

# SEMINAR LOGIC-BASED KNOWLEDGE REPRESENTATION

## Introduction / Course Organization

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[https://iccl.inf.tu-dresden.de/web/Seminar\\_Logic-Based\\_Knowledge\\_Representation\\_\(SS2023\)](https://iccl.inf.tu-dresden.de/web/Seminar_Logic-Based_Knowledge_Representation_(SS2023))

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# Course information

- Seminar sessions: Mondays at DS5
- Examination: presentation and term paper (for modules: INF-AQUA, INF-04-HS, INF-D-940, MCL-PS, CMS-SEM)
- Examination: non-graded oral exam (for module: INF-PM-FOR)
- For each seminar session, there will be a text to read
- Each text will be presented by a student and discussed afterwards
- For more information (e-mail, slides, ...):

[`https://iccl.inf.tu-dresden.de/web/Seminar\_Logic-Based\_Knowledge\_Representation\_\(SS2023\)`](https://iccl.inf.tu-dresden.de/web/Seminar_Logic-Based_Knowledge_Representation_(SS2023))

# Aims of the course

Three objectives:

1. Develop skills to do research on previously unknown formalisms;
2. Learn how to present key concepts in a well-structured way (orally as well as in written form);
3. Obtain an understanding of a selection of key topics in Knowledge Representation and Reasoning such as:
  - The role of logic in KR
  - Modal Logics and some extensions
  - Nonmonotonic Reasoning
  - Algorithms and Systems

# What is Knowledge Representation and Reasoning?

# What is Knowledge?

Unsettled question and subject to an involved (philosophical) discussion.

What seems clear:

- Statements that involve the notion of “knowledge” typically are of the form: “John knows that Mary is going to the party”.
- Knowledge involves an agent (e.g. John) who forms a judgment about some proposition  $p$  (e.g.  $p \hat{=}$  “Mary is going to the party”).
- Knowledge involves the truth of the proposition.
- This observation can be used to distinguish knowledge from belief.

↪ Our working “definition” of knowledge: **Justified true belief.**

# What is Representation?

This question seems to be equally vexing.

Roughly, we see representation as:

- A relationship between two domains, where the first is meant to take the place of the second.
- We call the first domain the representor. It is typically more accessible than the second.
- We are mostly concerned with formal symbols as type of representor (e.g. “7” stands for the number 7).

Knowledge representation can then be understood as: “The field of study concerned with using formal symbols to represent a collection of propositions believed by some putative agent” (Brachman & Levesque, 2004: 4).

# What is Reasoning?

Brachman & Levesque: “It is the formal manipulation of the symbols representing a collection of believed propositions to produce representations of new ones (2004: 4)”.

In our case, this production of new propositions is done via logical inference. With that, we could summarize the general procedure of (logic-based) knowledge representation as follows:

1. Start with some set of propositions.
2. Find a good way to formally represent these propositions.
3. Apply a suitable form of logical inference to produce new propositions.

# General Course Expectations



# Presentation

## Expectations:

- Presentation of the text for a session of around 30 minutes.
- Goal: Introduce the formalism and key concepts from the text on a formal as well as on an intuitive level.
- Use slides to support your presentation but try to speak from your notes as little as possible.
- Answer central questions such as:
  - What motivates this particular formalism?
  - How does it accomplish that?
  - What are the advantages and disadvantages of this approach?
- Take questions from the audience after your presentation.
- 50% of the final grade.

# Term Paper

## **Expectations:**

- Term paper of around 5 pages where you scrutinize one of the formalisms from the seminar in more detail.
- The term paper will be written during the summer break.
- There will be a consultation session by the end of the semester.
- Make use of additional literature by doing a little bit of research on your own.
- Have a reasonable research question.
- 50% of the final grade.
- Possible approach:
  1. Concisely present one of the formalisms from the seminar;
  2. Pick one of its drawbacks;
  3. Find out how that drawback can be overcome.

# Seminar

## **Expectations:**

- Everyone is expected to have read the text for each session (before the seminar starts);
- Everyone is encouraged to contribute to a (hopefully) lively discussion after the presentations.

# Literature and Presentation Dates

# First Block: Modal Logic and Extensions

## 08.05. **Introduction to Modal Logics – Semantics**

Text: Rosja Mastop: [Modal Logic for Artificial Intelligence](#) (2011), Chapters 2–4.3

## 15.05. **Introduction to Modal Logics – Proof Theory**

Text: Rosja Mastop: [Modal Logic for Artificial Intelligence](#) (2011), Chapters 5 & 6

## 22.05. **Temporal Reasoning**

Text: [Handbook of Knowledge Representation](#) (2008), Chapters 12–12.2.3  
& Rosja Mastop: [Modal Logic for Artificial Intelligence](#) (2011), Chapters 8–8.4

## 05.06. **Epistemic Logic**

Text: Ernest Davis, Leora Morgenstern: [Epistemic Logic and its Applications: Tutorial Notes](#) (2009)

# Second Block: Nonmonotonic Reasoning

## 12.06. **Introduction to NMR**

Text: [Handbook of Knowledge Representation \(2008\)](#), Chapter 6

## 19.06. **Default Logic**

Text: Grigoris Antoniou: [A Tutorial on Default Logics \(1999\)](#)

## 26.06. **Autoepistemic Logic**

Text: R.C. Moore: [Semantical Considerations on Nonmonotonic Logic \(1985\)](#)

## 03.07. **NMR – Recap and Criticism**

Text: Raymond Reiter: [Nonmonotonic Reasoning \(1987\)](#)

# Third Block: Algorithms and Systems

## 10.07 **Introduction to Reasoning under Uncertainty**

Text: Denoeux, Dubois, Prade: [Representations of Uncertainty in Artificial Intelligence: Probability and Possibility](#) (2020), Chapters 1–3.4

## 17.07 **Dempster Shafer Theory**

Text: Liu, Yager: [Classic Works of the Dempster-Shafer Theory of Belief Functions: An Introduction](#) (2008), Chapters 1–4

# Summary and Outlook

Reading material for every session that will be presented by a student.

In case you cannot find a reference, contact me.

Term paper at the end of the semester.

## **Open questions:**

- What's next? (A recap on logic – next week.)
- Are there any volunteers for the first presentations?