Fundamentals of Artificial Intelligence and Knowledge Representation
Module 1

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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Course content

- The course introduces the fundamental principles and methods used in Artificial Intelligence to solve problems, with a special focus on the search in the state space, planning, knowledge representation and reasoning, and on the methods for dealing with uncertain knowledge.
- The course will include hands-on labs and seminars on selected topics.
- Prerequisites: user-level knowledge of a high-level programming language, to understand case studies and applications presented during the lessons.

Course content

- Module 1
- Introduction to Artificial Intelligence: historical perspective, main application fields, introduction to knowledge-based systems and architectural organization.
- Problem-solving in AI: representation through the notion of state, forward e backward reasoning, solving as a search and search strategies. Games. Constraint satisfaction problems.
- Local Search methods, meta heuristics, solving through decomposition, constraint relaxation, branch-and-bound techniques
- Introduction to Planning, Linear planning, partial order planning, graph-based methods (GraphPlan), Scheduling.

Course content

PART II (Modules 2):

- Module 2 (Prof. Federico Chesani)
  - Introduction to knowledge representation and reasoning
  - Representing Terminological Knowledge: semantic networks, description logics, foundation of ontologies
  - Representing actions, situations, and events.
  - Reasoning with Beliefs.

- Module 3 (Prof. Paolo Torroni)
  - Uncertainty
  - Probabilistic Reasoning

Assessment Method

- The exam aims at assessing the student's knowledge and skills in the course topics and it consists of two independent parts:
- Part I, covering the material taught in the fall semester (Module 1),
- Part II, covering the material taught in the spring semester (Modules 2 and 3).
- There will be a separate written exam for each part. Each written exam will include exercises and open questions about all the topics presented in the relevant part of the course.

- We propose challenges: one on a game and one on robotic dancing to be submitted to a contest (not mandatory)
- More information later during the course

Exam dates

- January 20, 2026 Room 0.5
- February 3, 2026 Room 0.5
- Lists on Almaesami
- Possibly a date before Christmas

Hands on sessions

- During the course there will be hands-on sessions.
- Bring your laptop
- If no laptop available, let us know

- Software:
- AIMA library and Java
- Graphplan, SAT plan, Black box

Text books

Slides will be distributed during the course on the VIRTUALE web site

Recommended textbook:

- **S. J. Russel, P. Norvig, *Artificial Intelligence: A modern approach*, Prentice Hall, International edition.**

Further readings:

- R. J. Brachman, H. J. Levesque, *Knowledge Representation and Reasoning*, Elsevier, 2004.
- F. Baader, D. Calvanese, D.L. McGuinness, D. Nardi, P.F. Patel-Schneider (editors), *The description logic handbook: Theory, implementation, and applications*, Cambridge University Press New York, NY, USA, 2007

Other AI books:

- Nils J. Nilsson: *Artificial Intelligence: A New Synthesis*, Morgan Kaufman, 1998.
- M. Ginsberg: *Essentials of Artificial Intelligence*, Morgan Kaufman,1993.
- P. H. Winston: *Artificial Intelligence*, Addison-Wesley, 1992.

Useful Information

- Office hours
  - Thursday 10-12 (via Teams)
  - Send me an email if you need to talk to me
- Email
  - michela.milano@unibo.it
  - **Important:** I receive a huge amount of email. Please use as subject **Foundamentals of AI**
- Phone 051.20.93790

Tutors

- The tutors will follow the challenges and hands on sessions. You can contact them on teams or via email.

- Matteo Francobaldi: matteo.francobaldi2@unibo.it

- Joseph Giovanelli: j.giovanelli@unibo.it