Modularity for Ontology Development, Maintenance and Reuse

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Ian Horrocks and Ulrike Sattler)

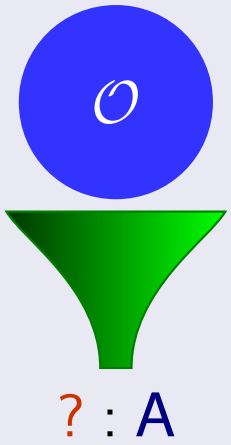
The University of Oxford

November 6, 2007

Classical Reasoning Support for Ontologies

- Provides engine for querying of ontologies ➤ Birte's talk

Ontology



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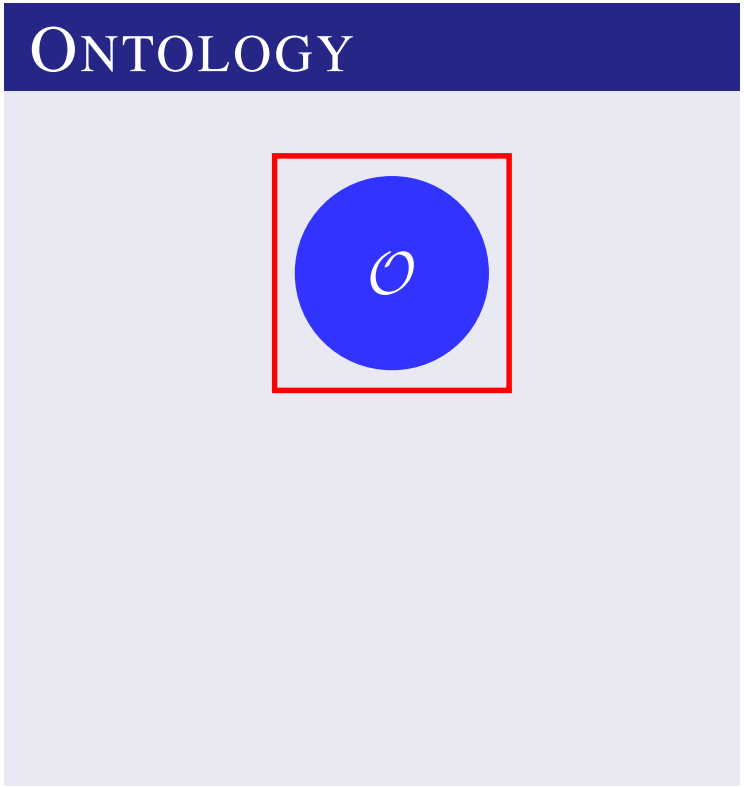
- Provides tools for ontology development:



Classical Reasoning Support for Ontologies

- Provides engine for querying of ontologies ➤ Birte's talk
- Provides tools for ontology development:
  - ✔ Checking global consistency

Ontology

$$\mathsf{Male} \sqcap \mathsf{Female} \sqsubseteq \bot$$

$$\mathsf{Sam} : \mathsf{Male}$$

$$\mathsf{Sam} : \mathsf{Female}$$

$$\models \bot$$

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- Provides engine for querying of ontologies ➤ Birte's talk
- Provides tools for ontology development:
  - ✔ Checking global consistency
  - ✔ Detecting unsatisfiable classes

Ontology

$$\mathsf{Male} \sqcap \mathsf{Female} \sqsubseteq \bot$$

$$\mathsf{Hermaphrodite} \sqsubseteq \mathsf{Male} \sqcap \mathsf{Female}$$

$$\models \mathit{Hermaphrodite} \sqsubseteq \bot$$

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- Provides tools for ontology development:
  - ✔ Checking global consistency
  - ✔ Detecting unsatisfiable classes
  - ✔ Detecting unintended subsumptions

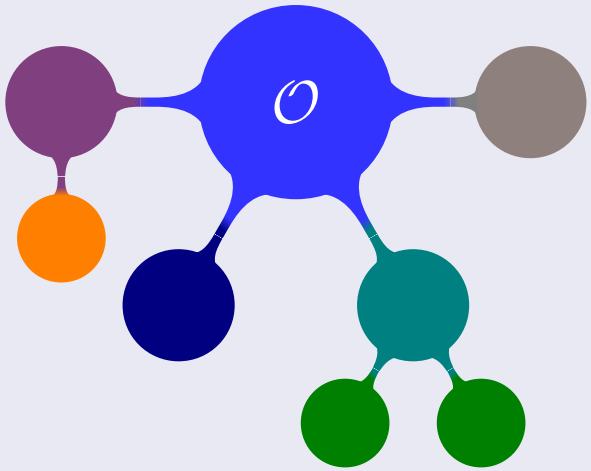
Ontology

$$\mathsf{Man} \equiv \mathsf{Male} \sqcup \mathsf{Female}$$
$$\mathsf{Man} \equiv \mathsf{Male}$$
$$\models \mathit{Female} \sqsubseteq \mathit{Male}$$

Classical Reasoning Support for Ontologies

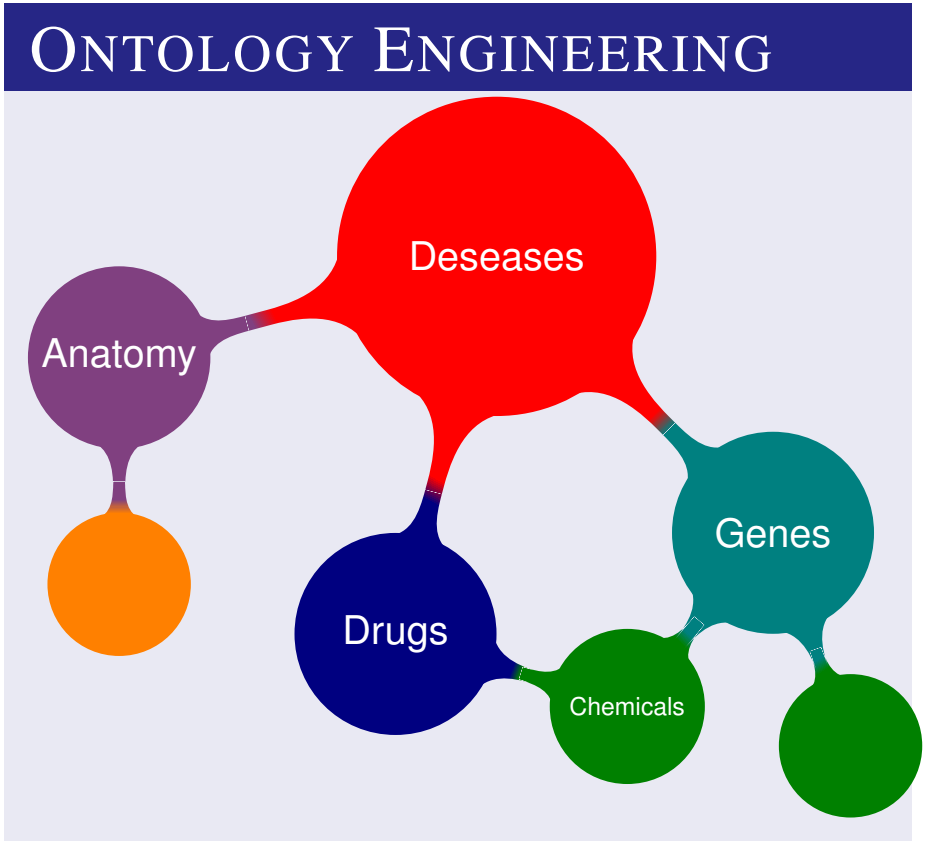
- Provides engine for querying of ontologies ➤ Birte's talk
- Provides tools for ontology development:
  - ✔ Checking global consistency
  - ✔ Detecting unsatisfiable classes
  - ✔ Detecting unintended subsumptions
- Not sufficient for large-scale ontology development

Ontology



Ontology Engineering at the Large Scale

- Collaborative development
- Involves experts in different fields
- Continuous process
- The notion of modularity becomes apparent



Ontology Engineering at the Large Scale

- Collaborative development
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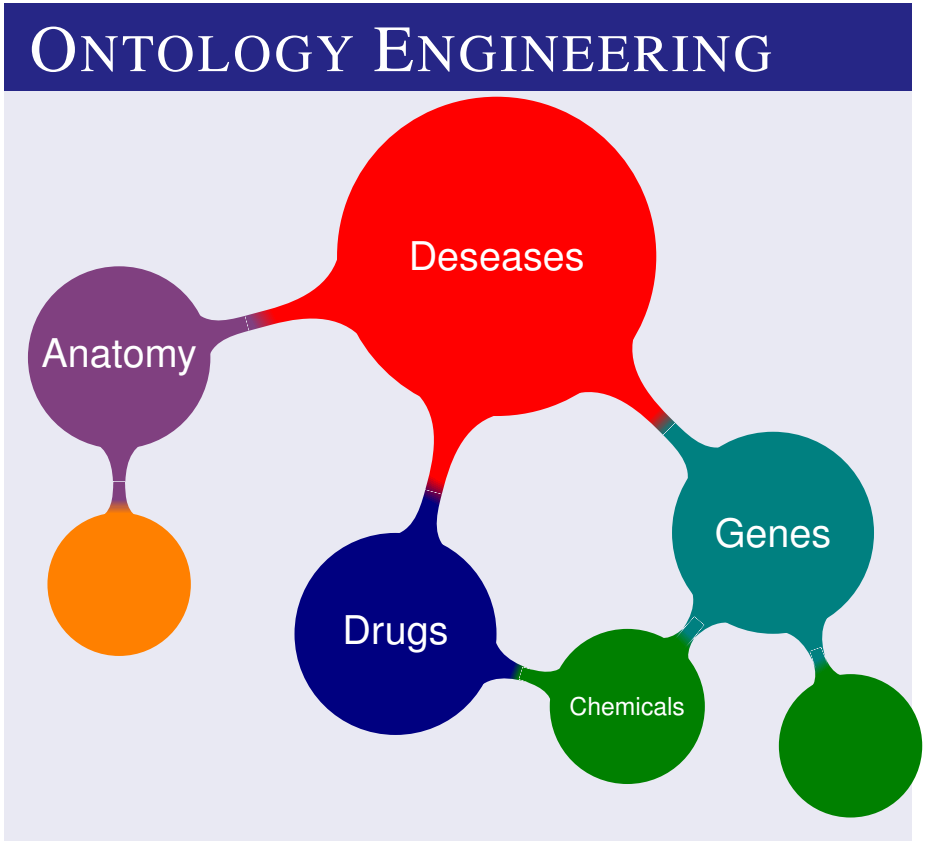
- The notion of modularity becomes apparent
- Problems:
  - ✔ Safe integration of ontologies
  - ✔ Partial ontology reuse



A Motivating Example

Ontology of Research Projects

$$\mathsf{Cystic\_Fibrosis\_EUProject} \equiv \mathsf{EUProject} \sqcap \exists \mathsf{has\_Focus}.\mathsf{Cystic\_Fibrosis}$$

$$\mathsf{Genetic\_Disorder\_Project} \equiv \mathsf{Project} \sqcap \exists \mathsf{has\_Focus}.\mathsf{Genetic\_Disorder}$$

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Ontology Reuse

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Ontology of Medical Terms

$\mathsf{Genetic\_Disorder} \equiv \ldots$

$\mathsf{Cystic\_Fibrosis} \equiv \ldots$

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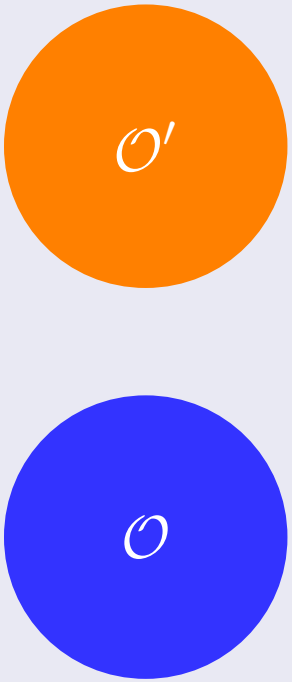

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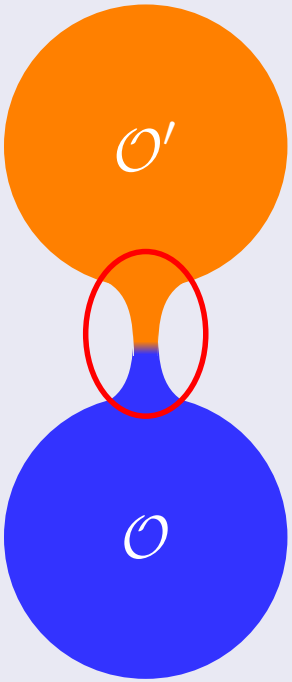

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Safety and Ontology Integration

1. Independent ontology development:
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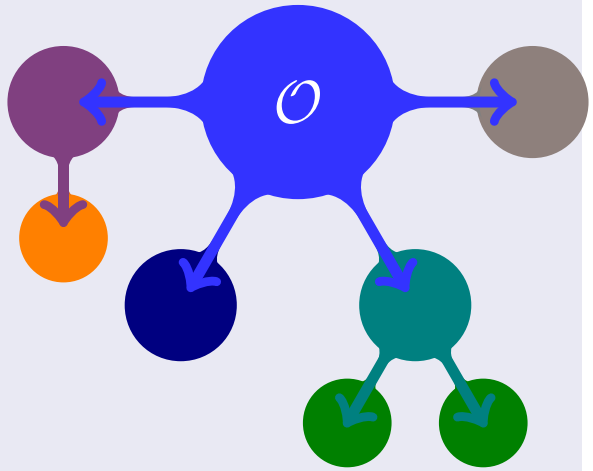
Ontology Reuse



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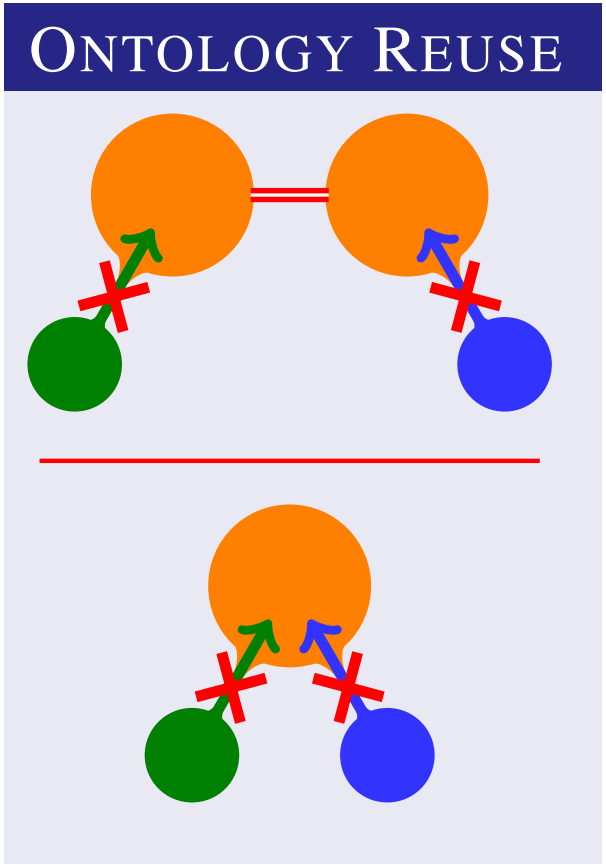

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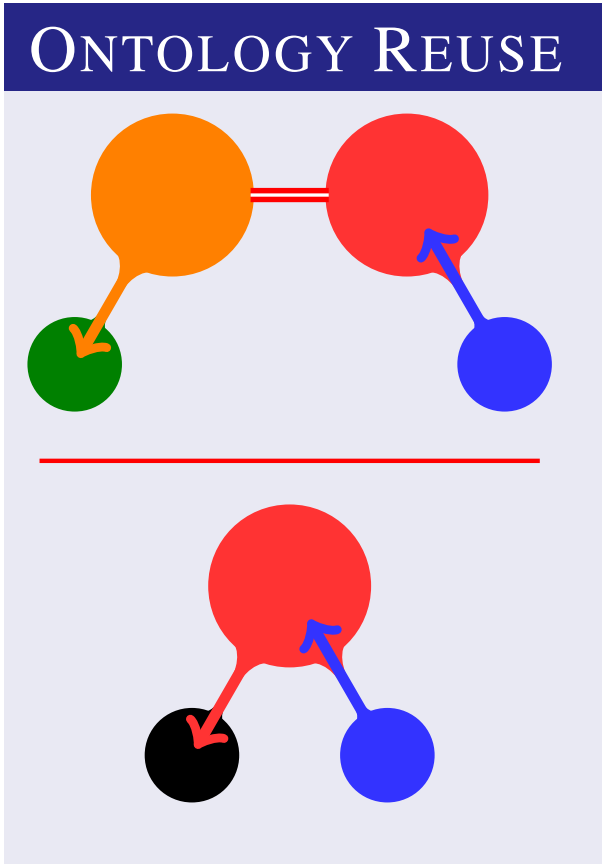

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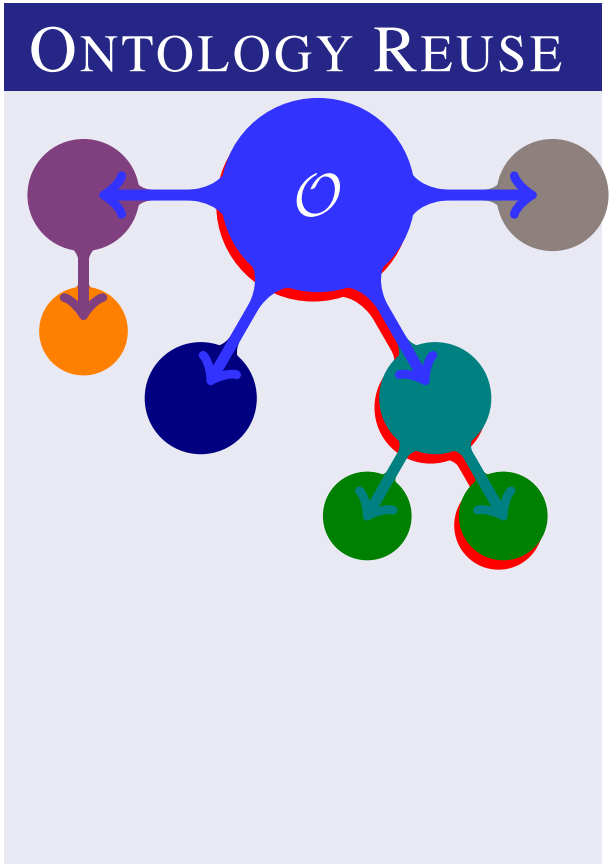

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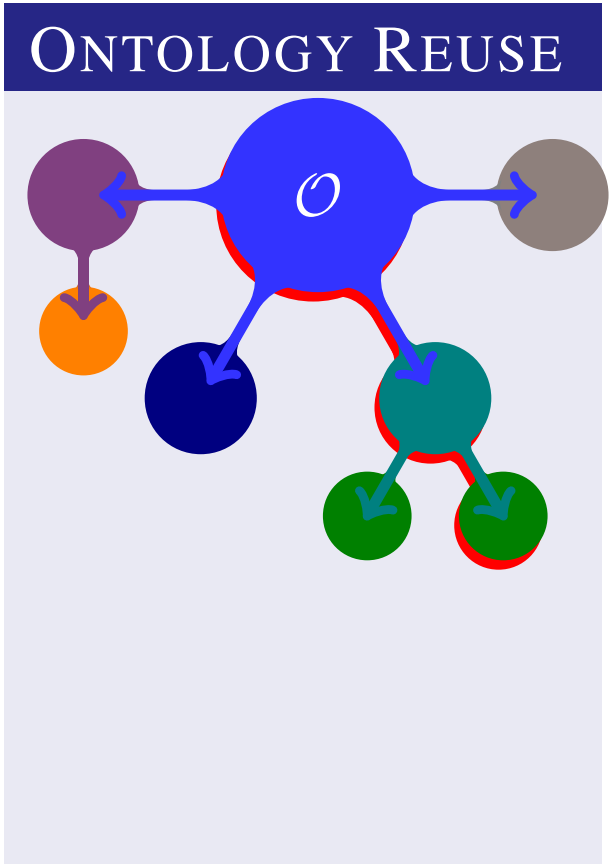
Provided the safety conditions are satisfied!



Partial Ontology Reuse

- Available ontologies often big and contain lots of irrelevant information

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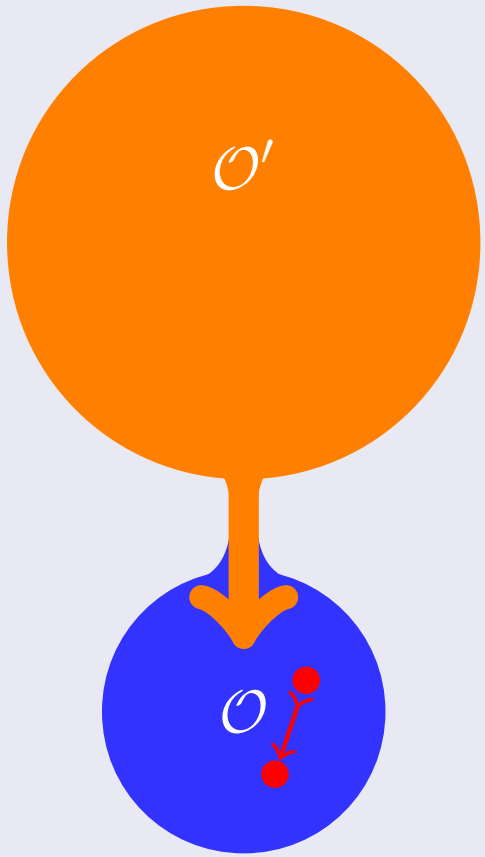

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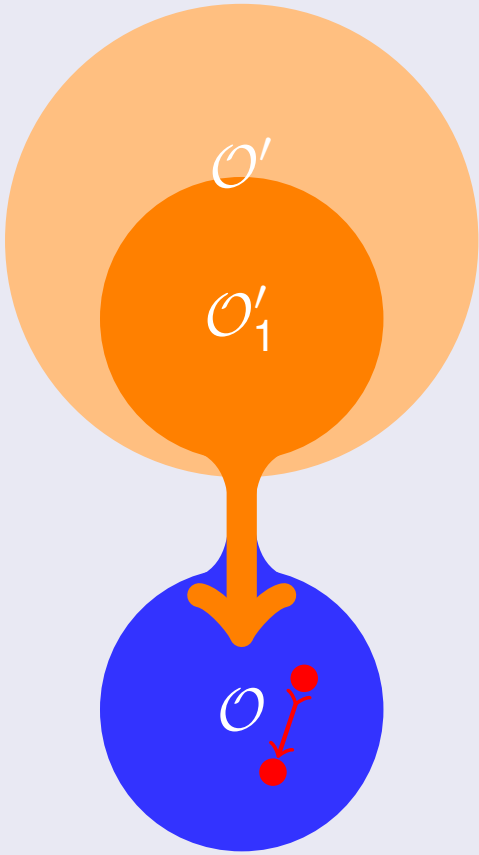

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- A module $\mathcal{O}_1'$ in $\mathcal{O}'$ w.r.t. $\mathcal{O}$.

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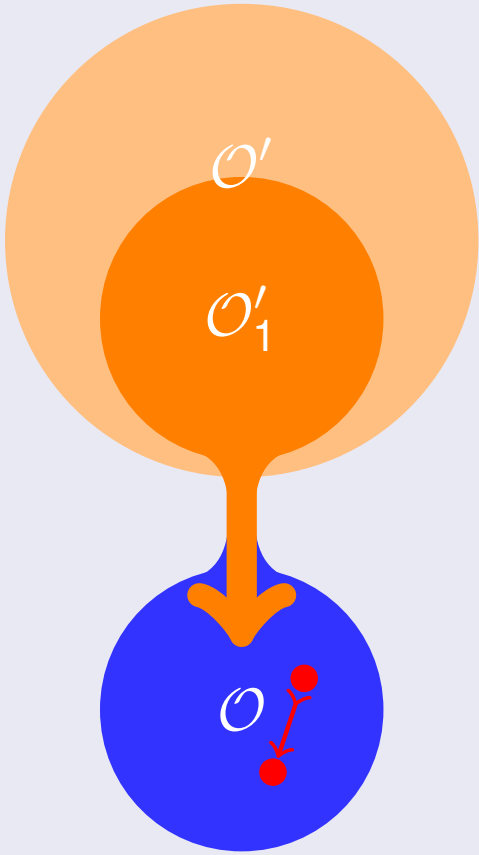

Our Contributions

- Formalization for the notions for safety and modules using a logical notion of conservative extension
- Theoretical studies for the relevant tasks
- Practical algorithms for extracting modules and safety checking with guarantied correctness of the results

1. B. Cuenca Grau, I. Horrocks, Y. Kazakov, and U.Sattler. A logical framework for modularity of ontologies. In Proc. of IJCAI 2007
2. B. Cuenca Grau, I. Horrocks, Y. Kazakov, and U. Sattler. Just the right amout: Extracting modules from ontologies. In Proc. of WWW 2007
3. B. Cuenca Grau, I. Horrocks, Y. Kazakov, and U. Sattler. Modular Reuse of Ontologies: Theory and Practice. JAIR 2008, to appear

EMPERICAL EVALUATION

Ontology	♯ Atomic	A1: Prompt-Factor		A2: Mod. in [GC 06]		A3: Loc.-based mod.	
	Concepts	Max.(%)	Avg.(%)	Max.(%)	Avg.(%)	Max.(%)	Avg.(%)
NCI	27772	87.6	75.84	55	30.8	0.8	0.08
SNOMED	255318	100	100	100	100	0.5	0.05
GO	22357	1	0.1	1	0.1	0.4	0.05
SUMO	869	100	100	100	100	2	0.09
GALEN-Small	2749	100	100	100	100	10	1.7
GALEN-Full	24089	100	100	100	100	29.8	3.5
SWEET	1816	96.4	88.7	83.3	51.5	1.9	0.1
DOLCE-Lite	499	100	100	100	100	37.3	24.6