Description Logics: a nice family of logics
Introduction Part 2: OWL & DLs

ESSLLI, 15 August 2016

Uli Sattler
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Ontology Language - a Motivation

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Ontology Language - a Motivation

What's the Problem?

- Typical web page markup consists of:
  - Rendering information (e.g., font size and colour)
  - Hyper-links to related content
- Content is accessible to humans but not (easily) to computers…

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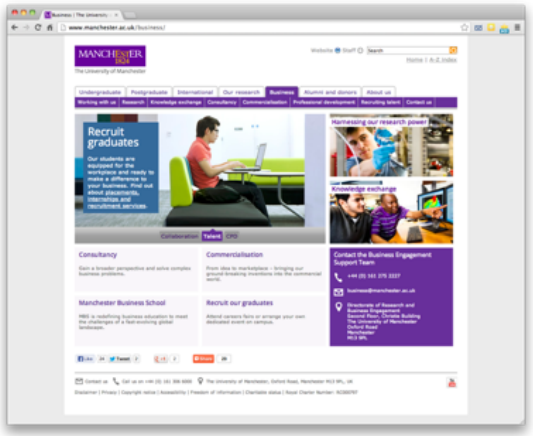

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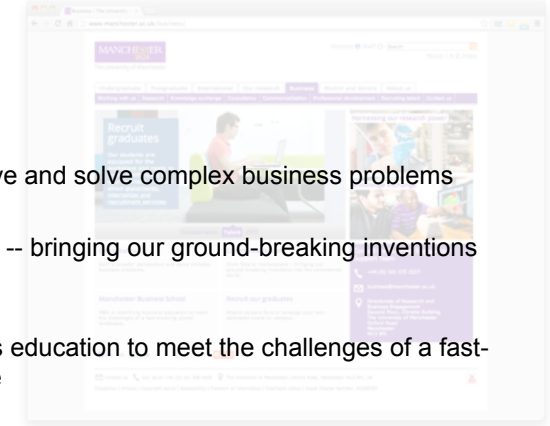
Information we can see



- University of Manchester
  - The Business School
- Consultancy
  - Gain a broader perspective and solve complex business problems
- Commercialisation
  - From idea to marketplace -- bringing our ground-breaking inventions into the commercial world
- Manchester Business School
  - MBS is redefiing business education to meet the challenges of a fast-evolving global landscape
- Recruit our graduates
  - Attend careers fairs or arrange your own dedicated event on campus
- Contact the Business Engagement Support Team
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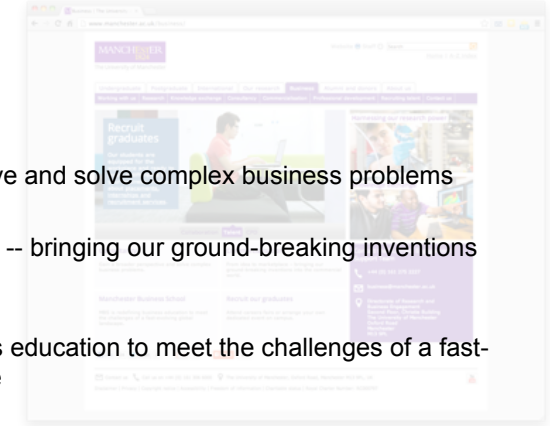

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Information a computer can see…

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Information a computer can see…

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Solution: XML markup with “meaningful” tags?

<university> … </university>
<school> … </school>
<address> … </address>
<topic> … </topic>
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But what about....?

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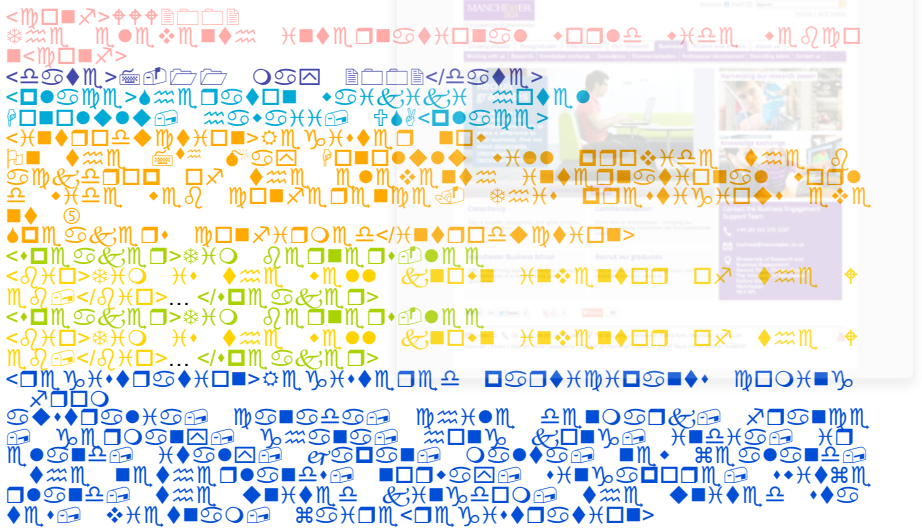
Still the Machine only sees…



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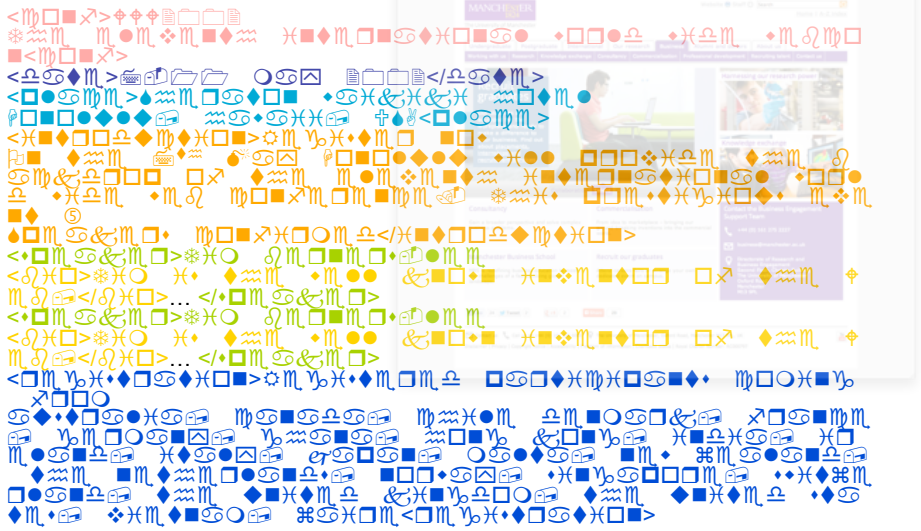

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Still the Machine only sees…

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Need to Add “Semantics”

shoulder_catches_during_movement
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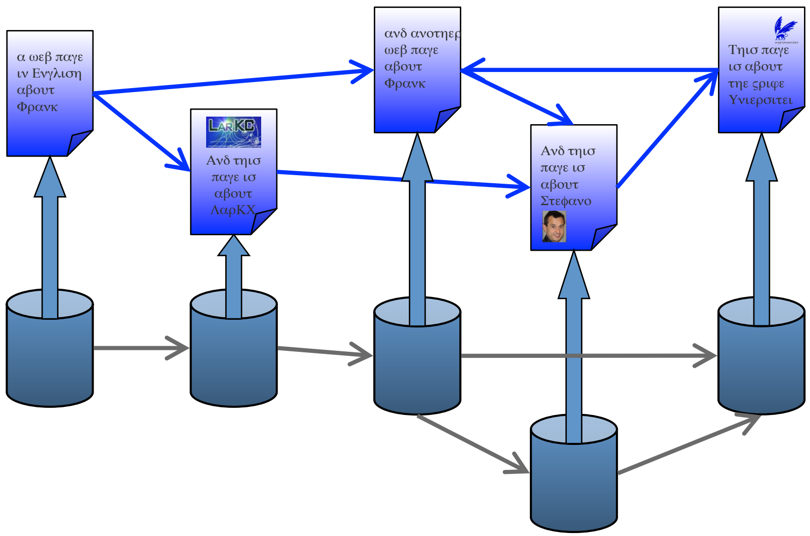
Four principles towards a *Semantic Web of Data**



* With thanks to Frank van Harmelen

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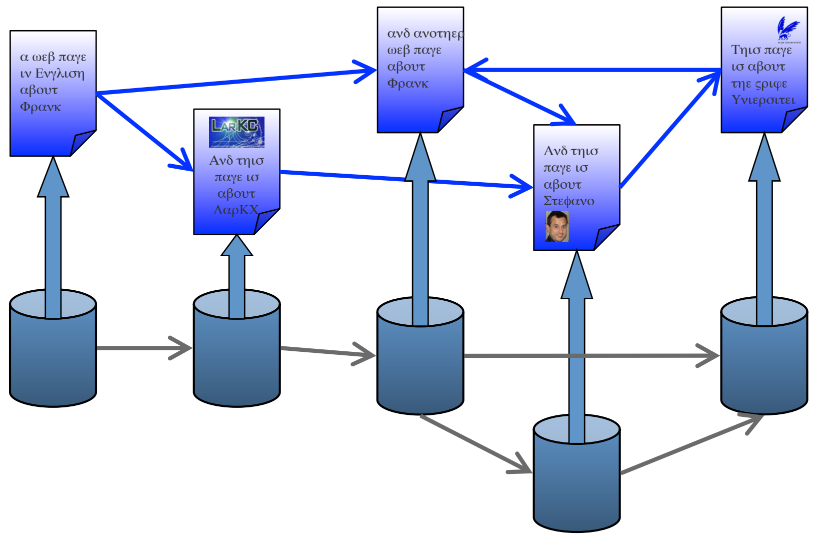

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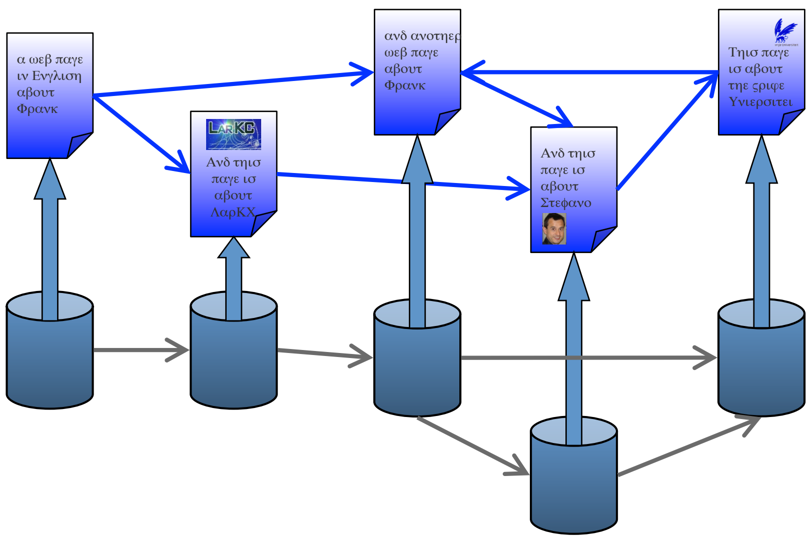

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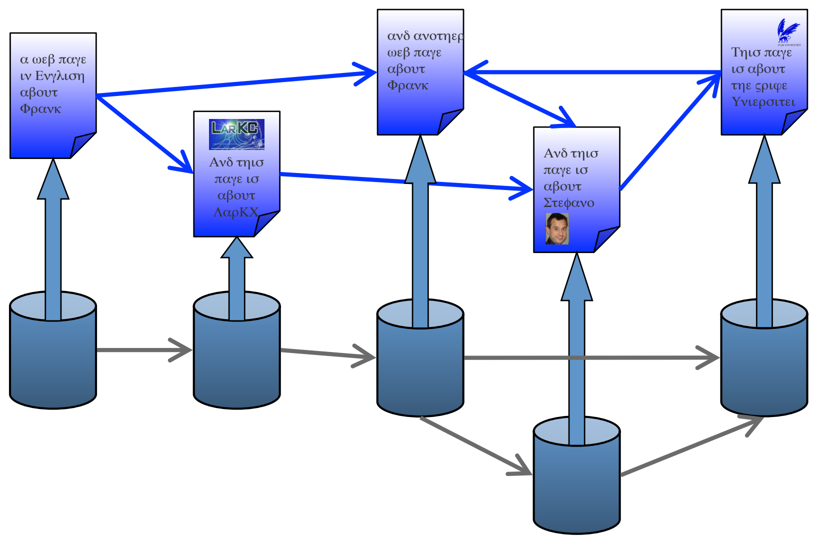

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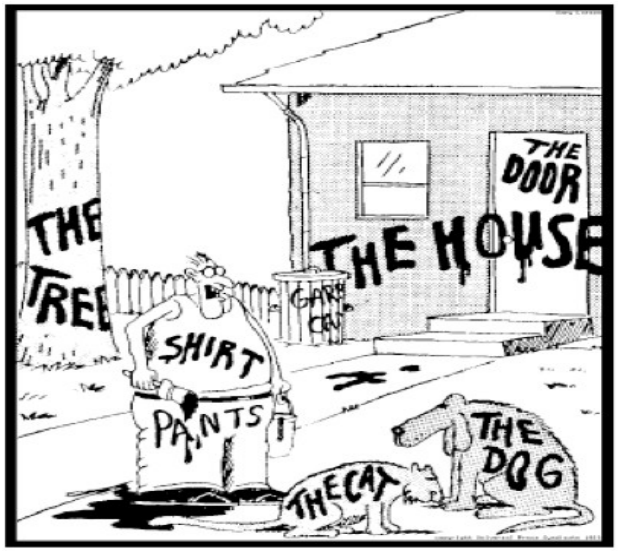
Principle 1: Give all things a name



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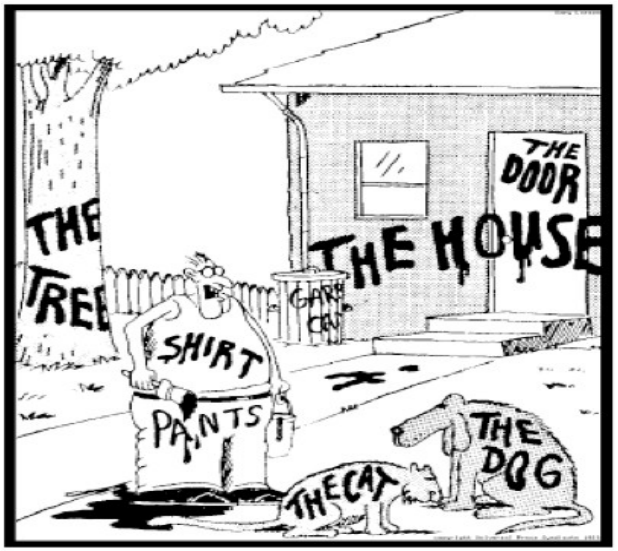

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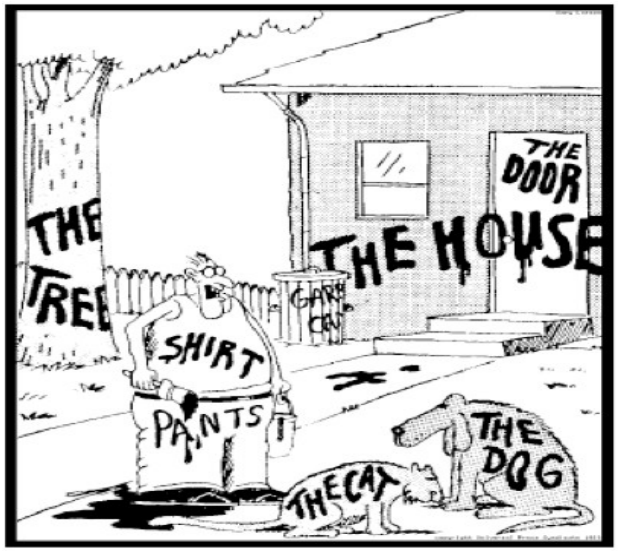

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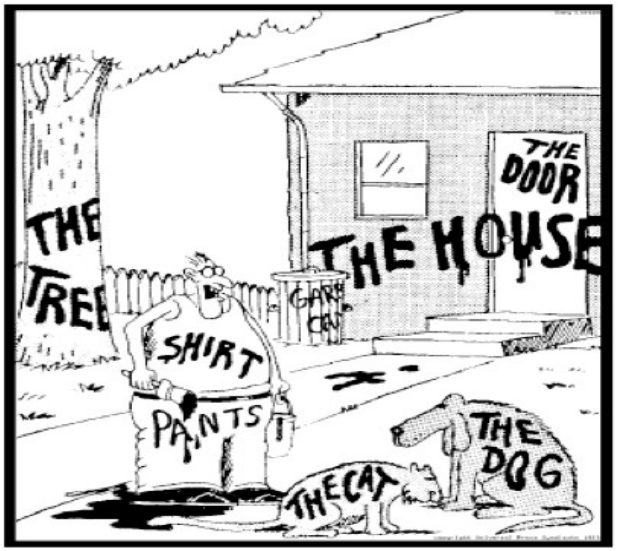

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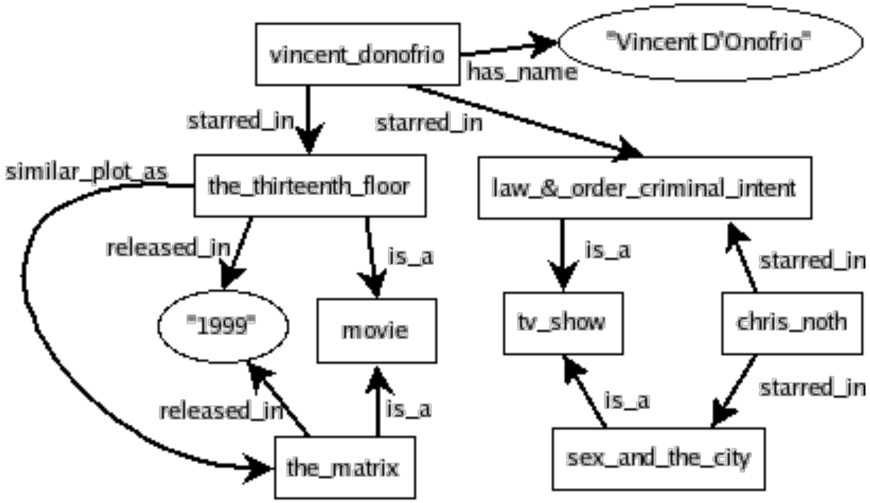
Principle 2: Relationships form a graph between things



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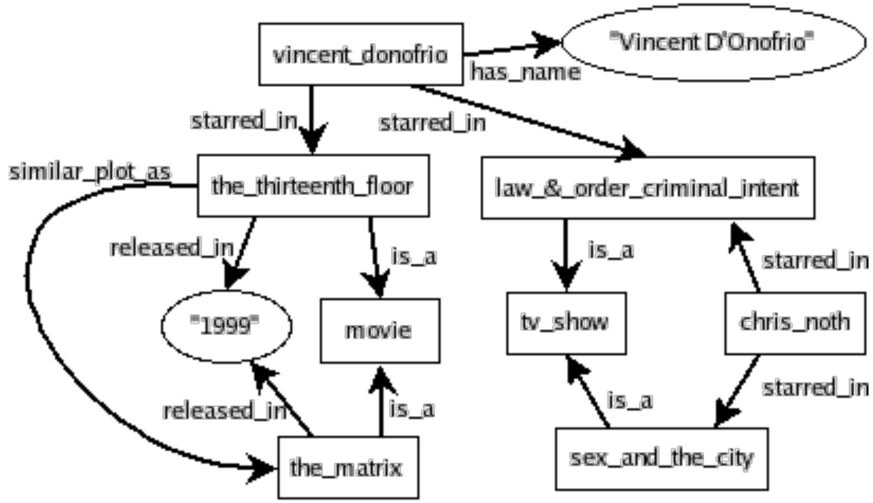

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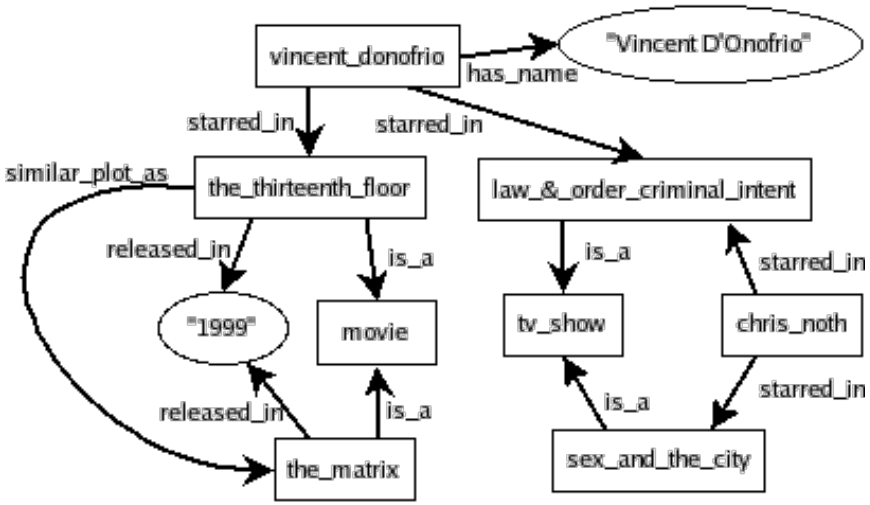

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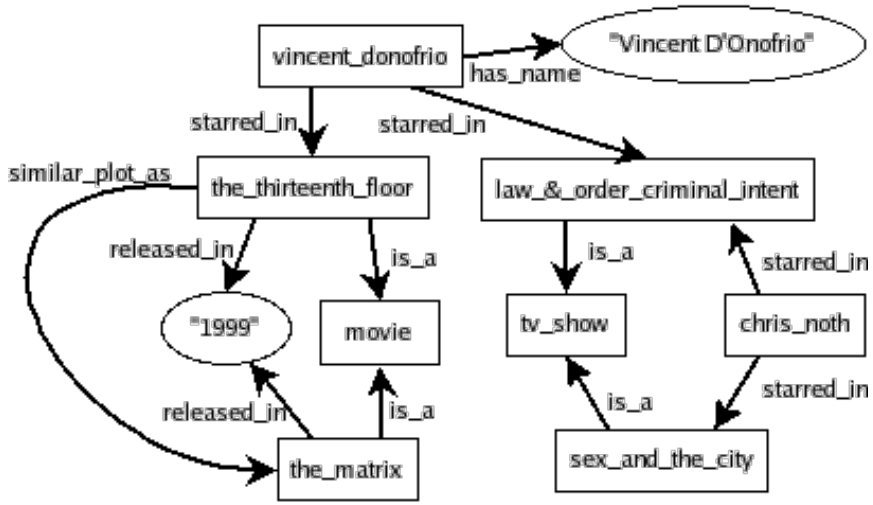

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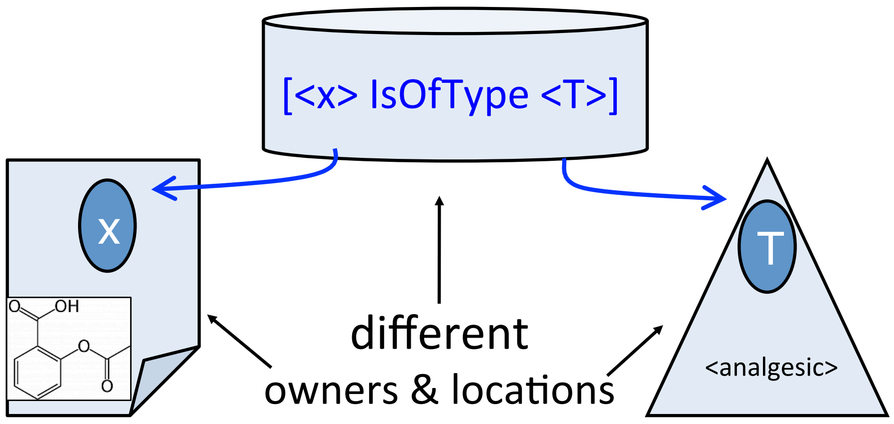
Principle 3: The names are addresses on the Web



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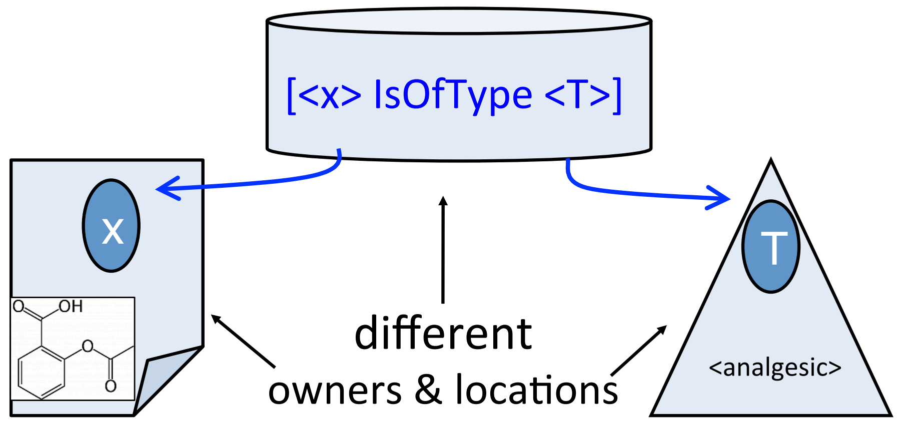

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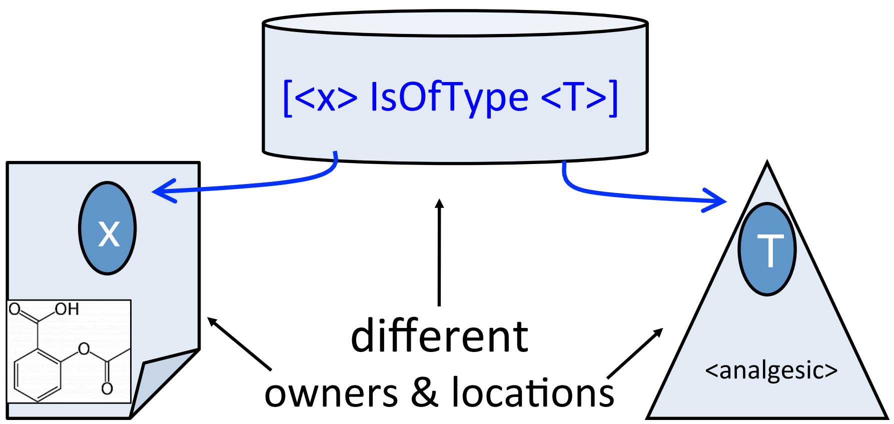

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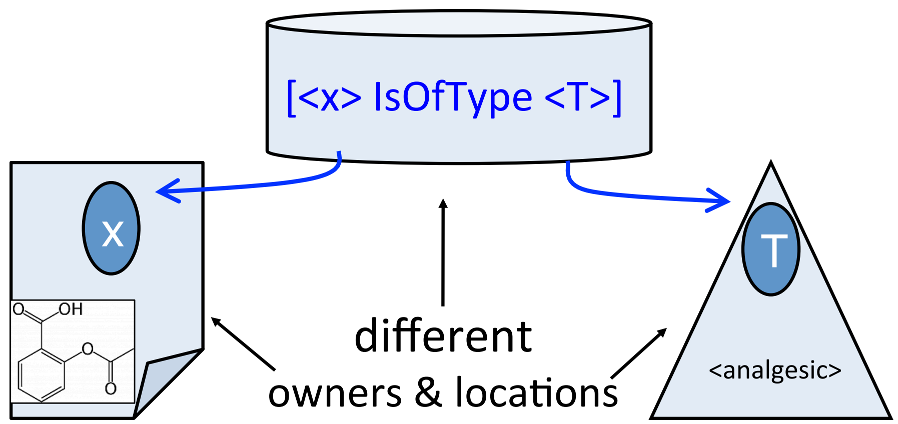

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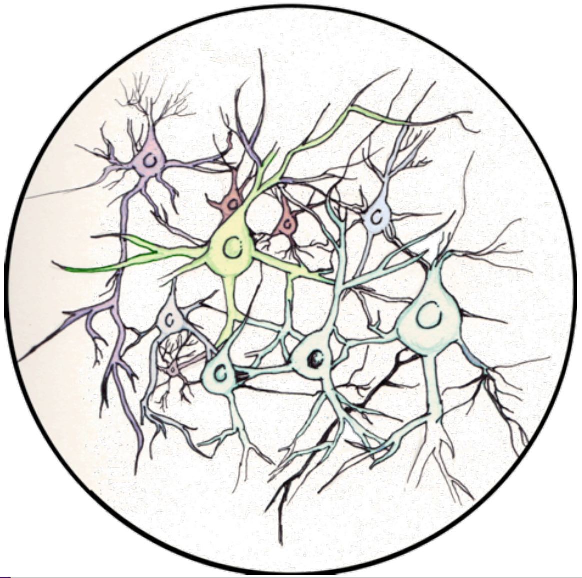
P1 + P2 + P3 = Giant Global Graph



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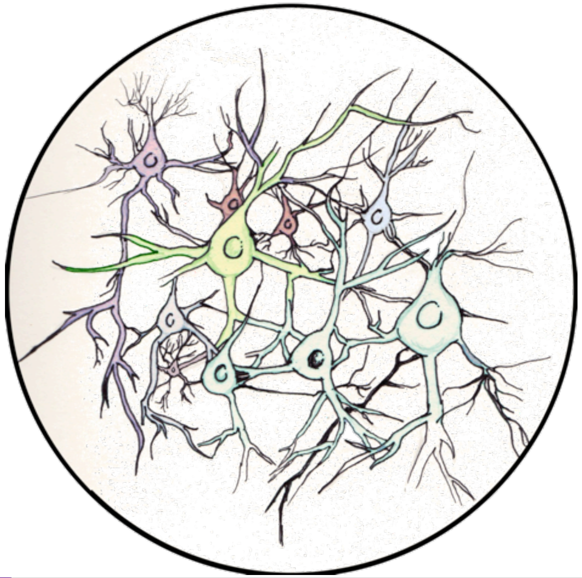

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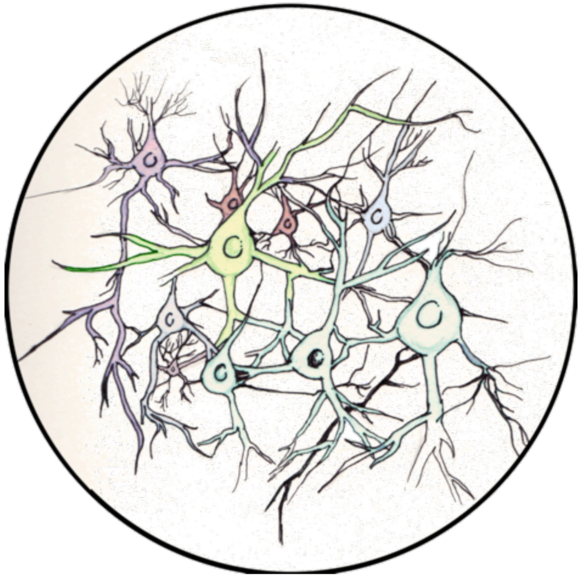

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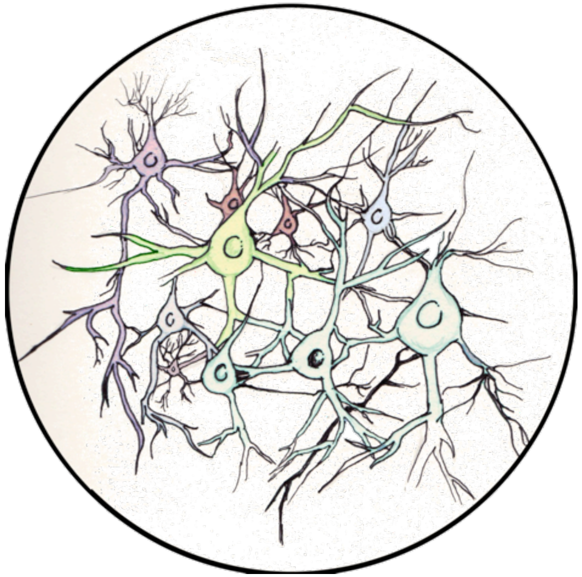
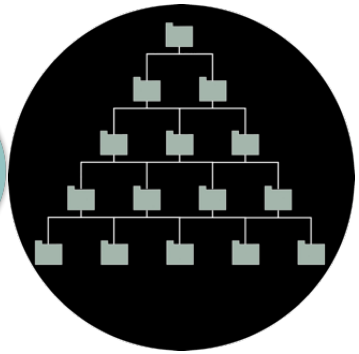


Principle 4: Explicit, Formal *Semantics*

So we all agree on

- meaning of statements in this graph/*ontology*
- entailments of statements
  - hierarchies
  - query answers
  - …

Base ontology language on **description logic**!



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Introduction to OWL

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Winnie-the-Pooh [A. A. Milne]

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OWL is based on *Description Logics*

- precise semantics
- OWL is based on an extension of $\mathcal{ALC}$
  - later more
- decades of research on
  - *automated reasoning* techniques
    - to base tool support on
    - to help domain expert with design, maintenance,...
  - *computational complexity* to understand trade-offs
  - *model theory*

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OWL is a *Web* Ontology Language

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  eg http://www.cs.man.ac.uk/~sattler/ontologies/WebST2016/RunningExample#Endocardium
- various web friendly syntaxes
  - RDF/XML
  - OWL/XML
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- import mechanism
- version mechanism
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  eg http://www.cs.man.ac.uk/~sattler/ontologies/WebST2016/RunningExample#Endocardium
- various web friendly syntaxes
  - RDF/XML
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OWL Axioms - an Example

Inflammation	*SubClassOf*	Disease
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OWL & DL via our Example

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OWL Manchester Syntax for $\mathcal{ALC}$

OWL	DL
Class	Concept
Property	Role
A SubClassOf B	$A \sqsubseteq B$
A EquivalentTo B	$A \equiv B$
Thing	$\top$
Nothing	$\bot$
not A	$\neg A$
A and B	$A \sqcap B$
A or B	$A \sqcup B$
R some A	$\exists R.A$
R only A	$\forall R.A$

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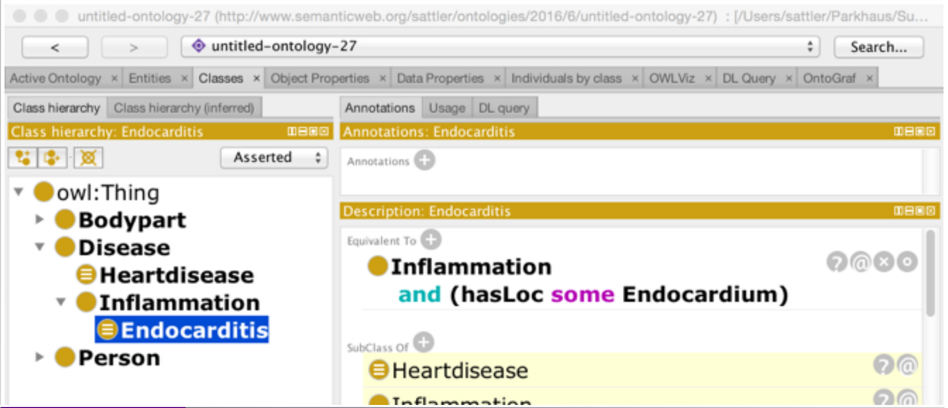

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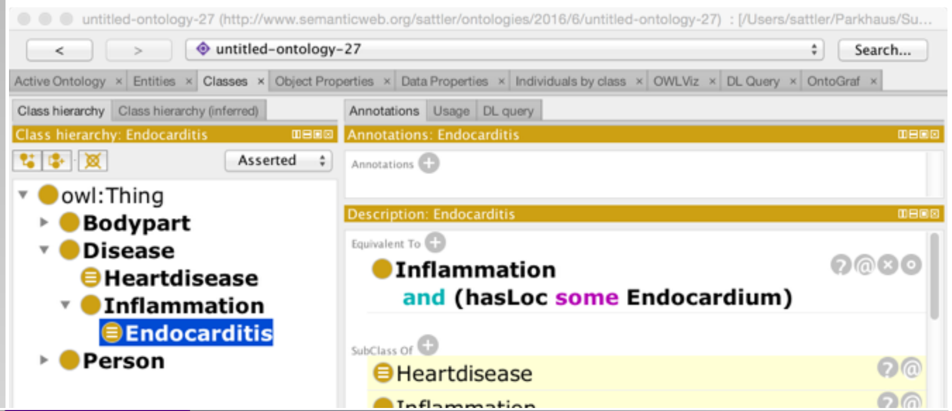

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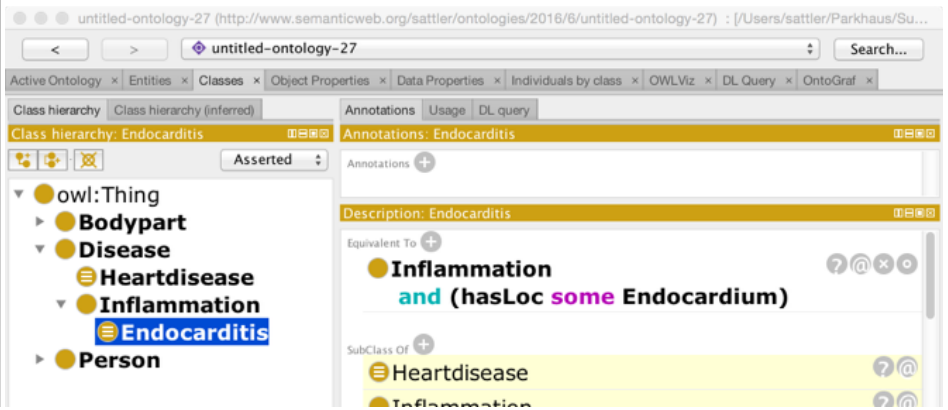

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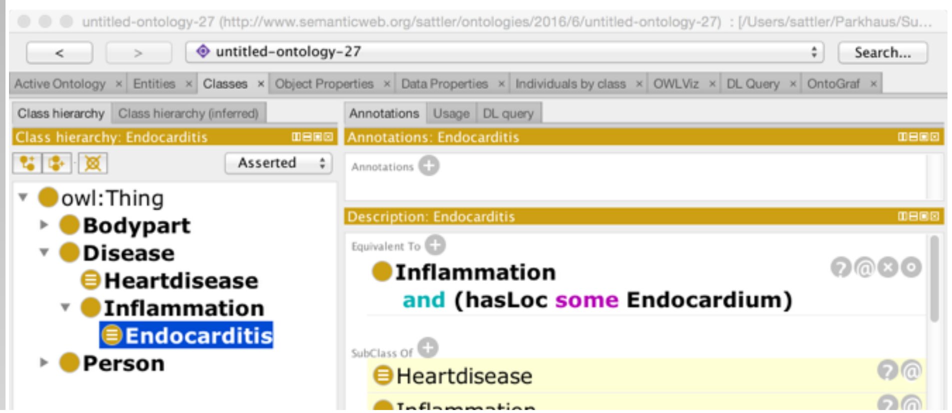

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I.e., DL reasoners

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OWL/DL reasoning

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Semantics reminder: Entailments etc. (3)

Let O be an ontology, α an axiom, A, B concepts, b an individual name:

- O is **consistent** if there exists some model I of O
- O **entails** α (written $O \models \alpha$) if α is satisfied in **all** models of O
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Classifying O is a *reasoning service* consisting of

1. testing whether O is consistent; if yes, then
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3. checking, for each individual name b and concept name A in O, whether $O \models b{:}A$

…returning the result in a suitable form: O's **inferred class hierarchy**

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- here, we have concentrated on OWL for $\mathcal{ALC}$, e.g., no
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  - SubPropertyOf, InverseOf
  - datatype properties
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look others up:

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