
EXPLOITING STRUCTURE IN DECISION MAKING UNDER THE LENS OF RECENT ADVANCES IN STARAI

[MARCEL GEHRKE](#)¹, NAZLI NUR KARABULUT, FLORIAN MARWITZ, AND TANYA BRAUN²



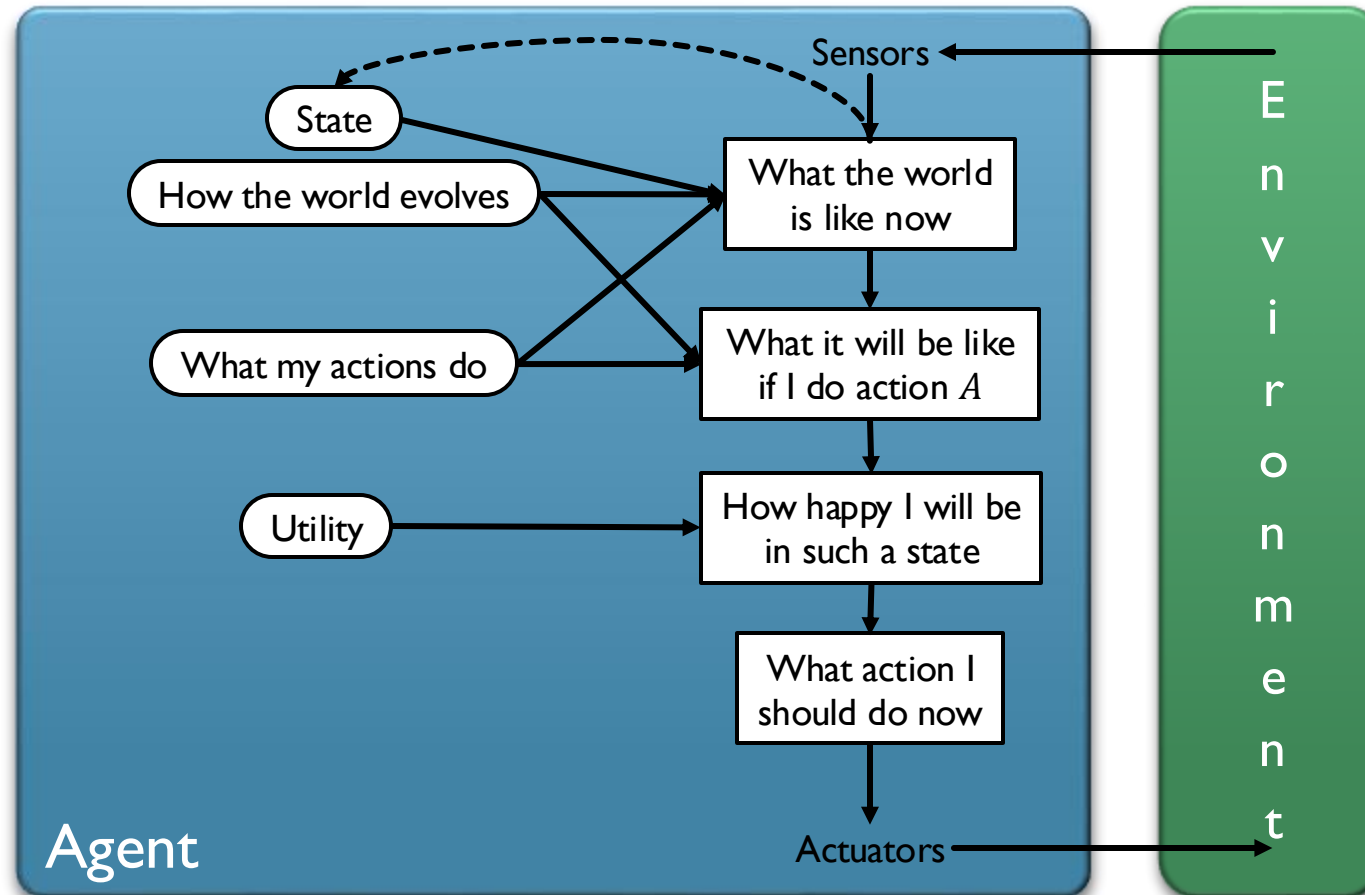
¹Institute of Humanities-Centered Artificial Intelligence, University of Hamburg
²Computer Science Department, University of Münster



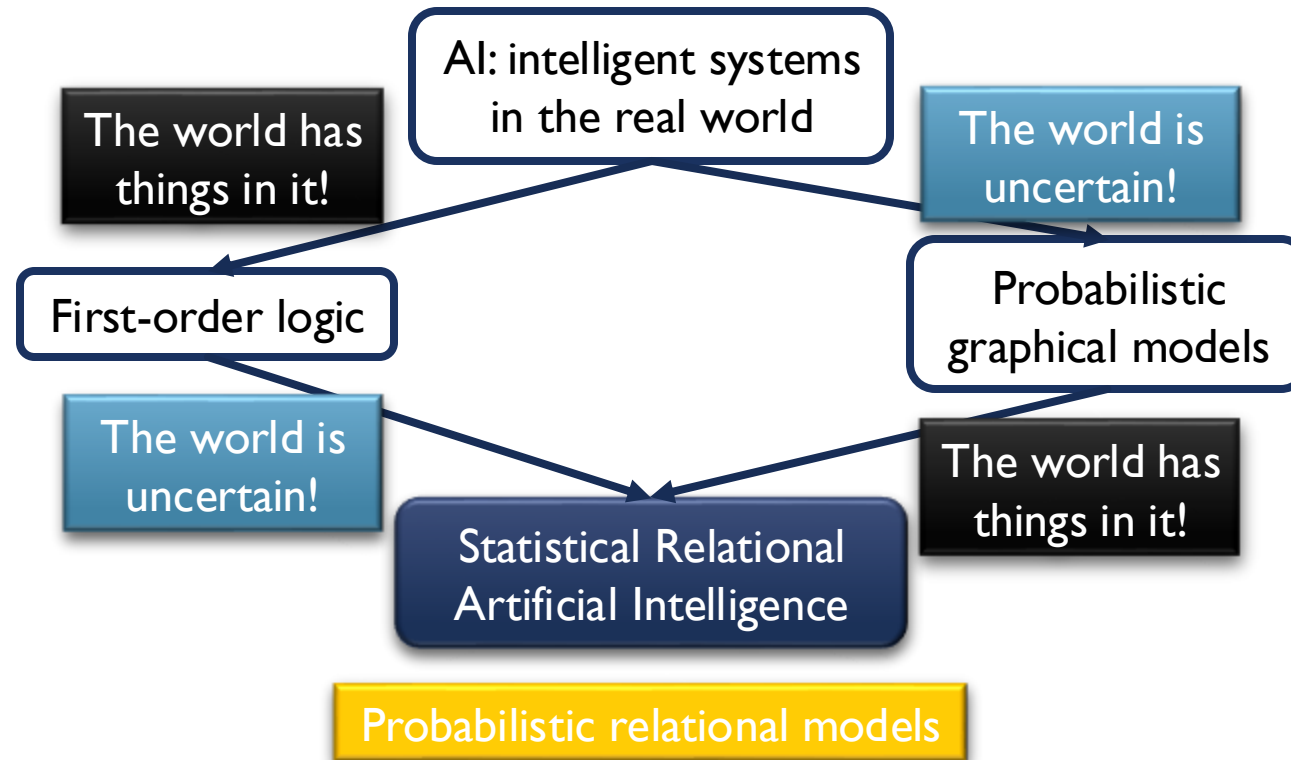
AGENDA

1. Introduction to Relational Models and Online Decision Making [Marcel]
2. Offline Decision Making [Flo]
3. Multi-Agent Decision Making [Nazlı]
4. Summary [Marcel]

GENERAL AGENT SETTING



WHY RELATIONAL DECISION MAKING?



WHAT KINDS OF SYMMETRIES HAVE WE EXPLOITED TODAY

- Symmetries in the state space for a compact encoding
- Symmetries in the value function for efficient computations
- Symmetries in the action space for efficient computations, allowing new query types in reasonable time
- Symmetries between agents for compact encoding and efficient computations

... ARE THESE ALL SYMMETRIES TO CONSIDER?

- Most likely not!
- Symmetries are everywhere. They just have to be recognised and have to be appropriately used.
- Things we have not talked about today:
 - Learning (e.g. benefits of a first-order representation) [Kersting & Nataraj 13]
 - Details about how lifted inference works [Poole 03]
 - How to identify symmetries (e.g. colour-passing algorithm) [Ahmadi et al. 13, Lutterman et al. 24]
 - Explainability, causality, privacy... [Atzmueller et al. 24, Lutterman et al. 24a, Lutterman et al. 24b, G. et al. 24]

Thank you!



For slides, please go to (QR code goes to this address): <https://www.uni-muenster.de/Informatik.AGBraun/en/research/tutorials/ki-24.html>



BIBLIOGRAPHY

ORDERED ALPHABETICALLY

BIBLIOGRAPHY

- **Atzmueller et al. 24**

Martin Atzmueller, Johannes Fürnkranz, Tomáš Kliegr, and Ute Schmid. Explainable and interpretable machine learning and data mining. *Data Mining and Knowledge Discovery*, 2024.

- **Ahmadi et al. 13**

Babak Ahmadi, Kristian Kersting, Martin Mladenov, and Sriraam Natarajan. Exploiting Symmetries for Scaling Loopy Belief Propagation and Relational Training. In *Machine Learning*. 92(1):91-132, 2013

- **G. et al. 24**

Marcel Gehrke, Johannes Liebenow, Esfandiar Mohammadi, and Tanya Braun. Lifting in Support of Privacy-Preserving Probabilistic Inference. *KI - Künstliche Intelligenz*, 2024

- **Kersting & Natarajan 15**

Kristian Kersting and Sriraam Natarajan, *Statistical Relational Artificial Intelligence: From Distributions through Actions to Optimisation*, *KI - Künstliche Intelligenz*, 2015.

BIBLIOGRAPHY

- **Luttermann et al. 24**
Malte Luttermann, Tanya Braun, Ralf Möller, and Marcel Gehrke. Colour Passing Revisited: Lifted Model Construction with Commutative Factors. In AAI-24 Proceedings of the Thirty-Eighth AAI Conference on Artificial Intelligence, 2024.
- **Luttermann et al. 24a**
Malte Luttermann, Mattis Hartwig, Tanya Braun, Ralf Möller, and Marcel Gehrke. Lifted Causal Inference in Relational Domains. In CLear-24 Proceedings of the Third Conference on Causal Learning and Reasoning, 2024
- **Luttermann et al. 24b**
Malte Luttermann, Tanya Braun, Ralf Möller and Marcel. Estimating Causal Effects in Partially Directed Parametric Causal Factor Graphs. In SUM24 Proceedings of the 16th International Conference on Scalable Uncertainty Management, 2024

BIBLIOGRAPHY

- Poole 03

David Poole: First-order Probabilistic Inference. In IJCAI-03 Proceedings of the 18th International Joint Conference on Artificial Intelligence, 2003.

- AMAI, Russel/Norvig

Russell & Norvig: Artificial Intelligence: A Modern Approach. 2020