INF3580 – Semantic Technologies – Spring 2011

Lecture 8: RDF and RDFS semantics

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Today's Plan

1. Why we need semantics
2. Model-theoretic semantics from a birds-eye perspective
3. Repetition: Propositional Logic
4. Simplified RDF semantics
5. Open World Semantics

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2. characterisation results such as soundness and completeness.

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But RDF was supposed to be the data liberation movement!

Another look at the Semantic Web cake

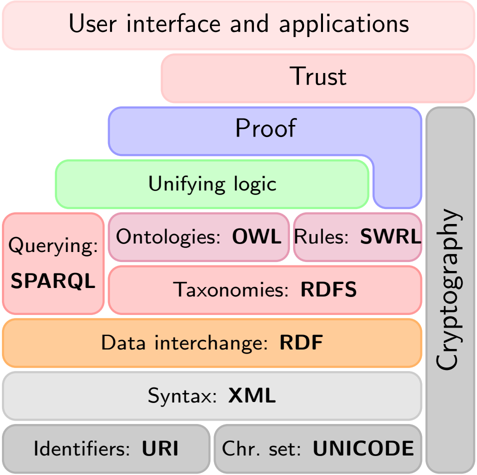

Figure: Semantic Web Stack

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- Complete answers in the course of later lectures. Foundations now.

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- Whatever these models all share can be said to be entailed by those features.

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  - but every formula can be "parsed" uniquely.

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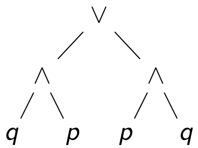

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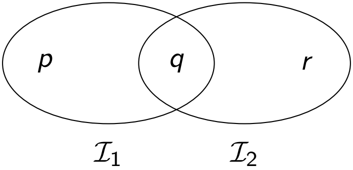

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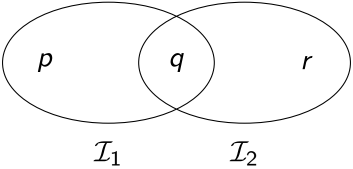

- But in $\mathcal{I}_2 = \{q, r\}$, p is false, but r is true.

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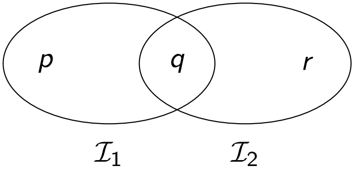

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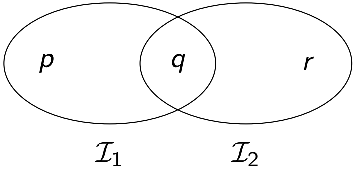

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- In other words, for all letters p:

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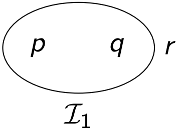

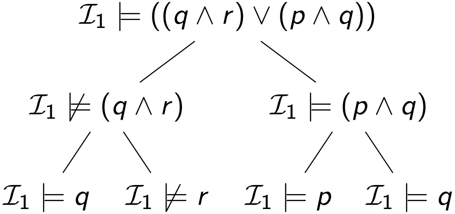

Truth Table

- Semantics of $\neg$, $\wedge$, $\vee$ often given as *truth table*:

A	B	$\neg A$	$A \wedge B$	$A \vee B$
f	f	t	f	f
f	t	t	f	t
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Outline

1 Why we need semantics

2 Model-theoretic semantics from a birds-eye perspective

3 Repetition: Propositional Logic

4 Simplified RDF semantics

5 Open World Semantics

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The semantics of typed and tagged literals is considerably more complex.

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- DL syntax, without namespaces:

$loves(romeo, juliet)$
$Lady(juliet)$

$Lady \sqsubseteq Person$
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$\mathrm{dom}(loves, Lover)$
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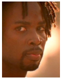
- Given these, it will be possible to say whether a triple holds or not.

An example "intended" interpretation

- $\Delta^{\mathcal{I}_1} = \{$ , ,  $\}$

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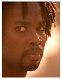
- $\Delta^{\mathcal{I}_1} = \{$ , ,  $\}$
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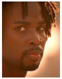
- $\Delta^{\mathcal{I}_1} = \{$ , ,  $\}$
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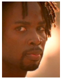
- $\Delta^{\mathcal{I}_1} = \{$ , ,  $\}$
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- In fact, there is *no way* of ensuring they denote only what we think!

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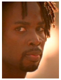
$Lover^{\mathcal{I}_1} = \{$ ,  $\} \subseteq Person^{\mathcal{I}_1} = \{$ , ,  $\}$

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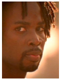
    $\mathit{Lover}^{\mathcal{I}_1} = \{$ ,  $\} \subseteq \mathit{Person}^{\mathcal{I}_1} = \{$ , ,  $\}$
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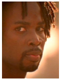
    $Lover^{\mathcal{I}_1} = \{$ ,  $\} \subseteq Person^{\mathcal{I}_1} = \{$ , ,  $\}$
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- then by set theory $\mathit{juliet}^{\mathcal{I}} \in \mathit{Person}^{\mathcal{I}}$

Countermodels

- If $\mathcal{A} \not\models T$,...
- then there is an $\mathcal{I}$ with
  - $\mathcal{I} \models \mathcal{A}$
  - $\mathcal{I} \not\models T$
- Vice-versa: if $\mathcal{I} \models \mathcal{A}$ and $\mathcal{I} \not\models T$, then $\mathcal{A} \not\models T$
- Such an $\mathcal{I}$ is called a *counter-model* (for the assumption that $\mathcal{A}$ entails T)
- To show that $\mathcal{A} \models T$ does *not* hold:
  - Describe an interpretation $\mathcal{I}$ (using your fantasy)
  - Prove that $\mathcal{I} \models \mathcal{A}$ (using the semantics)
  - Prove that $\mathcal{I} \not\models T$ (using the semantics)

Countermodel Example

- $\mathcal{A}$ as before:

$$\mathcal{A} = \{loves(romeo, juliet),\ Lady(juliet),\ Lady \sqsubseteq Person,\ loves \sqsubseteq knows,\ \mathrm{dom}(loves, Lover),\ \mathrm{rg}(loves, Beloved)\}$$

- Does $\mathcal{A} \models Lover \sqsubseteq Beloved$?
- Holds in $\mathcal{I}_1$ and $\mathcal{I}_2$.
- Try to find an interpretaion with $\Delta^{\mathcal{I}} = \{a, b\}$, $a \neq b$.
- Interpret $romeo^{\mathcal{I}} = a$ and $juliet^{\mathcal{I}} = b$
- Then $\langle a, b\rangle \in loves^{\mathcal{I}}$, $a \in Lover^{\mathcal{I}}$, $b \in Beloved^{\mathcal{I}}$.
- With $Lover^{\mathcal{I}} = \{a\}$ and $Beloved^{\mathcal{I}} = \{b\}$, $\mathcal{I} \not\models Lover \sqsubseteq Beloved$!
- Choose

$$loves^{\mathcal{I}} = knows^{\mathcal{I}} = \{\langle a, b\rangle\} \qquad Lady^{\mathcal{I}} = Person^{\mathcal{I}} = \{b\}$$

to complete the count-model while satisfying $\mathcal{I} \models \mathcal{A}$

Outline

1 Why we need semantics

2 Model-theoretic semantics from a birds-eye perspective

3 Repetition: Propositional Logic

4 Simplified RDF semantics

5 Open World Semantics

Open and closed world reasoning

RDF semantics is open-world: Entailment is defined in terms of all models:

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An RDF graph $\mathcal{A}$ entails a graph $\mathcal{B}$ if every interpretation $\mathcal{I}$ that satisfies $\mathcal{A}$ also satisfies $\mathcal{B}$.

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- more about this later in lecture 11.

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Supplementary reading

RDF semantics:

- http://www.w3.org/TR/rdf-mt/

The metamodelling architecture of Web Ontology Languages:

- http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.22.7263

On closed world reasoning in SPARQL:

- http://clarkparsia.com/pellet/icv