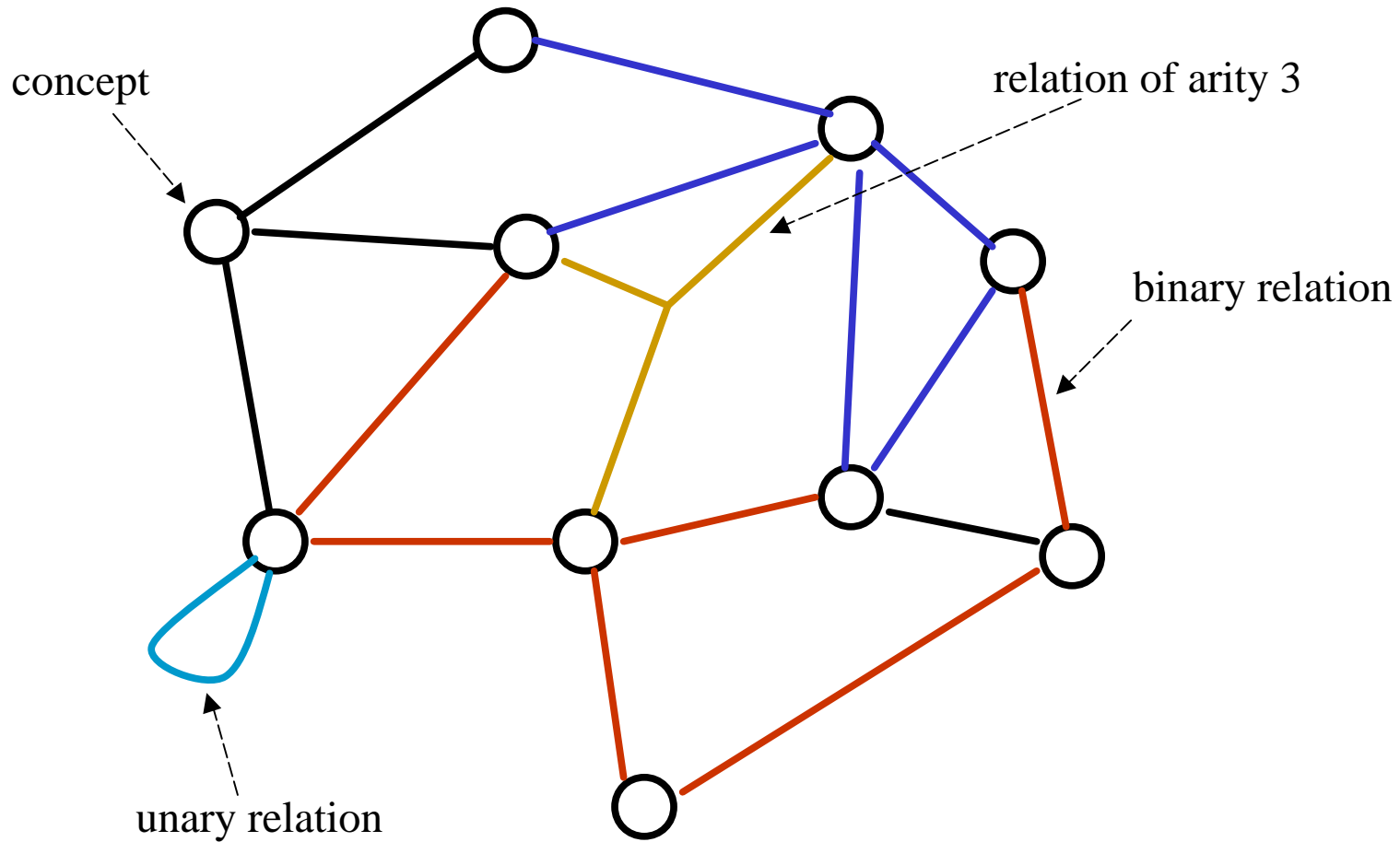


Ontologies

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Concepts & Relations?



Defining ontologies

- The Philosophical perspective
- The Linguistics perspective
- The Knowledge Representation perspective
- Pragmatic perspective

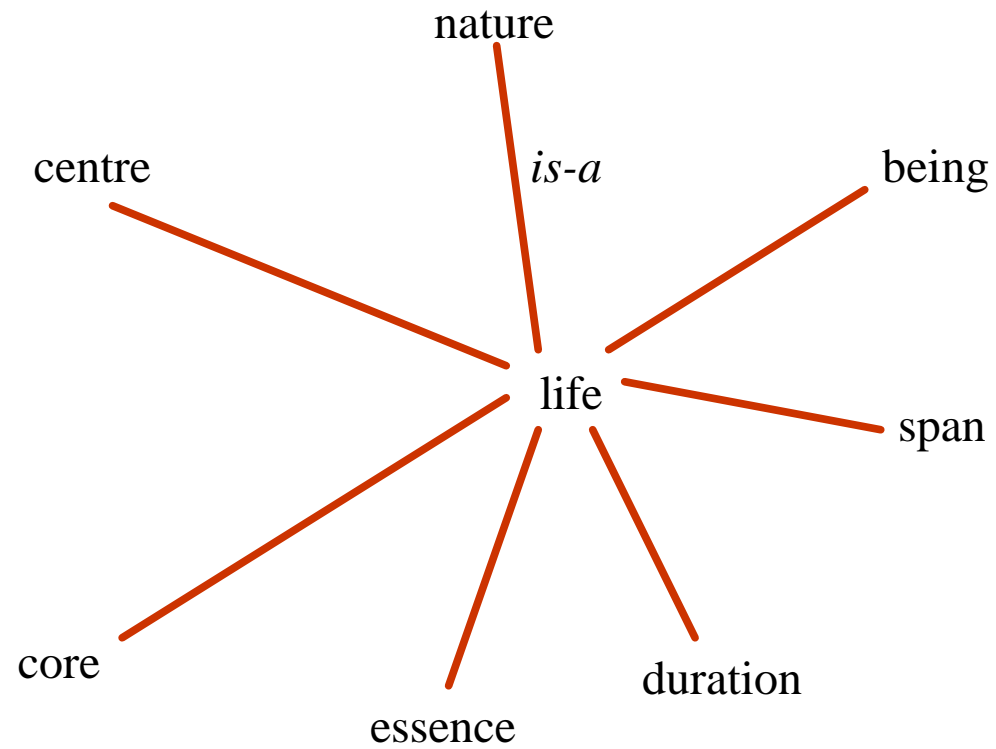
The Philosophical perspective

- The Ontology – The science of being as ~~sucks~~ such
- The Ontology tries to answer questions:
 - What is being?
 - What are the features common to all beings?
- Long history: Aristotle (*Metaphysics*) →
- Formal Ontology and a theory of distinctions between objects (*concepts*)

The Linguistics perspective

- Terminological ontologies
 - Concepts are *words*
 - Large amount of concepts ($>100\ 000$)
 - Only few relation types (*is-a*)
 - Concepts apply small number of relations (*sparse*)
 - Concepts and relations rarely formally defined
- Ontology can be seen as a *thesaurus* or a *taxonomy*
- Usage in language processing
 - Machine translation
 - Text summarization
 - Text generation
- Real life example: WordNet

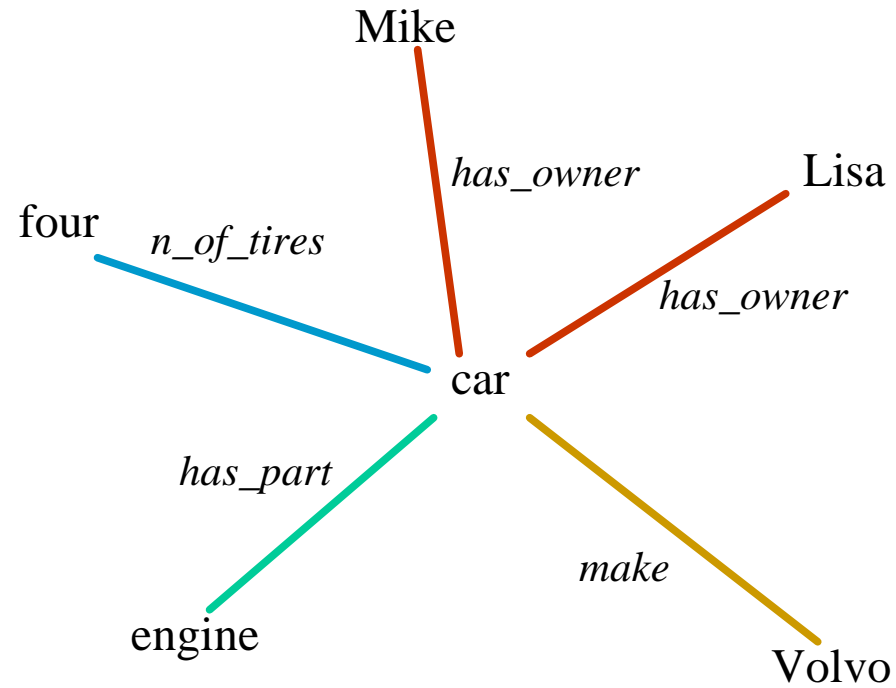
Example: Tiny *Terminological* ontology of life



The Knowledge Representation perspective

- Conceptual ontologies
 - Domain specific vocabulary (*not only dictionary words*)
 - Small number of concepts (<10 000)
 - Rich set of relation types
 - Concepts apply many different relations (*dense*)
 - Concepts and relations formally defined (*logic*)
- Ontology can be seen as a *knowledge base* of a given domain.
- Usage in
 - Modelling reality (Qualitative modelling)
 - Language engineering
 - Database design
 - Information modelling, integration, retrieval and extraction
 - Object-oriented analysis
 - *Sharing information*
- Real life example: CYC

Example: Tiny *Conceptual* ontology of a car



Pragmatic perspective

- What are ontologies for?
 - I want my questions answered → Query processing!
- What benefits does the ontology provide (addition to all excellent answers to my questions)?
 - Reusability of terminology for communication and representation

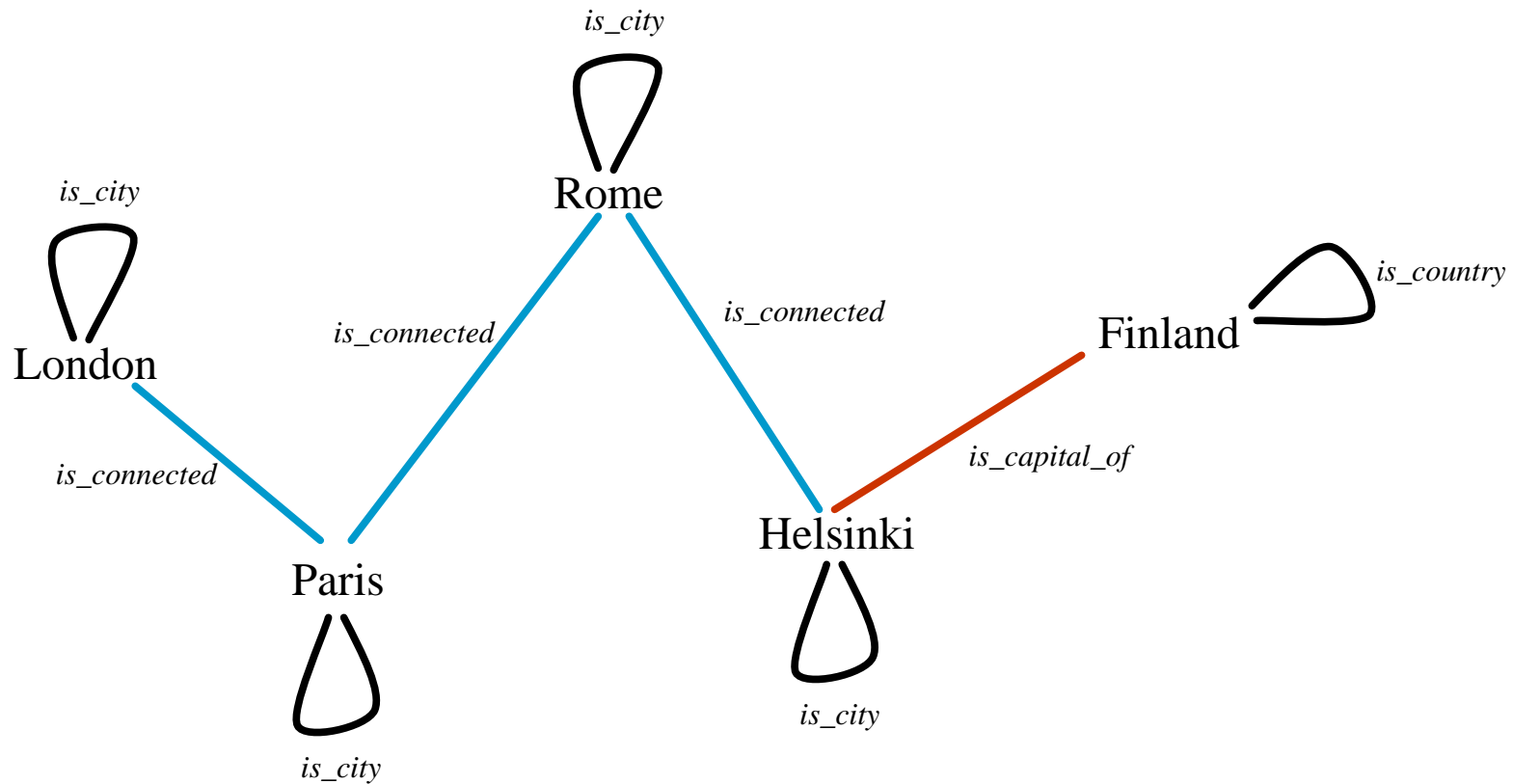
Components of ontologies

- Thinking components *Not* so formally
 - Vocabulary of terms
 - Precise specification of what those terms mean
- Thinking components formally
 - Objects
 - Relations
 - Clauses of predicative logic

Example: Tiny formally defined ontology of cities

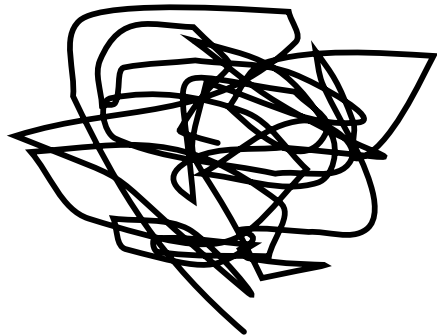
- Objects
 - London
 - Rome
 - Paris
 - Helsinki
 - Finland
- Relations
 - is_capital_of(x,y)
 - is_connected(x,y)
 - is_city(x)
 - is_country(x)
- Clauses of predicative logic
 - is_capital_of(Helsinki, Finland)
 - is_connected(London, Paris)
 - is_connected(Paris, Rome)
 - is_connected(Helsinki, Rome)
 - is_city(Paris)
 - is_city(London)
 - is_city(Rome)
 - is_city(Helsinki)
 - is_country(Finland)
 - for all x, y, if is_capital_of(x, y) \rightarrow is_country(y) and is_city(x)

Example: Tiny formally defined ontology of cities (visualizing it all)



Conceptualization

- Semantic structure which encodes the rules constraining the structure of reality.



Reality ☹️

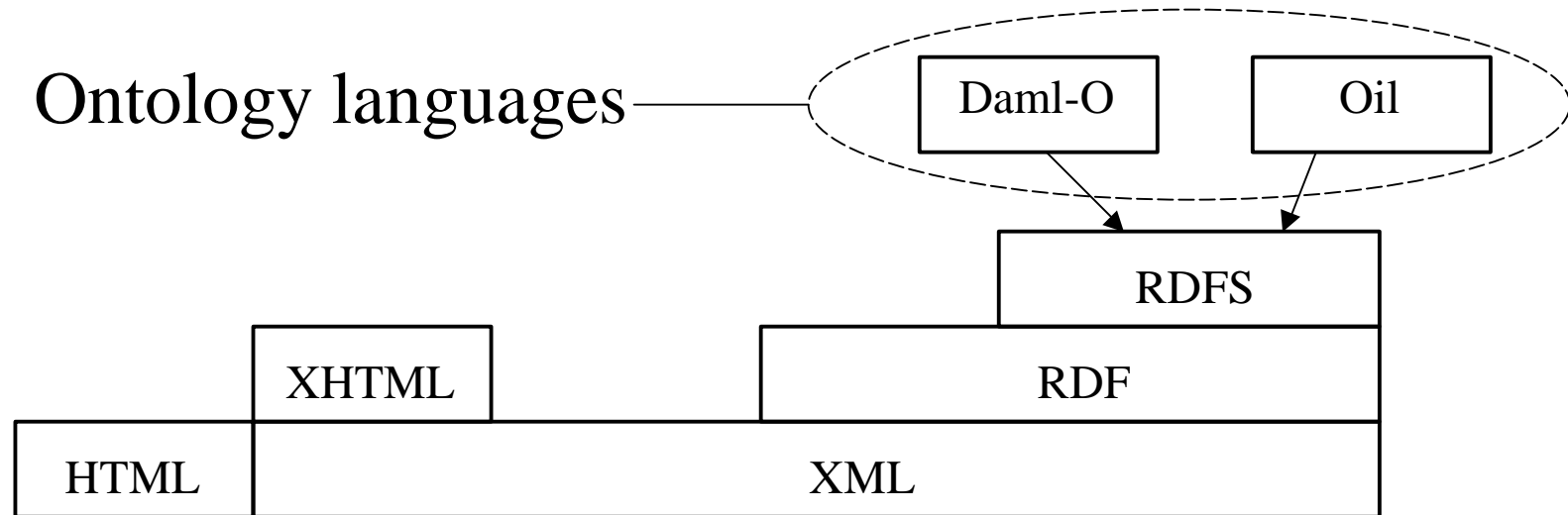


for all x , $\text{is_apple}(x) \rightarrow \text{is_fruit}(x)$
for all x , $\text{is_banana}(x) \rightarrow \text{is_fruit}(x)$
for all x , $\text{is_apple}(x) \rightarrow \text{not is_banana}(x)$
for all x , $\text{is_banana}(x) \rightarrow \text{not is_apple}(x)$
there exists x , $\text{is_apple}(x) \rightarrow \text{is_red}(x)$
there exists x , $\text{is_banana}(x) \rightarrow \text{is_yellow}(x)$

Conceptualized Reality 😊

- Conceptualization is used to build ontologies.

Semantic web???



- Usage
 - DTD & Schema type document validation.
 - Semantic validation.
 - Query processing
 - Ontology answers questions

Where's the Research? Here we are...

- Looooong history of traditional ontology research
- Long history of terminological ontology research
- Short history of knowledge ontology reseach (AI community)
- Very short history of semantic web & ontologies reserch (W3 org, 1998)
- ANSI Ad Hoc Committee on Ontology Standardization (1998)
- There exists many ontologies on different domains
 - WordNet, CYC, MikroKosmos, SENSUS
- There exists many tools to build ontologies
 - OilEd, Protege, FRODO RDFSVizTool, Ontoligua, SHOE

Where's the Research? Open questions

- "How can I be confident that a particular ontology is the right one for my application?"
- "How can I prove that a particular ontology is complete?"
- Measuring ontologies
- Comparing ontologies (equivalent or subsumed)
- Evolution of ontologies
- Ontology creation for non-computer scientists

For more information see

- <http://www.formalontology.it>
- <http://www.ontology.org>
- <http://www.kr.org/top/>
- <http://www-ksl.stanford.edu>
- <http://www.ladseb.pd.cnr.it>
- <http://www.w3.org/2001/sw/>
- http://www.xml.com/pub/rg/Ontology_Tools
- <http://www.cs.utexas.edu/users/mfkb/related.html>

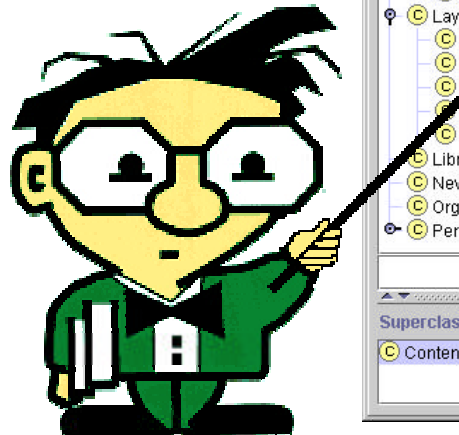
Keywords for search machines

- Ontology, ontologies
- Knowledge representation

Software demonstration: Protege

http://protege.stanford.edu/applet_demo/Newspaper/newspaper.html

- **A tool** which allows the user to:
 - Construct a domain ontology
 - Customize knowledge-acquisition forms
 - Enter domain knowledge
- **A platform** which can be extended with graphical widgets for tables, diagrams, animation components to access other knowledge-based systems embedded applications;
- **A library** which other applications can use to access and display knowledge bases.



The screenshot shows the Protege-2000 software interface. The title bar reads "newspaper Protégé-2000 [http://protege.stanford.edu/applet_demo/Newspaper/newspaper.ppr]". The menu bar includes "Project", "Edit", "Window", and "Help". The toolbar contains icons for "Classes", "Slots", "Forms", and "Instances". The "Classes" tab is active, showing a class hierarchy in the left pane. The "Advertisement" class is selected, and its details are shown in the right pane. The "Role" is set to "Abstract". The "Template Slots" table is visible below.

Name	Type	Cardinality	Other Face
ad_name	String	single	
content_layout	Instance	single	classes={Content_Lay
expiration_date	String	single	
page_number	Integer	single	
published_in	Instance	single	classes={Newspaper}
purchaser	Instance	single	classes={Person}
salesperson	Instance	single	classes={Salesperson}
section	Instance	single	classes={Section}
urgent	Boolean	single	