Seminars @ Knowledge-based Systems Group 192-03

SS 2024

Seminar Topic Presentation

Institute of Logic and Computation
Knowledge-Based Systems Group

www.kr.tuwien.ac.at

Overview

Offered Seminars:

➤ Seminar in Theoretical Computer Science

➤ Seminar in Artificial Intelligence

➤ Seminar in Logic

➤ Seminar in Knowledge Representation and Reasoning

Organisation:

➤ Any of the topics listed in the following can be chosen for any of our offered seminars.

➤ A 40min presentation has to be prepared.

➤ The talks will be given at the end of the semester.

Topics

Topics (ctd.)

Topics Group Ortiz
➤ Learning Ontologies
➤ Reasoning and Planning with LLMs
➤ Causality
➤ Explainable and Safe AI
➤ Formalisms for Graph Data

Topics Group Egly
➤ Problem Solving on a Quantum Computer

Assignment
☞ If you are interested in a topic of group X, then please write an email with subject "[KBS SE]" to person X.
☞ Additionally, please register to the group X of the seminar(s) for which you want to receive your certificate(s).

Rejection Calculi

1. T. Skura. *Refutation systems in propositional logic.* Handbook of Philosophical Logic, 2011.

2. T. Skura. *Refutation Methods in Modal Propositional Logic*, 2013.

3. V. Goranko and T. Skura. *Refutation systems in the finite.* Reasoning: Games, Cognition, Logic, College Publications, 2020.

4. A. Tamminga. *Logics of rejection: Two systems of natural deduction.* Logique & Analyse, 1994.

5. V. Goranko. *Refutation systems in modal logic.* Studia Logica, 1994.

6. R. Dutkiewicz. *The method of axiomatic rejection for the intuitionistic propositional calculus.* Studia Logica, 1989.

Rejection Calculi (ctd.)

7. P. Bonatti, N. Olivetti. *Sequent Calculi for Propositional Nonmonotonic Logics.* ACM Transactions on Computational Logic, 2002.

8. Olaf Beyersdorff, Leroy Chew: *The Complexity of Theorem Proving in Circumscription and Minimal Entailment.* IJCAR 2014: 403-417

9. Olaf Beyersdorff: *The Complexity of Theorem Proving in Autoepistemic Logic.* SAT 2013: 365-376.

10. Olaf Beyersdorff, Arne Meier, Michael Thomas, Heribert Vollmer: *The Complexity of Reasoning for Fragments of Default Logic.* Journal of Logic and Computation 22(3): 587-604, 2012.

Nonsense Logics

➤ What are nonsense logics?

- Family of three-valued logics where the third truth value represents a "nonsensical proposition"
- useful, e.g., to analyse logical paradoxes, like Russell's antinomy.

➤ Possible topics:

- Finn & Grigolia: Nonsense Logics and Their Algebraic Properties. In: Theoria 59(1–3), 1993.
- Coniglio & Corbalan: Sequent Calculi for the classical fragment of Bochvar and Hallden's Nonsense Logics. In: EPTCS 113, 2013.
- Karpenko & Tomova: Bochvar's Three-valued Logic and Literal Paralogics. In: Logic and Logical Philosophy, 26, 2017

Quantum Logic

➤ P. Gibbins, *Particles and Paradoxes*, Cambridge University Press, 1987.
  From the Contents:

  1. Quantum Mechanics for Natural Philosophers
  2. Wave-Particle Duality
  3. The Copenhagen Interpretation
  4. Projection Postulates
  5. Nonlocality and Hidden Variables
  6. A User-friendly Quantum Logic
  7. Quantum Logic: What it can and can't do

➤ Additionally:

  • M. L. Dalla Chiara and R. Giuntini. *Quantum Logics*. Handbook of Philosophical Logic Vol. 6, 2002.
  • Paul Weingartner. *Matrix-based Logic for Application in Physics*. The Review of Symbolic Logic, 2(1):132–63, 2009.

The Emperor's New Mind

➤ Roger Penrose: *The Emperor's New Mind - Concerning Computers, Minds, and the Laws of Physics*, 1989

➤ From the Contents:

1. Can a Computer Have a Mind?
2. Algorithms and Turing Machines
3. Mathematics and Reality
4. Truth, Proof, and Insight
5. The Classical World
6. Quantum Magic and Quantum Mystery
7. Cosmology and the Arrow of Time
8. In search Quantum Gravity
9. Real Brains and Model Brains
10. Where Lies the Physics of Mind?

Cognitive Psychology and its Implications

➤ John R. Anderson: *Cognitive Psychology and its Implications*, Eighth Edition, 2014

➤ From the Contents:

History of Logic I (ctd.)

➤ Additional topics not covered in the VO History of Logic held last semester!

➤ Topics (not exhaustive):

- Aristotle (384–322 v.Chr.): Modal Syllogisms
  - From: Fred Johnson: Aristotle's Modal Syllogisms
    In: Gabbay & Woods: *Handbook of the History Handbook of the History of Logic, Volume 1: Greek, Indian and Arabic Logic*, 2004

- Leibniz (1646-1716): Works about modal logic
  - From: Wolfgang Lenzen: Leibniz's Logic.
    In: Gabbay & Woods: *Handbook of the History of Logic, Volume 3: The Rise of Modern Logic—From Leibniz to Fregel Concepts*, 2004.

- Rudolf Carnap (1891-1970):
  - Meaning and Necessity: A Study in Semantics and Modal Logic, 1947

History of Logic II

➤ **Logicomix**
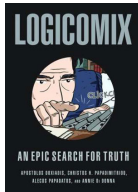
- An entertaining journey through the beginnings of modern formal logic
- Tell the story and zoom into some technical aspect

History of Logic II

Charles Sanders Peirce (1839–1914)

➤

- Philosopher, mathematician, logician, and many more
- Studied abductive reasoning, inductive reasoning, deductive reasoning and their interrelationship
- Developed *existential graphs*, ako diagrammatic version of predicate calculus

➤ Report on life & some technico-philosophical achievement(s)

Theory and Logic

➤ *Algebraic Model Counting* (JAL, 2017)

➤ *On Quantifying Literals in Boolean Logic and its Applications to Explainable AI* (IJCAI 2022, JAIR)

➤ *LTL on Weighted Finite Traces: Formal Foundations and Algorithms* (IJCAI 2022)

➤ *Verification and Realizability in Finite-Horizon Multiagent Systems* (KR 2022)

➤ *The Logical Expressiveness of Graph Neural Networks* (ICLR 2020)

➤ . . .

Knowledge Representation and Reasoning

➤ **Temporal and Stream Reasoning**

- *MeTeoR: Practical Reasoning in Datalog with Metric Temporal Operators* (AAAI 2022)

- *I-DLV-sr: A Stream Reasoning System based on I-DLV* (TPLP 2021, RR+RW 2022)

- *RDF Stream Reasoning via Answer Set Programming* (ISWC'18)

- *Stream Reasoning in Temporal Datalog* (AAAI 18)

- *Handling Impossible Derivations During Stream Reasoning* (ESWC 2020)

- *Abnormal Situations Interpretation in Industry 4.0 using Stream Reasoning* (KES 2019)

- *Out of Sight But Not Out of Mind: Traffic Analysis in ASP* (IJCAI 2019)

Knowledge Representation and Reasoning, cont'd

➤ **Reasoning with Large Language Models**

- *LLMs Can't Plan, But Can Help Planning in LLM-Modulo Frameworks.* CoRR abs/2402.01817 (2024)

- *Advancing Spatial Reasoning in Large Language Models: An In-Depth Evaluation and Enhancement Using the StepGame Benchmark.* CoRR abs/2401.03991 (2024)

- *Large Language Models for Mathematical Reasoning: Progresses and Challenges.* CoRR abs/2402.00157 (2024)

- *Efficient Causal Graph Discovery Using Large Language Models.* arXiv:2402.01207 (2024)

- *Contextualization Distillation from Large Language Model for Knowledge Graph Completion.* arXiv:2402.01729 (2024)

- . . .

Knowledge Representation and Reasoning, cont'd

➤ **Normative Reasoning**

- *Obligation as Optimal Goal Satisfaction* (J. Philosophical Logic, 2018)

- *Understanding the Spirit of a Norm: Challenges for Norm-Learning Agents* AI Mag. (2023)

- *Temporal Deontic Action Logic For the Verification of Compliance to Norms in Asp* (ICAIL 2013)

- *Norm Conflict Resolution in Stochastic Domains* (AAAI 2018)

- *A Normative Supervisor for Reinforcement Learning Agents* (CADE, 2021)

- *Multi-Objective Reinforcement Learning for Designing Ethical Environments* (IJCAI 2021)

- *Defeasible Normative Reasoning* (Synthese, 2020)

- *Practical Reasoning with Norms for Autonomous Software Agents* (EAAI, 2017)
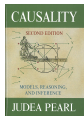
Artificial Intelligence

➤ **Explainability**

- *Explanation in Artificial Intelligence: Insights From the Social Sciences* (AIJ, 2019)

- *xclingo: A System for Explainable Answer Set Programming* (ICLP 2020)

- *Enhancing Ethical Explanations of Large Language Models through Iterative Symbolic Refinement.* arXiv:2402.00745 (2024)

- *Tractable Explanations for d-DNNF Classifiers* (AAAI 2022)

- *On the Computation of Necessary and Sufficient Explanations* (AAAI 2022)

- *An ASP-Based Approach to Counterfactual Explanations for Classification* (RuleML+RR 2020)

Artificial Intelligence, cont'd

➤ **Causality**

- *Causality: Models, Reasoning, Inference.* (J. Pearl, CUP, 2009)

- *Actual Causality* (J. Halpern, MIT Press 2016)

- *A Modification of the Halpern-Pearl Definition of Causality* (IJCAI 2015)

- *On Testing for Discrimination Using Causal Models* (AAAI 2022)

- *Reasoning about Causal Models with Infinitely Many Variables* (AAAI 2022)

Artificial Intelligence, cont'd

➤ **Neuro-Symbolic AI**

- *Logic Tensor Networks* (NESY 2016, IJCAI 2017)
- *Neuro-Symbolic Learning of Answer Set Programs from Raw Data.* IJCAI 2023: 3586-3596
- *Neuro-Symbolic AI for Compliance Checking of Electrical Control Panels* (ArXive 2023)
- *A Symbolic-Neural Reasoning Model for Visual Question Answering* (ICNN, 2023)
- *Knowledge-Based Counterfactual Queries for Visual Question Answering* (AAAI-MAKE 2023)
- *Reliable Natural Language Understanding with Large Language Models and Answer Set Programming* (ICLP 2023)
- *Leveraging Large Language Models to Generate Answer Set Programs.* (KR 2023)
- *Coupling Large Language Models with Logic Programming for Robust and General Reasoning from Text* (arXive 2023)

Artificial Intelligence, cont'd

➤ **AI Classics & Highlights**

- *HAL / 2001: A Space Odyessy*
- *DeepBlue*
- *AlphaGo & Co*
- *Libratus & Pluribus*
- *Sony's Gran Turismo Sophy*^{TM} (ACM SIGAI Industry Award, 2022)
- *Interpretable Machine Learning: Bringing Data Science Out of the "Dark Age"* (Squirrel Award 2022)
- *Kidney/Organ Exchange* (AAAI 2016, AAAI 2012)
  www.cs.cmu.edu/~sandholm/organExchangeTutorials/organExchangeTutorial.aaai16.html
- *AAAI Award for Artificial Intelligence for the Benefit of Humanity*
- *ChatGTP & co*
- ...

Access to papers:

https://owncloud.tuwien.ac.at/index.php/s/j1SE8IdAHWITEEA   password: sem1923

Also possible: similar / related / further topics, your proposal!

Knowledge Representation and Reasoning

➤ **Learning ontologies**

- *Learning Description Logic Ontologies: Five Approaches. Where Do They Stand?* (KI, 2020)

- *Learning Description Logic Concepts: When can Positive and Negative Examples be Separated?* (Funk et al., IJCAI 2019)

➤ **Learning queries and rules**

- *Fitting Algorithms for Conjunctive Queries* (SIGMOD 2024)

- *Inductive logic programming* (Encyc. ML & DM, 2017)
  Inductive logic programming: Theory and methods (JLP 1994)

Practically all things KR can be presented!
https://kr.org/proclist.html

Artificial Intelligence / Knowledge Representation

➤ **Reinforcement learning and Reward Specification**

- *Using Reward Machines for High-Level Task Specification and Decomposition in Reinforcement Learning* (PMLR 2018)

➤ **Reinforcement learning and Rule Learning**
- *Relational Reinforcement Learning* (ML 2001)

Artificial Intelligence / Knowledge Representation
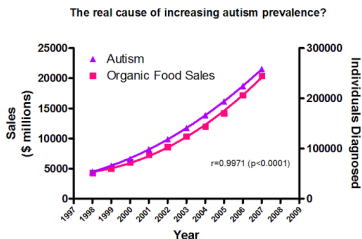
➤ **Reasoning and Planning with LLMs**

- *On the Planning Abilities of Large Language Models - A Critical Investigation* (NeurIPS 2023)

- *Leveraging Pre-trained LLMs to Construct and Utilize World Models for Model-based Task Planning* (NeurIPS 2023)

- *On the Paradox of Learning to Reason from Data* (IJCAI 2023)
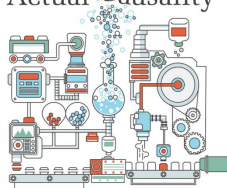
Artificial Intelligence

➤ **Causality**

- *Towards Causal Representation Learning* (Proc. IEEE, 2021)

- *Causal Parrots: Large Language Models May Talk Causality But Are Not Causal* (TMLR 2023)

- *Actual Causality* - one chapter
  `https://direct.mit.edu/books/oa-monograph/3451/`
  `Actual-Causality`

The real cause of increasing autism prevalence?

Sources: Organic Trade Association, 2011 Organic Industry Survey; U.S. Department of Education, Office of Special Education Programs, Data Analysis System (DANS), OMB# 1820-0043 *Children with Disabilities Receiving Special Education Under Part B of the Individuals with Disabilities Education Act

Actual Causality

Joseph Y. Halpern

Artificial Intelligence

➤ **Explainable and Safe AI**

- *Building Ethically Bounded AI* (AAAI 2019)
- *Argumentative XAI: A Survey* (IJCAI 2021)

**Similar topics also possible.
Make your own proposals!**

Theoretical CS

➤ **Formalisms for graph data**

- *PG-Schema: Schemas for Property Graphs*, (Proc./, ACM 2023)

- *GPC: A Pattern Calculus for Property Graphs* (PODS 2023)

- *A Researcher's Digest of GQL*, (ICDT 2023)

`https://www.gqlstandards.org/`

Access to papers:

`https://owncloud.tuwien.ac.at/index.php/s/9Qss2LFaqBQl3OT password: sem1923`

Problem Solving on a Quantum Computer (1)

▶ Barenco et al. *Approximate Quantum Fourier Transform and Decoherence*. https://arxiv.org/abs/quant-ph/9601018

▶ Mosca/Ekert: *The Hidden Subgroup Problem and Eigenvalue Estimation on a Quantum Computer*. https://arxiv.org/abs/quant-ph/9903071

▶ J. Proos, C. Zalka: *Shor's Discrete Logarithm Quantum Algorithm for Elliptic Curves*. https://arxiv.org/abs/quant-ph/0301141   assigned

▶ B. Duan et al.: *A survey on HHL algorithm: From theory to application in quantum machine learning*. Physics Letters A, Volume 384, Issue 24, 2020.

▶ Farhi/Goldstone/Gutmann: *A Quantum Approximate Optimization Algorithm*. https://arxiv.org/abs/1411.4028

▶ The Munich Quantum Toolkit: Theory and Practice
Starting point: https://pypi.org/project/mqt.ddsim/

Problem Solving on a Quantum Computer (2)

➤ van Dam/Seroussi: *Efficient Quantum Algorithms for Estimating Gauss Sums*. https://arxiv.org/pdf/quant-ph/0207131.pdf

➤ Raz/Tal: *Oracle Separation of BQP and PH.* JACM 69(4), 2022
https://dl.acm.org/doi/pdf/10.1145/3313276.3316315