TECHNISCHE
UNIVERSITÄT
DRESDEN

SEMINAR: KNOWLEDGE REPRESENTATION

Session 1: Introduction / Course Organization

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Computational Logic Group

Slides based in part on Material of Bernardo Cuenca Grau, Ian Horrocks, and Przemysław Wałęga

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Course information

- Seminar Sessions: Mondays at DS 3
- Examination: Presentation and Term Paper (for modules: INF-AQUA, INF-04-HS, INF-D-940, MCL-PS)
- Examination: non-graded Oral Exam (for modul: 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 (email, slides, ...):

  https://iccl.inf.tu-dresden.de/web/Seminar:
  _Knowledge_Representation_(WS2021)

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
   - Reasoning under Uncertainty

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."
- It seems: Knowledge involves an agent (e.g. John) who forms a judgment about some proposition p
  (e.g. Mary is going to the party).
- Knowledge seems to involve the truth of the proposition.
- This observation can be used to distinguish knowledge from 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 propisitions.
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 as little from your notes 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

26.04 **Introduction to Modal Logics - Semantics**
Text: Rosja Mastop: Modal Logic for Artificial Intelligence (2011) (Chapter 2 - 4.3)

03.05 **Introduction to Modal Logics - Proof Theory**
Text: Rosja Mastop: Modal Logic for Artificial Intelligence (2011) (Chapter 5 + 6)

10.05 **Temporal Reasoning**
Text: Handbook of Knowledge Representation, Temporal Representation and
Reasoning (2008) (Chapter 12 - 12.2.3) + Rosja Mastop: Modal Logic for Artificial
Intelligence (2011) (Chapter 8-8.4)

17.05 **Epistemic Logic**
Text: Ernest Davis: Epistemic Logic and its Applications: Tutorial Notes (2009)

Second Block: Nonmonotonic Reasoning

31.05 **Introduction to NMR**
Text: Handbook of Knowledge Representation, Nonmonotonic Reasoning (2008)
(Chapter 6)

07.06 **Default Logic**
Text: Grigoris Antoniou: A Tutorial on Default Logics (1999)

14.06 **Autoepistemic Logic**
Text: R.C. Moore: Semantical Considerations on Nonmonotonic Logic (1985)

21.06 **New: NMR - Recap and Critizism**
Text: Raymond Reiter: Nonmonotonic Reasoning (1987)

Third Block: Reasoning under Uncertainty

28.06 **Introduction to Reasoning under Uncertainty**
Text: Denoeux, Dubois, Prade: Representations of Uncertainty in Artificial
Intelligence: Probability and Possibility (2020) (Chapter 1 - 3.4)

05.07 **Dempster Shafer Theory**
Text: Liu, Yager: Classic Works of the Dempster-Shafer Theory of Belief Functions:
An Introduction (2008) (Chapter 1 - 4)

12.07 **Paradoxes in Dempster Shafer Theory**
Text: Khan, Anwar: Paradox Elimination in Dempster-Shafer Combination Rule with
Novel Entropy Function: Application in Decision-Level Multi-Sensor Fusion (2019)

Summary and Outlook

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

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?