ONTOLOGIES & DESCRIPTION LOGICS

Parcours IA - Représentation des connaissances

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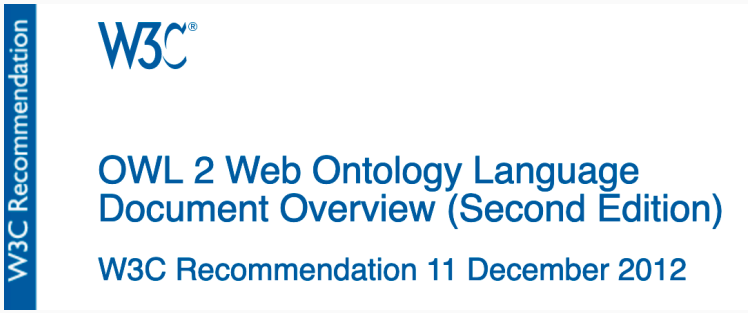
OWL

OWL: WEB ONTOLOGY LANGUAGE

Standard of the World Wide Web Consortium (W3C)

- Original version: OWL 1 from 2004
- Current version: OWL 2 from 2012 (introduces EL, QL, RL profiles)



Motivated by the Semantic Web

Based upon (highly expressive) description logics, but offers

- extra features, like annotations, comments, imports
- several different formats (serializations):
  - XML, Turtle (RDF), Manchester syntax

Much more well known than DLs outside academia

Building blocks of OWL

- individuals
- classes $\rightsquigarrow$ concepts in DLs
- object properties $\rightsquigarrow$ roles in DLs
- data properties:
  - connect individuals to data values (integers, strings)
- annotation properties:
  - used to annotate ontologies, classes, axioms, etc.
  - metadata, not used for reasoning

Axioms

DL syntax	OWL (Manchester syntax)
$C \sqsubseteq D$	C SubClassOf: D
$C \equiv D$	C EquivalentTo: D
$C \sqsubseteq \neg D$	C DisjointWith: D
$R \sqsubseteq S$	R SubPropertyOf: S

CONSTRUCTORS IN OWL

DL syntax	OWL (Manchester syntax)
$\neg C$	not C
$C \sqcup D$	C or D
$C \sqcap D$	C and D
$\exists r.C$	r some C
$\forall r.C$	r only C
$\exists r.\{a\}$	r value $\{a\}$
$\geq n\, r.C$	r min n C
$\leq n\, r.C$	r max n C
r^-	inverse r
$\top$	owl:Thing
$\bot$	owl:Nothing

EXAMPLE CLASSES IN OWL

Female **and** Scientist

Cat **or** Dog

Person **and** (**not** Parent)

teaches **some** (CompSciCourse **and** (offeredBy **some** FrenchUniv))

teaches **only** CompSciCourse

hasIngredient **max** 5 owl:Thing

ONTOLOGY CONSTRUCTION

TASK OF ONTOLOGY CONSTRUCTION

No single ‘correct’ ontology for any domain

- many possible ways to model a given domain
- different people will model in different ways
- need to consider how it will be used

Generally not possible to fully automate ontology design

- needs domain expert, analysis of application needs

Guidelines / methodologies for ontology design

- present approach from ‘Ontology Development 101’ (Noy & McGuinness, 2001)

STEPS IN ONTOLOGY CONSTRUCTION

1) Determine **domain and scope of the ontology**

- what is the domain that the ontology will cover?
- how is the ontology going to be used?
- what types of questions should the information in the ontology allow us to answer? (competency questions)
- who will use and maintain the ontology?

$\rightsquigarrow$ help to choose appropriate level of detail, ontology language

2) Consider **reusing (parts of) existing ontologies**

3) Make a **list all of the important terms**

Steps in ontology construction (cont.)

4) Define the classes and organize them into hierarchy

- different approaches: top-down / bottom-up / mixed

5) Define properties and link them to the classes

- add existential / universal / cardinality restrictions to classes

6) Define other characteristics of properties

- subproperties, inverses
- functionality, transitivity, ...
- domain and range

7) Create individuals and assertions about them

Note: iterative, not linear process, will likely need revisit steps!

ZOOM ON STEP 4: DEFINING AND ORGANIZING CLASSES

Ensure **concept hierarchy reflects subclass ('is-a')** relationship

- If *C* is subclass of *D*, every member of *C* must be a member of *D*
- don't just organize into classes by association!
  - example: HockeyStick and Goalie are *not* subclasses of Hockey

Multiple inheritance is allowed (e.g. *C* subclass of *D*, *E*, and *F*)

'Sibling' classes should have **same level of generality**

Keep **number of sibling classes reasonable** (roughly 2-12)

- avoid having just a single class on a given 'level'
- if large number of sibling classes, see if it would make sense to group them into intermediate classes

MORE ON STEP 4: DEFINING AND ORGANIZING CLASSES

When to add a new class?

- a subclass usually has some further characteristics / restrictions / participates in different relationships than its superclasses

Class or individual?

- not always obvious, really depends on application

Add **disjointness axioms** where appropriate

- useful for debugging

Limiting the scope

- cannot describe every possible aspect of the domain
- don't go into more detail than you need for your application

DEBUGGING, REASONING SUPPORT

Run the reasoner often and fix problems right away

- if too many problems, reasoner may fail / very slow
- better to fix modelling errors early, else lose lots of time

Errors to look for:

- unsatisfiable concepts (marked in red in Protégé)
- unsatisfiable KB (error message, owl:Thing subclassOf owl:Nothing)
- any unexpected entailments

Take advantage of Protégé's **'explain inference' facility** (button marked ?) to help **understand source of problems**

- **justifications** = minimal sets of axioms / assertions that are sufficient to get the entailment