Approximate Deduction

This material by
Holger Wache
(VU, Knowledge Web)
Approximation (in Semantic Web System)

- DL-Reasoning in EXPTIME (OWL DL in NEXPTIME)
Approximation Approaches

- Language Weakening
- Knowledge Compilation
- Approximate Deduction

Input ➔ Output
Approximate Deduction through Simplification

- Simplify query
- Simple query \(\Rightarrow\) fast query answering
- Simple query \(\Rightarrow\) approximated answers
- Incremental completion of the query
- Anytime behavior
How to simplify?

Rewrite some parts (e.g. $\Phi$, $\Psi$)

Query = $\ldots \bigcap \ldots \bigcap (\ldots \bigcup \ldots \bigcup \ldots)$

Cadoli-Schaerf-Approximation

$C_i^\top : \exists R.C \rightarrow \top$

$C_i^\bot : \exists R.C \rightarrow \bot$
Cadoli-Schaerf-Approximation for DLs

- Depth of subconcept $D$: number of universal quantifiers that have $D$ in its scope.

\[(\exists \text{friend.tall}) \sqcap \forall \text{friend.}((\forall \text{friend.doctor}) \sqcap \exists \text{friend.} \neg \text{doctor})\]

- Depth: 0
- Depth: 2
- Depth: 1
Approximation Approaches

- Language Weakening
- Knowledge Compilation
- Approximate Deduction
Approximation through Language Weakening

T-Box
OWL-FULL
OWL-DLP

OWL-DLP
DLP-Reasoning

Input

Ontology

DL-Reasoning

Output

A-Box
Role-free
DataBase Queries
Approximation Approaches

- Language Weakening

- Knowledge Compilation

- Approximate Deduction

Input ➔ Ontology ➔ Output
Approximation through Knowledge Compilation
Approximation through Knowledge Compilation

1. Get rid of nominals. [language weakening]
2. Translate into clausal form.
3. Saturate TBox+RBox by taking all consequences. [compilation]
4. Eliminate function symbols.

- Compile
  - OWL-DL ⇒ Disjunctive LP
  - Complete but incorrect

- Deduce
  - regarding disjunctive heads of rules as conjunctions
  - Use SLD resolution
Approximation through Knowledge Compilation

1. Get rid of nominals. [Language weakening]
2. Translate into clausal form.
3. Saturate TBox+RBox by taking all consequences. [Compilation]
4. Eliminate function symbols.

- Compile
  - OWL-DL \(\Rightarrow\) Disjunctive LP
  - Complete but incorrect

- Deduce
  - regarding disjunctive heads of rules as conjunctions
  - Use SLD resolution
  - Complete but incorrect