OWL 1.1 Design Decisions

OWL 1.1 Draft Team

Contents

- General Design Principles
- Structural Specification
- Expressivity Enhancements
- Metamodeling
- Anonymous Individuals
- Imports
- Annotations on Axioms
- RDF Mapping

General Design Principles

- **Extend OWL with things that users need**
  - **expressivity enhancements**
- **Bring the spec closer to tools**
  - **features of OWL have never been implemented (correctly) should be reconsidered**
- **Make specification cleaner and clearer**
  - **OWL 1.0 spec is rather cumbersome**
  - **important questions are not answered by the spec**
  - **many implementations interpret the spec wrongly**
  - **for some parts of the spec we even do not know whether they can be implemented correctly**

Structural Specification (I)

- **Example ontology O:**
  - `Class ( Student partial Person )`
- **Questions:**
  - What are the classes contained in this ontology?
    - I.e., is the class `Person` a part of this ontology?
  - Is such an ontology syntactically valid?
    - I.e., should all classes be defined before they are used?
  - Is this axiom the same thing as the following axiom:
    - `SubClassOf ( Student Person )`
- **Answers to these questions in OWL 1.0…**
  - …varied from user to user
  - …were difficult to give because an ontology is just a bunch of text

Structural Specification (II)

- Solution: define OWL 1.1 (DL) as an object model
- Structural spec allows us to…
  - …to give precise answers to questions mentioned
    - by talking about properties of structures, not of text
  - …talk explicitly about the constructs of the language
  - …define operations on ontologies (= DIG 2.0)
    - defined in terms of operations on data structures
  - …talk about OWL constructs at a higher abstraction level
    - several RDF triples often define one construct
  - …easily derive a storage model for OWL 1.1 (DL)
    - it was used as basis for OWL 1.1 API
- Target audience: implementors and modelers

Expressivity Enhancements

- **Qualified number restrictions**
  - **"A quadruped is an animal that has four legs."**
    - *A. Rector and G. Schreiber. Qualified Cardinality Restrictions (QCRs): Constraining the Number of Values of a Particular Type for a Property. W3C Working Draft, November 2 2005.*
- **Role composition**
  - **"Abnormality of a part of an anatomical structure constitutes an abnormality of the structure as a whole."**
  - **needed in numerous domains (e.g. medicine)**
    - *A. Rector. Analysis of Propagation along Transitive Roles: Formalisation of the Galen Experience with Medical Ontologies. In Proc. DL 2002, Toulouse, France, 2002.*
    - *A. Rector and C. Welty. Simple Part-whole Relations in OWL Ontologies. W3C Working Draft, August 11 2005.*
  - **reflexive, irreflexive, antisymmetric, exists-self**
  - **negative role assertions**
- **Datatype enhancements**

Metamodeling

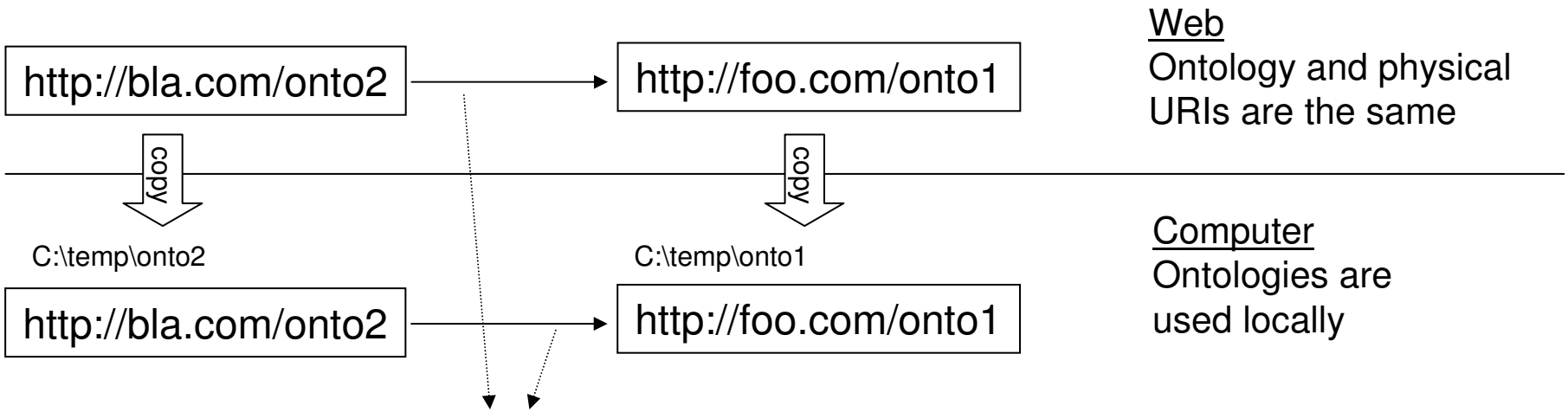
- **Metamodeling is often needed in practice**
  - **even in applications of OWL DL**
  - *G. Schreiber. The Web is not well-formed. IEEE Intelligent Systems, 17(2):79–80, 2002.*
  - *L. Stojanovic, A. Abecker, N. Stojanovic, R. Studer: On Managing Changes in the Ontology-Based E-government, CoopIS/DOA/ODBASE (2) 2004: 1080–1097*
- **Possible approach: punning**
  - **simple and does not require changing existing implementations**
  - **most applications do not expect new consequences**
    - **only syntactic metamodeling is needed**
- **Alternative approaches:**
  - **OWL-Full**
    - **undecidable**
    - **no tool implements it (correctly and completely)**
  - **HiLog-semantics**
    - **decidable and could be implemented with minor changes to reasoners**
    - **requires changing the existing semantics of OWL 1.0 DL**
  - *B. Motik. On the Properties of Metamodeling in OWL. Journal of Logic and Computation, 17(4):617–637, 2007.*

Anonymous Individuals (aka B-nodes)

- Lead to undecidaiblity if allowed freely
- No tool implements the real semantics
  - RDF- or DL-based
- Solution: legalize their status as Skolems

Imports

- Ontology files rarely live on the Web
- Most applications use ontology files locally



- If imports refer to the physical location, then copying breaks the dependency
- OWL 1.1 spec does not specify how to locate imports
  - resolving ontology to physical URIs is implementation specific

Annotations on Axioms

- **Applications often need to…**
  - **…store information about axioms**
    - **who created an axiom**
    - **when was the axiom added to the ontology**
  - **…associate special status to axioms**
    - **integrity constraints**
      - *B. Motik, I. Horrocks, and U. Sattler. Bridging the Gap Between OWL and Relational Databases. WWW 2007, 807–816, 2007*
    - **fuzzy or certainty values**
      - *G. Stoilos, G. Stamou, V. Tzouvaras, J. Z. Pan, and I. Horrocks. Fuzzy OWL: Uncertainty and the semantic web. OWL-ED 2005*
- **Such information is metalogical**
  - **treat it as comments**
  - **can be thrown away without affecting the entailments**

RDF Mapping (I): Requirements

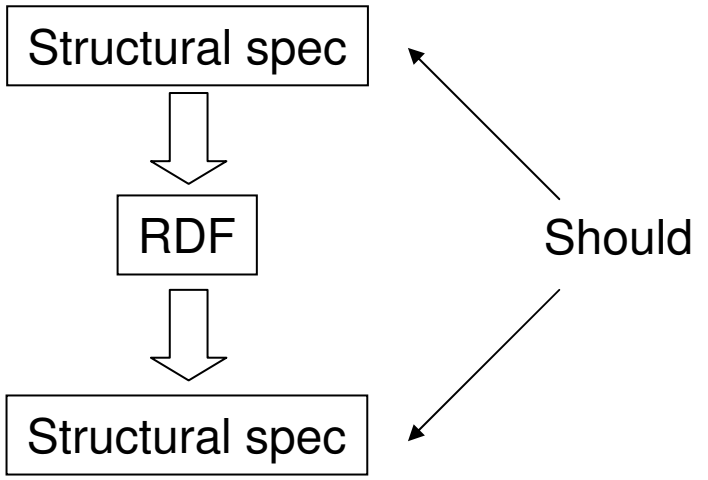
- Capture all features of OWL 1.1
  - annotations on axioms
  - negative property assertions
  - punning
  - ...
- Fix clarity issues in OWL 1.0 mapping
- Make it easier to implement
  - should reduce bugs in tools
  - should improve interoperability between tools

RDF Mapping (II): Two-Way Translation

- **Parsing OWL 1.0 RDF is really hard**
  - **there is even a paper about it:**
    - *S. Bechhofer, J. J. Carroll. OWL DL: Trees or Triples? WWW2004, New York, June 2004.*
  - **in practice, it is based on nonnormative documents**
    - *S. Bechhofer. Parsing OWL in RDF/XML. W3C Working Group Note, January 21 2004.*
  - **there is no one well-defined defined solution**
  - **source of numerous errors in practice**
- **Species validation is hard**
  - **an RDF graph G is in OWL DL is an OWL ontology O exists such that the translation of O produces the triples of G**
  - **really hard to interpret in practice**
  - **Is it decidable?**
  - **How to tell whether an implementation is correct?**

RDF Mapping (II): Two-Way Translation

- **So we provided an explicit inverse translation**
- **Relationship between them:**



- **OWL 1.1 should support full round-tripping**
  - **We need n-ary versions of all constructs!**

RDF Mapping (III): Typed Vocabulary

- **Required if punning is allowed**
  - **otherwise, we do not know the context in which a URI is used**
- **Assume that we ban punning from OWL 1.1 (DL)**
  - **⟨ c owl:someValuesFrom d ⟩, ⟨ c owl:onProperty p ⟩**
  - **Is p an object or a data property?**
    - **we must know this**
      - **object and data properties are interpreted separately**
    - **required for a clean semantics and decidability**
  - **How do we disambiguate the types?**
    - **Solution 1: we type vocabulary usage**
      - **simple solution**
      - **easy to parse**
    - **Solution 2: we have explicit type specifications**

RDF Mapping (III): Typed Vocabulary

- Solution 2: we have explicit type specifications
- How does typing interact with imports?
  - parsing is really difficult if one should look into imported files
  - Can I parse an ontology if imports are broken?
  - Can different ontologies provide the type for the same property?
    - one might expect “redeclaration” errors
- How does typing interact with the structural spec?
  - structural spec is naturally typed
    - we have an `ObjectProperty` and a `DataProperty` class
  - there is no explicit notion of typing in structural spec
    - How to import a functional-style syntax ontology into an RDF ontology?
- How does typing interact with RDF?
  - OWL-Full semantics adds certain typing triples
    - the domain of `owl:someValuesFrom` is `owl:Class`
  - Should we look at inferred typing triples during parsing?
    - Should we compute RDF entailments before parsing?