Semantic Web Technologies

Topic: Understanding Semantic Web Datasets

Olaf Hartig
olaf.hartig@liu.se

LINKÖPING UNIVERSITY

Goal

- Familiarize with a given dataset
- Achieve an initial understanding of the dataset and its structure
  - What types of entities does the dataset describe?
  - What vocabularies are used to represent properties of entities and relationships among them?

- Note, understanding is not about analyzing the data and deriving insights from it

image source: https://www.flickr.com/photos/tambako/3689136427

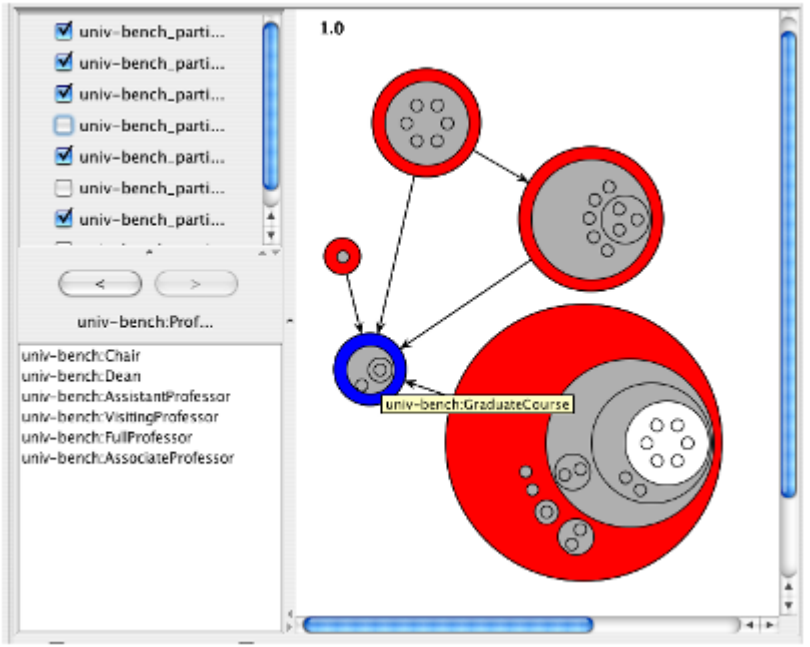
Options

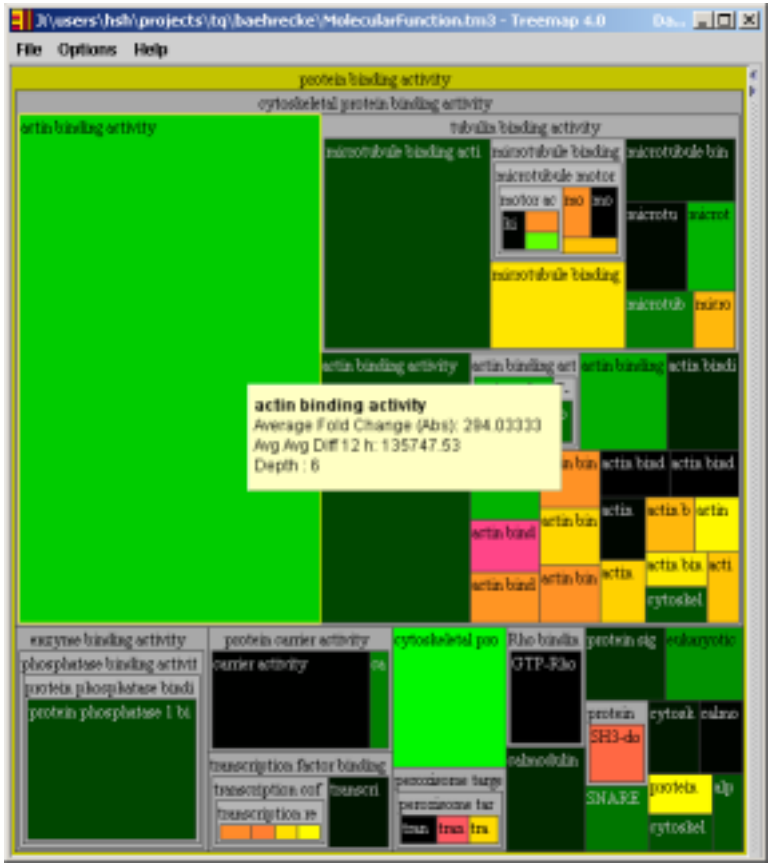
- Ontology visualization
- Exploratory queries
- Dataset summarization and profiling

Ontology Visualization

Diagram Types for Ontology Visualization

- Nested rectangles (treemaps)
  - e.g., OWL-VisMod, Jambalaya
- Nested circles
  - e.g., CropCircles

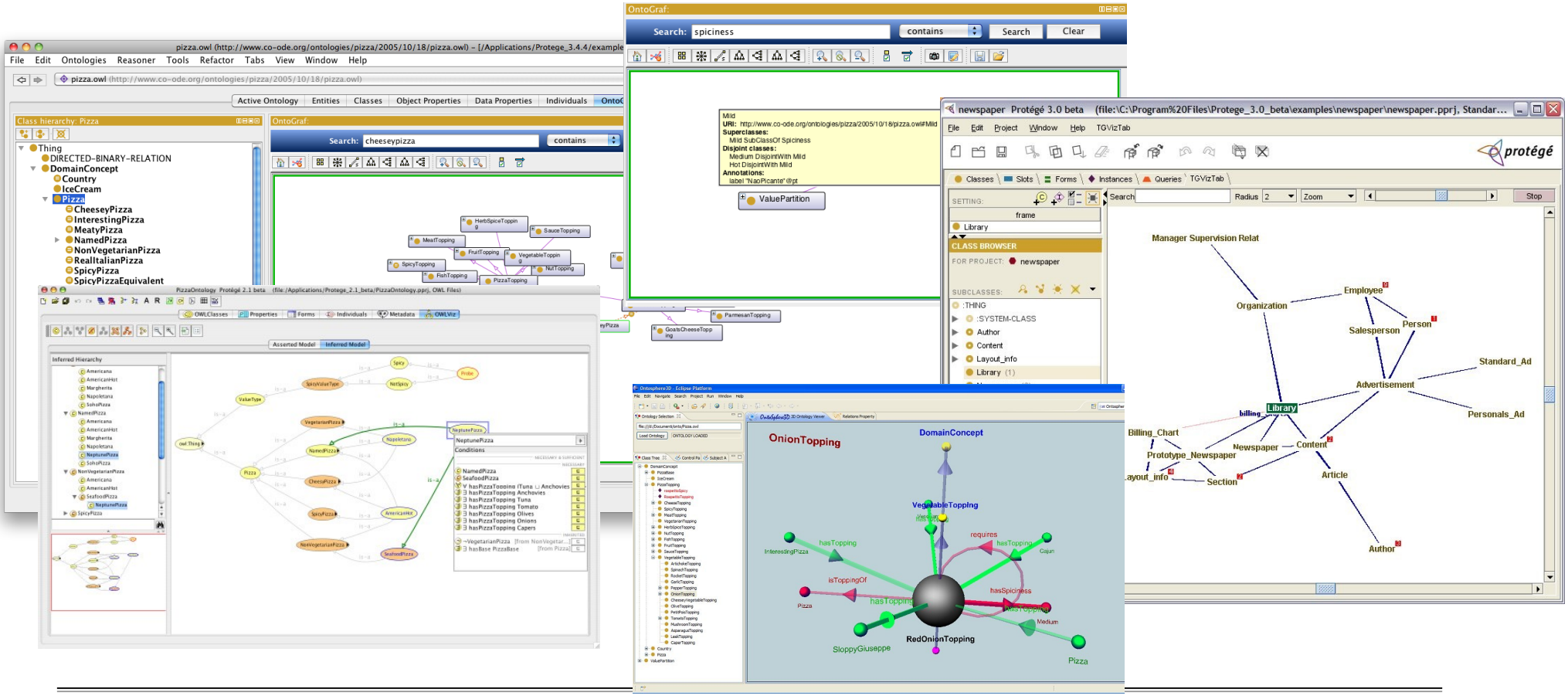




- Graphs (node-link diagrams)

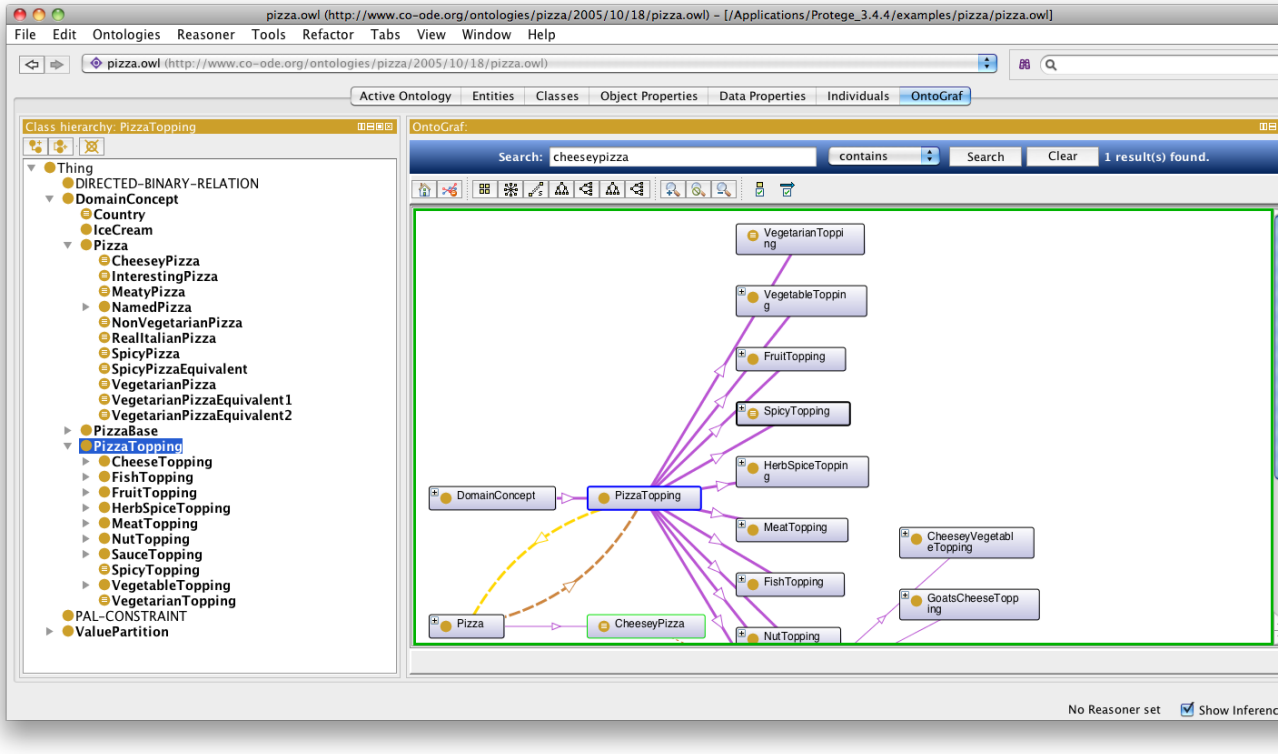
Graph Visualizations of Ontologies

- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate



Graph Visualizations of Ontologies

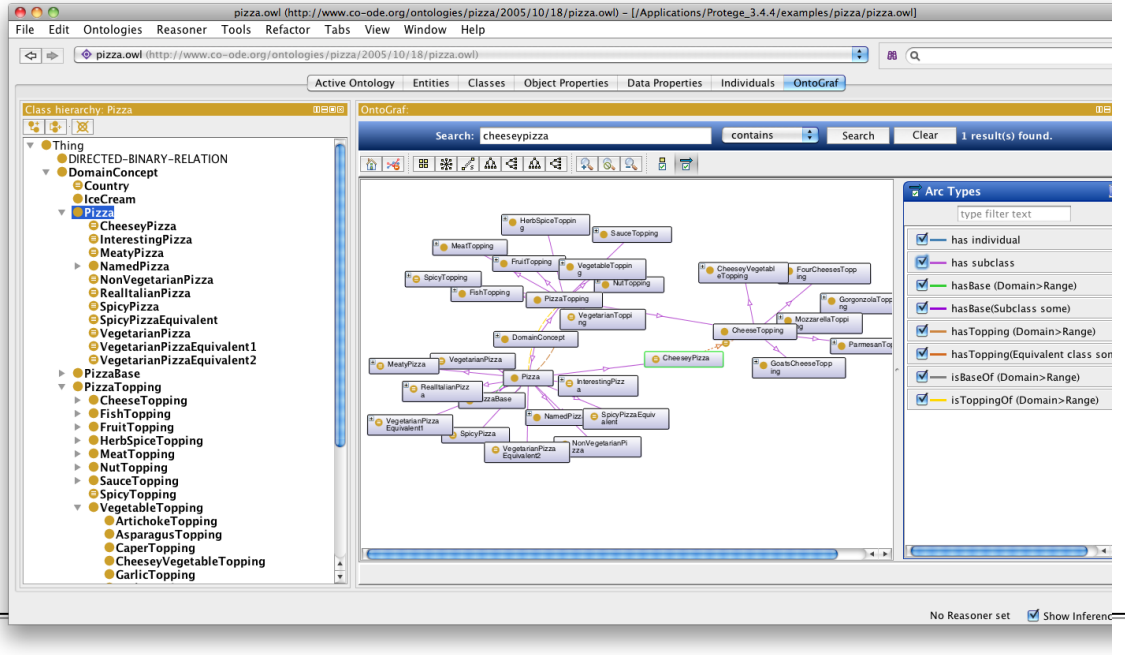
- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate
  - Class hierarchy (i.e., sub-class relationships)



Screenshot: OntoGraf

Graph Visualizations of Ontologies

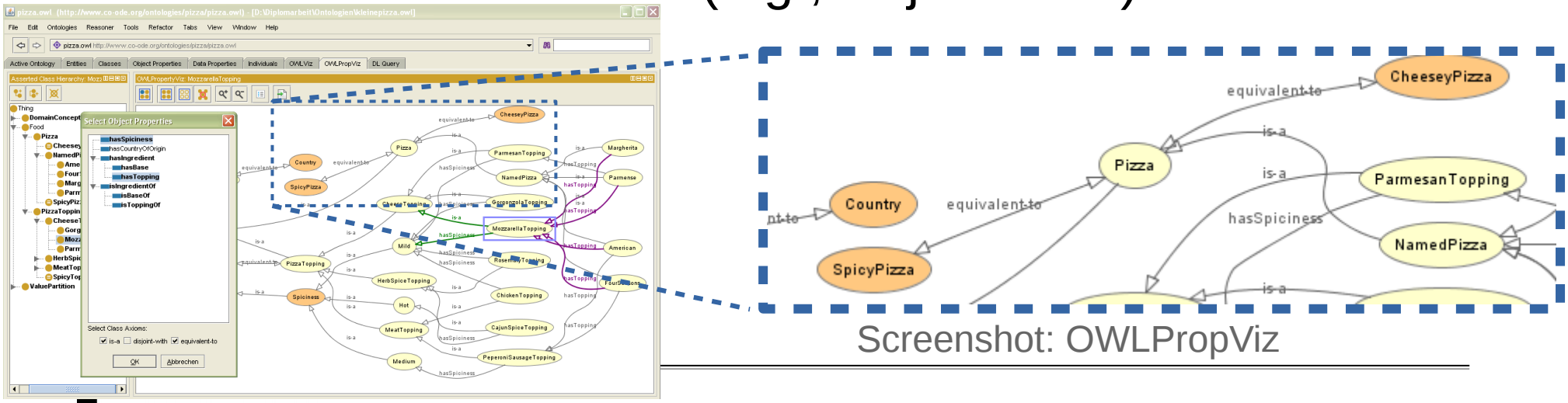
- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate
  - Class hierarchy (i.e., sub-class relationships)
  - Properties-based relationships between classes (i.e., domain and range of properties)



Screenshot: OntoGraf

Graph Visualizations of Ontologies

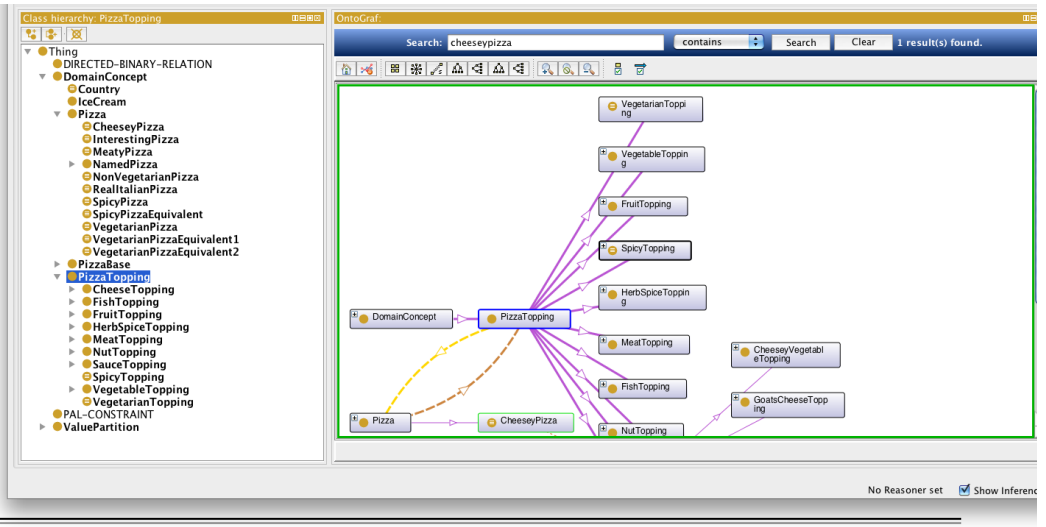
- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate
  - Class hierarchy (i.e., sub-class relationships)
  - Properties-based relationships between classes (i.e., domain and range of properties)
  - Other relationships between classes (e.g., disjointness)



Screenshot: OWLPropViz

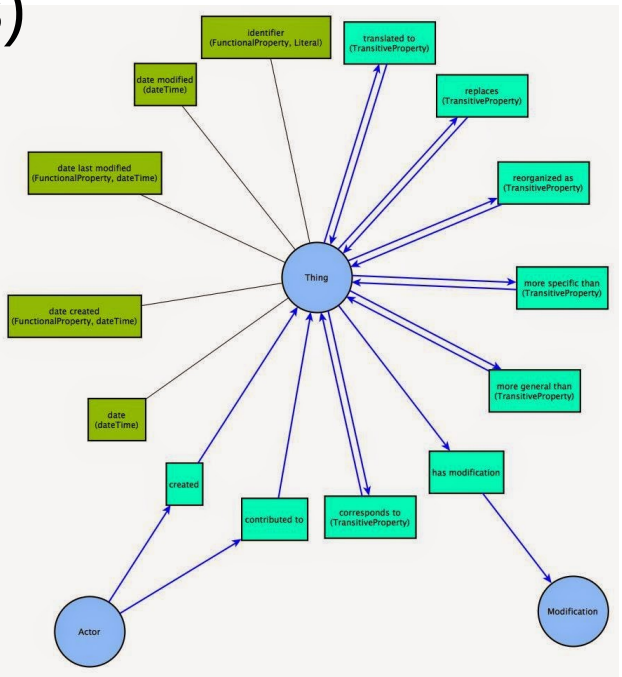
Graph Visualizations of Ontologies

- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate
  - Class hierarchy (i.e., sub-class relationships)
  - Properties-based relationships between classes (i.e., domain and range of properties)
  - Other relationships between classes (e.g., disjointness)
- Rendering of graphs
  - hierarchical



Graph Visualizations of Ontologies

- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate
  - Class hierarchy (i.e., sub-class relationships)
  - Properties-based relationships between classes (i.e., domain and range of properties)
  - Other relationships between classes (e.g., disjointness)
- Rendering of graphs
  - hierarchical
  - radial



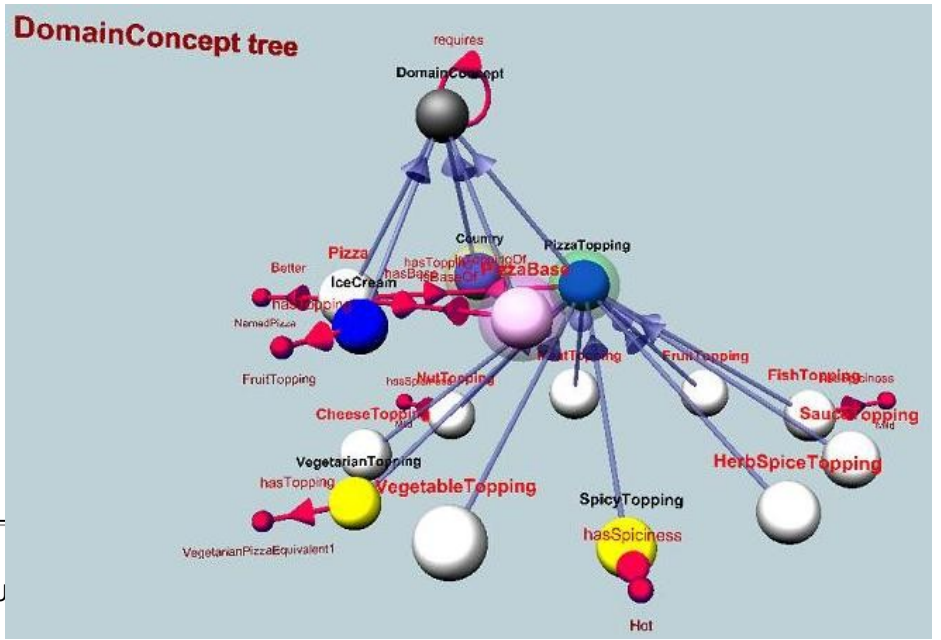
Graph Visualizations of Ontologies

- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate
  - Class hierarchy (i.e., sub-class relationships)
  - Properties-based relationships between classes (i.e., domain and range of properties)
  - Other relationships between classes (e.g., disjointness)
- Rendering of graphs
  - hierarchical
  - radial
  - force-directed

- Characteristics:
  - Tends to place highly-connected classes to the center
  - All edges have roughly the same length
  - Tends to avoid edge crossings
- e.g., ProtégéVOWL / WebVOWL

Graph Visualizations of Ontologies

- Most common approach to visualize ontologies
- Tools differ by what elements they illustrate
  - Class hierarchy (i.e., sub-class relationships)
  - Properties-based relationships between classes (i.e., domain and range of properties)
  - Other relationships between classes (e.g., disjointness)
- Rendering of graphs
  - hierarchical
  - radial
  - force-directed
  - three-dimensional



Screenshot: OntoSphere3D

Features of Ontology Visualization Tools

	Classes	Enumeration	Property restrictions	Cardinality	Intersection	Union	Complement	subClassOf	equivalentClass	disjointWith	Object properties	Datatype properties	Instances	Annotations
COE	•	•	•	•	•		•	•	•	•	•	•	•	
CropCircles	•							•						
FlexViz	•							•					•	
GLOW	•				•			•			•	•	•	
GrOWL	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Jambalaya	•		•					•			•		•	
KC-Viz	•							•			•			
Knoocks	•							•			•	•	•	
NavigOWL	•	•	•	•	•	•	•	•	•	•	•	•	•	•
OntoGraf	•							•			•		•	
OntologyVisualizer	•							•			•	•	•	
OntoRama	•	•		•	•			•	•		•	•	•	•
OntoSphere3D	•				•	•		•		•	•	•	•	
OWLGrEd	•	•	•	•	•	•	•	•	•	•	•	•	•	•
OWLPropViz	•							•	•	•	•			
OWLViz	•							•						
RelFinder	•										•		•	
SOVA	•	•	•	•	•	•	•	•	•	•	•	•	•	
TGViz	•							•	•		•		•	
TopBraid Composer	•	•	•	•	•	•	•	•	•	•	•	•	•	•
ProtégéVOWL	•		•		•			•	•		•	•		
WebVOWL	•		•	•	•	•	•	•	•	•	•	•	•	

Balzer, Do, and Maseluk: *Comparison and Evaluation of Ontology Visualizations.* 2015. http://dx.doi.org/10.18419/opus-3499

VOWL: Visual Notation for OWL Ontologies

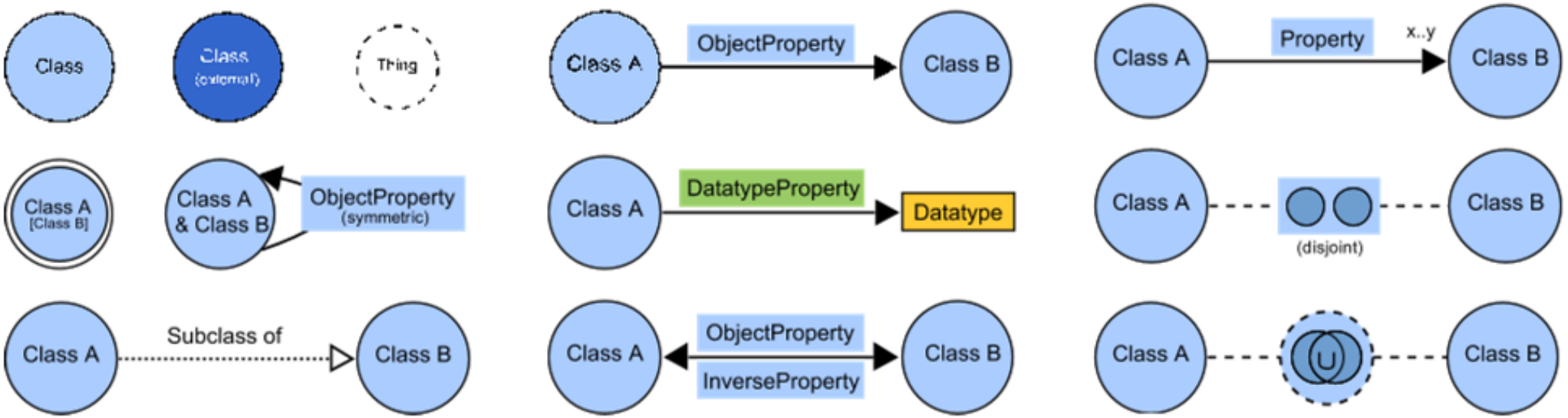
- Comprehensive visual language for representing OWL ontologies
- Graph visualization
- Graphical Primitives:

Primitive	Application	Primitive	Application
	classes		datatypes, property labels
	properties		special classes/properties
	property directions	text number symbol	labels, cardinalities

Negru, Lohmann, and Haag. *VOWL: Visual notation for OWL ontologies*. 2014. http://purl.org/vowl/spec/

Lohmann, Negru, Haag, and Ertl: *Visualizing Ontologies with VOWL*. Semantic Web 7(4): 399-419 (2016)

Visual Elements of VOWL



Negru, Lohmann, and Haag. *VOWL: Visual notation for OWL ontologies*. 2014. http://purl.org/vowl/spec/

Lohmann, Negru, Haag, and Ertl: *Visualizing Ontologies with VOWL*. Semantic Web 7(4): 399-419 (2016)

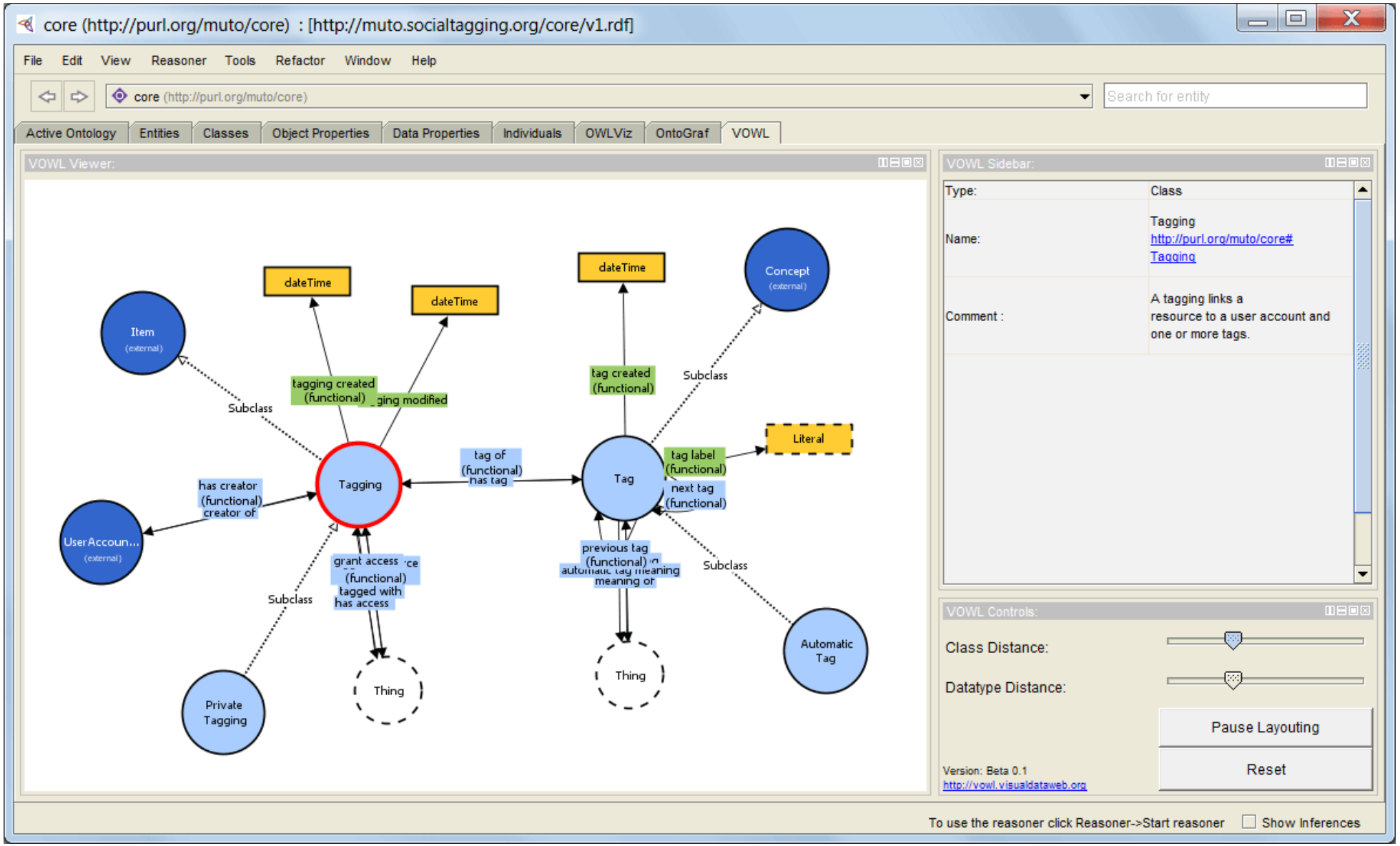
VOWL Color Scheme

Name	Color	Application
General		classes, object properties, disjointness
External		external classes and properties
Deprecated		deprecated classes and properties
Datatype		datatypes, literals
Datatype property		datatype properties
Highlighting		circles, rectangles, lines, borders, arrows

Negru, Lohmann, and Haag. *VOWL: Visual notation for OWL ontologies*. 2014. http://purl.org/vowl/spec/

Lohmann, Negru, Haag, and Ertl: *Visualizing Ontologies with VOWL*. Semantic Web 7(4): 399-419 (2016)

ProtégéVOWL



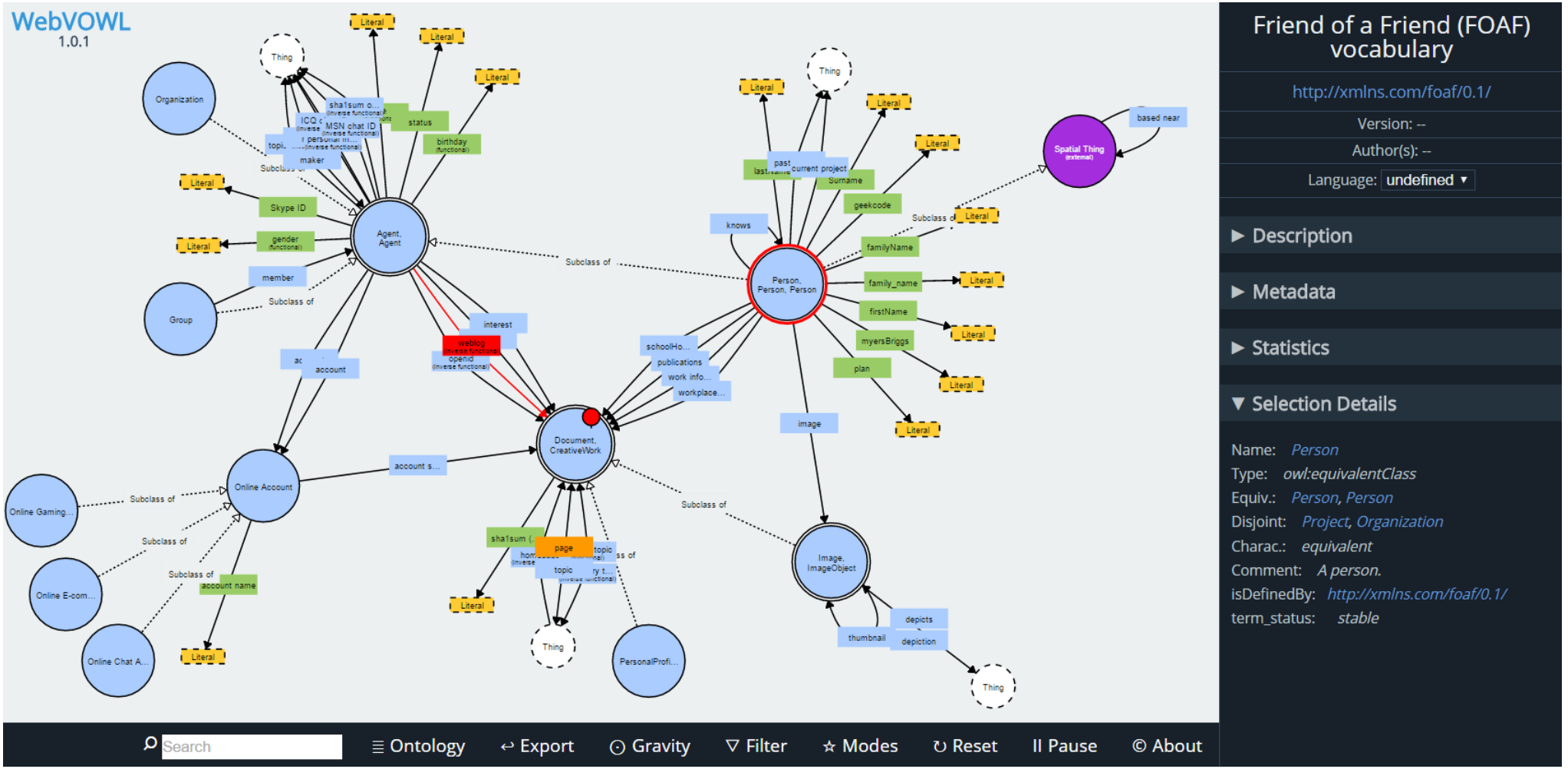
WebVOWL Demo

- Create a VOWL description of the Semantic Sensor Network ontology (SSN)

```
java -jar owl2vowl.jar -iri "http://www.w3.org/ns/ssn/"
```

- Rename the resulting `default.json` file to `ssn.json` and copy it into the `data` directory of WebVOWL
- Add an option for SSN to the `index.html` of WebVOWL
- Open the `index.html` in a browser

WebVOWL Demo



Exploratory Queries

Exploratory Queries

- Idea: issue a number of SPARQL queries to explore the content of a given dataset
- Example: *What properties are used in the data?*

```
SELECT DISTINCT ?p WHERE {
  ?s ?p ?o
}
```

- *What classes are used?*

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>

SELECT DISTINCT ?t WHERE {
  ?s rdf:type ?t
}
```

Exploratory Queries (cont'd)

- *What properties are used and how often?*

```
SELECT ?p (COUNT(?p) AS ?count) WHERE {
  ?s ?p ?o
}
GROUP BY ?p
ORDER BY DESC(?count)
```

- *What classes are used and how often?*

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>

SELECT ?t (COUNT(?t) AS ?count) WHERE {
  ?s rdf:type ?t
}
GROUP BY ?t
```

Exploratory Queries (cont'd)

- *List a few example instances of a particular class*

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX ssn: <http://purl.oclc.org/NET/ssnx/ssn#>

SELECT ?s WHERE {
  ?s rdf:type ssn:SensingDevice
}
LIMIT 10
```

Further Examples

- Bob DuCharme's "Learning SPARQL" (2nd edition!) has an "*Exploring the Data*" section in Chapter 11
  - http://learningsparql.com/

  - What classes are declared?
  - What properties are declared?
  - Which classes have instances?
  - What properties are used?
  - Which classes use a particular property?
  - How much is a given property used?
  - How much is a given class used?
  - A given class has lots of instances. What are these things?
  - What data is stored about a class?
  - What values does a given property have?

Dataset Summarization and Profiling

Summarization and Profiling Approaches

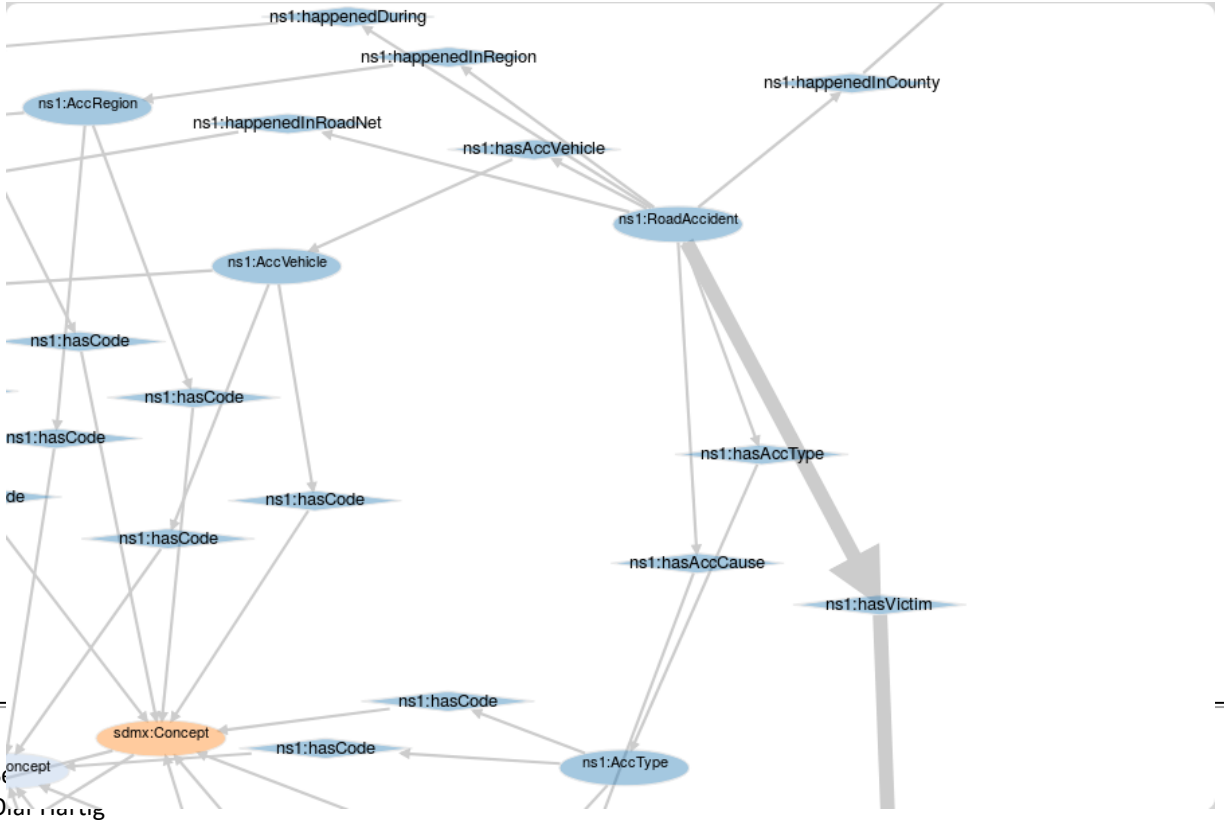
- RDFStats (Langegger and Wöß, 2009)
- ExpLOD (Khatchadourian and Consens, 2010)
- LODStats (Auer et al., 2012)
- ProLOD (Böhm et al., 2010)
- ProLOD++ (Ziawasch et al., 2014)
- LODSight (Dudás et al., 2015)
- Loupe (Mihindukulasooriya et al., 2015)

Loupe

- Understand which vocabularies are used (classes and properties), incl. statistics and frequent triple patterns
  - Start from high-level statistics,
  - zoom into details,
  - all the way down to the corresponding triples
- Class explorer: Which classes? How many instances? Which properties used by these instances?
- Property explorer: Which properties? How many triples? Instances of which classes use a property?
- Online demo: http://loupe.linkeddata.es/loupe/index.jsp
- The summary data is obtained by querying the dataset using SPARQL (http://loupe.linkeddata.es/loupe/methods.html)

LODSight

- Visual summary of a dataset as an interactive graph
  - Nodes represent classes
  - Edges represent predicates that connect instances of the classes in the dataset
  - Example instances can be shown in the graph



LODSight

- Visual summary of a dataset as an interactive graph
  - Nodes represent classes
  - Edges represent predicates that connect instances of the classes in the dataset
  - Example instances can be shown in the graph
- Features of the visualization tool:
  - Ontology filter
  - Predicate filter
  - Example instances
- The summary data is obtained by querying the dataset via a SPARQL endpoint (no support for RDF files!)
- Not trivial to set up (but possible, in contrast to Loupe)

RDFStats

- Generates statistical metadata for a dataset by executing several SPARQL queries
  - Dataset may be given in an RDF file or accessed via a SPARQL endpoint
- Generated metadata includes:
  - an URI histogram over URI subjects
  - number of anonymous subjects (blank nodes)
  - a histogram for each property and associated ranges (depending on the ranges of a property, different histograms are available, e.g., integer / double / boolean / date /string histogram)
- Generated statistics captured in RDF using a specific RDFStats vocabulary that is based on SCOVO

www.liu.se

LINKÖPING UNIVERSITY