



Aalto University
School of Science



OWL Web Ontology Language

An Introduction

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Learning objective



- Learn Web Ontology Language OWL

Contents



- OWL: background and context
- The OWL language



OWL: Background and Context



Languages

- *Data exchange language:* *RDF*
- *Vocabulary/schema languages:* *SKOS, OWL*
- *Data/ontology query language:* *SPARQL*
- *Rules for reasoning:* *RIF, SWRL, SPIN, ...*

Storages and querying

- Triplestore systems (Fuseki, Sesame, Redland, Virtuoso, ...)
 - <http://en.wikipedia.org/wiki/Triplestore>

Development tools

- Ontology editors
 - *Protégé* <https://protege.stanford.edu/>
 - *TopBraid Composer* <https://www.topquadrant.com/topbraid-composer-install/>
- Software development tools
 - *Java: Apache Jena* <https://jena.apache.org/>
 - *Python: RDFLib* <https://pypi.org/project/rdflib/>

What is OWL



- Standard language (W3C) for representing vocabularies/ontologies/schemas
- Much richer than RDF Schema and SKOS (W3C recommendations for light-weight vocabularies)
- Original OWL
 - *Published as W3C recommendation on 10.2.2004*
- OWL 2 = OWL
 - *Latest W3C recommendation on 11.12.2012*
 - *Extends and replaces the old recommendation*

Requirements for Ontology Languages

- **Syntax**, convenience for expressing knowledge
- Formal **semantics**
- Sufficient **expressive** power
- Efficient **reasoning** support



OWL Syntaxes



- Based on RDF(S)
 - *Turtle and RDF/XML*
- Specific OWL/XML schema
- More user-friendly notations
 - *Functional-style syntax* (*for specifications*)
 - *Manchester syntax* (*simple notation for non-logicians*)

Formal Semantics



- Defines precise meaning for syntactic expressions
- As with RDF Schema two alternative semantics are provided
 - *Direct semantics (formal logic formulation)*
 - *RDF-based semantics (rules for inferring new triples)*
- Basis for interpreting expressions in reasoning:

`:p rdfs:range :D .`

`:x :p :y .`

\Rightarrow `:y rdf:type :D .`

- Goal: OWL can be used without being a formal logician

Sufficient Expressive Power



- RDF(S) semantics is limited
 - *Class membership (instance-class relations)*
 - *Class and property hierarchies*
 - *Domain and range of properties*
- OWL introduces lots of new features, e.g.
 - *Equivalence (classes) & Equality (individuals)*
 - *Disjointness (classes) & Difference (individuals)*
 - *Boolean combination of classes*
 - *Local (class-wise) scope of properties*
 - *Special relational characteristics of properties*
 - *Cardinality of properties*

Reasoning Support



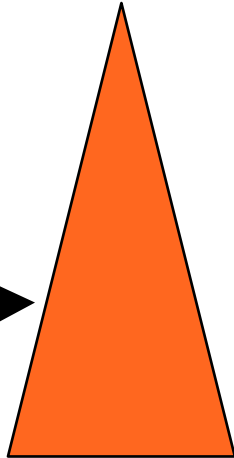
- Enriching ontology and metadata with new facts
- Checking consistency
- Finding unintended relations
- Tradeoff between expressive power and efficient reasoning
 - Different versions “profiles” of OWL are available

Enriching Ontology by Reasoning

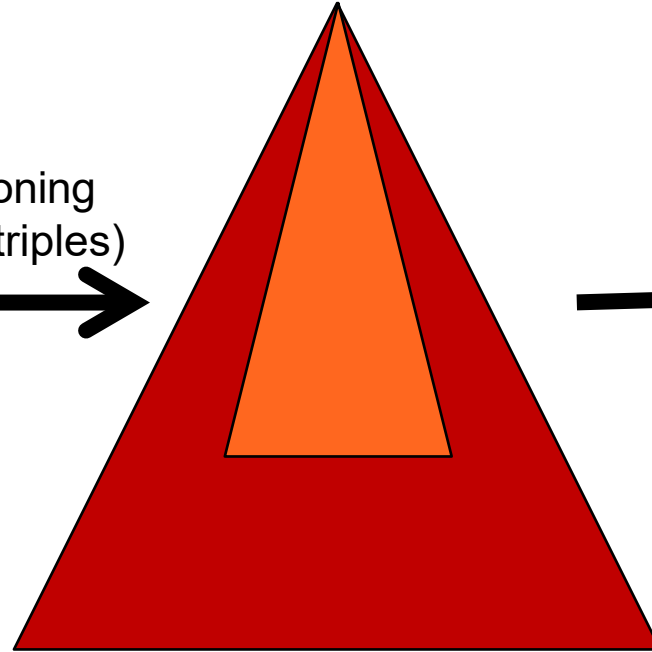


Ontology edited, (small, simple) **Enriched Ontology (larger, more complex)**

Ontology editor



Reasoning
(new triples)



End user



Protégé Editor for Editing Ontologies



OWL constructs

Plugins

The screenshot displays the Protégé editor interface for an ontology named 'families'. The top menu bar includes 'File', 'Edit', 'View', 'Reasoner', 'Tools', 'Refactor', 'Window', and 'Help'. The 'Reasoner' menu item is circled in red. Below the menu is a search bar and a tabbed interface with tabs for 'Active Ontology', 'Entities', 'Classes', 'Object Properties', 'Data Properties', 'Individuals by class', 'OWLviz', 'DL Query', and 'SPARQL Query'. The 'Classes' tab is active, showing a class hierarchy on the left and a class diagram in the main workspace. The class hierarchy on the left lists classes such as 'Thing', 'Adult', 'Dead', 'Female', 'Grownup', 'HappyPerson', 'Human', 'JohnsChildren', 'MyBirthdayGuests', 'NarcisticPerson', 'Orphan', 'Parent', 'Person', 'SocialRole', 'Teenager', and 'YoungChild'. The class diagram in the main workspace shows a hierarchy of classes with 'is-a' relationships. The 'Thing' class is at the top, with 'Person' and 'Grownup' as subclasses. 'Person' has subclasses 'Human', 'ChildlessPerson', 'Teenager', 'Parent', and 'Man'. 'Human' has subclasses 'Woman' and 'Man'. 'Parent' has subclasses 'Mother' and 'Father'. 'Man' has subclasses 'Father' and 'Grandfather'. 'Grownup' has subclasses 'Adult' and 'HappyPerson'. 'SocialRole', 'Dead', 'YoungChild', 'MyBirthdayGuests', 'NarcisticPerson', 'JohnsChildren', 'Female', and 'Orphan' are also shown as subclasses of 'Thing'. The bottom right corner of the interface shows 'Reasoner active' and a checked 'Show Inferences' checkbox.

<https://protege.stanford.edu/>

TopBraid Composer



- Commercial product with a free edition option
- SPIN rules for reasoning
- SPARQL querying

The screenshot displays the TopBraid Composer interface for editing an ontology. The left pane shows a class hierarchy with 'Father' selected. The center pane shows the 'Resource Form' for 'Father', including annotations and other properties. The right pane lists various properties, with 'hasSSN' highlighted. The bottom pane shows a table of instances for 'John'.

[Resource]	rdf:type	rdfs:label	rdfs:comment
John	owl:NamedIndividual	hasChild	

<https://www.topquadrant.com/topbraid-composer-install/>



OWL 2 Web Ontology Language Document Overview (Second Edition)

W3C Recommendation 11 December 2012

This version:

<http://www.w3.org/TR/2012/REC-owl2-overview-20121211/>

Latest version (series 2):

<http://www.w3.org/TR/owl2-overview/>

Latest Recommendation:

<http://www.w3.org/TR/owl-overview>

Previous version:

<http://www.w3.org/TR/2012/PER-owl2-overview-20121018/>

Editors:

W3C OWL Working Group (see [Acknowledgements](#))

Please refer to the [errata](#) for this document, which may include some normative corrections.

A [color-coded version of this document showing changes made since the previous version](#) is also available.

This document is also available in these non-normative formats: [PDF version](#).

See also [translations](#).

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Abstract

The OWL 2 Web Ontology Language, informally OWL 2, is an ontology language for the Semantic Web with formally defined meaning. OWL 2 ontologies provide classes, properties, individuals, and data values and are stored as Semantic Web documents. OWL 2 ontologies can be used along with information written in RDF, and OWL 2 ontologies themselves are primarily exchanged as RDF documents.

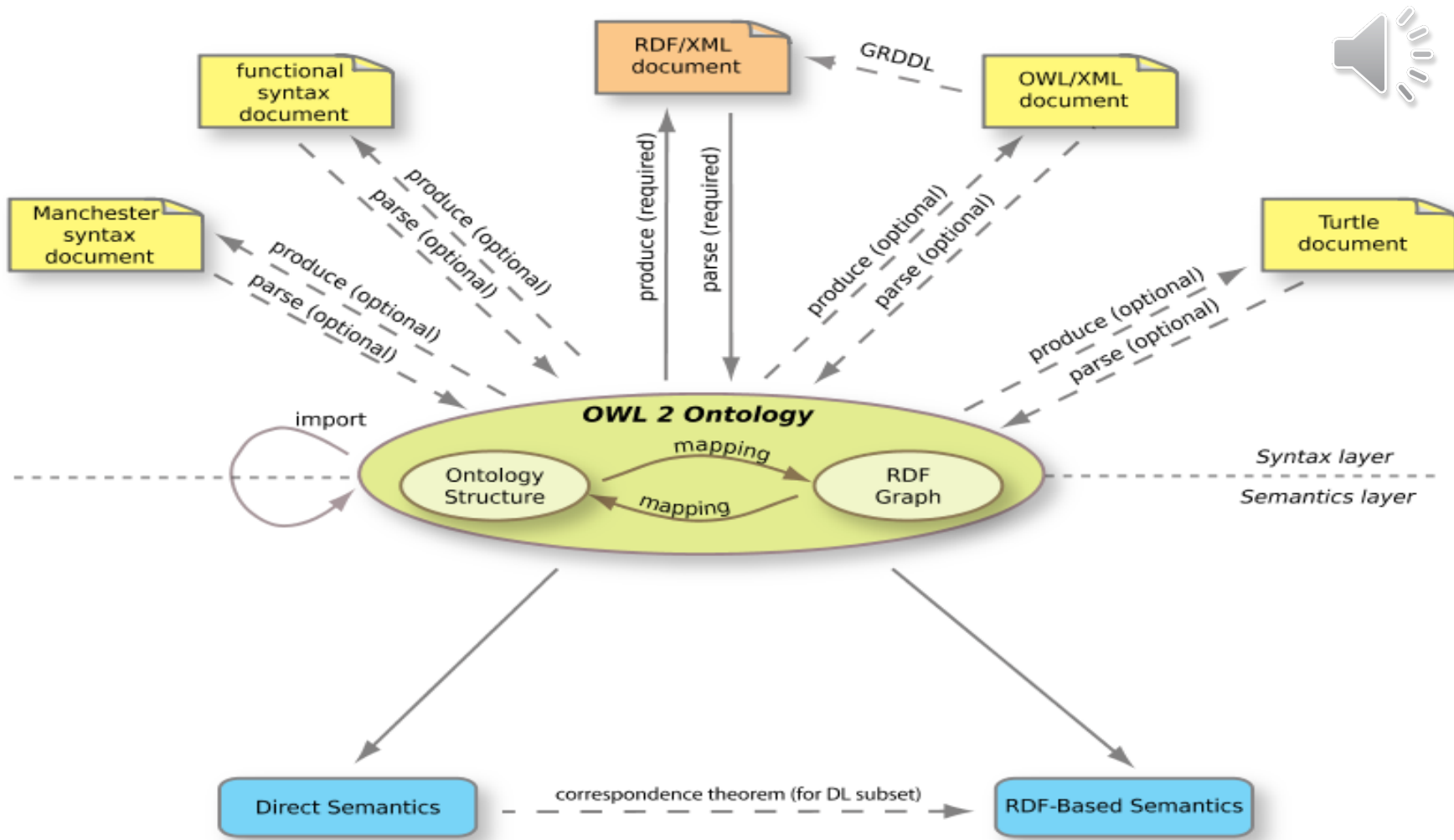


Figure 1. The Structure of OWL 2

Summary



- Background and context of OWL was specified
- See next lecture for learning the OWL language