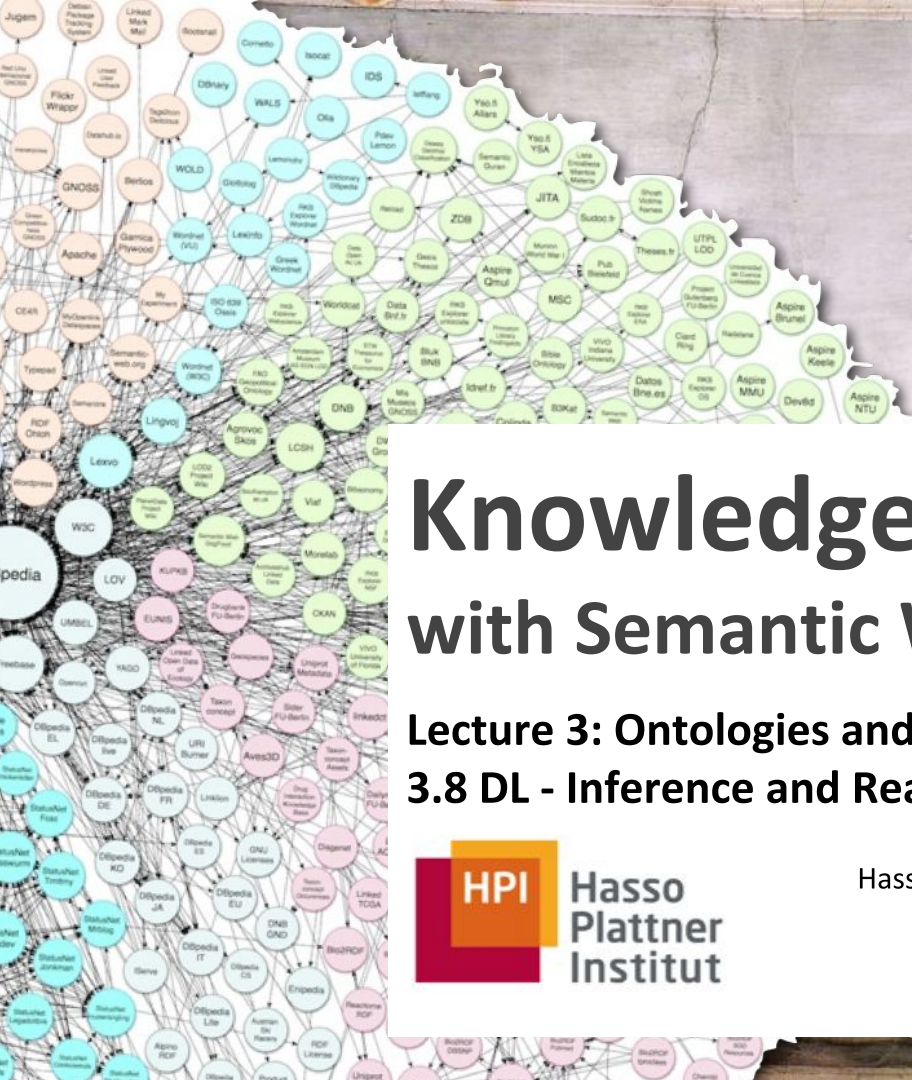




Knowledge Engineering with Semantic Web Technologies

Lecture 3: Ontologies and Logic 3.8 DL - Inference and Reasoning



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Autumn 2015



General DL Architecture

DL Knowledge Base

TBox

$\mathcal{T}$

Terminological Knowledge

Knowledge about concepts of a domain

$\text{Writer} \sqsubseteq \text{Person} \sqcap \exists \text{author. Book}$

ABox

$\mathcal{A}$

Assertional Knowledge

Knowledge about Individuals / Entities

$\text{Writer}(\text{GeorgeOrwell})$

$\text{author}(\text{AnimalFarm}, \text{GeorgeOrwell})$

RBox

$\mathcal{R}$

Role-centric Knowledge

Knowledge about roles interdependencies

$\text{coAuthor} \sqsubseteq \text{author}$

Inference Engine

Interface

Problems of Inference (1)

- Global (In)Consistency of the knowledge base

$KB \models \perp?$

- *Does the knowledge base make sense?*

- Class(in)consistency

$C \equiv \perp ?$

- *Must class C be empty?*

- Class inclusion (Subsumption)

$C \sqsubseteq D?$

- *Structuring the knowledge base*

- Class equivalency

$C \equiv D?$

- *Are two classes the same?*

Problems of Inference (2)

- Class disjointness
 - *Are two classes disjoint?*
- Class membership
 - *Is individual a contained in class C?*
- Instance generation (Retrieval)
 - *Find all (known!) Individuals of class C.*

$$C \sqcap D = \perp?$$

$$C(a)?$$

„find all x with $C(x)$ “

Decidability and DLs

- **DLs** (most times) are decidable fragments of FOL
- Therefore, **FOL inference algorithms** (e.g. Tableaux algorithm) can also be used for DL, but must be adapted for **DLs** to guarantee termination
(for the lecture we will restrict to $\mathcal{ALC}$ tableaux algorithm)
- In general, the tableaux algorithm shows the **unsatisfiability** of a theory (knowledge base)
- Therefore, we have to adapt the introduced entailment problems to the **detection of contradictions in the knowledge base**, i.e. proof of the **unsatisfiability** of the knowledge base!

Reduction to Unsatisfiability (1)

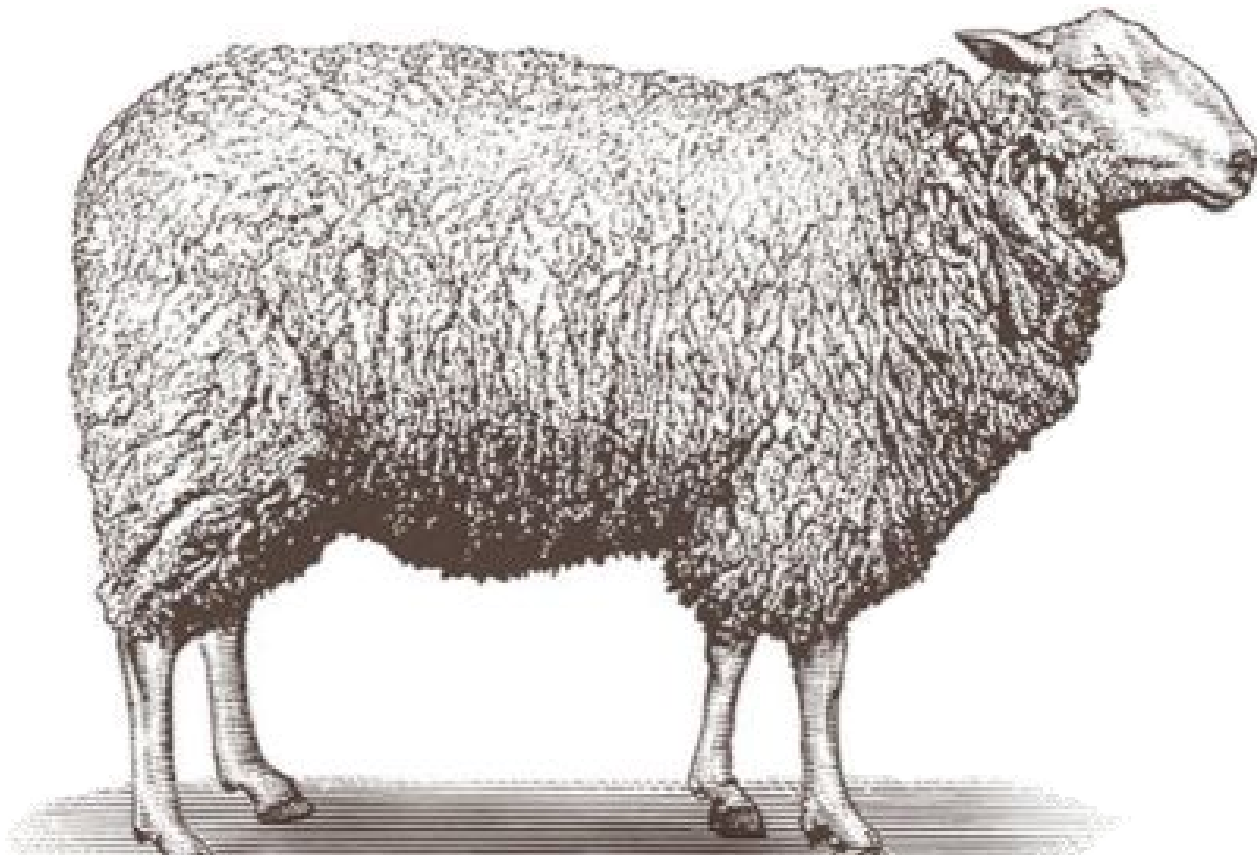
- Class (in)consistency $C \equiv \perp$
 - iff $\text{KB} \cup \{C(a)\}$ unsatisfiable (a new)
- Class inclusion (Subsumption) $C \sqsubseteq D$
 - iff $\text{KB} \cup \{(C \sqcap \neg D)(a)\}$ unsatisfiable (a new)
- Class equivalency $C \equiv D$
 - iff $C \sqsubseteq D$ and $D \sqsubseteq C$

Reduction to Unsatisfiability (2)

- Class disjunctness $C \sqcap D = \perp$
 - iff $\text{KB} \cup \{ (C \sqcap D)(a) \}$ unsatisfiable (a new)
- Class membership $C(a)$
 - iff $\text{KB} \cup \{ \neg C(a) \}$ unsatisfiable
- Instance generation (Retrieval) „find all x with $C(x)$ “
 - *Check class membership for all individuals*

Inference Problems and DLs

- If the **Tableaux Algorithm** (or similar algorithms) is used for **DL Reasoning**:
 - we have to adapt the reasoning problems to the **detection of contradictions in a knowledge base**,
i.e. we have to prove the **unsatisfiability of a knowledge base**



09: DLs and the Open World Assumption

OpenHPI - Course Knowledge Engineering with Semantic Web Technologies

Lecture 3: Ontologies and Logic