Description Logic Programs: Overview for DAML and WebOnt

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Motivation from "DAML Rules" effort

• Goal: the hybridization of DAML+OIL/OWL with Logic Program rules
  – original aim: extend expressiveness of DAML KR beyond DAML+OIL/OWL.

• for defining ontologies, and for rules plus ontologies
  – current thrust focuses on Description Logic Programs as KR
Motivation from Semantic Web “Stack”

[Diagram http://www.w3.org/DesignIssues/diagrams/sw-stack-2002.png is courtesy Tim Berners-Lee]
Motivation from DAML-Services

- Rule-based Semantic Web Services (RSWS)
- Application Scenarios
- For details, see the full Rules Report presentation by Benjamin Grosof from the DAML PI Meeting.
**Description Logic Programs (DLP)**

- **Status**: [Grosof & Horrocks 10/02] working paper, Joint Committee discussions, including early use cases.

- **Goal**: understand relationship between DL and LP/HornFOL as KR's
  - **Insight**: expressive intersection is also a key to expressive combination/union

- **1st step**: expressive intersection of DL and Logic Programs = "Description Logic Programs" (or "Description Rules")
Venn Diagram: Expressive Overlaps among KR’s

- First-Order Logic
- Description Logic
- Horn Logic Programs

Description Programs
(Negation As Failure)

Logic Programs
(Procedural Attachments)
LP as a superset of DLP

• “Full” LP, including with non-monotonicity and procedural attachments, can thus be viewed as including an “ontology sub-language”, namely the DLP subset of DL.
Candidate: First Order Logic

- FOL has practical and expressive drawbacks for union of DL and Rules:
  - Undecidable/Intractable
  - Lacks non-monotonicity and procedural attachments
  - Unfamiliar to mainstream software engineers

- Variant of DLP: “Horn Description Logic (HDL)”
  - Intersection of Horn Logic and Description Logic
  - Subset of FOL

- (general concept of “Description Rules”: covers DLP or HDL)
Overview of DLP Features

- Essentially, DLP captures RDFS subset of DL -- plus a bit more.
- RDFS subset of DL permits the following statements:
  - Class C is Subclass of class D.
  - Domain of property P is class C.
  - Range restriction on property P is class D.
  - Property P is Subproperty of property Q.
  - a is an instance of class C.
  - (a,b) is an instance of property P.
- DLP also captures:
  - Using the Intersection connective (conjunction) in class descriptions
  - Stating that a property P is Transitive.
  - Stating that a property P is Symmetric.
- DLP can partially capture: most other DL features.
- Relevant technical issues in LP:
  - treatment of equality, e.g., uniqueness of names.
Examples of DL beyond DLP

• DLP is a *strict* subset of DL.

• Examples of DL that is not (completely) representable in DLP:
  – State a subclass of a complex class expression which is a disjunction. E.g.,
    • \((\text{Human} \cap \text{Adult}) \subseteq (\text{Man} \cup \text{Woman})\)
  – State a subclass of a complex class expression which is an existential. E.g.,
    • \(\text{Radio} \subseteq \exists \text{hasPart.Tuner}\)

• Why not? Because: LP/Horn, and thus DLP, cannot represent a disjunction or existential in the head.
Examples of LP beyond DLP

- DLP is a strict subset of Horn LP.
- Examples of Horn LP that are not (completely) representable in DLP:
  - A rule involving multiple variables. E.g.,
  - Chaining (besides simple transitivity) to derive values of Properties. E.g.,
- Why not? Essentially because: Decidability of DLs crucially dependent on tree model property.
  - Intuition: DL’s not used to represent “more than one free variable at a time”.

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Benefits: What DLP Enables, in Principle

• LP rules "on top of" DL ontologies.

• Translation of LP rules to/from DL ontologies.

• Use of efficient LP rule/DBMS engines for DL fragment.

• Development of ontologies in LP.
• Development of rules in DL.

• Translation of LP conclusions to DL.
• Translation of DL conclusions to LP.
Related Work to DLP

- CARIN [Halevy & Rousset 1998] on extending DL with some aspects of LP. Focus is on querying DL style KBs.

- [Antoniou 2002] on Defeasible Logic rules + Description Logic (variant) ontologies.