# OWL Web Ontology Language. Overview


### Abstract

The OWL Web Ontology Language is designed for use by applications that need to process the content of information instead of just presenting information to humans. OWL facilitates greater machine interpretability of Web content than that supported by XML, RDF, and RDF Schema (RDF-S) by providing additional vocabulary along with a formal semantics. OWL has three increasingly-expressive sublanguages: OWL Lite, OWL DL, and OWL Full.

This document is written for readers who want a first impression of the capabilities of OWL. It provides an introduction to OWL by informally describing the features of each of the sublanguages of OWL. Some knowledge of RDF Schema is useful for understanding this document, but not essential. After this document, interested readers may turn to the OWL Guide for more detailed descriptions and extensive examples on the features of OWL. The normative formal definition of OWL can be found in the OWL Semantics and Abstract Syntax.


### 1. Introduction

This document describes the OWL Web Ontology Language. OWL is intended to be used when the information contained in documents needs to be processed by applications, as opposed to situations where the content only needs to be presented to humans. OWL can be used to explicitly represent the meaning of terms in vocabularies and the relationships between those terms. This representation of terms and their interrelationships is called an ontology. OWL has more facilities for expressing meaning and semantics than XML, RDF, and RDF-S, and thus OWL goes beyond these languages in its ability to represent machine interpretable content on the Web. OWL is a revision of the DAML+OIL web ontology language incorporating lessons learned from the design and application of DAML+OIL.

#### 1.1 Document Roadmap

The OWL Language is described by a set of documents, each fulfilling a different purpose, and catering to a different audience. The following provides a brief roadmap for navigating through this set of documents:

- This OWL Overview gives a simple introduction to OWL by providing a language feature listing with very brief feature descriptions;
- The OWL Guide demonstrates the use of the OWL language by providing an extended example. It also provides a glossary of the terminology used in these documents;
- The OWL Reference gives a systematic and compact (but still informally stated) description of all the modelling primitives of OWL;
- The OWL Semantics and Abstract Syntax document is the final and formally stated normative definition of the language;
- The OWL Web Ontology Language Test Cases document contains a large set of test cases for the language;
- The OWL Use Cases and Requirements document contains a set of use cases for a web ontology language and compiles a set of requirements for OWL.

The suggested reading order of the first four documents is as given since they have been listed in increasing degree of technical content. The last two documents complete the documentation set.

#### 1.2 Why OWL?

The Semantic Web is a vision for the future of the Web in which information is given explicit meaning, making it easier for machines to automatically process and integrate information available on the Web. The Semantic Web will build on XML's ability to define customized tagging schemes and RDF's flexible approach to representing data. The first level above RDF required for the Semantic Web is an ontology language what can formally describe the meaning of terminology used in Web documents. If machines are expected to perform useful reasoning tasks on these documents, the language must go beyond the basic semantics of RDF Schema. The OWL Use Cases and Requirements Document provides more details on ontologies, motivates the need for a Web Ontology Language in terms of six use cases, and formulates design goals, requirements and objectives for OWL.

OWL has been designed to meet this need for a Web Ontology Language. OWL is part of the growing stack of W3C recommendations related to the Semantic Web.

- XML provides a surface syntax for structured documents, but imposes no semantic constraints on the meaning of these documents.
- XML Schema is a language for restricting the structure of XML documents and also extends XML with datatypes.

- RDF is a datamodel for objects ("resources") and relations between them, provides a simple semantics for this datamodel, and these datamodels can be represented in an XML syntax.
- RDF Schema is a vocabulary for describing properties and classes of RDF resources, with a semantics for generalization-hierarchies of such properties and classes.
- OWL adds more vocabulary for describing properties and classes: among others, relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes.

### 1.3 The three sublanguages of OWL

OWL provides three increasingly expressive sublanguages designed for use by specific communities of implementers and users.

- *OWL Lite* supports those users primarily needing a classification hierarchy and simple constraints. For example, while it supports cardinality constraints, it only permits cardinality values of 0 or 1. It should be simpler to provide tool support for OWL Lite than its more expressive relatives, and OWL Lite provides a quick migration path for thesauri and other taxonomies. Owl Lite also has a lower formal complexity than OWL DL, see the section on OWL Lite in the OWL Reference for further details.
- *OWL DL* supports those users who want the maximum expressiveness while retaining computational completeness (all conclusions are guaranteed to be computable) and decidability (all computations will finish in finite time). OWL DL includes all OWL language constructs, but they can be used only under certain restrictions (for example, while a class may be a subclass of many classes, a class cannot be an instance of another class). OWL DL is so named due to its correspondence with *description logics*, a field of research that has studied the logics that form the formal foundation of OWL.
- *OWL Full* is meant for users who want maximum expressiveness and the syntactic freedom of RDF with no computational guarantees. For example, in OWL Full a class can be treated simultaneously as a collection of individuals and as an individual in its own right. OWL Full allows an ontology to augment the meaning of the pre-defined (RDF or OWL) vocabulary. It is unlikely that any reasoning software will be able to support complete reasoning for every feature of OWL Full.

Each of these sublanguages is an extension of its simpler predecessor, both in what can be legally expressed and in what can be validly concluded. The following set of relations hold. Their inverses do not.

- Every legal OWL Lite ontology is a legal OWL DL ontology.
- Every legal OWL DL ontology is a legal OWL Full ontology.
- Every valid OWL Lite conclusion is a valid OWL DL conclusion.
- Every valid OWL DL conclusion is a valid OWL Full conclusion.

Ontology developers adopting OWL should consider which sublanguage best suits their needs. The choice between OWL Lite and OWL DL depends on the extent to which users require the more-expressive constructs provided by OWL DL. The choice between OWL DL and OWL Full mainly depends on the extent to which users require the meta-modeling facilities of RDF Schema (e.g. defining classes of classes, or attaching properties to classes). When using OWL Full as compared to OWL DL, reasoning support is less predictable since complete OWL Full implementations do not currently exist.

OWL Full can be viewed as an extension of RDF, while OWL Lite and OWL DL can be viewed as extensions of a restricted view of RDF. Every OWL (Lite, DL, Full) document is an RDF document, and every RDF document is an OWL Full document, but only some RDF documents will be a legal OWL Lite or OWL DL document. Because of this, some care has to be taken when a user wants to migrate an RDF document to OWL. When the expressiveness of OWL DL or OWL Lite is deemed appropriate, some precautions have to be taken to ensure that the original RDF document complies with the additional constraints imposed by OWL DL and OWL Lite. Among others, every URI that is used as a class name must be explicitly asserted to be of type owl:Class (and similarly for properties), every individual must be asserted to belong to at least one class (even if only owl:Thing), the URI's used for classes, properties and individuals must be mutually disjoint. The details of these and other constraints on OWL DL and OWL Lite are explained in appendix E of the OWL Reference.

## 3. Language Description of OWL Lite

OWL Lite uses only some of the OWL language features and has more limitations on the use of the features than OWL DL or OWL Full. For example, in OWL Lite classes can only be defined in terms of named superclasses (superclasses cannot be arbitrary expressions), and only certain kinds of class restrictions can be used. Equivalence between classes and subclass relationships between classes are also only allowed between named classes, and not between arbitrary class expressions. Similarly, restrictions in OWL Lite use only named classes. OWL Lite also has a limited notion of cardinality - the only cardinalities allowed to be explicitly stated are 0 or 1.