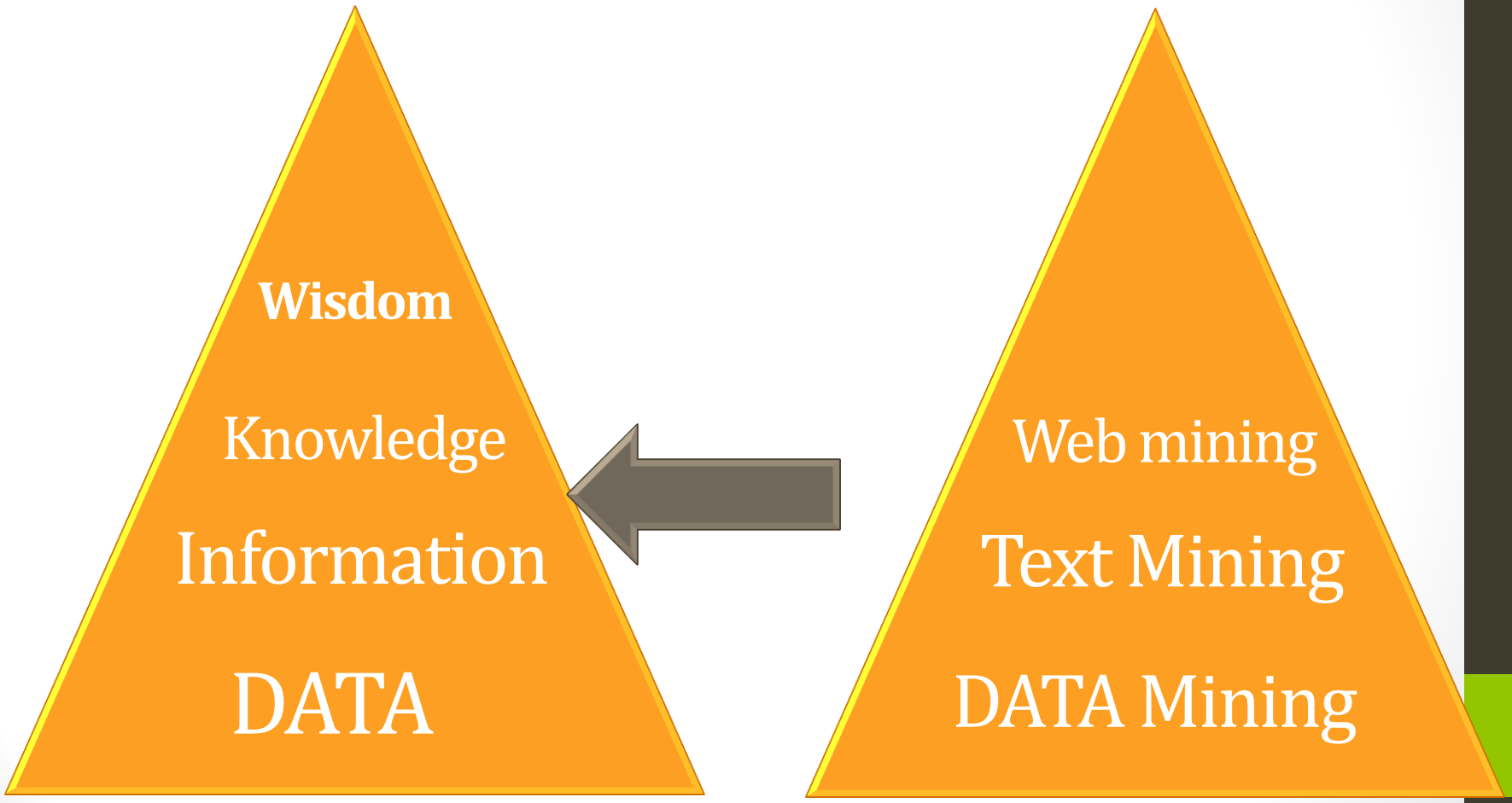
WEB MINING
Lecture 14

DR.Herlina Jayadianti, ST,MT

Where are we????


Wisdom
Knowledge
Information
DATA
Web mining
Text Mining
DATA Mining

World Wide Web – a brief history

- Who invented the wheel is unknown
- Who invented the **World-Wide Web** ?
  - (Sir) Tim Berners-Lee
  - Professor **Sir Timothy John Berners-Lee**, OM, KBE, FRS, FREng, FRSA, DFBCS (born 8 June 1955)
  - in 1989, while working at CERN, invented the World Wide Web, including URL scheme, HTML, and in 1990 wrote the first server and the first browser
  - Mosaic browser developed by Marc Andreessen and Eric Bina at NCSA (National Center for Supercomputing Applications) in 1993; helped rapid web spread
  - Mosaic was basis for Netscape …

WWW Specifics

- Web: A huge, widely-distributed, highly heterogeneous, semi-structured, hypertext/hypermedia, interconnected information repository

- Web is a huge collection of documents plus
  - Hyper-link information
  - Access and usage information

Data Mining vs. Web Mining

- Traditional data mining
  - data is structured and relational
  - well-defined tables, columns, rows, keys, and constraints.

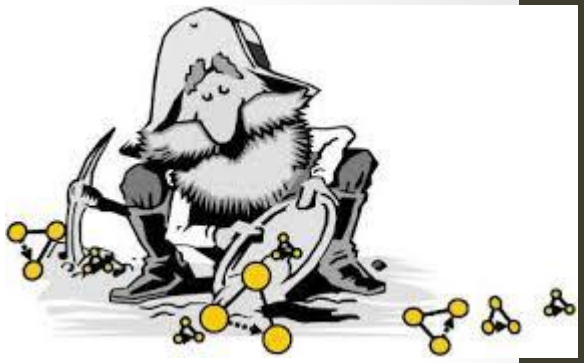
- Web data
  - Semi-structured and unstructured
  - readily available data
  - rich in features and patterns

Data Mining and Web Mining

- **Data mining** → turn data into knowledge.

- **Web mining** → is to apply data mining techniques to extract and uncover **knowledge** from *web documents* and *services*.

What is Web Mining?



- **Discovering interesting and useful information from Web *content* and *usage***

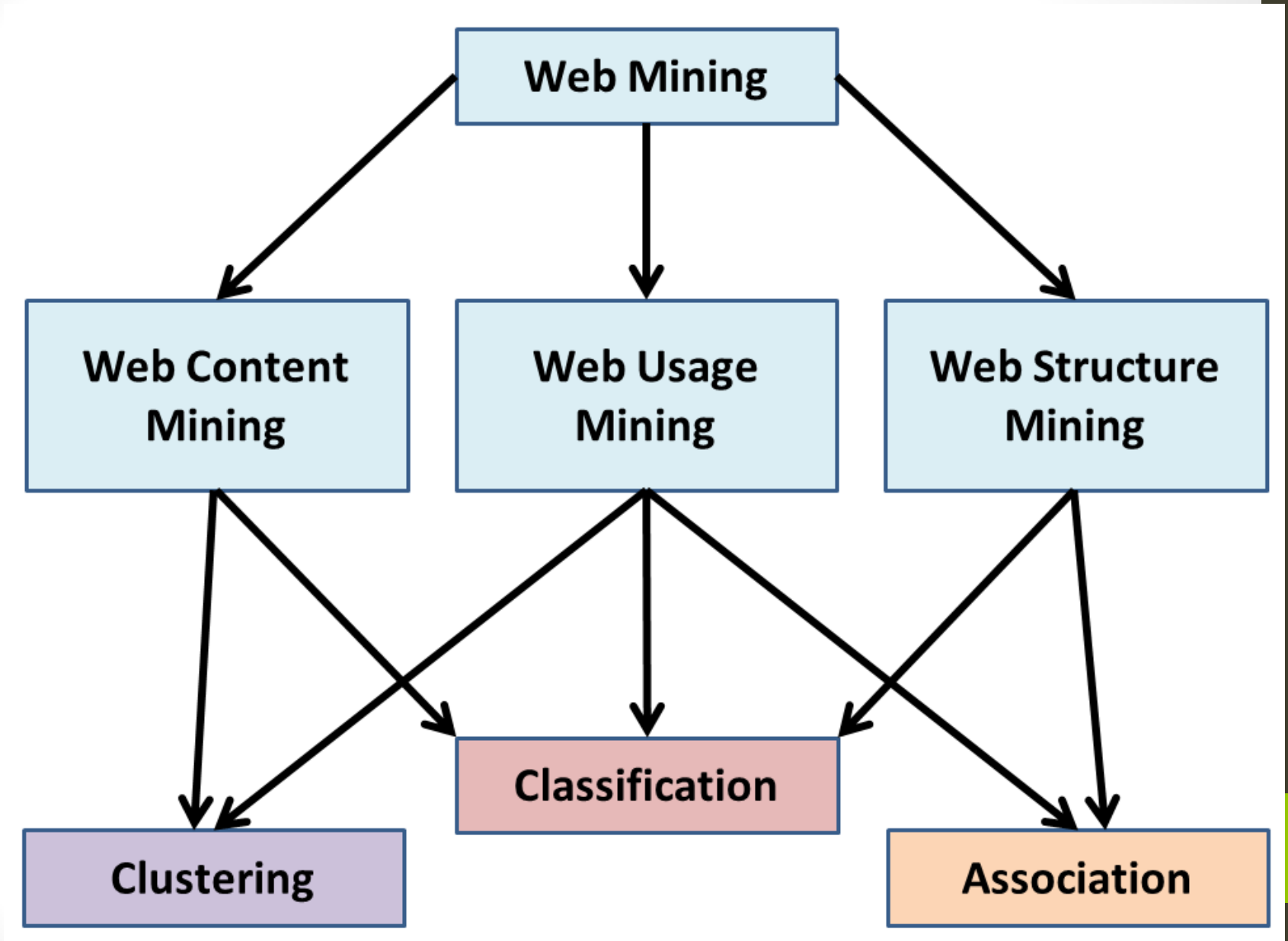
- The term created by Orem Etzioni (1996) Application of data mining techniques to automatically discover and extract information from *Web data*

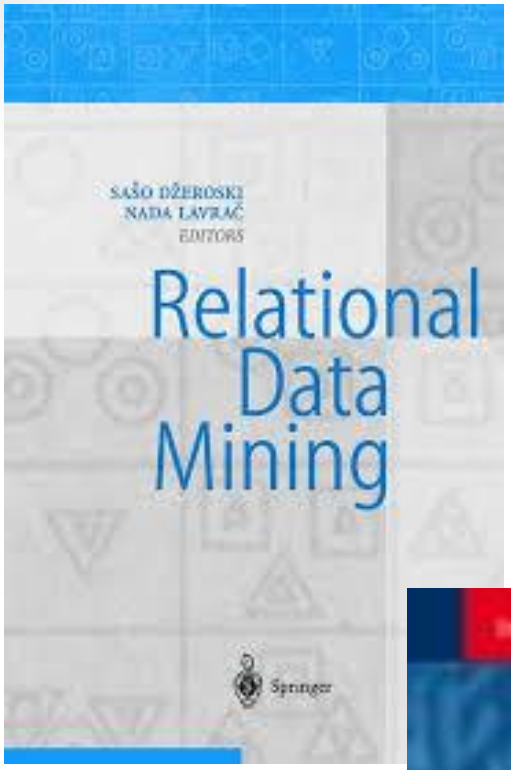
A Few Themes in Web Mining

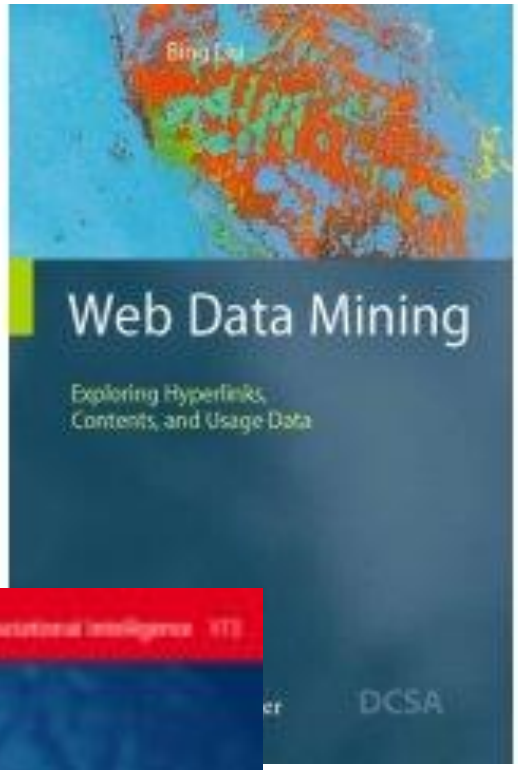
- Some interesting problems on Web mining
  - Mining what Web search engine finds
  - Identification of authoritative Web pages
  - Identification of Web communities
  - Web document classification
  - Warehousing a Meta-Web: Web yellow page service
  - Weblog mining (usage, access, and evolution)
  - Intelligent query answering in Web search

Web Mining taxonomy

- **Web Content Mining**
  - Web Page Content Mining
- **Web Structure Mining**
  - Search Result Mining
  - Capturing Web's structure using link interconnections
- **Web Usage Mining**
  - General Access Pattern Mining
  - Customized Usage Tracking


Web Mining
Web Content Mining
Web Usage Mining
Web Structure Mining
Classification
Clustering
Association


SAŠO DŽEROSKI
NADA LAVRAČ
EDITORS
Relational Data Mining
Springer


Bing Liu
Web Data Mining
Exploring Hyperlinks, Contents, and Usage Data
DCSA


Bing Liu
Web Data Mining
Springer


J-Hsien Ting
Web Mining Applications in E-commerce and E-services

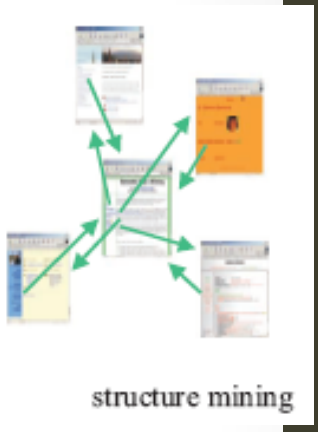
Content Mining

- Type of Text Mining
- Uses Tags
- Detect co-occurrences
- Event detection
- Reconstruction of page content
- Relations in a domain

content mining

Web Structure Mining

- **WebPages as a whole**
  - Uses hyperlinks
  - Identify relevance
- **Single Pages**
  - Five types of Web Pages
    - Head Pages
    - Navigation Pages
    - Content Pages
    - Look up Pages
    - Personal Pages



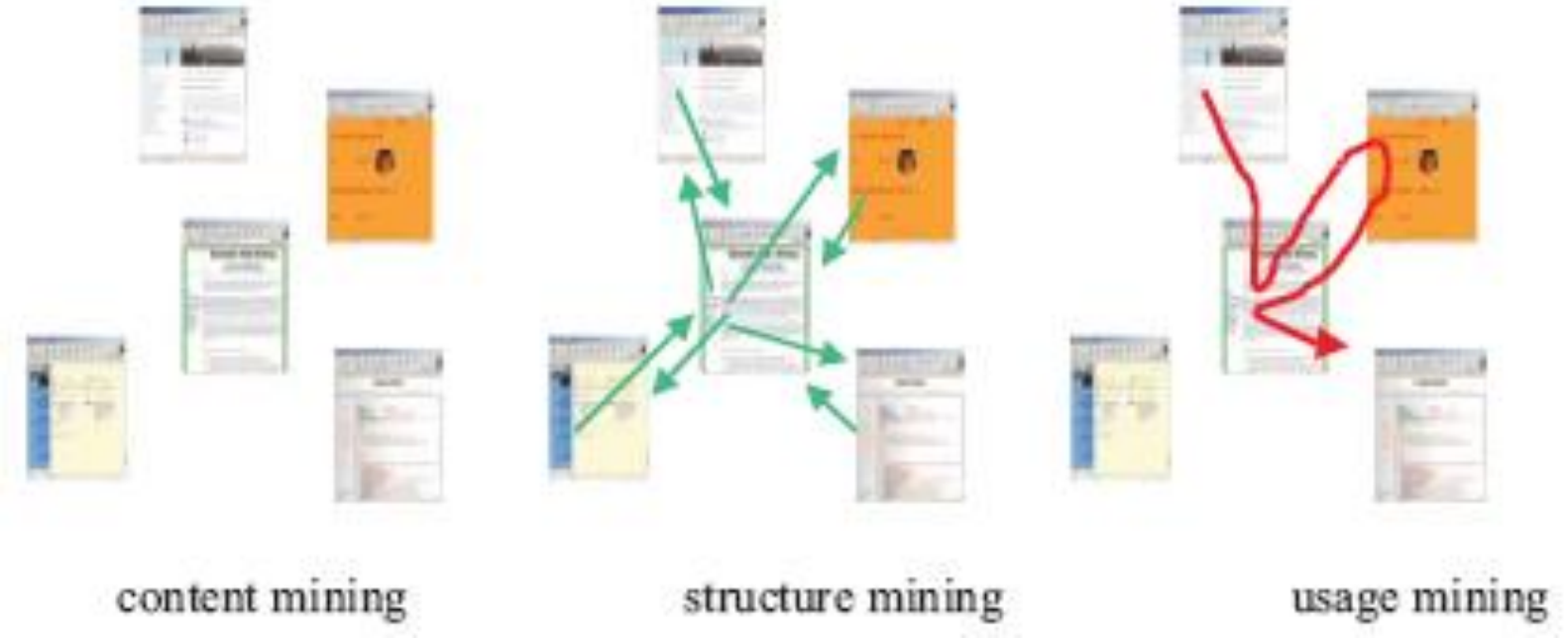
structure mining

Web Usage Mining

- Request by Visitors
- Additional Structure
- Unintended Relationships

usage mining

Web Mining



content mining

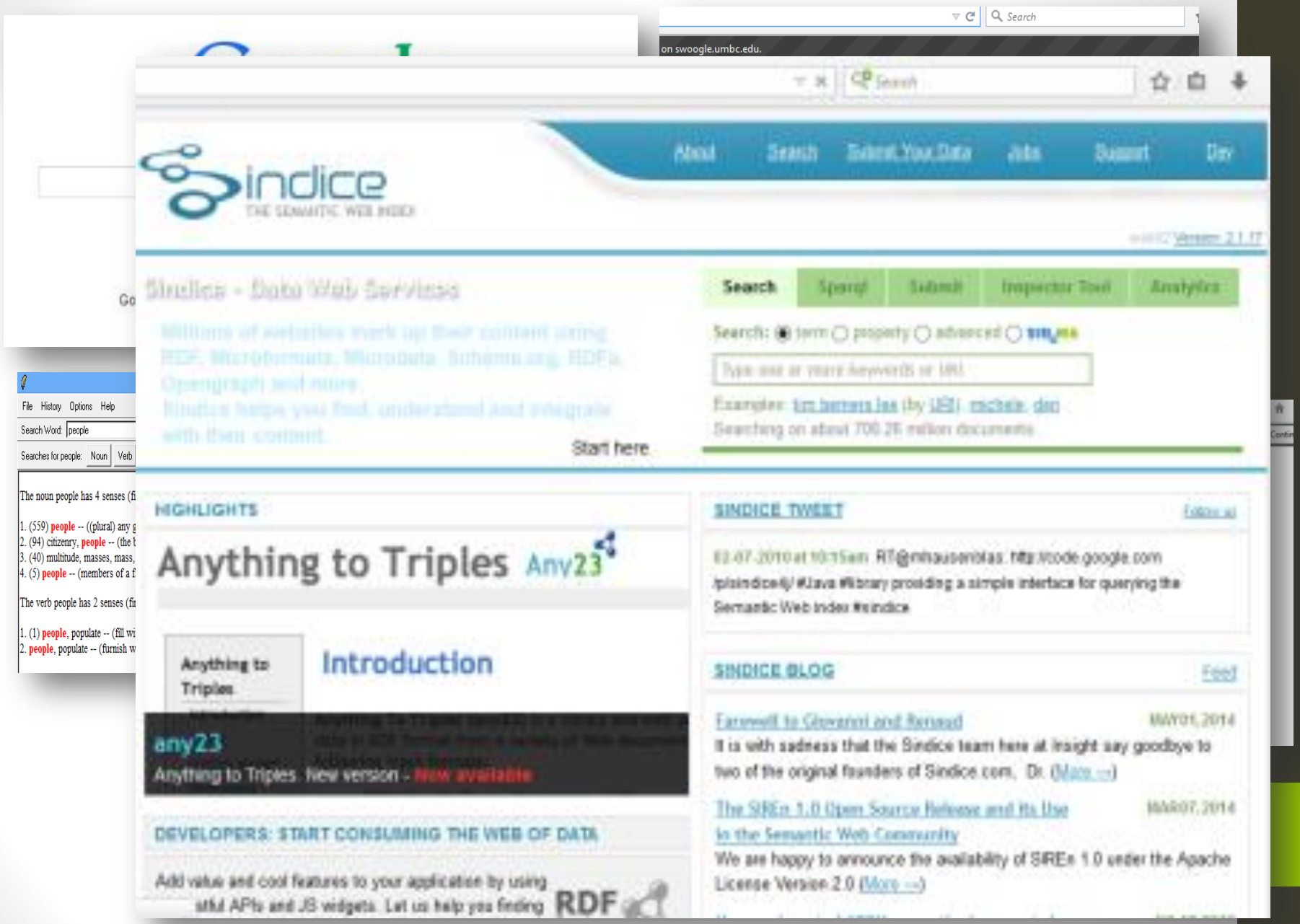
structure mining

usage mining

What is Web Mining? Example

Examples:

- **Web search**, e.g. Google, Yahoo, MSN, Ask, …
- **Specialized search**: e.g. Froogle (comparison shopping), job ads (Flipdog)
- **eCommerce** :
  - Recommendations: e.g. Netflix, Amazon
  - improving conversion rate: next best product to offer
- **Advertising**, e.g. Google Adsense
- **Fraud detection**: click fraud detection, …
- Improving Web site design and performance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HIGHLIGHTS
Anything to Triples
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Introduction
Anything to Triples
any23
Anything to Triples: New version - Now available
DEVELOPERS: START CONSUMING THE WEB OF DATA
Add value and cool features to your application by using
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RDF
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Follow us
RT@mhausenblas: http://code.google.com
/p/sindice4j/ #Java #library providing a simple interface for querying the
Semantic Web index #sindice
SINDICE BLOG
Feed
Farewell to Giovanni and Renaud
MAY01, 2014
It is with sadness that the Sindice team here at Insight say goodbye to
two of the original founders of Sindice.com, Dr. (More →)
The SIREn 1.0 Open Source Release and Its Use
In the Semantic Web Community
MAR07, 2014
We are happy to announce the availability of SIREn 1.0 under the Apache
License Version 2.0 (More →)
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Search Word: people
Searches for people: Noun Verb
The noun people has 4 senses (fi
1. (559) people -- ((plural) any g
2. (94) citizenry, people -- (the
3. (40) multitude, masses, mass,
4. (5) people -- (members of a f
The verb people has 2 senses (fi
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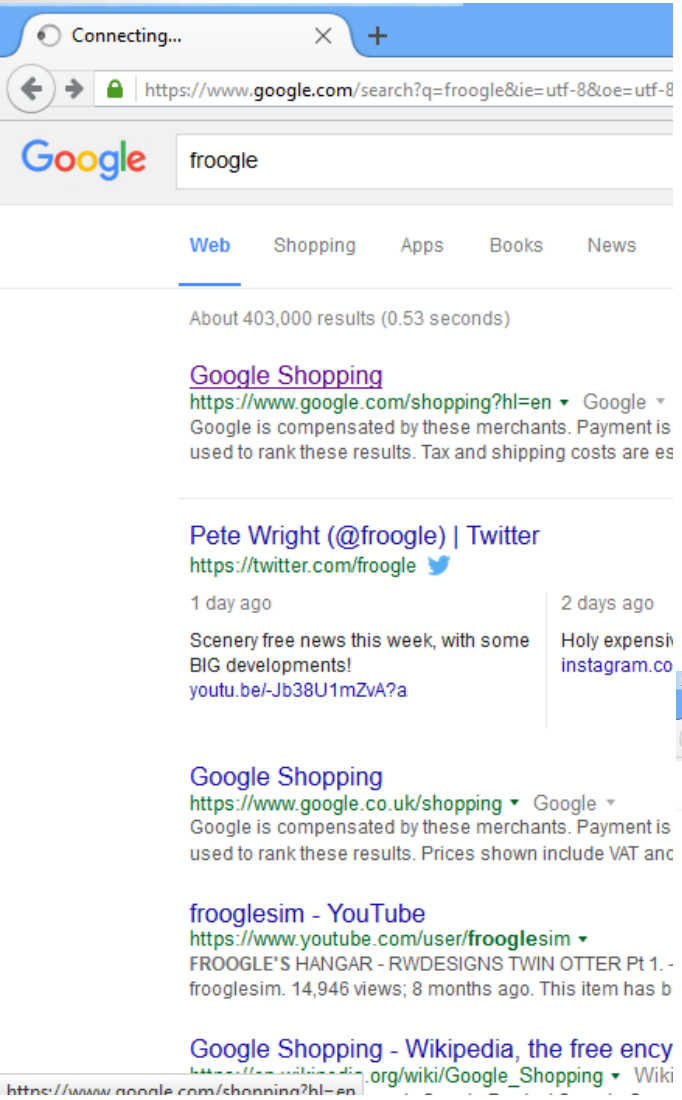
2. people, populate -- (furnish w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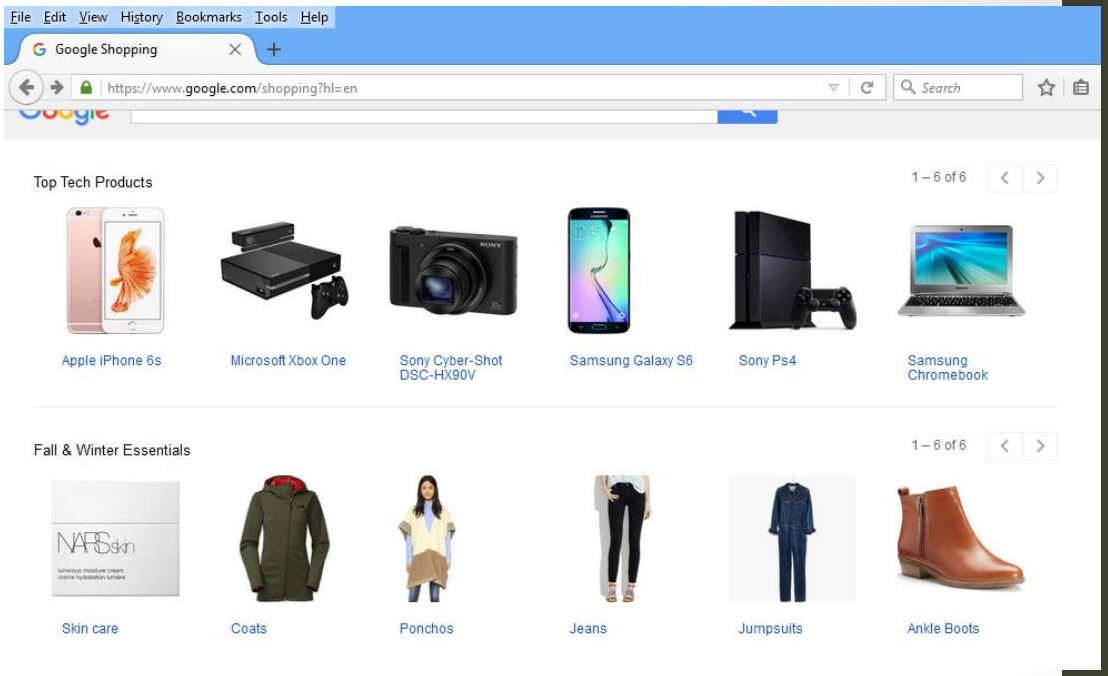
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Microsoft Xbox One
Sony Cyber-Shot DSC-HX90V
Samsung Galaxy S6
Sony Ps4
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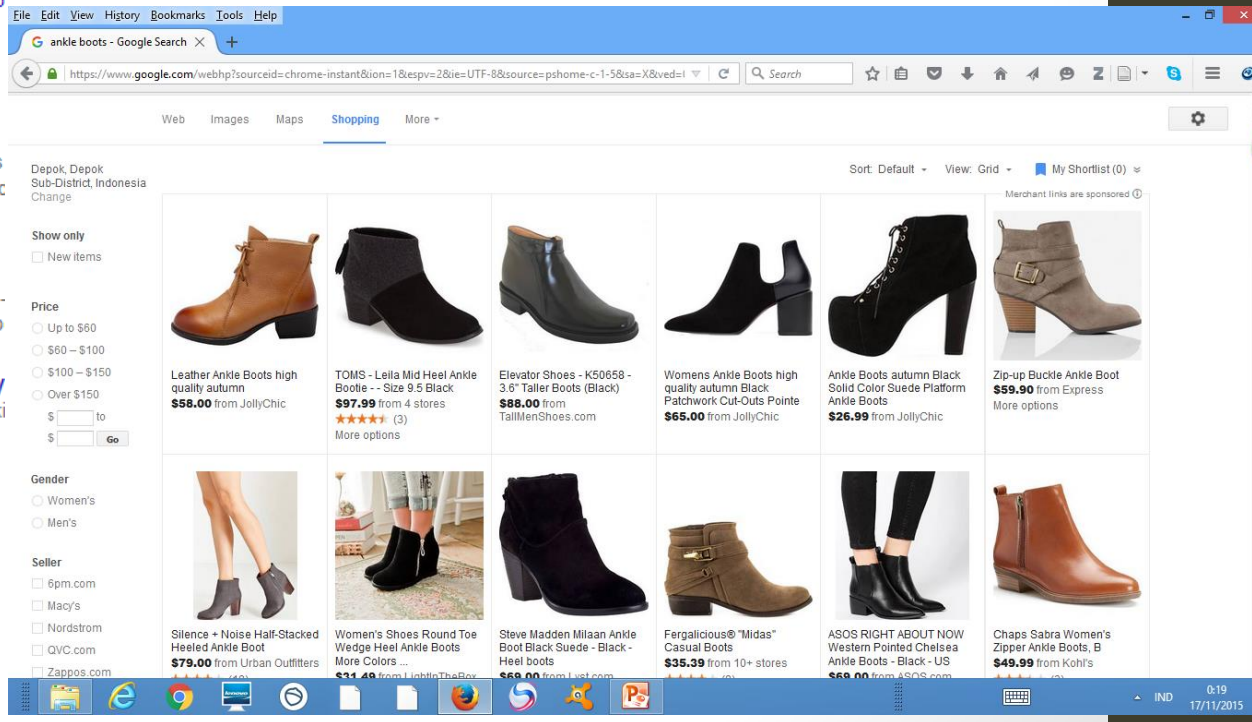
Ankle Boots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Shopping
More
Depok, Depok Sub-District, Indonesia
Change
Sort: Default
View: Grid
My Shortlist (0)
Merchant links are sponsored
Show only
New items
Price
Up to $60
$60 – $100
$100 – $150
Over $150
Gender
Women's
Men's
Seller
6pm.com
Macy's
Nordstrom
QVC.com
Zappos.com
Leather Ankle Boots high quality autumn
$58.00 from JollyChic
TOMS - Leila Mid Heel Ankle Bootie - - Size 9.5 Black
$97.99 from 4 stores
(3)
More options
Elevator Shoes - K50658 - 3.6" Taller Boots (Black)
$88.00 from TallMenShoes.com
Womens Ankle Boots high quality autumn Black Patchwork Cut-Outs Pointe
$65.00 from JollyChic
Ankle Boots autumn Black Solid Color Suede Platform Ankle Boots
$26.99 from JollyChic
Zip-up Buckle Ankle Boot
$59.90 from Express
More options
Silence + Noise Half-Stacked Heeled Ankle Boot
$79.00 from Urban Outfitters
Women's Shoes Round Toe Wedge Heel Ankle Boots More Colors ...
Steve Madden Milaan Ankle Boot Black Suede - Black - Heel boots
Fergalicious® "Midas" Casual Boots
$35.39 from 10+ stores
ASOS RIGHT ABOUT NOW Western Pointed Chelsea Ankle Boots - Black - US
$69.00 from ASOS.com
Chaps Sabra Women's Zipper Ankle Boots, B
$49.99 from Kohl's
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Froogle

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ankle boots - Google Search

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Search

Web Images Maps Shopping More

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Change

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Show only
- New items

Price
- Up to $60
- $60 – $100
- $100 – $150
- Over $150
- $ to
- $ Go

Gender
- Women's
- Men's

Seller
- 6pm.com
- Macy's
- Nordstrom
- QVC.com
- Zappos.com

Leather Ankle Boots high quality autumn
$58.00 from JollyChic

TOMS - Leila Mid Heel Ankle Bootie - - Size 9.5 Black
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★★★★½ (3)
More options

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Women's Shoes Round Toe Wedge Heel Ankle Boots More Colors ...
$31.49 from LightInTheBox

Steve Madden Milaan Ankle Boot Black Suede - Black - Heel boots
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Search

Chaps Sabra Women's Zipper Ankle Boots, B

from Kohl's

3 product reviews

Look your finest in these women's ankle boots from Chaps. SHOE FEATURES Zippers on both sides Treaded sole SHOE CONSTRUCTION Manmade upper & lining TPR outsole SHOE DETAILS ... more »

Size: 5.5 · Shop all sizes »

Shop all 3 colors »

$49.99

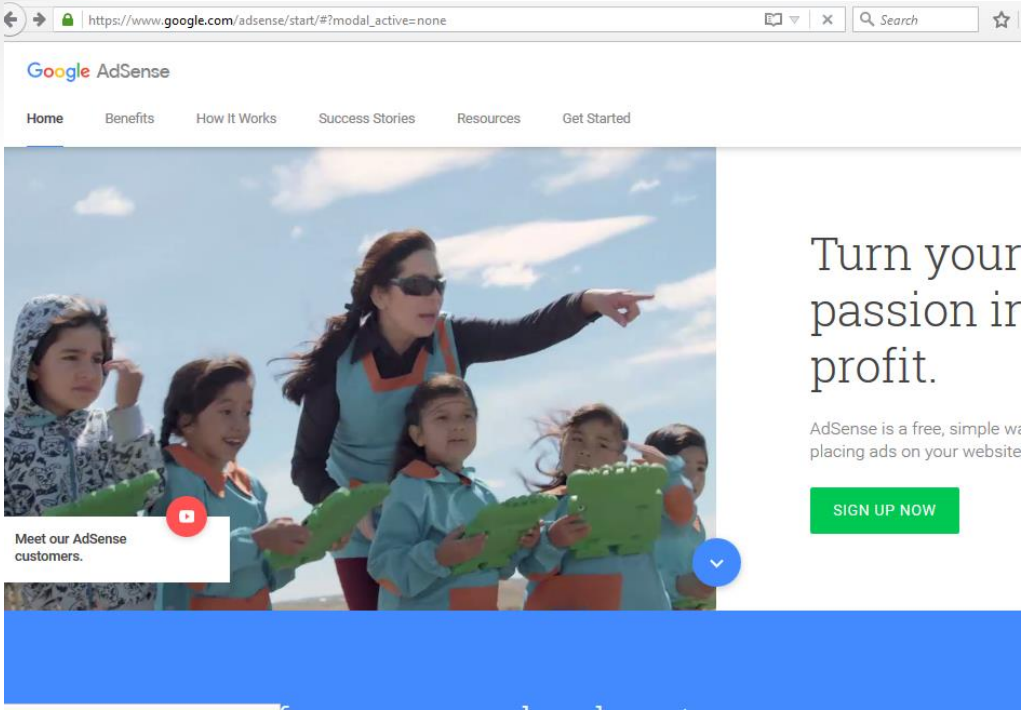
Kohl's

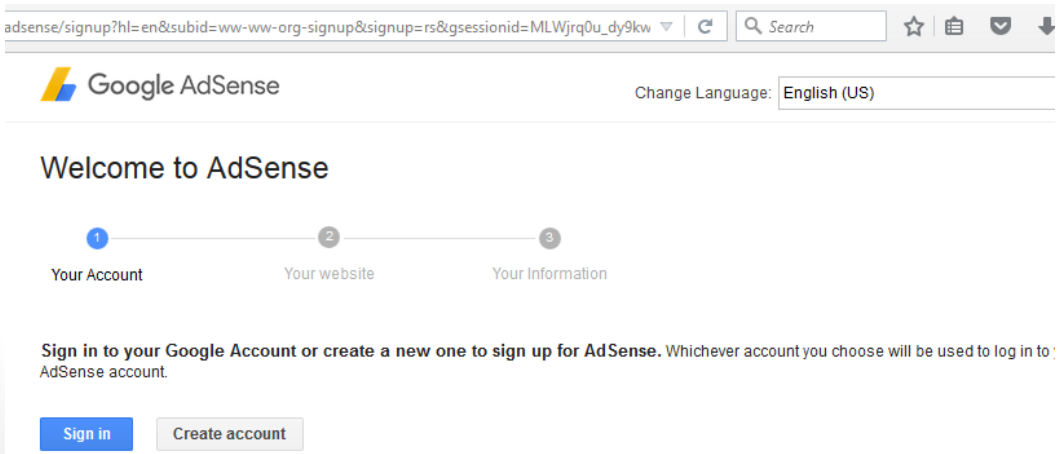
(58)

Shop

Reviews

Save to Shortlist





GoogleAdSense

How does it differ from "classical" Data Mining?

- **The web is not a relation**
  - Textual information and linkage structure
- **Usage data is huge and growing rapidly**
  - Google's usage logs are bigger than their web crawl
  - Data generated per day is comparable to largest conventional data warehouses
- **Ability to react in real-time to usage patterns**
  - No human in the loop

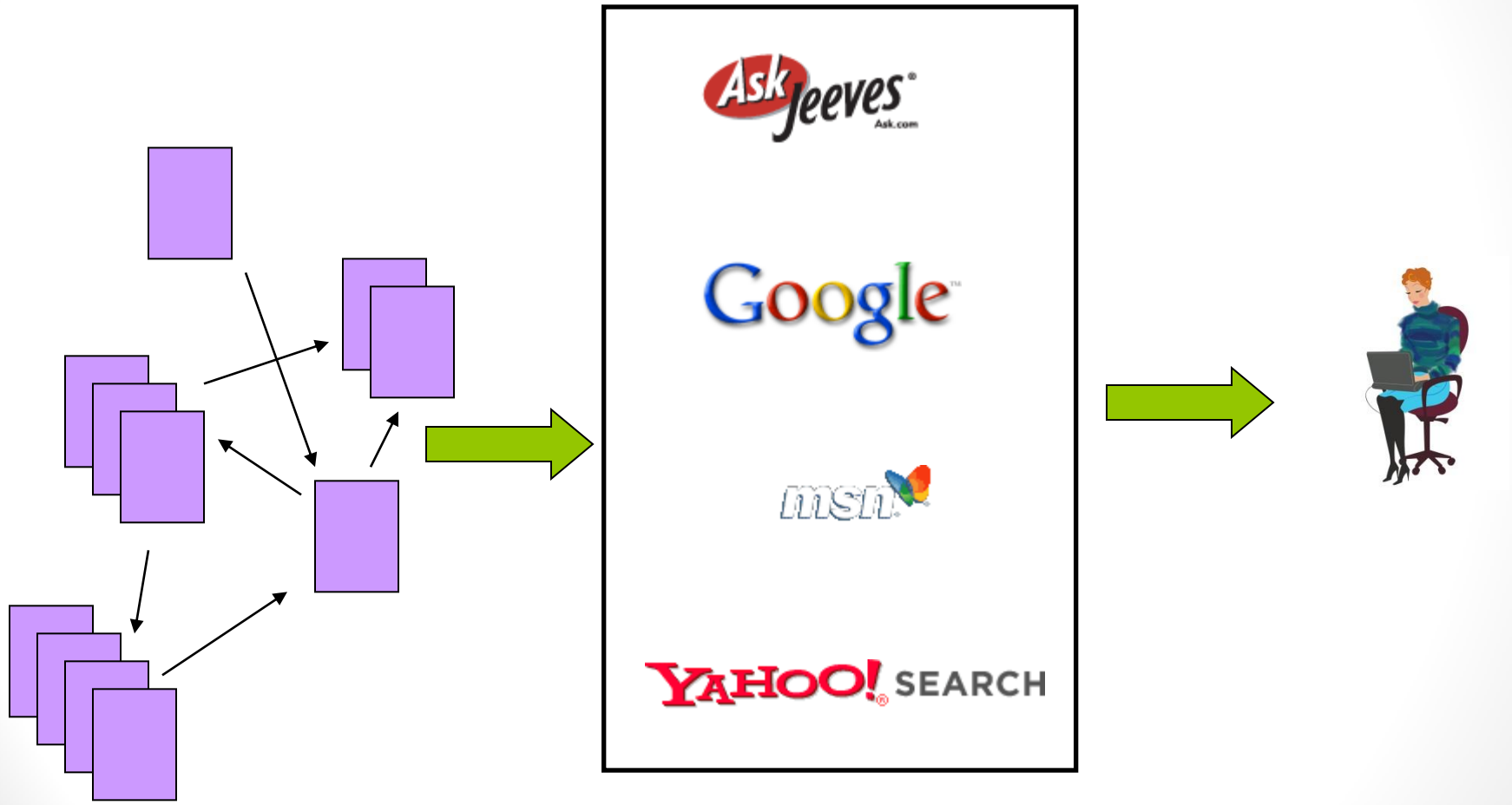
How big is the Web ?

- Number of pages
  - Technically, infinite
    - Because of dynamically generated content
    - Lots of duplication (30-40%)
  - Best estimate of “unique” static HTML pages comes from search engine claims
    - Google = 8 billion, Yahoo = 20 billion
    - Lots of marketing hype

The web as a graph

- **Pages = nodes, hyperlinks = edges**
  - Ignore content
  - Directed graph
- High linkage
  - 8-10 links/page on average
  - Power-law degree distribution

Searching the Web



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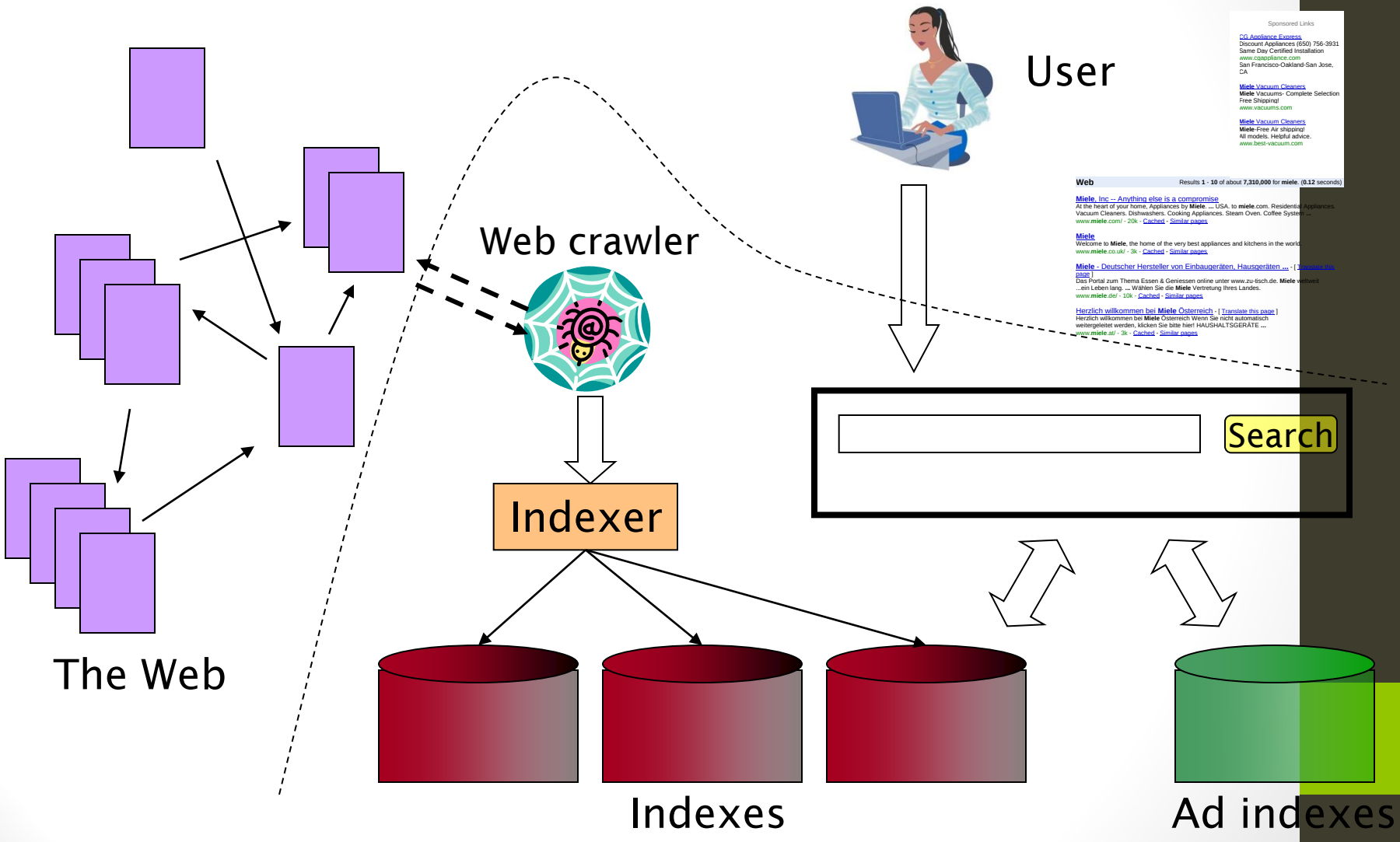
Web Mining topics

- Crawling the web
- Web graph analysis
- Structured data extraction
- Classification and vertical search
- Collaborative filtering
- Web advertising and optimization
- Mining web logs
- Systems Issues

Web search basics



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Search engine components

- Spider (a.k.a. crawler/robot) – builds corpus
  - Collects web pages recursively
    - For each known URL, fetch the page, parse it, and extract new URLs
    - Repeat
  - Additional pages from direct submissions & other sources
- The indexer – creates inverted indexes
  - Various policies wrt which words are indexed, capitalization, support for Unicode, stemming, support for phrases, etc.
- Query processor – serves query results
  - Front end – query reformulation, word stemming, capitalization, optimization of Booleans, etc.
  - Back end – finds matching documents and ranks them

Towards Semantic Web Mining

Semantic Web Mining

- Combination of Semantic Web and Web Mining
- Improve Web Mining using Semantic Web
- Improve Semantic Web using Web Mining

Extracting Semantics

- Ontology Learning
  - Learn structures of Ontologies
- Instance Learning
  - Populates the Ontologies

Ontology

An ontology is a specification of a conceptualization that is designed for reuse across multiple applications and implementations. a specification of a conceptualization is a written, formal description of a set of concepts and relationships in a domain of interest.

Reasons

To share common understanding of the structure of information among people or software agent

Ontology Integration

Mapping

is the process of relating similar concepts or relations from different sources through some equivalence relation

Matching / Alignment

is the process of determining correspondences between concepts. A set of correspondences is also called an alignment.

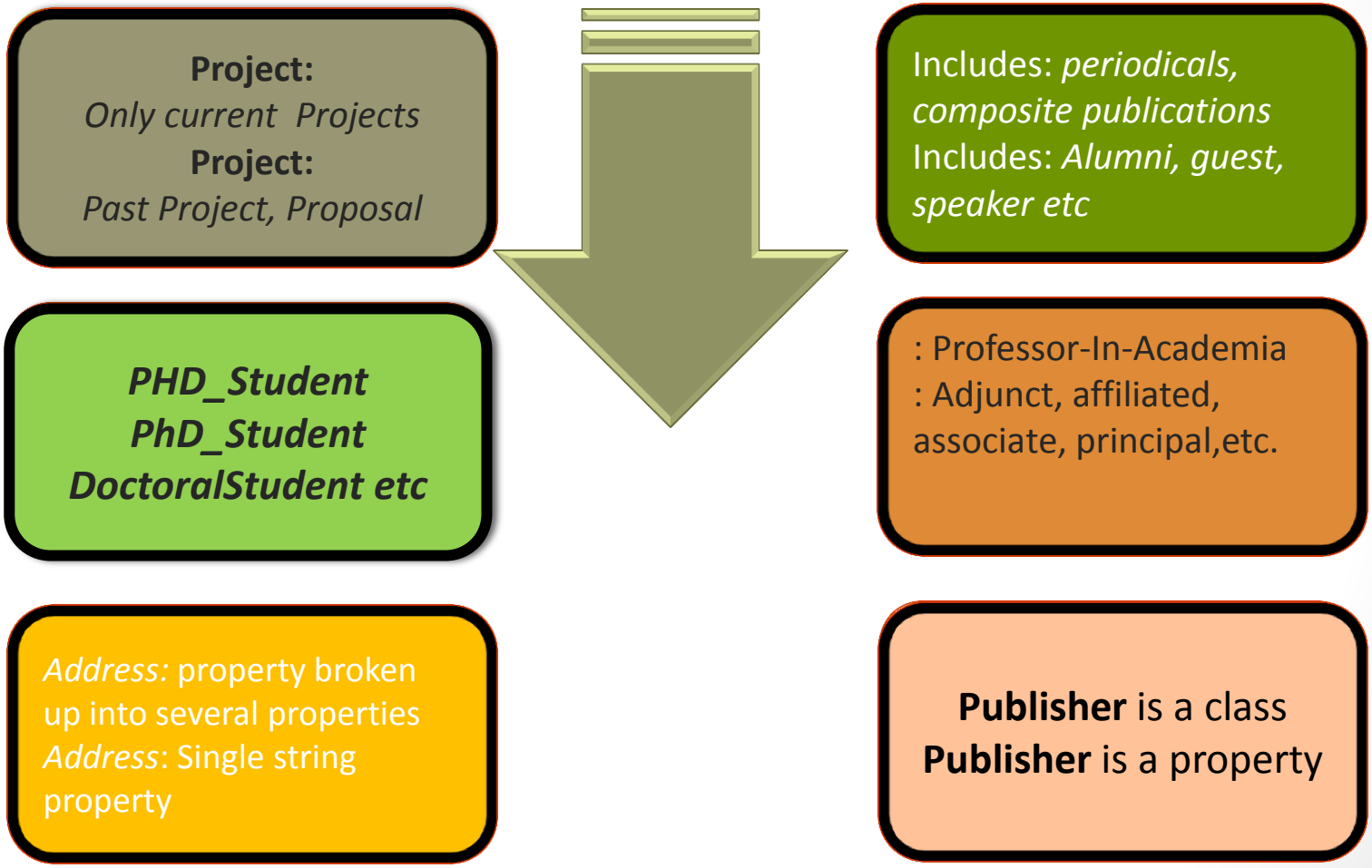
Merging

Combination

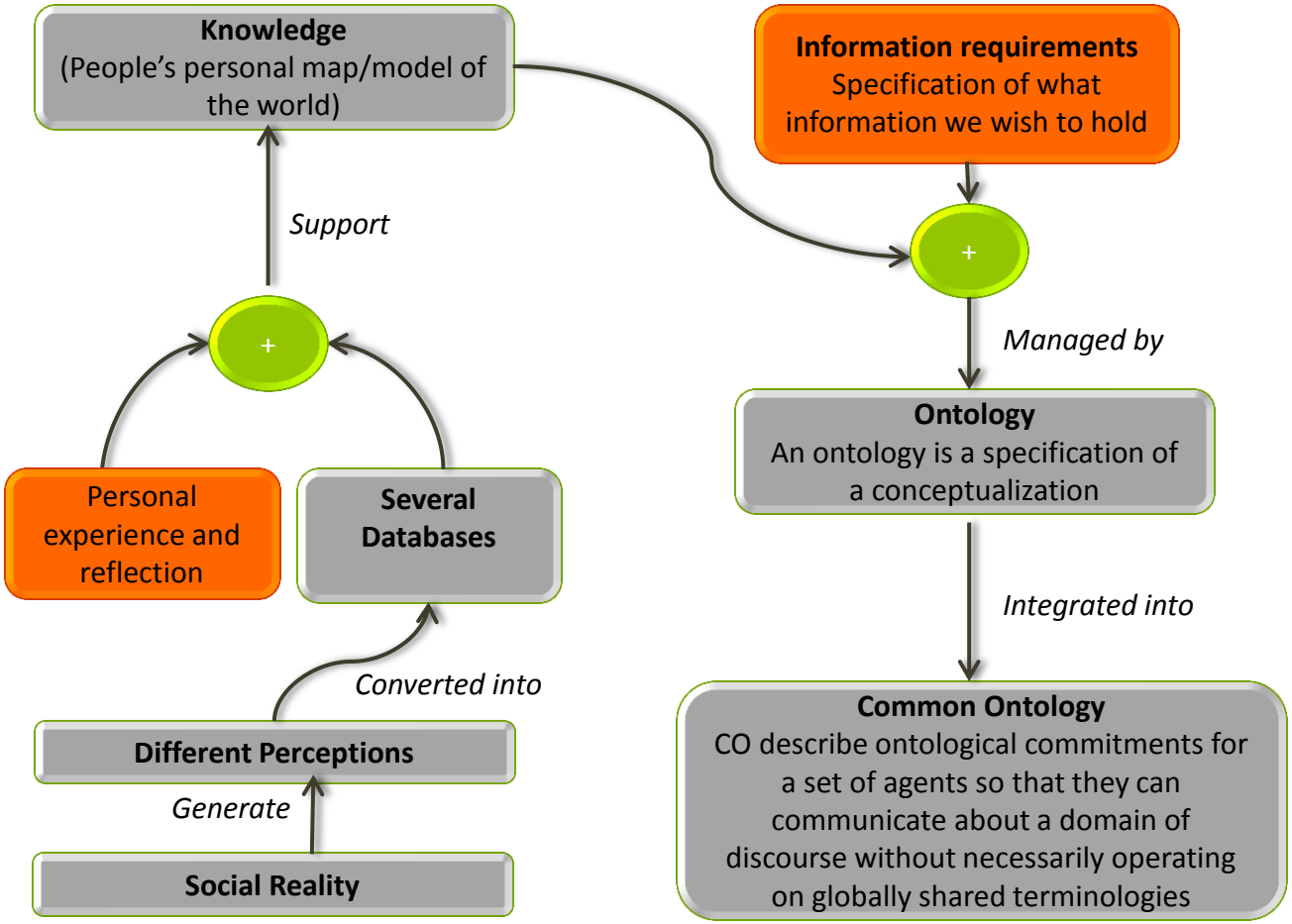
Reasons

- Mismatches
- Ontology is not a reality it is a subjective representation of it.
  - **Different designers have a different views**

Ex :Ontology Mismatches



Scenario


Knowledge
(People's personal map/model of the world)
Information requirements
Specification of what information we wish to hold
Support
+
+
Managed by
Ontology
An ontology is a specification of a conceptualization
Personal experience and reflection
Several Databases
Integrated into
Converted into
Common Ontology
CO describe ontological commitments for a set of agents so that they can communicate about a domain of discourse without necessarily operating on globally shared terminologies
Different Perceptions
Generate
Social Reality

Class Design : 'Y

UV1

- Thing
  - Area
  - Assets
  - Contraceptive
  - Education
  - FoodConsume
    - FishConsume
    - MeatConsume
    - VegetableConsume
  - GovernmentAid
    - BLT
    - Credit
    - Food
  - HealthProblem
  - Hospital
  - HouseCondition
    - FloorCondition
    - RoofCondition
    - WallCondition
  - Job
  - Person
    - HeadOfHouseHold
    - MemberOfHouseHold

CO:

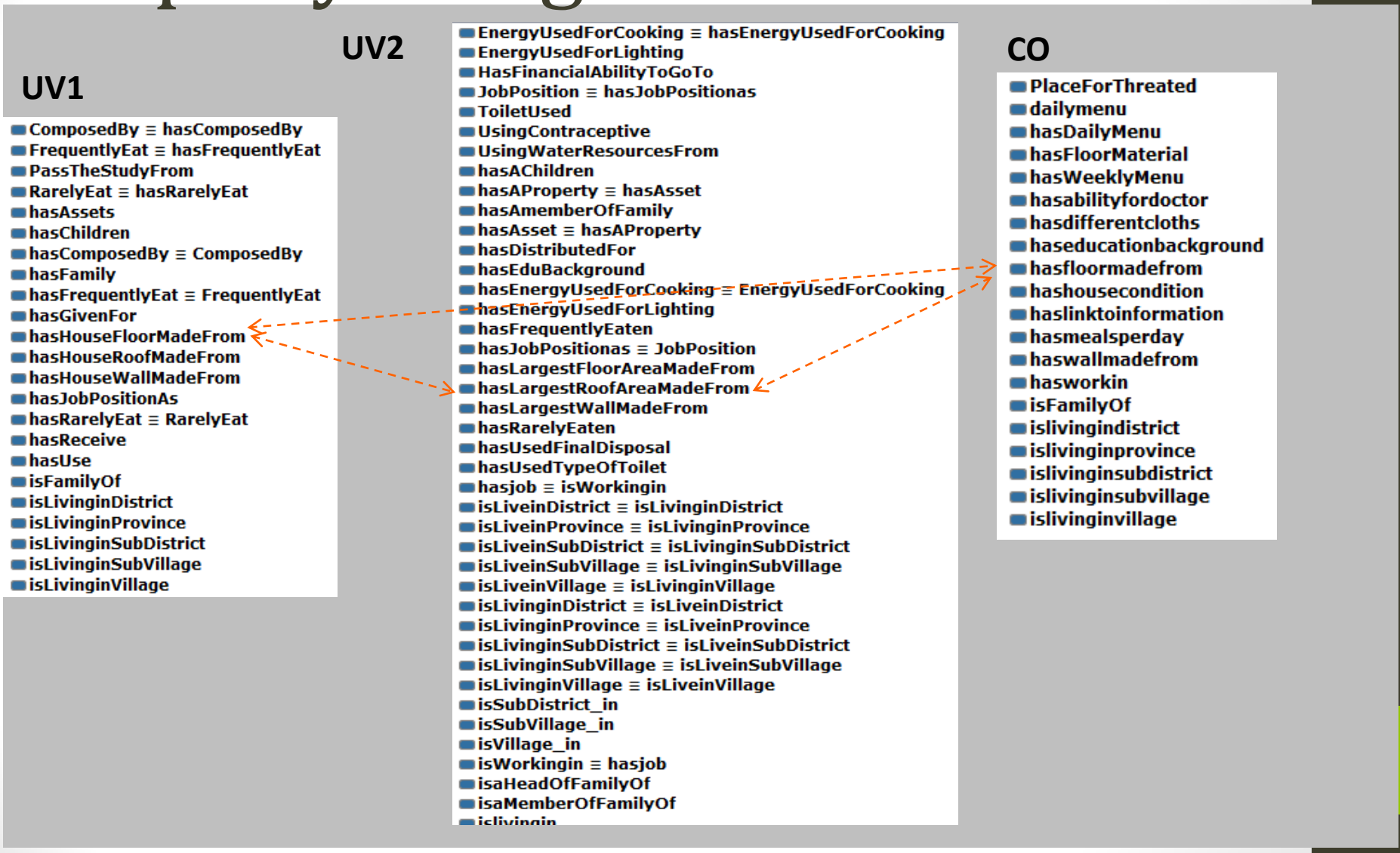
- Thing
  - BirthControl
  - Education
  - Food
  - Health
  - House
    - Floor
    - Roof
    - Wall
  - Location
  - People
    - Headoffamily
    - MemberofFamily
  - Property
  - Work
  - hospital

UV2

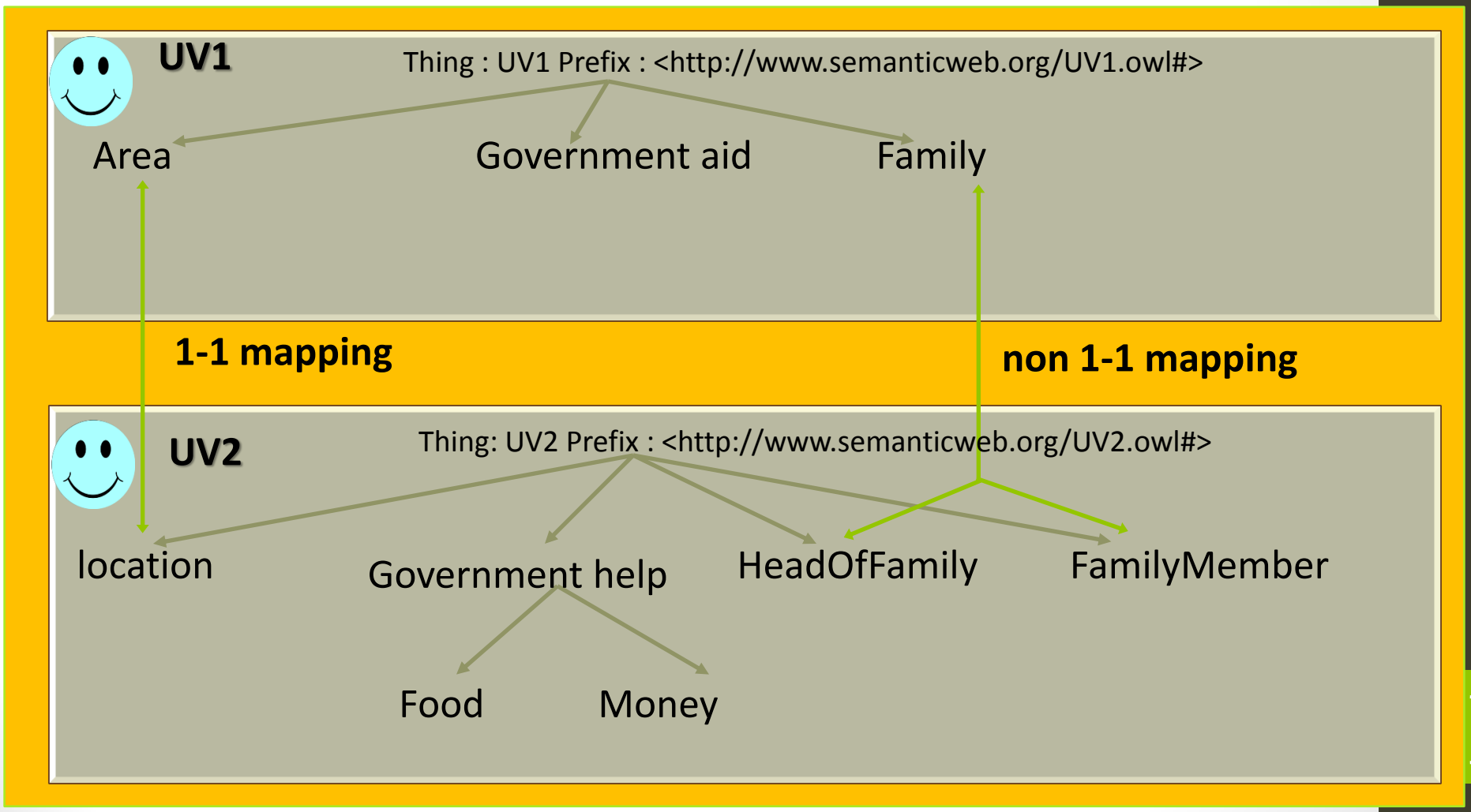
- Thing
  - Asset
  - BirthControlMethod
  - EducationLevel
  - Food
    - Food_Fish
    - Food_Meat
    - Food_Peanut
    - Food_Rice
    - Food_Vegetable
  - GeographicArea
  - GovHelp
  - HeatlhCondition
    - Disability
    - Disease
  - Hospital
    - Clinic_Doctor
    - Private_Hospital
    - Public_Hospital
  - HouseParameter
    - Energy
    - Floor
    - Roof
    - Sanitation
    - Wall
    - Water
  - JobArea
  - Person
    - HeadOfFamily
    - MemberOfFamily
  - Work

is more specific than

Property Design

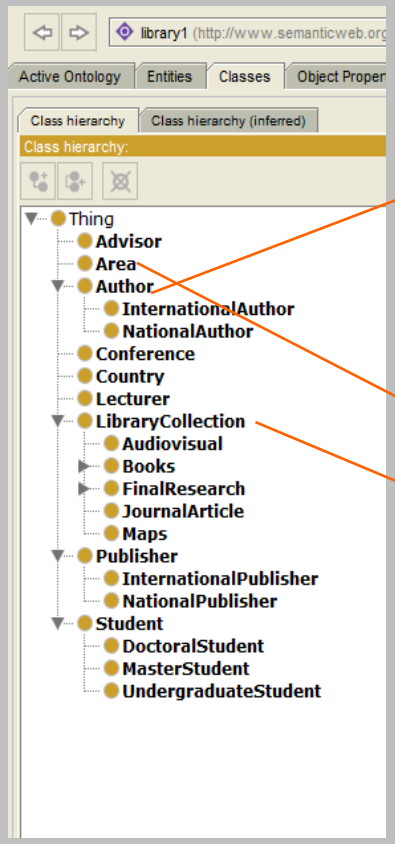


Semantic Mapping between ontologies : Poverty



Class Design : LIBRARY

Library 1



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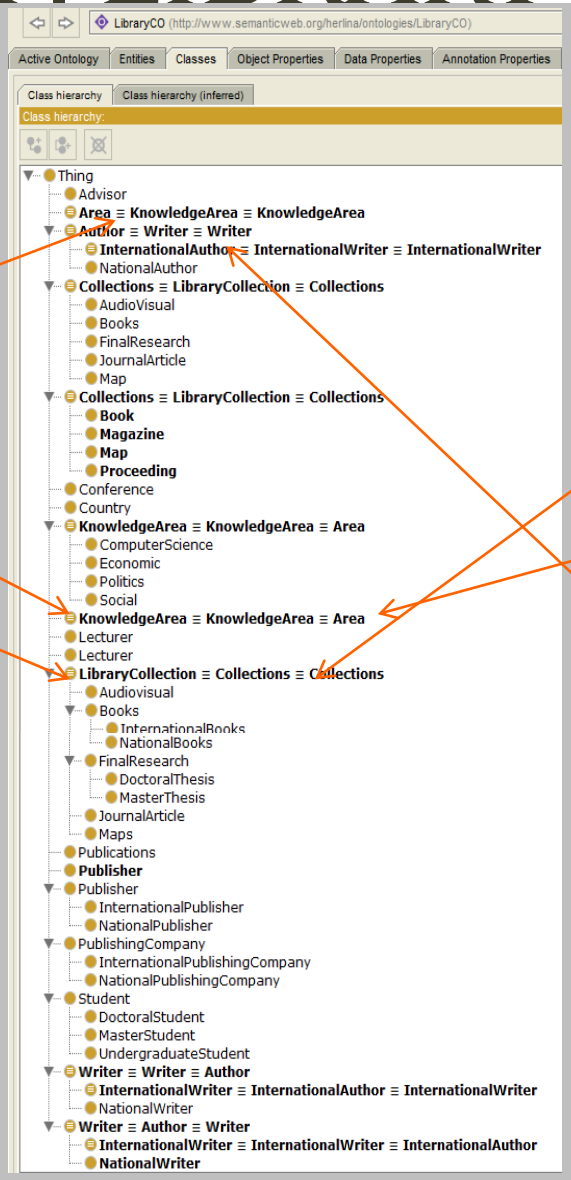
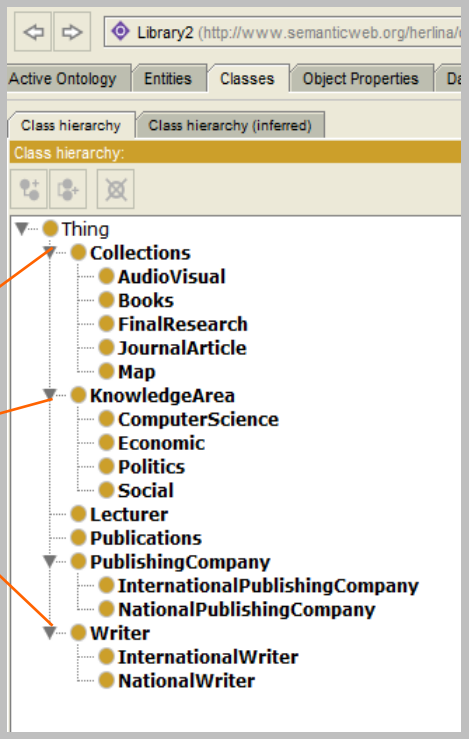
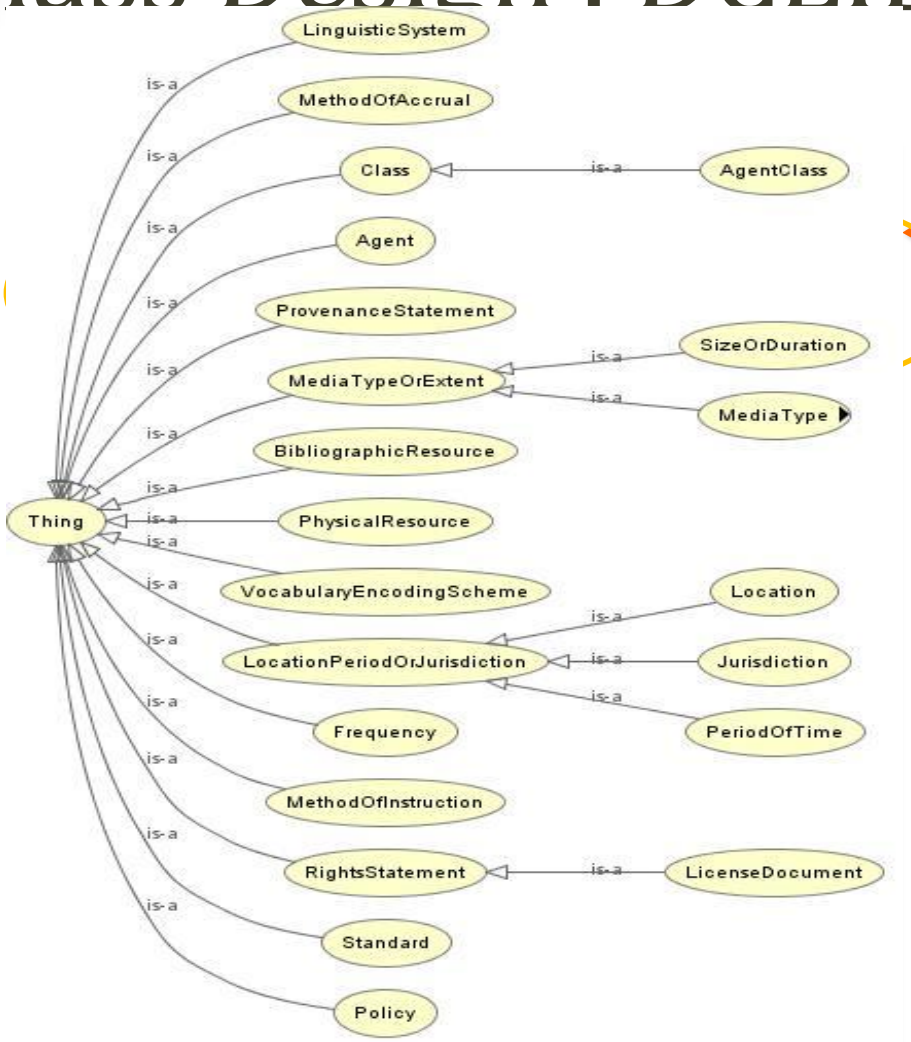


Library 2

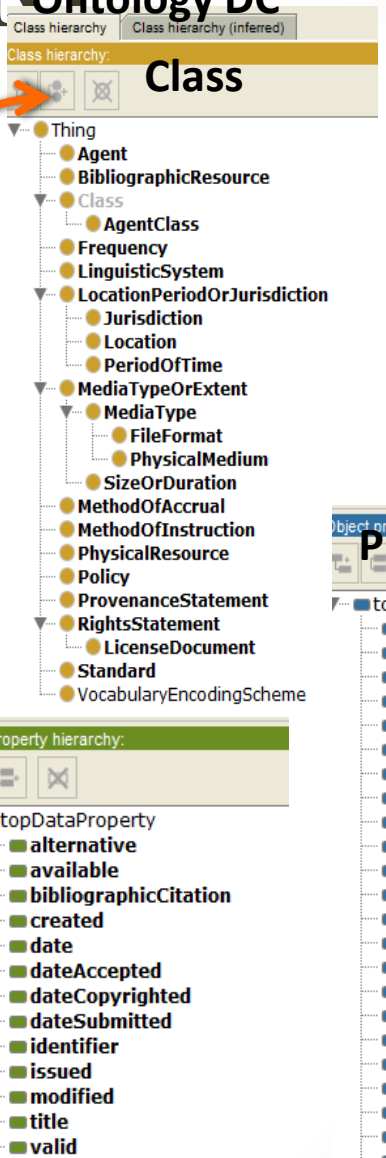


Class Design : DCLIBRARY

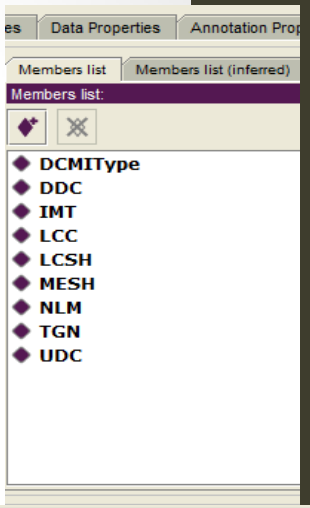


Ontology DC

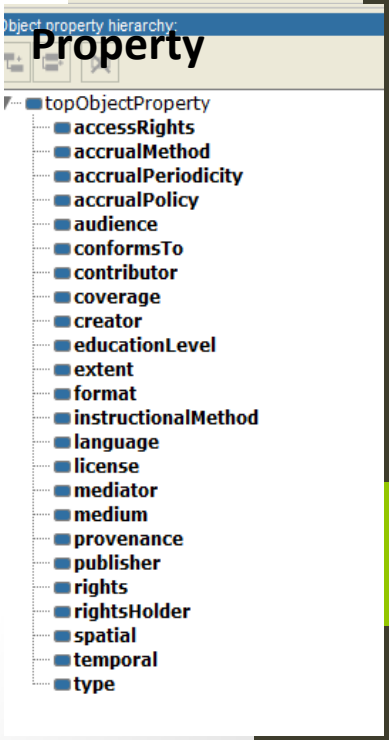
Class

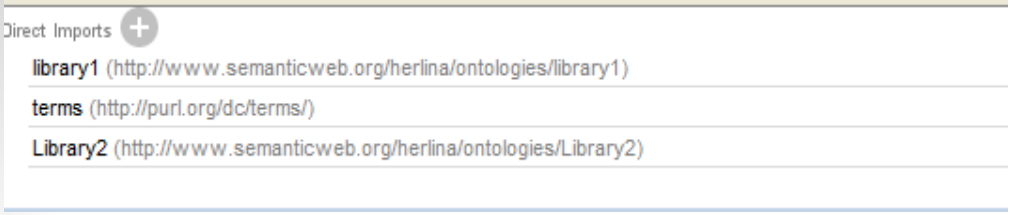


Instances



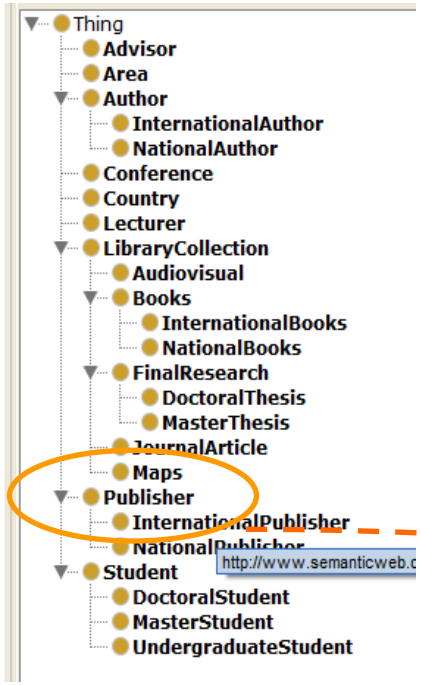
Property



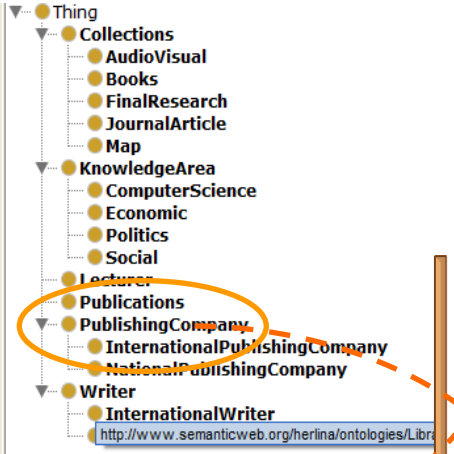


Ontology CO

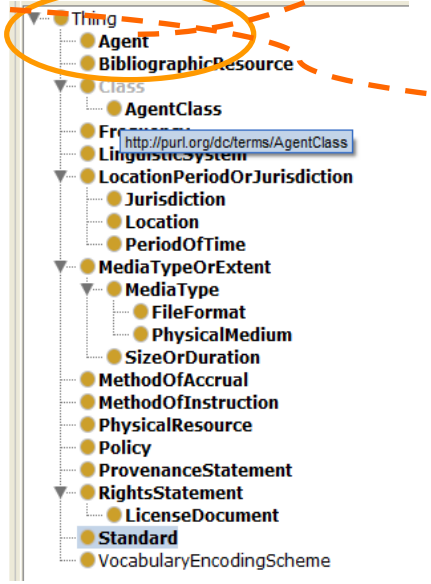
Ontology Library1

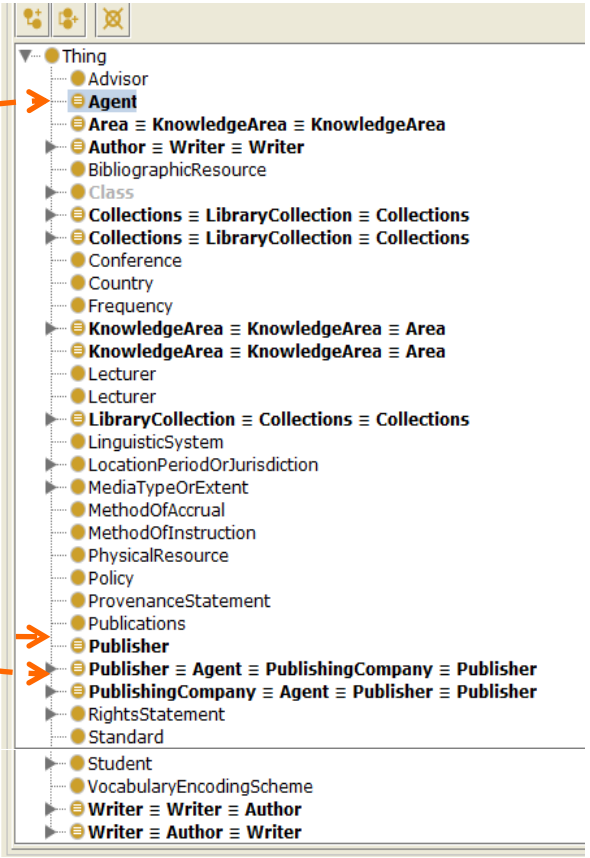


Ontology Library2

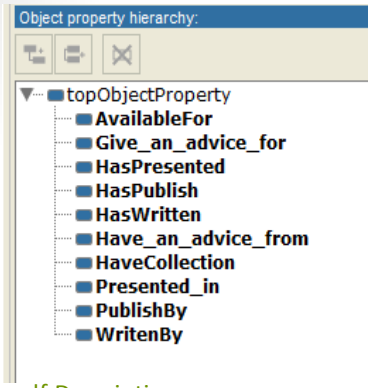


Ontology DC





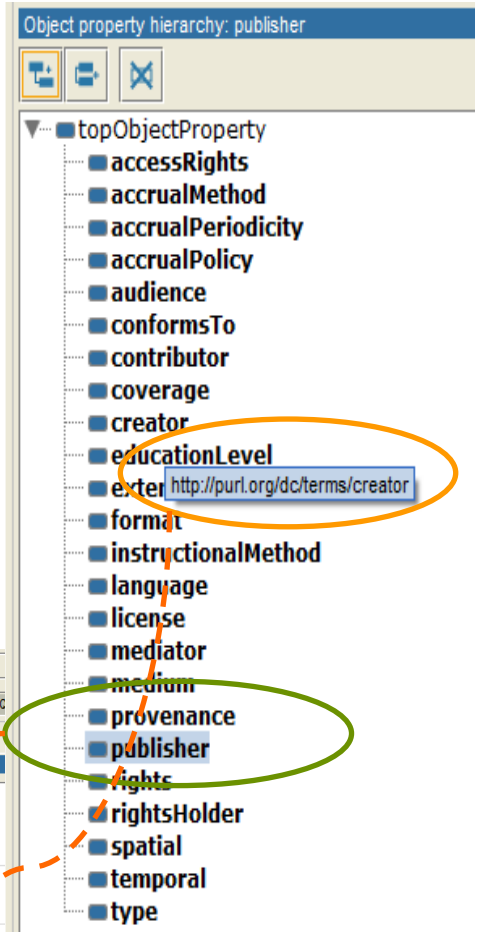
Ontology Library1

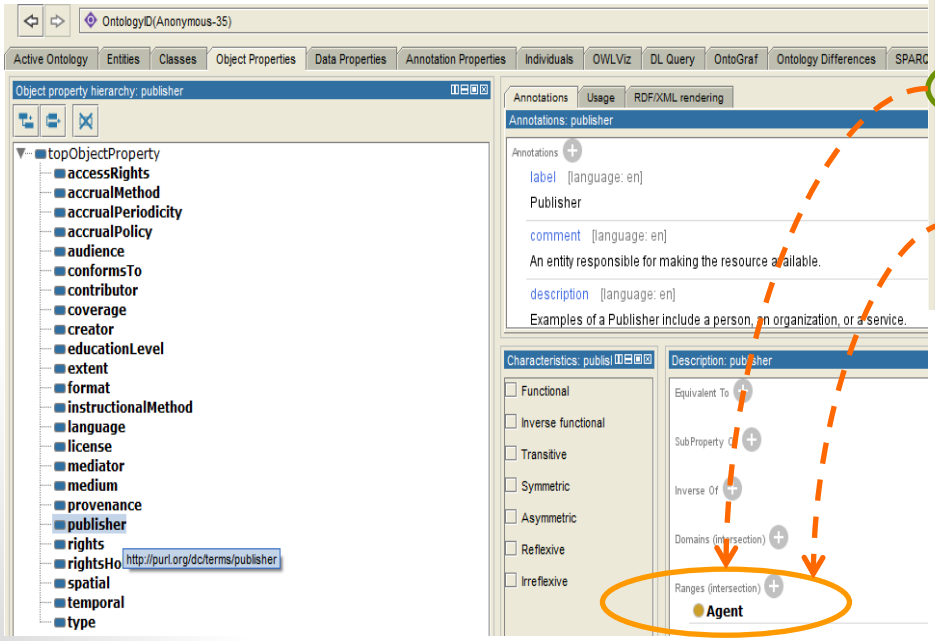


Ontology Library2


```
<rdf:Description
rdf:about="http://www.semanticweb.org/herlina/ontologies/Library2#herlinajayadianti">
      <sameAs rdf:resource="&LibraryCO;herlina_jayadianti"/>
      <sameAs
rdf:resource="http://www.semanticweb.org/herlina/ontologies/library1#Herlina_Jayadianti"/>
   </rdf:Description>
```

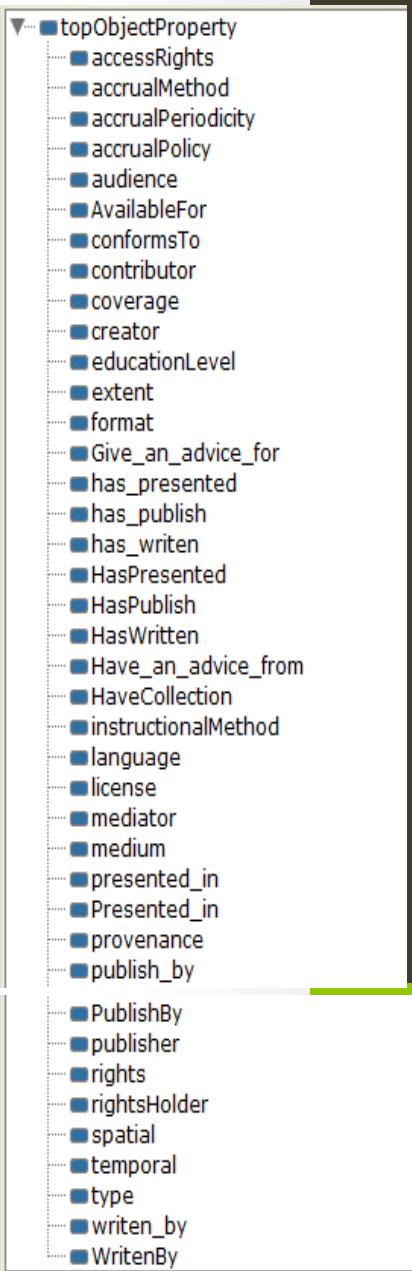
Ontology DC

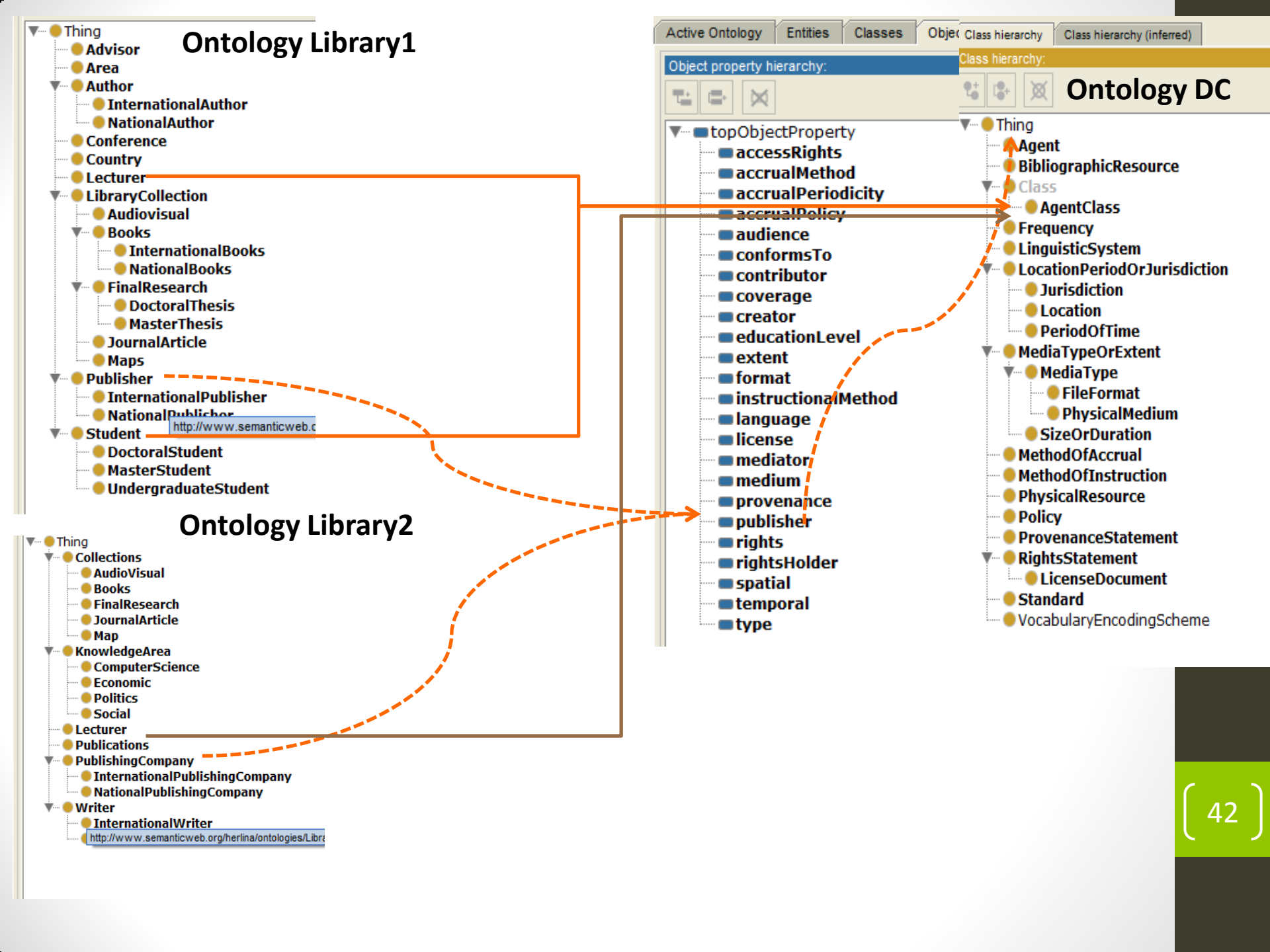




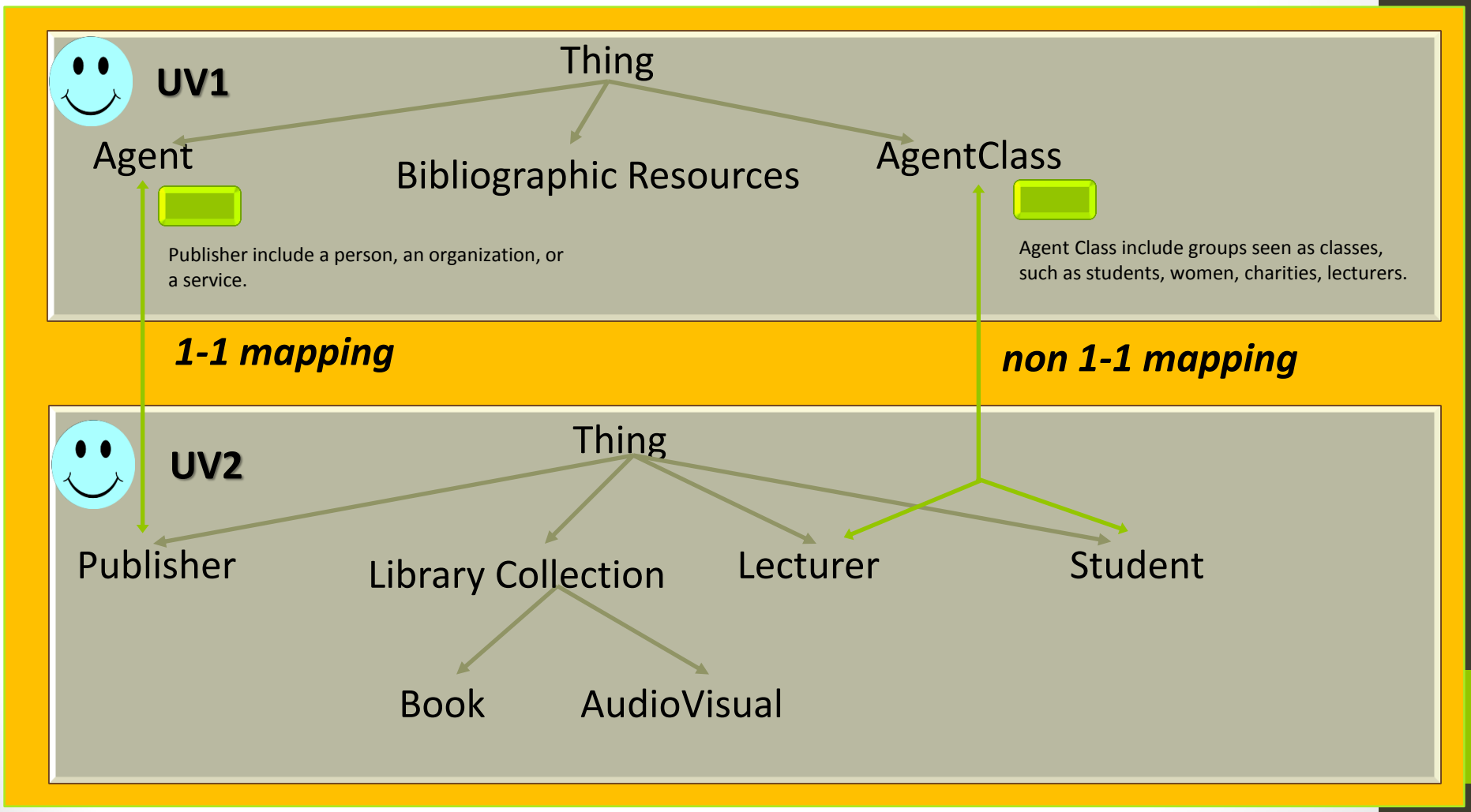
Ontology CO

http://www.semanticweb.org/herlina/ontologies/LibraryCO

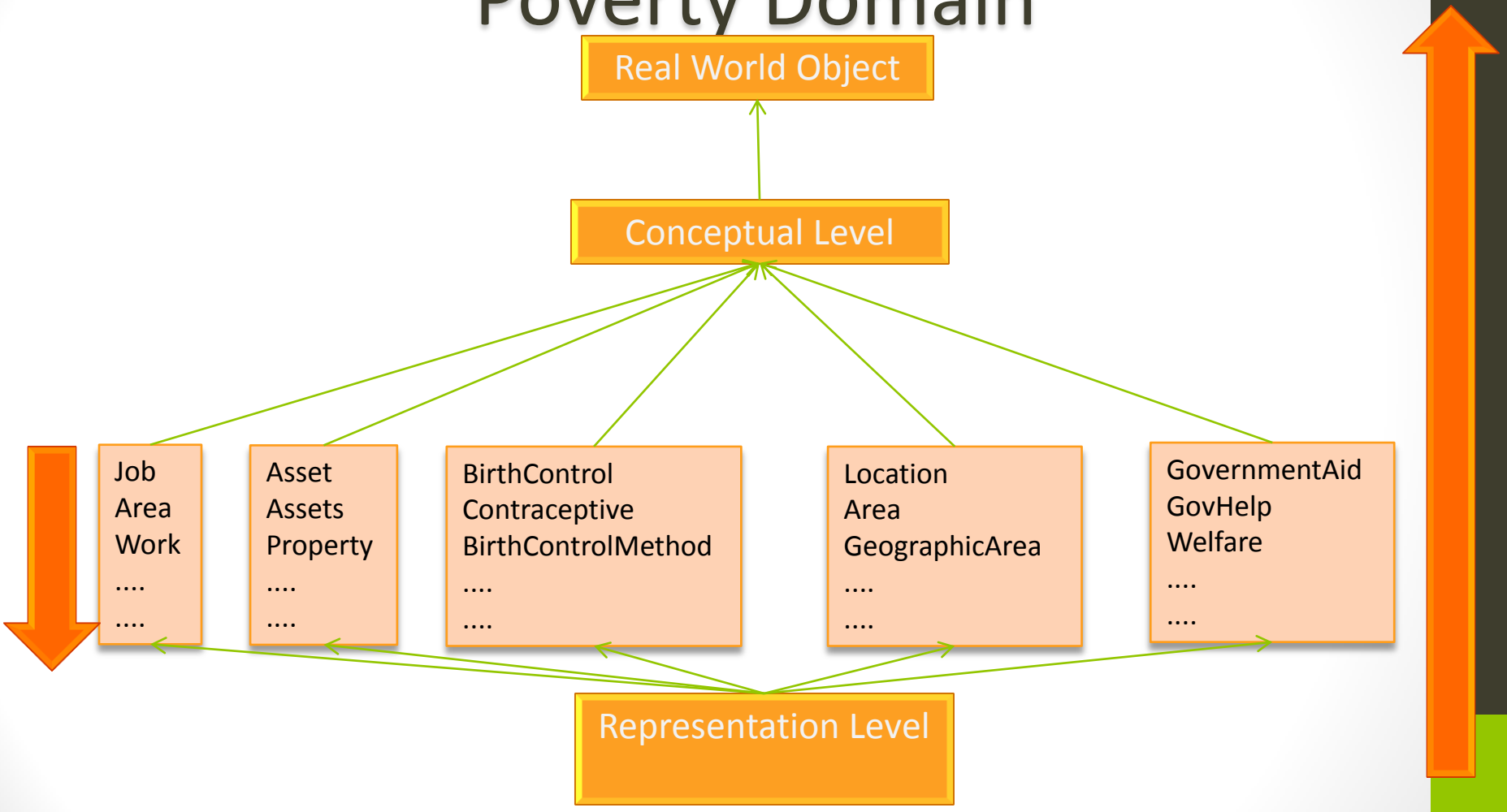



Ontology Library1
Thing
Advisor
Area
Author
InternationalAuthor
NationalAuthor
Conference
Country
Lecturer
LibraryCollection
Audiovisual
Books
InternationalBooks
NationalBooks
FinalResearch
DoctoralThesis
MasterThesis
JournalArticle
Maps
Publisher
InternationalPublisher
NationalPublisher
Student
DoctoralStudent
MasterStudent
UndergraduateStudent
Ontology Library2
Thing
Collections
AudioVisual
Books
FinalResearch
JournalArticle
Map
KnowledgeArea
ComputerScience
Economic
Politics
Social
Lecturer
Publications
PublishingCompany
InternationalPublishingCompany
NationalPublishingCompany
Writer
InternationalWriter
Active Ontology
Entities
Classes
Class hierarchy
Class hierarchy (inferred)
Object property hierarchy:
topObjectProperty
accessRights
accrualMethod
accrualPeriodicity
accrualPolicy
audience
conformsTo
contributor
coverage
creator
educationLevel
extent
format
instructionalMethod
language
license
mediator
medium
provenance
publisher
rights
rightsHolder
spatial
temporal
type
Class hierarchy:
Ontology DC
Thing
Agent
BibliographicResource
Class
AgentClass
Frequency
LinguisticSystem
LocationPeriodOrJurisdiction
Jurisdiction
Location
PeriodOfTime
MediaTypeOrExtent
MediaType
FileFormat
PhysicalMedium
SizeOrDuration
MethodOfAccrual
MethodOfInstruction
PhysicalResource
Policy
ProvenanceStatement
RightsStatement
LicenseDocument
Standard
VocabularyEncodingScheme

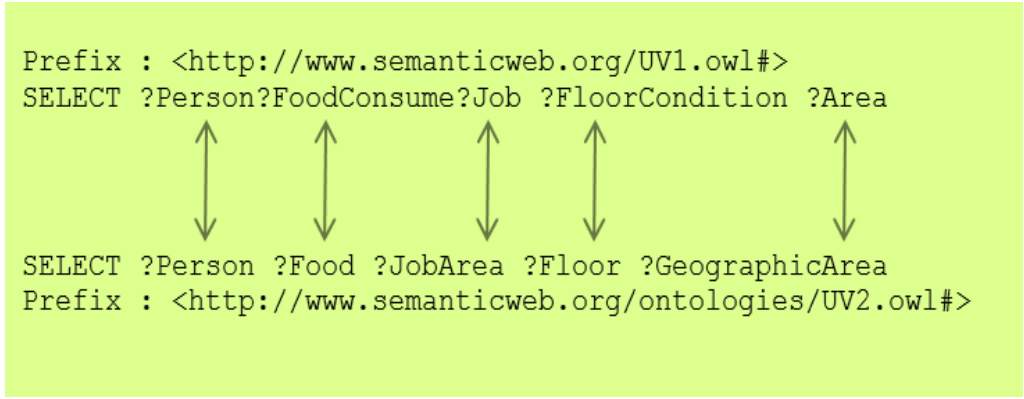
Semantic Mapping between ontologies Library



Semantic Mapping between ontologies: Poverty Domain



Semantic Mapping between ontologies : Poverty – UV1 and UV2



Prefix : <http://www.semanticweb.org/UV1.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?Person ?FoodConsume ?Job ?FloorCondition ?Area
WHERE { ?Person :hasRarelyEat ?FoodConsume.
?Person :hasJobPositionAs ?Job.
?Person :hasFloorMaterial ?FloorCondition.
?Person :isLivinginVillage ?Area.
?FoodConsume :FoodName ?value1.?Job :JobName ?value2.
?FloorCondition :TypeOfFloor ?value3.
?Area :hasName ?value4.
FILTER (?value1 = 'Chicken' && ?value2 ='Farmer' && ?value3 = 'Soil' && ?value4 = 'Widodomartani')}

Prefix : <http://www.semanticweb.org/ontologies/UV2.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?Person ?Food ?JobArea ?Floor ?GeographicArea
WHERE {?Person :hasFrequentlyEat ?Food.
?Person :hasLargestFloorAreaMadeFrom ?Floor.
?Person :hasjob ?JobArea.
?Person :isLiveinSubDistrict ?GeographicArea.
?Food :NameOfFood ?value1.
?JobArea :JobsArea ?value2. ?Floor :FloorMaterial ?value3.
?GeographicArea :hasCityName ?value4.
FILTER (?value1 ='Chicken' && ?value2='Government' && ?value3='Cement' && ?value4='Moyudan')}

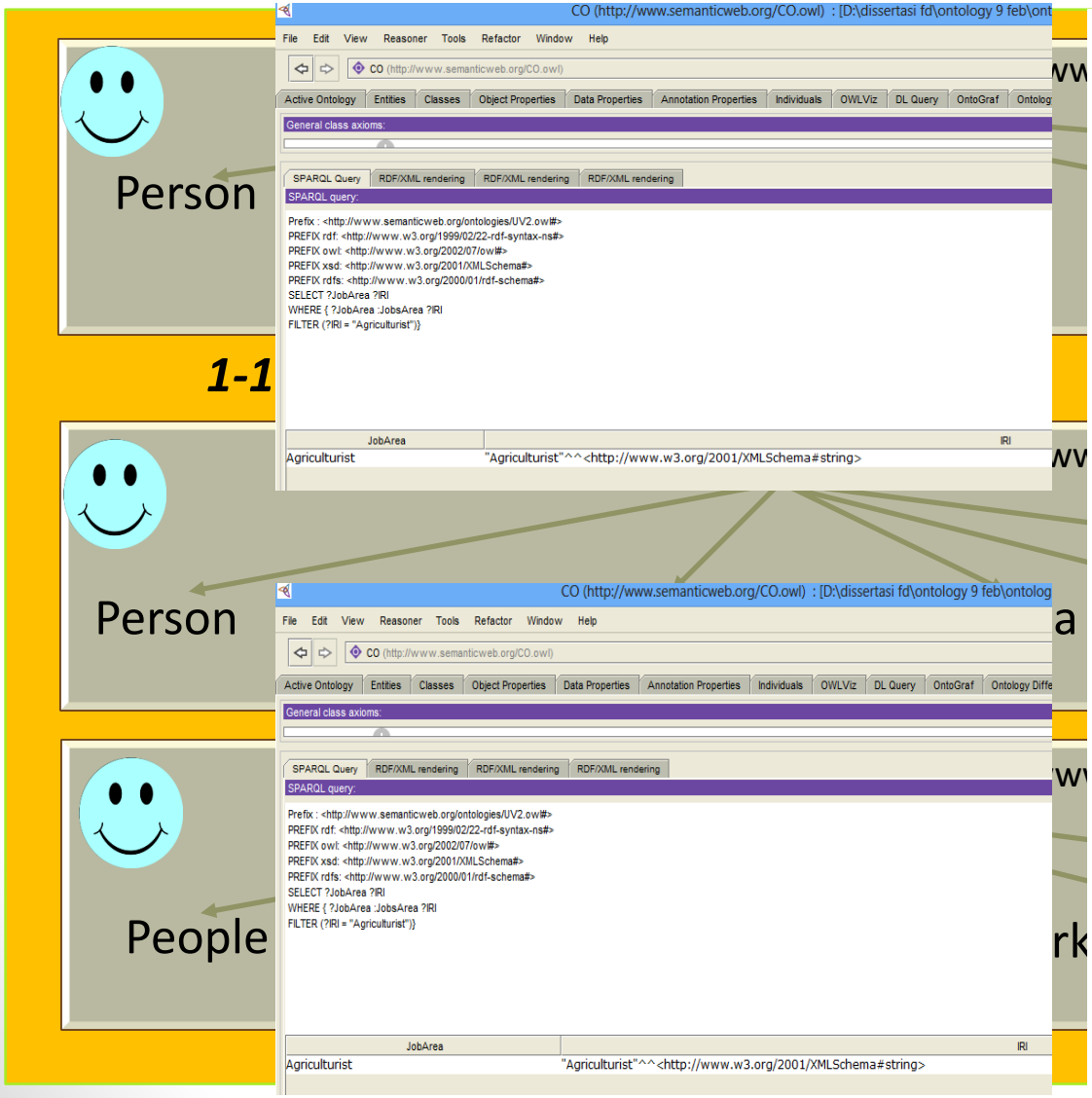
Semantic Mapping between ontologies Poverty – UV1 and UV2

```
Prefix : <http://www.semanticweb.org/UV1.owl#>

SELECT ?Person ?Area
          ↕      ↕
SELECT ?Person ?GeographicArea

Prefix : <http://www.semanticweb.org/ontologies/UV2.owl#>
```

Prefix : <http://www.semanticweb.org/ontologies/UV2.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT **?Person ?GeographicArea**
WHERE {?Person :isLiveinSubDistrict ?GeographicArea.
?GeographicArea :hasCityName **?value.**
FILTER (?value = 'Ngemplak')
}

Prefix : <http://www.semanticweb.org/UV1.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT **?Person ?Area**
WHERE {?Person :isLivinginSubDistrict ?Area.
?Area :hasName**?value.**
FILTER (?value ='Ngemplak')}

Semantic Mapping between ontologies : Poverty – CO, UV1 and UV2



- Thing
  - Area ≡ Location ≡ GeographicArea
  - Asset ≡ Property ≡ Assets
  - Assets ≡ Asset ≡ Property
  - BirthControl ≡ Contraceptive ≡ BirthControlMethod
  - BirthControlMethod ≡ Contraceptive ≡ BirthControl
  - Contraceptive ≡ BirthControl ≡ BirthControlMethod
  - Education ≡ EducationLevel ≡ Education
  - Education ≡ EducationLevel ≡ Education
  - EducationLevel ≡ Education ≡ Education
  - Food ≡ FoodConsume ≡ Food
  - Food ≡ Food ≡ FoodConsume
  - FoodConsume ≡ Food ≡ Food
  - GeographicArea ≡ Location ≡ Area
  - GovernmentAid ≡ GovHelp
  - GovHelp ≡ GovernmentAid
  - Health
  - HealthProblem ≡ HeatlhCondition
  - HeatlhCondition ≡ HealthProblem
  - hospital ≡ Hospital ≡ Hospital
  - Hospital ≡ Hospital ≡ hospital
  - Hospital ≡ Hospital ≡ hospital
  - House ≡ HouseParameter ≡ HouseCondition
  - HouseCondition ≡ House ≡ HouseParameter
  - HouseParameter ≡ House ≡ HouseCondition
  - Job ≡ JobArea ≡ Work ≡ Work
  - JobArea ≡ Job ≡ Work ≡ Work
  - Location ≡ Area ≡ GeographicArea
  - People ≡ Person ≡ Person
  - Person ≡ People ≡ Person
  - Person ≡ People ≡ Person
  - Property ≡ Asset ≡ Assets
  - Work ≡ Job ≡ JobArea ≡ Work
  - Work ≡ Job ≡ JobArea ≡ Work

Semantic Mapping between ontologies : Poverty, CO, UV1 and UV2

www.w3.org/RDF/Validator/rdfval

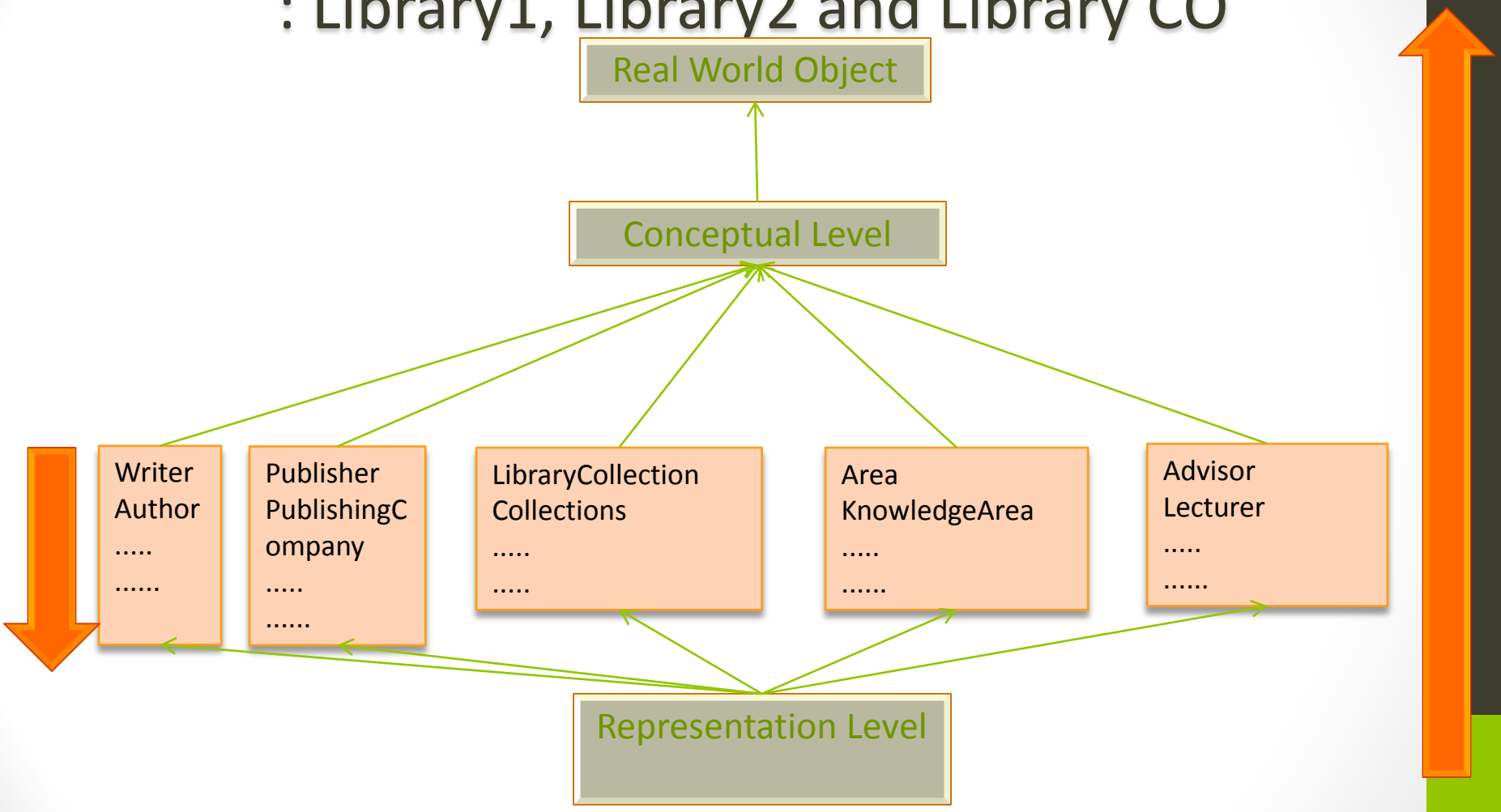
Feedback

Back to Validator Input

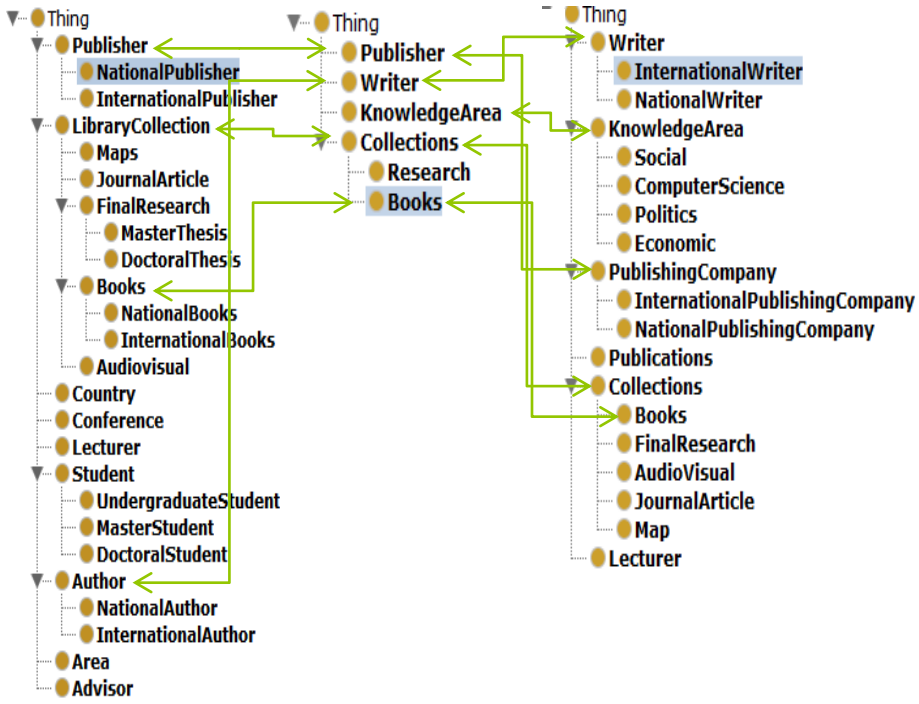
Triples of the Data Model

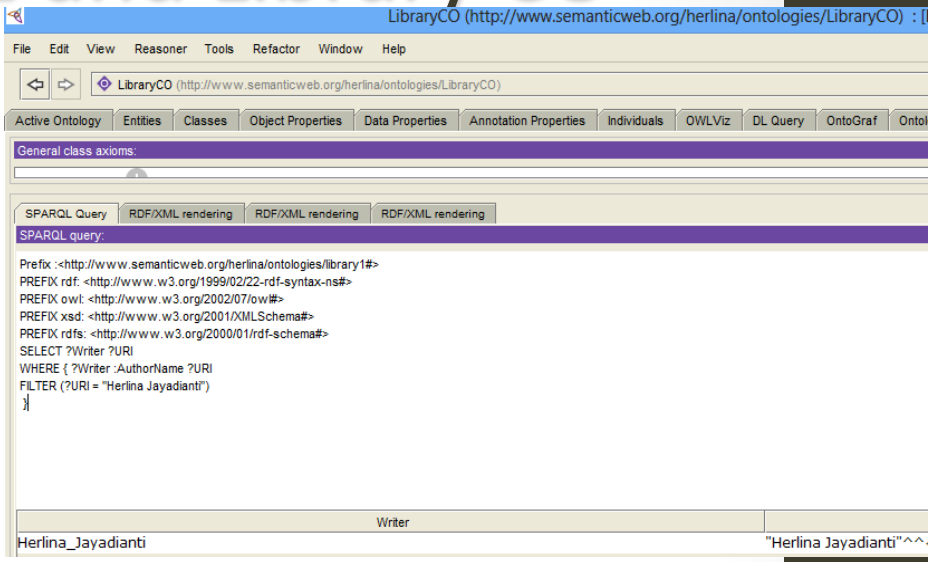
Number	Subject	Predicate	Object
1	http://www.semanticweb.org/CO.owl	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2002/07/owl#Ontology
2	http://www.semanticweb.org/CO.owl	http://www.w3.org/2002/07/owl#imports	http://www.semanticweb.org/UV1.owl
3	http://www.semanticweb.org/CO.owl	http://www.w3.org/2002/07/owl#imports	http://www.semanticweb.org/ontologies/UV2.owl
4	http://www.semanticweb.org/CO.owl#People	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2002/07/owl#Class
5	http://www.semanticweb.org/CO.owl#People	http://www.w3.org/2002/07/owl#equivalentClass	http://www.semanticweb.org/UV1.owl#Person
6	http://www.semanticweb.org/CO.owl#People	http://www.w3.org/2002/07/owl#equivalentClass	http://www.semanticweb.org/ontologies/UV2.owl#Person
7	http://www.semanticweb.org/UV1.owl#Person	http://www.w3.org/2002/07/owl#equivalentClass	http://www.semanticweb.org/ontologies/UV2.owl#Person
8	http://www.semanticweb.org/bkkbn.owl#Headoffamily	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2002/07/owl#Class
9	http://www.semanticweb.org/bkkbn.owl#Headoffamily	http://www.w3.org/2000/01/rdf-schema#subClassOf	http://www.semanticweb.org/CO.owl#People
10	http://www.semanticweb.org/bkkbn.owl#MemberofFamily	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2002/07/owl#Class
11	http://www.semanticweb.org/bkkbn.owl#MemberofFamily	http://www.w3.org/2000/01/rdf-schema#subClassOf	http://www.semanticweb.org/CO.owl#People
12	http://www.semanticweb.org/bkkbn.owl#Work	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/2002/07/owl#Class

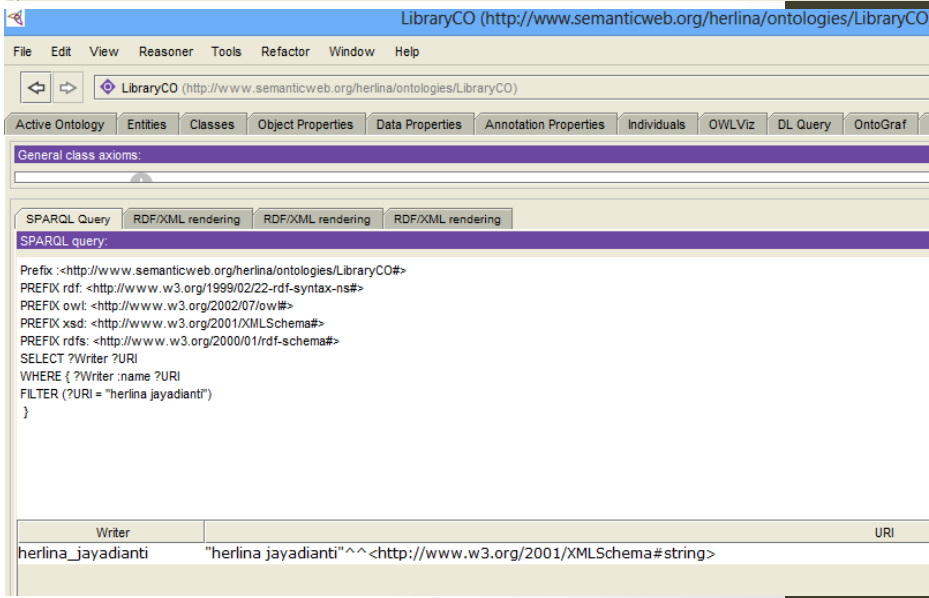
Semantic Mapping between ontologies : Library1, Library2 and Library CO



Semantic Mapping between ontologies : Library1, Library2 and Library CO







Thank you


Person
1..*
married-to
1..*


Thing
Person
Employ
AcademicStuff
FacultyMember
AssistantProfessor
AssociateProfessor
FullProfessor
AdministrativeStaff
TechnicalStaff
Student
Graduate
PhdStudent
Undergraduate
Publication
Article
Book
InBook
InCollection
InProceedings
TechReport
Thesis
MasterThesis
PhdThesis
Thing
Person
Student
GraduateStudent
UndergraduateStudent
Employee
AdministrativeStaff
Director