Ontology Languages

Introduction to Ontology

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Objectives

Objective

Explain the concept of ontologies

Objective

Explain the use of ontologies in industrial applications

Definition and Background

An ontology is a formal, explicit, shared specification of a conceptualization of a domain (Gruber, 1993)

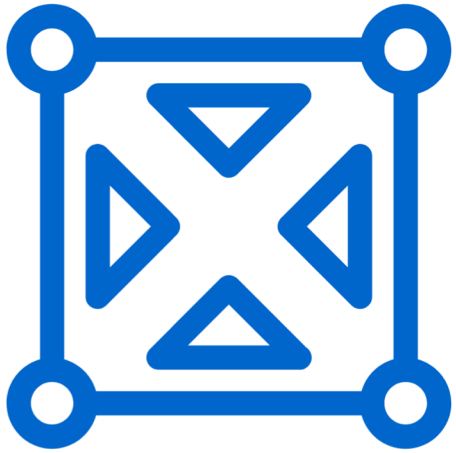
***Conceptualization*: the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that hold among them**

- A conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose

Today the word ontology is often a synonym for a shared knowledge base

Formal Languages for Ontologies

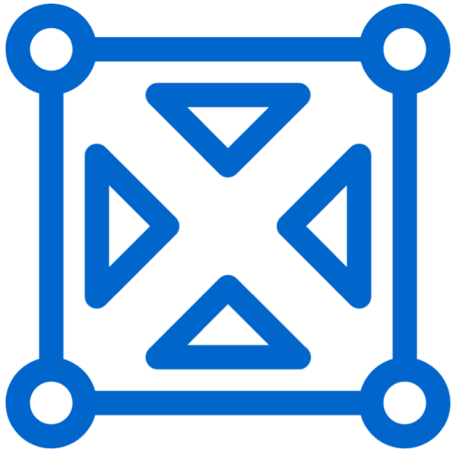
- **Ontologies are typically expressed in some formal logic-based language (e.g., first-order logic).**
- **The literature also offers special formalisms for defining ontologies that contain mainly taxonomic knowledge:**
  - Semantic networks
  - Frames
  - Description logics
  - RDF, RDFS and OWL in the Semantic Web.



Formal Languages for Ontologies, cont'd

You can think about these formalisms as being object-oriented logics:

- They have special constructs for representing knowledge about individuals (or objects), categories (or classes) and relationships (or roles).
- Categories are organized into taxonomies.
- They have special reasoning methods to deal with these constructs.



Taxonomies

Taxonomy is the practice and science of classification.

Taxonomies have been used profitably in various technical fields

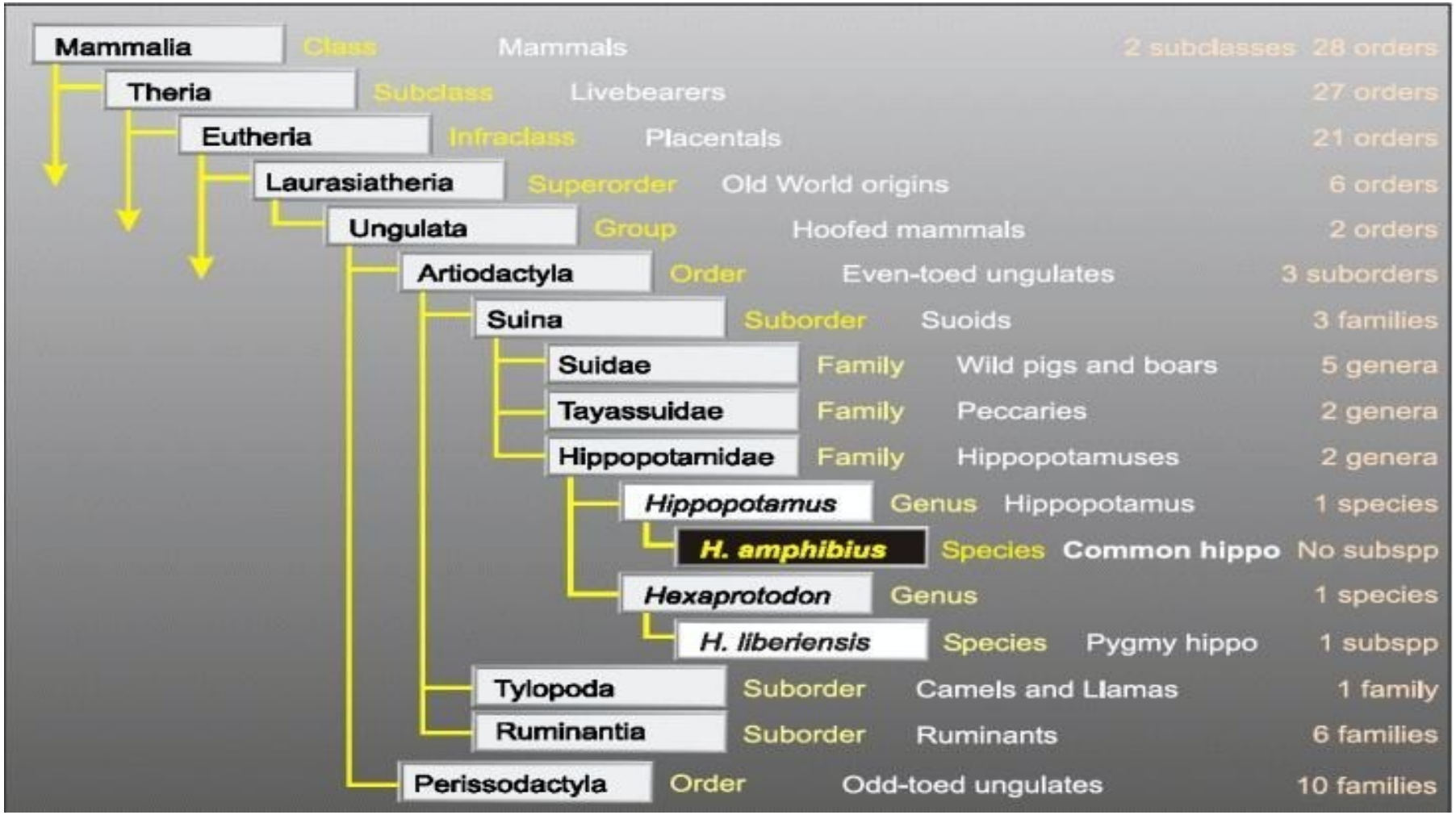
- e.g., biology, medicine, library science
- e.g., programming languages, databases and software engineering

Taxonomies are very important in modern applications:

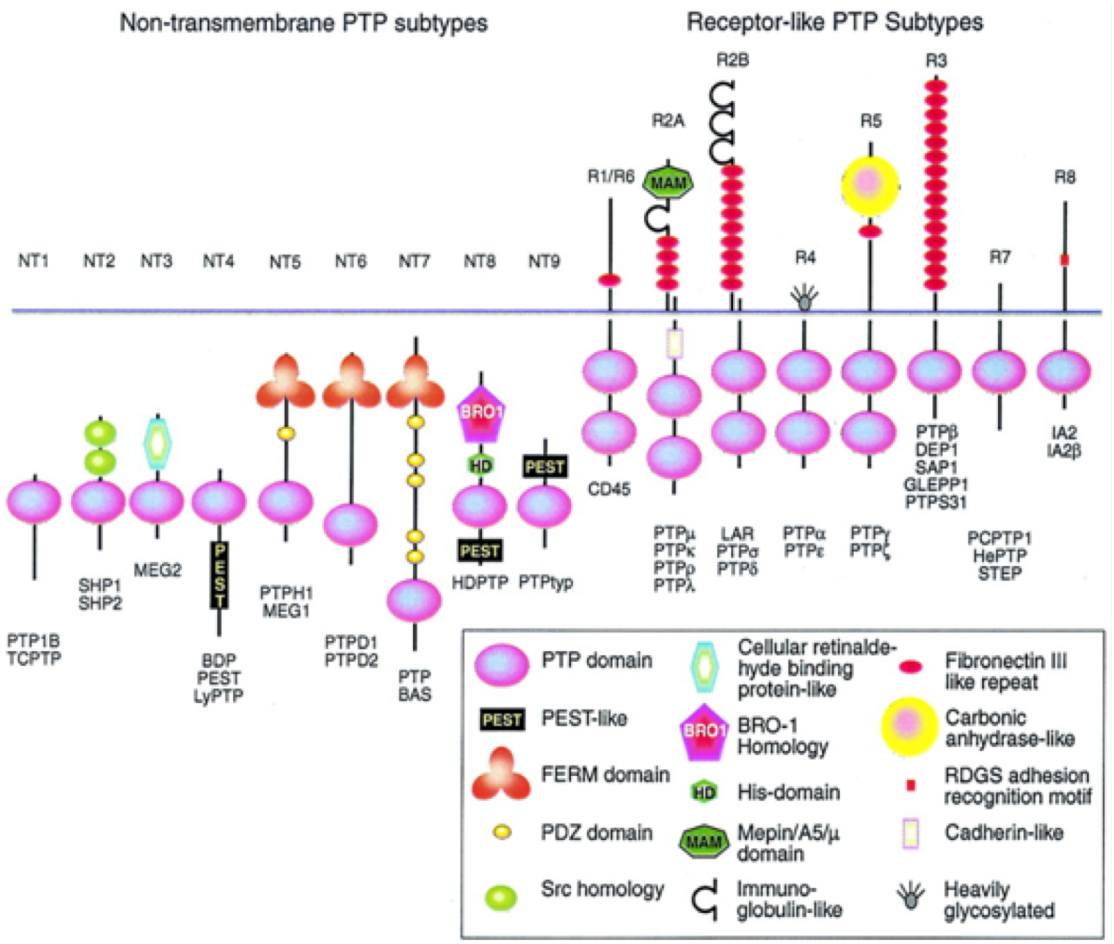
- Web information retrieval and integration,
- knowledge management,
- e-commerce,
- e-science,
- e-government, etc.

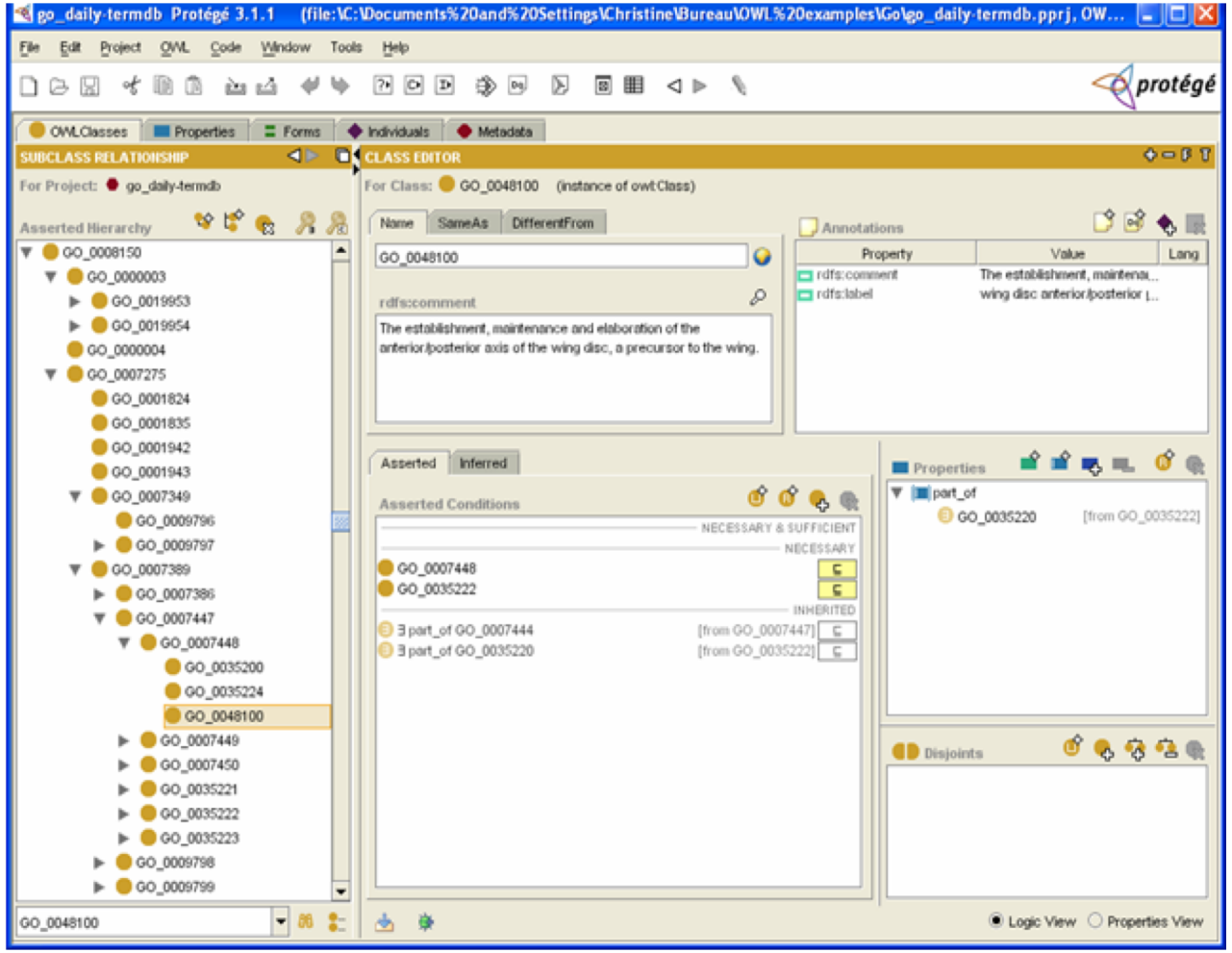
Ontology Example: Lightweight Taxonomies

Linnaean taxonomy: a classification of living things



Ontology Example: e-Science





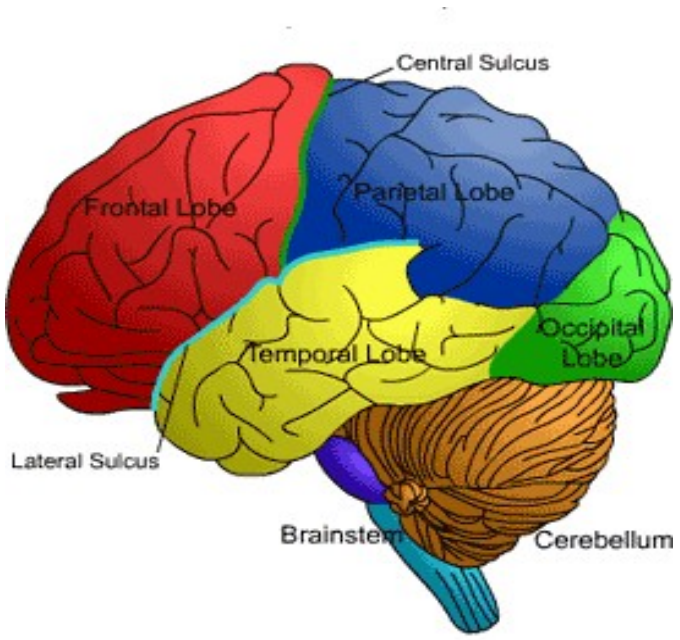
GO http://www.geneontology.org/

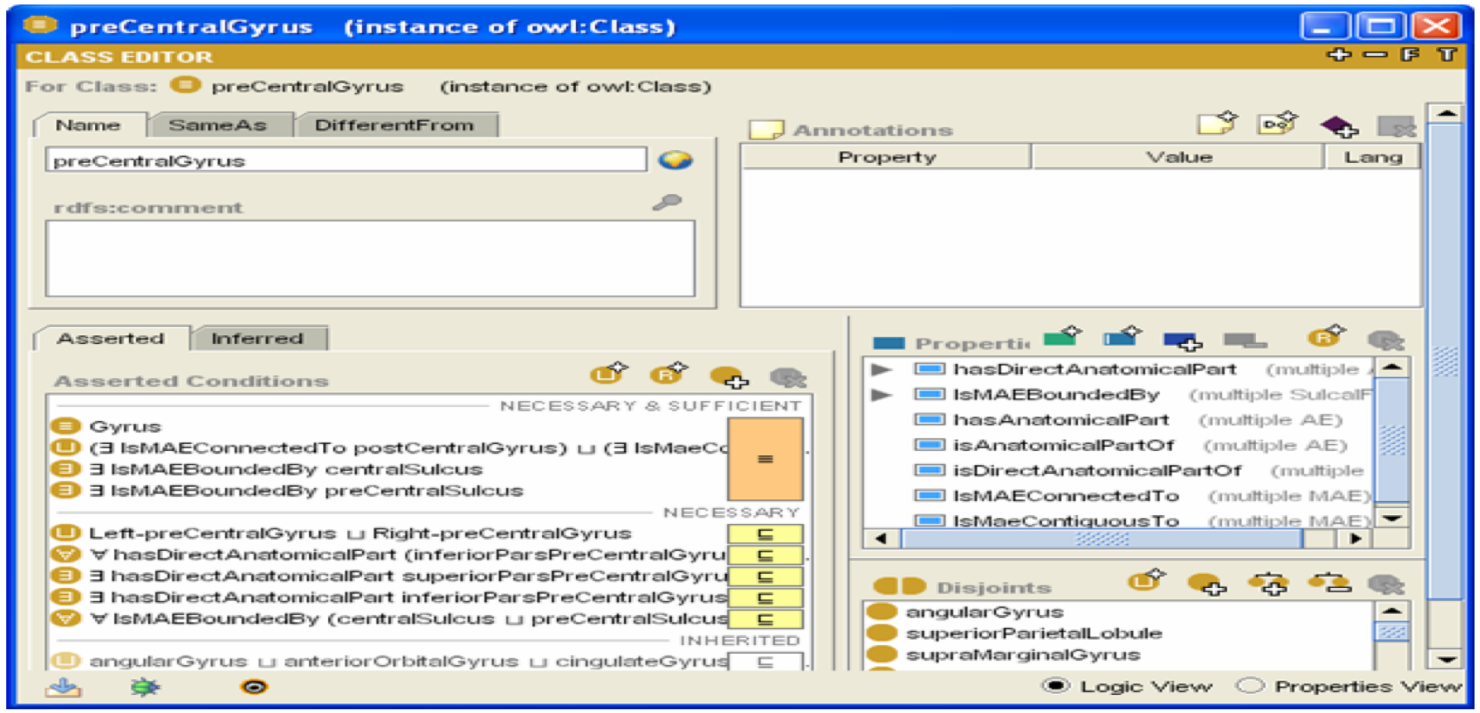
MGED http://mged.sourceforge.net/ontologies/MGEDontology.php

Ontology Example: Medicine

- Terminologies such as Snomed CT, NCI, Galen and FMA

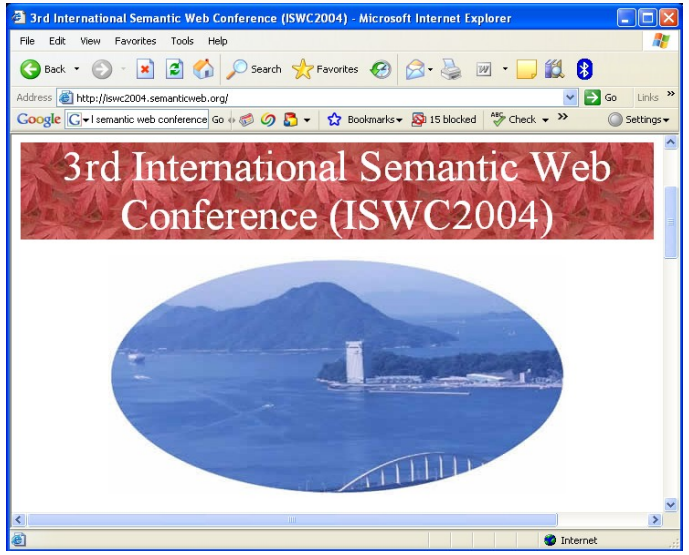
  Used, e.g., for semi-automated annotation of MRI images

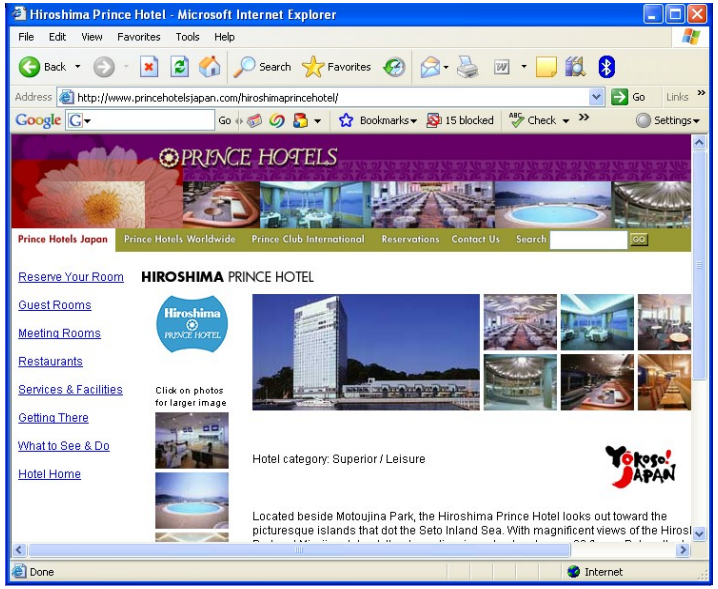


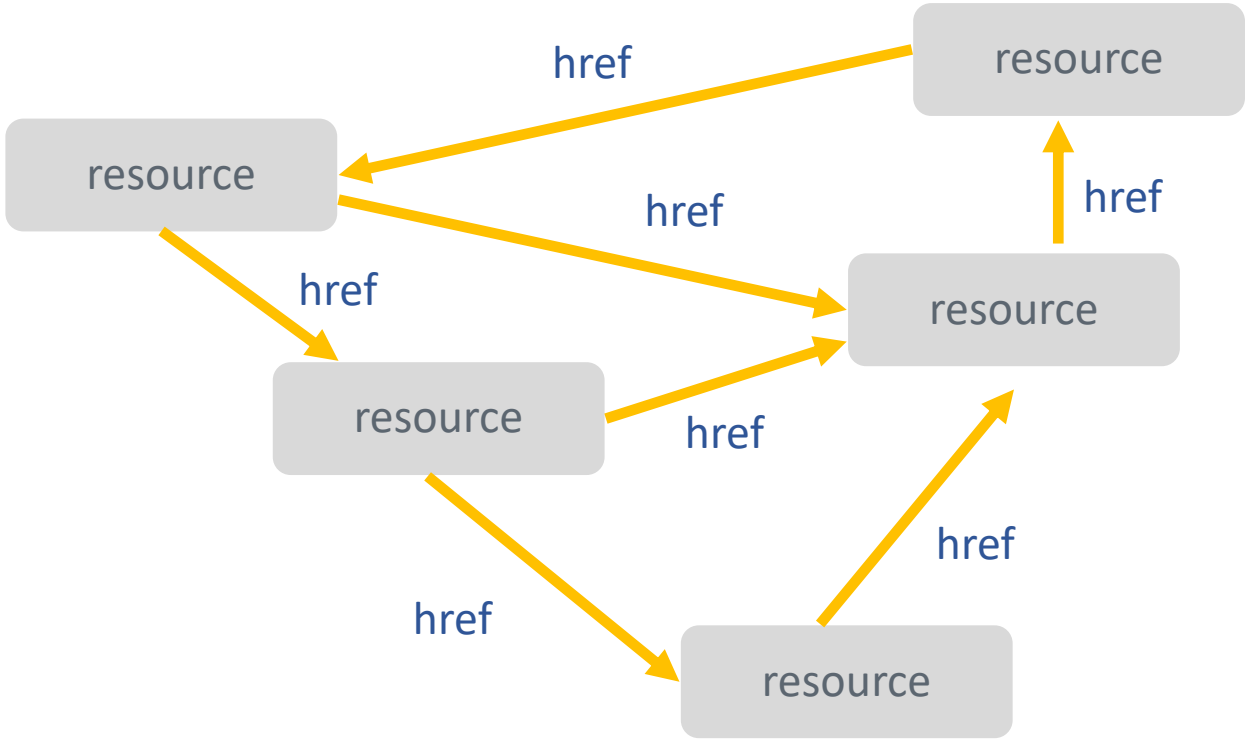


Clinicians use different terms that mean the same thing: ‘heart attack,’ ‘myocardial infarction,’ and ‘MI’ may mean the same thing to a cardiologist, but to a computer, they are all different.

Ontology Example Application: Semantic Web



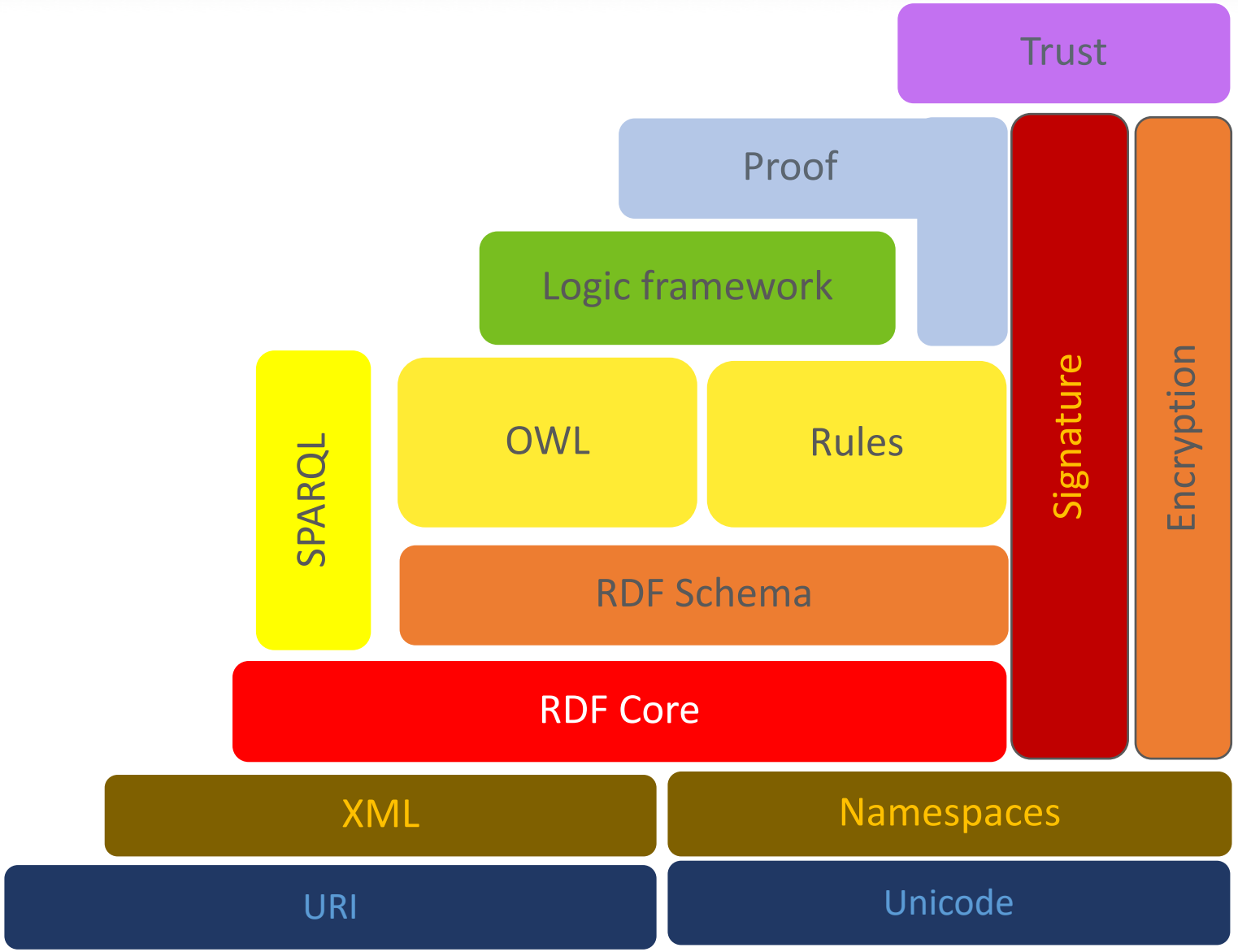




Syntactic Web

Credit

The Semantic Web “Layer Cake”



The Syntactic Web is…

A place where **computers** do the **presentation** (easy)
and **people** do the **linking** and **interpreting** (hard).

A hypermedia, a digital library

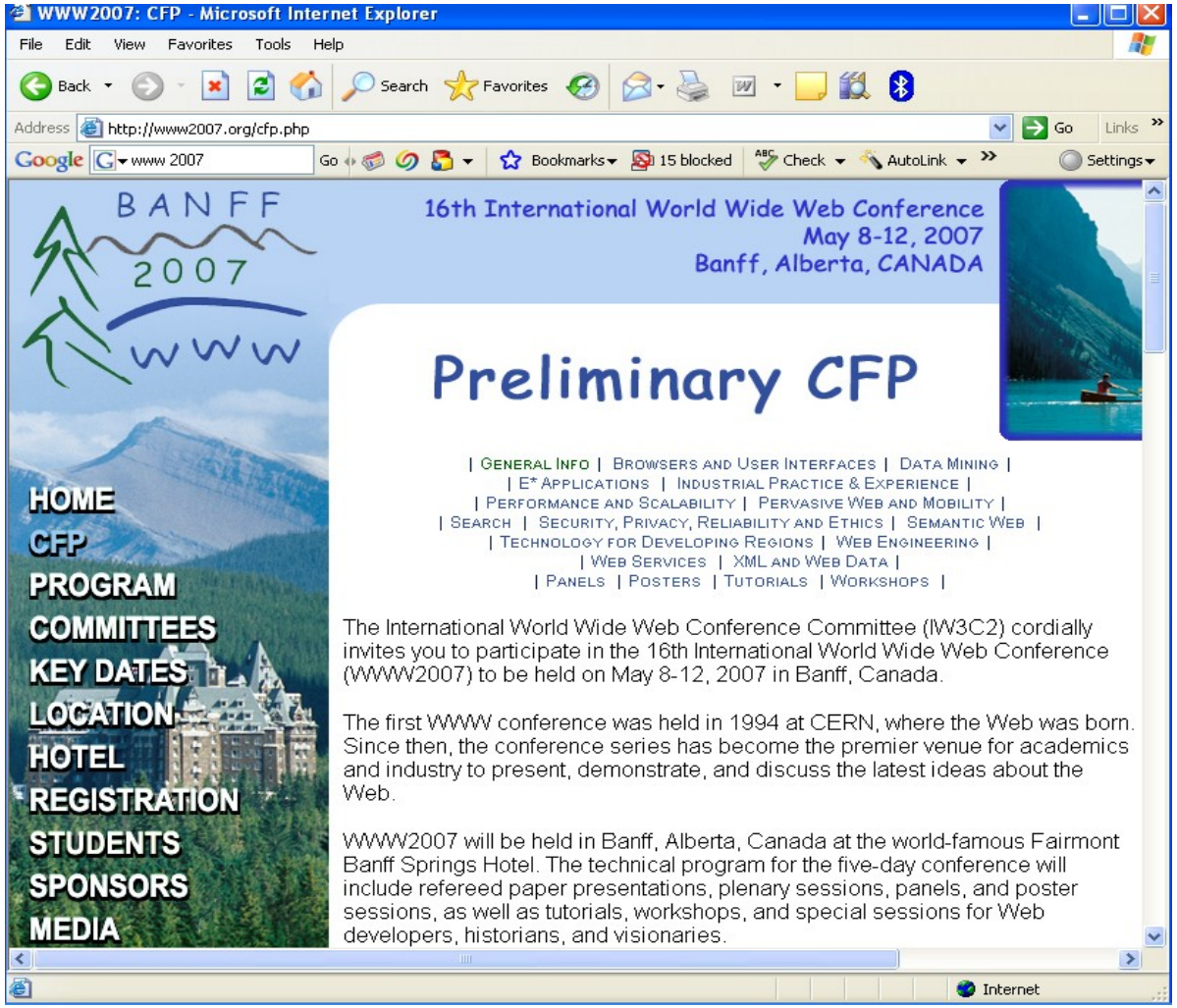
- A library of documents (called web pages) interconnected by links

A database, an application platform

- A common portal to applications accessible through web pages, and presenting their results as web pages

A platform for multimedia

What is the Problem?



Typical Web Page

Markup consists of

- Rendering information (e.g., font size and color)
- Hyperlinks to related content

Semantic content is accessible to humans but not (easily) to computer…

The Information We Can See

WWW2007

The sixteenth International World Wide Web Conference May 8–12, 2007 Banff, Alberta, Canada

Preliminary Call for Papers

The International World Wide Web Conference Committee (IW3C2) cordially invites you to participate in the 16th International World Wide Web Conference (WWW2007) to be held on May 8-12, 2007 in Banff, Canada.

The first WWW conference was held in 1994 at CERN, where the Web was born. Since then, the conference series has become the premier venue for academics and indus- try to present, demonstrate, and discuss the latest ideas about the Web.

WWW2007 will be held in Banff, Alberta, Canada at the world-famous Fairmont Banff Springs Hotel. The technical program for the five-day conference will include refereed paper presentations, plenary sessions, panels, and poster sessions, as well as tutorials, workshops, and special sessions for Web developers, historians, and visionaries.

The Information a Machine Can See

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Solution: XML Markup with “Meaningful” Tags?

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The sixteenth International World Wide Web Conference</name>
<date>May 8–12, 2007</date>
<location>Banff, Alberta, Canada</location>
<slogan>Preliminary Call for Papers</slogan>

<announcement>The International World Wide Web Conference Committee (IW3C2) cordially invites you to participate in the 16th International World Wide Web Confer- ence (WWW2007) to be held on May 8-12, 2007 in Banff, Canada.</announcement>

<statement>The first WWW conference was held in 1994 at CERN, where the Web was born. Since then, the conference series has become the premier venue for aca- demics and industry to present, demonstrate, and discuss the latest ideas about the Web. WWW2007 will be held in Banff, Alberta, Canada at the world-famous Fairmont Banff Springs Hotel. The technical program for the five-day conference will include refereed paper presentations, plenary sessions, panels, and poster sessions, as well as tutorials, workshops, and special sessions for Web developers, historians,
and visionaries.</statement>

But What About…

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Still the Machine Only Sees…

Need to add ontologies: agreement on the meaning of annotations!

Difficulties with the Syntactic Web

Complex queries involving background knowledge

- Find information about “animals that use sonar but are neither bats nor dolphins” (e.g., Barn Owl)

Locating information in data repositories

- Travel inquires
- Prices of goods and services
- Results of human genome experiments

Finding and using “web services”

- Visualize surface interactions between two proteins

Delegating complex tasks to web “agents”

- Book me a holiday next weekend somewhere warm, not too far away, and where they speak French or English

Requirements for Ontology Languages

A well-defined syntax.

- This is a necessary condition for machine-processing of ontologies.

A formal semantics, i.e., a precise description of the meaning of the sentences of an ontology.

- One important use of a formal semantics is to define what the correct answers to queries to an ontology are.
- **Answering queries** will also be called **reasoning**.

Efficient automated support for answering queries (also called automated reasoning support).

Sufficient expressive power to model the domain of interest.

Some Ontology Languages

Weak languages:

- From conceptual modeling: ER-diagrams, UML-diagrams.
- Schema.org (Microdata, RDFa) for markup of websites
- The Resource Description Framework (RDF) and its extension RDFS with schema vocabulary.

More expressive languages:

- Description logics and the standard OWL (Web Ontology Language);
- Datalog and rule-based languages;
- Conceptual graphs;
- First-order Logic.

Wrap-Up