



ALMA MATER STUDIORUM  
UNIVERSITÀ DI BOLOGNA

# Fundamentals of AI and KR

## Module 2

### Introduction to the module

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## Rationale of this Module

- A field of AI is devoted to **represent** and **reasoning** over **knowledge**
- Many different paradigms are available for representing knowledge and reasoning upon it
  - Historically, many different logics have been proposed...
  - ... but also rule-based approaches



## Objective of this module

Introduce the students to the general topic of KR&R techniques

1. Knowledge... what is it? *what* are we going to *represent*?
2. Knowledge... *how* are we going to *represent* it?
3. Knowledge... how are we going to *reason* upon such *represented knowledge*?



## Textbook(s)

- **Artificial Intelligence: A Modern Approach.**

Russel, Norvig, 4<sup>th</sup> edition.

When a topic is discussed in classroom, a pointer to the corresponding book chapter is given in the slides

- Knowledge Representation and Reasoning. Brachman, and Levesque. Elsevier.
- Process Mining. van der Aalst. Springer-Verlag
- Foundations of Probabilistic Logic Programming. Riguzzi, 2nd edition. River Publishers



# Organization of this module

**Part 0** – Shall we agree on a common language?

**Part 1** – First Order Logic for representing knowledge: a fragment we can reason upon

**Part 2** – Knowledge about facts and categories

**Part 3** – Knowledge about temporal information

**Part 4** – Probabilistic knowledge and reasoning

**Part 5** – Forward (vs. backward) reasoning

**Part 6** – Representing Processes



# Organization of this module

Part 0 – Shall we agree on a common language?

- **Lesson 1:** A common language we can all understand: Propositional Logic, FOL, Interpretation, Models, Logical consequence, Resolution



# Organization of this module

Part 1 – First Order Logic for representing knowledge: a fragment we can reason upon

- **Lesson 2:** Prolog, terminology, SLD Resolution, Arithmetic, Iteration and recursion, Lists, Cut, Negation
- **Lesson 3:** Meta-predicates
- **Lesson 4:** Meta-interpreters



# Organization of this module

## Part 2 – Knowledge about facts and categories

- **Lesson 5:** Upper ontologies, Objects and categories, reification, disjunctness, exhaustive decomposition, partition, physical composition (composed objects vs. bunch of), measures. Objects: things vs. stuff, intrinsic vs. extrinsic properties
- **Lesson 6:** Semantic networks
- **Lesson 7:** Description Logics
- **Lesson 8:** Introduction to Protégé
- **Lesson 9:** Semantic Web and Knowledge Graphs





## Organization of this module

### Part 3 – Knowledge about temporal information

- **Lesson 10:** As time goes by: Event Calculus, Allen's Temporal Logic.
- **Lesson 11:** Modal logics and Linear-Time Temporal Logic (LTL)
- Exercise: Event Calculus in Prolog.



# Organization of this module

## Part 4 – Probabilistic knowledge and reasoning

- **Lesson 12:** Probabilistic Logic Programming
- Case study: assessing the fall risk of an elder

## Part 5 – Forward (vs. backward) reasoning

- **Lesson 13:** Forward Reasoning: Rete and Drools
- Case study – CEP as a mix of temporal reasoning and forward reasoning; the Habitat project example



# Organization of this module

## Part 6 – Representing Processes

- **Lesson 14:** Introduction to BPM
- **Lesson 15:** Workflow Nets and BPMN
- **Lesson 16:** Declarative approaches
- **Lesson 17:** Process Discovery
- **Lesson 18:** Representing Decisions



## Learning Resources

- Textbook
- Slides of the course
- Scientific papers mentioned within each topic lesson

### Software:

- SWI Prolog
- DROOLS (and Java)
- Python (and Google API for few experiments)
- DISCO (Process Discovery)



## Exam – when?

- 4 (four) different dates will be available
  - 15<sup>th</sup> of January 2025 (TO BE CONFIRMED)
  - 5<sup>th</sup> of February 2025 (TO BE CONFIRMED)
  - June 2025
  - September 2025
- A special date, **reserved** for Erasmus students only, in December 2024

**It is mandatory to book on AlmaEsami!**



## Exam – how?

- Written text (on the old-fashion paper!!!)
- 4 exercise/questions; usually:
  - 2 exercise about Prolog/meta-interpreters
  - 2 open questions
- Duration: 1 hour
- Grades on a 21-point scale (20 the maximum, +1 point for exceptional essays)
- No material can be consulted during the exam
- No consultation with colleagues is allowed
- **If you don't like the grade, you can retry. As soon as you submit, you "loose" the previous grade.**



## Exam – examples?

- On [virtuale.unibo.it](http://virtuale.unibo.it) you can find a collection of the exams of the previous years



## Contacts

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