

# OIL

## ontology inference and interchange

On-To-Knowledge project



## Topics for this presentation

- OIL as a **common core language** (4)
- aspects of OIL (5)
- OIL on the Web
  - Why XML is not enough (3)
  - Why RDF(S) is not enough (9)
  - **OIL as RDF(S) extension** (3)
- Current results & plans (4)

## Requirements for a common core Ontology-language

- Well defined **syntax** (pretty obvious)
  - read ontologies
- Well defined **semantics**
  - often overlooked but equally important
  - process (“understand”) ontologies
- **Expressive** enough
  - to capture many ontologies
- Easy **mapping**
  - to/from other ontology languages
- Efficient **reasoning support**

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

3

## Why Reasoning Support?

- Reasoning support is key feature of OIL-core
- Important
  - as design support tool
  - for large ontologies
  - with multiple authors
  - for integrating and sharing ontologies
- Because it allows to
  - Establish inter-ontology relationships
  - Check for consistency
  - Check for (unexpected) implied relationships
- Shown useful for DB schema integration

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

4

## Ingredients for a common core

### ■ Frame Based Languages

- intuitive for many users
- Extensive set of modelling primitives
- OKBC, OKBC-lite, XOL

### ■ (Description) Logic-based languages

- negation and disjunction (e.g disjointness)
- properties for slots/relations
  - e.g. transitivity for **contained-in**
- Formal semantics
- Reasoning support
  - inconsistency-detection, implicit superclass-detection

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

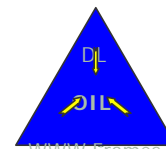
5

## Proposed common core: OIL

- Based on standard frame languages (OKBC)
  - restricts & extends
- Has both XML and **RDF(S)** based syntax
- formalised by DL style logical constructs
- Still has frame “look and feel”
- Can still function as a basic frame language
- OIL-lite language restricted:
  - to allow for reasoning support

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)



## OIL-lite: Restricts Frame Languages

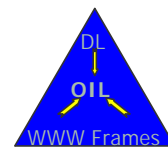
- No defaults
- limited axioms/rules
- only definition of ontology (not individuals)

### Main reasons for this:

- Reasoning support
- Semantics

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)



## OIL: Extends Frame Languages

- Classes can be primitive (nec. conditions)
  - elephant  $\Rightarrow$  animal that has-colour grey
- or defined (nec. and sufficient conditions)
  - vegetarian  $\Leftrightarrow$  person who eats meat nor fish
- Classes allowed in slot constraints
  - slot-constraint eats has-value meat  
(eats some meat)
  - slot-constraint eats value-type meat  
(eats only meat)

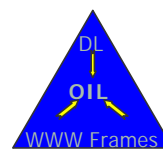
Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)



## OIL: Extends Frame Languages

- Can use arbitrary class expressions instead of only class names
  - slot-constraint eats value-type NOT (OR meat fish)
- Cardinality constraints can include value-types
  - slot-constraint eats max-cardinality 1 plant
- Supports sub-slot relation
  - daughter-of sub-slot of child-of
- Slot properties
  - transitive (e.g., part-of )
  - symmetrical (e.g., connected-to)



## OIL has a Formal semantics

- Defined by mapping to very expressive DL
  - slot-constraint eats has-value meat, fish
  - =
  - \$ eats:meat Ç \$ eats:fish
- Mapping is used to provide reasoning support from a DL system (e.g., FaCT)



## OIL (explained by example)

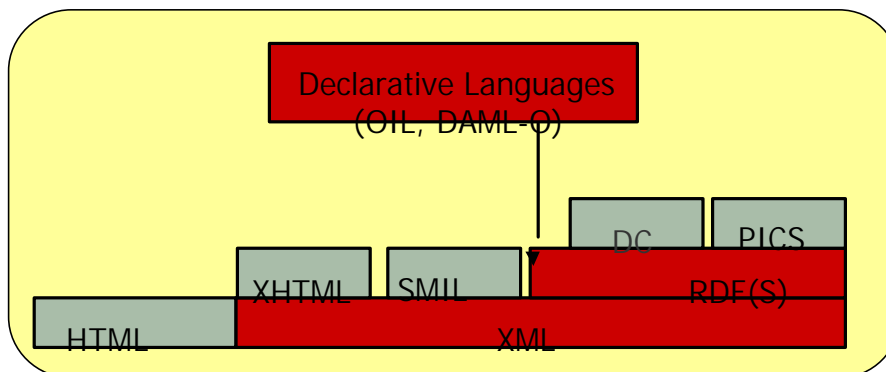
```

class-def animal % animals are a class
class-def plant % plants are a class
  subclass-of NOT animal % that is disjoint from animals
class-def tree
  subclass-of plant % trees are a type of plants
class-def branch
  slot-constraint is-part-of % branches are parts of some tree
  has-value tree
  max-cardinality 1
class-def defined carnivore % carnivores are animals
  subclass-of animal
  slot-constraint eats % that eat any other animals
  value-type animal
class-def defined herbivore % herbivores are animals
  subclass-of animal, NOT carnivore % that are not carnivores, and
  slot-constraint eats % they eat plants or parts of plants
  value-type plant OR (slot-constraint is-part-of has-value plant)
  
```

11

## How to put ontologies on the Web (internet, intranet, extranet)

The W3C hierarchy of languages:



Frank van Harmelen

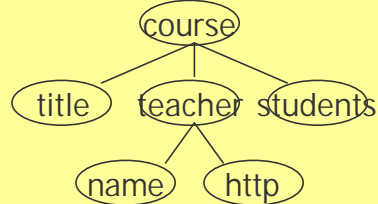
[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

12

## XML: Document = labelled tree

- node = label + attr/values + contents

```
<course date="...">
  <title>...</title>
  <teacher>...</teacher>
    <name>...</name>
    <http>...</http>
  <students>...</students>
</course>
```



- **DTD**: simple grammars to describe legal trees
- So:  
**why not use XML to represent ontologies?**

## XML: limitations for semantic markup

XML makes no commitment on:

- ❶ Domain specific ontological **vocabulary**
- ❷ Ontological **modelling primitives**

⇒ requires pre-arranged agreement on ❶ & ❷

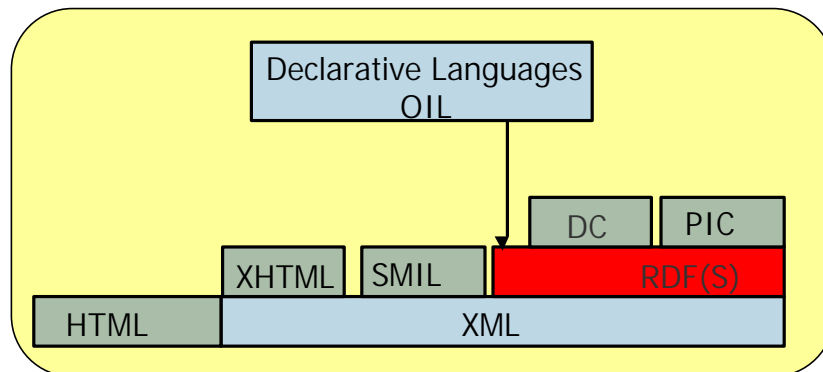
Only feasible for closed collaboration

- agents in a small & stable community
- pages on a small & stable intranet

**not for sharable Web-resources**



## Remember the W3C vision



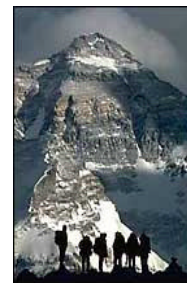
Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

15

## RDF(S): general background

- Intended for representation “meta-data”, basis for Web-based ontology-language
- W3C recommendation
- “Because it’s there”:
  - pushed hard by W3C (TBL Himself)
  - basis of \$ 80M DAML program
  - Already embraced by some vendors (Netscape)



Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

16

## Bluffer's guide to RDF (1)

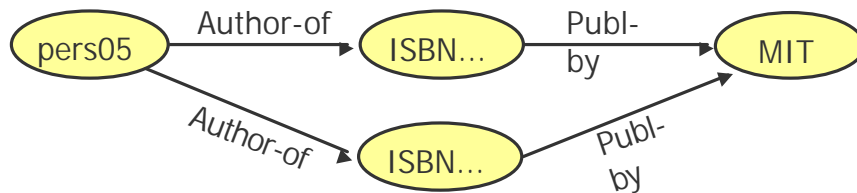
- Object --Attribute-> Value triples



- objects are **web-resources**

- Value is again an Object:

- triples can be **linked**
- data-model = graph



Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

17

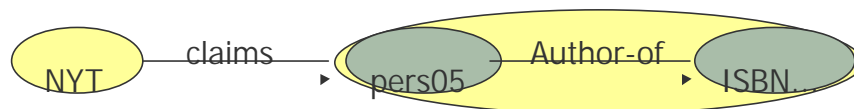
## Bluffer's guide to RDF (2)

- Object --Attribute-> Value **triples**

- objects are **web-resources**
- triples can be **linked**
- data-model = graph

- Any statement can be an object

- graphs can be **nested**



That's all there is to it

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

18

## Bluffer's guide to RDF Schema

### ■ So, RDF :

- (very small) commitment to modelling primitives
- but: no commitment to domain vocabulary

### ⇒ **RDF Schema**

### ■ Define **vocabulary** for RDF

### ■ Organise this vocabulary in a **typed hierarchy**

- **Class, subclassOf, type**
- **Property, subPropertyOf,**
- **domain, range**

## RDF Schema syntax in XML

```
<rdf:Description ID="MotorVehicle" >
  <rdf:type resource="http://www.w3.org/...#Class"/>
  <rdfs:subclassOf rdf:resource="http://www.w3.org/...#Resource"/>
</rdf:Description>

<rdf:Description ID="Truck" >
  <rdf:type resource="http://www.w3.org/...#Class"/>
  <rdfs:subclassOf rdf:resource="#MotorVehicle"/>
</rdf:Description>

<rdf:Description ID="registeredTo" >
  <rdf:type resource="http://www.w3.org/...#Property"/>
  <rdfs:domain rdf:resource="#MotorVehicle"/>
  <rdfs:range rdf:resource="#Person"/>
</rdf:Description>

<rdf:Description ID="ownedBy" >
  <rdf:type resource="http://www.w3.org/...#Property"/>
  <rdfs:subPropertyOf rdf:resource="#registeredTo"/>
</rdf:Description>
```

## State-of-the-art@W3C

- RDF: to **represent** “meta-data”
- RDF-S: to **define vocabulary** for RDF
  
- RDF is data-model + syntax
  - only a very **weak semantic interpretation**
  - **no inference model**
- RDF-S goes a step further, but still
  - **no** precisely described meaning
  - **no** inference model

## Quote from Ora Lassila (RDF)

Future: We Need More!

- **Structural modeling obviously not enough**
  - we need a “**logic layer**” on top of RDF
  - some type of **description logic** is a possibility (after all, we are talking about **frame systems**)
- **Exposing a wide variety of data sources as RDF** is useful, particularly if we have **logic/rules** which allow us to **draw inference** from this data
- My proposal: **RDF + DL = “Frame System for WWW”**
  - this is probably a good starting point for **DAML** as well (details to be worked out by **this workshop**)

## Quote from Henry Thompson

"The Semantic Web needs **a** logic on top"

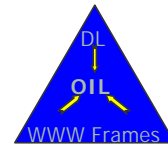
NB: "a" logic = the box with the crank  
<sup>1</sup> FOL

**OIL** =

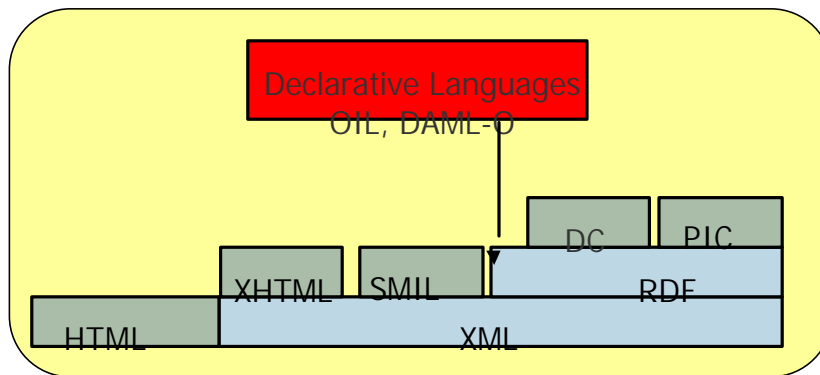
- modelling primitives from **frames** (*OKBC-lite*)
- + semantics and inference from **Description Logic**
- + syntax from **RDF(S) & XML(S)**

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

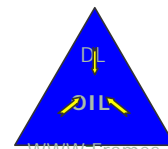


## OIL for the Semantic Web



Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)



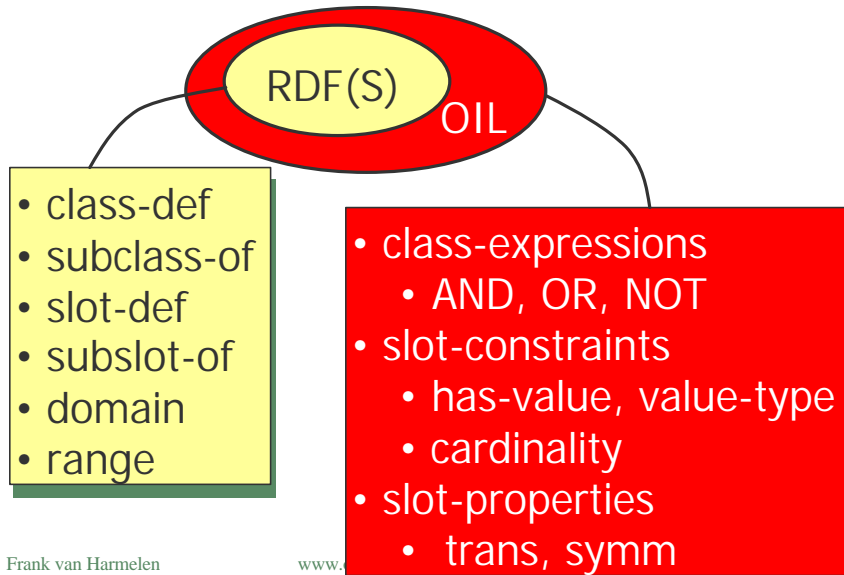
## OIL as RDF(S) extension (1/2)

```
<rdfs:Class rdf:ID="herbivore">  
  <rdfs:type  
    rdf:resource="http://www.ontoknowledge.org/#DefinedClass"/>  
  <rdfs:subClassOf rdf:resource="#animal"/>  
  <rdfs:subClassOf>  
    <oil:NOT>  
      <oil:hasOperand rdf:resource="#carnivore"/>  
    </oil:NOT>  
  </rdfs:subClassOf>  
</rdfs:Class>
```

## OIL as RDF(S) extension (1/2)

```
<rdfs:Class rdf:ID="herbivore">  
  
  <rdfs:subClassOf rdf:resource="#animal"/>  
  <rdfs:subClassOf>  
  
  </rdfs:subClassOf>  
</rdfs:Class>
```

## OIL as RDF(S) extension (2/2)



## OIL as the basis for DAML-O

- DAML = \$80M DARPA program for Semantic Web
- Ontologies are regarded as fundamental
- first version of DAML-O out < end 2000
- mandatory use for all DAML participants (W3C, Stanford, ISI, Lockheed, MIT, Nokia,...)
- OIL-lite and Standard OIL are the most likely basis for DAML-O

## OIL: currently available tools

- Definition of language
  - semantics
  - XML encoding
  - RDF encoding
- Tools:
  - translators (XSL based)
  - reasoner (FaCT, DL-based)
  - OntoEdit
- case-studies
  - GIS ontology mapping
  - (KA)<sup>2</sup> ontology
  - CIA world fact book

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

29

## OIL: some collaborating parties

- EU academics
  - University of Bremen
  - Univ. of A'dam
  - OU-UK
  - Univ. Manchester
  - A'dam Medical Centre
- US academics:
  - Univ. of Stanford (DB, KSL, Med.Inf)
  - Univ. of Maryland
  - SRI
- outside academia
  - W3C (RDF Working group)
  - DARPA (DAML initiative)
- EU IST Projects
  - On-To-Knowledge
  - IBROW
  - Comma
- EU industrials:
  - Swiss Life
  - BT
  - CognIT
  - Administrator

Frank van Harmelen

[www.ontoknowledge.org/oil](http://www.ontoknowledge.org/oil)

30

## OIL: current & future work

- Layered approach to language extensions
  - RDF(S)  $\subset$  OIL-lite  $\subset$  Standard OIL  $\subset$  OIL layer 1  $\subset$ ...
  - axioms, concrete domains, modules, defaults,...
- Ontology construction
- Ontology evolution
- Ontology mapping