

# Towards Combining Ontologies and Uncertain Knowledge

Prolog07:  
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SFB/TR8 Spatial Cognition – University of Bremen  
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# Outline

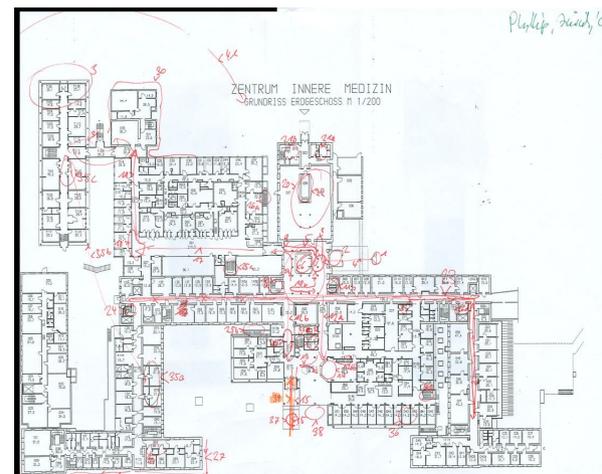


- Motivation
  - Application (Examples)
- Linguistic Ontology
- Spatial Uncertainty
- Ontology + Uncertainty
- Conclusion

# Motivation



- Human-centered spatial assistant systems
  - Natural language dialogues (spatial entities, spatial relations)
  - e.g. tourist guide, architectural design



# Spatial NL Expressions



- Linguistic ontology: [Generalized Upper Model](#)
  - Semantics of natural language
  - Structure influenced by linguistic evidence
  - Representation of spatial relation, location, motion
- Interpretation of semantics relies on:
  - Lexical information
  - Syntax
  - Contextual information

# Spatial NL Expressions



- Utterances not clear/precise enough
- Vary in context, social background
- Various possibilities
  - Purpose, Perspective, Alignment

# Spatial NL Expressions



- Utterances not clear/precise enough
- Vary in context, social background
- Various possibilities
  - Purpose, Perspective, Alignment
- Solutions
  - Asking back: safe, but intrusive
  - Reasoning under uncertainty in ontology
    - How to represent uncertainties in ontologies?

# Ontology vs. Uncertainty



- Ontology
  - “Shared understanding of a domain of interest” (Uschold & Gruninger 1996)
  - “A specific vocabulary used to describe a certain reality” (Guarino 1998)
  - Concepts and relations
  - Subsumption hierarchy
  - Logical Formalization
  - TBox (terminology), ABox (assertions)

# Ontology vs. Uncertainty



- Ontology

- Strict, not uncertain information
- Everything is known because it is well-defined
- In applications:  
Different sources of uncertain or vague information

- TBox (terminology), ABox (assertions)

# Ontology vs. Uncertainty



- Ontology

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Different sources of uncertain or vague information

Distinction between:

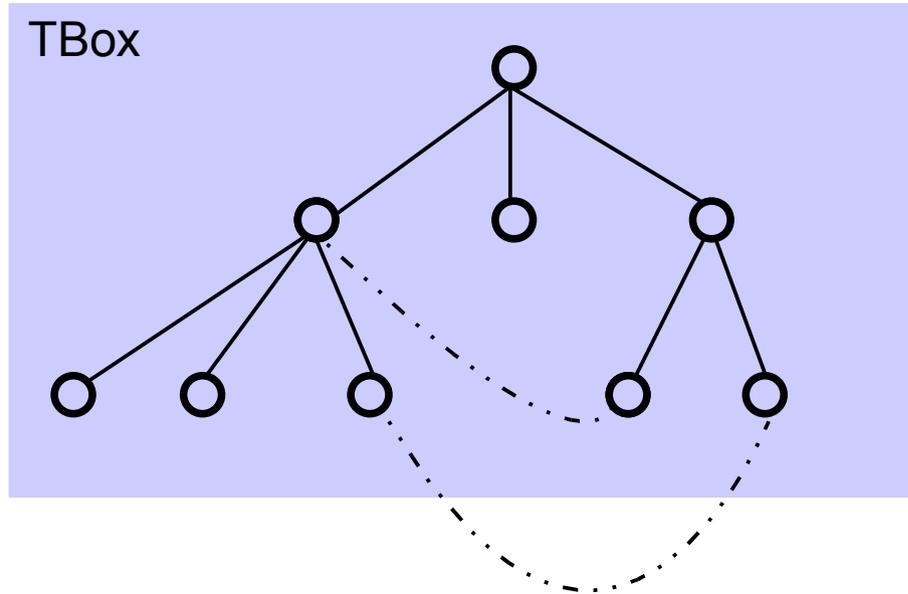
- TBox (terminology), ABox (assertions)

# TBox and ABox

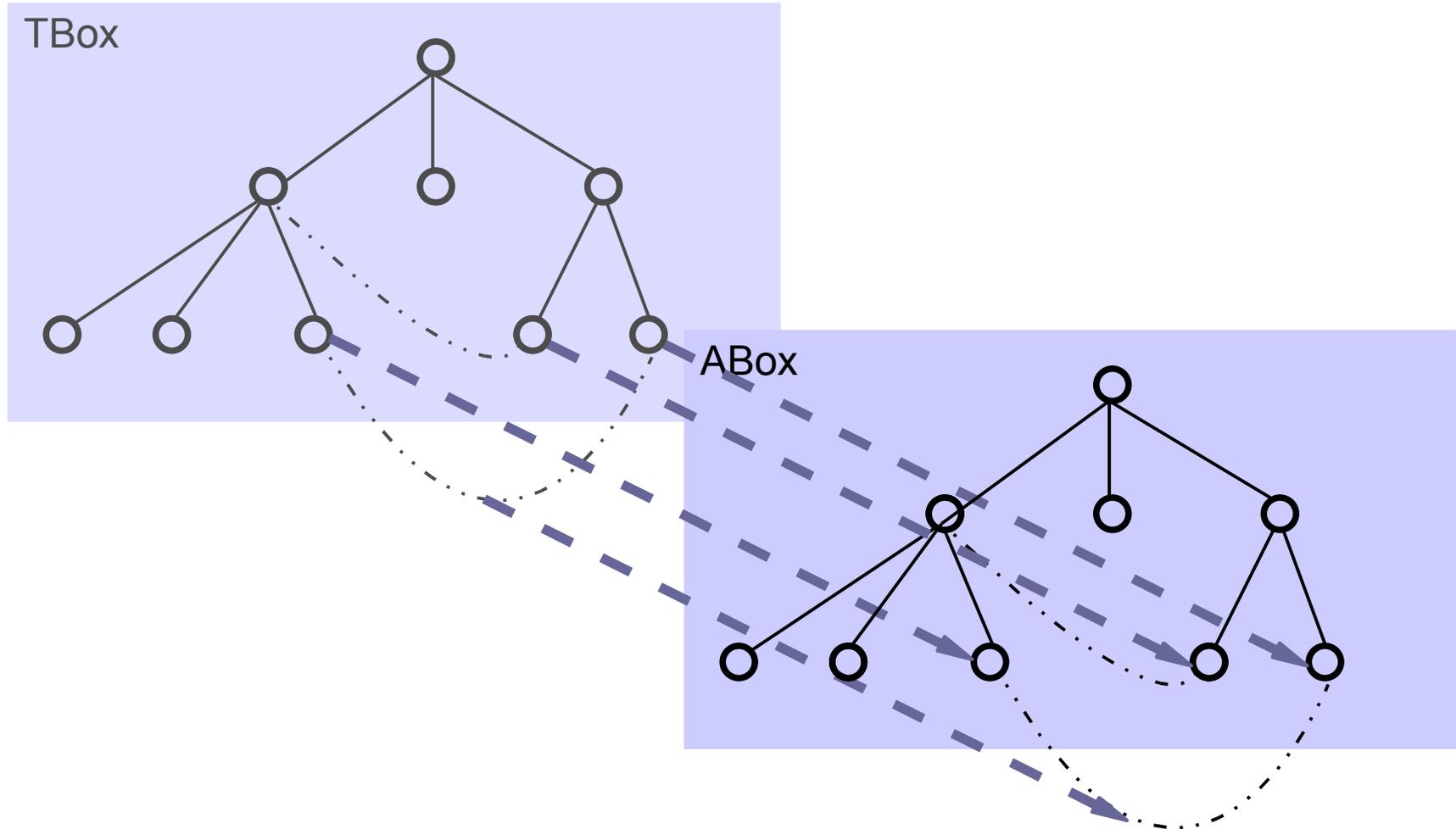


- TBox:
  - Strict, well-defined background knowledge
  - Statements (concepts and relations) about the domain
  - (No probabilities)
- ABox:
  - (imprecise) Knowledge of a situation
  - Facts (instantiations of concepts and relations) about the domain
  - Uncertainties about concept and relation instantiations

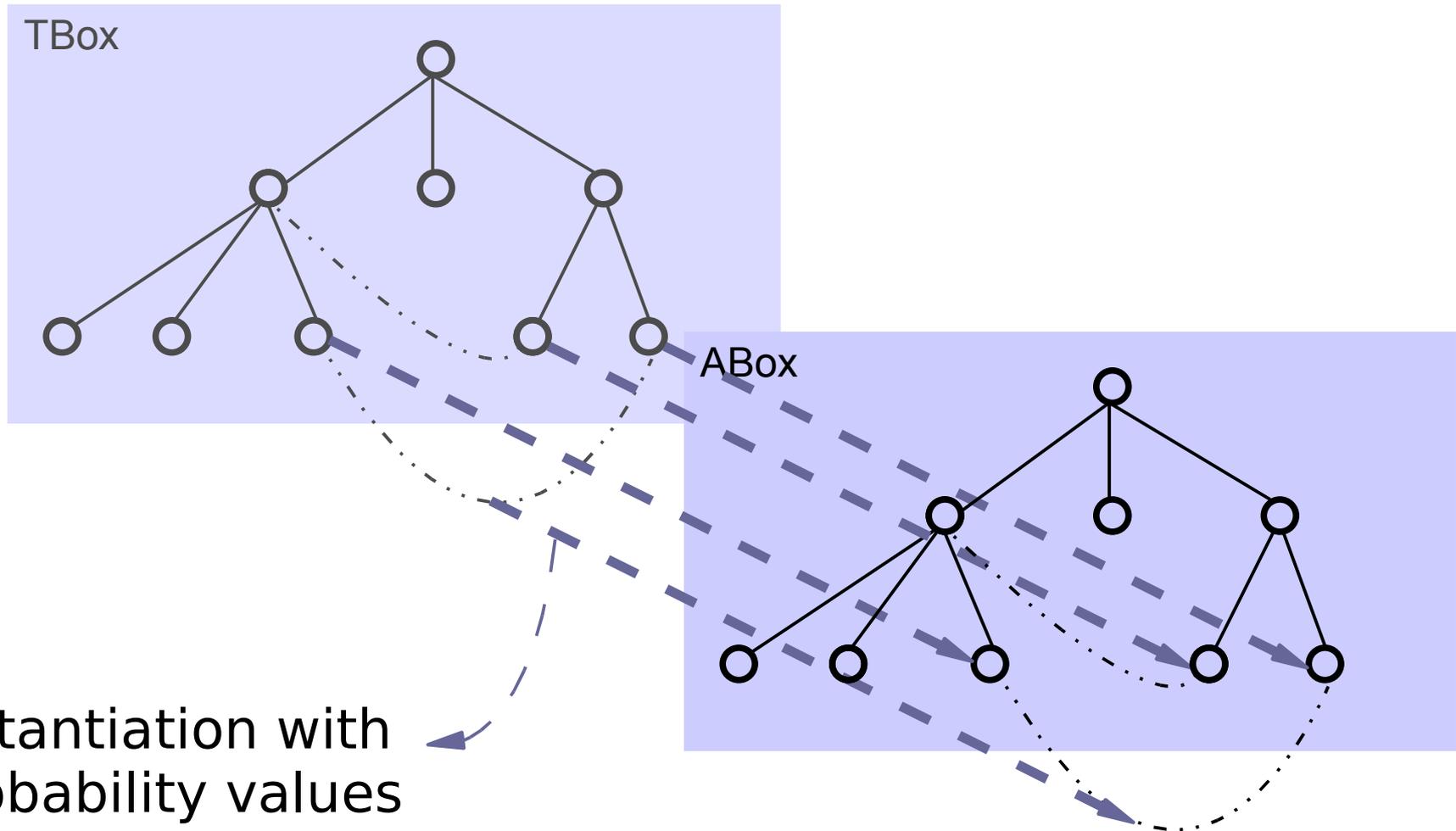
# TBox without Probabilities



# ABox with Probabilities



# ABox with Probabilities



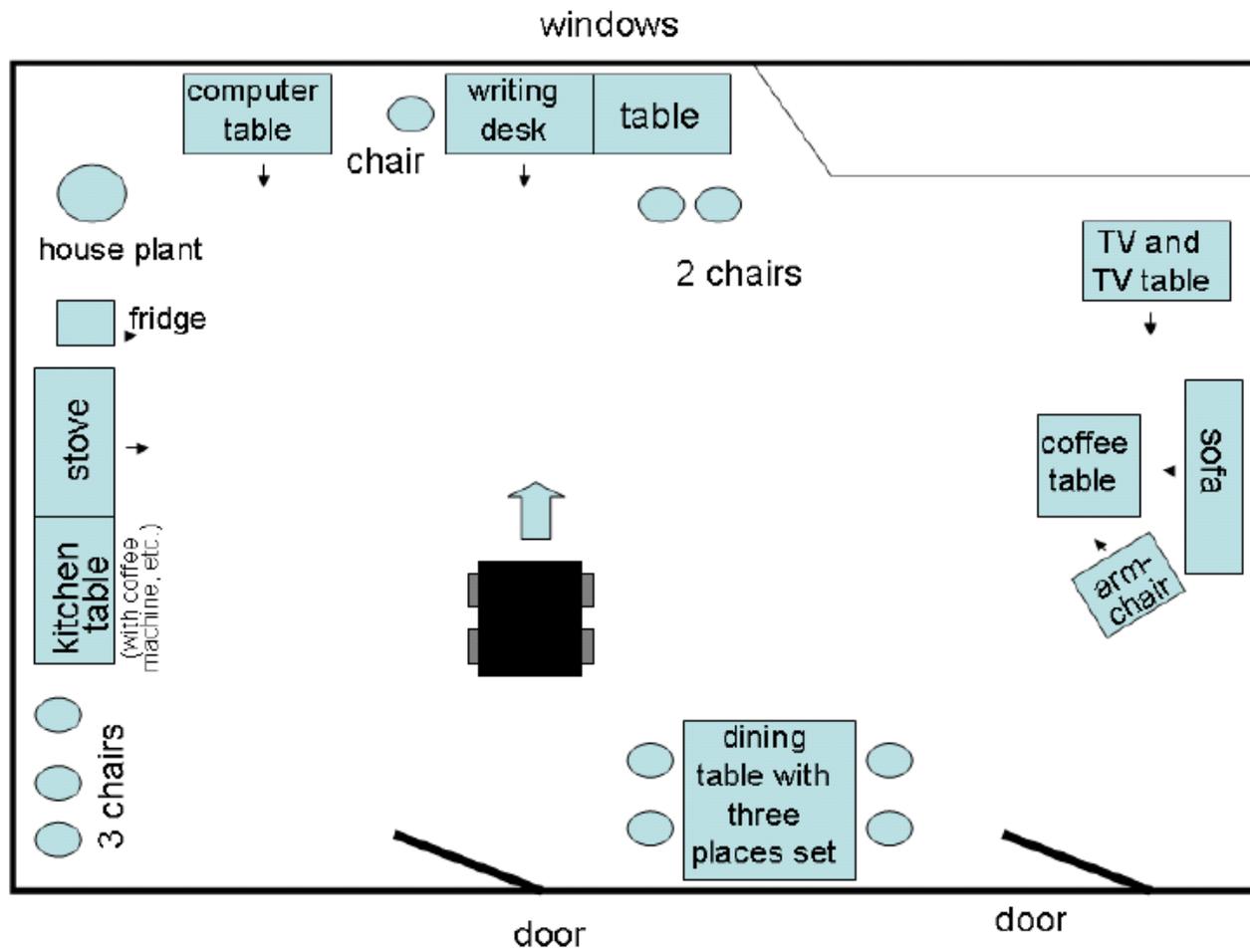
Instantiation with probability values

# ABox probabilities



- Representation of probabilities defined in TBox
- Representation according to context and depending on its semantics
  - (Uncertainty, Impreciseness, Vagueness, Fuzziness, ...)
- Reasoning techniques according to probability
  - Naïve Bayes, Dempster-Shafer, Fuzzy Logic, ...

# Example



# Example

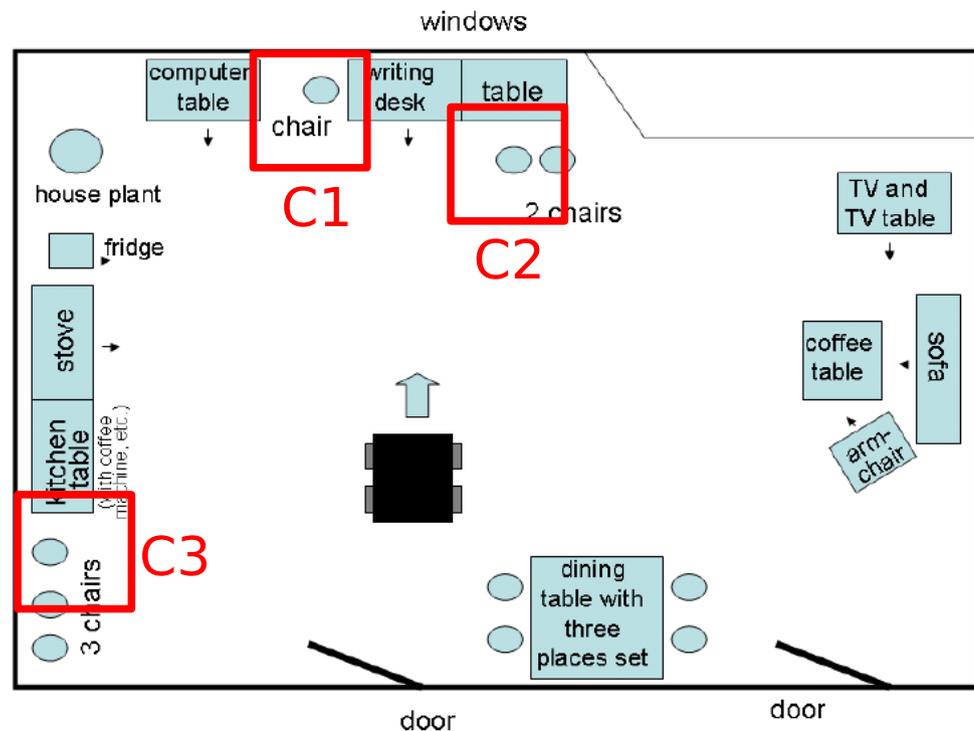


- “Go to the **left chair**”

- $R(C1, \text{“left chair”}, 0.4)$

- $R(C2, \text{“left chair”}, 0.5)$

- $R(C3, \text{“left chair”}, 0.1)$



# Conclusion / Future Work



- TBox defines probabilities of instances and relations
- ABox instantiates concepts and relations together with a probability value
- Integrating probabilities into ontologies
- Discriminating between reasoning techniques
- Evaluation