INF3580 – Semantic Technology – Spring 2010

Lecture 5: RDF and Web semantics

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Today's Plan

1. Why we need semantics
2. Model-theoretic semantics from a birds-eye perspective
3. Recalling classical consequence
4. RDF semantics—main features

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2. characterisation results such as soundness and completeness.

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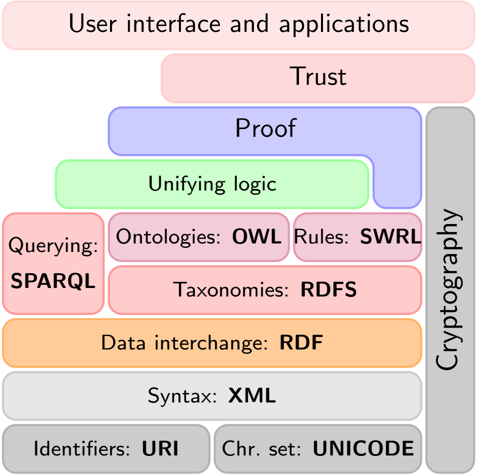
But RDF was supposed to be the data liberation movement!

Another look at the Semantic Web cake



User interface and applications

Trust

Proof

Unifying logic

Querying: **SPARQL**

Ontologies: **OWL**

Rules: **SWRL**

Taxonomies: **RDFS**

Data interchange: **RDF**

Syntax: **XML**

Identifiers: **URI**

Chr. set: **UNICODE**

Cryptography

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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Logical connectives

The logical symbols consists of

- $\wedge$ aka. logical conjunction,
- $\vee$ aka. logical disjunction,
- $\rightarrow$ aka. material implication, and
- $\neg$ aka. logical negation

or some functionally equivalent set

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Things to note

- The internal structure of atomic sentences remains unanalyzed.
- The unit of analysis is a complete, true or false sentence.
- A sentence mirrors a complete state of affairs,
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Propositional semantics

Truth tables

Truth-tables give the meaning of the logical constants:

P_1	P_2	$P_1 \wedge P_2$	$P_1 \vee P_2$	$\neg P_1$
F	F	F	F	T
F	T	F	T	T
T	T	T	T	F
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Valuations/interpretations/models

A propositional model/interpretation, usually called a valuation, is a function v

- on the set of all formulae,
- into the set $\{T, F\}$,
- that assigns values corresponding to one row in the truth-table

Satisfaction/truth in a model

Satisfiability

- A valuation v satisifes a formula P if $v(P) = T$.
- A formula P is satisfiable if $v(P) = T$ for some model/valuation/interpretation v.
- Intuitively P is satisfiable if it describes a possible configuration.

Example

The formula $P_1 \vee P_2$ is satisfiable:

- It is satisfied by all valuations v such that $v(P_1) = T$, and
- by all valuations v' (possibly the same) such that $v'(P_2) = T$

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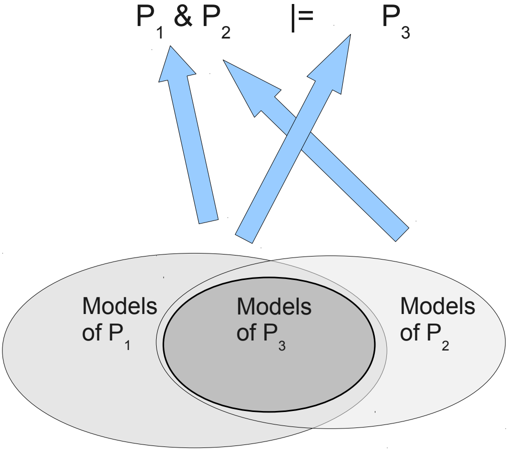
Validity of an inference/entailment

- A set of sentences A entails a formula P, written $A \vDash P$, iff there is no valuation v such that $v(P) = T$ for all $P \in A$ and $v(P) = F$.

Entailment/validity illustrated



More things to note

- Models differ in their particular makeup from logic to logic, but
  - satisfaction,
  - validity, and
  - entailment,

  are largely invariant.
- The concept of satisfaction, i.e. of truth, is the fundamental one.
  - we shall thus have to define the truth of a triple
- Classical semantics is open world in the sense that
  - one model does not in general suffices to draw conclusions,
  - i. e. one model, or set of facts, cannot be assumed to contain complete knowledge
  - we shall come back to this

Outline

1. Why we need semantics
2. Model-theoretic semantics from a birds-eye perspective
3. Recalling classical consequence
4. RDF semantics—main features

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Triples are true or false on the basis of what each part refers to.

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- `http://www.w3.org/2006/vcard/ns#locality`
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The semantics of typed and tagged literals is considerably more complex.

RDF interpretations in outline

RDF interpretations

An RDF interpretation I of a vocabulary V is defined (in part) by

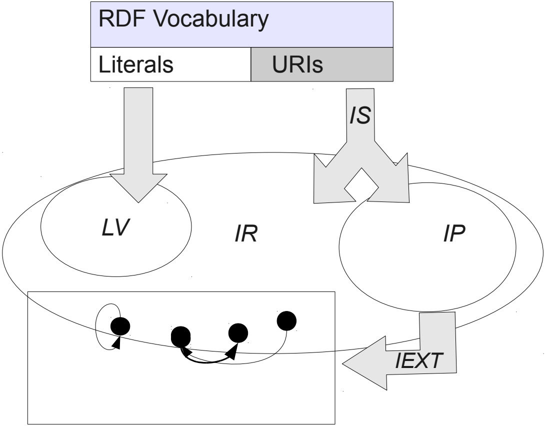
What there is:

- A non-empty set IR of resources, called the domain of I
- A subset $IP \subseteq IR$, called the set of properties of I
- A set $LV \subseteq IR$ of plain literals

The reference or meaning of words in the vocabulary, given by:

- A function IS from URIs in V into IR
- A function $IEXT$ from IP to $IR \times IR$
- Untyped literal values refer to themselves.

Interpretations

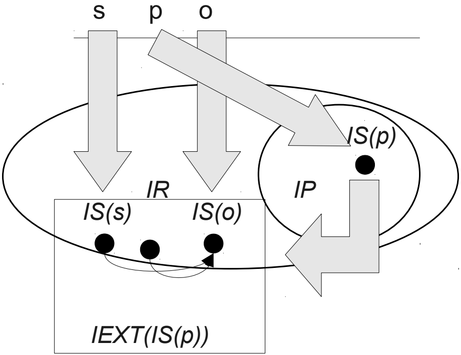


Satisfaction

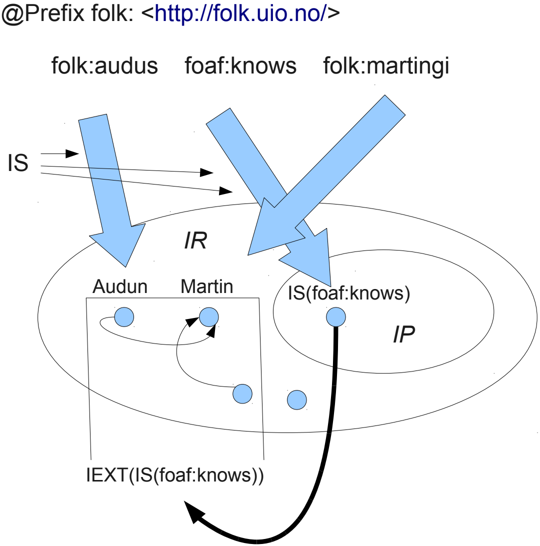
Truth of a triple in an interpretation

An RDF interpretation I satisfies a ground triple `s p o` if

- $\langle IS(s), IS(o)\rangle \in IEXT(IS(p))$



Satisfaction: A somewhat more concrete example

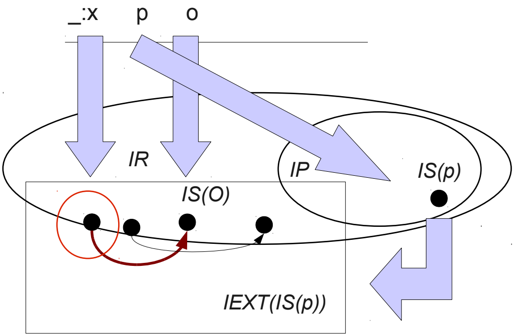


Interpretation of blank nodes

Interpretation of triples containing blank nodes

Let E be any RDF-triple. An interpretation I satisfies E if there is some substitution σ from the blank nodes in E into $IR - IP$, such that

- The ground triple $\sigma(E)$ is satisfied by I



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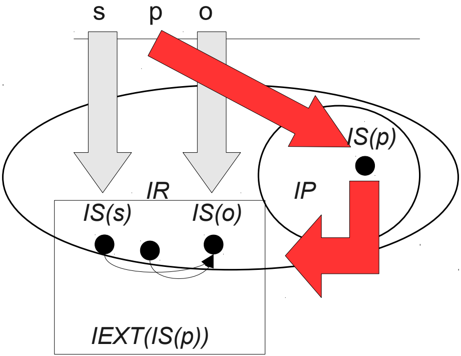
- So properties act as both objects and relations !?

Another look at satisfaction



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  - plain RDF graphs can be treated as data for OWL ontologies

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- data may be produced at any time
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Hence, we will rarely be able to conclude e. g.

- that Radiohead does not have an album called "Dark Continent",
- because althogh we cannot find information about such an album,
- or we may find a similarly named album by another band,
- we may yet discover new information as we go.

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- more about this later in lecture 7.

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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