Ontological Engineering

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Ontological Engineering

It refers to the set of activities that concern

the ontology development process,

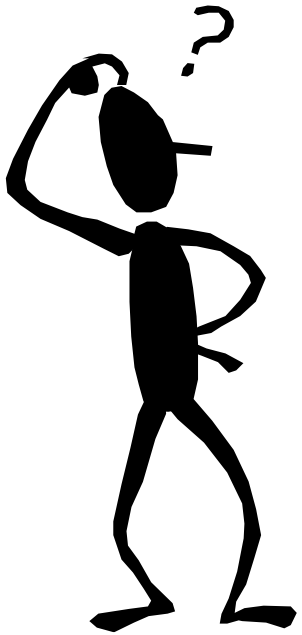
the ontology life cycle,

the methods and methodologies for building ontologies,

and the tool suites

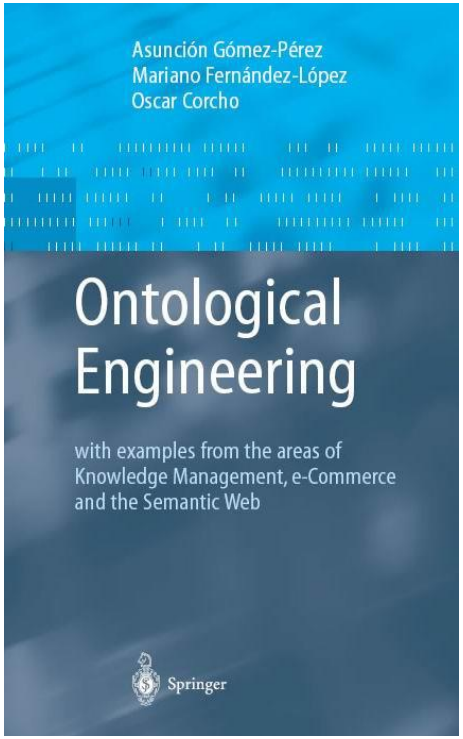
and languages that support them

I want to build my ontology



- Which are the key process and activities in ontology development?
- Which activities do I need in my development?
- When should I carry out each activity?
- Where is the relationship of one activity with the others?
- How do I collect the requirements of my ontology?
- Where can I find ontologies with the goal of reusing them?
- How can I reuse exiting knowledge resources?
- ...

References



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- Deliverable D5.3.1
- Deliverable D5.3.2
- Deliverable D5.4.1

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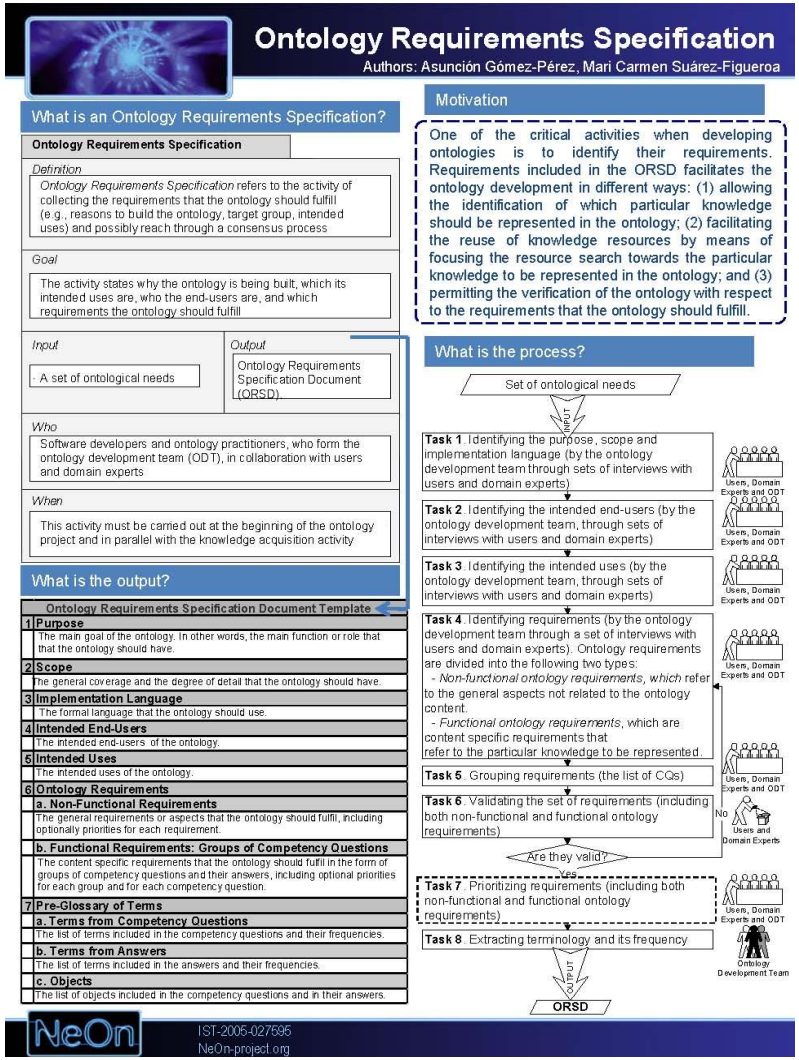
NeOn Methodology in a Nutshell

Title	Author(s)
Introduction	Asunción Gómez-Pérez, Enrico Motta, Mari Carmen Suárez-Figueroa
Definition of Ontology Networks	Mathieu d'Aquin, Aldo Gangemi, Peter Haase
NeOn Methodology Framework:	
Scenarios for Building Ontology Networks and Glossary of Processes and Activities	Mari Carmen Suárez-Figueroa, Asunción Gómez-Pérez
Collection of Ontology Life Cycle Models	Asunción Gómez-Pérez, Mari Carmen Suárez-Figueroa, Mariano Fernández-López
Methodology guidelines	
Ontology Requirements Specification	Asunción Gómez-Pérez, Mari Carmen Suárez-Figueroa
Searching Ontologies	Mathieu d'Aquin, Holger Lewen
Scheduling using gOntt	Mari Carmen Suárez-Figueroa, Asunción Gómez-Pérez
Reusing and Re-engineering Non-Ontological Resources	Asunción Gómez-Pérez, Boris Villazón-Terrazas
Reusing General Ontologies	Mariano Fernández-López, Asunción Gómez-Pérez, Mari Carmen Suárez-Figueroa
Reusing Domain Ontologies	Mari Carmen Suárez-Figueroa, Asunción Gómez-Pérez
Reusing Statements	Mari Carmen Suárez-Figueroa, Mathieu d'Aquin
Conceptualizing using ODPs	Eva Blomqvist, Enrico Daga, Aldo Gangemi, Valentina Presutti,

Executive Summaries on the NeOn Methodology



Ontology Requirements Specification

Authors: Asunción Gómez-Pérez, Mari Carmen Suárez-Figueroa

What is an Ontology Requirements Specification?

Ontology Requirements Specification

Definition

Ontology Requirements Specification refers to the activity of collecting the requirements that the ontology should fulfill (e.g., reasons to build the ontology, target group, intended uses) and possibly reach through a consensus process

Goal

The activity states why the ontology is being built, which its intended uses are, who the end-users are, and which requirements the ontology should fulfill

Input

A set of ontological needs

Output

Ontology Requirements Specification Document (ORSD)

Who

Software developers and ontology practitioners, who form the ontology development team (ODT), in collaboration with users and domain experts

When

This activity must be carried out at the beginning of the ontology project and in parallel with the knowledge acquisition activity

What is the output?

Ontology Requirements Specification Document Template

1 **Purpose**
The main goal of the ontology. In other words, the main function or role that that the ontology should have.

2 **Scope**
The general coverage and the degree of detail that the ontology should have.

3 **Implementation Language**
The formal language that the ontology should use.

4 **Intended End-Users**
The intended end-users of the ontology.

5 **Intended Uses**
The intended uses of the ontology.

6 **Ontology Requirements**
- **a. Non-Functional Requirements**
  The general requirements or aspects that the ontology should fulfill, including optionally priorities for each requirement.
- **b. Functional Requirements: Groups of Competency Questions**
  The content specific requirements that the ontology should fulfil in the form of groups of competency questions and their answers, including optional priorities for each group and for each competency question.

7 **Pre-Glossary of Terms**
- **a. Terms from Competency Questions**
  The list of terms included in the competency questions and their frequencies.
- **b. Terms from Answers**
  The list of terms included in the answers and their frequencies.
- **c. Objects**
  The list of objects included in the competency questions and in their answers.

Motivation

One of the critical activities when developing ontologies is to identify their requirements. Requirements included in the ORSD facilitates the ontology development in different ways: (1) allowing the identification of which particular knowledge should be represented in the ontology; (2) facilitating the reuse of knowledge resources by means of focusing the resource search towards the particular knowledge to be represented in the ontology; and (3) permitting the verification of the ontology with respect to the requirements that the ontology should fulfill.

What is the process?

Set of ontological needs

INPUT

Task 1. Identifying the purpose, scope and implementation language (by the ontology development team through sets of interviews with users and domain experts) — Users, Domain Experts and ODT

Task 2. Identifying the intended end-users (by the ontology development team, through sets of interviews with users and domain experts) — Users, Domain Experts and ODT

Task 3. Identifying the intended uses (by the ontology development team, through sets of interviews with users and domain experts) — Users, Domain Experts and ODT

Task 4. Identifying requirements (by the ontology development team through a set of interviews with users and domain experts). Ontology requirements are divided into the following two types:
- *Non-functional ontology requirements*, which refer to the general aspects not related to the ontology content.
- *Functional ontology requirements*, which are content specific requirements that refer to the particular knowledge to be represented.

— Users, Domain Experts and ODT

Task 5. Grouping requirements (the list of CQs) — Users, Domain Experts and ODT

Task 6. Validating the set of requirements (including both non-functional and functional ontology requirements) — Users and Domain Experts

No

Are they valid?

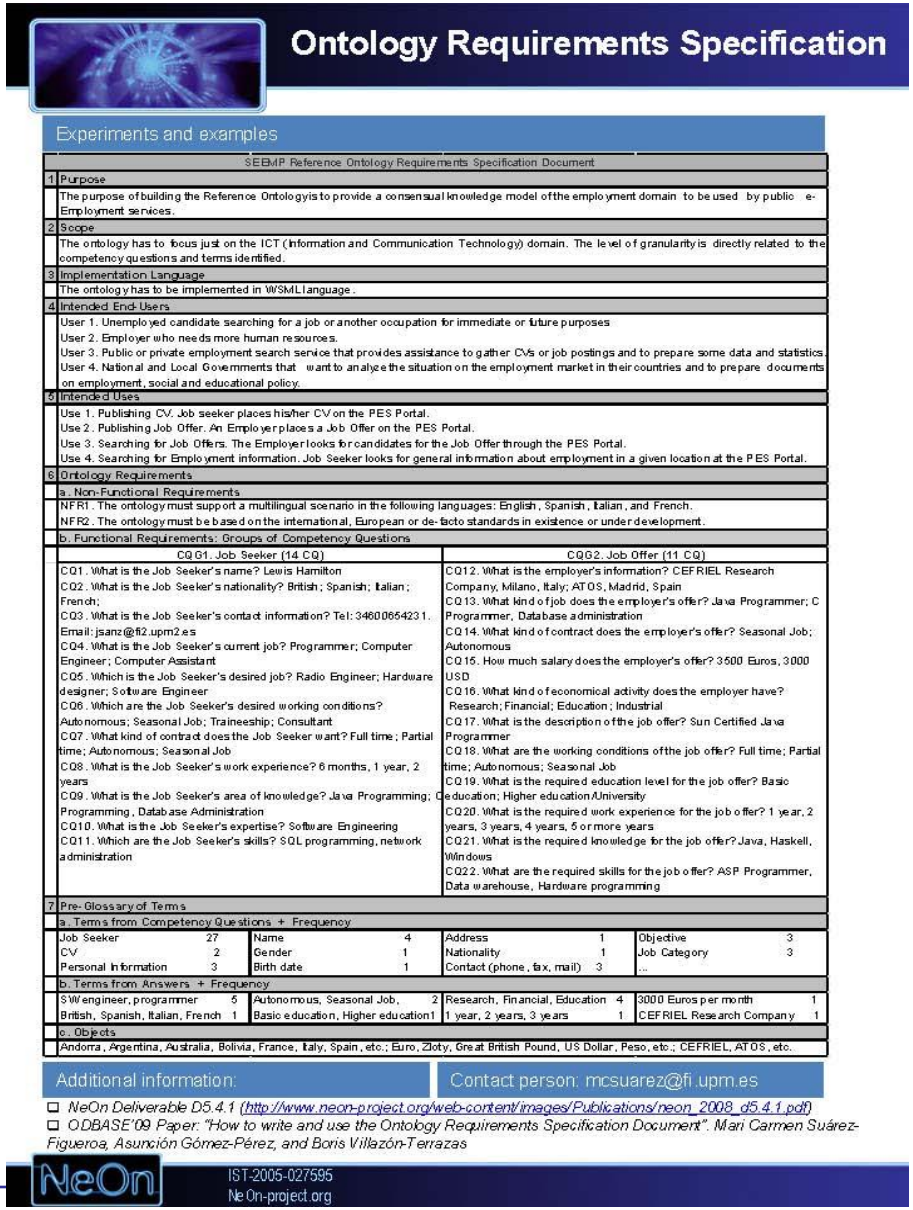
Yes

Task 7. Prioritizing requirements (including both non-functional and functional ontology requirements) — Users, Domain Experts and ODT

Task 8. Extracting terminology and its frequency — Ontology Development Team

OUTPUT

ORSD



Ontology Requirements Specification

Experiments and examples

SEEMP Reference Ontology Requirements Specification Document

1 **Purpose**
The purpose of building the Reference Ontology is to provide a consensual knowledge model of the employment domain to be used by public e-Employment services.

2 **Scope**
The ontology has to focus just on the ICT (Information and Communication Technology) domain. The level of granularity is directly related to the competency questions and terms identified.

3 **Implementation Language**
The ontology has to be implemented in WSML language.

4 **Intended End-Users**
User 1. Unemployed candidate searching for a job or another occupation for immediate or future purposes
User 2. Employer who needs more human resources.
User 3. Public or private employment search service that provides assistance to gather CVs or job postings and to prepare some data and statistics.
User 4. National and Local Governments that want to analyze the situation on the employment market in their countries and to prepare documents on employment, social and educational policy.

5 **Intended Uses**
Use 1. Publishing CV. Job seeker places his/her CV on the PES Portal.
Use 2. Publishing Job Offer. An Employer places a Job Offer on the PES Portal.
Use 3. Searching for Job Offers. The Employer looks for candidates for the Job Offer through the PES Portal.
Use 4. Searching for Employment information. Job Seeker looks for general information about employment in a given location at the PES Portal.

6 **Ontology Requirements**

a. Non-Functional Requirements

NFR1. The ontology must support a multilingual scenario in the following languages: English, Spanish, Italian, and French.
NFR2. The ontology must be based on the international, European or de-facto standards in existence or under development.

b. Functional Requirements: Groups of Competency Questions

CQG1. Job Seeker (14 CQ)	CQG2. Job Offer (11 CQ)
CQ1. What is the Job Seeker's name? Lewis Hamilton	CQ12. What is the employer's information? CEFRIEL Research
CQ2. What is the Job Seeker's nationality? British; Spanish; Italian; French;	Company, Milano, Italy; ATOS, Madrid, Spain
CQ3. What is the Job Seeker's contact information? Tel: 34600654231. Email: jsanz@fi2.upm2.es	CQ13. What kind of job does the employer's offer? Java Programmer; C Programmer, Database administration
CQ4. What is the Job Seeker's current job? Programmer; Computer Engineer; Computer Assistant	CQ14. What kind of contract does the employer's offer? Seasonal Job; Autonomous
CQ5. Which is the Job Seeker's desired job? Radio Engineer; Hardware designer; Software Engineer	CQ15. How much salary does the employer's offer? 3500 Euros, 3000 USD
CQ6. Which are the Job Seeker's desired working conditions? Autonomous; Seasonal Job; Traineeship; Consultant	CQ16. What kind of economical activity does the employer have? Research; Financial; Education; Industrial
CQ7. What kind of contract does the Job Seeker want? Full time; Partial time; Autonomous; Seasonal Job	CQ17. What is the description of the job offer? Sun Certified Java Programmer
CQ8. What is the Job Seeker's work experience? 6 months, 1 year, 2 years	CQ18. What are the working conditions of the job offer? Full time; Partial time; Autonomous; Seasonal Job
CQ9. What is the Job Seeker's area of knowledge? Java Programming; C Programming, Database Administration	CQ19. What is the required education level for the job offer? Basic Education; Higher education/University
CQ10. What is the Job Seeker's expertise? Software Engineering	CQ20. What is the required work experience for the job offer? 1 year, 2 years, 3 years, 4 years, 5 or more years
CQ11. Which are the Job Seeker's skills? SQL programming, network administration	CQ21. What is the required knowledge for the job offer? Java, Haskell, Windows
	CQ22. What are the required skills for the job offer? ASP Programmer, Data warehouse, Hardware programming

7 **Pre-Glossary of Terms**

a. Terms from Competency Questions + Frequency

Job Seeker	27	Name	4	Address	1	Objective	3
CV	2	Gender	1	Nationality	1	Job Category	3
Personal Information	3	Birth date	1	Contact (phone, fax, mail)	3	...	

b. Terms from Answers + Frequency

SW engineer, programmer	5	Autonomous, Seasonal Job,	2	Research, Financial, Education	4	3000 Euros per month	1
British, Spanish, Italian, French	1	Basic education, Higher education	1	1 year, 2 years, 3 years	1	CEFRIEL Research Company	1

c. Objects

Andorra, Argentina, Australia, Bolivia, France, Italy, Spain, etc.; Euro, Zloty, Great British Pound, US Dollar, Peso, etc.; CEFRIEL, ATOS, etc.

Additional information:

Contact person: mcsuarez@fi.upm.es

- *NeOn Deliverable D5.4.1 (http://www.neon-project.org/web-content/images/Publications/neon_2008_d5.4.1.pdf)*
- *ODBASE'09 Paper: "How to write and use the Ontology Requirements Specification Document". Mari Carmen Suárez-Figueroa, Asunción Gómez-Pérez, and Boris Villazón-Terrazas*

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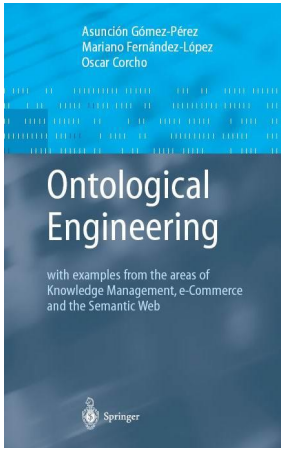
  - Creating the final Ontology Model

Building ontologies in the 90s

Methodologies for building single ontologies

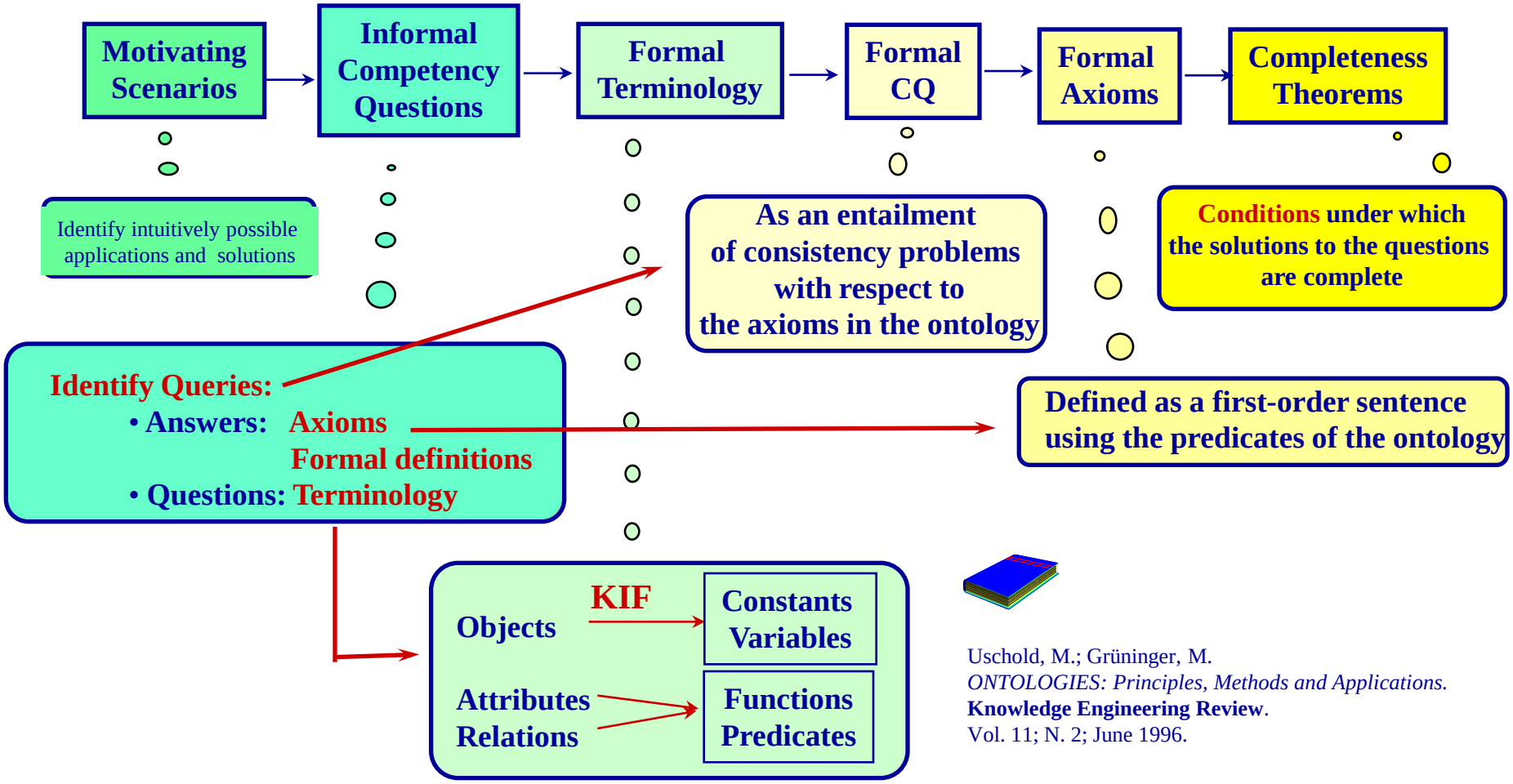
- Uschold and King's method
- Grüninger and Fox's methodology
- KACTUS approach
- METHONTOLOGY
- SENSUS method
- On-To-Knowledge
- DILIGENT



Ontology learning approaches for building ontologies from structured, semi-structured and non-structured data

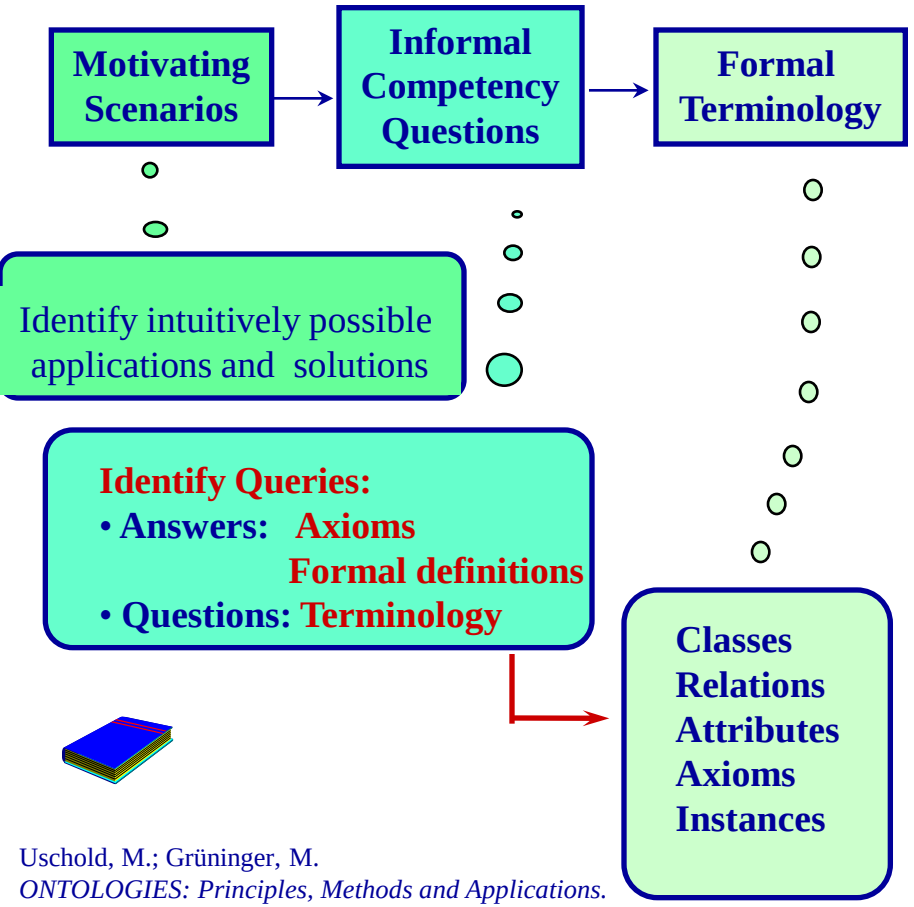
- Are not integrated with current methodologies
- Mainly from non-structured data using NLP techniques

TOVE Methodology



Uschold, M.; Grüninger, M.
ONTOLOGIES: Principles, Methods and Applications.
Knowledge Engineering Review.
Vol. 11; N. 2; June 1996.

Getting terminology using Competency Questions



Uschold, M.; Grüninger, M.
ONTOLOGIES: Principles, Methods and Applications.
Knowledge Engineering Review.
Vol. 11; N. 2; June 1996.

Find documents written by Person P

Identify Queries:
- **Questions: Document, Person, writes**
- **Answers: Document D1 is written by P1**

Classes: Document, Person
Relations: Writes, written by
Attributes: ---
Axioms
Instances: P1, D1

Uschold Methodology

1. Identify Purpose and Scope

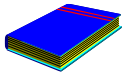
2. Building the ontology

   - Ontology Capture → • Identify key concepts and relationships • Produce unambiguous text definitions • Identify terms to refer to such concepts and relations
   - Ontology Coding → • Commit to a meta-ontology • Choose a representation language • Write the code
   - Integrating existing ontologies → How and whether to reuse ontologies that already exist

3. Evaluation

4. Documentation

5. Guideliness for each phase

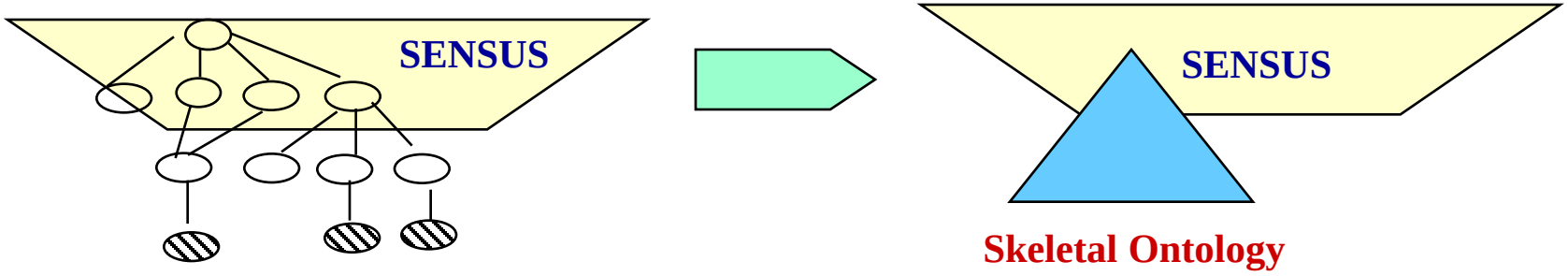


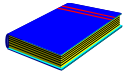
Uschold, M.; Grüninger, M. *ONTOLOGIES: Principles, Methods and Applications.* **Knowledge Engineering Review**. Vol. 11; N. 2; June 1996.

SENSUS as a basis for a domain-specific ontology (I)

Linking Domain Specific Terms to a broad Coverage Ontology

To identify the terms in SENSUS that are relevant to a particular domain and then prune the skeletal ontology using heuristics





B. Swartout; R. Patil; k. Knight; T. Russ. *Toward Distributed Use of Large-Scale Ontologies* **Ontological Engineering.** AAAI-97 Spring Symposium Series. 1997. 138-148.

SENSUS as a basis for a domain-specific ontology (II)

METHOD

1. Identify "seed" terms
2. Link seed terms to SENSUS by hand
3. Include nodes on the path to root
4. Add entire subtrees using the heuristic:

   If many nodes in a subtree are relevant,

   the other nodes in the subtree are relevant

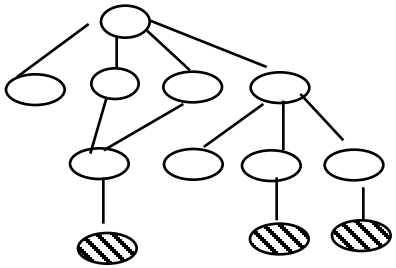

Sensus Term

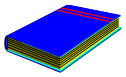

Seed


Path to root


Frequent Parent


Subtree Term

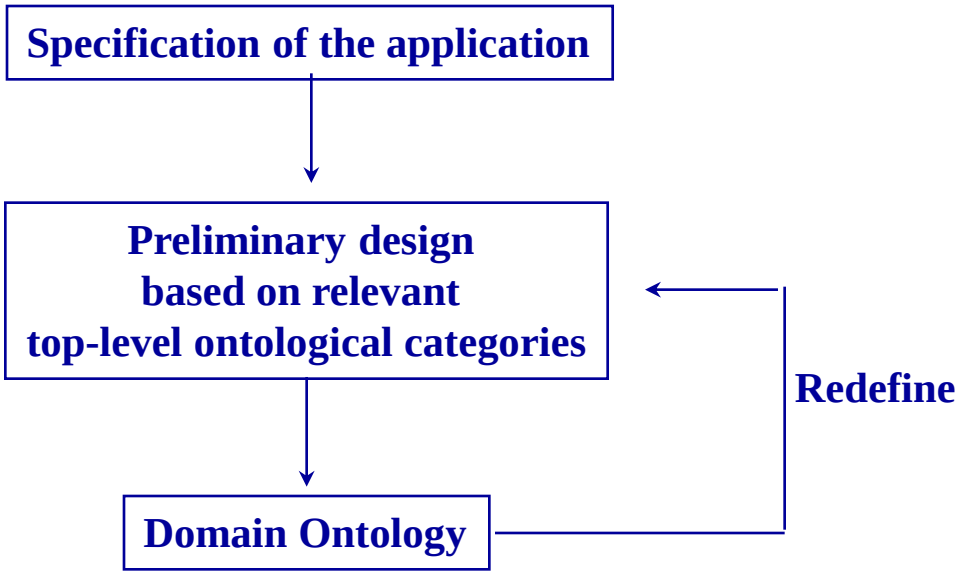


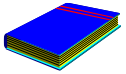


B. Swartout; R. Patil; k. Knight; T. Russ. *Toward Distributed Use of Large-Scale Ontologies* **Ontological Engineering.** AAAI-97 Spring Symposium Series. 1997. 138-148.

Bernara, Laresgoiti, Corera Methodology

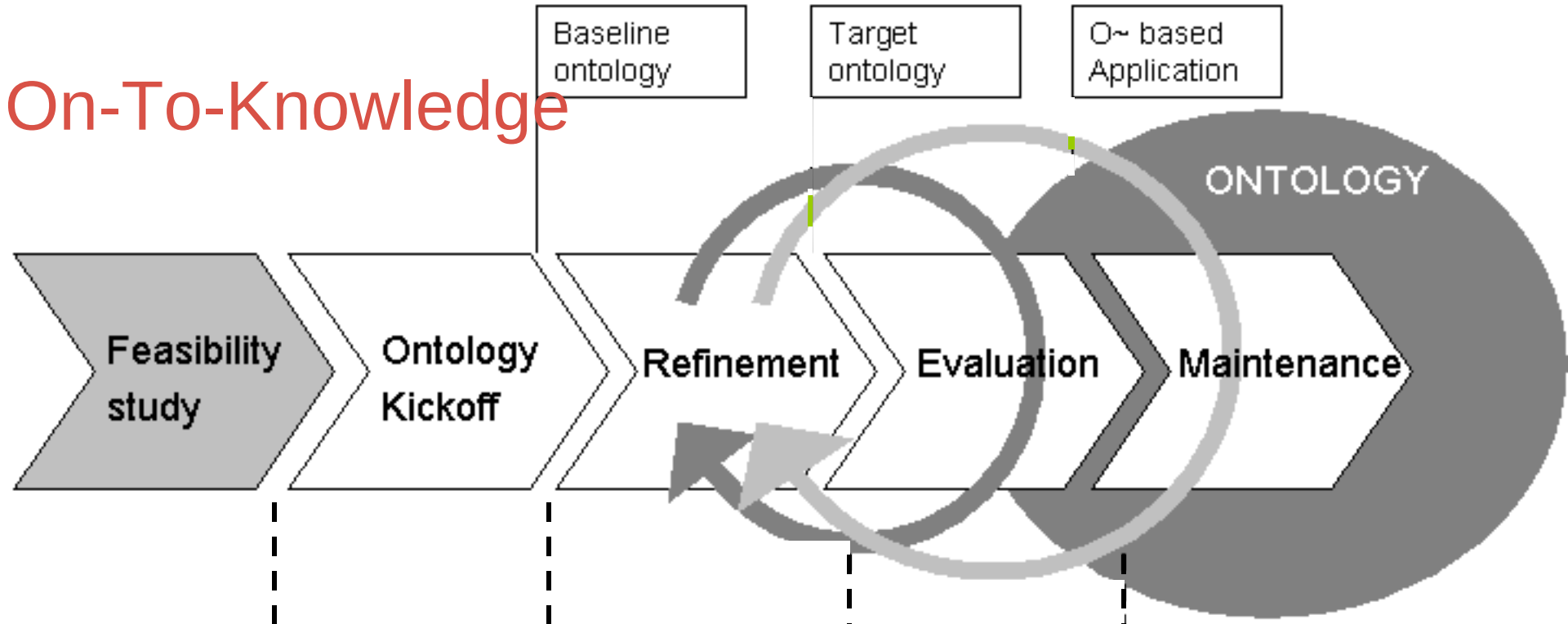
Build a preliminary ontology for refinement and augment with new definitions





A. Bernaras; I. Laresgoiti; J. Corera. *Building and reusing ontologies for electrical network applications* **ECAI96. 12th European Conference on Artificial Intelligence.** 1996. 298-302

On-To-Knowledge



- Identify problem and opportunity areas
- Select most promising focus area and target solution

- Requirement specification
- Analyze input sources
- Develop baseline taxonomy

- Concept elicitation with domain experts
- Develop base-line taxonomy
- Conceptualize and formalize
- Add relations and axioms

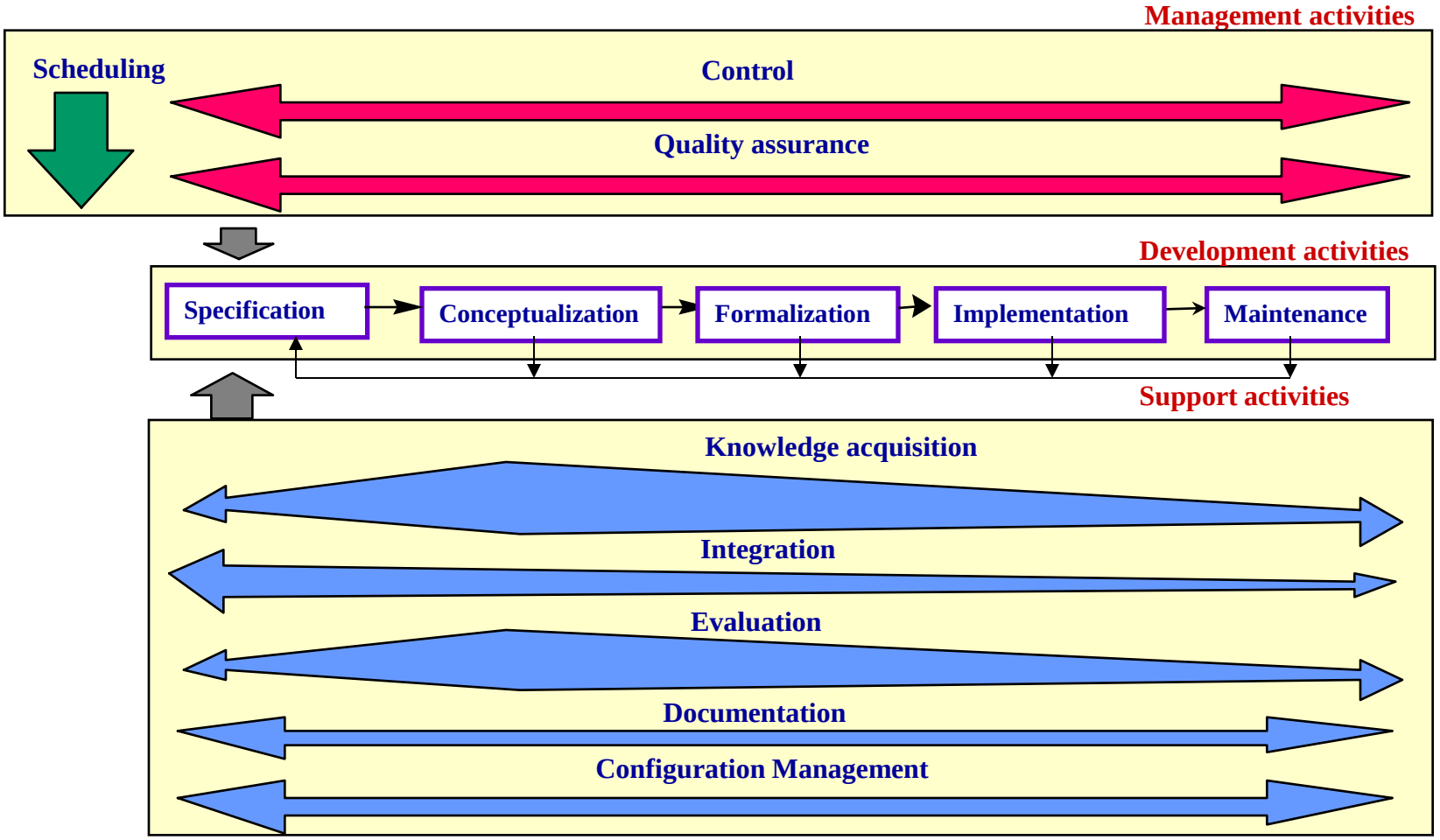
- Identify problem and opportunity areas
- Select most promising focus area and target solution

- Manage organizational maintenance process

Project setting

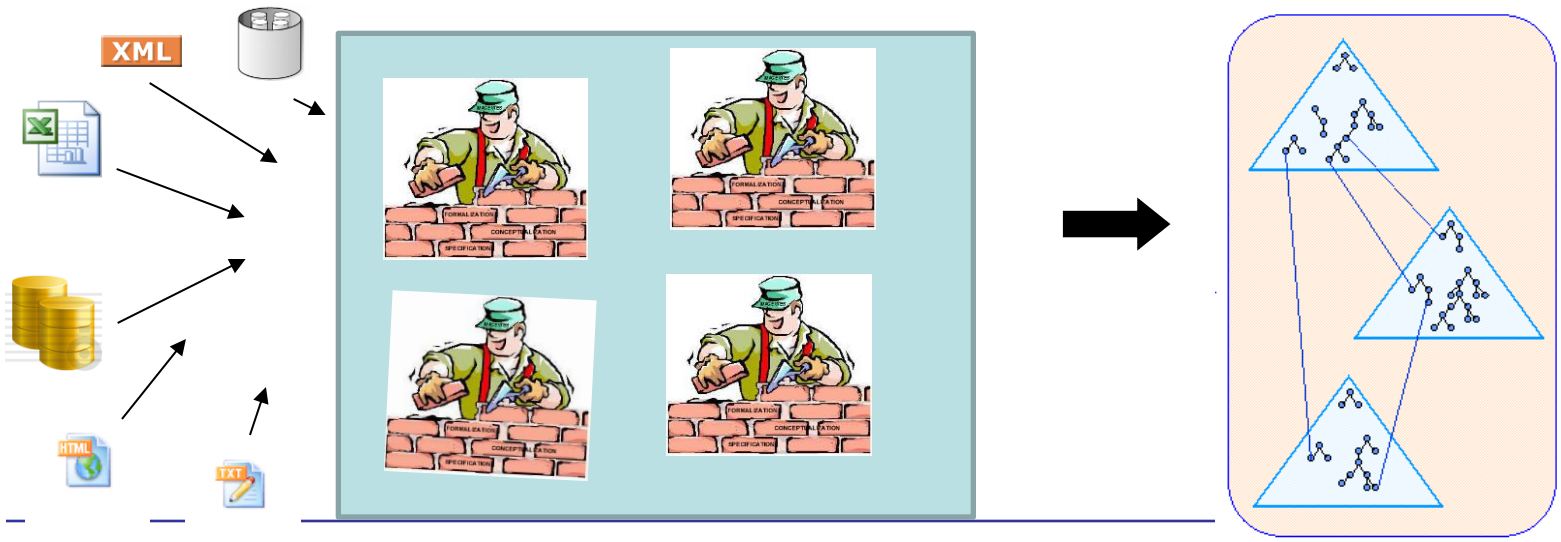
Ontology development

Methontology



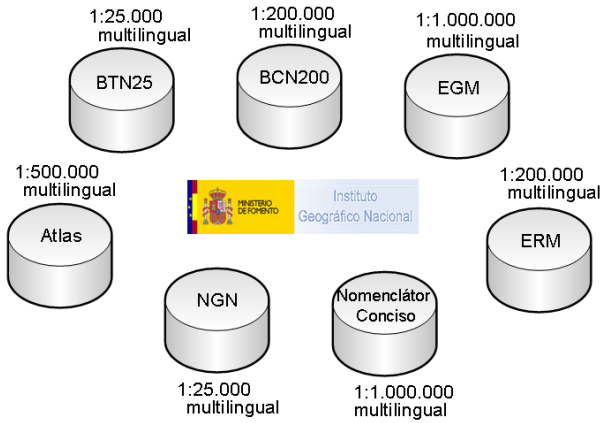
Current situation

- Reuse of knowledge-aware resources
- Ontologies are built collaboratively
- Ontologies are connected
- Multilingual features



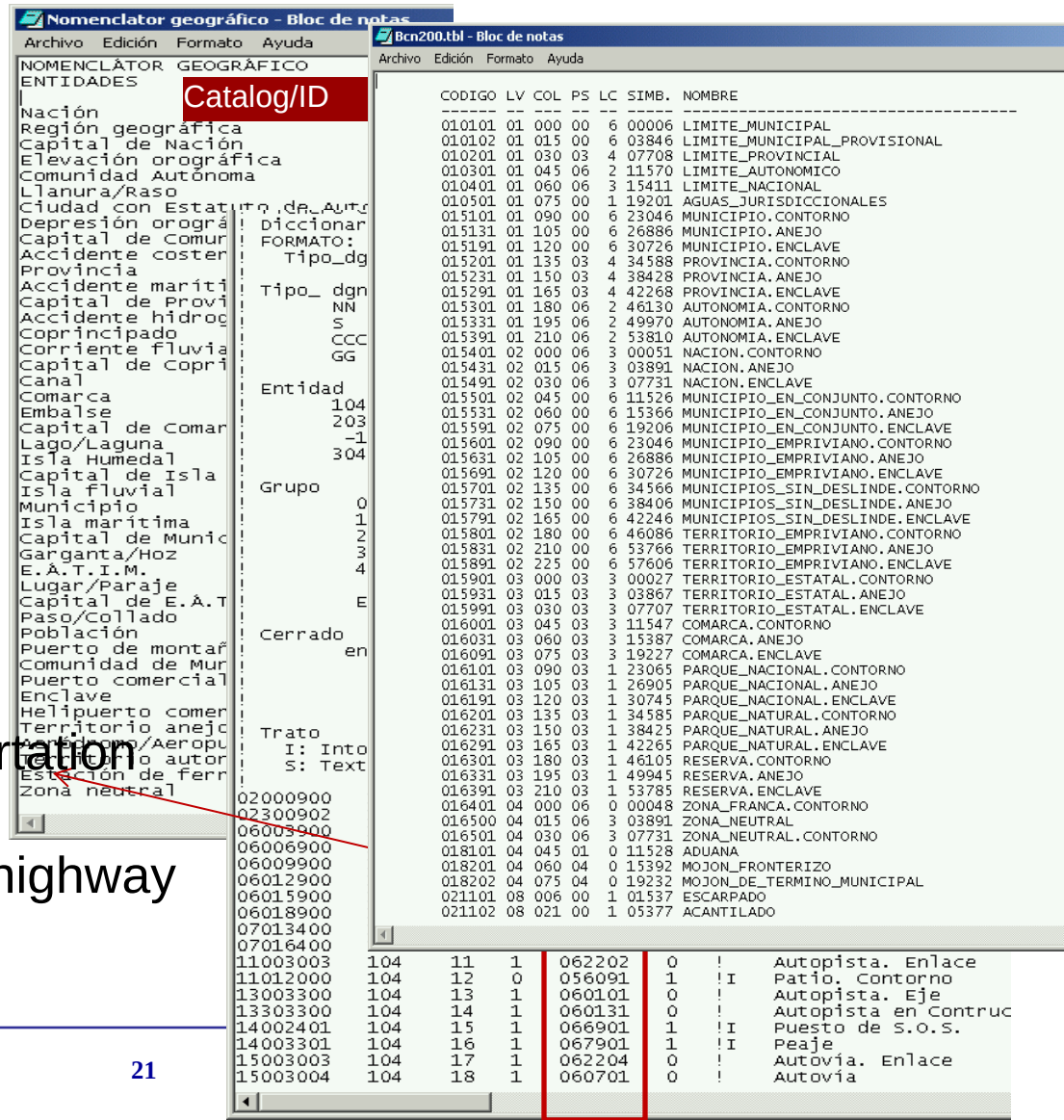
Where is the terminology?

DBs from a Geographical institute



Heterogeneity
.- Language
.- Terminology
.- Granularity

XX-YY-ZZ
02-01-02
02: transportation
01: road
02: 3-lines highway



Different Data Models with the same information

ID	CSI_Name
20000	Water area
20000.21000	Environmental area
20000.24020	Jurisdiction area
20000.22000	Fishing Statistical area
20000.21000.21001	Inland/marine
20000.21000.21002	Ocean
20000.21000.21003	North/South/Equatorial
20000.22000.22001	FAO statistical area
20000.22000.22002	Areal grid system

ID	CSI_Name	Parent
20000	Water area	
21000	Environmental area	20000
24020	Jurisdiction area	20000
22000	Fishing Statistical area	20000
21001	Inland/marine	21000
21002	Ocean	21000
21003	North/South/Equatorial	21000
22001	FAO statistical area	22000
22002	Areal grid system	22000

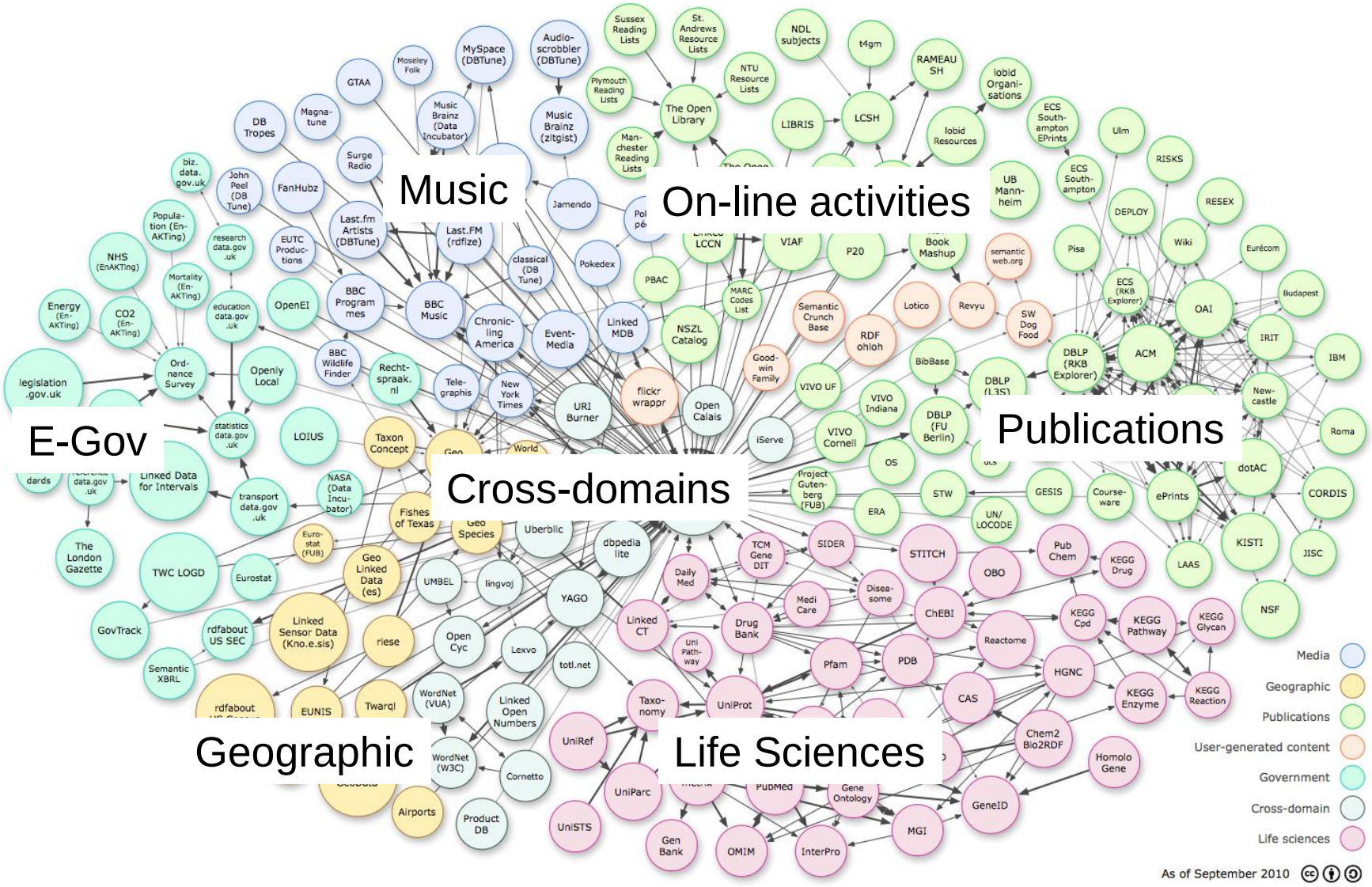
First Level	
ID	CSI_Name
20000	Water area

Second Level		
ID	First Level ID	CSI_Name
21000	20000	Environmental area
24020	20000	Jurisdiction area
22000	20000	Fishing Statistical area

Third Level		
ID	Second Level ID	CSI_Name
21001	21000	Inland/marine
21002	21000	Ocean
21003	21000	North/South/Equatorial
22001	22000	FAO statistical area
22002	22000	Areal grid system

First Level		Second Level		Third Level	
ID	CSI_Name	ID	CSI_Name	ID	CSI_Name
20000	Water area	21000	Environmental area	21001	Inland/marine
20000	Water area	21000	Environmental area	21002	Ocean
20000	Water area	21000	Environmental area	21003	North/South/Equatorial
20000	Water area	22000	Fishing Statistical area	22001	FAO statistical area
20000	Water area	22000	Fishing Statistical area	22002	Areal grid system
20000	Water area	24020	Jurisdiction area		

Lot of terminologies being used …



Tools for searching vocabularies

SchemaWeb

http://schemaweb.info

Swoogle
semantic web search
2007

http://swoogle.umbc.edu/

Linked Open Vocabularies

http://labs.mondeca.com/dataset/lov

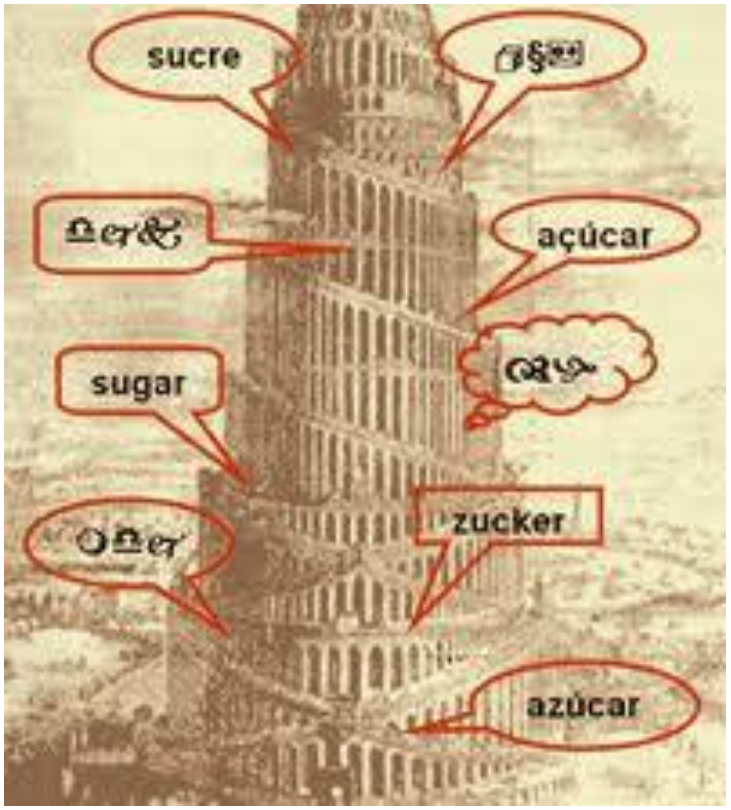
watson
exploring the semantic web

http://watson.kmi.open.ac.uk/WatsonWUI/

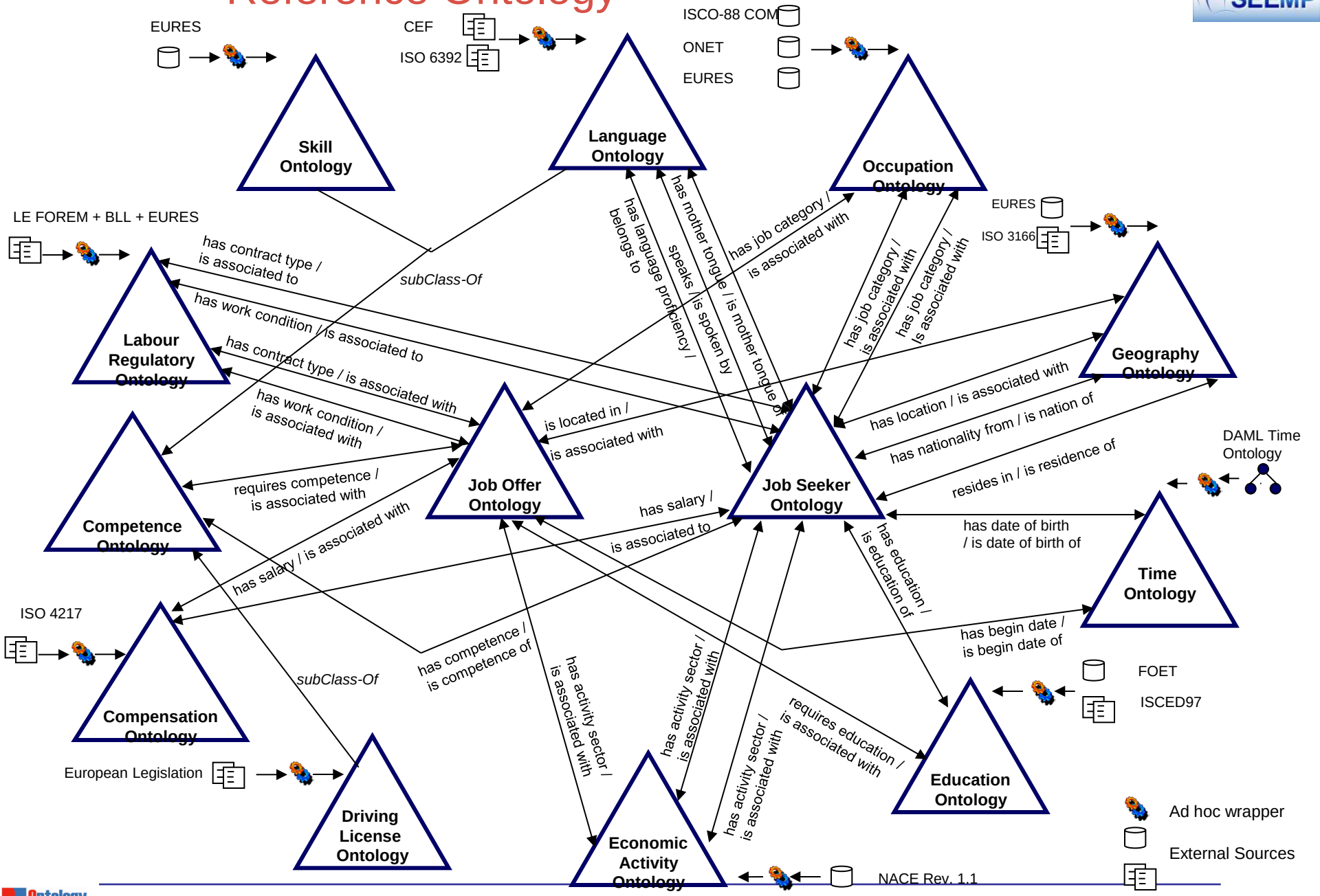
schema.org

Getting started with schema.org

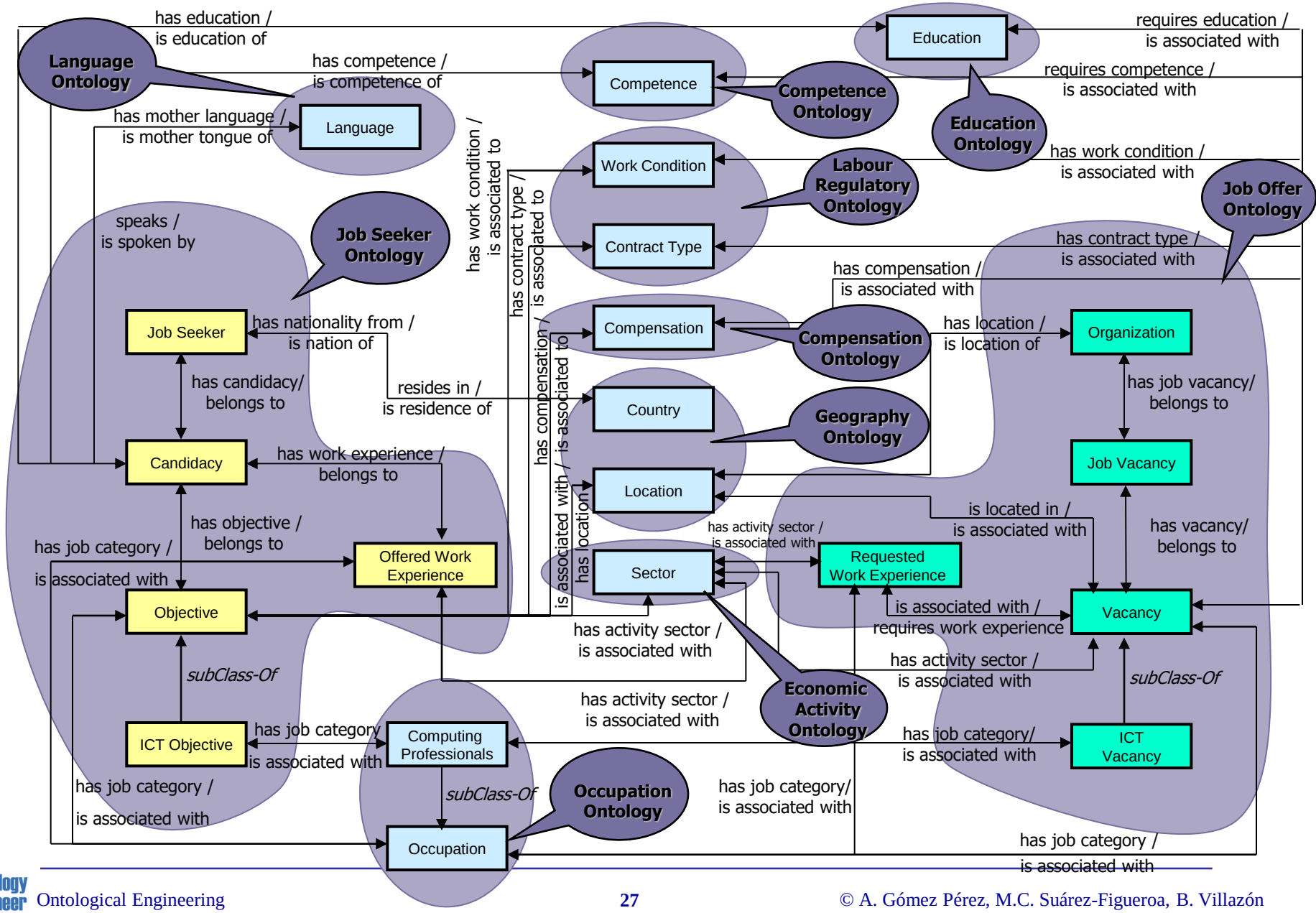
After some proces….



Reference Ontology



Details of the ontology



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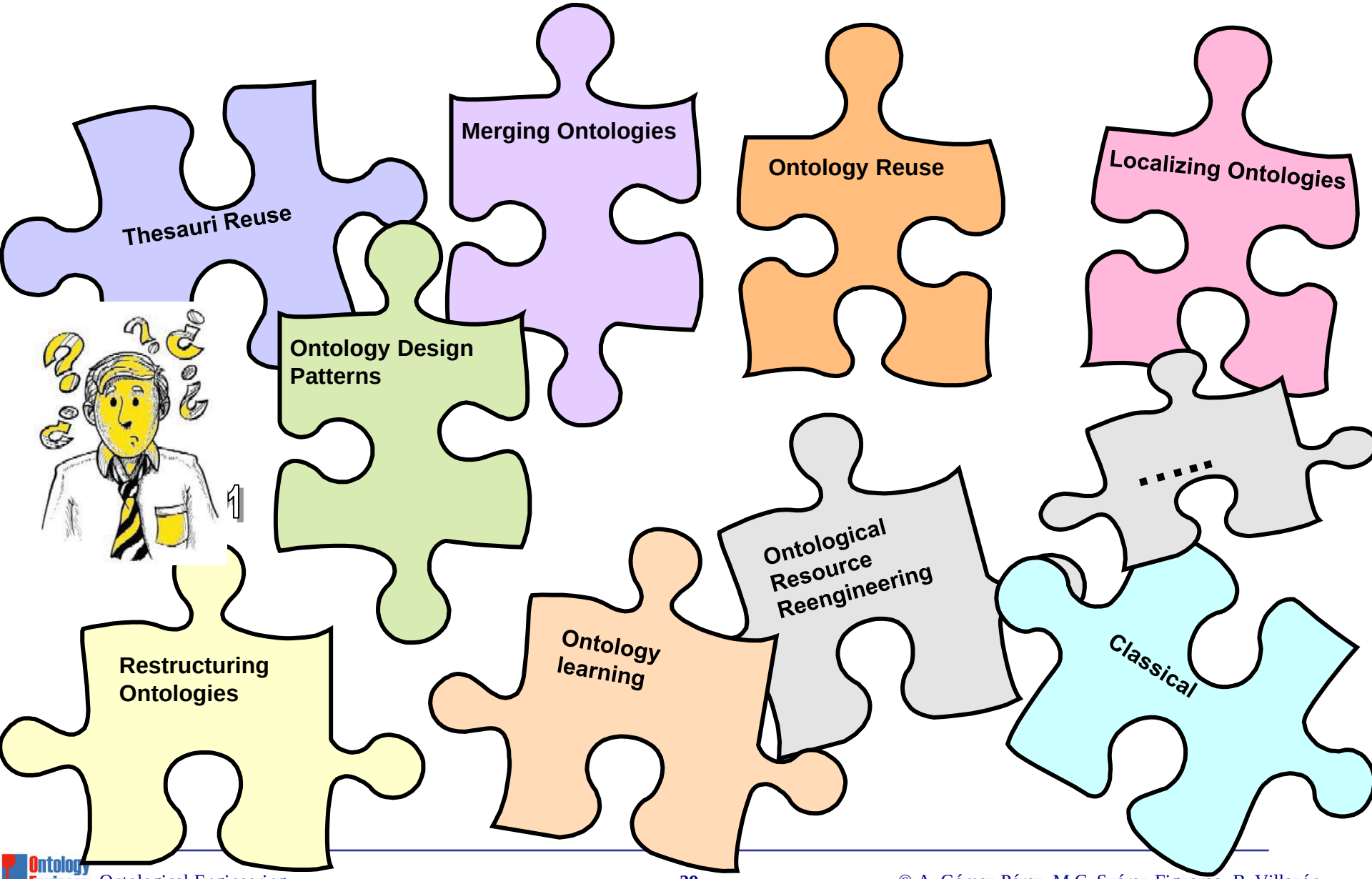
  - Creating the final Ontology Model

Too many activities…



Building Ontologies: Use Case

In our team, we want to build an OWL ontology in the pharmaceutical domain, but we want to use several pharmaceutical standards in XML and classification schemes in our own format.

Classical

Non Ontological Resource Reuse

Non Ontological Resource Reengineering

Building Ontologies: Use Case

In our team, we want to build an OWL ontology in fishery domain. We want to base on our ontolog about species and commodities, and we want have the ontolog several natural languages.

Classical

Ontological Resource Reuse

Ontological Resource Reengineering

Localizing Ontological Resources

Motivation

In our team, we want to build an ontology
human resources management domain.
ontology should include information ab
occupations and activity sectors, data must be k
in the original DBs, and we want to have
tology in seve atural languages.

Classical

Ontology

Mappings

Ontology-DB mapping

Ontological Resource Reuse

Re-engineering Non-ontological resources

Localizing Ontological Resources

Index

- **Introduction**
- Scenarios in Ontology Building
- The NeOn Methodology
  - Glossary of activities
  - Scenarios
  - Lifecycle models
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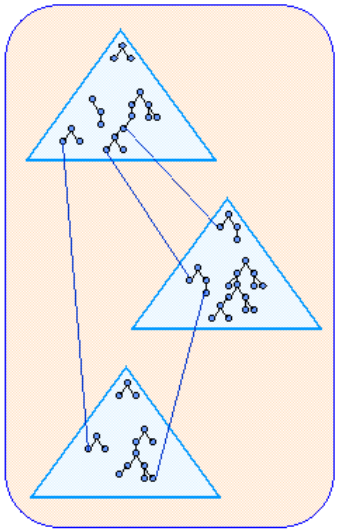
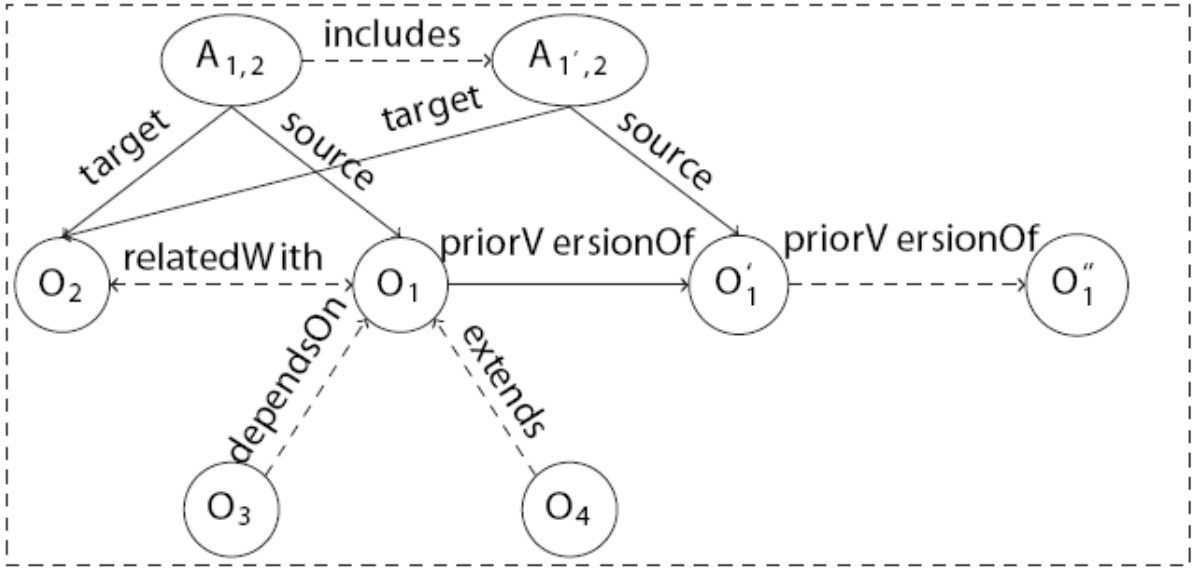
  - Methodological Guidelines for Ontology Specification
  - Quick Search of Existing Knowledge Resources
  - Guidelines for Ontology development project Planning
  - Methodological Guidelines for Non Ontological Resource Reuse and Reengineering
  - Methodological Guideliness for Ontology Reuse
  - Creating the final Ontology Model

Ontology Networks

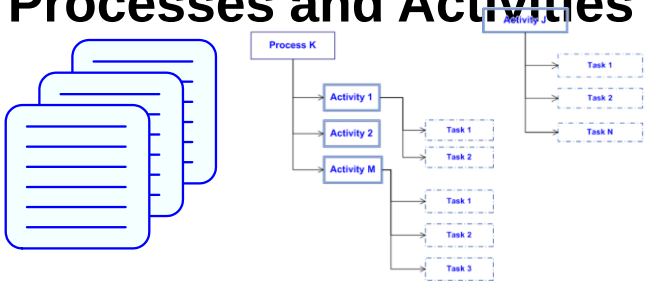
The Semantic Web of the future will be characterized by using a very large number of **ontologies embedded in ontology networks** built by distributed teams in a collaborative way.



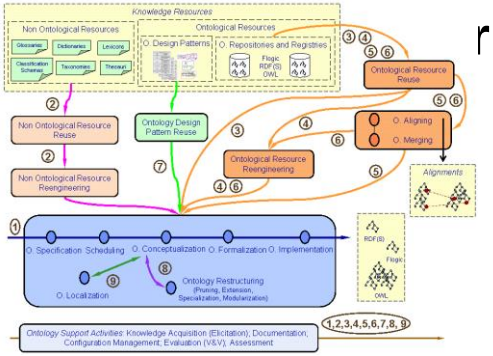


Framework: NeOn Methodology for Building Ontology Networks

NeOn Glossary of Processes and Activities



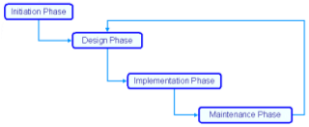
Scenarios for Building Ontology Networks



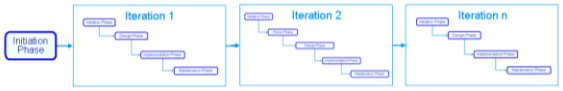
Scenario Description:
Assumptions
Prerequisite resources
Sequence of processes and activities
Main outcomes

Set of Ontology Network Life Cycle Models

Waterfall Model



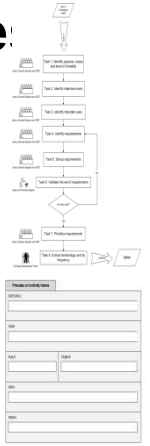
Iterative-Incremental Model



Methodological Guidelines

Process and Activity Description:
General Introduction
Filling Card
Workflow
Examples

Processes and Activities Covered:
- Ontology Requirements Specification
- Scheduling
- Reuse of General Ontologies
- Reuse of Domain Ontologies
- Reuse of Ontology Statements



The NeOn Glossary of Activities

- The *NeOn Glossary of Activities* identifies and defines 55 activities that are carried out when ontology networks are collaboratively built
- Published in the NeOn website
- Consensuated by *all NeOn* partners
- On-going procedure for getting feed-back from the community

NeOn Glossary of Activities

- Ontology Alignment / Aligning
- Ontology Articulation
- Ontology Assessment
- Ontology Combining
- Ontology Conceptualization
- Ontology Configuration Management
- Ontology Coordination
- Ontology Diagnosis
- Ontology Documentation
- Ontology Elicitation
- Ontology Enrichment
- Ontology Evaluation
- Ontology Evolution
- Ontology Extension
- Ontology Formalization
- Ontology Implementation
- Ontology Integration
- Knowledge Acquisition for Ontologies
- Ontology Learning
- Ontology Localization
- Ontology Mapping
- Ontology Matching
- Ontology Mediation

http://www.neon-project.org/

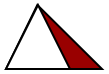
Activities for Building Ontologies

Conceptualize

Evaluate

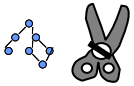
Specify Requirements

Extend

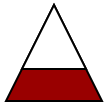


Import

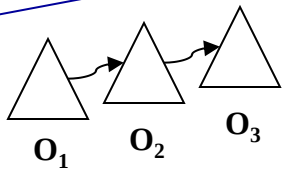
Prune



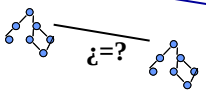
Specialize



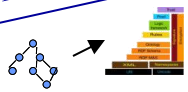
Evolution and Maintenance



Identify Differences

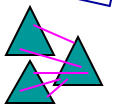


Export



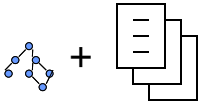
Integrate

Align

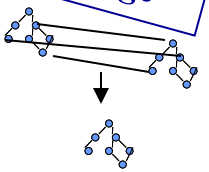


Reason

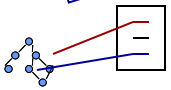
Document



Merge



Annotate



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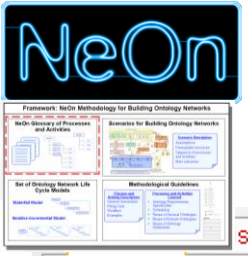


Some definitions

scussion | edit | history | protect | delete | move | watch | refresh

WP5WorkingArea: Knowledge Acquisition for Ontologies

- **Final Definition**: *Knowledge Acquisition for Ontologies* comprises activities for capturing knowledge (e.g., T-Box and A-Box) from a variety of sources. We distinguish between: **Ontology Elicitation**, **Ontology Learning** and **Ontology Population**.
- **Activity Group**: *Development*.

WP5WorkingArea: Ontology Elicitation

- **Final Definition**: *Ontology Elicitation* is a knowledge acquisition activity in which conceptual structures (e.g. T-Box) and their instances (e.g. A-Box) are acquired from domain experts.
- **Activity Group**: *Development*.

WP5WorkingArea: Ontology Learning

- **Final Definition**: *Ontology Learning* is a knowledge acquisition activity that relies on (semi-) automatic methods to transform unstructured (e.g. corpora), semi-structured (e.g. folksonomies, html pages, etc.) and structured data sources (e.g. data bases) into conceptual structures (e.g. T-Box).
- **Activity Group**: *Development*.

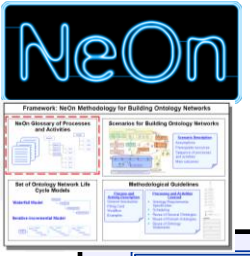
WP5WorkingArea: Ontology Population

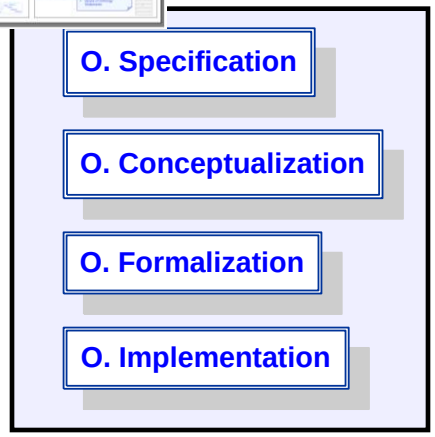
(Redirected from WP5WorkingArea: Ontology Population/Grounding)

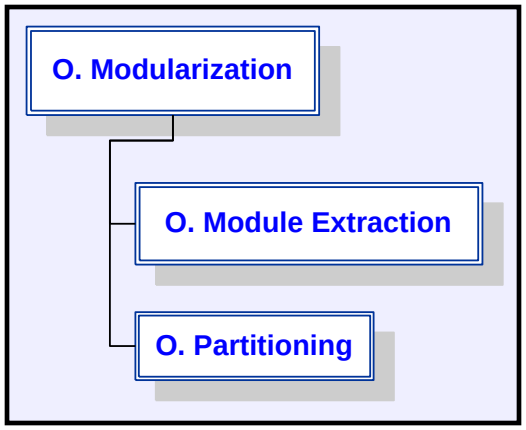
- **Final Definition**: *Ontology Population* is a knowledge acquisition activity that relies on (semi-) automatic methods to transform unstructured (e.g. corpora), semi-structured (e.g. folksonomies, html pages, etc.) and structured data sources (e.g. data bases) into instance data (e.g. A-Box).
- **Activity Group**: *Development*.

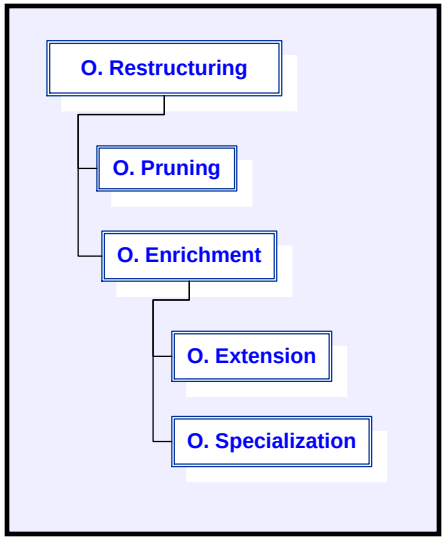
http://www.neon-project.org/wiki/index.php?title=WP5D5.3.1#NeOn_Glossary_of_Activities

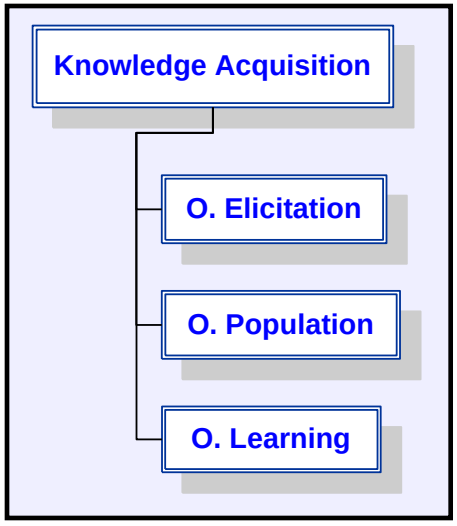
Relating Activities

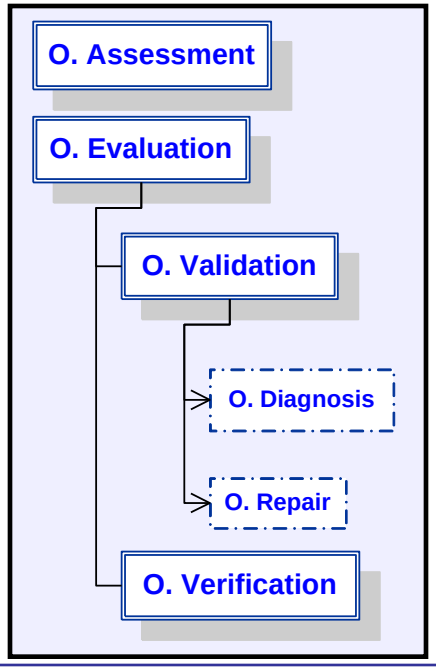


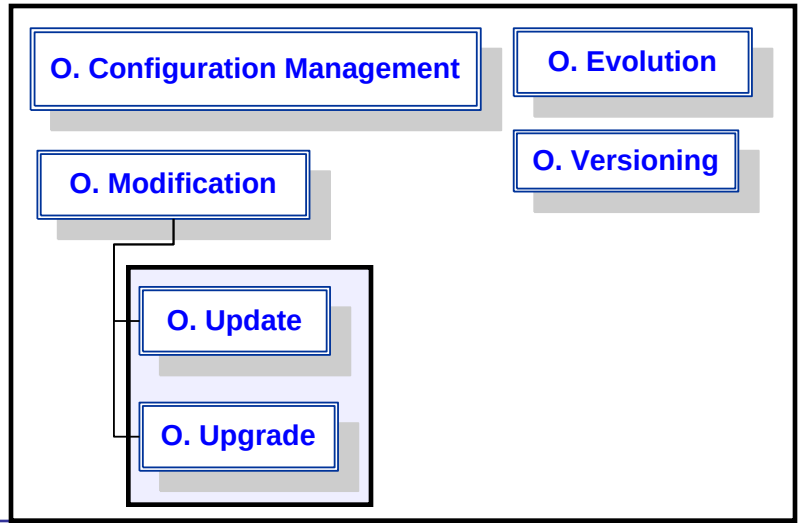












“Recommended and If-Applicable” Activities

- For each activity included in the NeOn Glossary of Activities, the table identifies which activities are required and which activities are optional (can be carried out or not, depending on the case)during the ontology network building process.

	Required	*If Applicable*
Ontology Conceptualization	X	
Ontology Evaluation	X	
Ontology Integration	X	
Knowledge Acquisition for Ontologies	X	
Ontology Learning		X
Ontology Localization		X
Ontology Matching		X
Ontology Search	X	
Ontology Specification	X	

NeOn Scenarios

D5.3.1

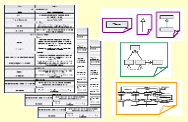
Knowledge Resources

Non Ontological Resources

Glossaries | Dictionaries | Lexicons | Classification Schemas | Taxonomies | Thesauri

Ontological Resources

O. Design Patterns



O. Repositories and Registries

Flogic
RDF(S)
OWL

Ontological Resource Reuse

Non Ontological Resource Reuse

Ontology Design Pattern Reuse

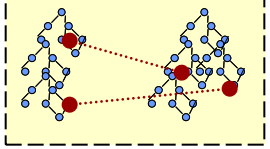
O. Aligning

O. Merging

Ontological Resource Reengineering

Non Ontological Resource Reengineering

Alignments



RDF(S)

Flogic

OWL

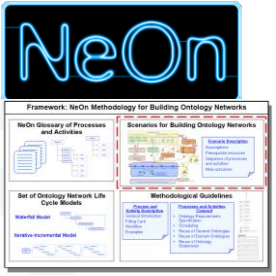
O. Specification | O. Conceptualization | O. Formalization | O. Implementation

O. Localization

Ontology Restructuring
(Pruning, Extension, Specialization, Modularization)

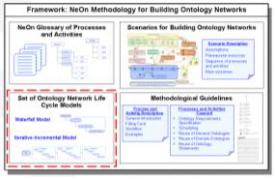
1,2,3,4,5,6,7,8, 9

Ontology Support Activities: Knowledge Acquisition (Elicitation); Documentation; Configuration Management; Evaluation (V&V); Assessment



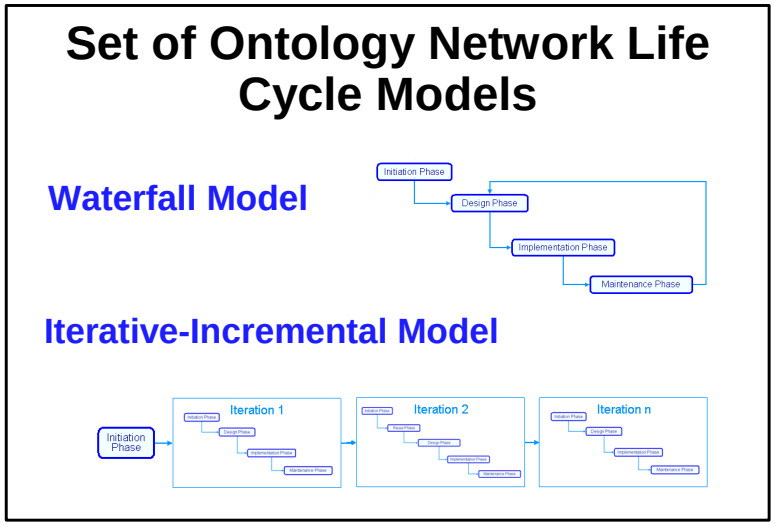
Scenarios

1. Building ontology networks from scratch without reusing existing resources.
2. Building ontology networks by reusing and reengineering non ontological resources.
3. Building ontology networks by reusing ontologies or ontology modules.
4. Building ontology networks by reusing and reengineering ontologies or ontology modules.
5. Building ontology networks by reusing and merging ontology or ontology modules.
6. Building ontology networks by reusing, merging and reengineering ontologies or ontology modules.
7. Building ontology networks by reusing ontology design patterns.
8. Building ontology networks by restructuring ontologies or ontology modules.
9. Building ontology networks by localizing ontologies or ontology modules.

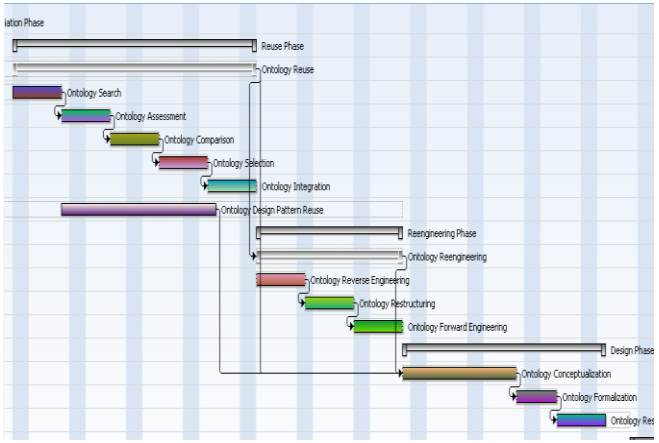


Life Cycle Models for Ontology Networks

- **Ontology network life cycle model**: a model to describe how to develop (and maintain) an ontology network project.



- The **ontology life cycle** is the specific sequence of activities that the ontology practitioners carry out for developing an ontology.



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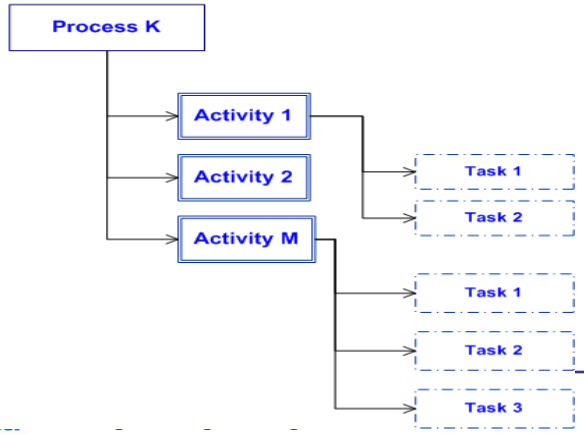
NeOn Methodology

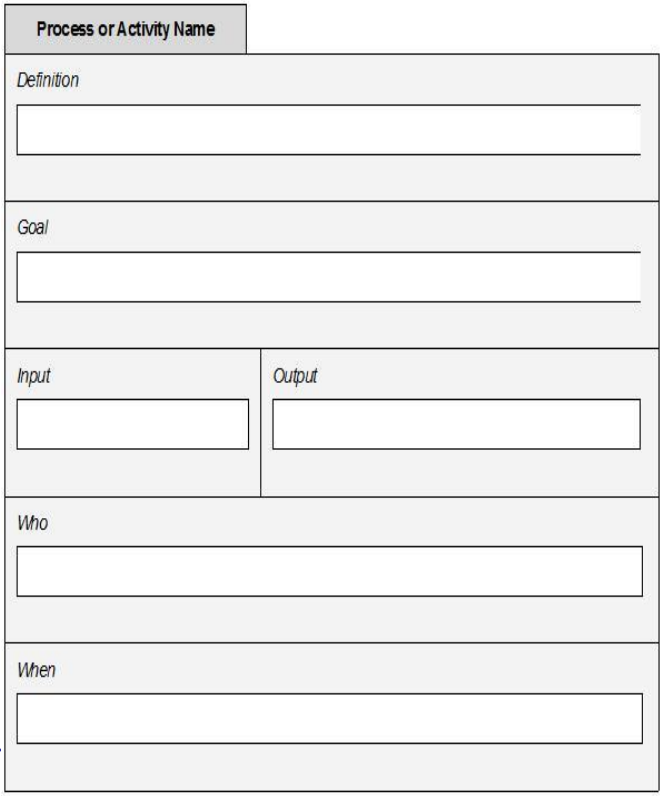
Process and activities covered:

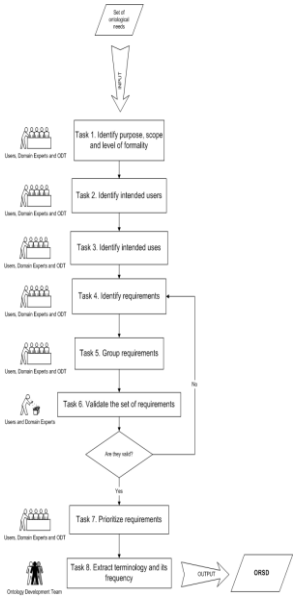
- Ontology Specification
- Scheduling
- Non Ontological Resource Reuse
- Non Ontological Resource Reengineering
- Reuse General Ontologies
- Reuse Domain Ontologies
- Reuse Ontology Statements
- Reuse Ontology Design Patterns



All processes and activities are described with:

- A filling card
- A workflow
- Examples





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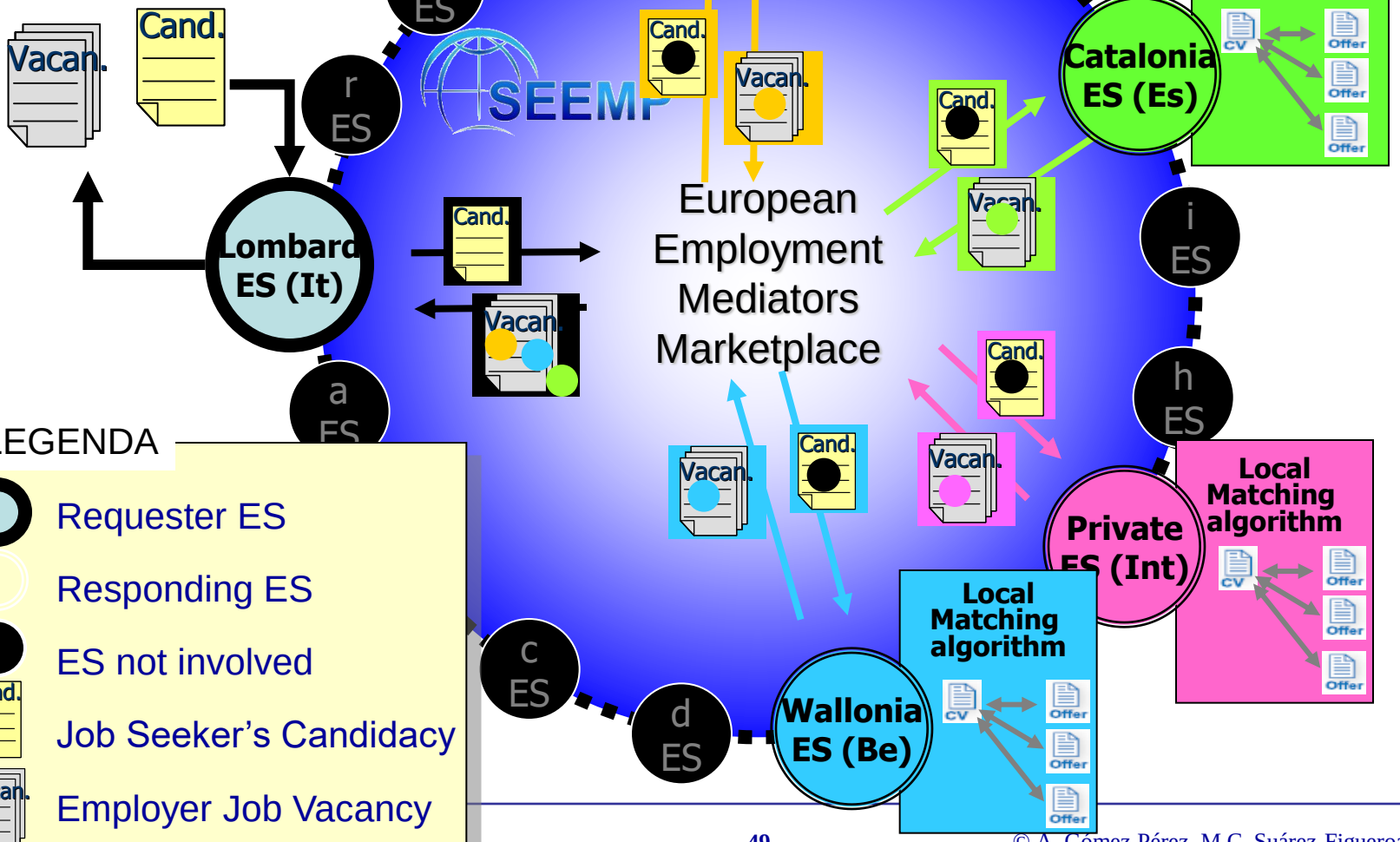
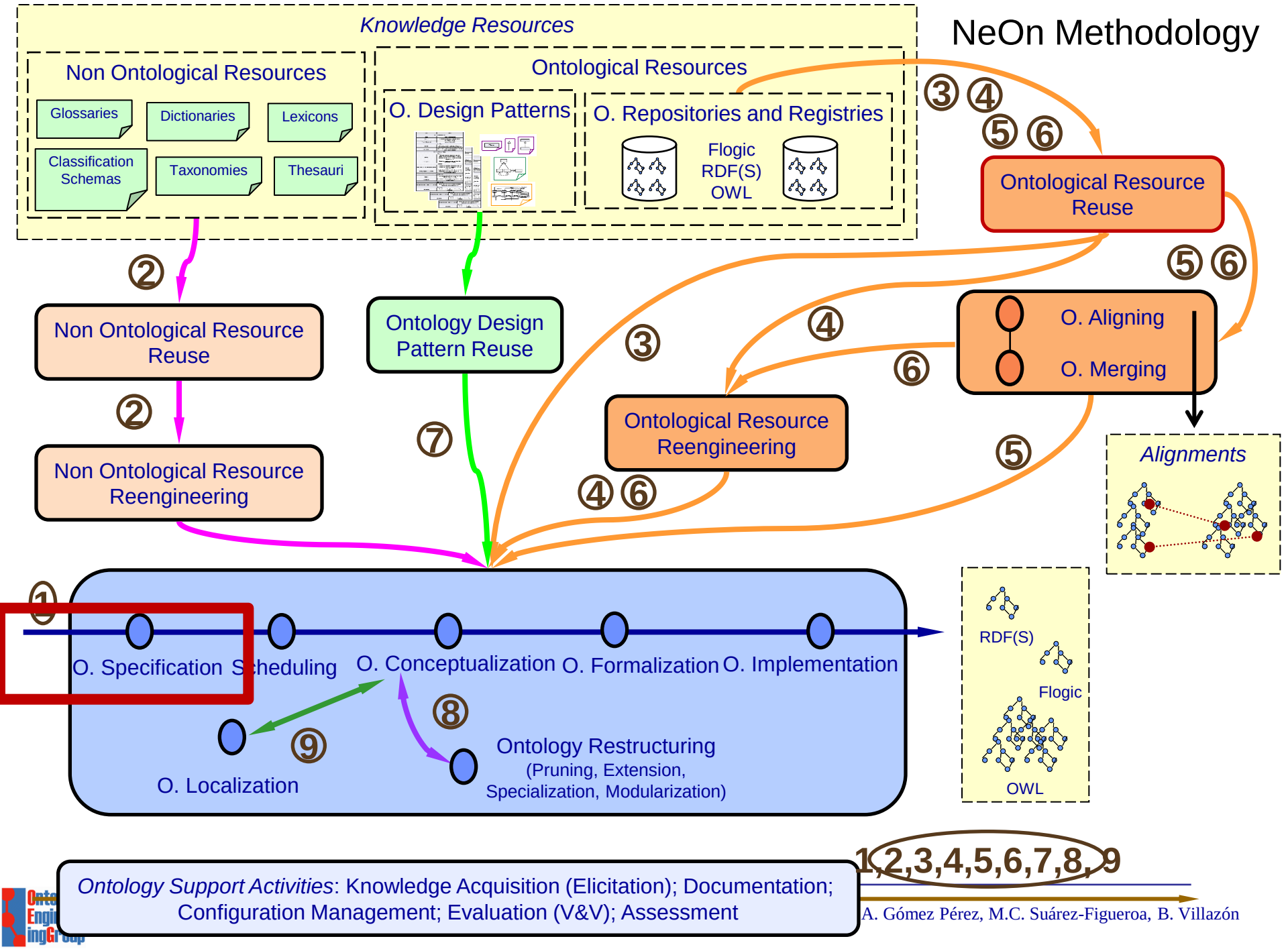
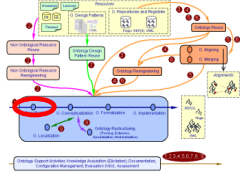
Helping Job Seekers on their way



NeOn Methodology



Ontology Requirement Specification



Ontology Specification

Definition

Ontology Specification refers to the activity of collecting the requirements that the ontology should fulfill, e.g. reasons to build the ontology, target group, intended uses, possibly reached through a consensus process.

Goal

The specification activity states why the ontology is being built, what its intended uses are, who the end-users are, and what the requirements the ontology should fulfill are.

Input

A set of ontological needs.

Output

Ontology Requirements Specification Document (ORSD).

Who

Software developers and ontology practitioners, who form the ontology development team (ODT), in collaboration with users and domain experts.

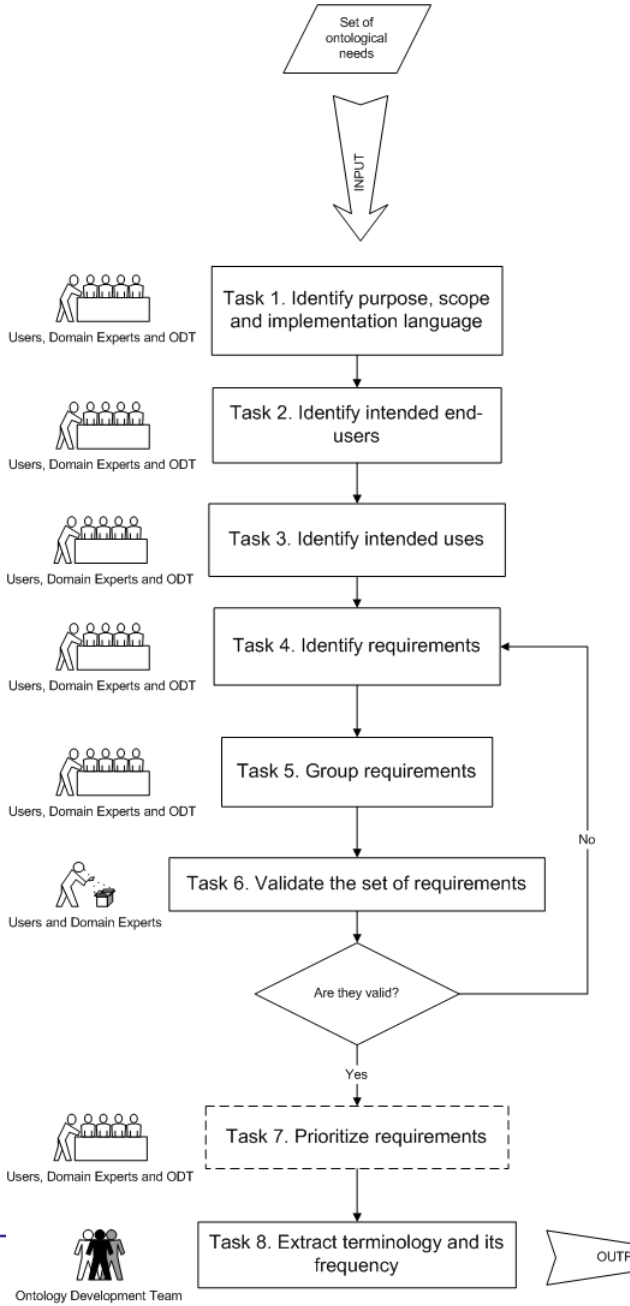
When

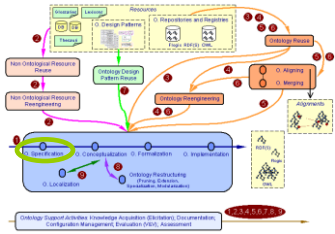
This activity must be carried out in parallel with the knowledge acquisition activity.

Competency Questions (CQs) are questions that the ontology to be built should be able to answer.

- CQs in natural language
- CQs in SPARQL

Ontology Requirements Specification. Tasks

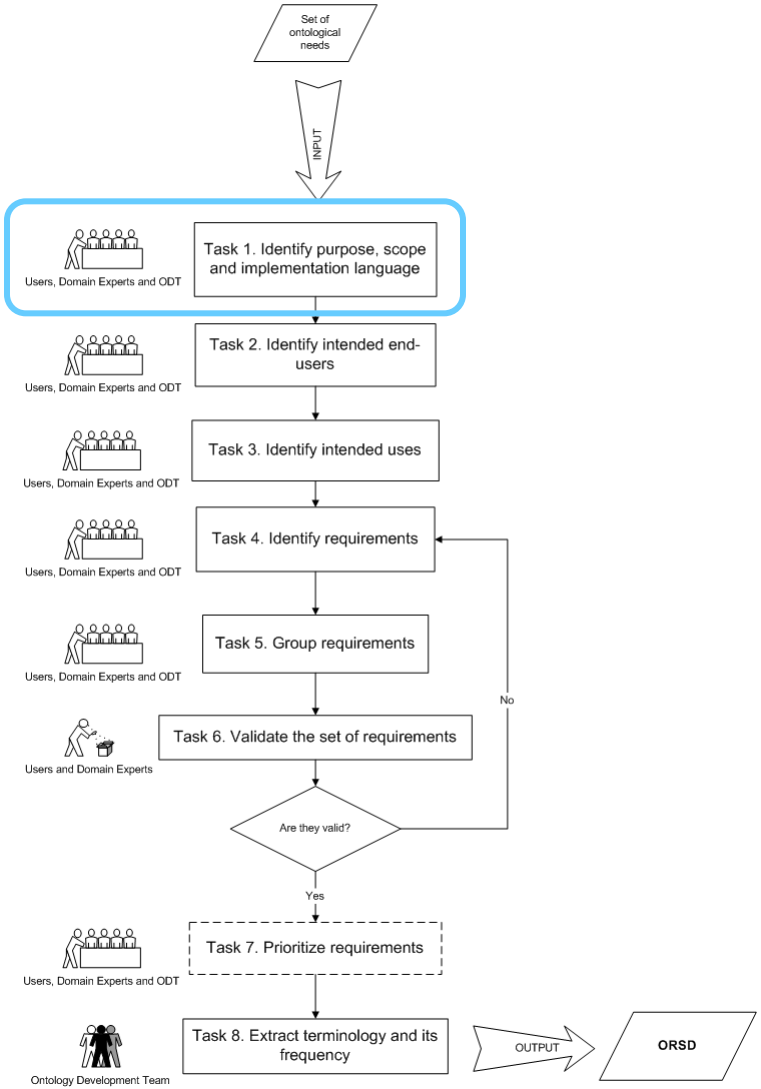




Ontology Requirements Specification Document. Template

Ontology Requirements Specification Document Template	
1	**Purpose**
	The main general goal of the ontology. In other words, the main function or role that the ontology should have.
2	**Scope**
	The general coverage and the degree of detail that the ontology should have.
3	**Implementation Language**
	The formal language that the ontology should have.
4	**Intended End-Users**
	The intended end-users expected for the ontology.
5	**Intended Uses**
	The intended uses expected for the ontology.
6	**Ontology Requirements**
	a. Non-Functional Requirements
	The general requirements or aspects that the ontology should fulfil, including optionally priorities for each requirement.
	b. Functional Requirements: Groups of Competency Questions
	The content specific requirements that the ontology should fulfil, in the form of groups of competency questions and their answers, including optionally priorities for each group and for each competency question.
7	**Pre-Glossary of Terms**
	a. Terms from Competency Questions
	The list of terms included in the competency questions and their frequencies.
	b. Terms from Answers
	The list of terms included in the answers and their frequencies.
	c. Objects
	The list of objects included in the competency questions and in their answers.

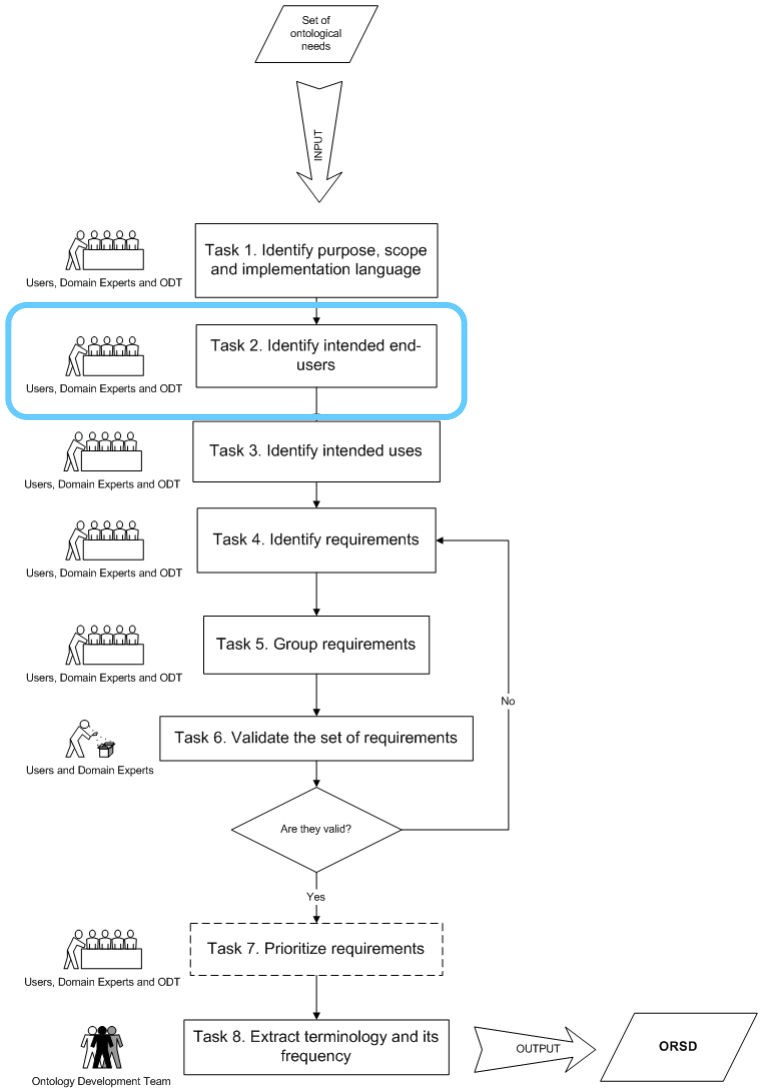
Ontology Requirements Specification. Task 1



- Input: a set of ontological needs
- Objective: obtaining the **purpose, scope and formality level of the ontology**
- Techniques: physical or virtual interviewers
- Output: purpose, scope and level of formality of the ontology, which will be included in the corresponding slots of the OSRD template

	SEEMP Reference Ontology Requirements Specification Document
1	**Purpose**
	The purpose of building the Reference Ontology is to provide a consensual knowledge model of the employment domain that can be used by public e-Employment services.
2	**Scope**
	The ontology has to focus just on the ICT (Information and Communication Technology) domain. The level of granularity is directly related to the competency questions and terms identified.
3	**Implementation Language**
	The ontology has to be implemented in WSML language.

Ontology Requirements Specification. Ta
2



- Input: a set of ontological needs
- Objective: identifying the **intended end-users**
- Techniques: physical or virtual interviewers
- Output: a list with the intended users, which will be included in the corresponding slot of the OSRD template

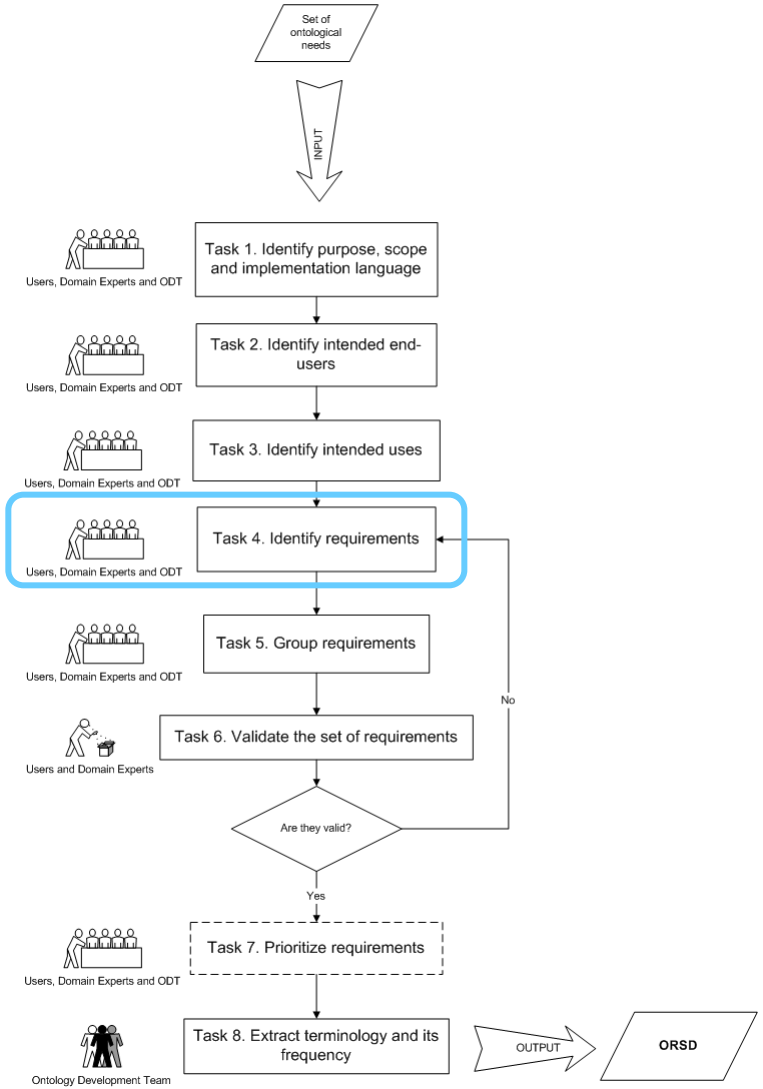
4	Intended End-Users	
	User 1.	Candidate who is unemployed and searching for a job or searching another occupation for immediate or future purposes
	User 2.	Employer who needs more human resources.
	User 3.	Public or private employment search service which offers services to gather CVs or job postings and to prepare some data and statistics.
	User 4.	National and Local Governments which want to analyze the situation on the employment market in their countries and prepare documents on employment, social and educational policy.
	User 5.	European Commission and the governments of EU countries which want to analyze the statistics and prepare international agreements and documents on the employment, social and educational policy.

Ontology Requirements Specification. Task 3

- Input: a set of ontological needs
- Objective: identifying the **intended uses**
- Techniques: physical or virtual interviewers between them
- Output: a list of intended uses in the form of scenarios. The scenarios can be described in natural language or expressed in UML as use cases. The list of scenarios will be included in the corresponding slot of the OSRD template.

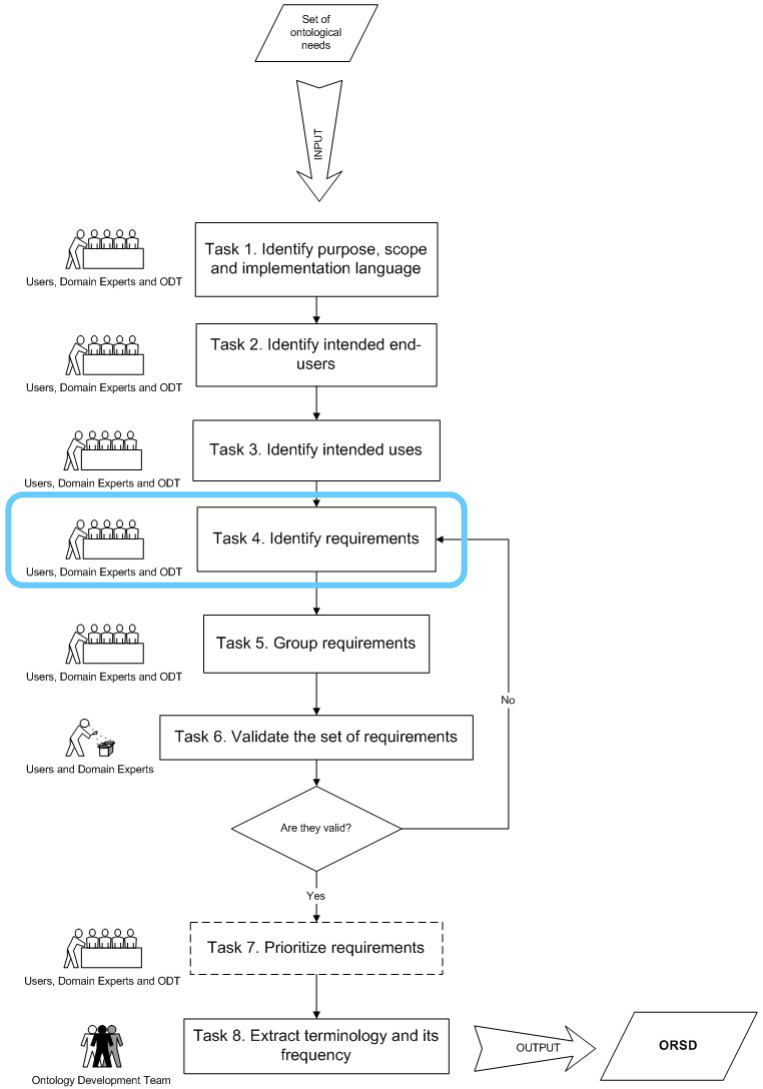
5	**Intended Uses**
Use 1.	Publish CV. Job seeker places his/her CV on the PES Portal.
Use 2.	Publish Job Offer. An Employer places a Job Offer on the PES Portal.
Use 3.	Search for Job Offers. The Employer looks for candidates for the Job Offer through PES Portal.
Use 4.	Search for Employment information. Job Seeker looks for of general information about employment in a given location at the PES Portal.
Use 5.	Provide Job Statistics. The PES Portal provides employment statistics to the Job Seeker and Employer.

Ontology Requirements Specification. Task 4 (I)



- *Input*: a set of ontological needs
- *Objective*: identifying the set of **ontology requirements that the ontology should satisfy**
  - ***Non-functional ontology requirements*** refer to the characteristics, qualities, or general aspects not related to the ontology content that the ontology should satisfy
  - ***Functional ontology requirements***, which can be also seen as content specific requirements, refer to the particular knowledge to be represented by the ontology
- *Techniques*: interview users and domain experts. For functional ontology requirements → writing the requirements in Natural Language in the form of the so-called **competency questions (CQs)**
- *Tools*: mind map tools, excel, and collaborative tools (e.g., Cicero)
- *Output*: (1) a list of non-functional ontology requirements written in natural language; and (2) a list functional ontology requirements in the form of CQs and their associated answers

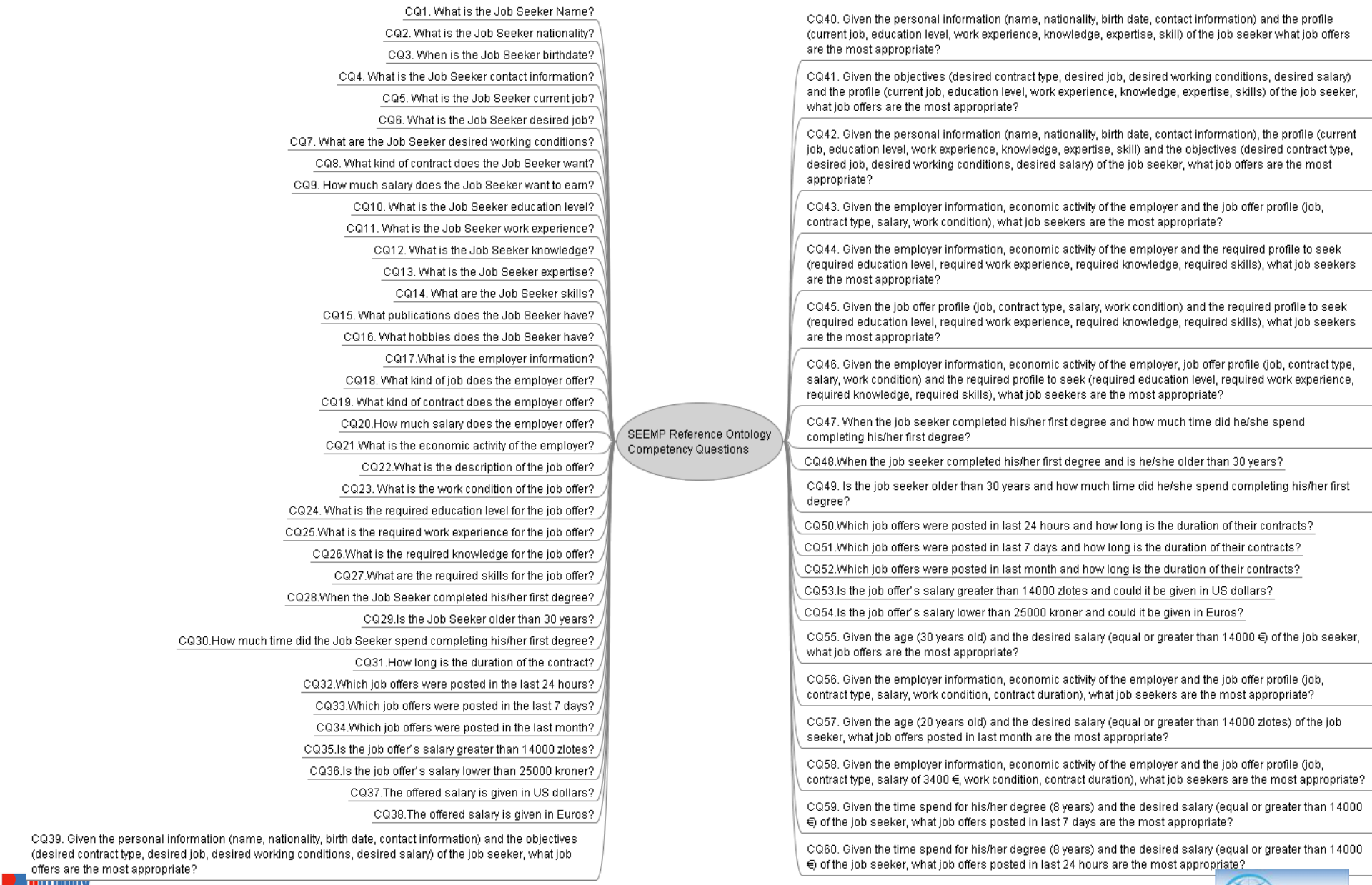
Ontology Requirements Specification. Task 4 (II)



- *Approaches*:
  - Top-Down: Complex questions are decomposed in simple ones.
  - Bottom-Up: Simple questions that are organised to form complex ones.
  - Middle out: Mix approach between top-down and bottom-up.

6	**Ontology Requirements**
	a. Non-Functional Requirements
	NFR1. The ontology must support a multilingual scenario in the following languages: English, Spanish, Italian, and French. NFR2. The ontology must be based on the international, European or de-facto standards in existence or under development.

Task 4. Identify requirements: Functional requirements

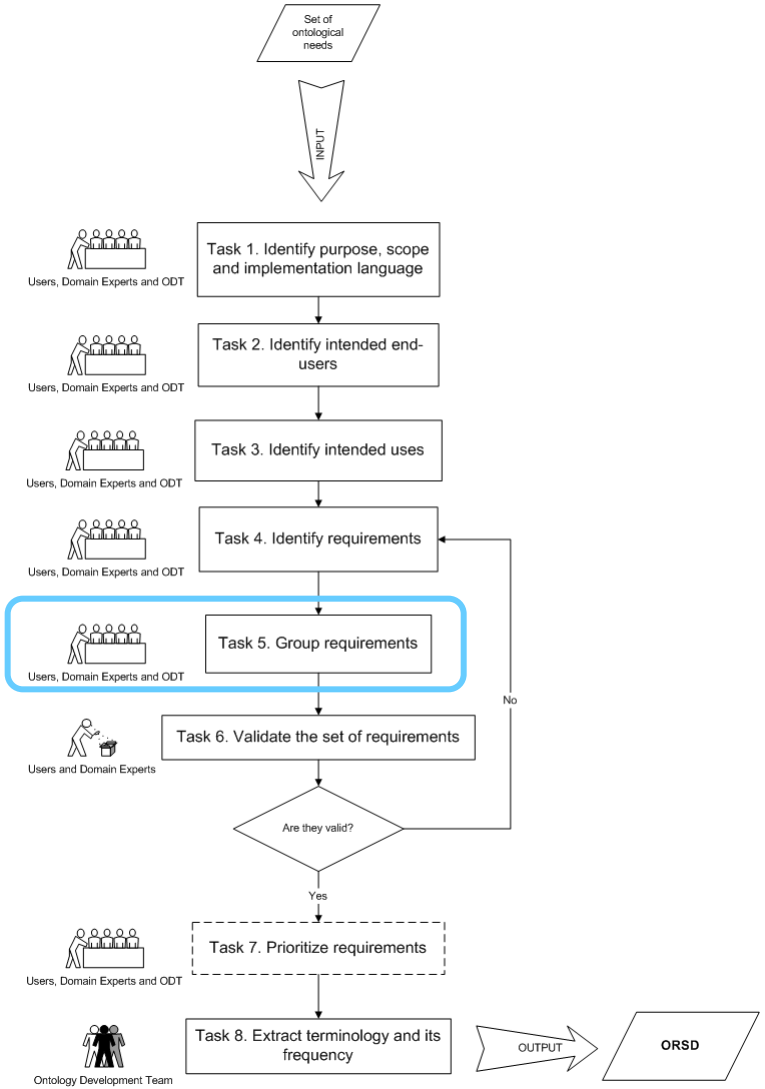


Task 4. Identify requirements. SEEMP Example

	A	B	C
1	N	Competency Questions	Answers
2	CQ1	What is the Job Seeker Name?	Lewis Hamilton
3	CQ2	What is the Job Seeker nationality?	British; Spanish; Italian; French; German
4	CQ3	When is the Job Seeker birthdate?	13/09/1984; 30/03/1970; 15/04/1978
5	CQ4	What is the Job Seeker contact information?	
6	CQ5	What is the Job Seeker current job?	Programmer; Computer Engineer; Computer Assistant
7	CQ6	What is the Job Seeker desired job?	Radio engineer; Hardware designer; Software Engineer
8	CQ7	What are the Job Seeker desired working conditions?	Autonomous; Seasonal Job; Traineeship;Consultant
9	CQ8	What kind of contract does the Job Seeker want?	
10	CQ9	How much salary does the Job Seeker want to earn?	
11	CQ10	What is the Job Seeker education level?	Basic education; Higher education/University
12	CQ11	What is the Job Seeker work experience?	3 months, 6 months, 1 year, 2, years, 3 years
13	CQ12	What is the Job Seeker knowledge?	
14	CQ13	What is the Job Seeker expertise?	
15	CQ14	What are the Job Seeker skills?	SQL programming, network administration
16	CQ15	What publications does the Job Seeker have?	
17	CQ16	What hobbies does the Job Seeker have?	
18	CQ17	What is the employer information?	CEFRIEL Research Company, Milano, Italy
19	CQ18	What kind of job does the employer offer?	Java Programmer; C Programmer, Database administration
20	CQ19	What kind of contract does the employer offer?	
21	CQ20	How much salary does the employer offer?	3500 euros, 3000 USD, 2000 euros
22	CQ21	What is the economic activity of the employer?	Research; Financial; Education; Industrial
23	CQ22	What is the description of the job offer?	Sun Certified Java Programmer
24	CQ23	What is the work condition of the job offer?	Full time; Partial time; Autonomous; Seasonal Job;
25	CQ24	What is the required education level for the job offer?	Basic education; Higher education/University
26	CQ25	What is the required work experience for the job offer?	1 year, 2 years, 3 years, 4 yerars, 5 or more years
27	CQ26	What is the required knowledge for the job offer?	Java, Object oriented design, Haskell, Windows
28	CQ27	What are the required skills for the job offer?	ASP Programmer, Data warehouse, Hardware programming
29	CQ28	When the Job Seeker completed his/her first degree?	2001; March 1999; 23/10/1970
30	CQ29	Is the Job Seeker older than 30 years?	
31	CQ30	How much time did the Job Seeker spend completing his/her first degree?	4 years, 6 years, 7 years and 6 months
32	CQ31	How long is the duration of the contract?	1 month, 6 months, 1 year, 2 years, 3 years
33	CQ32	Which job offers were posted in the last 24 hours?	
34	CQ33	Which job offers were posted in the last 7 days?	
35	CQ34	Which job offers were posted in the last month?	

Competency Questions

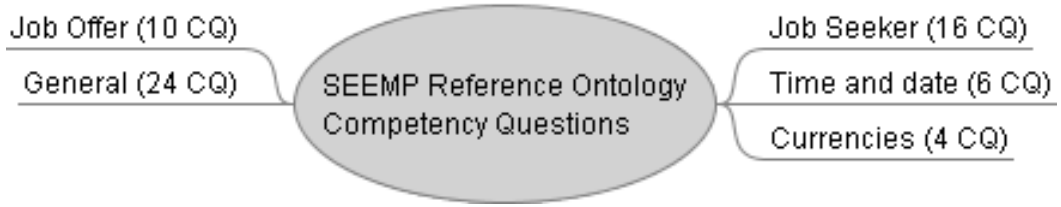
Ontology Requirements Specification. Task 5

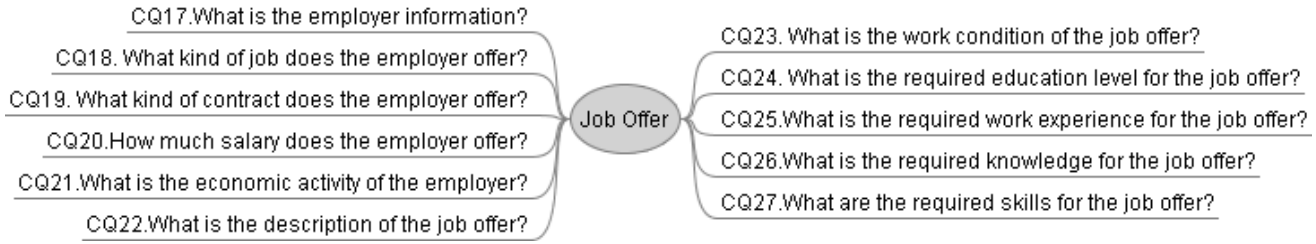


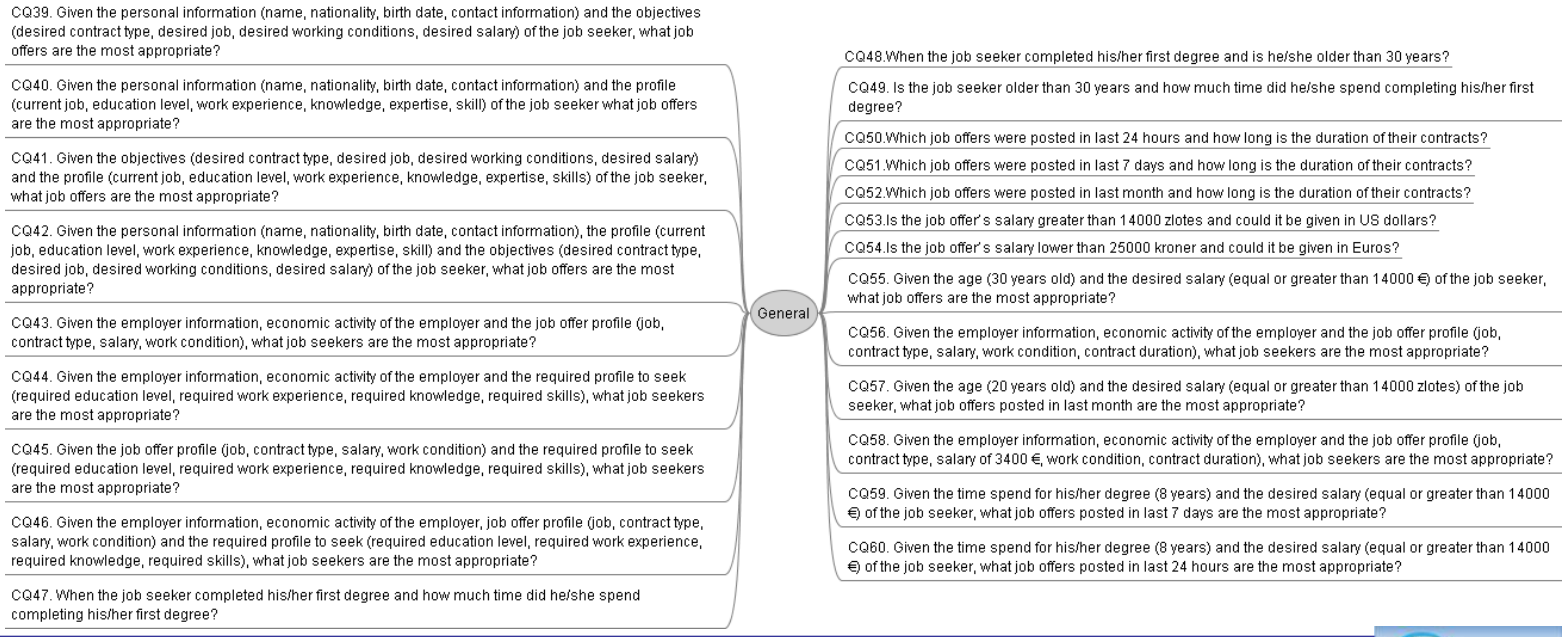
- *Input*: the list of CQs
- *Objective*: obtaining different **groups of CQs**
- *Techniques*: Card Sorting, when the grouping is done manually, and Clustering NL sentences or Information Extraction when the grouping is done automatically
- *Tools*: MindMap Tools or Cicero Tool (for distributed teams)
- *Output*: a set of groups including CQs

- *Hybrid approach*:
  - The analysis of the frequency of terms and the grouping of CQs based on those terms that have a higher frequency.
  - The use of pre-established categories, such as time and date, units of measure, currencies, location, languages, etc.

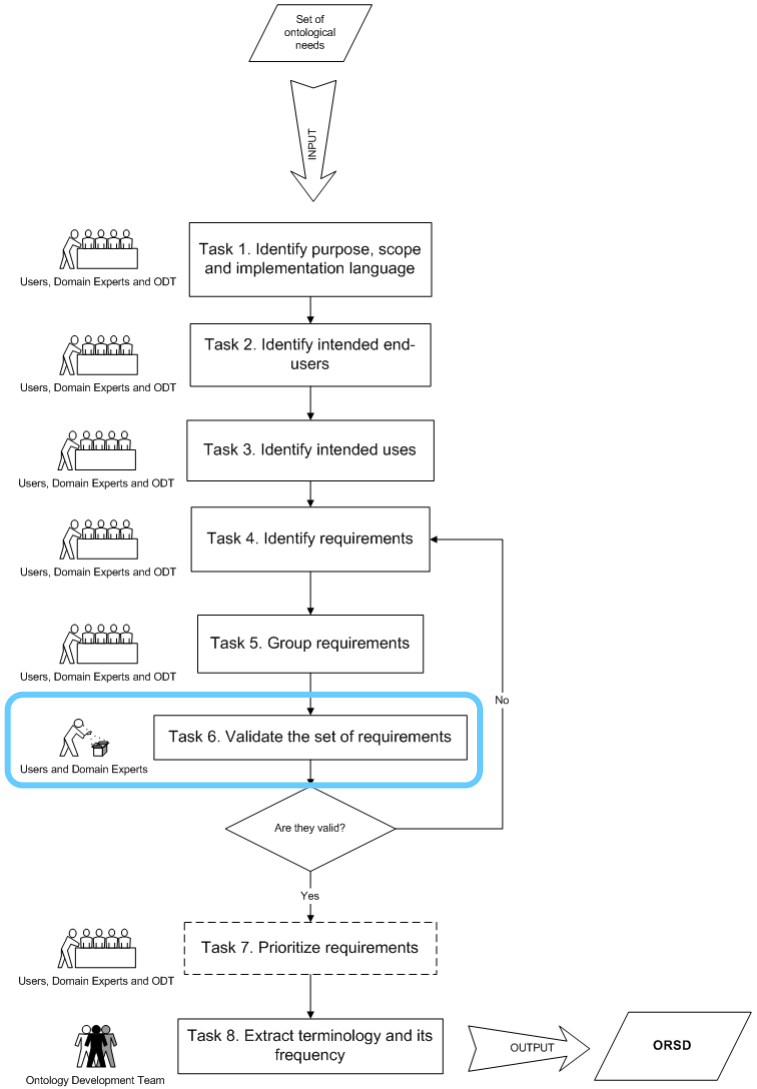
Task 5. Group requirements (CQs)







Ontology Requirements Specification. Task 6



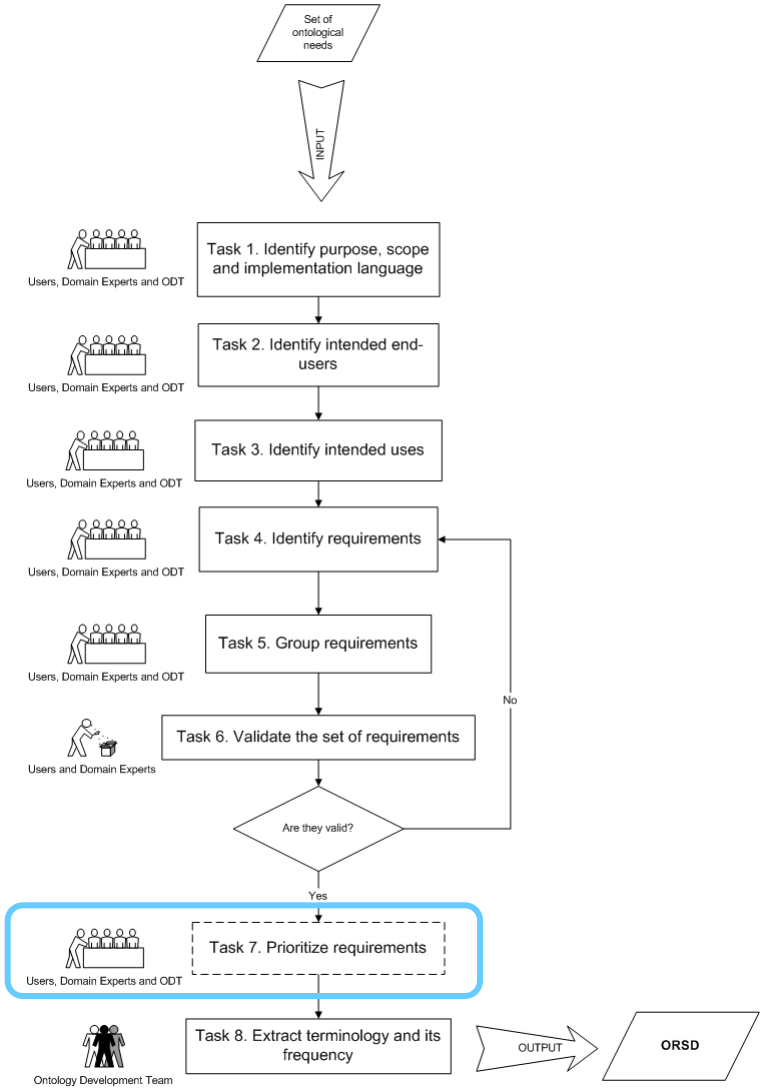
- *Input*: the set of grouped CQs
- *Objective*: to identify possible conflicts between CQs, missing CQs, and contradictions in CQs. To decide **if such CQs are valid or not**
- *Output*: a confirmation about the validity of the set of CQs
- *Criteria*:

Correctness.
Consistent.
Understandable.
Conciseness.
Modifiable.
Traceable.
Completeness.
Verifiable.
No Ambiguity.
Realism.

Correctness. Domain experts checked the correctness of each competency question, verifying that its formulation and answers were correct.

Consistent. Domain experts also verified that the competency questions did not have any possible inconsistency.

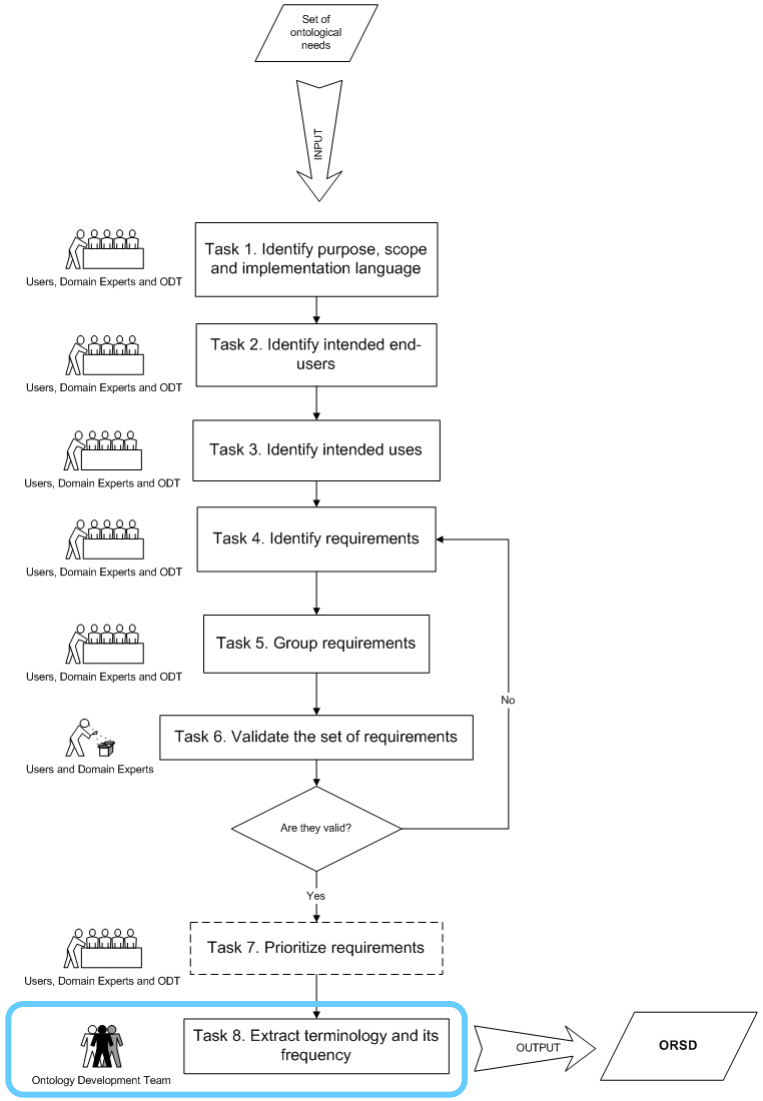
Ontology Requirements Specification. Task 7



- *Input*: the groups of CQs written in natural language (obtained in task 5)
- *Objective*: to give **different levels of priority** to the different groups of CQs, and within each group to the identified requirements (in the form of CQs)
- *Output*: a set of priorities attached to each group of CQs and to each CQ in a group

Within the SEEMP Reference Ontology specification we did not carry out this step. This means the first version of the ontology must be able to represent the knowledge contained in all the competency questions.

Ontology Requirements Specification. Task 8



- *Input*: the list of identified CQs and their answers
- *Objective*: to extract from the list of CQs a pre-glossary to be used in the conceptualization activity. Obtaining a list of the **most used terms**
- *Techniques*: terminology extraction techniques and tools supporting such techniques

From the requirements in form of competency questions, we extract the terminology (names, adjectives and verbs) that will be formally represented in the ontology by means of concepts, attributes and relations.

From the answers to the CQs we extract the objects in the universe of discourse that will be represented as instances.

Task 8. Extract terminology and its frequency

7	**Pre-Glossary of Terms**			
	a. Terms from Competency Questions + Frequency			
	Job Seeker	27	Address	1
	CV	2	Nationality	1
	Personal Information	3	Contact (phone, fax, mail)	3
	Name	4	Objective	3
	Gender	1	Job Category	3
	Birth date	1	...	
	b. Terms from Answers + Frequency			
	SW engineer, programmer	5	Research, Financial, Education	4
	British, Spanish, Italian, French	1	1 year, 2 years, 3 years	1
	Autonomous, Seasonal Job,	2	3000 Euros per month	1
	Basic education, Higher education	1	CEFRIEL Research Company	1
	c. Objects			
	Andorra, Angola, Argentina, Australia, Bolivia, France, Italy, Malta, Spain, etc. Euro, Zloty, Great British Pound, US Dollar, Peso, etc. CEFRIEL, ATOS, etc.			

SEEMP Ontology Requirement Specification Document

	SEEMP Reference Ontology Requirements Specification Document
1	**Purpose**
	The purpose of building the Reference Ontology is to provide a consensual knowledge model of the employment domain that can be used by public e-Employment services.
2	**Scope**
	The ontology has to focus just on the ICT (Information and Communication Technology) domain. The level of granularity is directly related to the competency questions and terms identified.
3	**Implementation Language**
	The ontology has to be implemented in WSML language.

4	Intended End-Users
	User 1. Candidate who is unemployed and searching for a j occupation for immediate or future purposes
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	User 3. Public or private employment search service which c CVs or job postings and to prepare some data and statis
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	User 5. European Commission and the governments of EU c analyze the statistics and prepare international agreen the employment, social and educational policy.

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	Use 3. Search for Job Offers. The Employer looks for cand through PES Portal.
	Use 4. Search for Employment information. Job Seeker information about employment in a given location at th
	Use 5. Provide Job Statistics. The PES Portal provides emp Job Seeker and Employer.

6	Ontology Requirements
	a. Non-Functional Requirements
	NFR1. The ontology must support a multilingual scenario in the following languages: English, Spanish, Italian, and French.
	NFR2. The ontology must be based on the international, European or de-facto standards in existence or under development.

6	Ontology Requirements
	b. Functional Requirements: Groups of Competency Questions
	CQG1. Job Seeker (14 CQ)
	ish; Italian; French;
	0/03/1970; 15/04/1978
	Tel: 34600654231. Email:
	mer; Computer Engineer;
	gineer; Hardware designer;
	conditions? Autonomous;
	t? Full time; Partial time;
	m? 3000 Euros per month,
	Basic education; Higher
	hs, 1 year, 2 years
	amming; C Programming,
	neering
	, network administration
	esearch Company, Milano,
	r? Java Programmer; C
	easonal Job; Autonomous
	Euros, 3000 USD
	yer? Research; Financial;
	ied Java Programmer
	r? Full time; Partial time;
	b offer? Basic education;
	Higher education/University
	CQ23. What is the required work experience for the job offer? 1 year, 2 years, 3 years, 4 years, 5 or more years
	CQ24. What is the required knowledge for the job offer? Java, Haskell, Windows
	CQ25. What are the required skills for the job offer? ASP Programmer, Data warehouse, Hardware programming

7	Pre-Glossary of Terms			
	a. Terms from Competency Questions + Frequency			
	Job Seeker	27	Address	1
	CV	2	Nationality	1
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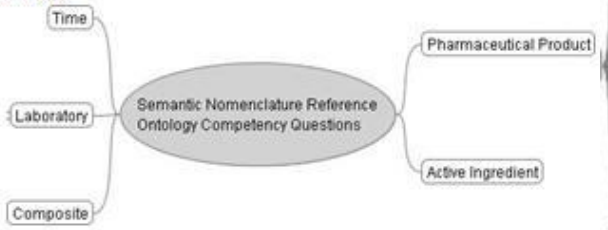
	Name	4	Objective	3
	Gender	1	Job Category	3
	Birth date	1	...	
	b. Terms from Answers + Frequency			
	SW engineer, programmer	5	Research, Financial, Education	4
	British, Spanish, Italian, French	1	1 year, 2 years, 3 years	1
	Autonomous, Seasonal Job,	2	3000 Euros per month	1
	Basic education, Higher education	1	CEFRIEL Research Company	1
	c. Objects			
	Andorra, Angola, Argentina, Australia, Bolivia, France, Italy, Malta, Spain, etc.			
	Euro, Zloty, Great British Pound, US Dollar, Peso, etc.			
	CEFRIEL, ATOS, etc.			

Semantic Nomenclature Reference Ontology Specification Document

	Semantic Nomenclature Reference Ontology Requirements Specification
1	**Purpose**
	The purpose of building the Reference Ontology is to provide a network of ontologies for the pharmaceutical domain. This model is a compilation of the main terms and objects for this particular domain and could be used by health & pharmaceutical entities.
2	**Scope**
	The ontology has to focus just on the Spanish & European pharmaceutical domain. The level of granularity is directly related to the competency questions and terms identified.
3	**Level of Formality**
	The ontology has to be implemented in OWL
4	**Intended Users**
	User 1: Pharmacist. Pharmacists are the end-users of the ontology and navigate across the ontology searching for drug information. User 2: GSCoP technician. GSCoP technicians navigate across the ontology network and search for more information or relations about a given concept (drug, active ingredient, etc.). Also, GSCoP technicians extract the latest information from different sources and update their BOTPlus database User 3: Spanish Government. Spanish Government analysts study the situation of the pharmaceutical product information in the Spanish market or update the content.
5	**Intended Uses**
	Use1. Search updated information about the characteristics of pharmaceutical products Use2. Connect heterogeneous pharmaceutical models Use3. Update pharmaceutical product information databases
6	**Groups of Competency Questions**
	CQG1. Pharmaceutical Product (29 competency questions) CQG2. Laboratory (4 competency questions) CQG3. Active Ingredient (12 competency questions). CQG4. Composed ones (16 competency questions). CQG5. Time / Date



- CQ11.Which is the drug generic name?
- CQ12.Which is the drug defined daily doses DDDs?
- CQ13.Which is the drug composition?
- CQ14.Is it a narcotic?
- CQ15.Which are the drug contraindications?
- CQ16.What is the drug dosage?
- CQ17.Which method of administration has the drug?
- CQ18.What is the drug pharmaceutical form?

7	**Pre-Glossary of Terms**
	Terms

Term	Frequency
Drug	29
• *Date (registration, withdrawal)*	3
• *Price (reference, commercial)*	3
• *Therapeutical Subgroup*	3
• *Dosage*	1
• *Composition*	2
• *Identification*	2
• *National Health financing*	2
• *Route of administration*	1
• *Units content*	1
• *Indications*	2
• *Status*	1
• *Pharmaceutical form*	1

Objects

Active Ingredient Objects
Ibuprofeno
Butibufeno
Penicilamina
Niflumico Acid
Galamina
Tetrazepam
Procaina
Ketamina

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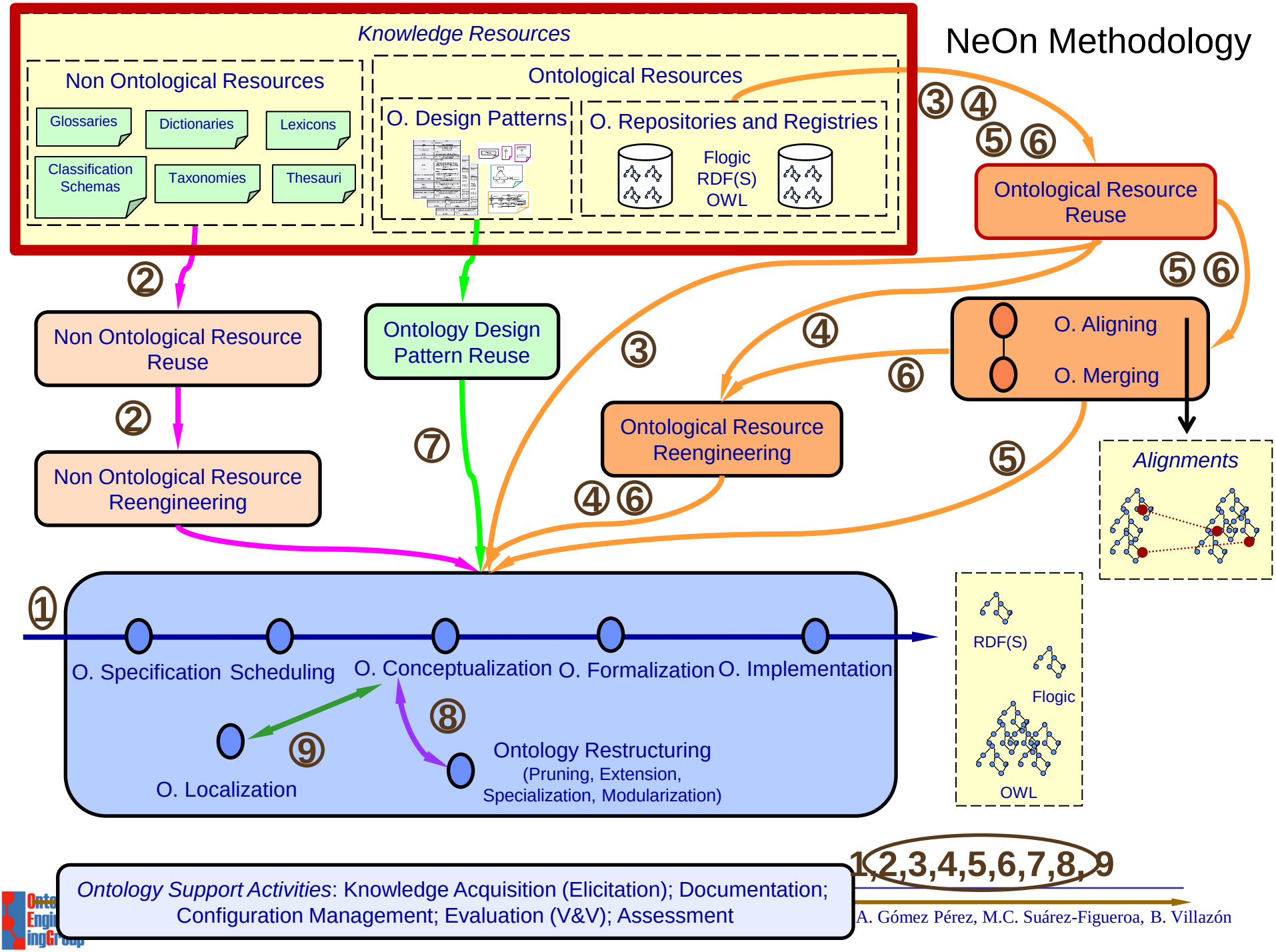
- Use cases in Ontology Building
- The NeOn Methodology
  - Glossary of activities
  - Scenarios
  - Lifecycle models
- Main Activities
  - Methodological Guidelines for Ontology Specification
  - Quick Search of Existing Knowledge Resources
  - Guidelines for Ontology development project Planning
  - Methodological Guidelines for Non Ontological Resource Reuse and Reengineering
  - Methodological Guideliness for Ontology Reuse
  - Creating the final Ontology Model

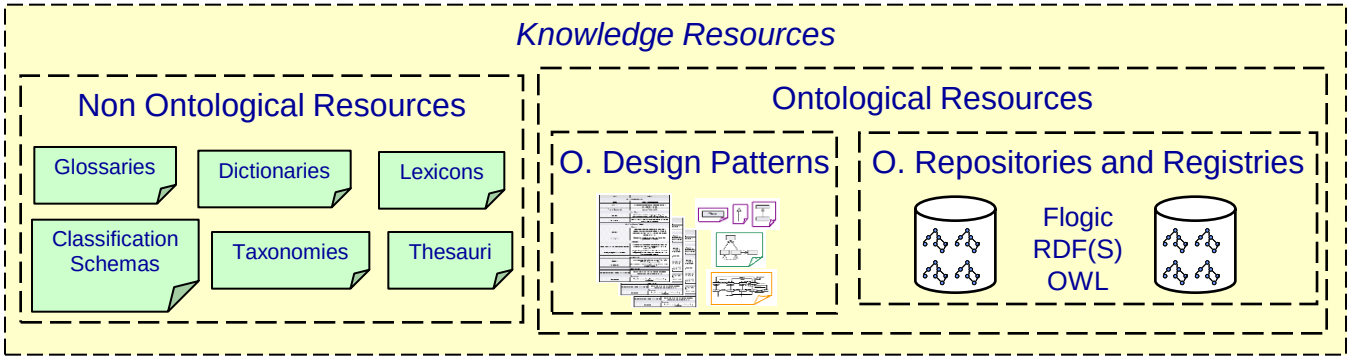
NeOn Methodology



Ontology Support Activities: Knowledge Acquisition (Elicitation); Documentation; Configuration Management; Evaluation (V&V); Assessment

Searching Resources

- Use the terminology from the ORSD
- Find resources covering the terminology



Objects

Objects in the universe of discourse, which are instances of:

- Job Category
  - O1. Computer System Designer
  - O2. Computer System Analyst
  - O3. Programmer
  - O4. Computer Engineer
  - O5. Computer Assistant
  - O6. Computer Equipment Operator
  - O7. Industrial Robot Controller
  - O8. Telecommunication Equipment Operator
  - O9. Medical Equipment Operator
  - O10. Electronic Equipment Operator
  - O11. Image Equipment Operator
- Nationality
  - O12. Austrian
  - O13. Belgian
  - O14. Danish
  - O15. Estonian
  - O16. Finnish
  - O17. French
  - O18. German
  - O19. Greek
  - O20. Italian

- Where:
  - Internet
  - Standardization bodies (ISO,…)
  - Intranet of the organization
  - Ontology Registries

ISO 4217 (currencies)

Entitiy	Currency	Code	
		Alphabetic	Numeric
AFGHANISTAN	Afghani	AFN	971
ALBANIA	Lek	ALL	008
ALGERIA	Algerian Dinar	DZD	012
AMERICAN SAMOA	US Dollar	USD	840
ANDORRA	Euro	EUR	978
ANGOLA	Kwanza	AOA	973
ANGUILLA	East Caribbean Dollar	XCD	951
ANTARCTICA	No universal currency		
ANTIGUA AND BARBUDA	East Caribbean Dollar	XCD	951
ARGENTINA	Argentine Peso	ARS	032
ARMENIA	Armenian Dram	AMD	051
ARUBA	Aruban Guilder	AWG	533
AUSTRALIA	Australian Dollar	AUD	036
AUSTRIA	Euro	EUR	978
AZERBAIJAN	Azerbaijanian Manat	AZN	944
BAHAMAS	Bahamian Dollar	BSD	044
BAHRAIN	Bahraini Dinar	BHD	048
BANGLADESH	Taka	BDT	050
BARBADOS	Barbados Dollar	BBD	052
BELARUS	Belarussian Ruble	BYR	974

ISO 3166 (countries)

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  </ISO_3166-1_Entry>
  <ISO_3166-1_Entry>
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  <ISO_3166-1_Entry>
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  </ISO_3166-1_Entry>
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  </ISO_3166-1_Entry>
```

Non-ontological resources - ISCO-88 (COM)

level	description EN	description FR	description DE	texte auto EN	
3	Religious professionals	Membres du clergé	Geistliche, Seelsorger		
3	Public service administrative professionals	Cadres administratifs des services publics	Wissenschaftliche Verwaltungsfachkräfte des öffentlichen Dienstes	This is a new minor group, designed explicitly for the classification of occupations in which the primary tasks consist of general administrative functions within the public	Hier han ausdrück deren Ha
3	Physical and engineering science technicians	Techniciens des sciences physiques et techniques	Material- und ingenieurtechnische Fachkräfte		
3	Computer associate professionals	Pupitreurs et autres opérateurs de matériels informatiques	Datenverarbeitungsfachkräfte	If the job title and associated information on activities does not permit a clear distinction, additional information on a level of relevant qualifications or description of tasks may	Wenn di Informati erlauben
3	Optical and electronic equipment operators	Techniciens d'appareils optiques et électroniques	Bediener optischer und elektronischer Anlagen		
3	Ship and aircraft controllers and technicians	Techniciens des moyens de transport maritime et aérien	Schiffs-, Flugzeugführer und verwandte Berufe		
3	Safety and quality inspectors	Inspecteurs d'immeubles, de sécurité, d'hygiène et de qualité	Sicherheits- und Qualitätskontrolleure		
3	Life science technicians and related associate professional	Techniciens et travailleurs assimilés des sciences de la vie et de la santé	Biotechniker und verwandte Berufe		
3	Health associate professionals (except nursing)	Professions intermédiaires de la médecine moderne (à l'exception du personnel infirmier)	Medizinische Fachberufe (ohne Krankenpflege)		
3	Nursing and midwifery associate professionals	Personnel infirmier et sages-femmes (niveau intermédiaire)	Nicht-wissenschaftliche Krankenpflege- und Geburtshilfefachkräfte	Concerning "Nursing and midwifery professionals", see notes to sub-major group 22.	Für "Wis Geburtsh
3	Primary education teaching associate professionals	Professions intermédiaires de l'enseignement primaire	Nicht-wissenschaftliche Lehrkräfte des Primarbereiches		
3	Pre-primary education teaching associate professionals	Professions intermédiaires de l'enseignement préprimaire	Nicht-wissenschaftliche Lehrkräfte des Vorschulbereiches		
3	Special education teaching associate professionals	Professions intermédiaires de l'éducation des handicapés	Nicht-wissenschaftliche Sonderschullehrkräfte		

Searching non ontological resources

- *We select the most appropriate standards and taxonomies for:*
  - Occupation Classification
    ISCO-88 (COM), SOC, ISCO-88, ONET, Eures Taxonomy.
  - Classification of Economic Activities
    ISIC Rev. 3.1, NACE Rev. 1.1, NAICS
  - Apprenticeship classifications
    ISCED 97, FOET
  - Currency Classification
    ISO 4217
  - Geography Classification
    ISO 3166, Eures Taxonomy

Language Classification
ISO 6392, CEF
Driving License Classification
European Legislation
Skill Classification
Eures Taxonomy
Contract Types Classification
LE FOREM, Eures and BLL Classification
Work Condition Classification
LE FOREM, Eures and BLL Classification

Is the terminology included in the Ontology Requirements Specification Document covered by the resources?

Selection of Ontologies

- Search ontologies
- Compare ontologies in the same domain using a set of criteria
- Assess if the ontologies cover the set of competency questions
- Select the best ontology based on
  - Coverage of the domain
  - Expressivity of the Implementation language

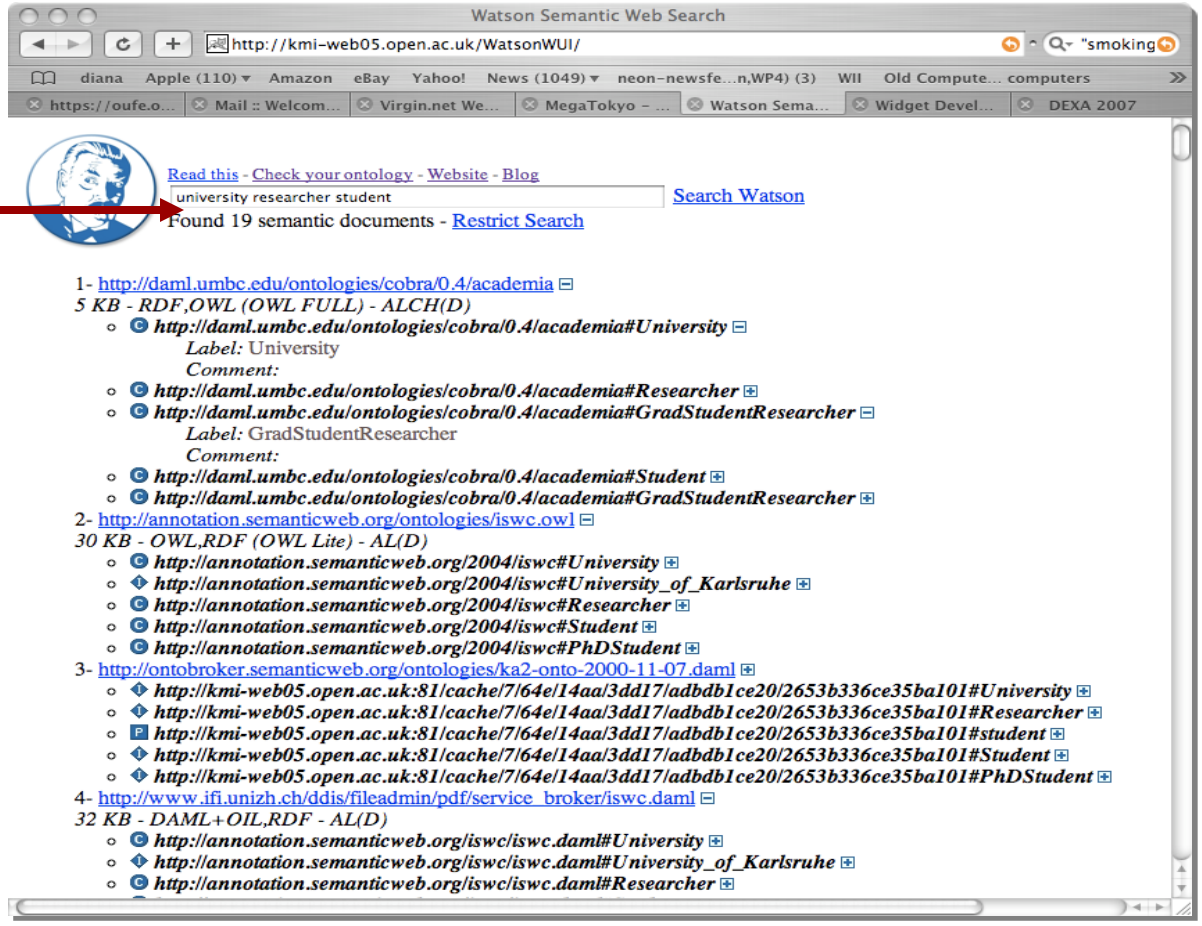
Searching Ontologies in Watson

Ontology Requirement Specification Document

Objects

Objects in the universe of discourse, which are instances of:

- Job Category
  - O1. Computer System Designer
  - O2. Computer System Analyst
  - O3. Programmer
  - O4. Computer Engineer
  - O5. Computer Assistant
  - O6. Computer Equipment Operator
  - O7. Industrial Robot Controller
  - O8. Telecommunication Equipment Operator
  - O9. Medical Equipment Operator
  - O10. Electronic Equipment Operator
  - O11. Image Equipment Operator
- Nationality
  - O12. Austrian
  - O13. Belgian
  - O14. Danish
  - O15. Estonian
  - O16. Finnish
  - O17. French
  - O18. German
  - O19. Greek
  - O20. Italian
- Activity Sector
  - O21. Telecommunication
  - O22. Justice and Judicial
  - O23. Public Security and law
  - O24. Manufacture of machine tools
  - O25. Research and Development
  - O26. Hardware Consultancy
  - O27. Software Consultancy and Supply
  - O28. Data processing
- Education
  - O29. Life Science
  - O30. Mathematics
  - O31. Computer Science
  - O32. Computer Use
  - O33. Statistics
  - O34. Physics
  - O35. Network Administration
- Languages
  - O36. Swedish
  - O37. Spanish
  - O38. Slovenian
  - O39. Portuguese
  - O40. English
  - O41. French
  - O42. German
- Currency
  - O43. Euro
  - O44. Krone
  - O45. Great British Pound
  - O46. Zlote
  - O47. US Dollar
  - O48. Franc
- Location
  - O49. Austria
  - O50. Belgium
  - O51. Danmark
  - O52. Estonia
  - O53. Finland
  - O54. France
  - O55. Germany
  - O55. Greece



Watson NeOn Toolkit plugin

- While building an ontology with the Neon toolkit
- Find descriptions of existing entities in Web ontologies
- Integrate these descriptions into the edited ontology
- Thus allowing knowledge reuse at the scale of the Semantic Web
- In one simple, integrated, and interactive tool