INF3580 – Semantic Technologies – Spring 2010

Lecture 7: The Jena Inference system. OWL introduction

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Today's Plan

1. Jena inference support
2. Using the built-in reasoners
3. Using an external reasoner
4. Simple reasoner configuration
5. Introduction to OWL

Outline

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  - using `ModelFactory.createInfModel(reasoner, model)`

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Generic rule reasoner: A rule-based reasoner that supports user defined rules.

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- `ReasonerRegistry.getTransitiveReasoner()`

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This abstract two-step procedure will be the default, since;

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- And since it is suitable for built-in and external reasoners alike

Accessing all built-in reasoners

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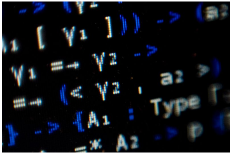

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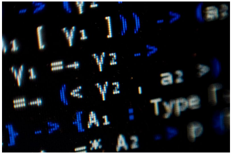

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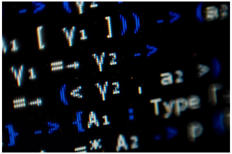

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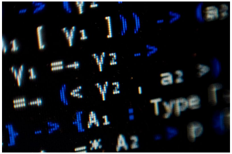

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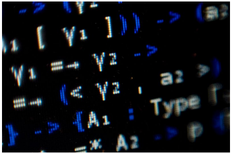

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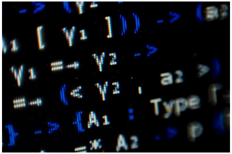

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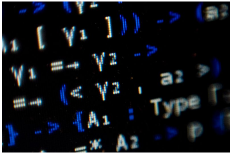

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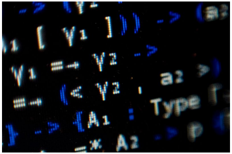

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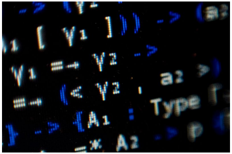

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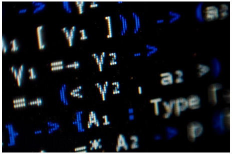

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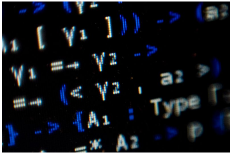

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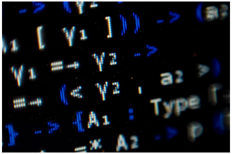

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  - and is usually replaced with `null`.

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Querying the inventory

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PREFIX jr:  <http://jena.hpl.hp.com/2003/JenaReasoner#>
PREFIX rdf:  <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?reasoner ?desc WHERE {
    ?reasoner rdf:type jr:ReasonerClass .
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```

InfModels by lookup

Reasoners and descriptions

reasoner	desc
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jr:TransitiveReasoner	"Provides reflexive-transitive closure of subClassOf ..."
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jr:DAMLMicroReasonerFactory	"RDFS rule set with small extensions to support DAML"

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contd.

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  - Likely to change with new releases of Jena.

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External reasoners are are best manipulated directly, that is

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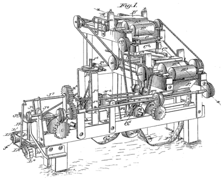

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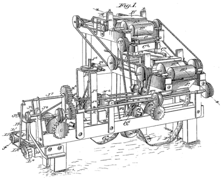

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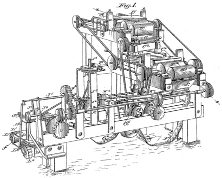

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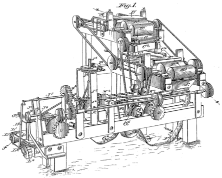

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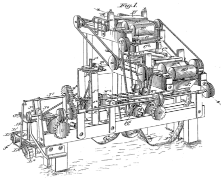

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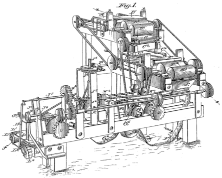

External reasoners can be combined with `InfModels` and `OntModels` alike.

contd.

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contd.

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Using Pellet with an `InfModel`

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Reasoner reas = PelletReasonerFactory.theInstance().create();
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Using Pellet with an OntModel

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OntModelSpec spec = new OntModelSpec(OntModelSpec.OWL_DL_MEM);
OntModel ont = ModelFactory.createOntologyModel(spec, mod);
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  - from conclusions to premises (so-called backwards chaining),
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- it is no longer convenient to use the convenience methods in `ModelFactory`.

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Binding Pellet to schema

```
Reasoner r = PelletReasonerFactory.theInstance().create();
Reasoner custom = r.bindSchema(schema);
InfModel inf = ModelFactory.createInfModel(custom, data);
```

A very simple taxonomy

Consider again the RDFS ontology given by:

```
ex:KillerWhale a rdfs:Class .
ex:Mammal a rdfs:Class .
ex:Vertebrate a rdfs:Class .

ex:KillerWhale rdfs:subClassOf ex:Mammal .
ex:Mammal rdfs:subClassOf ex:Vertebrate .
```

And suppose we assert:

```
ex:Keiko a ex:KillerWhale .
```

Tracing the derivations could be useful for

- debugging,
- automatic explanation.

Logging derivations

Telling the reasoner to log derivations

```
Reasoner r = ReasonerRegistry.getRDFSReasoner();
r.setDerivationLogging(true);
```

Printing derivations

```
PrintWriter out = new PrintWriter(System.out);
StmtIterator it = inf.listStatements();

while(it.hasNext()){
  Statement stat = (Statement) it.next();
  for(Iterator id = inf.getDerivation(stat);id.hasNext();){
    Derivation deriv = (Derivation) id.next();
    deriv.printTrace(out, true);
  }
}
```

A sample trace

```
Rule rdfs9-alt concluded (ex:Keiko rdf:type ex:Vertebrate) <-
   Fact (ex:KillerWhale rdfs:subClassOf ex:Vertebrate)
   Rule rdfs9-alt concluded (ex:Keiko rdf:type ex:KillerWhale) <-
       Fact (ex:KillerWhale rdfs:subClassOf ex:KillerWhale)
       Known (ex:Keiko rdf:type ex:KillerWhale) - already shown
```

Outline

Quick facts

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- DLs have well-understood and attractive computational properties.

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  - OWL 2 RL:
    - Designed for compatibility with rule-based inference tools.

The $\mathcal{ALEC}$ fragment of OWL

$\mathcal{ALEC}$ In DL-notation

$$
\begin{array}{rlcl}
C, D \rightarrow & A & \mid & \text{(atomic concept)} \\
& \top & \mid & \text{(universal concept)} \\
& \bot & \mid & \text{(bottom concept)} \\
& \neg C & \mid & \text{(atomic negation)} \\
& C \sqcap D & \mid & \text{(intersection)} \\
& \forall R.C & \mid & \text{(value restriction)} \\
& \exists R.C & \mid & \text{(existential restriction)}
\end{array}
$$

Semantics

$\mathcal{ALEC}$ in DL-notation

$$
\begin{aligned}
\top^{\mathcal{I}} &= \Delta^{\mathcal{I}} \\
\bot^{\mathcal{I}} &= \emptyset \\
(\neg C)^{\mathcal{I}} &= \Delta^{\mathcal{I}} \setminus C^{\mathcal{I}} \\
(C \sqcap D)^{\mathcal{I}} &= C^{\mathcal{I}} \cap D^{\mathcal{I}} \\
(\forall R.C)^{\mathcal{I}} &= \{a \in \Delta^{\mathcal{I}} \mid \forall b (a,b) \in R^{\mathcal{I}} \rightarrow b \in C^{\mathcal{I}}\} \\
(\exists R.C)^{\mathcal{I}} &= \{a \in \Delta^{\mathcal{I}} \mid \exists b (a,b) \in R^{\mathcal{I}} \wedge b \in C^{\mathcal{I}}\}
\end{aligned}
$$

OWL ontologies in DL-notation

$$
\begin{aligned}
Cystic\_Fibrosis &\equiv Fibrosis \sqcap \exists locatedIn.Pancreas \\
Genetic\_Fibrosis &\sqsubseteq Genetic\_Disorder \\
Fibrosis \sqcap \exists locatedIn.Pancreas &\sqsubseteq Genetic\_Fibrosis
\end{aligned}
$$

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   - That is, it has a propositional logic as a fragment.
3. Full propositional negation facilitates consistency checking.

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  - If a thing has a lawyer child,
  - and that thing is a woman,
  - then that thing is a proud mother

Existential restrictions in Turtle syntax

Lawyer children

```
[a  owl:Restriction;
    owl:onProperty :hasChild:
    owl:somValuesFrom :Lawyer] .
```

- `owl:Restriction` signals a class description,

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- The description is a blank node, since it has no name.

Existential restrictions illustrated

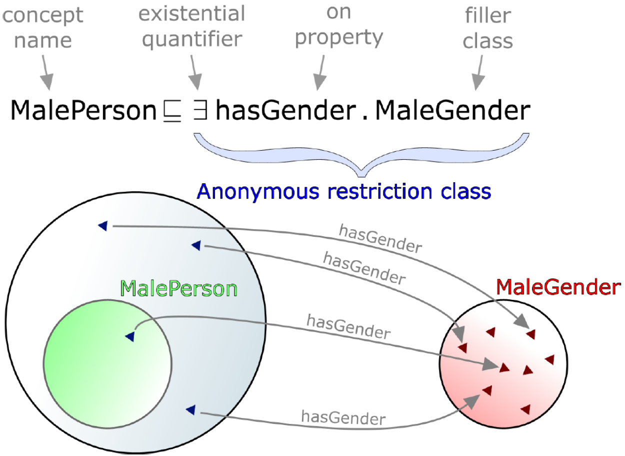

Figure: Existential restrictions. From Julian Seidenberg "Web Ontology Segmentation: Extraction, Transformation, Evaluation"

Horisontal relations between classes

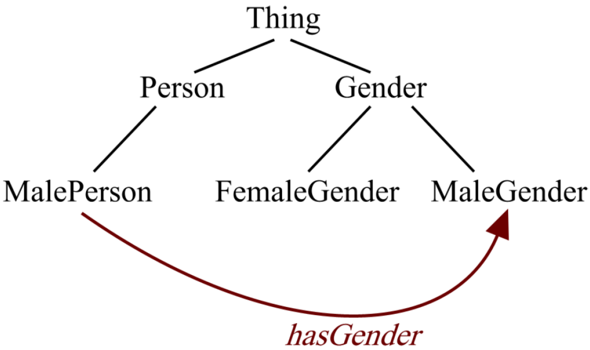

Figure: Existential restrictions relate classes (from Julian Seidenberg "Web Ontology Segmentation: Extraction, Transformation, Evaluation")

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Suppose we assert:

1. `:OsloPhilharmonic :conductor :Saraste .`

And we say that

2. $\texttt{Orchestra} \equiv \exists \texttt{conductor}.\top \sqcap \exists \texttt{hasInstrument}.\top$

Then from [1.] we may infer that

3. `:OsloPhilharmonic a :Orchestra .`
4. `:OsloPhilharmonic :hasInstrument _:x .`

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- then we know that
  - `:MusicaAntiqua a :ChurchEnsemble .` (nope)

Existential restrictions in OntModels

Implementing the example

```
OntModel m = ModelFactory.createOntologyModel(OntModelSpec.OWL_DL_MEM);
OntClass c = m.createClass("ex:Cantor");
OntClass e = m.createClass("ex:ChurchEnsemble");
ObjectProperty cond = m.createObjectProperty("ex:conductor");

// null denotes the URI in an anonymous restriction
SomeValuesFromRestriction r = m.createSomeValuesFromRestriction(null, cond, c);
Statement stmt = model.createStatement(r,OWL.subClassOf, e);

model.add(stmt);
```

More about this later

Supplementary reading

- The Jena ontology API:
- Jena Inference Engine user manual:
- Using a DIG Description Logic reasoner with Jena:

All available from the Jena website.