming BFS in a labyrinth. *Literature*: textbook, (Russell & Norvig 2020), (Nilsson 1998) |
| 7. Procedure GRAPHSEARCH. The solver and the planner. A* search algorithm. | 2 | | | 2 | | | **4** | **4** | *Literature*: textbook, (Nilsson 1982; 1998) |
| 8. Forward chaining (FC): from the facts to the goal, non-recursive. Backward chaining (BC): from the goal to the facts, recursive. Rule format: A1,…, An → B. | 2 | | | 4 | | | **6** | **4** | Programming FC. *Literature*: textbook, (Negnevitsky 2011) |
| 9. Hill climbing strategy. | 2 | | | 0 | | | **2** | **4** | *Literature*: textbook, (Nilsson 1982; 1998) |
| 10. Knowledge-based reasoning, the resolution rule, deduction. Inference forwards and backwards. Logic-based knowledge representation. | 2 | | | 2 | | | **4** | **6** | Programming BC. *Literature*: textbook, (Nilsson 1998), (Russell & Norvig 2020) |
| 11. Elements of expert systems architecture: a knowledge base (facts and rules), an inference engine and user interface. | 2 | | | 2 | | | **4** | **4** | *Literature*: textbook, (Nilsson 1998) |
| 12. Extra-logical choice in decision making, e.g., "low-quality but cheap" versus "good-quality but expensive". Transforming the problem of impossibility of achieving several goals into a weighing problem. Deduction and abduction rules. Defeating argumentation trees. | 2 | | | 2 | | | **4** | **4** | *Literature*: textbook, (Bench-Capon & Prakken 2006) |
| 13. The Internet shopping world (see Russell & Norvig 2003, p. 344–348): specifying a search engine. A category tree as an ontology. | 2 | | | 2 | | | **4** | **4** | *Literature*: textbook, (Russell & Norvig 2003; 2020) |
| 14. Knowledge representation methods: structural representation, frames, semantic networks. | 2 | | | 2 | | | **4** | **4** | *Literature*: textbook, (Nilsson 1998) |

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| 15. Extensional relational structure, intensional relational structure (conceptualization), intended models, and ontology. | 2 | | | 2 | | | **4** | **4** | *Literature*: https://www.researchgate.net/publication/226279556_What_Is_an_Ontology |
| 16. Summing up the principles of artificial intelligence. Discussing the examination. | 2 | | | 2 | | | **4** | **4** | Preparing to the exam |
| **Total** | **32** | | | **32** | | | **64** | **66** | |

| Assessment strategy | Weight | Deadline | Assessment criteria |
|---|---|---|---|
| 1. Simple programs. For instance, the Tower of Hanoi puzzle, the Knight's tour, labyrinth path search (DFS, BFS), A*. | 0% | Week 6 | Each assignment shall be finished in due time, no delay. Forward chaining and backward chaining programs shall be finished in four weeks. Week 1: your program reads initial data and prints it. Week 2: simple tests. Week 3: complex testing. Week 4: – acceptance.<br>Assignments' assessment criteria: the quality of programming, testing and documenting. The output of a test comprises 1) input data from a file, 2) execution trace (log), and 3) the results. The code shall contain comments, step numbering, and explanations of data structures.<br>**A review instead of FC/BC**. An option (e.g., for students who are less-skilled in programming) is (1) investigating a chosen problem, article or book, (2) writing a review, and (3) making a presentation. Font 12 pt, spacing 1, ~20 pages with references. Evidence of understanding the problem.<br>**For examination** it is obligatory to pass all assignments. Assignments rate 30% of the exam's score.<br>It is strongly recommended to attend ≥ 75% of lectures and practice. |
| 2. Forward and backward chaining programs (FC and BC). | 30% | Week 11 FC, Week 15 BC | |
| 3. Examination. | 70% | Examination date | The examination comprises a theory question and an exercise. The exercise: for a given graph, draw search trees from a node ***s*** to ***t*** according to procedures BACKTRACK1 and GRAPHSEARCH "depth-first"; indicate distinctions.<br>The assignments score counts if each question is answered in the affirmative. In other words, the exam grade is placed positive only if each exam question is answered in the affirmative (≥ 5 out of 10). |

| Author | Publi-shing year | Title | Number or volume | Publisher or URL |
|---|---|---|---|---|
| **Required reading** | | | | |
| 1. Vytautas ČYRAS | 2023 | Artificial Intelligence (a textbook) | | https://klevas.mif.vu.lt/~cyras/AI/ai-cyras.pdf |
| 2. Nils NILSSON | 1997 | Artificial intelligence: a new synthesis | | Elsevier Science & Technology. VU MIF, 004.8 Ni-133. https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=1179844 |
| 3. Stuart RUSSELL, Peter NORVIG | 2020 | Artificial intelligence: a modern approach (4th edition) | | Prentice Hall, 1115 p. VU MIF, 2nd edn (2003), Ru122. https://aima.cs.berkeley.edu. https://ebookcentral.proquest.com/lib/viluniv-ebooks/detail.action?docID=5495854 |
| 4. Michael NEGNEVITSKY | 2011 | Artificial intelligence: a guide to intelligent systems (3rd edition) | | Pearson Education. VU MIF, 2nd edn. (2005), 004.8/Ne-44. https://ebookcentral.proquest.com/lib/viluniv- |

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| | | | | ebooks/detail.action?docID=5186211 |
| **Recommended reading** | | | | |
| 1. Nils NILSSON | 2009 | The quest for artificial intelligence: a history of ideas and achievements | | Cambridge University Press. VU MIF, 004.8 Ni-133. https://doi.org/10.1017/CBO9780511819346 |
| 2. Nils NILSSON | 1982 | Principles of artificial intelligence | | Springer-Verlag |
| 3. George LUGER | 2009 | Artificial intelligence: structures and strategies for complex problem solving (6th ed.) | | Addison-Wesley, 928 p. https://www.cs.unm.edu/~luger/. VU MIF, 004.8/Lu-59 |

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