Part 7
Reasoning tasks and their reducibility

Jostein Solaas   Håkon Dissen

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• Queries and reasoning on DLs
• Will look at a few problems
• Some can be reduced to each other
• KB is satisfiable iff there exists an $I$ such that $I \models KB$
• Otherwise contradictory (unsatisfiable)
• Principle of explosion
Axiom Entailment

- We want to check if a statement $\alpha$ entailed by the KB
- Proof by contradiction
- We have $\alpha$, $\beta$ and $KB$
- $\beta$ is the opposite of $\alpha$
- Lets use Satisfiability
- Iff the $KB \cup \{\beta\}$ is unsatisfiable KB entails $\alpha$
• If $C$ may contain individuals, it is satisfiable
• Could signal modeling errors
• There exists a model for $C$ that makes $C^I \neq \emptyset$
• Can be reduced to axiom entailment
• $KB \models C \sqsubseteq \bot$
The task of retrieving all instances of concept C

Two problems:
  - Many models that can differ on the class of an individual
  - Models may vary, and may not even contain the same individuals

Two solutions:
  - Retrieve only if individual belongs to C for each model of KB
  - Only retrieve named individuals

The problem can be formulated as $KB \models C(a)$
Classification

- Seeks to create a hierarchy of subsumption relationships of concepts
- Defines $\sqsubseteq_{KB}$ by $A \sqsubseteq_{KB} B$ iff $KB \models A \sqsubseteq B$
- $\sqsubseteq_{KB}$ is a preorder, which makes it faster to calculate
- Helps in the KB modeling phase
- Preprocessing for subsequent KB work
Conjunctive Query Answering

- Sequence of logical ands
- Query either returns true/false or tuples with individuals
  - $\exists y \exists z (\text{childOf}(x, y) \land \text{childOf}(x, z) \land \text{married}(y, z))$
  - $\exists x \exists y \exists z (\text{childOf}(x, y) \land \text{childOf}(x, z) \land \text{married}(y, z))$
- Not polynomial
Other Reasoning Tasks

- Induction
  - Generalize facts
- Abduction
  - Given $KB$ and $\alpha$, guess $KB \cup KB' \models \alpha$
- Explanation
  - Given $KB \models \alpha$ find $KB' \subset KB$ such that $KB' \models \alpha$ while $KB'' \subset KB'$ and $KB'' \not\models \alpha$
- Module Extraction
  - Find smaller KBs in a large KB