

Ontology-related data and reengineering

Design by Re-engineering

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Course Outline

- Ontologies and the Semantic Web
- Ontology Design and Ontology Design Patterns
- Content Ontology Design Patterns
- **Design by Re-Engineering**

Reengineering OPs

Definition

- Reengineering OPs are transformation rules applied in order to create a new ontology (target model) starting from elements of a source model
- The target model is an ontology, while the source model can be either an ontology, or a non-ontological resource
 - e.g., a thesaurus concept, a data model pattern, a UML model, a linguistic structure, etc.
- **Two types:**
 - Schema reengineering OPs are rules for transforming a non-OWL DL metamodel into an OWL DL ontology
 - Refactoring OPs provide designers with rules for transforming, i.e. “refactoring”, an existing OWL DL “source” ontology into a new OWL DL “target” ontology
 - E.g. a guideline to reengineer a piece of an OWL ontology in presence of a requirement change, as when moving from individuals to classes, or from object properties to classes. See also N-ary relation transformation pattern

Ontology-related data: knowledge resource types

- **Modeling Languages**
 - E/R, UML, XSD, Petri Nets, ebXML, BPEL4WS
- **Conceptual models**
 - Database schemas, UML diagrams, XSD schemas, etc.
- **Informal Data Structures**
 - Spreadsheets, tables, etc.
- **Lexical resources**
 - WordNet, FrameNet, Oxford Dictionary, etc.
- **Concept Schemes**
 - Thesauri, classifications, nomenclatures, etc.
- **Open tag systems**
 - Flickr, Wikipedia, MySpace, ...
- **Linked Open Data**
 - DBpedia, Microformats, RDFa, etc.
- **Text extractors**
 - Text2Onto, TermExtractor, SST, Frame Detector, ...

Searching and using ontologies, on-the-fly data reengineering

- Watson and the NeOn Toolkit
- Sindice
- Yago
- Umbel
- Freebase
- OpenLink Data Explorer over Linked Open Data
- GRDDL, RDFa and Microformats



desire

Search results for term "desire", found about 3.71 thousand

- [Prison of Desire](#) (RDF)
 - + 2008-06-16 - 108 triples in 18.4 kb
 - http://dbpedia.org/resource/Prison_of_Desire (Search) (Cached)
- [Desire Quotes](#) (MICROFORMAT)
 - + 2008-06-18 - 3 triples in 352 bytes
 - <http://quotationsbook.com/subject/desire/> (Search) (Cached)
- [Goddess of Desire](#) (RDF)
 - + 2008-06-11 - 104 triples in 18.1 kb
 - http://dbpedia.org/resource/Goddess_of_Desire (Search) (Cached)
- [Hearts Desire](#) (RDF)
 - + 2008-07-06 - 10 triples in 1.2 kb
 - <http://sws.geonames.org/5973180/> (Search) (Cached)
- [Port Desire](#) (RDF)
 - + 2008-07-07 - 10 triples in 1.2 kb
 - <http://sws.geonames.org/6111725/> (Search) (Cached)
- [Un tranvia llamado Deseo. A Streetcar Named Desire](#) (RDF)
 - + 2008-06-09 - 93 triples in 17.5 kb
 - http://dbpedia.org/resource/A_Streetcar_Named_Desire (Search) (Cached)
- [Maple Heights-Lake Desire](#) (RDF)
 - + 2008-06-12 - 184 triples in 35.2 kb
 - http://dbpedia.org/resource/Maple_Heights-Lake_Desire%2C_Washington (Search) (Cached)
- [T e N o ... discover your desire](#) (MICROFORMAT)
 - + 2008-06-11 - 11 triples in 1.2 kb
 - <http://www.teno.de/teno/deutsch/blog/> (Search) (Cached)
- [Fluid Imagination » Think D...](#) (MICROFORMAT)
 - + 2008-06-11 - 7 triples in 824 bytes
 - <http://fluidimagination.com/blog/2005/04/22/think-desire/> (Search) (Cached)
- [The Powerful Emotion of DESIRE](#) (MICROFORMAT)
 - + 2008-06-17 - 11 triples in 1.6 kb
 - <http://hypnosismarketingtips.com/direct-marketing-strategies/the-powerful-emotion-of-de>



[What is it?](#) - [Submit URI](#) - [Website](#) - [Blog](#) - [Mailing List](#)

desire [Search Watson](#)

Found 487 semantic documents - [Search Options](#)

- 1- <http://vocab.org/relationship/rel-vocab-20040308.rdf>
 - o [P http://purl.org/vocab/relationship/wouldLikeToKnow](http://purl.org/vocab/relationship/wouldLikeToKnow)
- 2- <http://www.nuin.org/ontology/ks>
 - o [C http://www.nuin.org/ontology/ks#Desire](http://www.nuin.org/ontology/ks#Desire)
 - o [C http://www.nuin.org/ontology/ks#Goal](http://www.nuin.org/ontology/ks#Goal)
 - o [P http://www.nuin.org/ontology/ks#hasActor](http://www.nuin.org/ontology/ks#hasActor)
- 3- <http://mogatu.umbc.edu/ont/2004/01/BDI.owl#MrBDI>
 - o [C http://mogatu.umbc.edu/ont/2004/01/BDI.owl#NonAchievableDesire](http://mogatu.umbc.edu/ont/2004/01/BDI.owl#NonAchievableDesire)
 - o [C http://mogatu.umbc.edu/ont/2004/01/BDI.owl#NonConflictingDesire](http://mogatu.umbc.edu/ont/2004/01/BDI.owl#NonConflictingDesire)
 - o [C http://mogatu.umbc.edu/ont/2004/01/BDI.owl#Goal](http://mogatu.umbc.edu/ont/2004/01/BDI.owl#Goal)
 - o [C http://mogatu.umbc.edu/ont/2004/01/BDI.owl#Desire](http://mogatu.umbc.edu/ont/2004/01/BDI.owl#Desire)
- 4- <http://pervasive.semanticweb.org/ont/2004/06/bdi>
 - o [C http://pervasive.semanticweb.org/ont/2004/06/bdi#Desire](http://pervasive.semanticweb.org/ont/2004/06/bdi#Desire)
 - o [D http://pervasive.semanticweb.org/ont/2004/06/bdi](http://pervasive.semanticweb.org/ont/2004/06/bdi)
- 5- <http://pervasive.semanticweb.org/ont/dev/bdi>
 - o [C http://pervasive.semanticweb.org/ont/dev/bdi#Desire](http://pervasive.semanticweb.org/ont/dev/bdi#Desire)
 - o [D http://pervasive.semanticweb.org/ont/dev/bdi](http://pervasive.semanticweb.org/ont/dev/bdi)
- 6- <http://city-sleep.livejournal.com/data/foaf>
 - o [D http://www.livejournal.com/interests.bml?int=fake+desire](http://www.livejournal.com/interests.bml?int=fake+desire)
 - o [D http://www.livejournal.com/interests.bml?int=real+desire](http://www.livejournal.com/interests.bml?int=real+desire)
- 7- http://users.livejournal.com/hot_pursuit/data/foaf
 - o [D http://www.livejournal.com/interests.bml?int=desire](http://www.livejournal.com/interests.bml?int=desire)
- 8- <http://withinamoment.livejournal.com/data/foaf>
 - o [D http://www.livejournal.com/interests.bml?int=desire](http://www.livejournal.com/interests.bml?int=desire)
- 9- <http://vocab.org/relationship/rel-term-wouldLikeToKnow-20040308.rdf>
 - o [P http://purl.org/vocab/relationship/wouldLikeToKnow](http://purl.org/vocab/relationship/wouldLikeToKnow)
- 10- <http://mogatu.umbc.edu/ont/2004/01/Agent.owl#MrAgent>
 - o [C http://mogatu.umbc.edu/ont/2004/01/BDI.owl#Desire](http://mogatu.umbc.edu/ont/2004/01/BDI.owl#Desire)

Integrated knowledge search

YAGO-query:

?id0: ?

?desire = [desire](#)
?what0 = [subClassOf](#)
?x = [tendency](#)

Yago

?desire = [desire](#)
?what0 = [subClassOf](#)
?x = [feeling](#)

?desire = [desire](#)
?what0 = [subClassOf](#)
?x = [arousal](#)

Umbel

Search Results

Narrow Results

Type

Freebase

everything based on a centralized ontology ... of mixed quality

OpenLink Data Explorer interface showing a search for 'Third Crusade'. The interface includes a search bar, a 'Query' button, and a 'Find' button. Below the search bar, there are tabs for 'What', 'Where', 'When', 'Who', 'Images', 'Grid view', 'Tag Cloud', 'SVG Graph', 'Raw triples', and 'Custom'. The main area displays a list of filtered triples with columns for 'Subject', 'Predicate', and 'Object'. A sidebar on the right shows 'Categories' and 'Filters'.

There are 148 triples available.
Page: 1 2

Human readable visible columns

#	Subject	Predicate	Object
1	Third Crusade	subject	Al-Adil
2	Third Crusade	subject	Des Inscriptions et Belles-Lettres
3	Third Crusade	subject	Akko
4	Third Crusade	subject	1191
5	Third Crusade	subject	1192
6	Third Crusade	subject	AcadAAA@mie
7	Third Crusade	subject	
8	Third Crusade	subject	1189
9	Third Crusade	subject	1190
10	Third Crusade	subject	Crusades
11	Third Crusade	subject	1188
12	Third Crusade	subject	Albigensian
13	Third Crusade	subject	Crusade
14	Third Crusade	subject	Campaignbox
15	Third Crusade	subject	Third
16	Third Crusade	subject	Al-Adil

Web browser showing the Wikipedia page for 'Third Crusade'. The page content includes a list of related resources and a detailed description of the event. The text is partially obscured by a large block of text on the left side of the image.

RDF triples can contain all sorts of relations, as shown with reference to DBpedia triples related to the Third Crusade: *subjects*, *alternate pages*, *copyright forms*, *types*, *icons*, etc. are all related to the Third Crusade page in a way that makes the results of the search still confusing (although better than googling, or browsing Wikipedia for a



How Linked Data Materialize on the Web

Generated "on the fly" via RDF middleware from:

- Existing Web Pages (POSH, Microformats, eRDF, RDFa, GRDDL)

- Web 2.0 Data Spaces (Social Networks, Blogs, Wikis, Bookmarks, Online Discussions / Conversations etc)

- Web Services (SOAP and REST)

Enterprise Data Sources

- SOA oriented Web Services

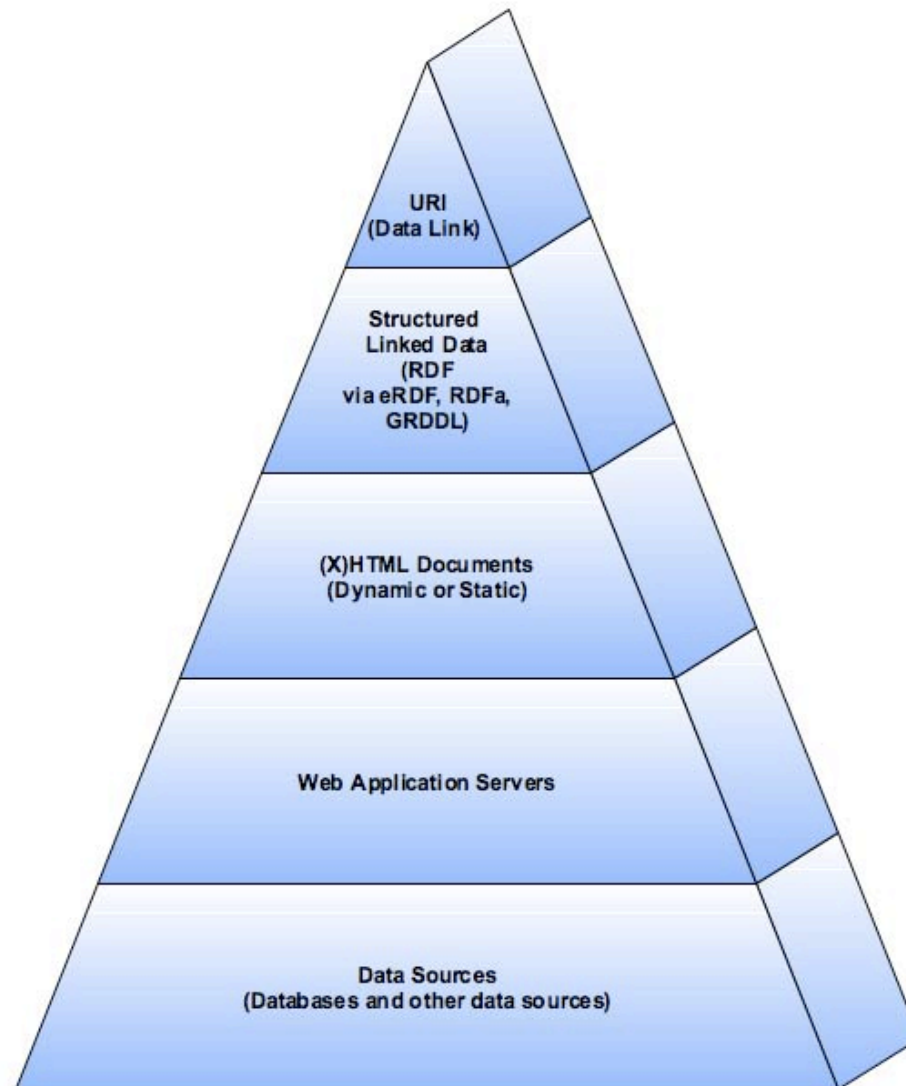
- XML based Data Warehouses and Views

- Enterprise Databases (ODBC, JDBC, OLE-DB, ADO.NET, XMLA, Native CLIs)

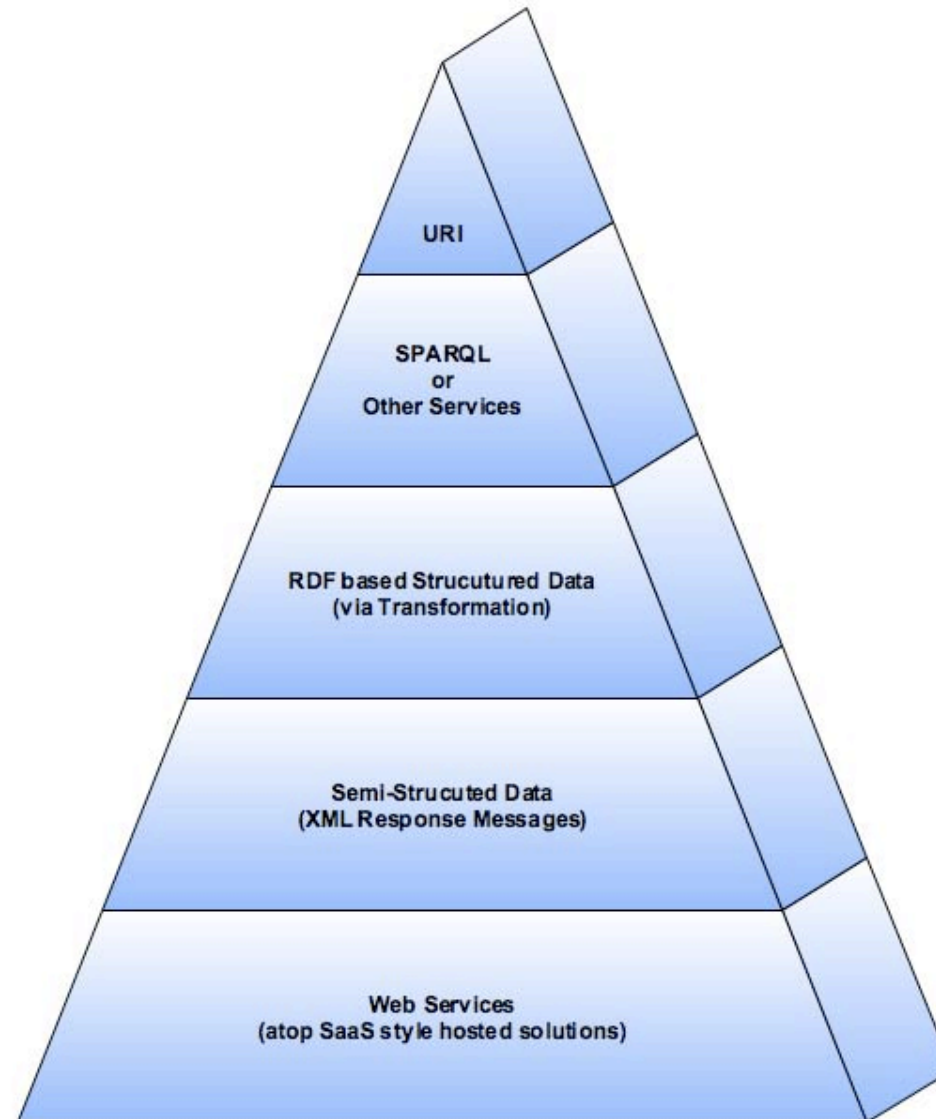
Community driven extraction efforts

- DBpedia, Bio2RDF, and many other Linking Open Data projects

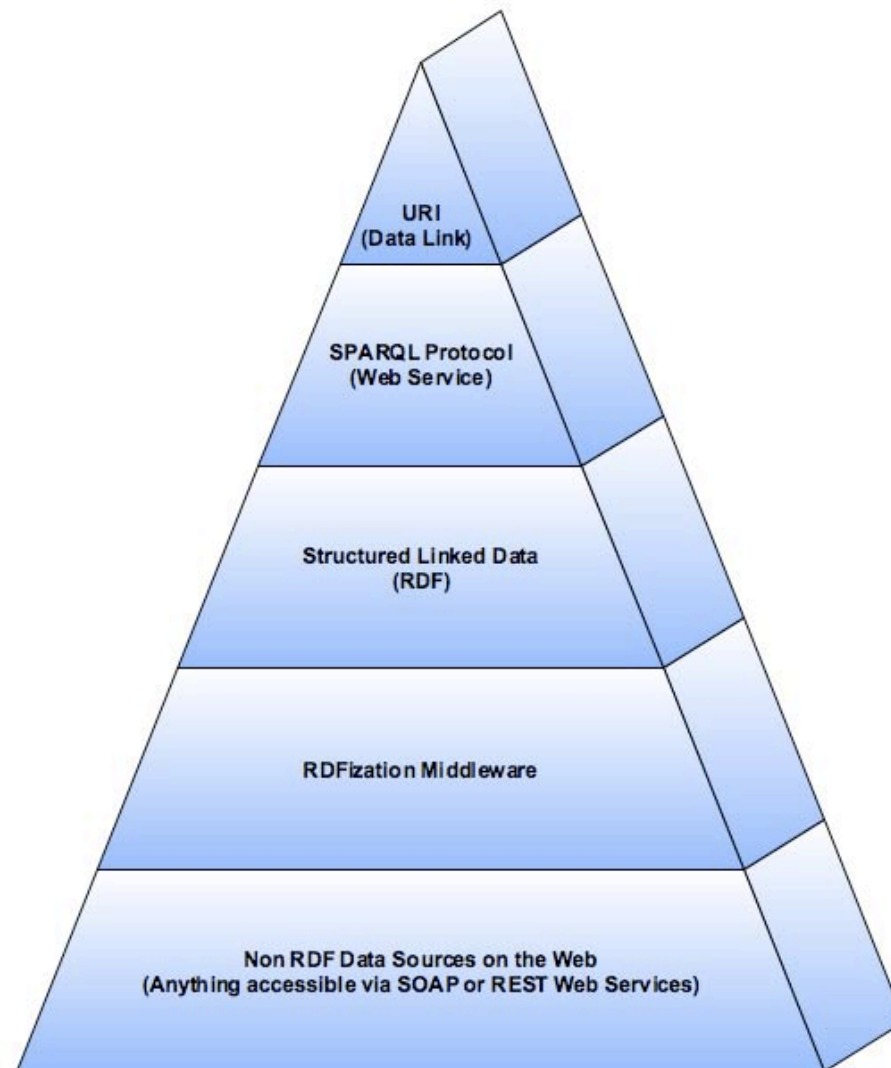
Reengineering dynamic web content



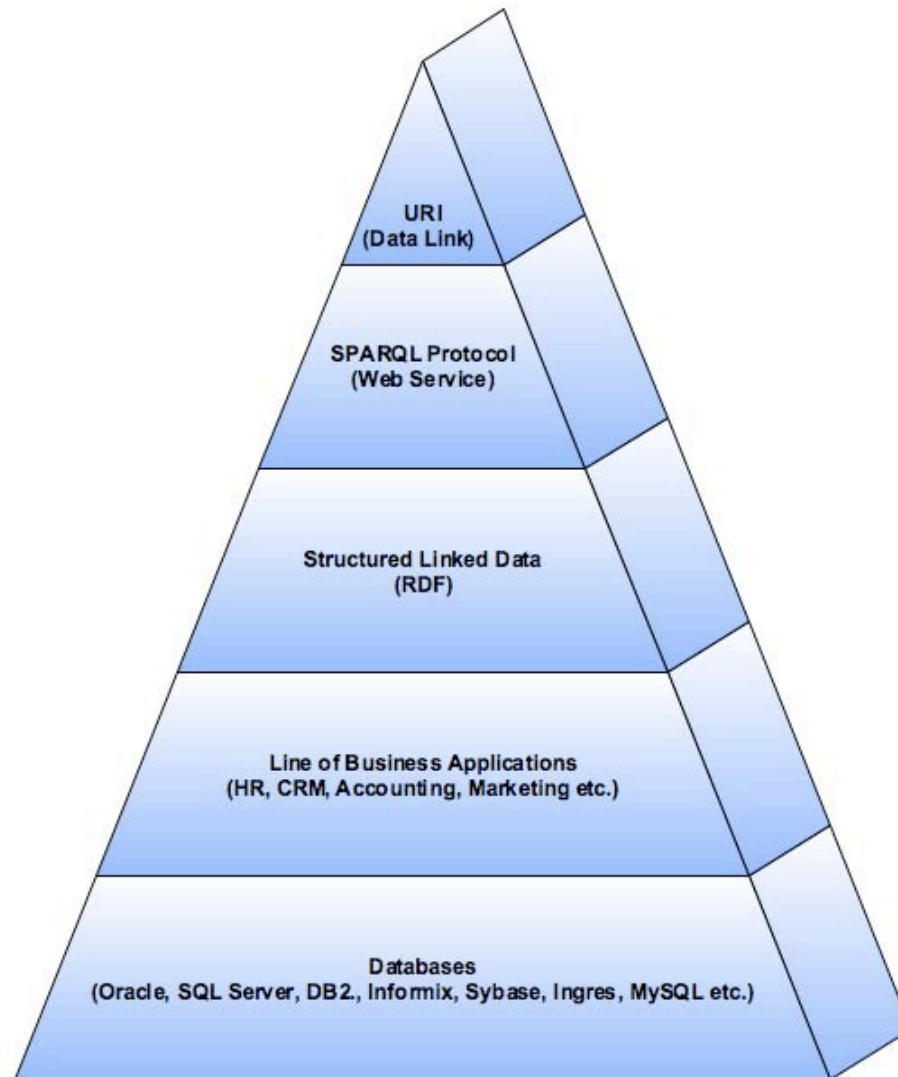
Reengineering web service content



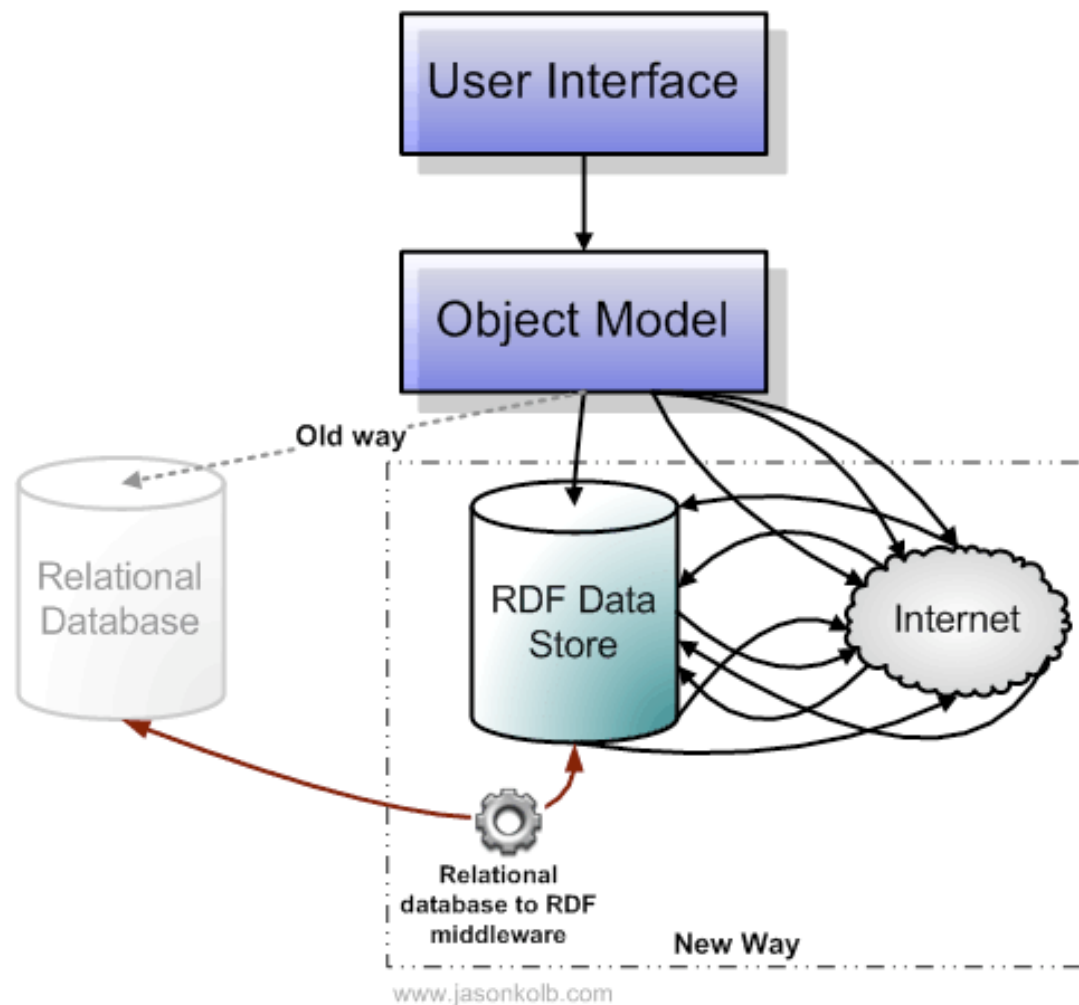
Reengineering web content



Reengineering enterprise data



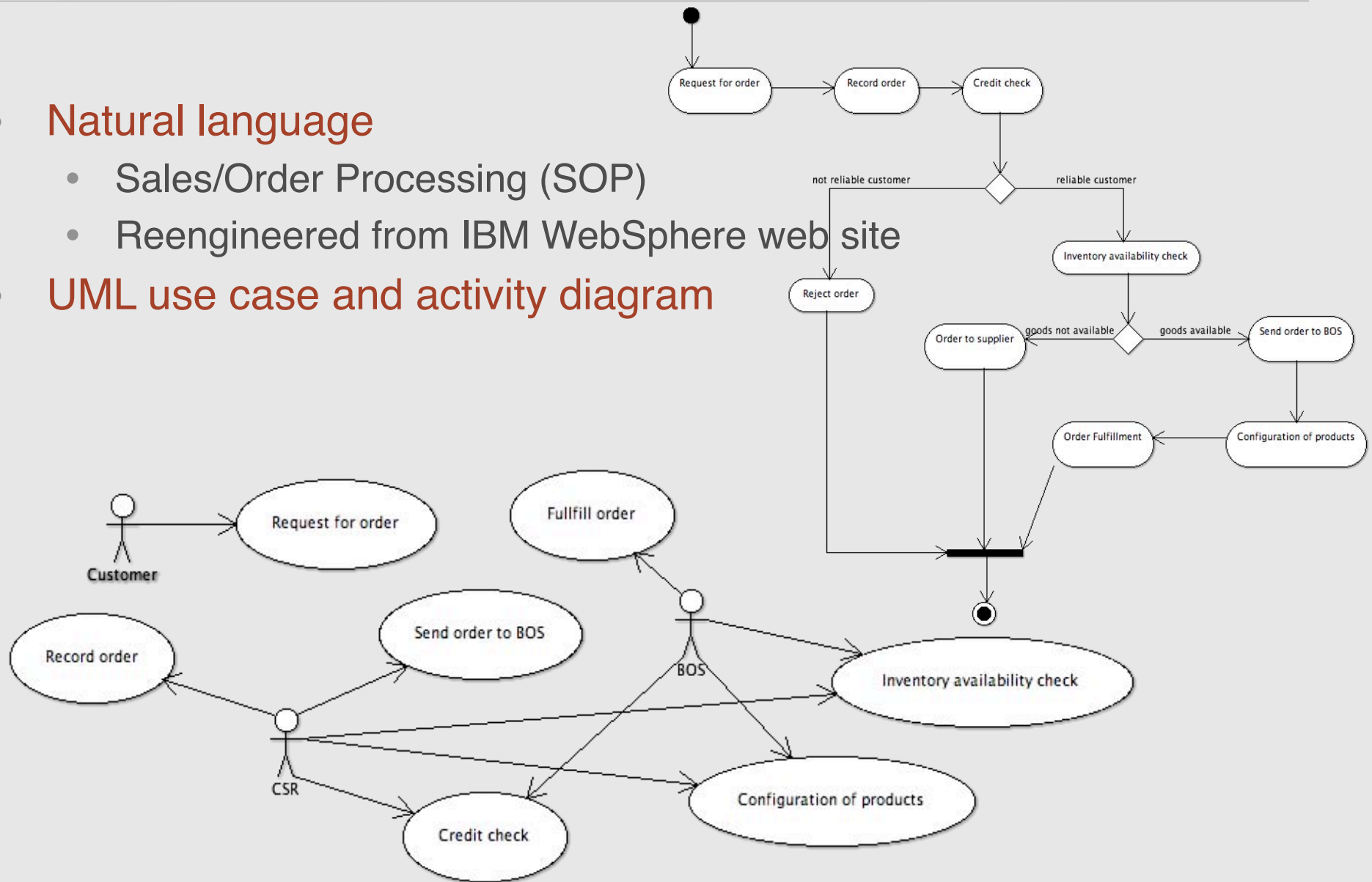
Reengineering relational databases



Modeling Languages, conceptual schemas, and informal data structures

Example: Sales/Order Process 1/2

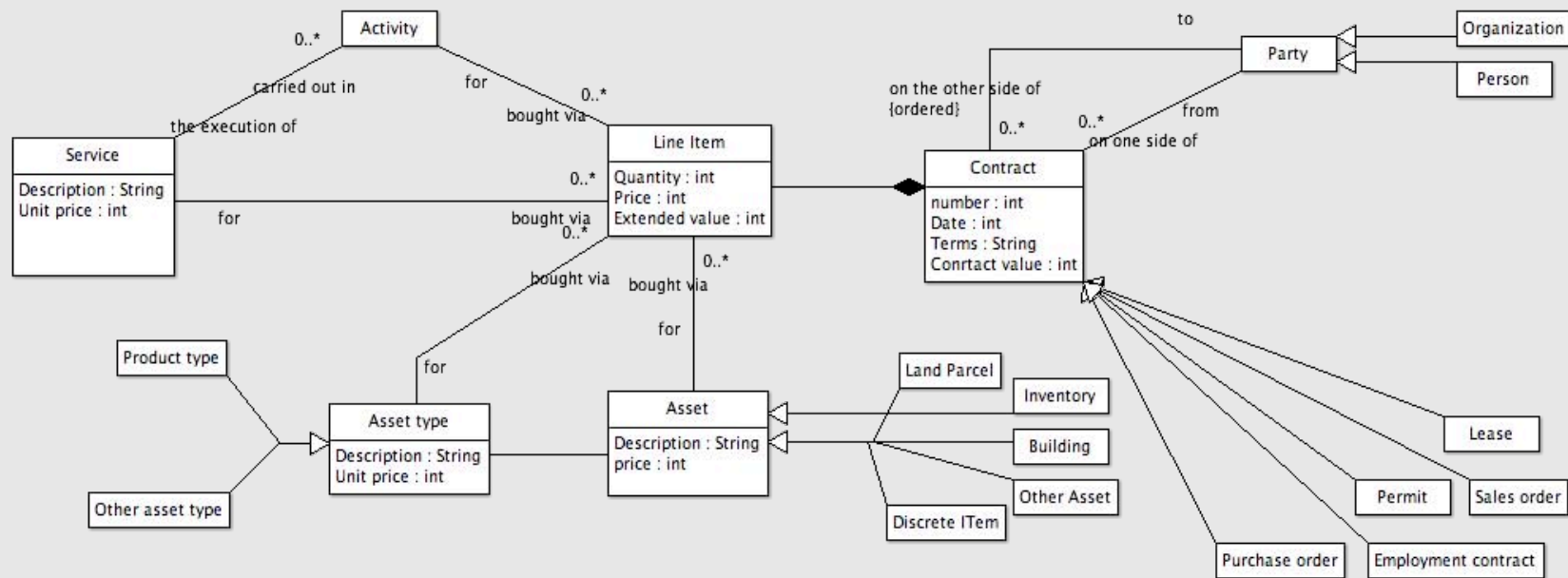
- **Natural language**
 - Sales/Order Processing (SOP)
 - Reengineered from IBM WebSphere web site
- **UML use case and activity diagram**



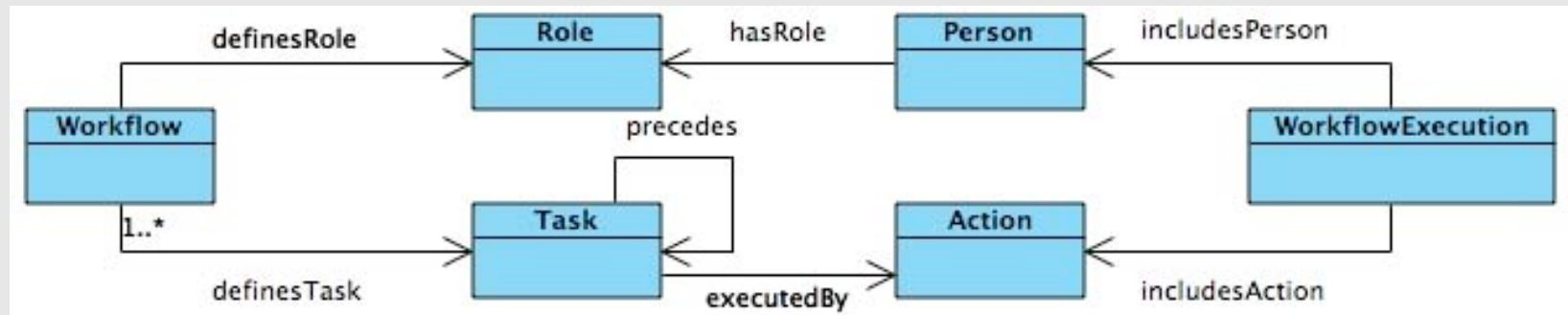
Example: Sales/Order Process 2/2

- Data model patterns

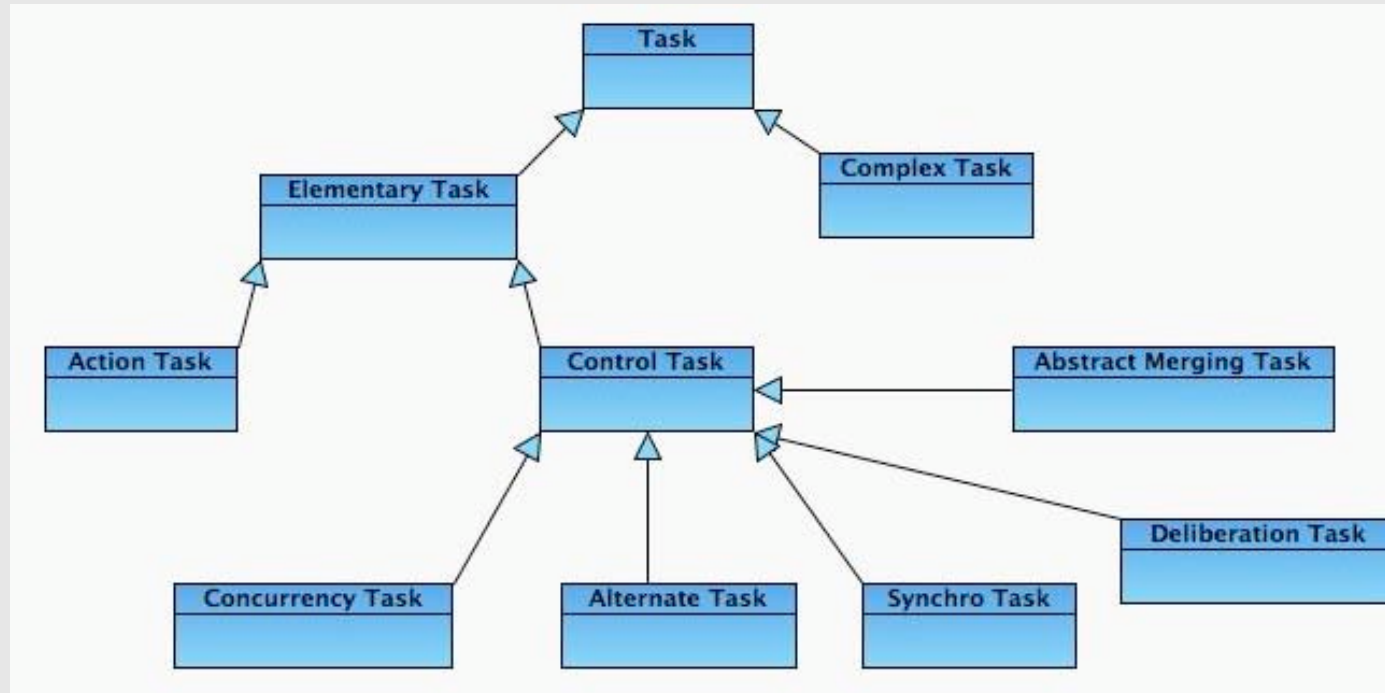
- *Kinds of Contracts*
- re-engineered from 'Data Model Patterns' (D.C. Hay. 96) Workflow patterns



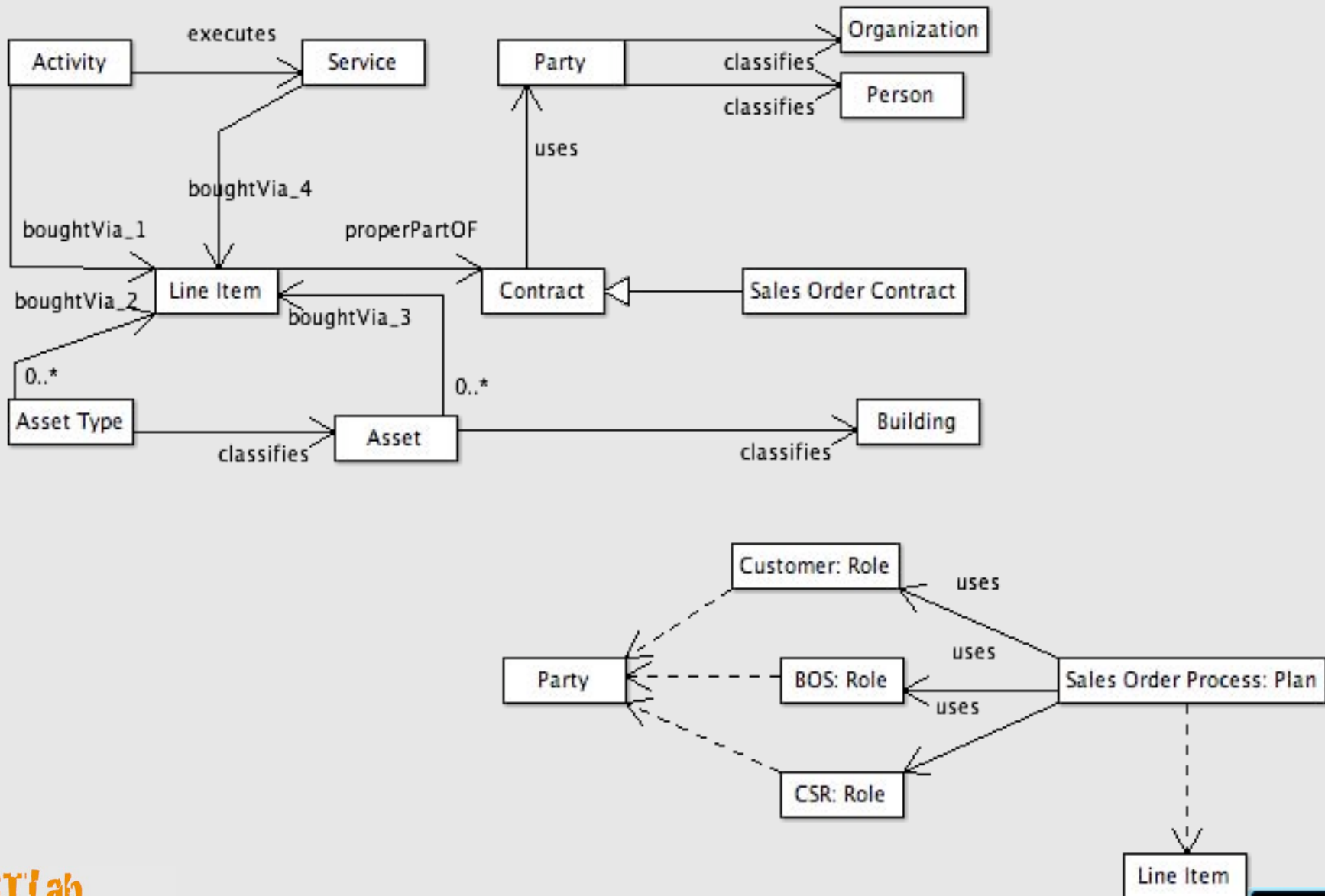
Workflow: CP specialization



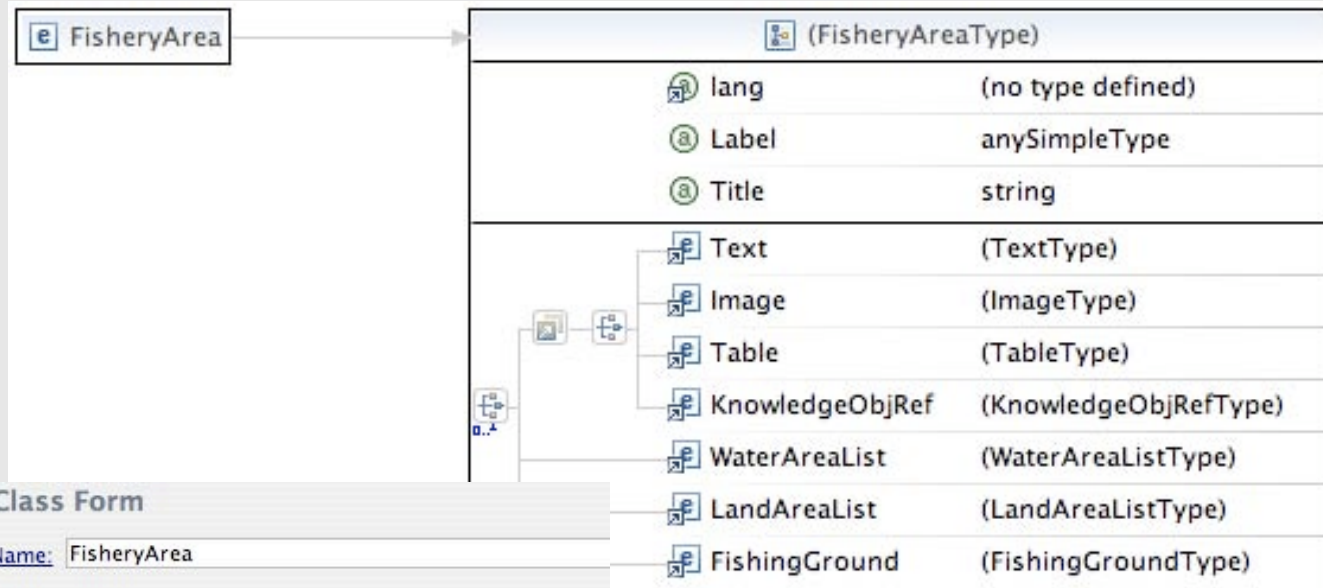
Some workflow patterns (re-engineered from van der Aalst)



Merging data models and workflow patterns in OWL CPs



An example from a DTD-based XSD



- FishEquipContext
- FishEquipFeature
- FishEquipIdent
- FishEquipOverview
- FishEquipProfile
- FishEquipRef
- Fisheries
- FisheriesManage
- FisheriesManageUnit
- FisheriesSector
- Fishery
- FisheryActivity
- FisheryActivityEntry
- FisheryAncestor
- FisheryArea**
- FisheryExploit
- FisheryHistory
- FisheryIdent
- FisheryIndicator
- FisheryKeys
- FisheryOverview
- FisheryRef
- FisheryStatusTrend
- FisheryStruct
- FishingActivityRef

Class Form

Name: FisheryArea

Annotations

Class Axioms

rdfs:subClassOf

- owl:Thing
- hasFishingGround all FishingGround
- hasImage all Image
- hasImage max 1
- hasKnowledgeObjRef all KnowledgeObjRef
- hasKnowledgeObjRef max 1
- hasLabel all xsd:anySimpleType
- hasLabel max 1
- hasLandAreaList all LandAreaList
- hasLang all xsd:string
- hasLang max 1
- hasTable all Table
- hasTable max 1
- hasText all Text
- hasText max 1
- hasTitle all xsd:string
- hasTitle max 1
- hasWaterAreaList all WaterAreaList

Spreadsheet2RDF (e.g. rdf123)

```
rdf123:metadata,,,,,,,,,
title,Computing lab members,,,,,,,,,
comment,8 June 2007,,,,,,,,,
row head,true,,,,,,,,,
start row,8,,,,,,,,,
type,rdf123:ConvertedSpreadsheetInRDF,,
NAME,EMAIL,OFFICE,,,,,,,,,
Al Turing,amt@umbc.edu,ITE332,,,,,,,,,
Don Knuth,dek@umbc.edu,ITE332,,,,,,,,,
Marvin Minsky,mlm@umbc.edu,ITE442,,,,,,,,,
```

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix rdf123: <http://rdf123.org/> .
```

```
<> a rdf123:ConvertedSpreadsheetInRDF;
dc:title "Computing lab members;
rdfs:comment "8 June 2007".
```

```
[] a foaf:Person;
foaf:name "Al Turing";
foaf:mbox "amt@umbc.edu";
foaf:officeNumber "ITE332".
```

```
[] a foaf:Person;
foaf:name "Don Knuth"; ...
...
```

Lexical resources, concept schemas, and web 2.0

Linguistic dictionaries and thesauri

Oxford American Dictionary

desire |də'zī(ə)r| |də,zɑɪ(ə)r| |di,zɑɪ(ə)r| |dɪ,zʌɪə|

noun

a strong feeling of wanting to have something or wishing for something to happen : [with infinitive] *a desire to work in the dirt with your bare hands.*

• strong sexual feeling or appetite : *they were clinging together in fierce mutual desire.*

verb [trans.]

strongly wish for or want (something) : *he never achieved the status he so desired* | [as adj.] (**desired**) *it failed to create the desired effect.*

• want (someone) sexually : *there had been a time, years ago, when he had desired her.*

• archaic express a wish to (someone); request or entreat.

ORIGIN Middle English : from Old French **desir** (noun), **desirer** (verb), from Latin **desiderare** (see **desiderate**).

Thesaurus

desire

noun

1 *a desire to see the world* wish, want, aspiration, fancy, inclination, impulse; yearning, longing, craving, hankering, hunger; eagerness, enthusiasm, determination; informal yen, itch, jones.

2 *his eyes glittered with desire* lust, sexual attraction, passion, sensuality, sexuality; lasciviousness, lechery, salaciousness, libidinousness; informal the hots, raunchiness, horniness.

verb

1 *they desired peace* want, wish for, long for, yearn for, crave, hanker after, be desperate for, be bent on, covet, aspire to; fancy; informal have a yen for, have a jones for, yen for, hanker after/for.

2 *she desired him* be attracted to, lust after, burn for, be infatuated by; informal fancy, have the hots for, have a crush on, be mad about, be crazy about.

STLab

WordNets

WordNetX

Lookup: ◀ ▶ Hierarchy

Senses	Relations
noun: An inclination to want things; "a man of many desires"	▼ Synonyms desire want
noun: The feeling that accompanies an unsatisfied state	▼ Derivationally Related needer wish desire desire desire
noun: Something that is desired	▼ Frames Somebody ----s something Somebody ----s that CLAUSE Somebody ----s to INFINITIVE Somebody ----s somebody to INFINITIVE
verb: Feel or have a desire for; want strongly; "I want to go home now"; "I want my own room"	▼ Hyponyms crave fancy miss hope wish wish wish itch like ambition feel like envy lust after hanker seek
verb: Express a desire for	
verb: Expect and wish; "I trust you will behave better from now on"; "I hope she understands that she cannot expect a raise"	

FrameNets

Frame Report (recent data)

[| Top of Frame Index](#) | [| Top of Lexical Unit Index](#) |

Desiring

Definition:

An **Experiencer** desires that an **Event** occur. (Note that commonly a resultant state of the **Event** will stand in for the **Event**.) In some cases, the **Experiencer** is an active participant in the **Event**, and in such cases the **Event** itself is often not mentioned, but rather some **Focal participant** which is subordinately involved in the **Event**.

Generally, the use of a word in this frame implies that the specific **Event** has not yet happened, but that the **Experiencer** believes that they would be happier if it did. Sometimes the **Time of Event**, **Purpose of Event**, or the **Location of Event** are mentioned without the explicit mention of the **Event**.

I only **WANTED** one piece of candy.

The company **was EAGER** for him to leave as soon as possible.

Susan **really WISHES** that you'd listen to her.

FEs:

Core:

Event [Evt]
Semantic Type
State_of_affairs

The change that the **Experiencer** would like to see.

Experiencer [Exp]
Semantic Type Sentient

The **Experiencer** is the person (or sentient being) who wishes for the **Event** to occur.

Focal participant [Foc]

This is the entity that the **Experiencer** wishes to be affected by some **Event**.

Location of Event [PEv]

The **Location of Event** is the place involved in the desired **Event**.
I **WANT** that box **on top of the other one**.

The prince **WISHES** you **here** before matins.

Thesauri: Agrovoc



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
helping to build a world without hunger

Agricultural Information Management Standards
■ *Interoperability, Reusability, and Cooperation* ■

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AGROVOC Concept Server | [Metadata schemas](#) | [Tools](#) | [Publications](#) | [News and Events](#)

■ **AGROVOC Thesaurus**

- Browse
- Sub-vocabularies
- Latest updates
- Suggest terms
- Download
- Webservices V1.5
- Copyright information

■ **Knowledge Organization Systems** NEW

- By Type
- By Subject area
- Suggest KOS

■ **Browse classification schemes**

■ **AGROVOC in AOS**

- The Concept Server
- Applied ontologies in FAO
- Ontology relationships

■ **NeOn**

■ **Glossary**

■ **Frequently Asked Questions**

AGROVOC Thesaurus Last Update: 13/02/2007

AGROVOC is a multilingual, structured and controlled vocabulary designed to cover the terminology of all subject fields in agriculture, forestry, fisheries, food and related domains (e.g. environment).

Learn more about AGROVOC by browsing: [AGROVOC Flyer](#)

Search term:

starting with **containing text** **exact match**

EN : Famine	BT : Disasters
FR : Famine	RT : Malnutrition
ES : Escasez de alimentos	RT : Nutritional status
AR : مجاعة	RT : Economic situation
ZH : 饥荒	RT : Food stocks
PT : Escassez de alimentos	RT : Agricultural situation
CS : hladomor	RT : Emergency relief
JA : 飢饉	RT : Food supply
TH : ความอดอยาก	SNX : Hunger (physiology)
SK : hladomor	UF : Hunger (socioeconomic problem)
DE : HUNGERSNOT	
HU : éhínség	

Term code: 2790

[Legend for relationships](#)

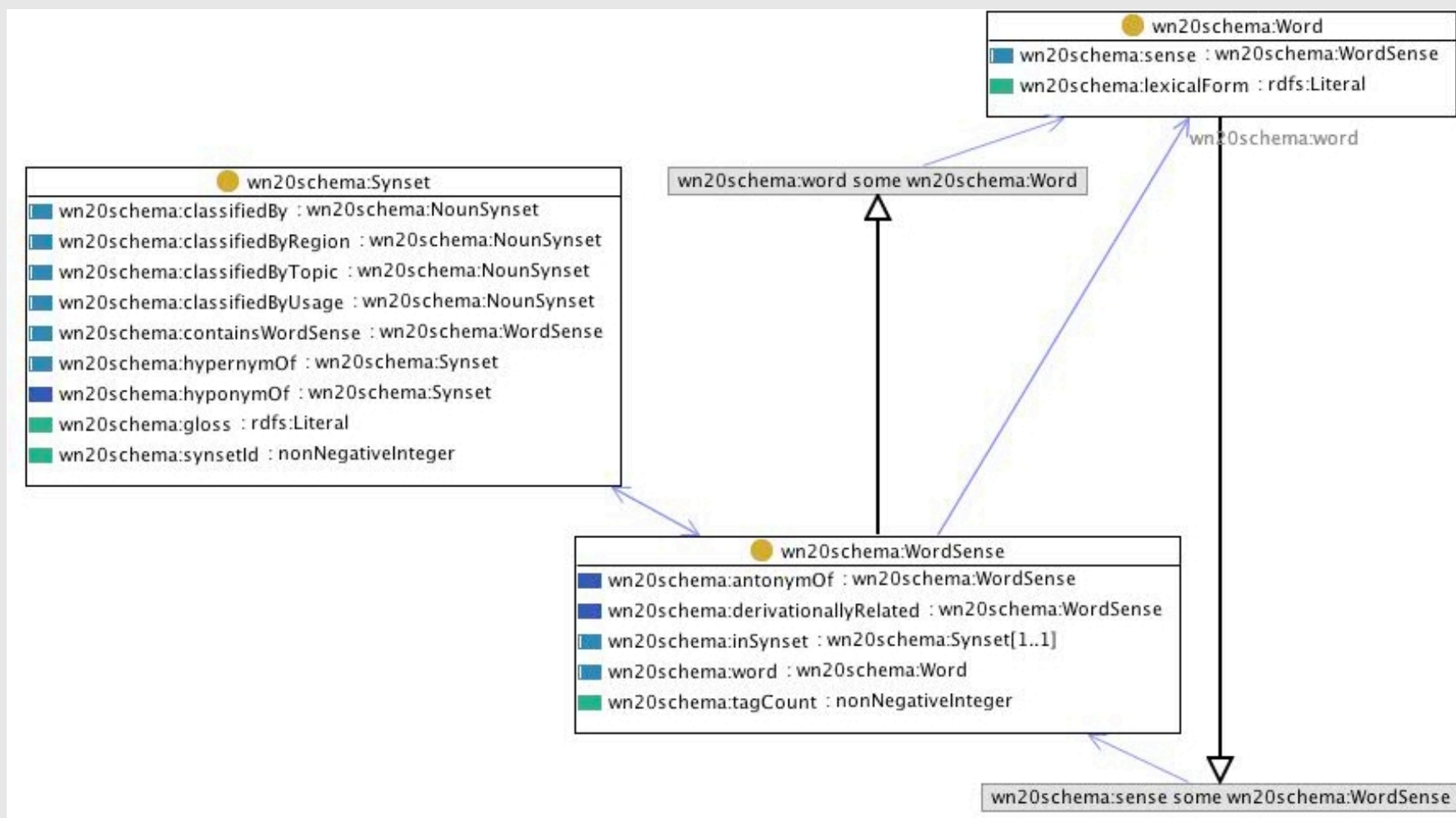
Do you want to know more about AGROVOC? [See some illustrations.](#)

How to compare them?

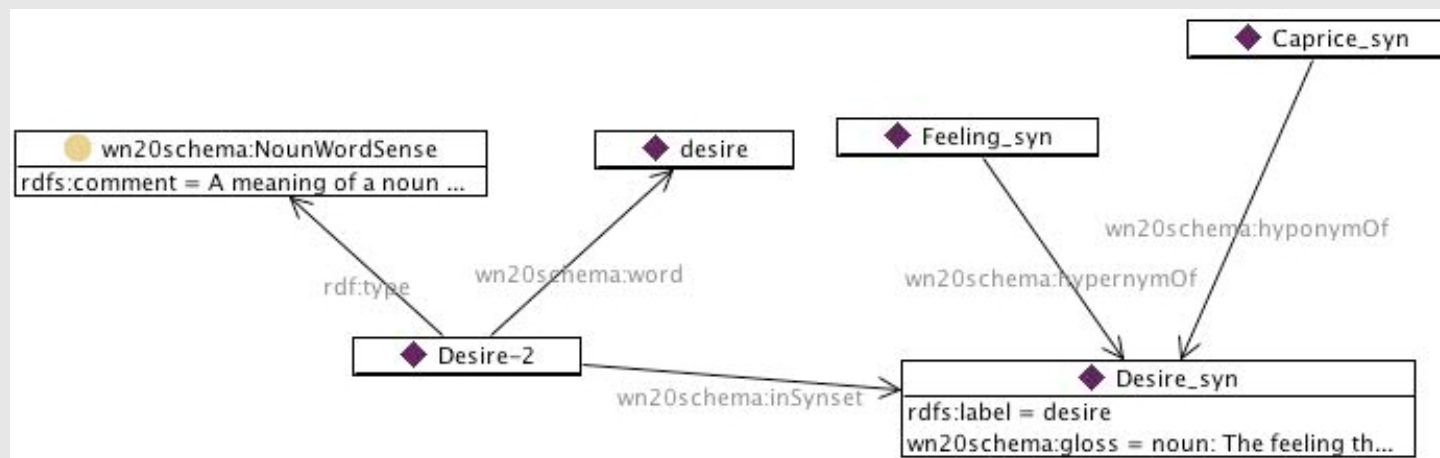
- How to compare descriptions that use different representations and are mostly missing formal semantics?
 - e.g. logic, informal, linguistic, topic-based, ...
- **Current trend: meta-modeling**
 - e.g. LMM for OWL, WordNet, FrameNet, KOS, LMF

W3C WNET Schema (Lexicon2ABox approach)

- <http://www.w3.org/2006/03/wn/wn20/>
- <http://www.w3.org/2001/sw/BestPractices/WNET/wn-conversion.html#primer>

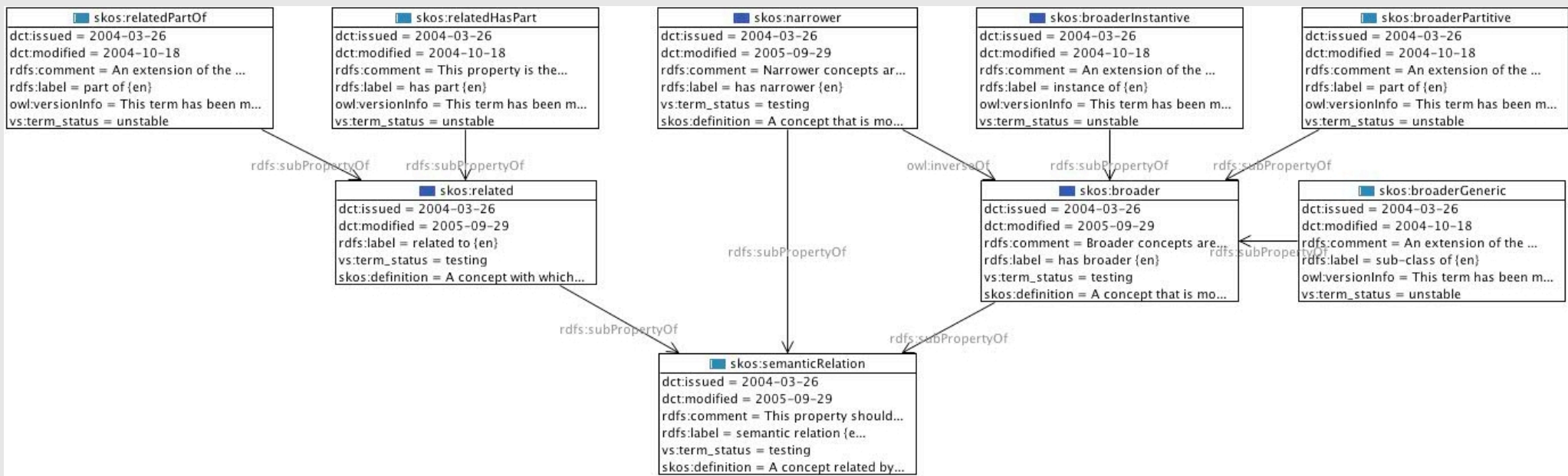


An example of wordnet in owl (Lexicon2ABox approach)



SKOS Vocabulary (KOS2ABox approach)

- <http://www.w3.org/2004/02/skos/vocabs>

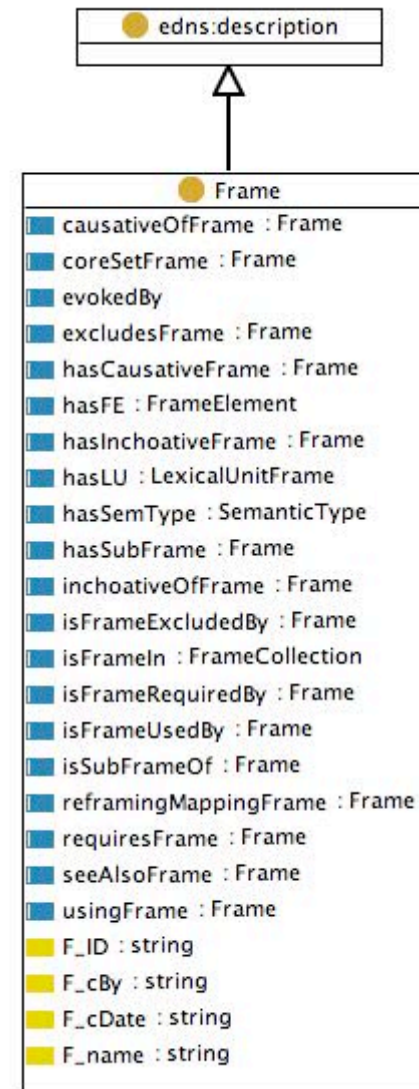


●	<code>skos:Concept</code>
■	<code>skos:inScheme</code> : <code>skos:ConceptScheme</code>
■	<code>skos:semanticRelation</code> : <code>skos:Concept</code>
■	<code>skos:subjectIndicator</code> : <code>foaf:Document</code>
■	<code>skos:externalID</code> : <code>rdfs:Resource</code>
■	<code>skos:isSubjectOf</code>

●	<code>skos:ConceptScheme</code>
■	<code>skos:hasTopConcept</code> : <code>skos:Concept</code>

OntoFrameNet (a different Lexicon2ABox approach)

- <http://www.loa-cnr.it/ontologies/FrameNet/ofn.owl>
- based on cDnS ontology: <http://www.loa-cnr.it/ontologies/OFN.owl>



From “raw” data to patterns

- Moving from “raw” knowledge resources to networked ontologies require:
 - Ontology requirement analysis (domain(s), task(s), and sustainability constraints for ontologies to be built/managed)
 - Tool/resource requirement analysis (functionalities to be covered by tools, and competences needed)
 - Project planning (deciding on knowledge resources, economic resources, team composition and responsibilities, data copyright management, tools)
 - Workflow decision (specially for **reengineering** and **argumentation**)
 - Rationale elicitation (“critiquing” the reengineered data)
 - Providing solutions (e.g. based on design patterns, or conveying new ones)
- Not one, “best” waterfall methodology
 - A project can start spontaneously to solve a rationale elicitation problem, can be planned in order to reengineer knowledge resources, or to reuse existing ontologies or patterns, etc.
 - A project can be started either with or without requirement analyses.
 - Even the solutions can consist only of a “bulk” reengineering process, without explicit patterns

Legacy *aquaculture* hierarchies from fishery terminology systems

AQUACULTURE (AGROVOC)

- NT1 fish culture
 - NT2 fish feeding
- NT1 frog culture
- ...
- rt agripisciculture
- rt aquaculture equipment
- ...
- Fr aquaculture
- Es acuicultura

AQUACULTURE (ASFA)

- NT Brackishwater aquaculture
- NT Freshwater aquaculture
- NT Marine aquaculture
- rt Aquaculture development
- rt Aquaculture economics
- rt Aquaculture engineering
- rt Aquaculture facilities

Biological entity (FIGIS)

- Taxonomic entity
- Major group
- Order
- Family
- Genus
- Species
 - Capture species (filter)
 - Aquaculture species (filter)
 - Production species (filter)
 - Tuna atlas spec

SUBJECT (OneFish)

- Aquaculture
 - Aquaculture development
 - Aquaculture economics @
 - Aquaculture planning

Sample data model analysis/conversion (KOS2TBox approach)

Term \neq Concept

Term = String (or Lexical Item)

Concept = Class

BT \approx subsumption between classes

RT \approx top-level conceptual relation

{Descriptors} = \cup {Classes},{Individuals}

Individual \in Class

Concept \neq Subject/Topic/Domain

Conversion: effects on translation (1)

- `agrovoc_schema:Descriptor`
 - `agrovoc:River`
 - `agrovoc:Amazon`



- `owl:Class(agrovoc:River)`
- `owl:Individual(agrovoc:Amazon(rdf:type agrovoc:River))`

Conversion: effects on translation (2)

- `agrovoc:RT`
- `agrovoc_schema:Descriptor`
 - `agrovoc:Fishing_vessel`
 - `agrovoc:Fishing_gear`
 - `agrovoc:Fishing_vessel,RT,Fishing_gear`



- `Class(agrovoc:Fishing_vessel partial`
 `(restriction(agrovoc:RT`
 `someValuesFrom(agrovoc:Fishing_gear))))`

Ontology evaluation

- **Domain: entity types, expertise patterns**
 - is the ontology appropriate to context?
- **Task: competency questions**
 - is the ontology appropriate to support relevant queries?
- **Resources: tools and personnel**
 - is the ontology (structure, function, annotations) manageable and cost-effective?
- **Direct measuring of graphs and annotations**
- **Black-box/glass-box measuring of admissibility wrt conceptualization**
- **Indirect measuring via user feedback, and correlation**
- **Principles, diagnosis and trade-offs**

Possible theses and research issues

- Re-engineering patterns
- Implementation of tools supporting pattern-based design
- Pattern-based evaluation and selection of ontologies
- ...