

# Intro To Description Logics for the Semantic Web

For CMCS498w

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# SemWeb Origins

- SemWeb (intellectual) stakeholders:
  - Digital Librarians
  - Search engine authors
  - Web hackers
  - Semi-structured data folks
  - Deductive databassits
  - Krepsters
    - Neats and scruffies
      - The Web is a Semantic Net?
    - First order and not first order
    - Description logicians...everyone else
- First round goes to the DL folks (mostly)!

# The Reason for DLs

- DLs: The background insight
  - The semantics of semantic nets was (expressible in) (a fragment of) FOL
- DLs: The core insight
  - Reasoner as (small) component of the system
  - Tractibility is essential
  - Trade expressivity for tractability
- DLs: The revisionist insight
  - People want more expressivity
  - Optimizations can make real world ontologies in an EXPTIME logic *practical*
  - Decidability is still essential

## *Knowledge Representation goes Global*

Knowledge representation is a field which is currently seems to have the reputation of being initially interesting, but which did not seem to shake the world to the extent that some of its proponents hoped. It made sense but was of limited use on a small scale, but never made it to the large scale. This is exactly the state which the hypertext field was in before the Web. Each field had made certain centralist assumptions -- if not in the philosophy, then in the implementations, which prevented them from spreading globally. But each field was based on fundamentally sound ideas about the representation of knowledge. **The Semantic Web is what we will get if we perform the same globalization process to Knowledge Representation that the Web initially did to Hypertext.** We remove the centralized concepts of absolute truth, total knowledge, and total provability, and see what we can do with limited knowledge.

<http://www.w3.org/DesignIssues/RDFnot.html>

# SemWeb: The View from DL

- DLs made semantic nets semantics *clear*
  - Thus, helped interoperability
- DLs limit expressivity
- DL reasoning is *decidable*
- DL reasoners are *scalable*
- DLs are *workable* for a slew of garden variety KR tasks
- DLs have *proven* themselves in real world applications
- DLs typically make the *open world assumption*
- DLs are straightforward to implement
- DLs lend themselves to *logic engineering*

# What is a DL?

- A decidable fragment of FOL
- A propositional modal logic
- A classes and properties (concepts and roles) oriented KR language
- Subsumption and satisfiability (consistency) are the key inferences
- Most DLs that we study are supersets of *ALC*
  - Boolean operators on concepts
  - Existential and Universal quantifiers
- OWL-DL is a large superset (SHOIN):
  - Property hierarchies & Transitive roles (SH)
  - Inverse (I)
  - Nominals (O) (hasValue and one of)
  - Number restrictions (counting quantifiers)

# Basic DL concepts

- Some basic terms
  - Classes & concepts
  - Class *expressions* and *constructors* and *axioms*
  - Properties/predicates/roles/slots
    - Slot fillers
- TBox
  - The *terminology*
  - Contains *definitions* of named classes
    - E.g., C subClassOf (D & E)
- ABox
  - Assertions about *individuals*
    - E.g., x type C, or x owns y
- Rbox (much less common)

# What's different about SemWeb?

- Very expressive TBoxen
- Huge ABoxen
- Heavy reliance on property hierarchies
- Multiple & mix and match ontologies
- Lots of “oneOf” and “inverse”
- Datatypes with complex reasoning

# Reading

- Description Logic Handbook (DLHB) Chapter 1: background
  - <http://www.cs.man.ac.uk/~franconi/dl/course/dlhb/dlhb-01.pdf>
  - Sections 1.1, 1.2 1.3, 1.7 and 1.8
- DLHB Chapter 2:
  - <http://www.cs.man.ac.uk/~franconi/dl/course/dlhb/dlhb-02.pdf>
  - Sections 2.1, 2.2.1, skim 2.2.2 (except 2.2.2.3), 2.2.3
  - If you want a jump start for reasoning, try 2.2.4