OIL: an Ontology Language for the Semantic Web

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Requirements for an Ontology Language

- Well designed
  - Intuitive to human users
  - Adequate expressive power
- Well defined
  - Clearly specified syntax (obviously)
  - Formal semantics (equally important)
  - Adequate expressive power
- Compatible with existing (web) standards

Standards for Ontology Languages

- Proposals already exist for W3C standard schema languages
  - XMLS (XML Schema)
  - RDFS (RDF Schema)
- Both have been touted as (standard) web ontology languages
- However, both suffer from
  - Expressive inadequacy — lack of basic modelling primitives
  - Poorly (un) defined semantics

Proposed Common Core: OIL

☞ Simple and intuitive Frame Language syntax

➟ Many users are frightened by logic-based syntax (I know I am!)

➟ Rich range of modelling primitives

➟ Can still function as a basic frame language

➟ Facilitates construction/adaption of tools

☞ Semantics defined by mapping to expressive Description Logic

➟ Well defined formal properties (decidability, complexity)

➟ Enriched expressive power (boolean connectives, etc.)

➟ Can provide reasoning services to support ontology design

☞ Compatibility provided by layering on top of RDFS

➟ Class hierarchy etc. accessible to any RDFS-aware agent

$$\text{Frames} + \text{DL} + \text{WWW} \Rightarrow \text{OIL}$$

Why Reasoning Support?

- Reasoning support is key feature of OIL
- Reasoning is important
  - as design support tool
  - for large ontologies
  - with multiple authors
  - for integrating and sharing ontologies
- Because it allows
  - Establishing inter-ontology relationships
  - Checking for consistency
  - Checking for (unexpected) implied relationships

"The Semantic Web needs a logic on top" (Henry Thompson)

OIL Language Overview

OIL restricts frame languages:

- ☞ No defaults
- ☞ Limited axioms/rules
- ☞ Ontology only (limited form of individuals)

Main reasons for this:

- ☞ Reasoning support
- ☞ Semantics

OIL extends frame languages:

- Defined classes (necessary and sufficient conditions)
- Enhanced slot constraints
  - Restriction to class as well as value
  - Existential and universal restrictions
  - Cardinality constraints with optional class qualifier
  - Boolean expressions as well as class names
  - Sub-slots as well as sub-classes
  - Properties on slots (transitive, symmetrical)
  - Inverse slots
  - ...
- Concrete data types
  - Integers and strings, with min, max, ranges etc.
- Additional kinds of axiom
  - Disjointness, disjoint-coverings, equivalence etc.

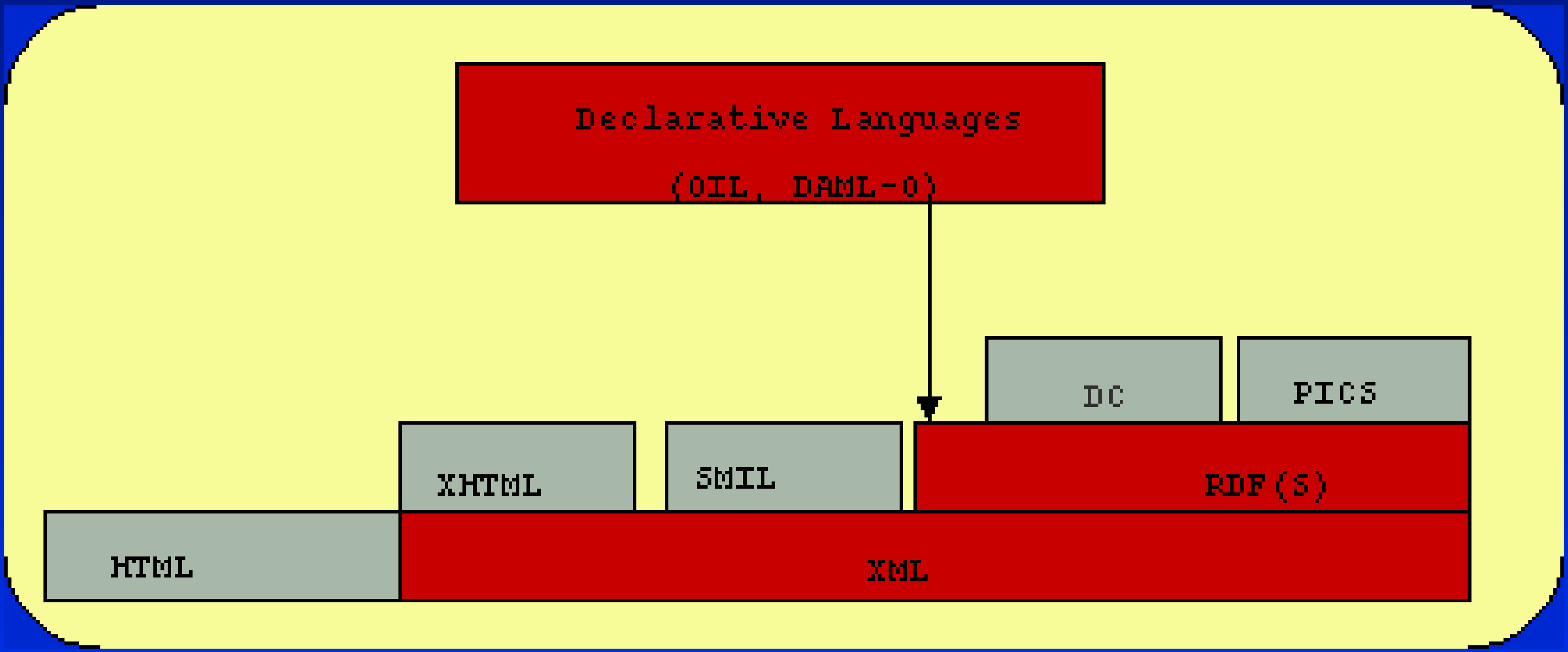
OIL by Example

slot-def part-of	% part-of is a slot
subslot-of structural-relation	% sub-slot of structural-relation
inverse has-part	% inverse is has-part
properties transitive	% it is transitive
class-def **defined** herbivore	% herbivore exactly defined as:
subclass-of animal	% sub-class of animal
slot-constraint eats	% that eats
value-type plant **OR**	% only plants
slot-constraint part-of	% or parts of
has-value plant	% plants
min-cardinality 2 vegetable	% and $\geqslant$2 types of vegetable
disjoint herbivore carnivore	% herbivore and carnivore disjoint

Semantics via translation to $\mathcal{SHIQ}$ DL:

OIL	Equivalent $\mathcal{SHIQ}$
slot-def part-of	
subslot-of structural-relation	% part-of $\sqsubseteq$ structural-relation
inverse has-part	% has-part $\doteq$ part-of$^-$
properties transitive	% part-of $\in \mathbf{R}_+$
class-def **defined** herbivore	% herbivore $\doteq$
subclass-of animal	% animal $\sqcap$
slot-constraint eats	
value-type plant **OR**	% $\forall$eats.(plant $\sqcup$
slot-constraint part-of	
has-value plant	% $\exists$part-of.plant) $\sqcap$
min-cardinality 2 vegetable	% $\geqslant 2.eats$vegetable
disjoint herbivore carnivore	% herbivore $\sqsubseteq$ $\neg$carnivore

How to Put Ontologies on the Web



Compatibility via RDFS delivery syntax:

```
<rdf:Property rdf:ID="has-part">
  <rdfs:subPropertyOf rdf:resource="#structural-relation"/>
  <oil:inverseRelationOf rdf:resource="#is-part-of"/>
</rdf:Property>

<rdfs:Class rdf:ID="herbivore">
  <rdf:type rdf:resource="http://www.ontoknowledge.org/oil/rdfs-schema/#Defi
  <rdfs:subClassOf rdf:resource="#animal"/>
  <oil:hasSlotConstraint>
    <oil:valueType>
      <oil:hasProperty rdf:resource="#eats"/>
      <oil:hasClass>
        <oil:OR>
          <oil:hasOperand rdf:resource="#plant"/>
          <oil:hasOperand>
            <oil:has-value>
              <oil:hasProperty rdf:resource="#is-part-of"/>
              <oil:hasClass rdf:resource="#plant"/>
            </oil:has-value>
          </oil:hasOperand>
                ⋮
```

Extensible OIL

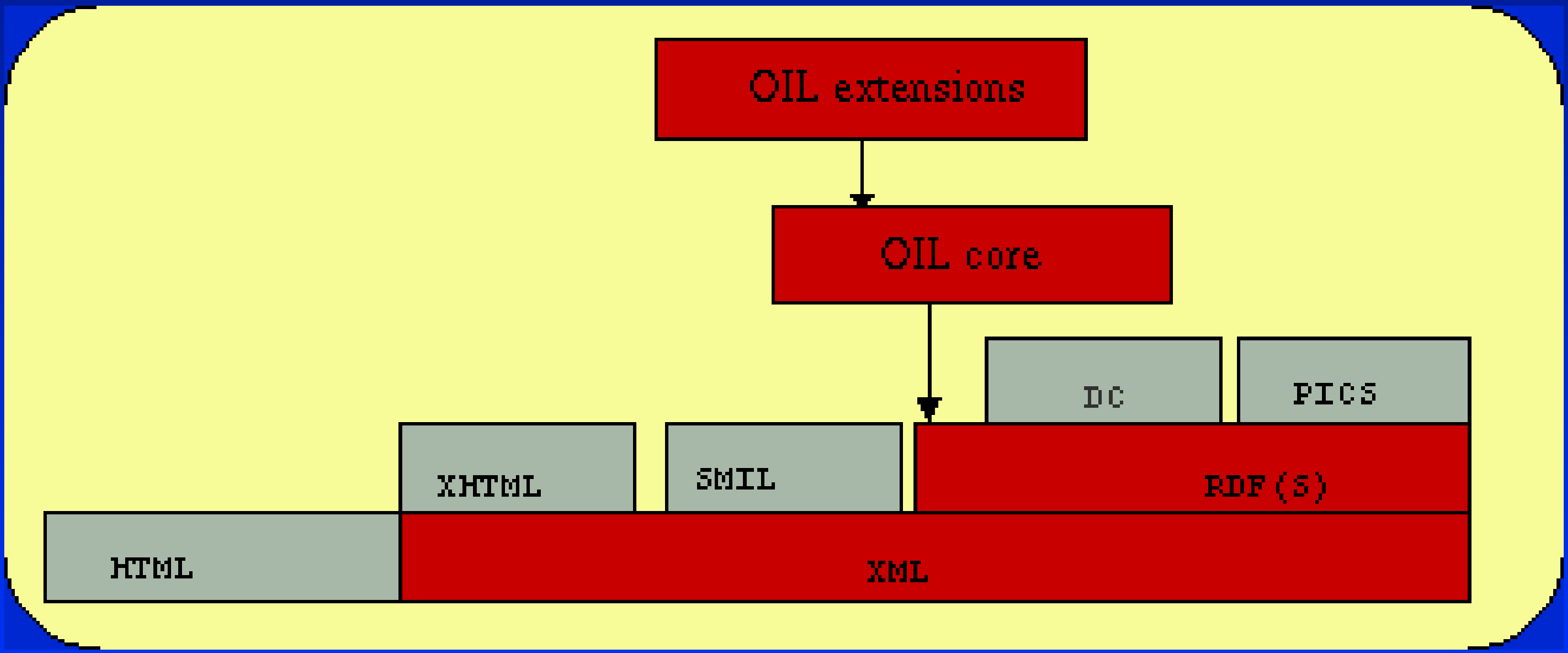
One of the key ideas behind OIL:

Don't make the core language too large

- Core language should contain only "consensus" primitives
- Additional expressive power provided by language extensions
- These could include:
  - Rules
  - Additional algebraic properties on slots
  - Limited second order features
  - Modules, import, etc.
  - ...

Extensions will (hopefully) have similar relationship with OIL core that OIL has with RDFS:

- Build on top of OIL core
- Use RDFS and OIL core modelling primitives wherever possible
- Maximise backward compatibility with RDFS and OIL core



DAML and OIL

- US DAML initiative also developing RDFS based ontology language
- Similar constructs to OIL but different RDFS encoding
- Joint US/EU Committee on Agent Markup Languages now established

? Ultimate aim is OIL/DAML based W3C standard ?

OIL Infrastructure

- Reasoning services provided by CORBA FaCT system
  - Currently via OIL $\leftrightarrow$ FaCT translators (XSL)
  - CORBA OIL coming soon
- Frame ontology editors being built/adapted to OIL
  - Protege editor (Stanford)
  - OntoEdit (Karlsruhe)
  - OilEd (Manchester)
- Additional infrastructure urgently required

OntoWeb Thematic Network

- EU Proposal to fund Semantic Web "network of excellence"
- 55 members from industry and academia in Europe and around the world (including US and Japan)
- key objectives
  - Technology transfer
  - Represent and co-ordinate ontology-related research
  - Disseminate information, research and application results
  - Represent EU ontology community and co-operating with related initiatives like DAML in the US
  - Cooperate with language and content standardisation efforts
- `http://www.ontoweb.org/`

See: `http://www.cs.man.ac.uk/~horrocks/Luxembourg.html` for notes on EU funding for Semantic Web

WonderWeb Research Project

- EU Proposal to fund Semantic Web infrastructure research
- 6 partners from Europe and US
  - University of Manchester, UK (coordinator)
  - Vrije Universiteit Amsterdam, Netherlands
  - LADSEB-CNR, Italy
  - University of Karlsruhe, Germany
  - InfoLab, Stanford University, USA
  - Interprice Technologies GmbH, Germany
- key objectives
  - Ontology languages and standardisation
  - Integration/reconciliation techniques for migration and sharing
  - Foundational ontologies for range of application domains
  - Technical infrastructure and tools for development and deployment
- `http://www.cs.man.ac.uk/~horrocks/WonderWeb/`