A Framework for Constructing Web Ontologies using Concept Maps

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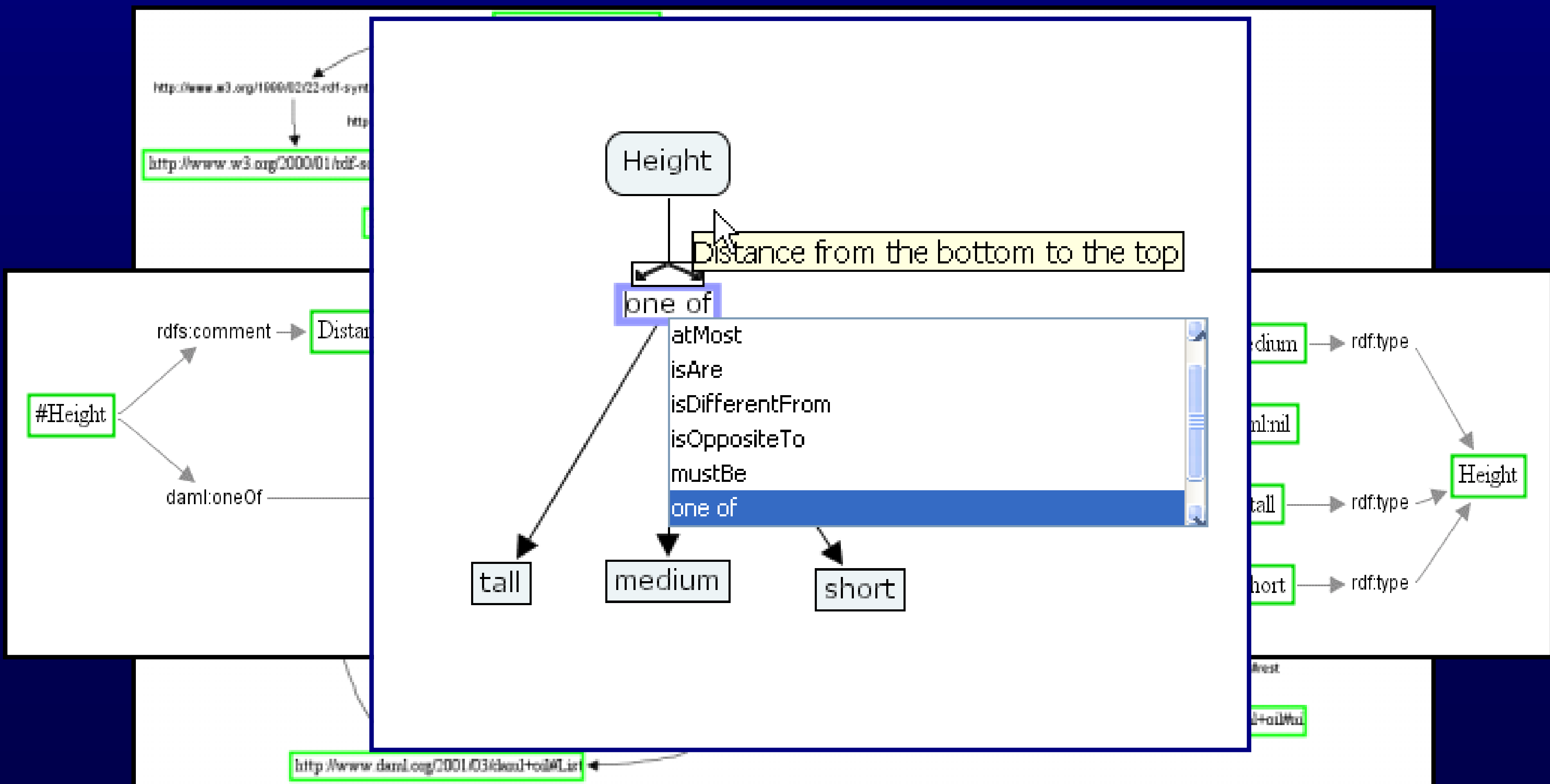
Project Goals

- A tool to build, edit and display OWL ontologies.
  - A graphical approach based on concept maps.
  - Concept maps as an ontology building tool
  - Representing existing ontologies as concept maps.

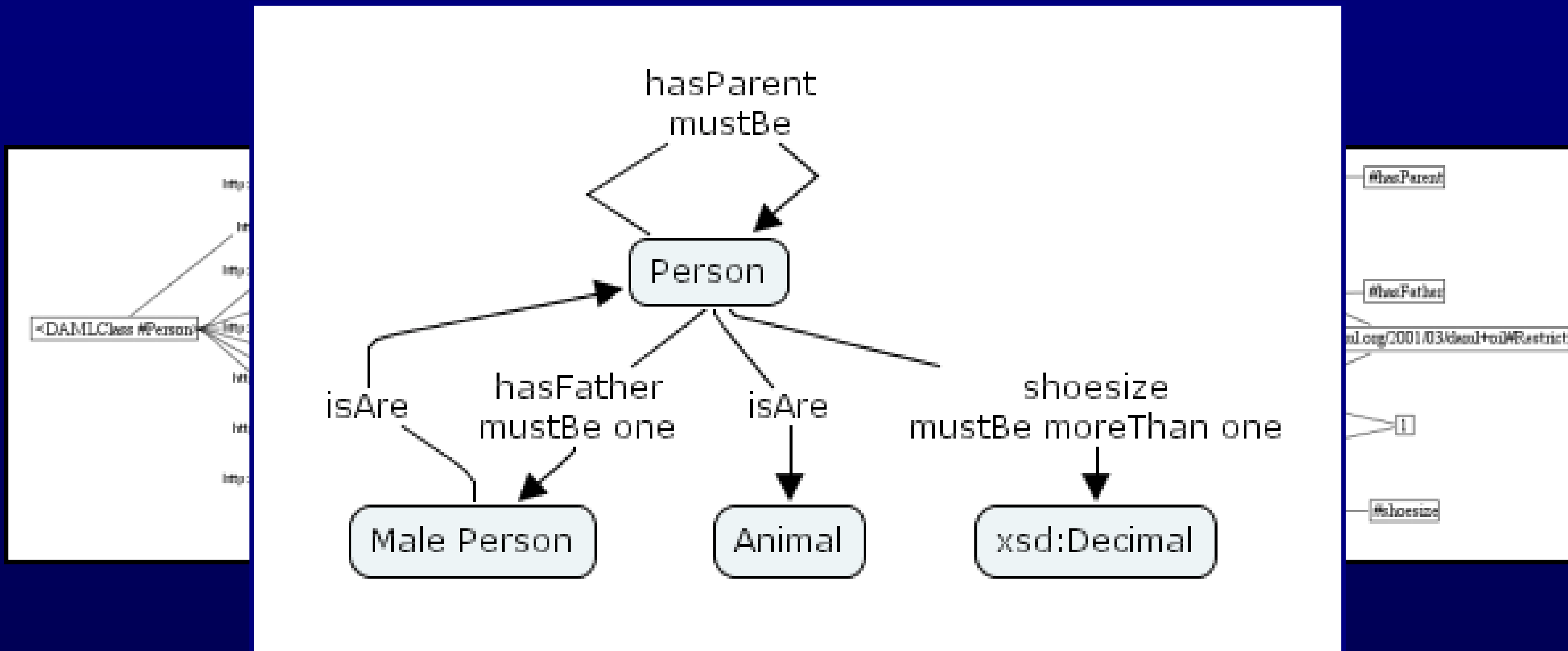
- Support tools for building OWL ontologies.
  - Search in ontologies for suitable concepts.
  - Cluster analysis

Simplifications of Maps after Import

- RDF lists, OWL restrictions, and other constructs are hidden from explicit view

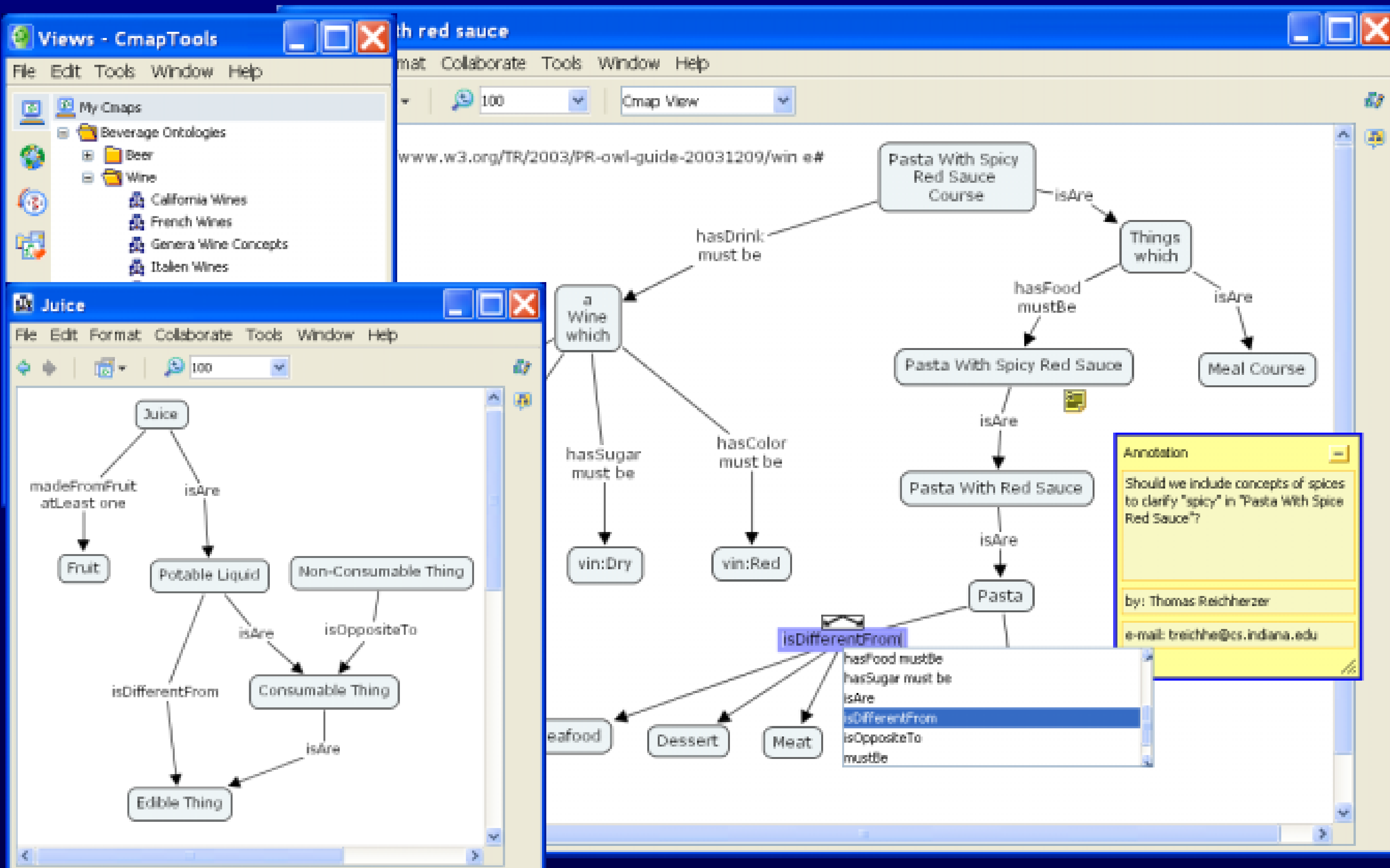


Simplifications of Maps after Import (Cont.)

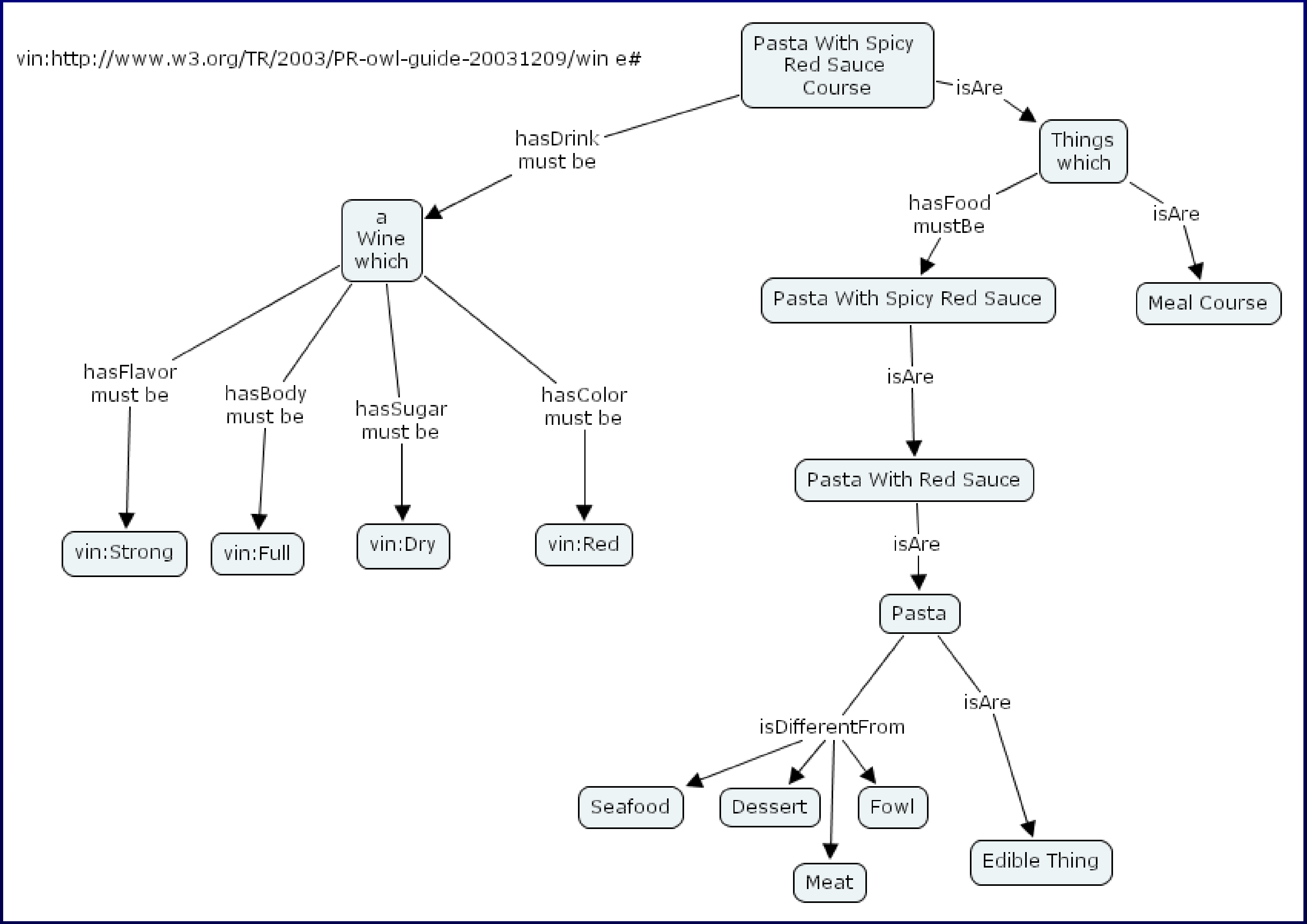


- Reduction of complex Cmap Ontology graphs into easier readable concept maps.

Cmap OWL Editor/Browser

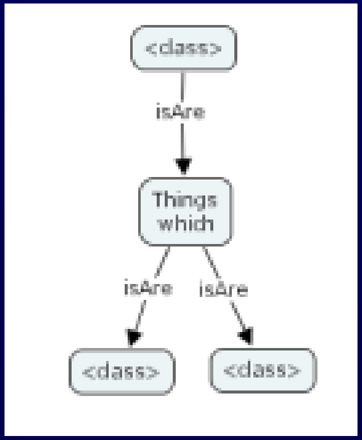


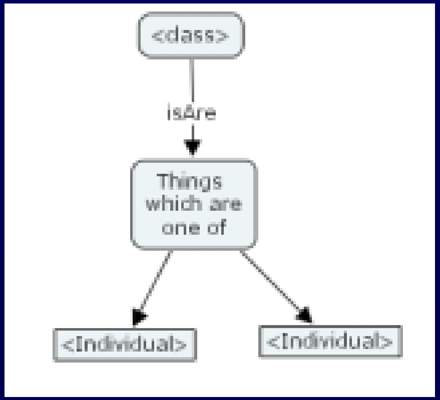
OWL Concept Map Examples (cont.)

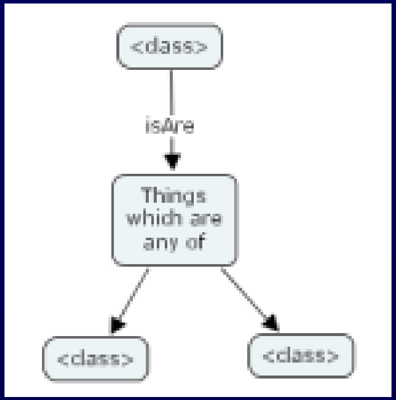


Constructing ontologies as concept maps

- Exporting concept maps to OWL format.
- Concept map conventions for defining restrictions.
  - atleast, atMost, must be, Things which
- Templates aid in forming most repetitive, complicated restrictions that can be exported to OWL.



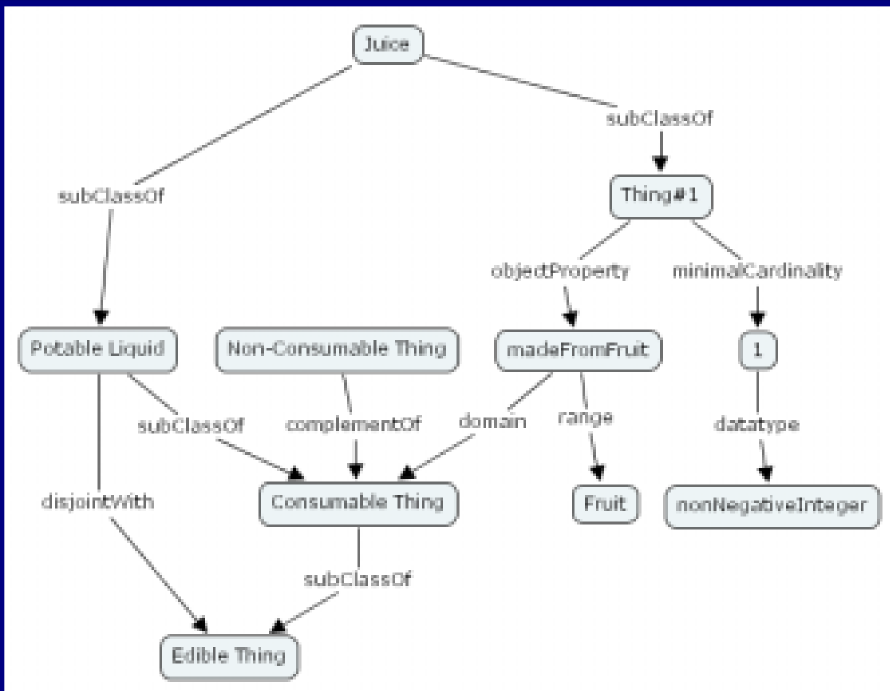


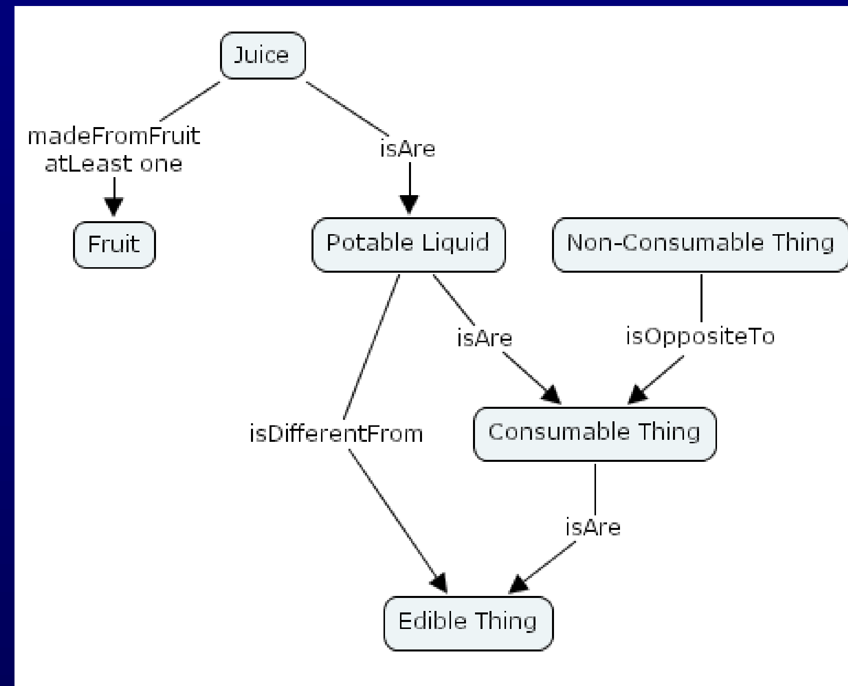


Rendering XML ontologies as concept maps

- Segmenting large ontologies into smaller, more user-manageable concept maps.
  - Topological approach to segmentation.
  - Consider particular restrictions or subclass hierarchies.
- Simplifying large ontologies.
  - Hiding technical details.
  - Collapsing large constructs into small set of nodes with special notations.
- Navigational support for large ontologies.
  - navigating by RDF statements (table of RDF triples)
  - navigating by concepts (rapid ordered search)

OWL Concept Map Examples





OWL ontology <u>represented</u> as a concept map.

OWL ontology <u>constructed</u> as a concept map using conventions.

Selecting concepts based on clustering

- User composing an ontology requires a concept. Invent one or re-use one?
  - Keyword-based matching to concept names in OWL directories is feasible …
  - …but may produce many results. Selection requires analysis of clustering and connectivity between and among existing concepts
- CODE tool will interface with Pragati's MVP-CA system to provide user analysis of concept reusability in context.
  - Preliminary studies using Cmap contexts for Web search are promising.

End

Some Principles of Web Logic

Pat Hayes
work in progress

The logic of the Sem Web

- All Sweb ontology languages are (subsets of) FOL.
  - Possible exceptions all seem to be concerned with ‘local’ information, eg non-mon rule applications to elements of a class described by Sweb notations: the global SW description sanctions the local use of non-mon rules. I will ignore these local issues.

- Abstraction: *FOL reasoners*/communicating agents in an *open world* linked by *Web transfer protocols*

- What *general conditions* constrain this picture?

Sweb: logic meets architecture

FOL reasoners/communicating agents in an *open world* linked by *Web transfer protocols*

1. Inference and communication should commute.

   A requests information P from **B** and performs valid FO inferences on it; or, **A** requests **B** to perform valid FO inferences on it and communicate the results. *Web logic should sanction the same inferences in both cases.*

2. Inference should be stable in the light of new information

   Weaker than strict monotonicity since individual-level data can be non-mon; knowledge may change, but *logical inference* (Web entailment) should not.

3. Content transfer on-demand (pull transfer) should be sufficient to perform Web inference

   Reasoners should not be required to *negotiate* before performing valid inferences

4. Lack of information should not restrict Web inference

   If A entails B when C is present, then A should entail B when C is not present.

Some consequences (1)

- 1. EITHER syntax must encode fixed global conventions OR logic must apply independently of syntactic constraints.

- Example: **A** uses a symbol as a relation name, **B** uses it as an individual name. Both uses are logically correct. *Commutation* requires (either that this is rendered impossible, or) that Web inference applies uniformly to both:
  - p=q from B
  - p(a b) from A
  - q(a b) odd conclusion using a valid FO logical principle
  - exists (x) x(a b) even odder conclusion using a valid FO logical principle

- This is all valid FO reasoning but without a fixed signature. SCL provides a framework and a semantics.

Some consequences (2)

- 2. The Horatio Principle: unrestricted universal quantification is *incoherent* in Web logic.
  - Example: **A** writes an ontology about fish which presumes that everything in the universe of discourse is a fish. B writes an ontology about vertebrates using a term from A's ontology. C writes an ontology about living things using a term from B's ontology. D writes an ontology about cellular chemistry using a term…The only way for D to safely use A's ontology is by restricting the quantifiers to the intended domain.
  - Any universal quantifier in an ontology must be understood as ranging over a subset of the global universe. *Nobody owns the universe.*
- Transmission of any ontology implicitly ***guards*** all its quantifiers with the name of the ontology's universe.
  - OWL currently violates this with *owl:complementOf* and *owl:Thing*. Better to use relative complement and a 'local' universe name. Quick fix would be to re-define *owl:imports.*
- Useful side-effect: *Web logic is locally full first-order but globally decideable*.