



# Ontological Engineering

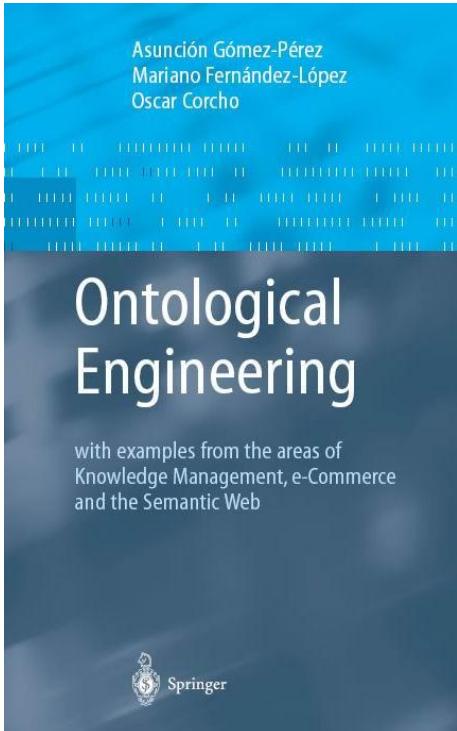
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# Ontological Engineering

**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**

# References



**<http://www.neon-project.org/>**

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

# Index

- **Introduction**
- Scenarios in Ontology Building
- 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

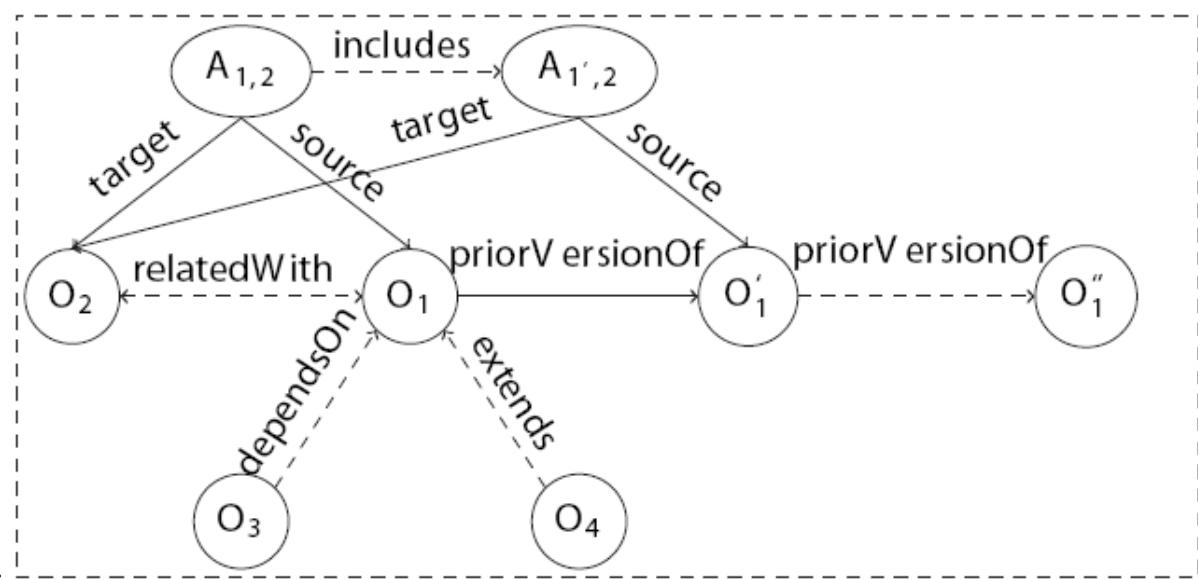
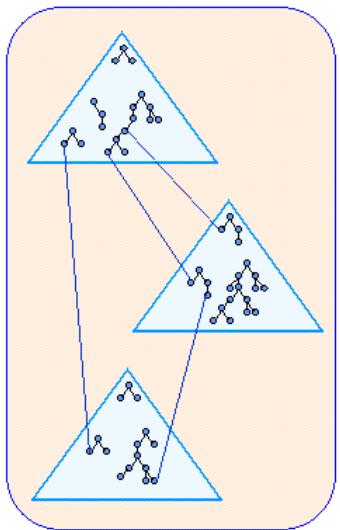
# I want to build my ontology



- 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 existing knowledge resources?
- ...

# Ontology Networks

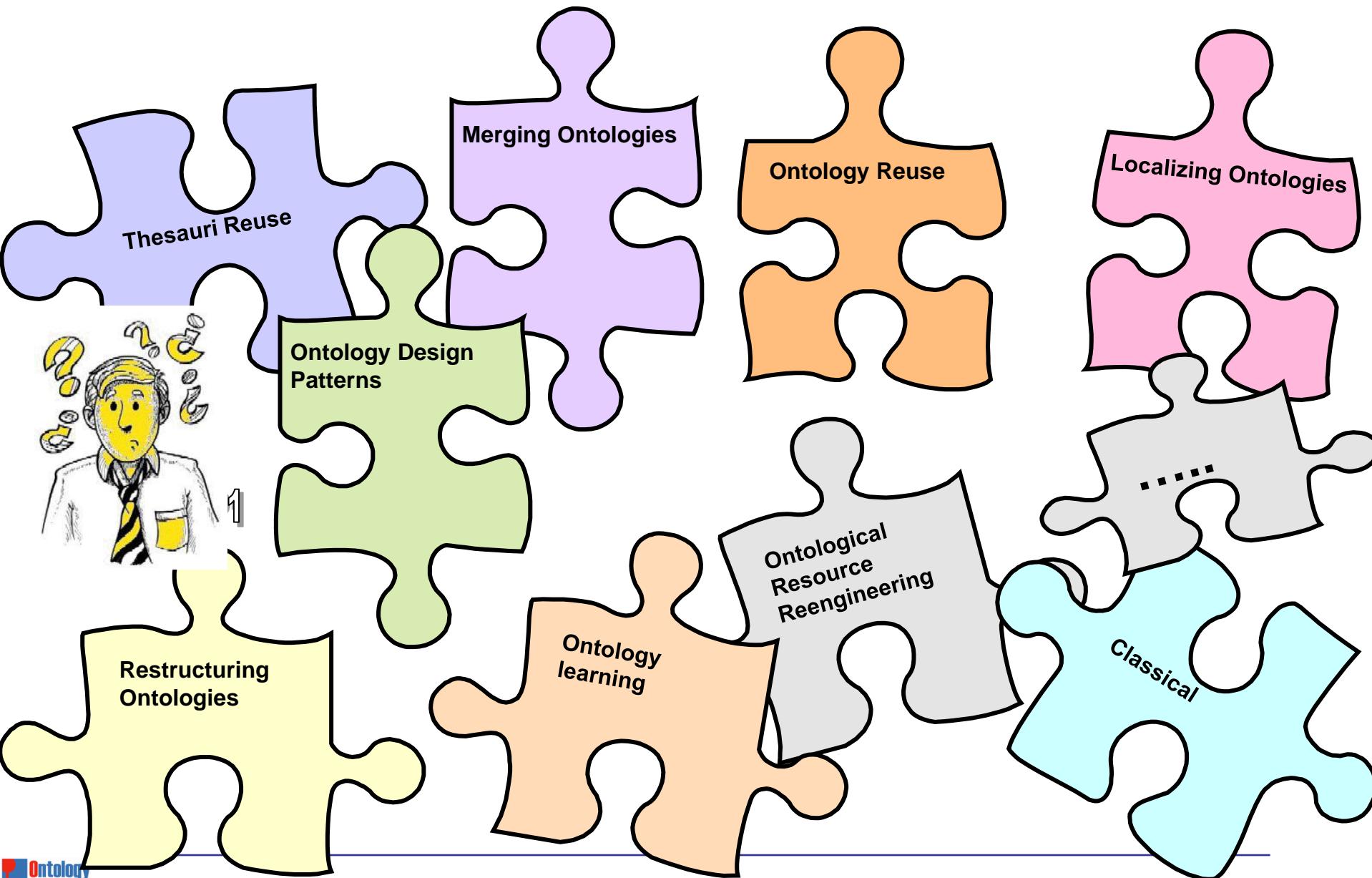
The Semantic Web of the future will be characterized by using a very large number of **ontologies embedded in ontology networks** built by distributed teams in a collaborative way.



# Index

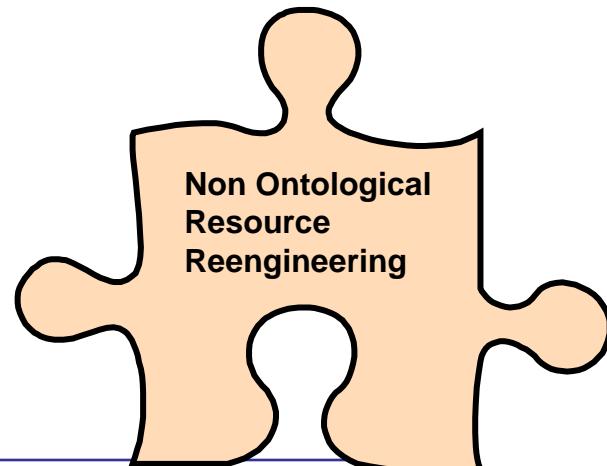
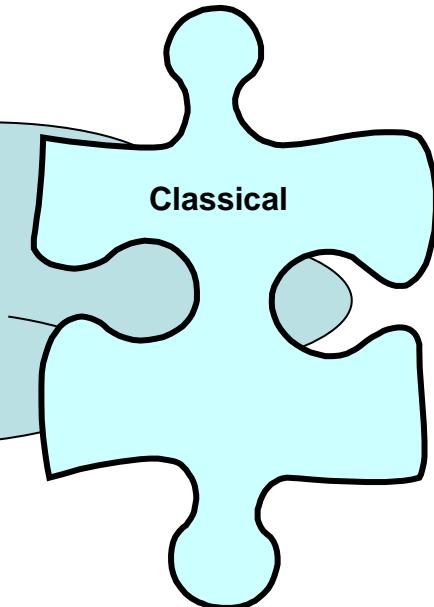
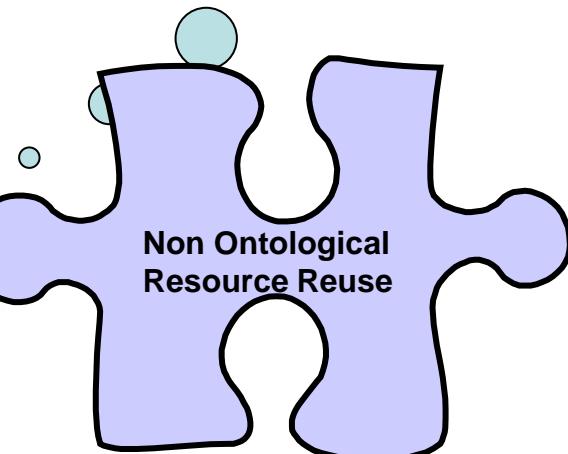
- Introduction
- **NeOn Scenarios in Ontology Building**
- Methodological Guidelines for Ontology Specification
- Quick Search of Existing Knowledge Resources
- Guidelines for Ontology development project Planning
- Methodological Guidelines for Non Ontological Resource Reuse and Reengineering
- Methodological Guideliness for Ontology Reuse
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# Too many activities...



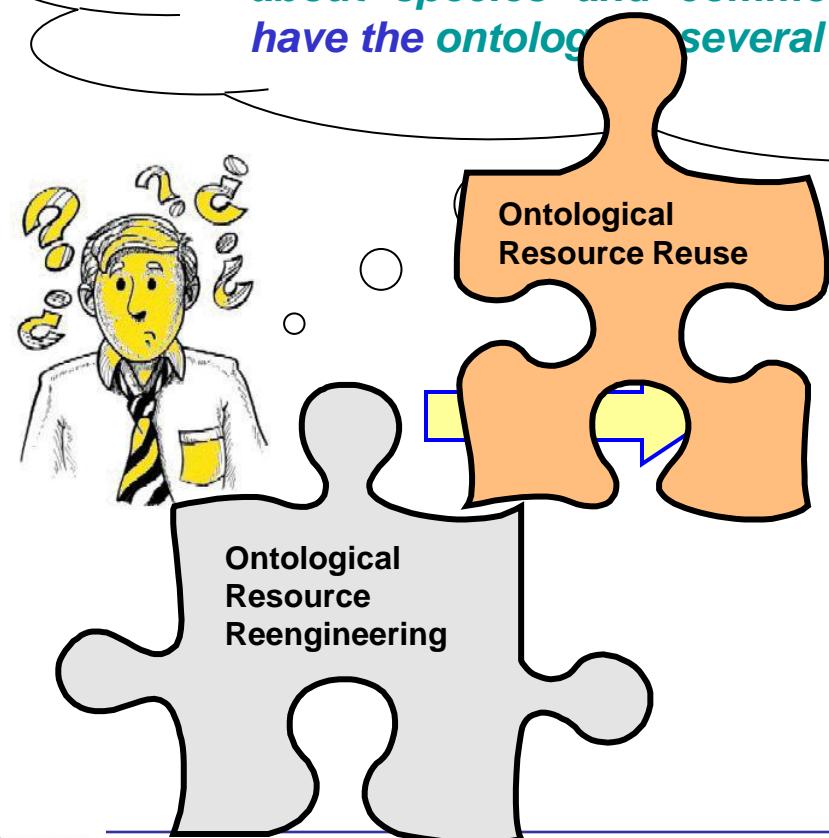
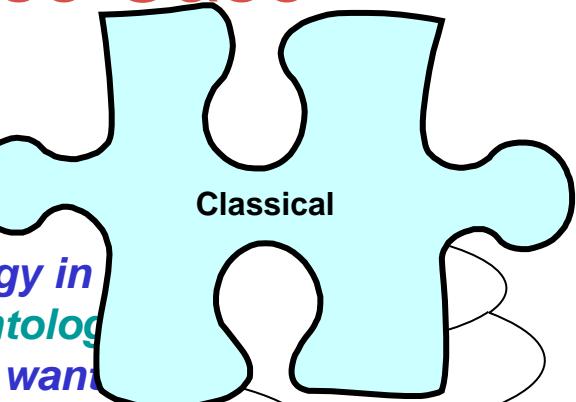
# Building Ontologies: Use Case

*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.*



# Building Ontologies: Use Case

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



# Key assets in the NeOn methodology

- The NeOn Glossary of activities
- Table of Recommended and If-Applicable” Activities
- The NeOn scenarios
- All processes and activities are described with:
  - A filling card
  - A workflow
  - Examples



# 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

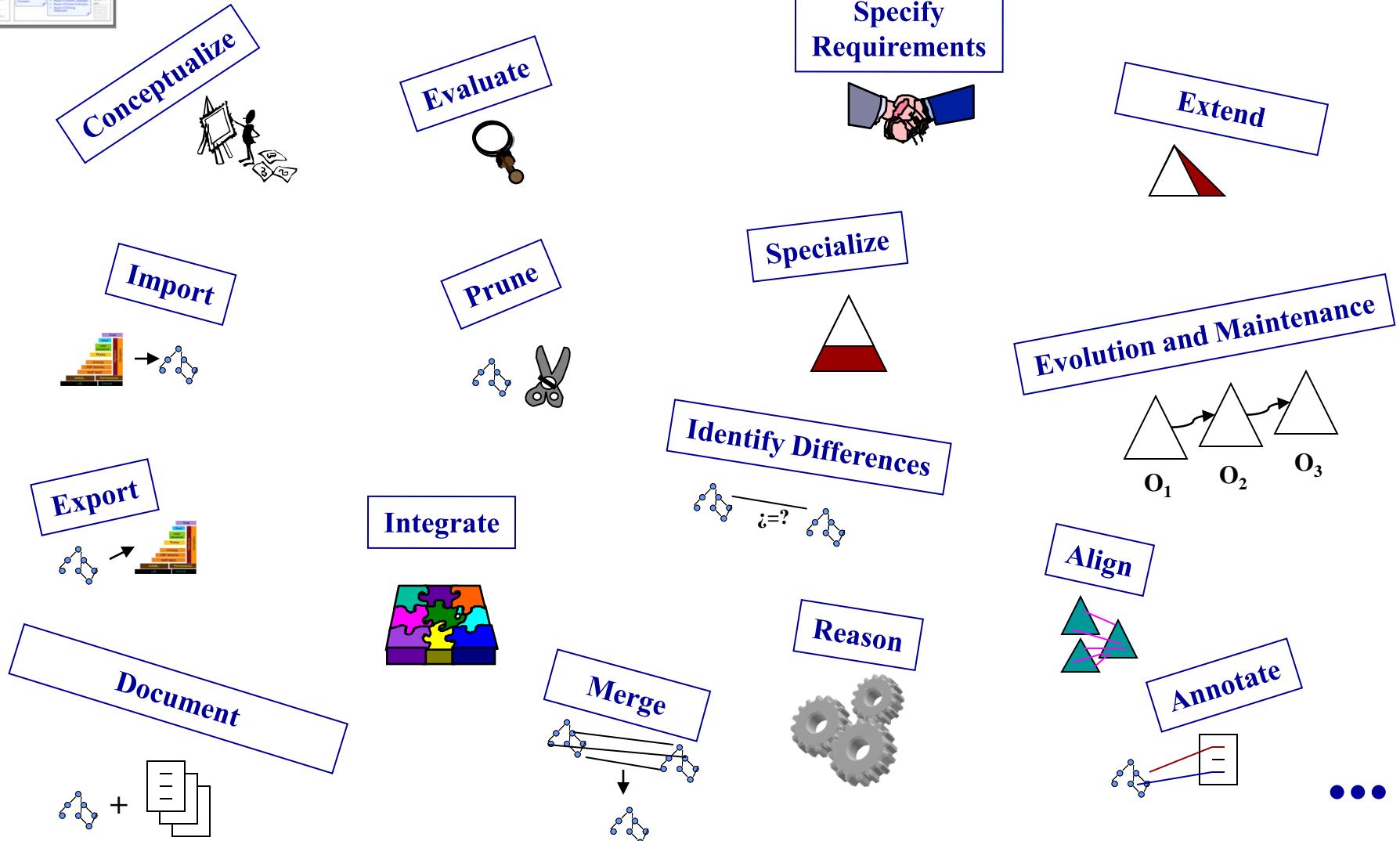


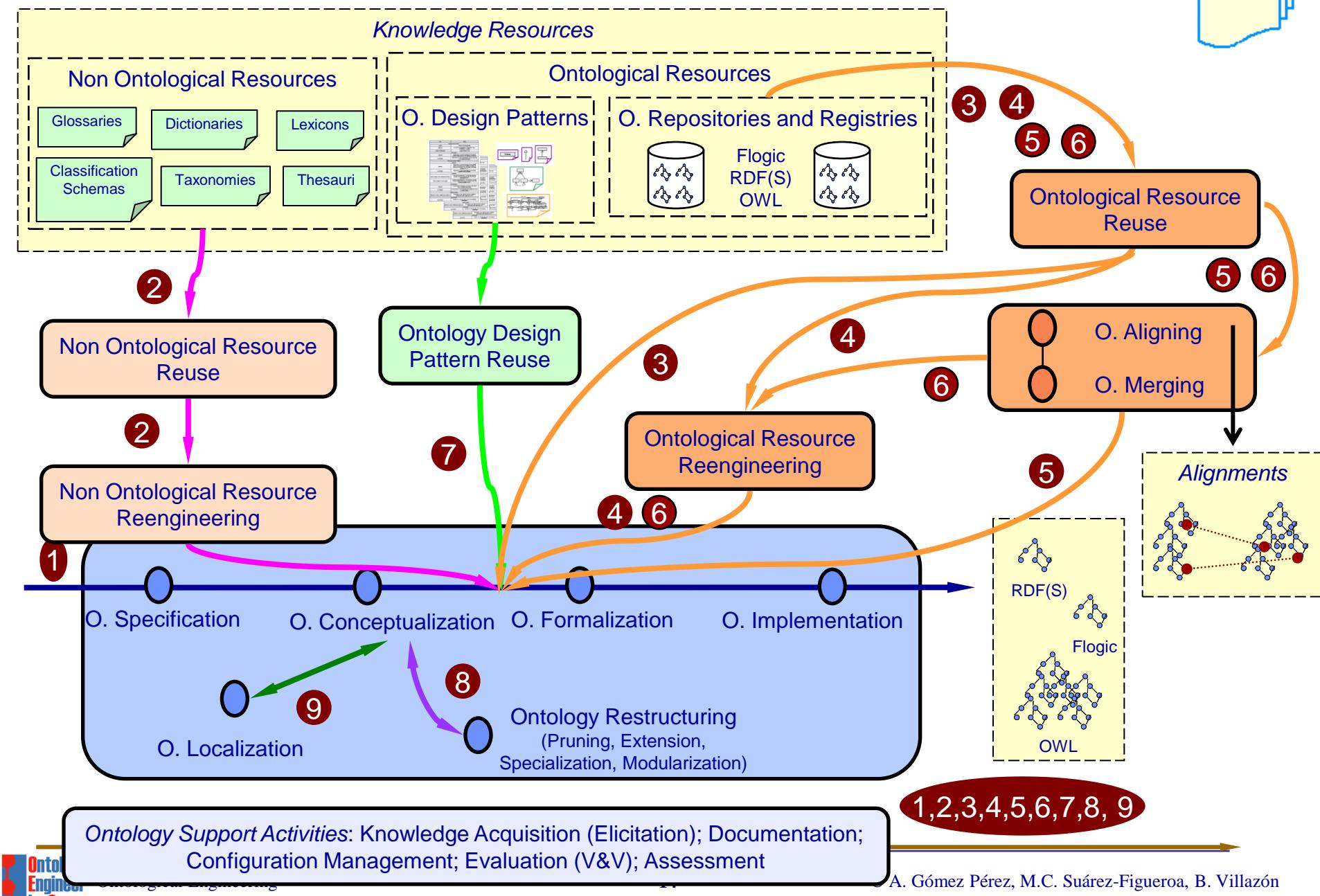
<http://www.neon-project.org/>

## 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**

# Activities for Building Ontologies





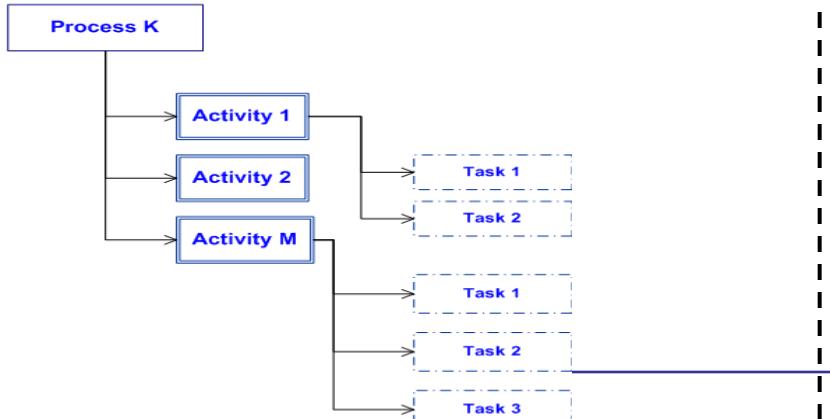
# Scenarios

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.

# NeOn Methodology

Process and activities covered:

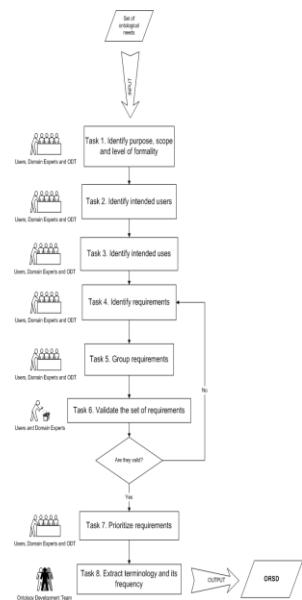
- Ontology Specification
- Scheduling
- Non Ontological Resource Reuse
- Non Ontological Resource Reengineering
- Reuse General Ontologies
- Reuse Domain Ontologies
- Reuse Ontology Statements
- Reuse Ontology Design Patterns



All processes and activities are described with:

- A filling card
- A workflow
- Examples

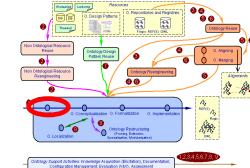
Process or Activity Name	
Definition	
Goal	
Input	Output
Who	
When	



# Index

- Introduction
- Scenarios in Ontology Building
- **Methodological Guidelines for Ontology Specification**
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# NeOn 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.

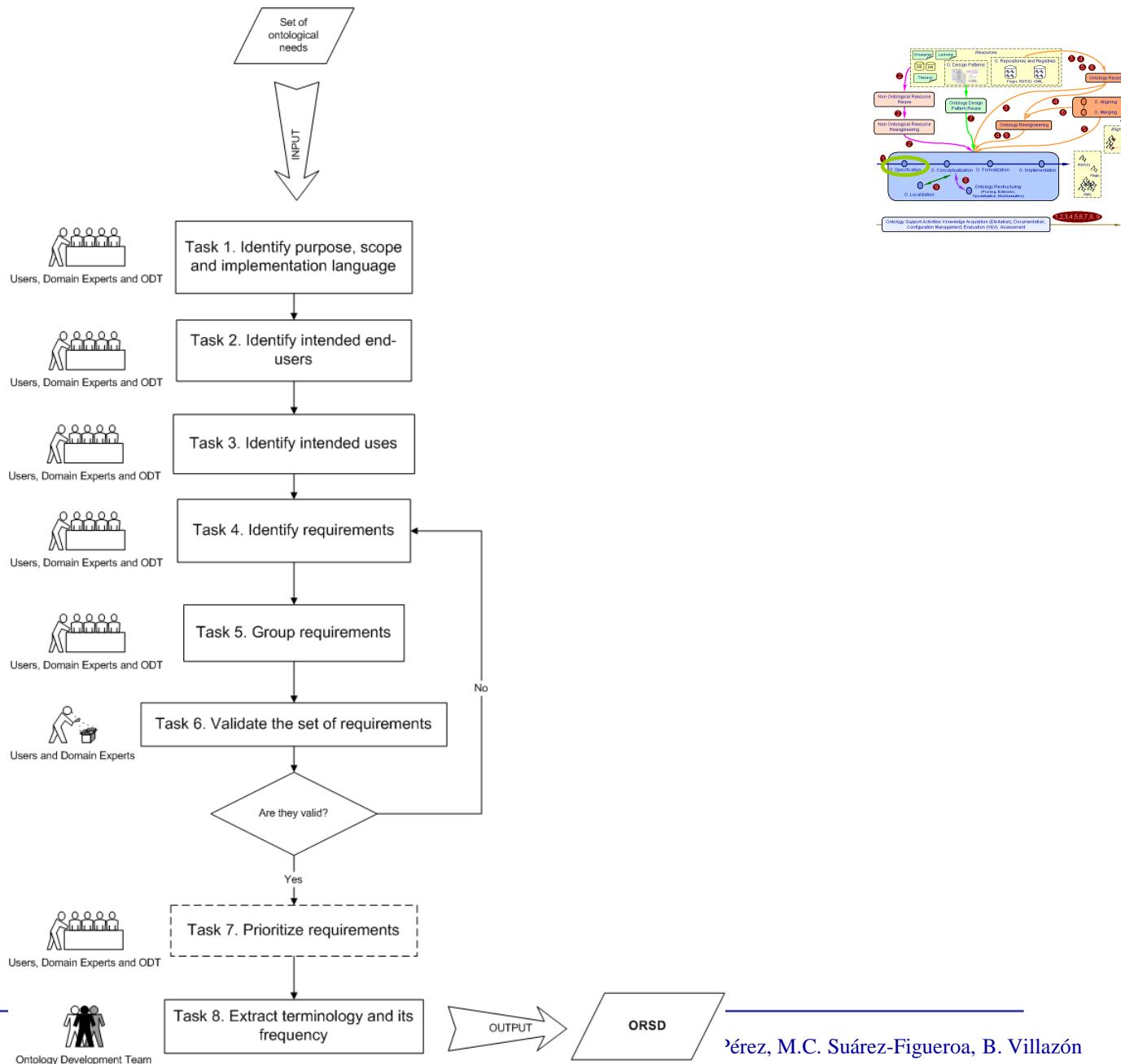
### When

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.

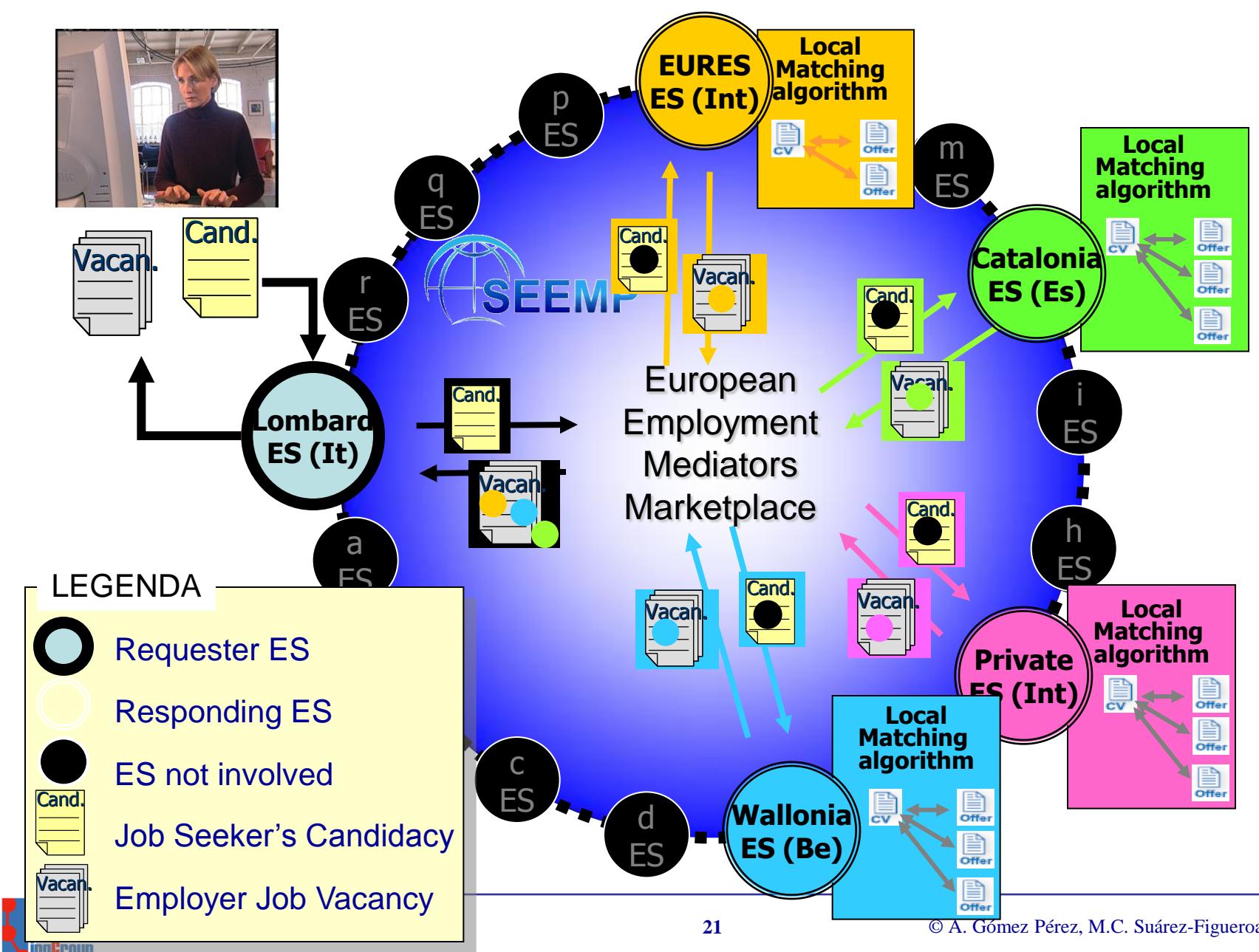
- CQs in natural language
- CQs in SPARQL

# Ontology Requirements Specification. Tasks

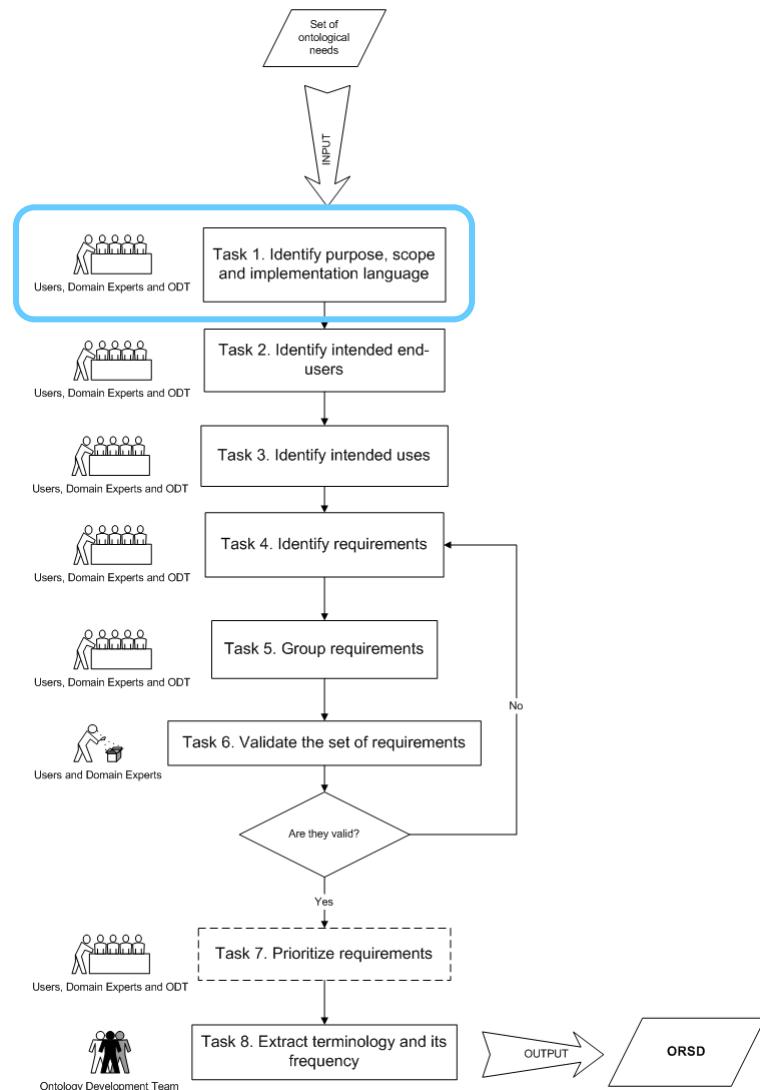


# Ontology Requirements Specification Document Template

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



# Ontology Requirements Specification. Task 1

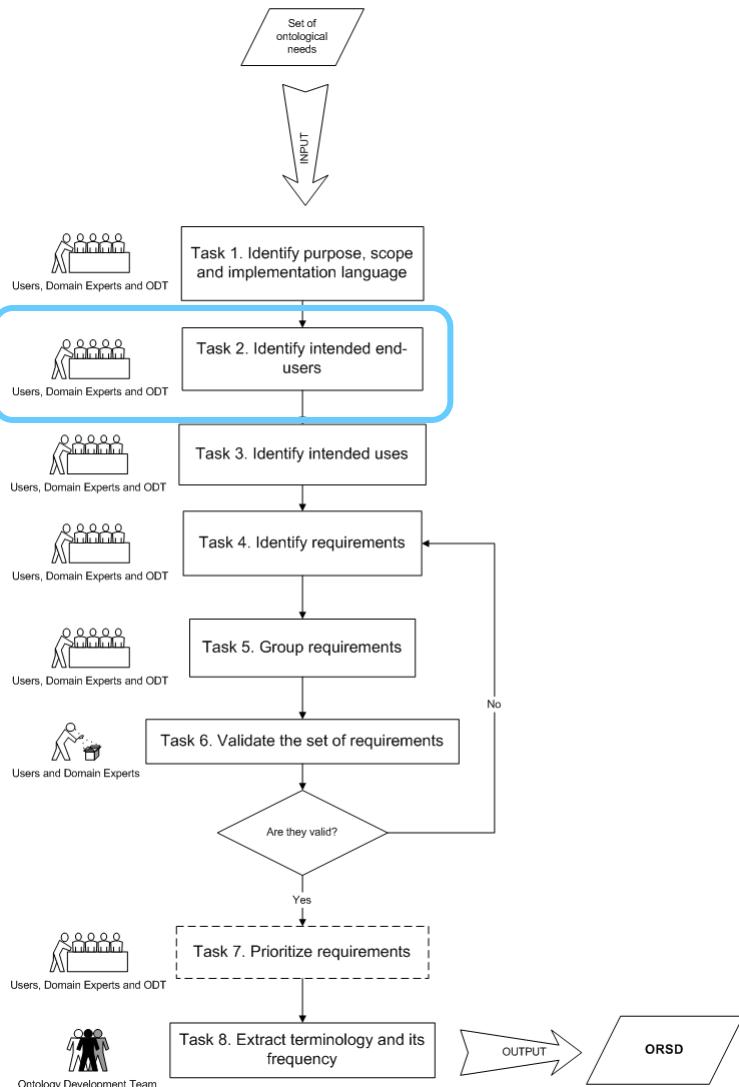


- ❑ Input: a set of ontological needs
- ❑ Objective: obtaining the **purpose, scope and formality level of the ontology**
- ❑ Techniques: physical or virtual interviewers
- ❑ Output: purpose, scope and level of formality of the ontology, which will be included in the corresponding slots of the OSRD template

SEEMP Reference Ontology Requirements Specification Document	
<b>1</b>	<b>Purpose</b>
	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.
<b>2</b>	<b>Scope</b>
	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.
<b>3</b>	<b>Implementation Language</b>
	The ontology has to be implemented in WSMIL language.

# Ontology Requirements Specification. I

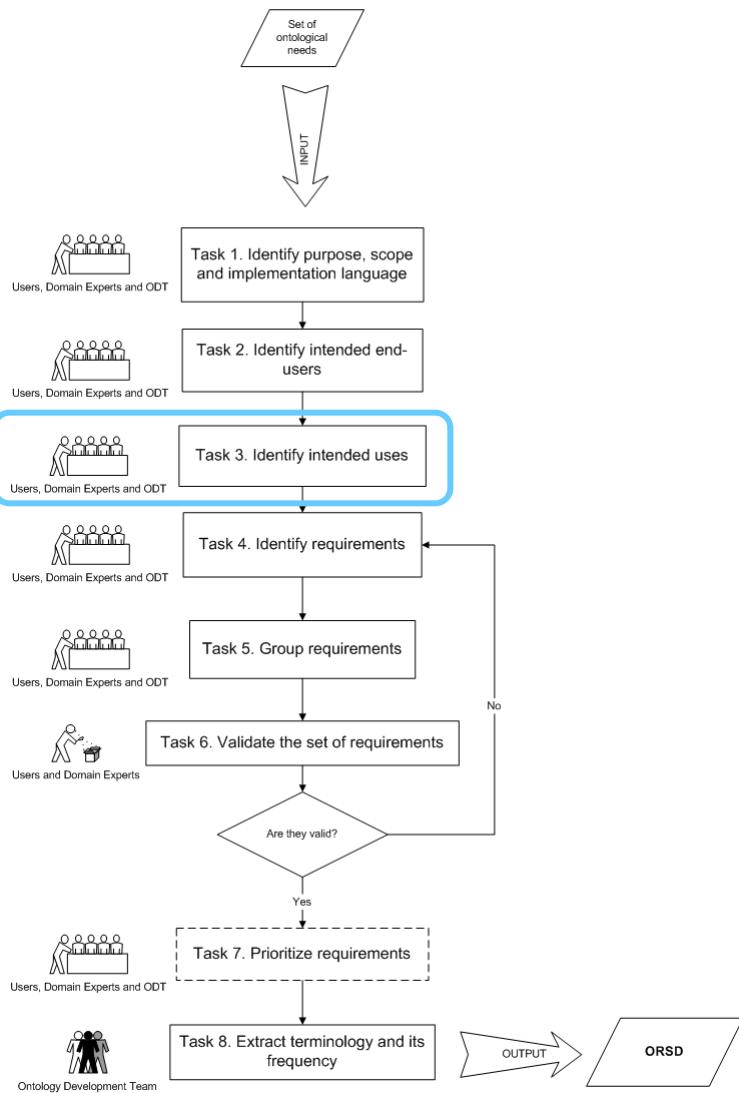
## 2



- ❑ 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

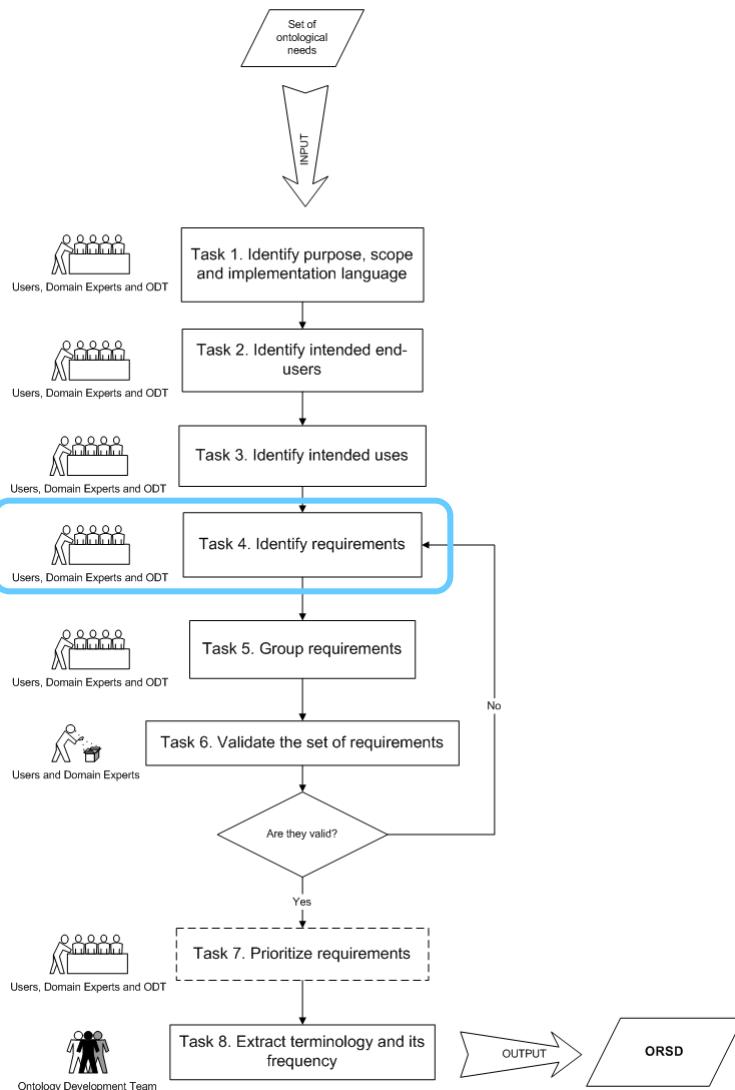


- Input: a set of ontological needs
- Objective: identifying the **intended uses**
- Techniques: physical or virtual interviewers between them
- Output: a list of intended uses in the form of scenarios. The scenarios can be described in natural language or expressed in UML as use cases. The list of scenarios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

5	Intended Uses
	<ul style="list-style-type: none"><li>Use 1. Publish CV. Job seeker places his/her CV on the PES Portal.</li><li>Use 2. Publish Job Offer. An Employer places a Job Offer on the PES Portal.</li><li>Use 3. Search for Job Offers. The Employer looks for candidates for the Job Offer through PES Portal.</li><li>Use 4. Search for Employment information. Job Seeker looks for general information about employment in a given location at the PES Portal.</li><li>Use 5. Provide Job Statistics. The PES Portal provides employment statistics to the Job Seeker and Employer.</li></ul>

# Ontology Requirements Specification.

## Task 4 (I)



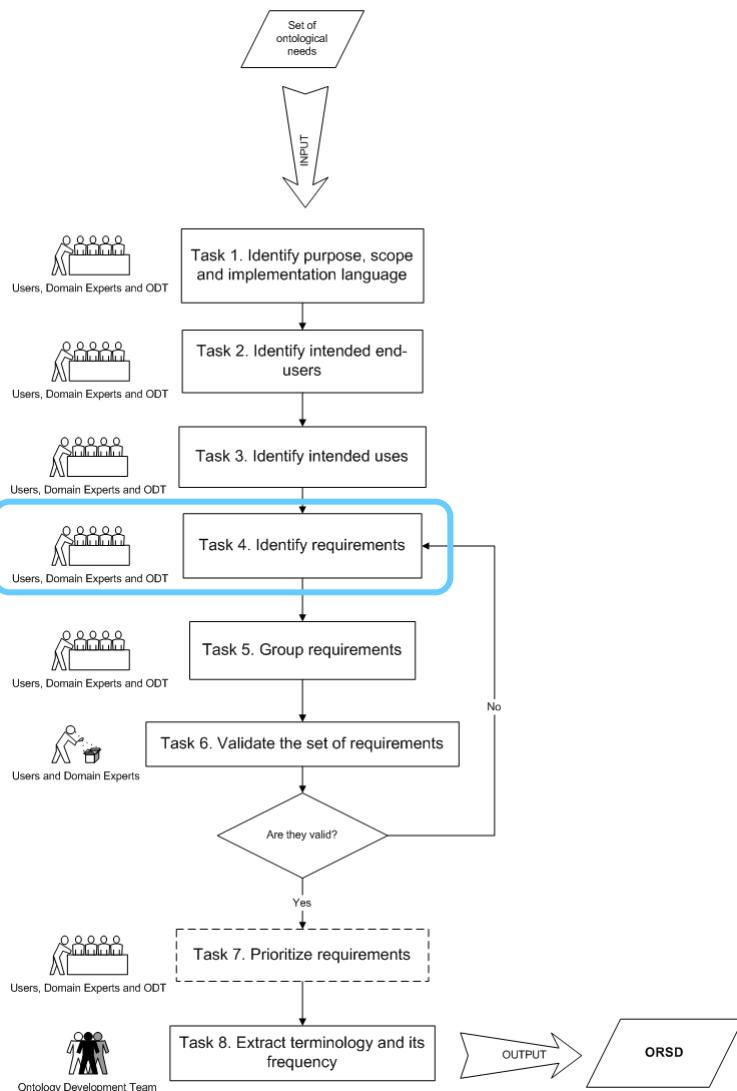
- ❑ *Input:* a set of ontological needs
- ❑ *Objective:* identifying the set of **ontology requirements that the ontology should satisfy**

- **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.

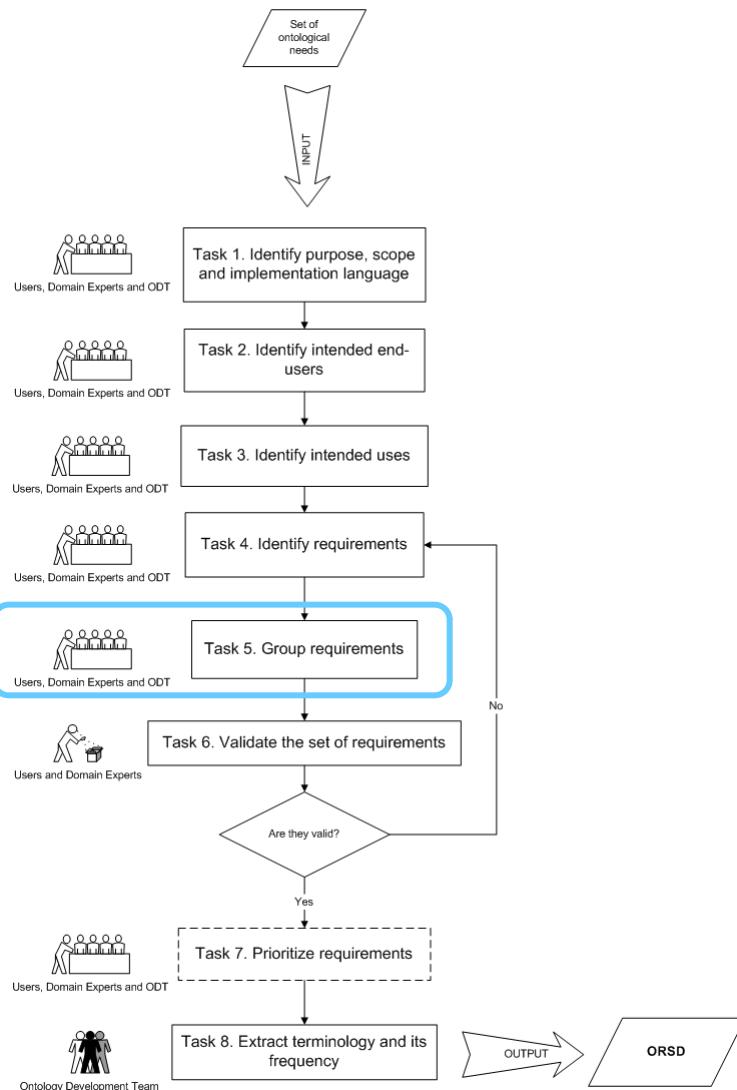
# Task 4. Identify requirements: Functional requirements

- CQ1. What is the Job Seeker Name?  
CQ2. What is the Job Seeker nationality?  
CQ3. When is the Job Seeker birthdate?  
CQ4. What is the Job Seeker contact information?  
CQ5. What is the Job Seeker current job?  
CQ6. What is the Job Seeker desired job?  
CQ7. What are the Job Seeker desired working conditions?  
CQ8. What kind of contract does the Job Seeker want?  
CQ9. How much salary does the Job Seeker want to earn?  
CQ10. What is the Job Seeker education level?  
CQ11. What is the Job Seeker work experience?  
CQ12. What is the Job Seeker knowledge?  
CQ13. What is the Job Seeker expertise?  
CQ14. What are the Job Seeker skills?  
CQ15. What publications does the Job Seeker have?  
CQ16. What hobbies does the Job Seeker have?  
CQ17. What is the employer information?  
CQ18. What kind of job does the employer offer?  
CQ19. What kind of contract does the employer offer?  
CQ20. How much salary does the employer offer?  
CQ21. What is the economic activity of the employer?  
CQ22. What is the description of the job offer?  
CQ23. What is the work condition of the job offer?  
CQ24. What is the required education level for the job offer?  
CQ25. What is the required work experience for the job offer?  
CQ26. What is the required knowledge for the job offer?  
CQ27. What are the required skills for the job offer?  
CQ28. When the Job Seeker completed his/her first degree?  
CQ29. Is the Job Seeker older than 30 years?  
CQ30. How much time did the Job Seeker spend completing his/her first degree?  
CQ31. How long is the duration of the contract?  
CQ32. Which job offers were posted in the last 24 hours?  
CQ33. Which job offers were posted in the last 7 days?  
CQ34. Which job offers were posted in the last month?  
CQ35. Is the job offer's salary greater than 14000 zlotes?  
CQ36. Is the job offer's salary lower than 25000 kroner?  
CQ37. The offered salary is given in US dollars?  
CQ38. The offered salary is given in Euros?  
CQ39. Given the personal information (name, nationality, birth date, contact information) and the objectives (desired contract type, desired job, desired working conditions, desired salary) of the job seeker, what job offers are the most appropriate?

SEEMP Reference Ontology  
Competency Questions

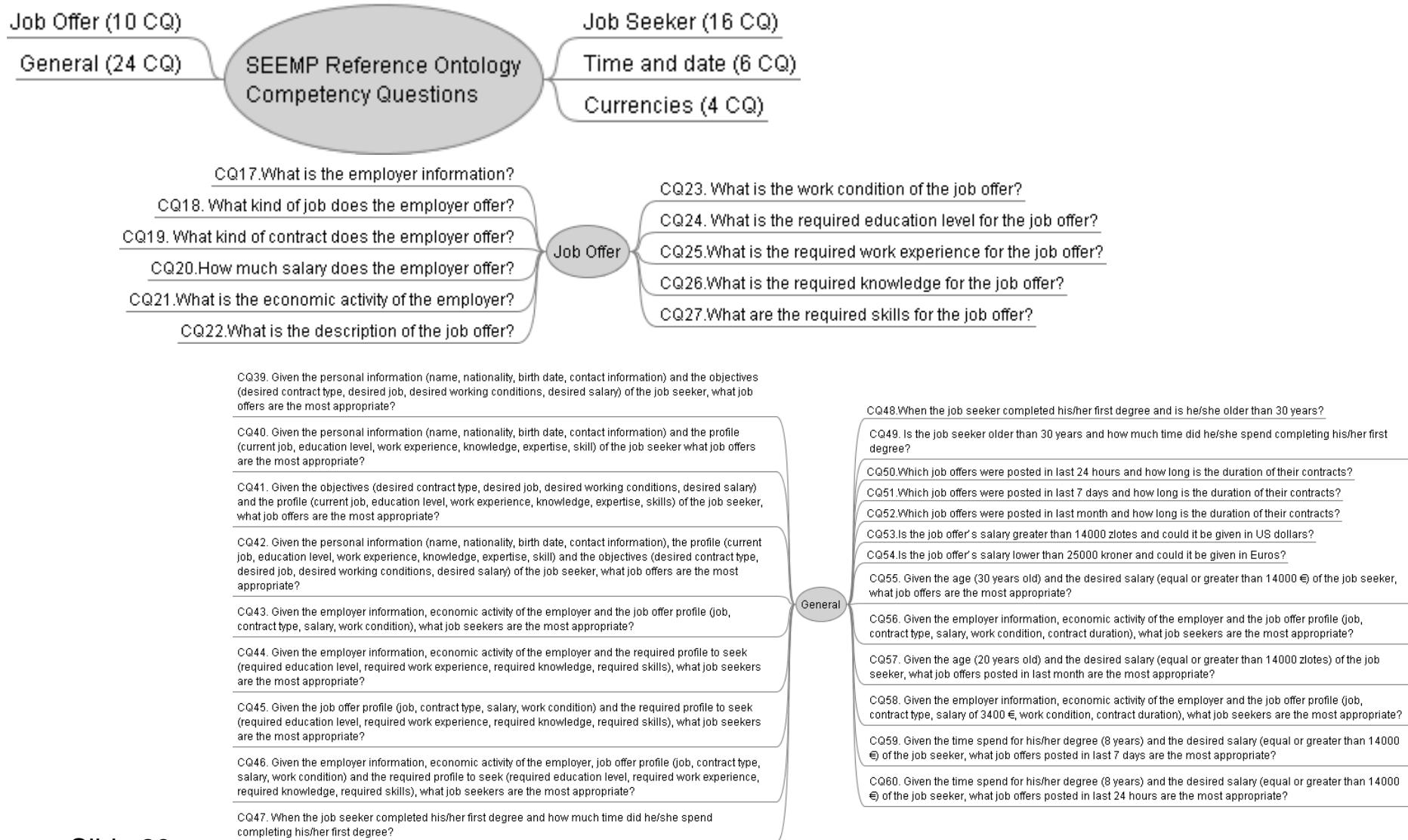
- CQ40. Given the personal information (name, nationality, birth date, contact information) and the profile (current job, education level, work experience, knowledge, expertise, skill) of the job seeker what job offers are the most appropriate?  
CQ41. Given the objectives (desired contract type, desired job, desired working conditions, desired salary) and the profile (current job, education level, work experience, knowledge, expertise, skills) of the job seeker, what job offers are the most appropriate?  
CQ42. Given the personal information (name, nationality, birth date, contact information), the profile (current job, education level, work experience, knowledge, expertise, skill) and the objectives (desired contract type, desired job, desired working conditions, desired salary) of the job seeker, what job offers are the most appropriate?  
CQ43. Given the employer information, economic activity of the employer and the job offer profile (job, contract type, salary, work condition), what job seekers are the most appropriate?  
CQ44. Given the employer information, economic activity of the employer and the required profile to seek (required education level, required work experience, required knowledge, required skills), what job seekers are the most appropriate?  
CQ45. Given the job offer profile (job, contract type, salary, work condition) and the required profile to seek (required education level, required work experience, required knowledge, required skills), what job seekers are the most appropriate?  
CQ46. Given the employer information, economic activity of the employer, job offer profile (job, contract type, salary, work condition) and the required profile to seek (required education level, required work experience, required knowledge, required skills), what job seekers are the most appropriate?  
CQ47. When the job seeker completed his/her first degree and how much time did he/she spend completing his/her first degree?  
CQ48. When the job seeker completed his/her first degree and is he/she older than 30 years?  
CQ49. Is the job seeker older than 30 years and how much time did he/she spend completing his/her first degree?  
CQ50. Which job offers were posted in last 24 hours and how long is the duration of their contracts?  
CQ51. Which job offers were posted in last 7 days and how long is the duration of their contracts?  
CQ52. Which job offers were posted in last month and how long is the duration of their contracts?  
CQ53. Is the job offer's salary greater than 14000 zlotes and could it be given in US dollars?  
CQ54. Is the job offer's salary lower than 25000 kroner and could it be given in Euros?  
CQ55. Given the age (30 years old) and the desired salary (equal or greater than 14000 €) of the job seeker, what job offers are the most appropriate?  
CQ56. Given the employer information, economic activity of the employer and the job offer profile (job, contract type, salary, work condition, contract duration), what job seekers are the most appropriate?  
CQ57. Given the age (20 years old) and the desired salary (equal or greater than 14000 zlotes) of the job seeker, what job offers posted in last month are the most appropriate?  
CQ58. Given the employer information, economic activity of the employer and the job offer profile (job, contract type, salary of 3400 €, work condition, contract duration), what job seekers are the most appropriate?  
CQ59. Given the time spent for his/her degree (8 years) and the desired salary (equal or greater than 14000 €) of the job seeker, what job offers posted in last 7 days are the most appropriate?  
CQ60. Given the time spent for his/her degree (8 years) and the desired salary (equal or greater than 14000 €) of the job seeker, what job offers posted in last 24 hours are the most appropriate?

# Ontology Requirements Specification. Task 5



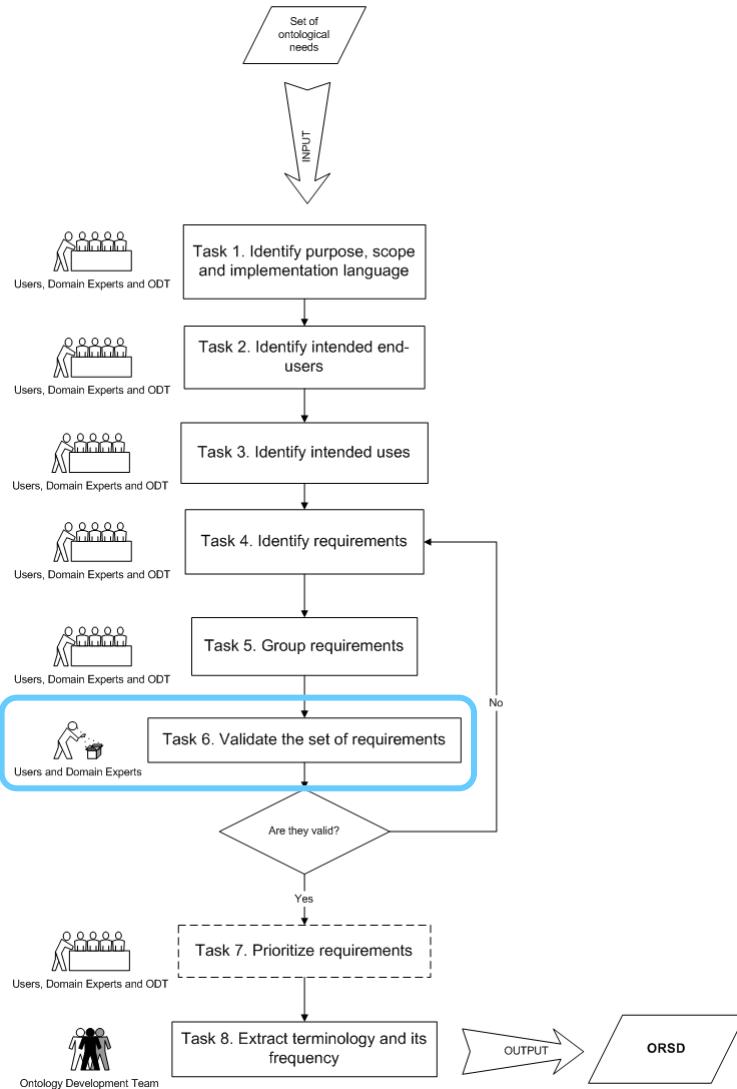
- **Input:** the list of CQs
  - **Objective:** obtaining different **groups of CQs**
  - **Techniques:** Card Sorting, when the grouping is done manually, and Clustering NL sentences or Information Extraction when the grouping is done automatically
  - **Tools:** MindMap Tools or Cicero Tool (for distributed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

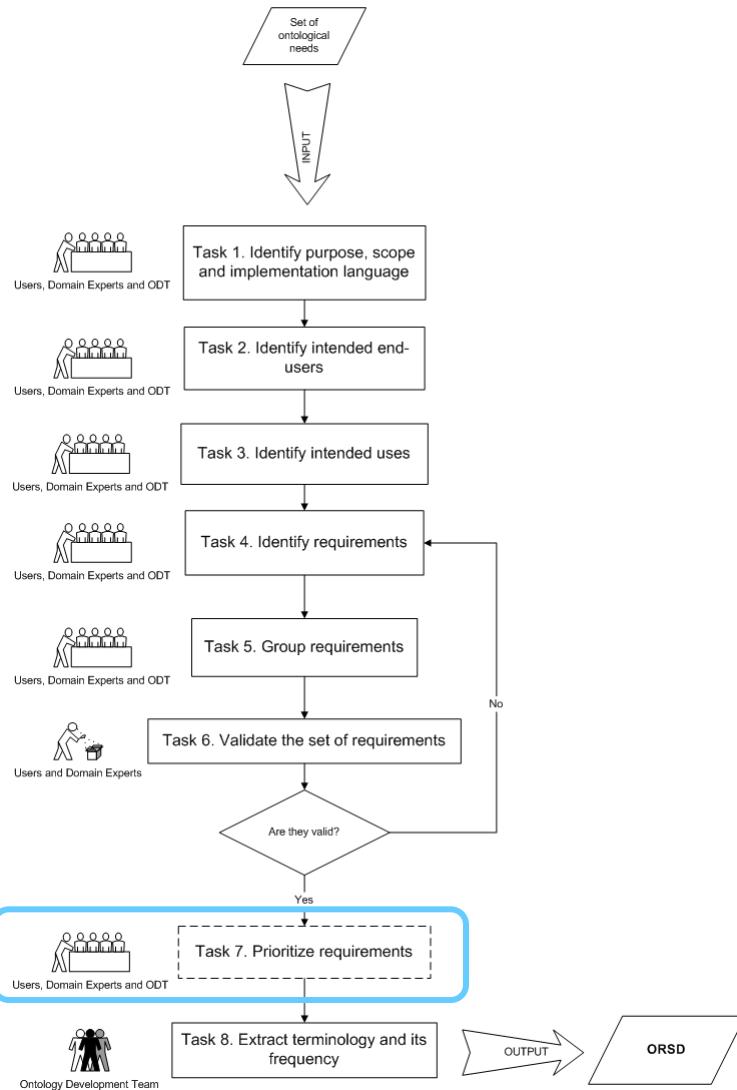
- |                        |                      |
|------------------------|----------------------|
| <i>Correctness.</i>    | <i>Completeness.</i> |
| <i>Consistent.</i>     | <i>Verifiable.</i>   |
| <i>Understandable.</i> | <i>No Ambiguity.</i> |
| <i>Conciseness.</i>    | <i>Realism.</i>      |
| <i>Modifiable.</i>     |                      |
| <i>Traceable.</i>      |                      |

**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

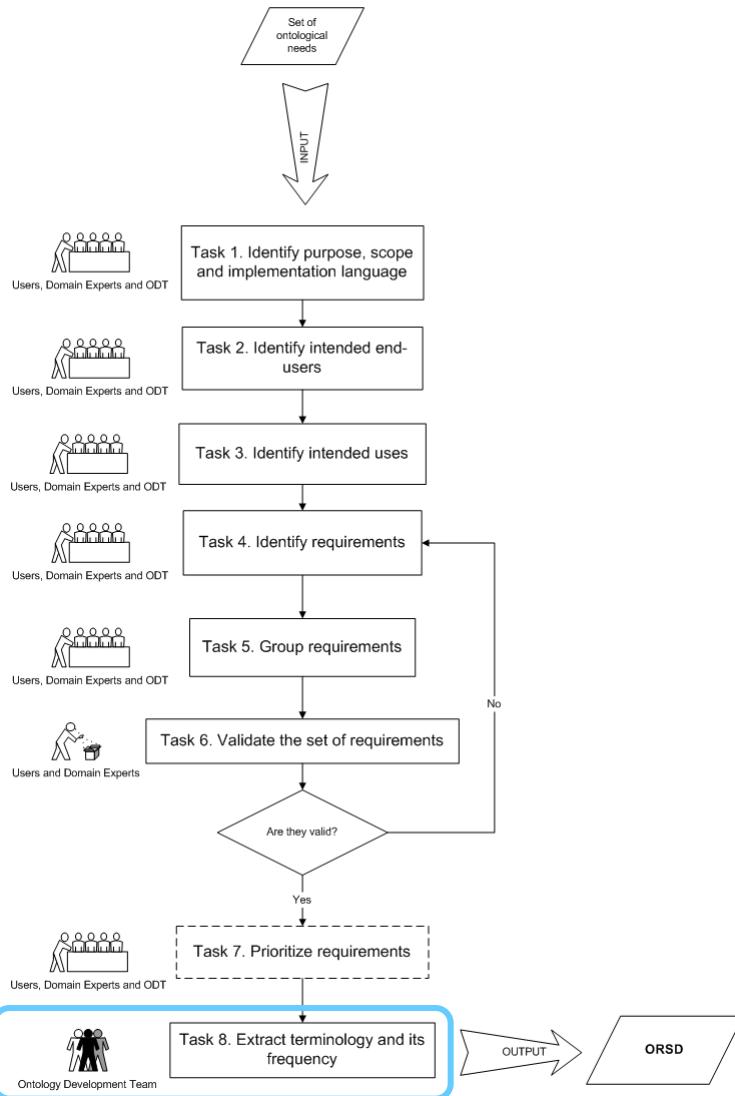


- ❑ *Input:* the groups of CQs written in natural language (obtained in task 5)
- ❑ *Objective:* to give **different levels of priority** to the different groups of CQs, and within each group to the identified requirements (in the form of CQs)
- ❑ *Output:* a set of priorities attached to each group 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	
<b>1 Purpose</b>	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.
<b>2 Scope</b>	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.
<b>3 Implementation Language</b>	The ontology has to be implemented in WSMIL language.
<b>4 Intended End-Users</b>	<p>User 1. Candidate who is unemployed and searching for a job occupation for immediate or future purposes</p> <p>User 2. Employer who needs more human resources.</p> <p>User 3. Public or private employment search service which collect CVs or job postings and to prepare some data and statistics</p> <p>User 4. National and Local Governments which want to analyze employment market in their countries and prepare documents about social and educational policy.</p> <p>User 5. European Commission and the governments of EU countries which want to analyze the statistics and prepare international agreements about the employment, social and educational policy.</p>
<b>5 Intended Uses</b>	<p>Use 1. Publish CV. Job seeker places his/her CV on the PES Portal.</p> <p>Use 2. Publish Job Offer. An Employer places a Job Offer on the PES Portal.</p> <p>Use 3. Search for Job Offers. The Employer looks for candidates through PES Portal.</p> <p>Use 4. Search for Employment information. Job Seeker finds information about employment in a given location at the PES Portal.</p> <p>Use 5. Provide Job Statistics. The PES Portal provides employment statistics for the Job Seeker and Employer.</p>

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

6	Ontology Requirements
	<p>b. Functional Requirements: Groups of Competency Questions</p> <p>CQG1. Job Seeker (14 CQ)</p>

7	Pre-Glossary of Terms																								
	<p>a. Terms from Competency Questions + Frequency</p> <table> <tbody> <tr> <td>Job Seeker</td> <td>27</td> <td>Address</td> <td>1</td> </tr> <tr> <td>CV</td> <td>2</td> <td>Nationality</td> <td>1</td> </tr> <tr> <td>Personal Information</td> <td>3</td> <td>Contact (phone, fax, mail)</td> <td>3</td> </tr> <tr> <td>Name</td> <td>4</td> <td>Objective</td> <td>3</td> </tr> <tr> <td>Gender</td> <td>1</td> <td>Job Category</td> <td>3</td> </tr> <tr> <td>Birth date</td> <td>1</td> <td>...</td> <td></td> </tr> </tbody> </table>	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	...	
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Name	4	Objective	3																						
Gender	1	Job Category	3																						
Birth date	1	...																							
	<p>b. Terms from Answers + Frequency</p> <table> <tbody> <tr> <td>SW engineer, programmer</td> <td>5</td> <td>Research, Financial, Education</td> <td>4</td> </tr> <tr> <td>British, Spanish, Italian, French</td> <td>1</td> <td>1 year, 2 years, 3 years</td> <td>1</td> </tr> <tr> <td>Autonomous, Seasonal Job,</td> <td>2</td> <td>3000 Euros per month</td> <td>1</td> </tr> <tr> <td>Basic education, Higher education</td> <td>1</td> <td>CEFRIEL Research Company</td> <td>1</td> </tr> </tbody> </table>	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								
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CEFRIEL, ATOS, etc.																									

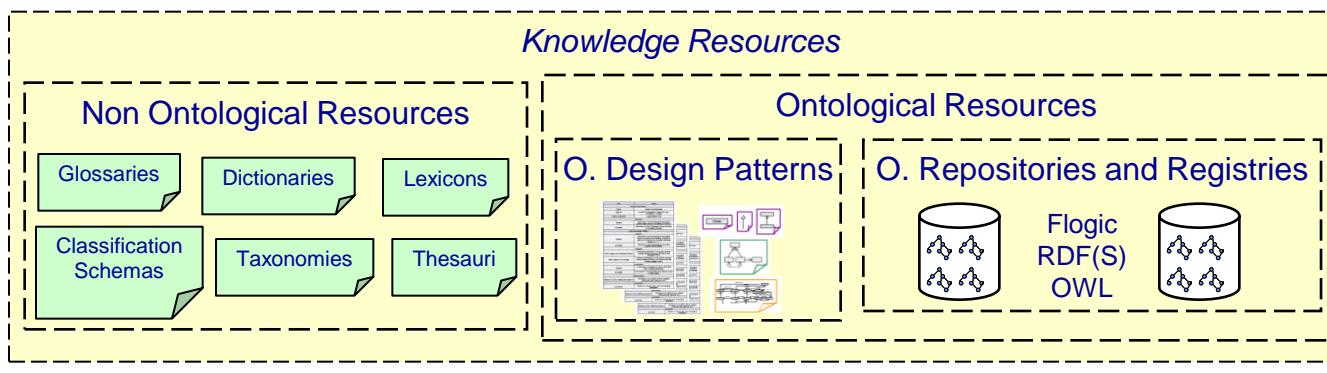
Higher education/University  
CQ23. What is the required work experience for the job offer? 1 year, 2 years, 3 years, 4 years, 5 or more years  
CQ24. What is the required knowledge for the job offer? Java, Haskell, Windows  
CQ25. What are the required skills for the job offer? ASP Programmer, Data warehouse, Hardware programming

# Index

- Introduction
- Scenarios in Ontology Building
- Methodological Guidelines for Ontology Specification
- **Quick Search and Selection 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

# Searching Resources

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



Objects
Objects in the universe of discourse, which are instances of:
<ul style="list-style-type: none"> <li>• Job Category           <ul style="list-style-type: none"> <li>O1. Computer System Designer</li> <li>O2. Computer System Analyst</li> <li>O3. Programmer</li> <li>O4. Computer Engineer</li> <li>O5. Computer Assistant</li> <li>O6. Computer Equipment Operator</li> <li>O7. Industrial Robot Controller</li> <li>O8. Telecommunication Equipment Operator</li> <li>O9. Medical Equipment Operator</li> <li>O10. Electronic Equipment Operator</li> <li>O11. Image Equipment Operator</li> </ul> </li> <li>• Nationality           <ul style="list-style-type: none"> <li>O12. Austrian</li> <li>O13. Belgian</li> <li>O14. Danish</li> <li>O15. Estonian</li> <li>O16. Finnish</li> <li>O17. French</li> <li>O18. German</li> <li>O19. Greek</li> <li>O20. Italian</li> </ul> </li> </ul>

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



## ISO 4217 (currencies)

Entity	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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# 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 ausdrückl 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 Geburtst
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 pré primaire	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

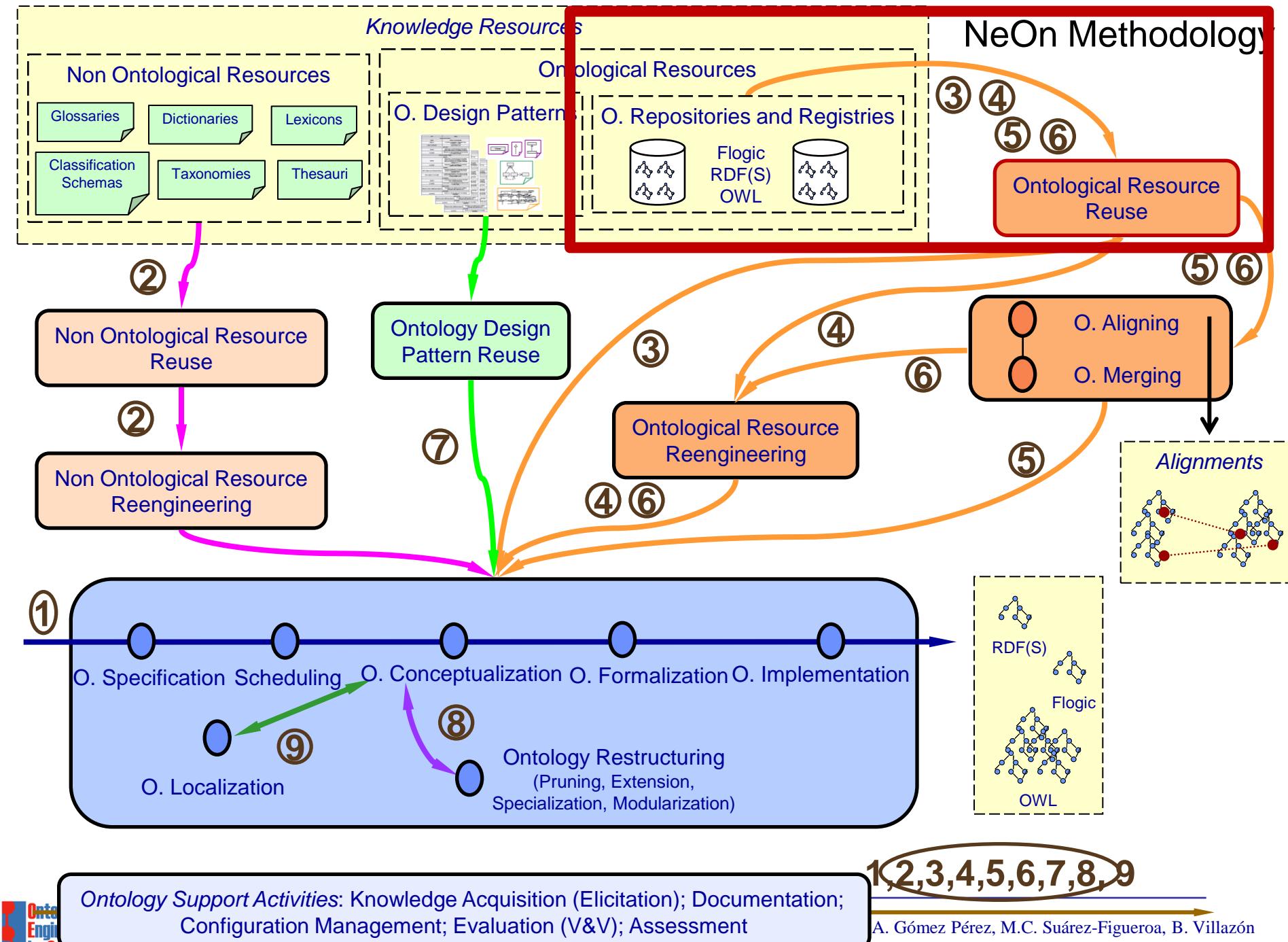
LE FOREM, Eures and BLL Classification

Work Condition Classification

LE FOREM, Eures and BLL Classification

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

# NeOn Methodology



# 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 domain of discourse, which are instances of:	
Job Category	<ul style="list-style-type: none"> <li>• Education</li> <li>• O29. Life Science</li> <li>• O30. Mathematics</li> <li>• O31. Computer Science</li> <li>• O32. Computer Use</li> <li>• O33. Statistics</li> <li>• O34. Physics</li> <li>• O35. Network Administration</li> </ul>
O1. Computer System Designer	<a href="#">Read this - Check your ontology - Website - Blog</a>
O2. Computer System Analyst	university researcher student
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	<ul style="list-style-type: none"> <li>• Languages</li> <li>• O36. Swedish</li> <li>• O37. Spanish</li> <li>• O38. German</li> <li>• O39. Portuguese</li> <li>• O40. English</li> <li>• O41. French</li> <li>• O42. German</li> </ul>
O12. Austrian	
O13. Belgian	
O14. Danish	
O15. Estonian	
O16. Finnish	
O17. French	
O18. German	
O19. Greek	
O20. Italian	
Activity Sector	<ul style="list-style-type: none"> <li>• Currency</li> <li>• O43. Euro</li> <li>• O44. Krone</li> <li>• O45. Great British Pound</li> <li>• O46. Złoty</li> <li>• O47. US Dollar</li> <li>• O48. Franc</li> </ul>
O21. Telecommunication	<ul style="list-style-type: none"> <li>• Location</li> <li>• O49. Austria</li> <li>• O50. Belgium</li> <li>• O51. Denmark</li> <li>• O52. Estonia</li> <li>• O53. Finland</li> <li>• O54. France</li> <li>• O55. Germany</li> <li>• O56. Greece</li> </ul>
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	

Watson Semantic Web Search  
<http://kmi-web05.open.ac.uk/WatsonWUI/>

diana Apple (110) ▾ Amazon eBay Yahoo! News (1049) ▾ neon-newsfe...n,WP4 (3) WII Old Compute... computers

https://oufe.o... Mail :: Welcom... Virgin.net We... MegaTokyo - ... Watson Sema... Widget Devel... DEXA 2007

 [Read this - Check your ontology - Website - Blog](#)  
[university researcher student](#) [Search Watson](#)

Found 19 semantic documents - [Restrict Search](#)

1- <http://daml.umbc.edu/ontologies/cobra/0.4/academia> □  
 5 KB - RDF,OWL (OWL FULL) - ALCH(D)  

- [http://daml.umbc.edu/ontologies/cobra/0.4/academia#University](#) □  
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- [http://daml.umbc.edu/ontologies/cobra/0.4/academia#Researcher](#) □  
 Label: Researcher
- [http://daml.umbc.edu/ontologies/cobra/0.4/academia#GradStudentResearcher](#) □  
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- [http://daml.umbc.edu/ontologies/cobra/0.4/academia#GradStudentResearcher](#) □

 2- <http://annotation.semanticweb.org/ontologies/iswc.owl> □  
 30 KB - OWL,RDF (OWL Lite) - AL(D)  

- [http://annotation.semanticweb.org/2004/iswc#University](#) □
- [http://annotation.semanticweb.org/2004/iswc#University\\_of\\_Karlsruhe](#) □
- [http://annotation.semanticweb.org/2004/iswc#Researcher](#) □
- [http://annotation.semanticweb.org/2004/iswc#Student](#) □
- [http://annotation.semanticweb.org/2004/iswc#PhDStudent](#) □

 3- <http://ontobroker.semanticweb.org/ontologies/ka2-onto-2000-11-07.daml> □  

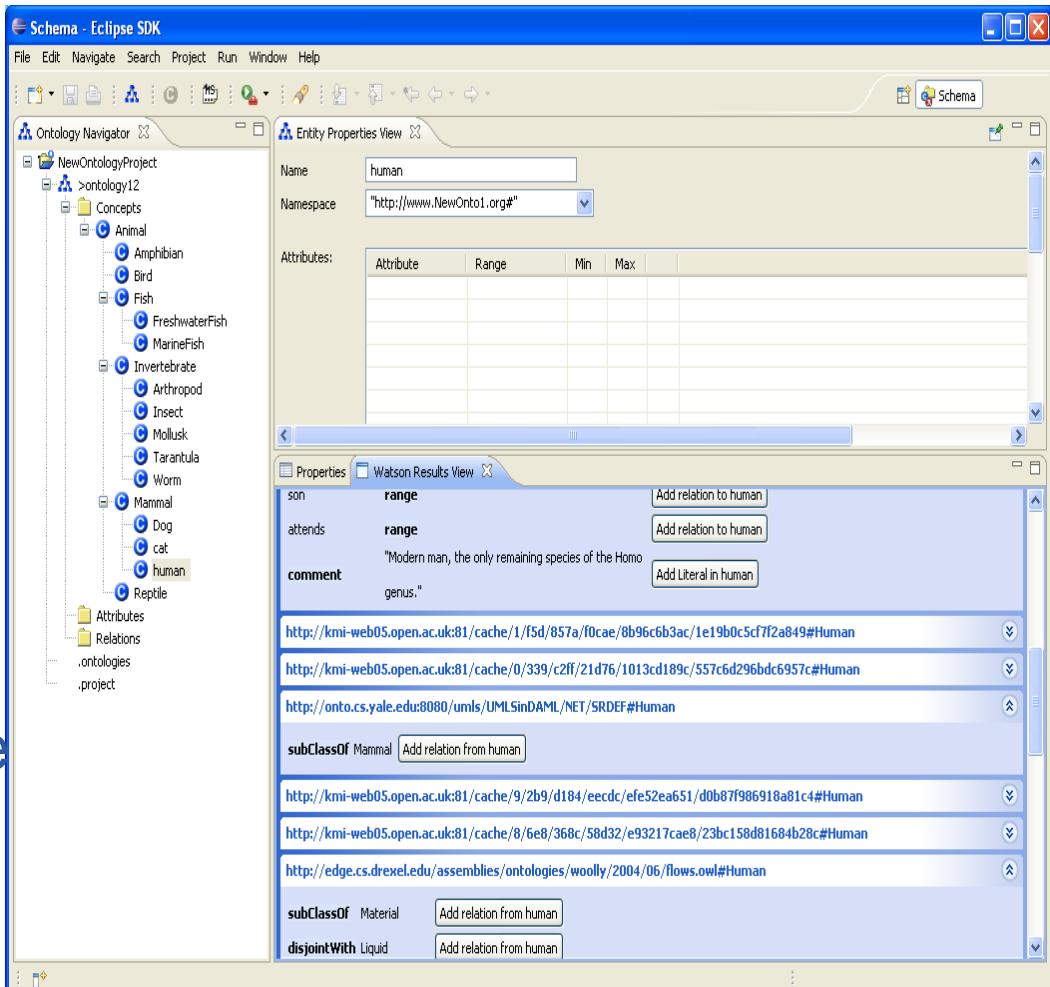
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 32 KB - DAML+OIL,RDF - AL(D)  

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# Watson NeOn Toolkit plugin

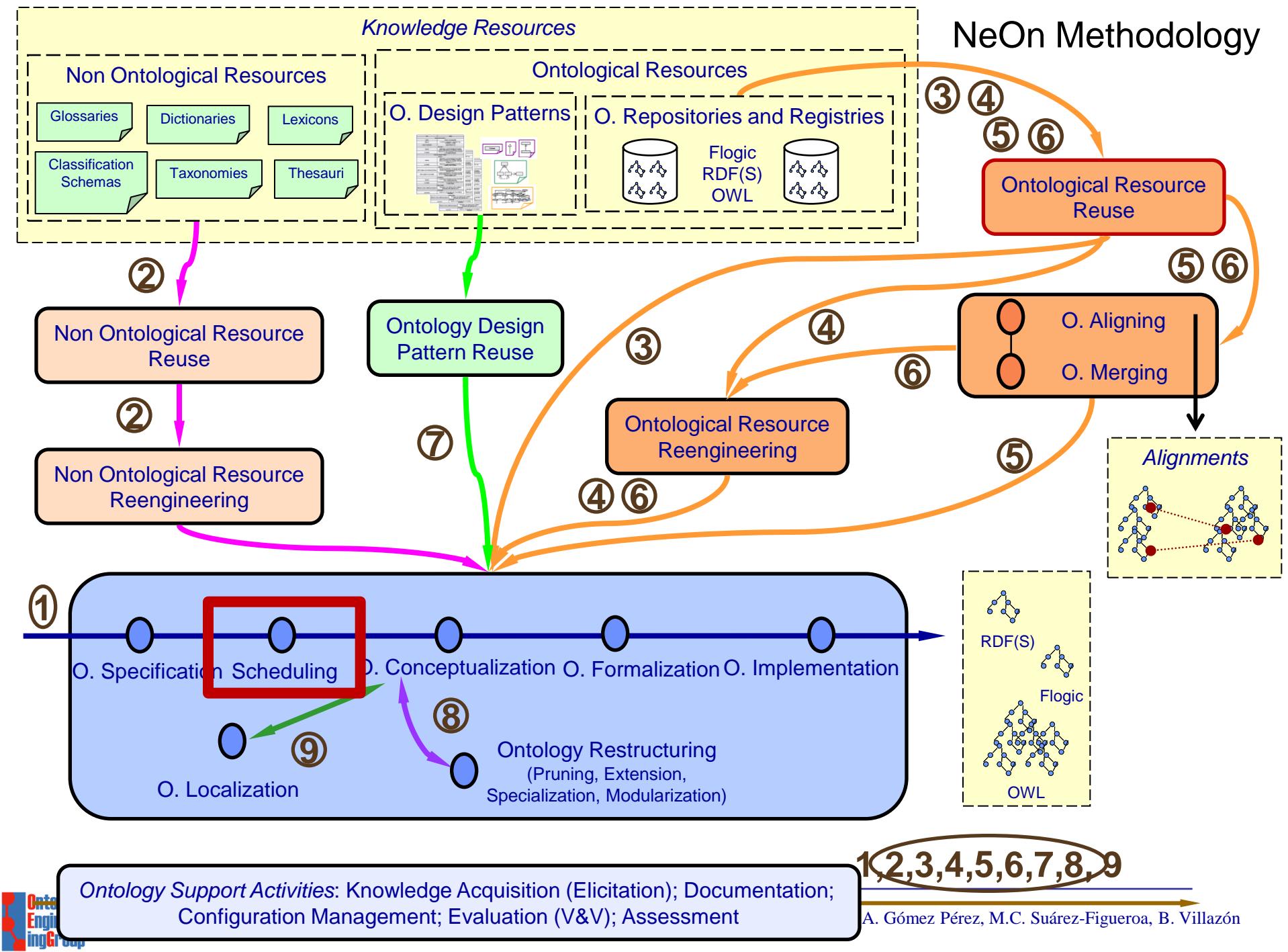
- While building an ontology with the Neon toolkit
- Find descriptions of existing entities in Web ontologies
- Integrate these descriptions into the edited ontology
- Thus allowing knowledge reuse at the scale of the Semantic Web
- In one simple, integrated, and interactive tool



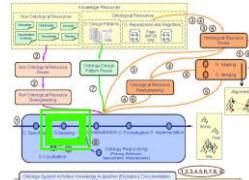
# Index

- Introduction
- Scenarios in Ontology Building
- Methodological Guidelines for Ontology Specification
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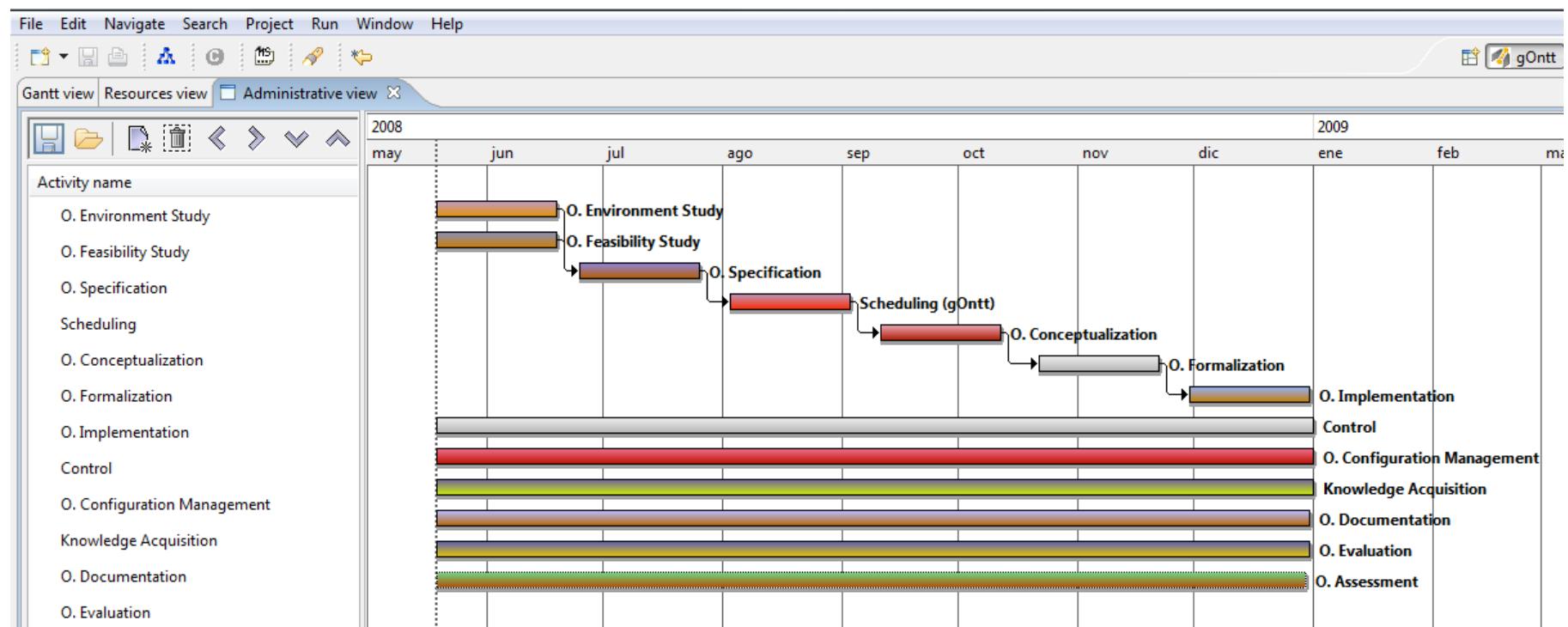
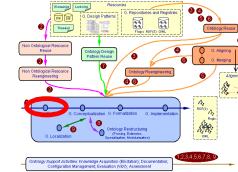
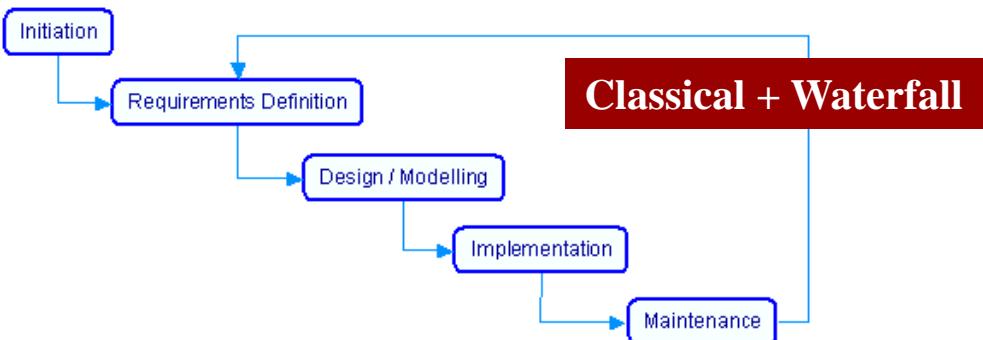
# NeOn Methodology



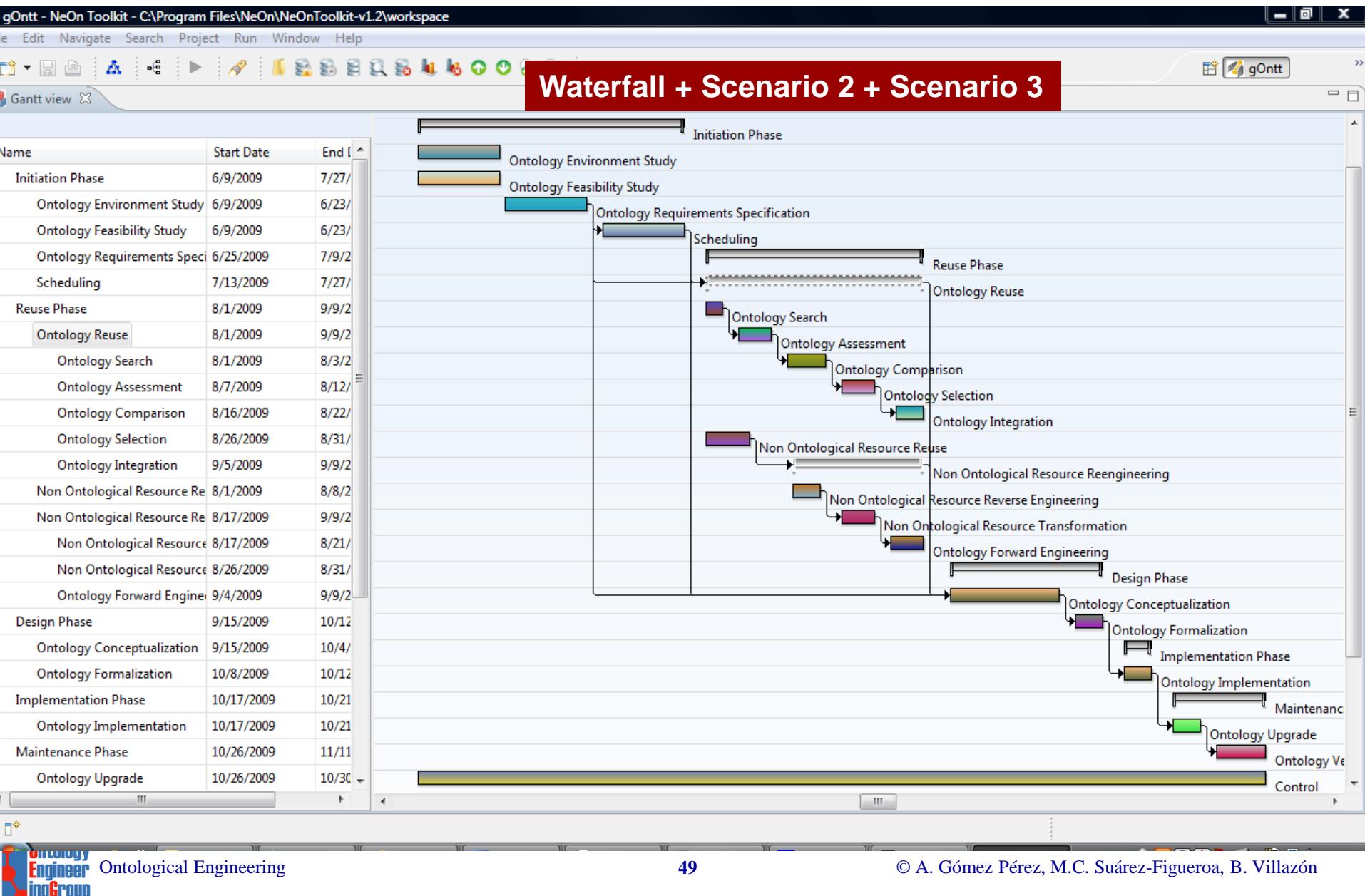
# Scheduling. Filling Card



Scheduling	
<p><b>Definition</b></p> <p><i>Scheduling</i> refers to the activity of identifying the different activities and processes to be performed during the ontology development, their arrangement, and the time and resources needed for their completion.</p>	
<p><b>Goal</b></p> <p>The scheduling activity states a concrete programming or scheduling to guide the ontology network development, including processes and activities, their order, and time and human resources restrictions and assignments.</p>	
<p><b>Input</b></p> <p>Ontology Requirements Specification Document (ORSD).</p>	<p><b>Output</b></p> <p>Schedule for the ontology network development.</p>
<p><b>Who</b></p> <p>Software developers and ontology practitioners, who form the ontology development team (ODT), in collaboration with users and domain experts.</p>	
<p><b>When</b></p> <p>This activity must be carried out after the ontology requirements specification activity.</p>	

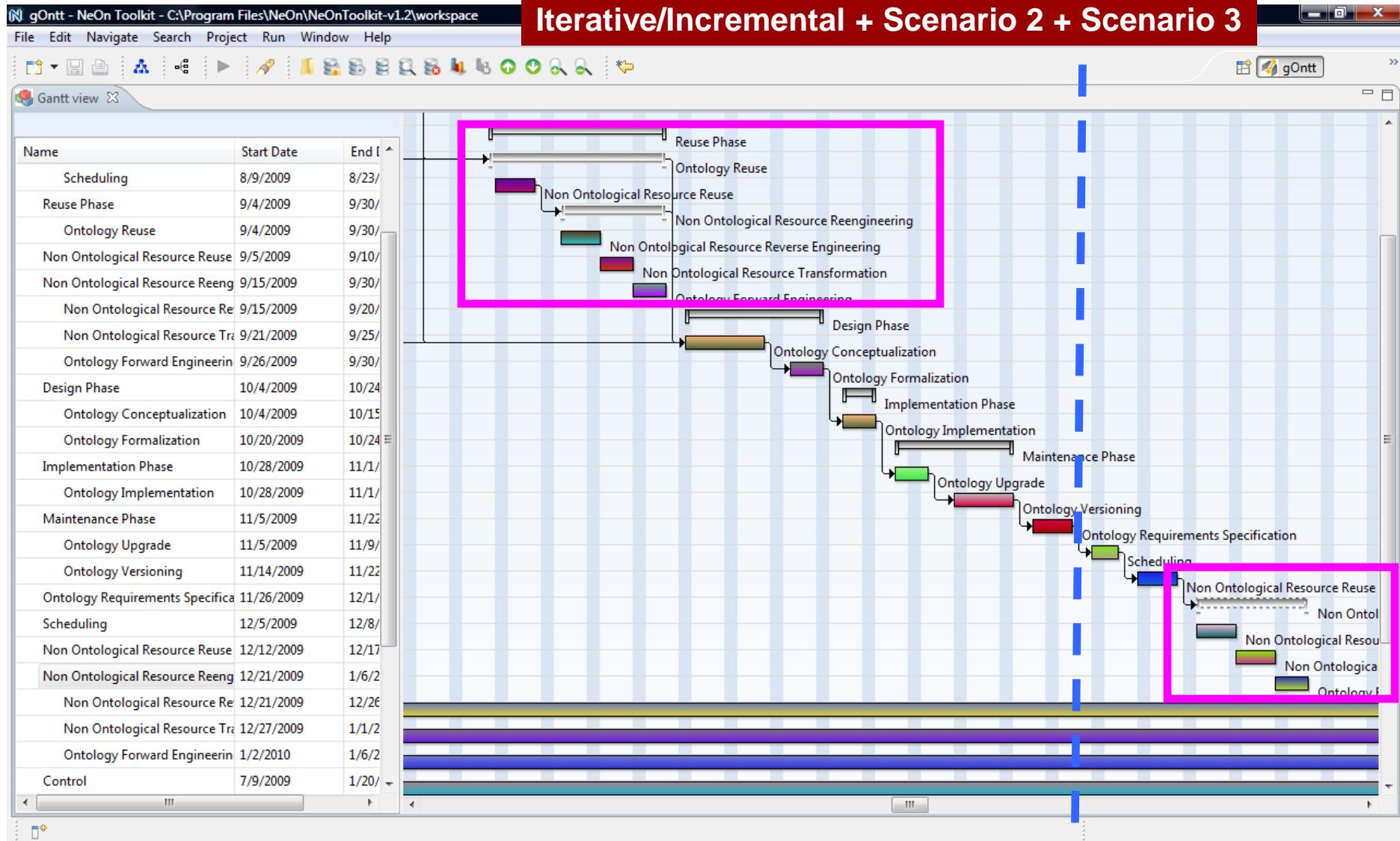


# Gantt chart for your project (I)



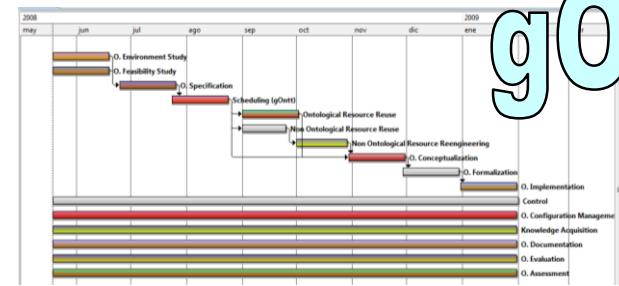
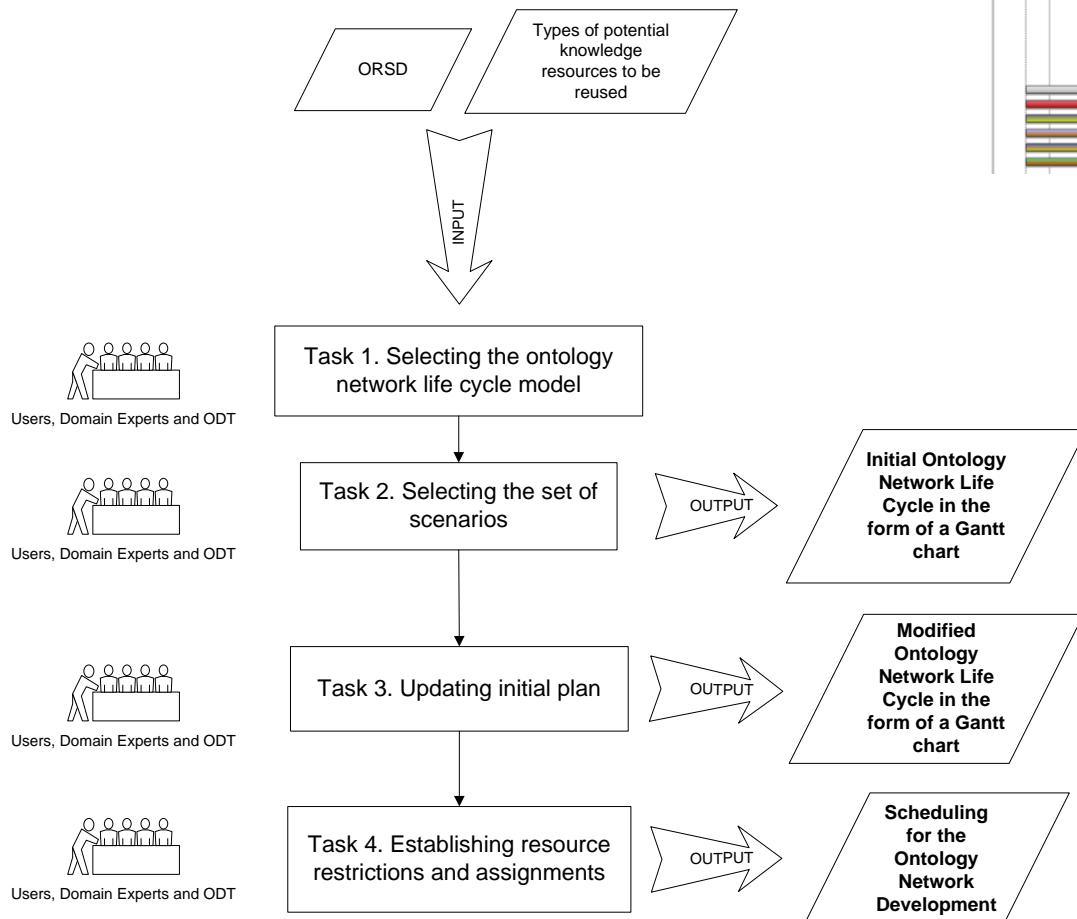
# Gantt chart for your project (II)

## Iterative/Incremental + Scenario 2 + Scenario 3

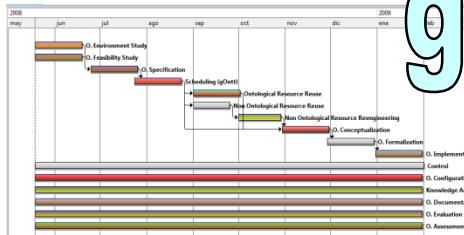


# Scheduling. Methodological Guidelines

gOntt  
NeOn

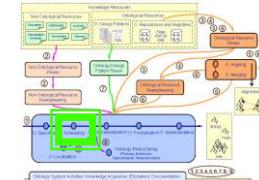


# Scheduling. gOntt Plug-in



gOntt

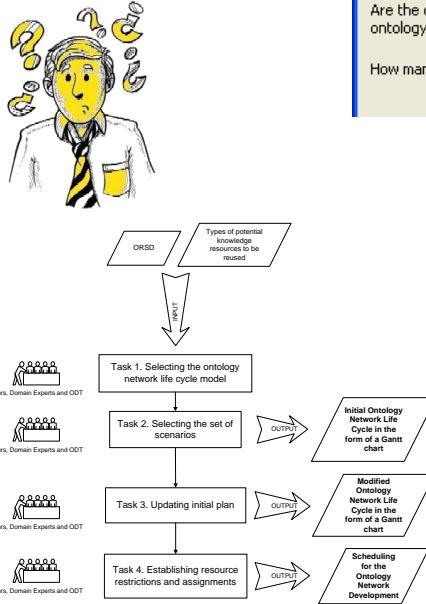
NeOn



- **gOntt helps in scheduling an ontology network development.**
- **gOntt is a NeOn plug-in for integrating the NeOn Methodology and the NeOn Toolkit.**
  - gOntt provides filling cards, workflows, and methodological guidelines.
  - gOntt triggers the NeOn plug-ins associated to each process and activity planned.



# Scheduling, gOntt and Methodological Guidelines



Are the ontology requirements assumed to be fully known at the begining of the ontology network development?

Yes  No

How many cycles do you want to perform in your ontology network development?

5

Scenario 1: From specification to implementation.

Yes  No

Scenario 2: Have you planned to use any non-ontological resource such as thesauri, data bases, etc. in your ontology network development?

Yes  No

Scenario 3: Have you planned to use any existing ontological resource in your ontology network development?

Yes  No

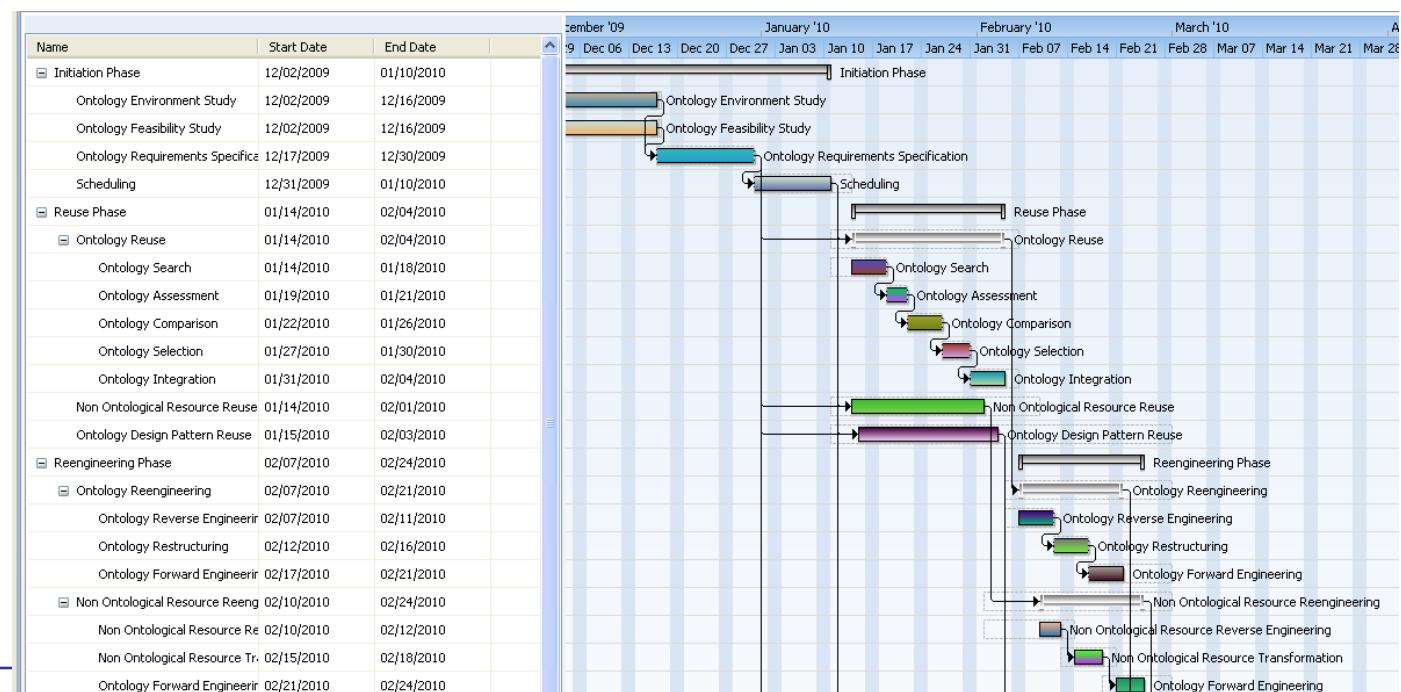
Scenario 4: Have you planned to use and modify any existing ontological resource in your ontology network development?

Yes  No

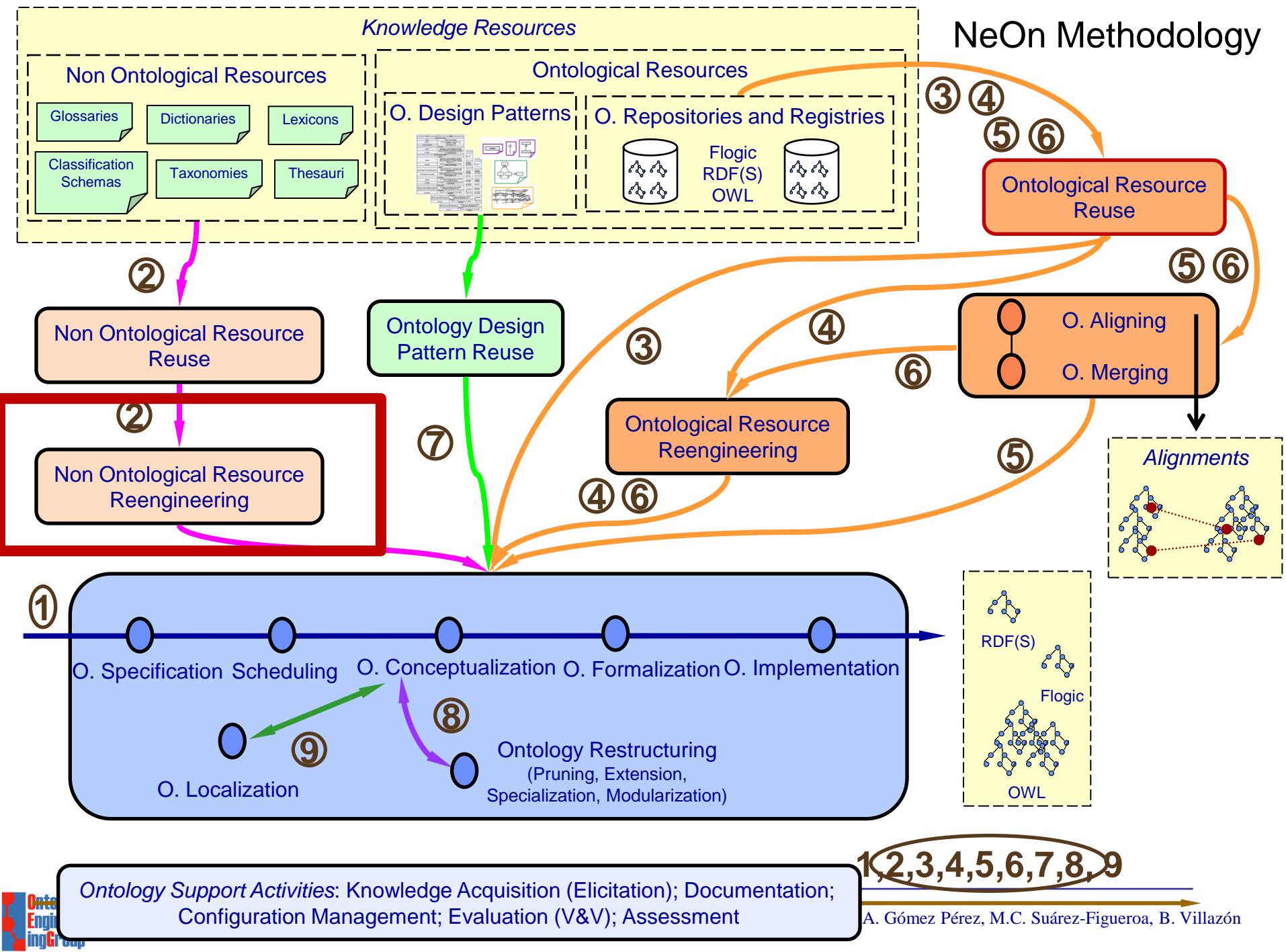
Scenario 5: Have you planned to use and merge a set of existing ontological resources in your ontology network development?

Yes  No

gOntt



# NeOn Methodology

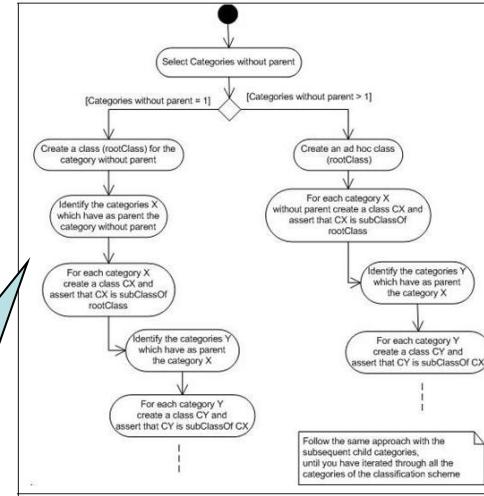


# Motivation

resource

Id	Category Name	Parent
20000	Water area	1
21000	Environmental area	20000
22000	Fishing Statistical area	20000
24020	Jurisdiction area	20000
21001	Inland/marine	21000
21002	Ocean	21000
21003	North/South/Equatorial	21000
21004	Sub Ocean	21000
21005	Large Marine ecosystem	21000

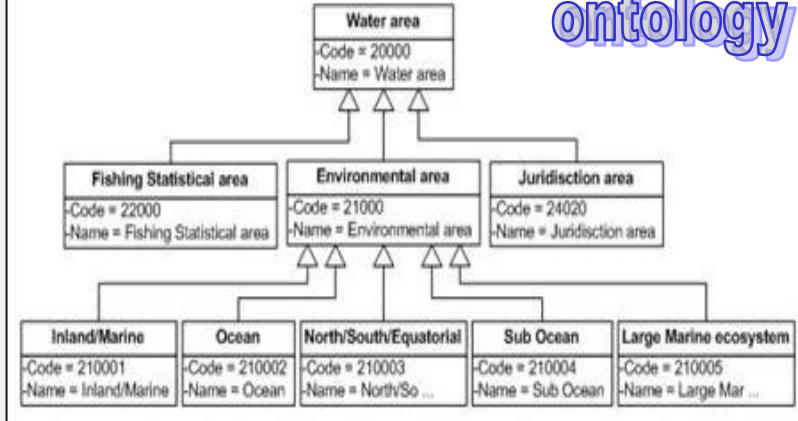
Algorithm



I want to transform my adjacency list-based classification into an ontology

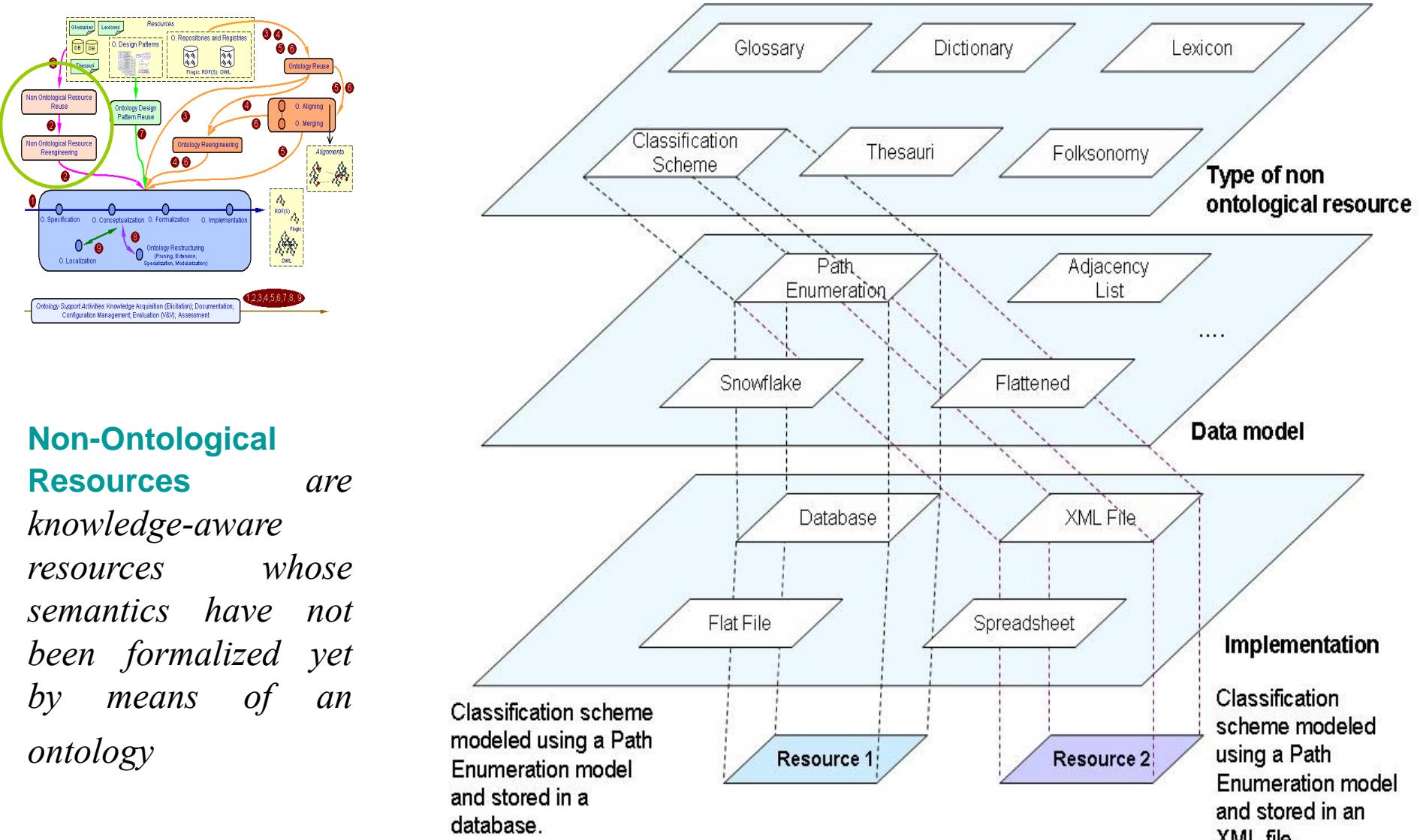


(UML)  
Example Solution  
Ontology



ontology

# Types of non-ontological resources

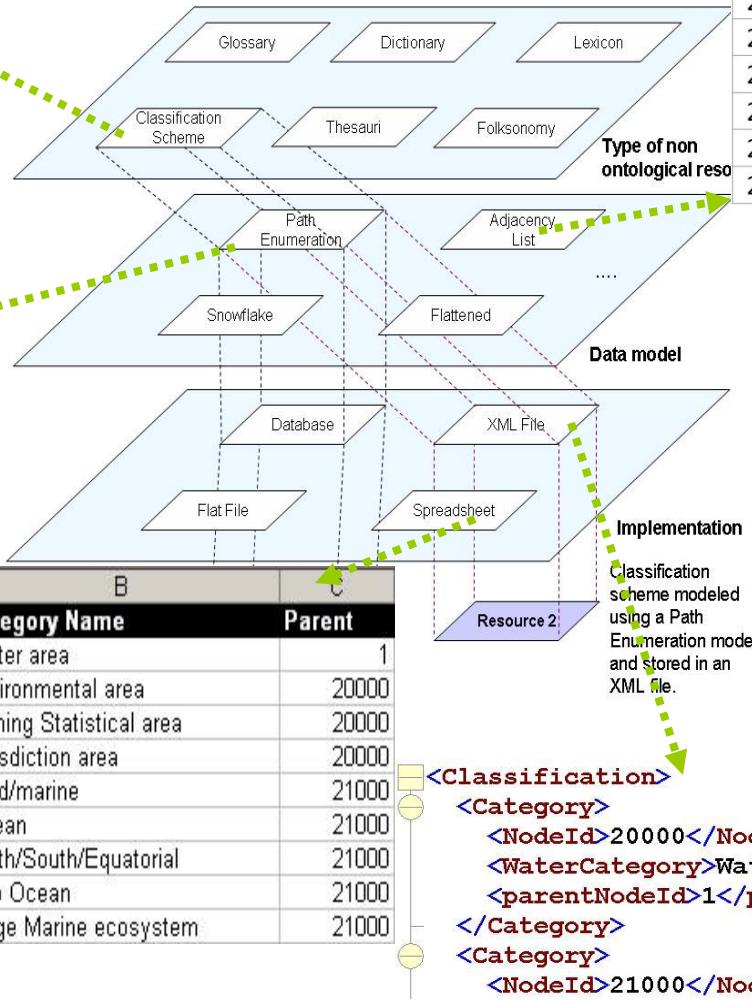


# Types of non-ontological resources

<input checked="" type="checkbox"/>	Water area
<input type="checkbox"/>	Environmental area
<input type="checkbox"/>	Inland/marine
<input type="checkbox"/>	Ocean
<input type="checkbox"/>	North/South/Equatorial
<input type="checkbox"/>	Sub-Ocean
<input type="checkbox"/>	Large Marine Ecosystem
<input type="checkbox"/>	Fishing Statistical area
<input type="checkbox"/>	Jurisdiction area
<input type="checkbox"/>	Fishery Management area
<input type="checkbox"/>	Reporting area

Id	Category Name
20000	Water area
20000.21000	Environmental area
20000.22000	Fishing Statistical area
20000.24020	Jurisdiction area
21000.21001	Inland/marine
21000.21002	Ocean
21000.21003	North/South/Equatorial
21000.21004	Sub Ocean
21000.21005	Large Marine ecosystem

A	B	C
Id	Category Name	Parent
1	Water area	1
2	Environmental area	20000
3	Fishing Statistical area	20000
4	Jurisdiction area	20000
5	Inland/marine	21000
6	Ocean	21000
7	North/South/Equatorial	21000
8	Sub Ocean	21000
9	Large Marine ecosystem	21000
10		



# NOR data models

- Non-Ontological Resources
  - Classification Schemes
    - Path Enumeration
    - Adjacency List
    - Snowflake
    - Flattened
  - Thesauri
    - Record based
    - Relation based
  - Lexicons
    - Record based
    - Relation based



# Lexicon data models

- Record-based data model

Word	Gloss	POS	Part Meronym	Part Holonym	Hypemym	Hponym	...
river	a large natural stream of water (larger than a creek); "the river was navigable for 50 miles"	N	estuary rapid waterfall	water system	stream		
	...						

- Relation-based data model

Synsetid	Word	POS	Gloss	...
108614198	river	n	a large natural stream of water (larger than a creek); "the river was navigable for 50 miles"	...
108814882	rapid	n	a part of a river where the current is very fast	...
108696219	stuary	n	the wide part of a river where it nears the sea; fresh and salt water mix	...
108854154	stream	n	a natural body of running water flowing on or under the earth	...
...	...	...	...	...

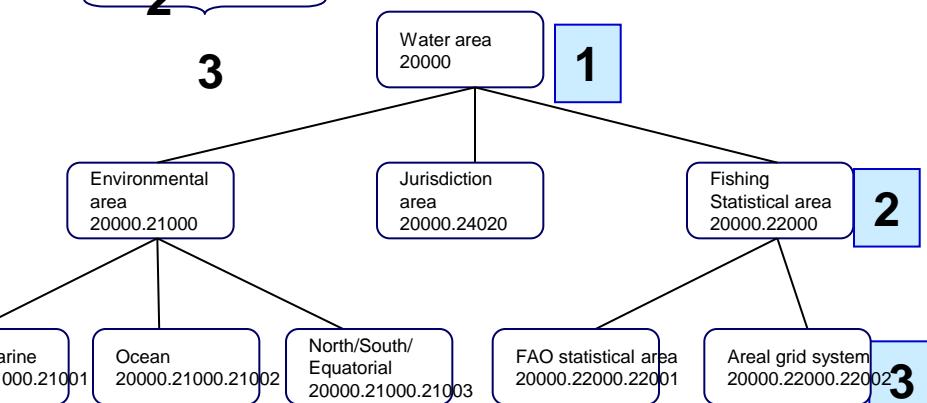
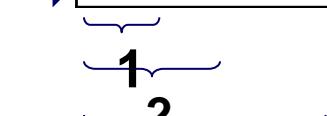
Synset1id	Synset2id	Linkid
108614198	108696219	11
108614198	108854154	1
...	...	...

Linkid	Link
1	hypernym
11	part holonym
12	part meronym
...	...

# Classification Scheme Data Models (I)

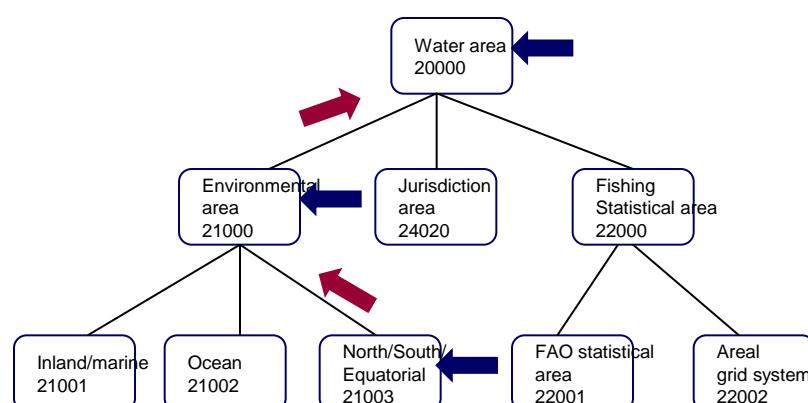
- **Path Enumeration Data Model** is defined as a model that stores for each node the path (as a string) from the root to the node.

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



- **Adjacency List** is a recursive structure for hierarchy representations that comprises a list of nodes with a linking column to their parent nodes.

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



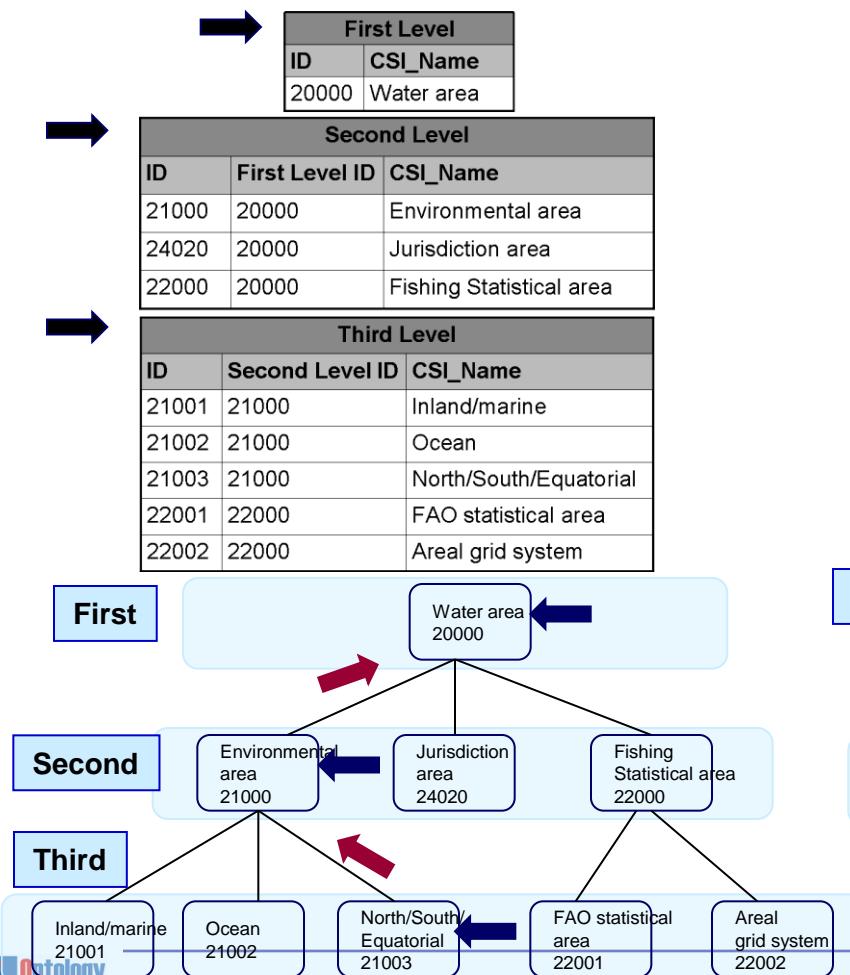
# Classification Scheme Data Models (II)

- **Snowflake Data Model** is a normalized structure for hierarchy representations. For each hierarchy level a entity is created. In this model each hierarchy node has a column linked to its parent node.

First Level	
ID	CSI_Name
20000	Water area

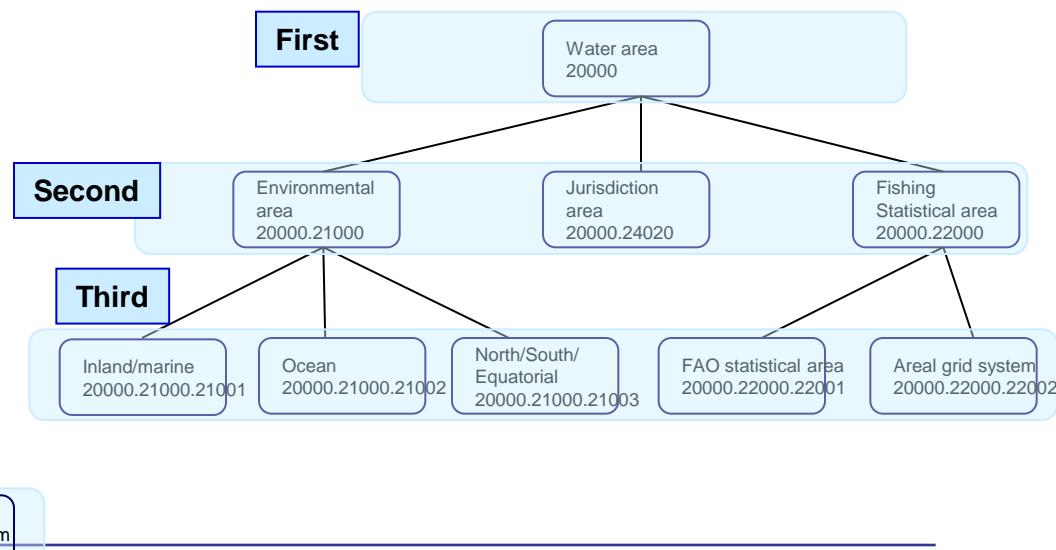
Second Level		
ID	First Level ID	CSI_Name
21000	20000	Environmental area
24020	20000	Jurisdiction area
22000	20000	Fishing Statistical area

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



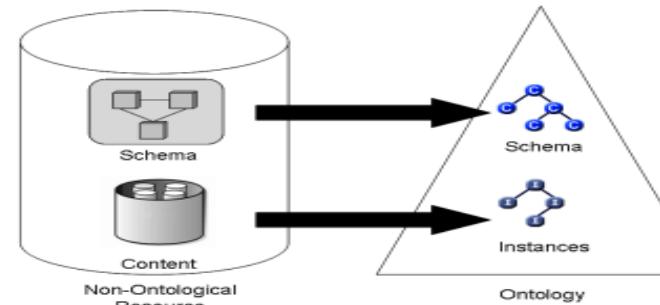
- **Flattened Data Model**, is a denormalized structure. The hierarchy is represented with an entity where each hierarchy level is stored on a different column.

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		



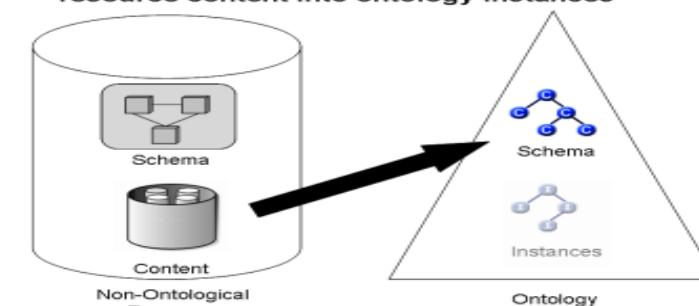
# Approaches to transform resources into ontologies

ABox



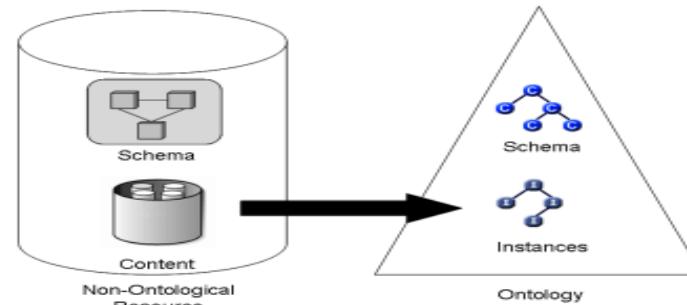
Transforming resource schema into an ontology schema, and resource content into ontology instances

TBox



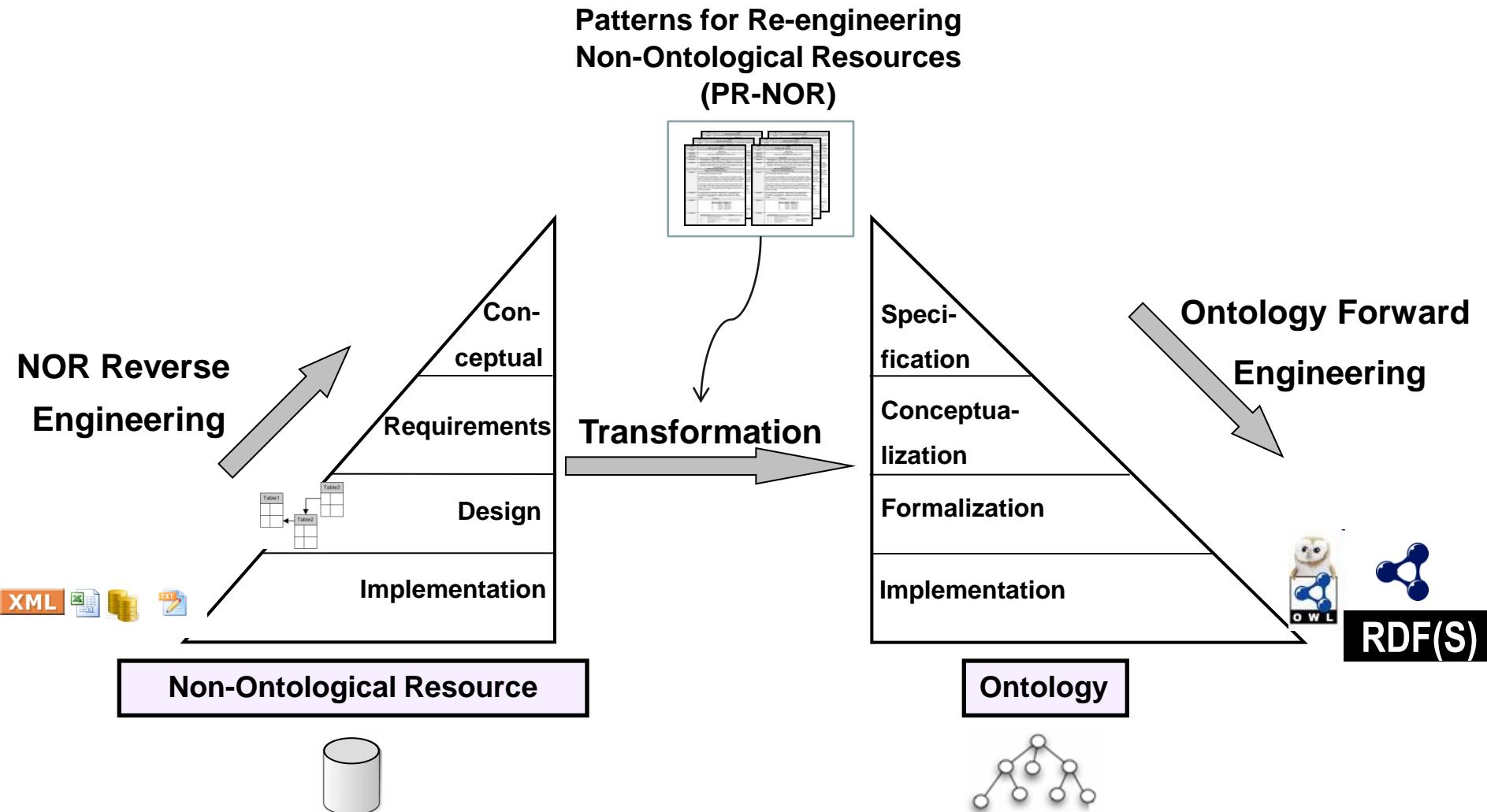
Transforming resource content into an ontology schema

Population



Transforming resource content into instances of an existing ontology

# Re-engineering Model for NORs



# Pattern for re-engineering a classification scheme, which follows the adjacency list data model, into an ontology schema

## INPUT: Non-Ontological Resource General

A non-ontological resource holds a classification scheme which follows the adjacency list model. A classification scheme is a rooted tree of concepts, in which each concept groups entities by some particular degree of similarity. The semantics of the hierarchical relation between parents and children concepts may vary depending of the context. The adjacency list data model for hierarchical classifications proposes to create an entity which holds a list of items with a linking column associated to their parent items.

Category Code	Category Name	Parent Category Code
1	Category1	Null
2	Category2	Null
3	Category3	1
4	Category4	1
5	Category6	3
6	Category7	4
...	...	...

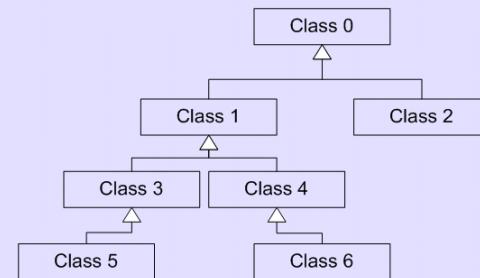
## Example

The FAO classification for water areas groups them according to some different criteria as environment, statistics, and jurisdiction, among others. This classification scheme is available at <http://www.fao.org/figis/servlet/RefServlet>

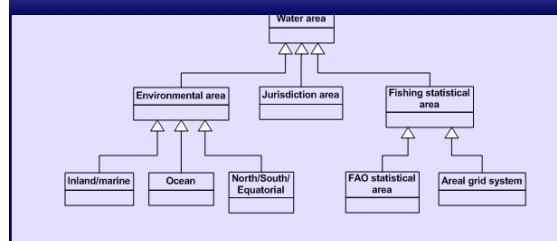
ID	CSI_Name	Parent
20000	Water area	
21000	Environmental area	20000
24020	Jurisdiction area	20000
22000	Fishing Statistical area	20000
21001	Inland/marine	21000
21002	Ocean	21000
21003	North/South/Equatorial	21000
22001	FAO statistical area	22000
22002	Areal grid system	22000

## OUTPUT: Ontology General

The ontology generated will be based on the taxonomy architectural pattern (AP-TX-01). Each category in the classification scheme is mapped to a class, and the semantics of the relationship between children and parent are disambiguated by using an external resource.



## Example



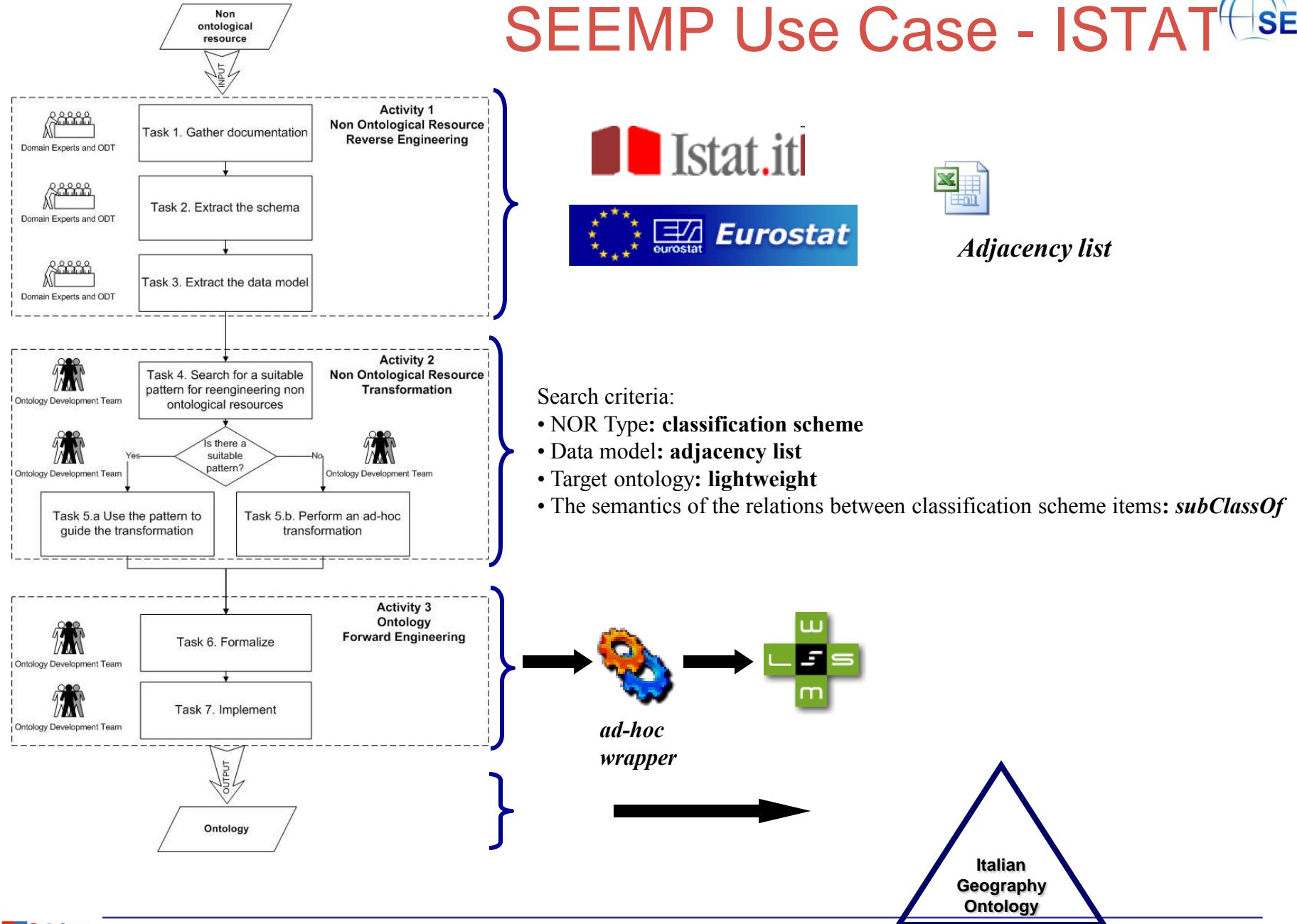
## PROCESS: How to Re-engineer

2. Create the Environmental area class.
3. Using the external resource identify the semantics of the relation between the Environmental area class and the Water area class, and set up the relation identified.
  - 3.1. Create the Inland/marine class.
  - 3.2. Using the external resource identify the semantics of the relation between the Inland/marine class and the Environmental area class, and set up the identified relation.
  - 3.3. Create the Ocean class.
  - 3.4. Using the external resource identify the semantics of the relation between the Ocean class and the Environmental area class, and set up the relation identified.
- 3.5. Create the North/South/Equatorial class.
- 3.6. Using the external resource identify the semantics of the relation between the North/South/Equatorial class and the Environmental area class, and set up the relation identified.
4. Create the Fishing Statistical area class.
5. Using the external resource identify the semantics of the relation between the Fishing Statistical area class and the Water area class, and set up the relation identified.
  - 5.1. Create the FAO statistical area class.
  - 5.2. Using the external resource identify the semantics of the relation between the FAO statistical area class and the Fishing Statistical area class, and set up the relation identified.
  - 5.3. Create the Areal grid system class.
  - 5.4. Using the external resource identify the semantics of the relation between the Areal grid system class and the Fishing Statistical area class, and set up the relation identified.
6. Create the Jurisdiction area class.
7. Using the external resource identify the semantics of the relation between the Jurisdiction area class and the Water area class, and set up the relation identified.

# SEEMP Use Case - ISTAT



SEEMP



## Example 2: Industry Production Index, Spreadsheet

### Industry Production Index

	2009	2008	2007	2006	2005	2004	2003
Total Nacional	3355830	342239	333657	3174393	3064129	2942500	293159
Alava	21988	22318	20678	19838	19779	19638	
Albacete	27380	27647	27088	25531	24765	23550	22547
Alicante	136239	142307	140145	133016	123333	113852	111805
Almería	43501	45100	43970	40871	36766	3260	33947
Asturias	71853	73124	72276	70115	68175	67048	65062
Vizcaya	11455	11708	11434	10900	10611	10319	10211
Badajoz	40874	41358	40168	38045	37052	34972	34866
Illes Balears	9182	93335	91254	88027	87024	85425	75951
Barcelona	467365	477942	469432	444410	436294	417425	37693
Burgos	29567	25891	25372	24504	23733	22882	2159
Cáceres	5307	26494	26064	25039	24846	20596	2340
Cádiz	62817	64505	63338	61691	58986	57138	5442
Cantabria	39611	40393	39560	37690	36561	35649	3401
Castellón	42122	43855	42476	39749	37865	37214	3421
Ciudad Real	32046	33011	31881	30446	29521	29011	26775
Córdoba	48979	50057	49302	47155	45405	43394	41964
Coruña, A	83748	84220	82873	79170	77023	74809	71748
Cuenca	14747	14928	14741	13822	13336	12829	12546
Girona	58404	51467	50108	47169	46827	45145	52482
Granada	60016	62269	61055	57223	54341	50508	4966
Guadalajara	13507	13735	12874	11825	10438	10120	942
Guipúzcoa	62034	63569	59546	58486	57193	56498	5593
Huelva	3783	27463	27063	25487	24777	24270	2237
Huesca	11837	17109	16694	16025	15390	15078	1483
Jaén	36157	37368	36962	35383	34675	33157	3244
Léon	33561	34012	33563	32359	31664	30992	30256
Lugo	36920	37638	36065	33956	32739	31515	29605
Lugo	24861	25035	24609	23780	23122	22479	22396
Madrid	511804	519307	503000	476202	456175	43607	407655
Málaga	113362	117833	114547	108713	102382	95587	88257
Murcia	95636	10007	97374	90698	85110	82484	75973
Navarra	43282	43847	43124	41083	40721	39679	38936
Ourense	23304	23711	23520	22942	22452	22118	21560
Palencia	10964	11111	11060	10694	10575	10390	10297

Province

```

<?xml version="1.0" encoding="UTF-8"?>
<!-- <nor xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="GenericSpreadSheet.xsd" type="GenericSpreadSheet" name="Spanish Employment">
  <Schema>
    <SchemaEntities>
      <SchemaEntity name="Location">
        <Attribute name="Name" valueFrom="pcaxis.[A11:A62]" type="string"/>
      </SchemaEntity>
      <SchemaEntity name="Dataset">
        <Attribute name="Name" valueFrom="pcaxis.[B6:H6]" type="string"/>
      </SchemaEntity>
      <SchemaEntity name="Year">
        <Attribute name="Name" valueFrom="pcaxis.[B9:H9]" type="string"/>
      </SchemaEntity>
    </SchemaEntities>
    <SchemaEntity name="IndustryProductionIndex" type="Nary">
      <Attribute name="hasValue" valueFrom="pcaxis.[B10:H62]" type="string"/>
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      <Relation name="inPeriod" usingSpreadSheetRow="9" destination="Year"/>
      <Relation name="dataset" usingSpreadSheetRow="6" destination="dataset"/>
    </SchemaEntity>
  </Schema>
  <DataModel>
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  </DataModel>
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</Nor>
  
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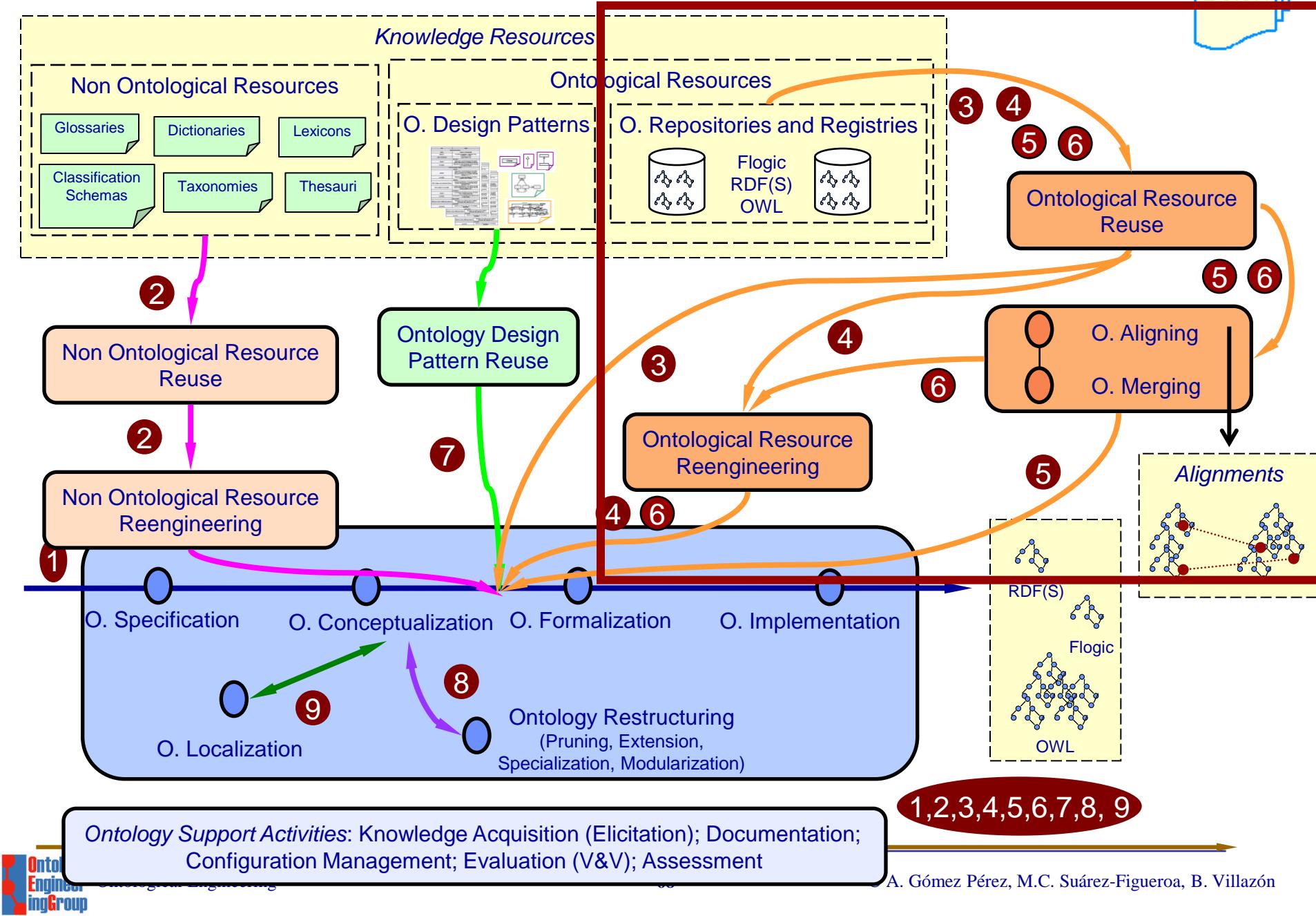


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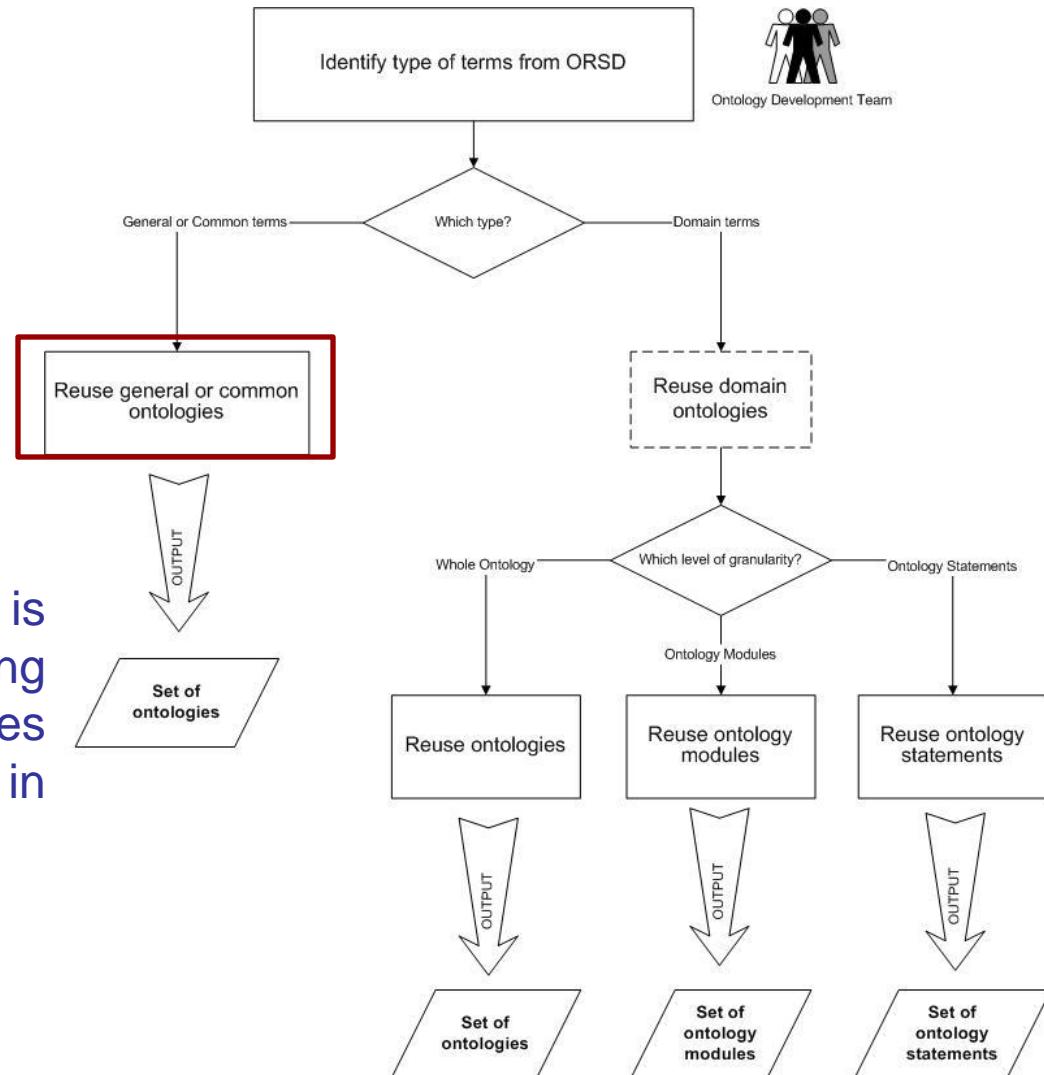
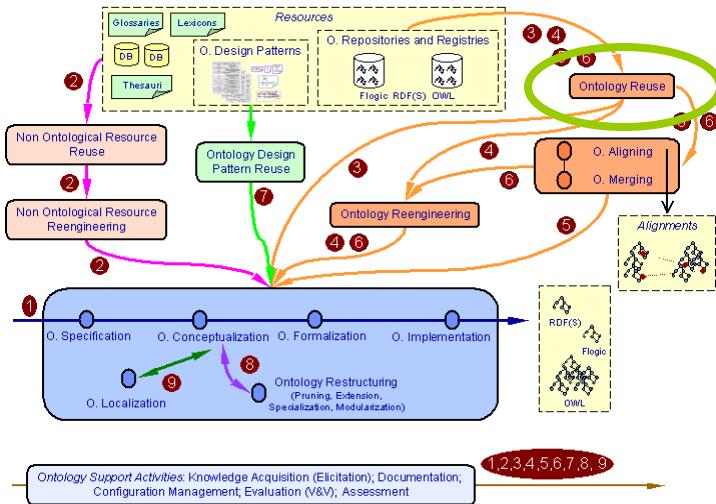
<!-- http://geo.linkeddata.es/resource/Estad%C3%ADstica/Madrid_ipi_2003 -->
<scv:Item rdf:about="Estad%C3%ADstica/Madrid_ipi_2003">
  <rdfs:label xml:lang="es">Índice de Producción Industrial de Madrid en el año 2003</rdfs:label>
  <rdf:value rdf:datatype="&xsd;double">407655.0</rdf:value>
  <scv:dimension rdf:resource="A%C3%B1o/2003"/>
  <scv:dataset rdf:resource="Estad%C3%ADstica/%25C3%258DndiceDeProducci%25C3%25B3nIndustrial"/>
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</scv:Item>
<!-- http://geo.linkeddata.es/resource/Estad%C3%ADstica/Madrid_ipi_2004 -->
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  <rdf:value rdf:datatype="&xsd;double">436074.0</rdf:value>
  <scv:dimension rdf:resource="A%C3%B1o/2004"/>
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  <onto:inProvincia rdf:resource="Provincia/Madrid"/>
</scv:Item>
  
```

# Download

- You can find the lastest version at:
  - <http://mccarthy.dia.fi.upm.es/nor2o/>

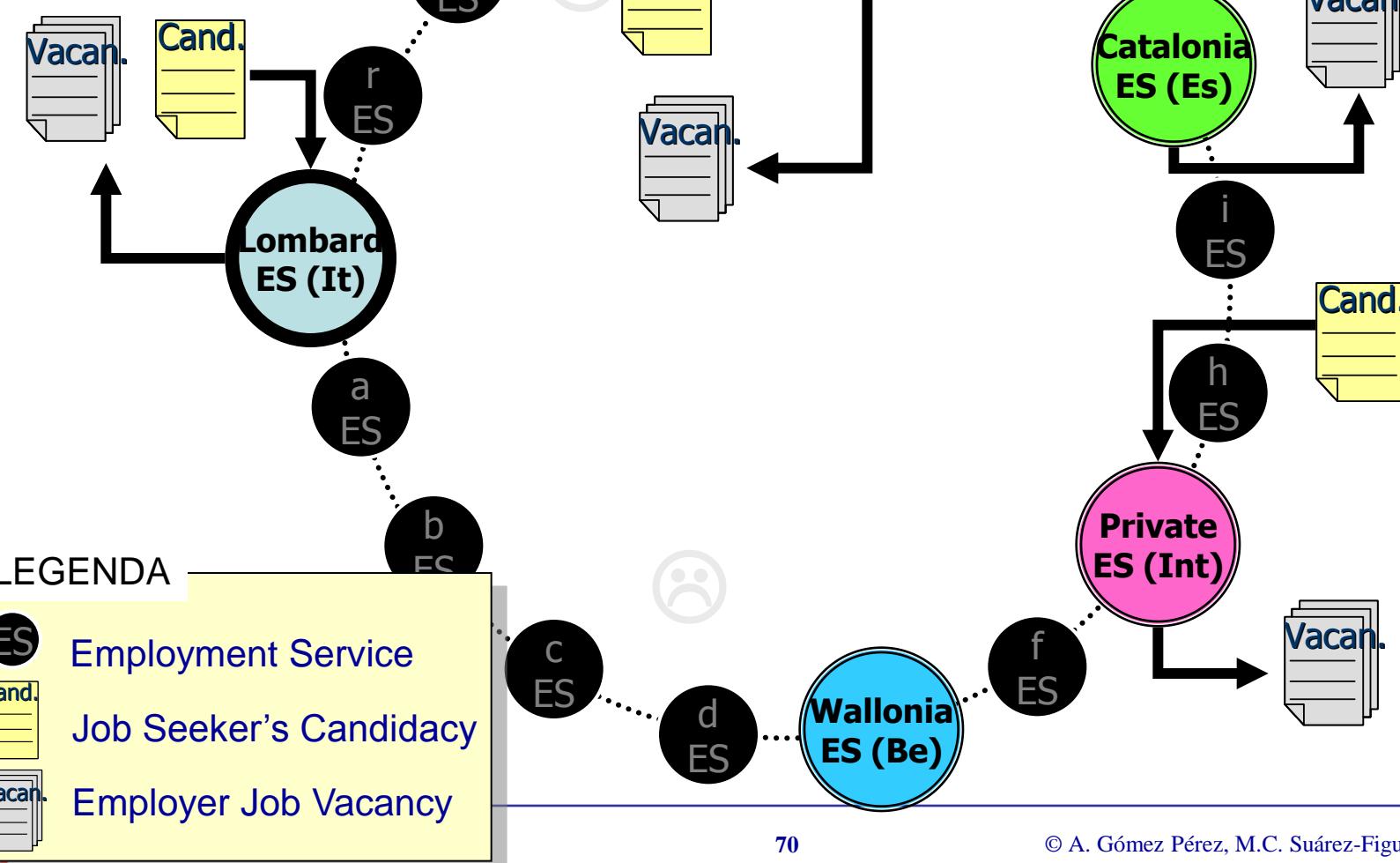


# Ontological Resource Reuse Process

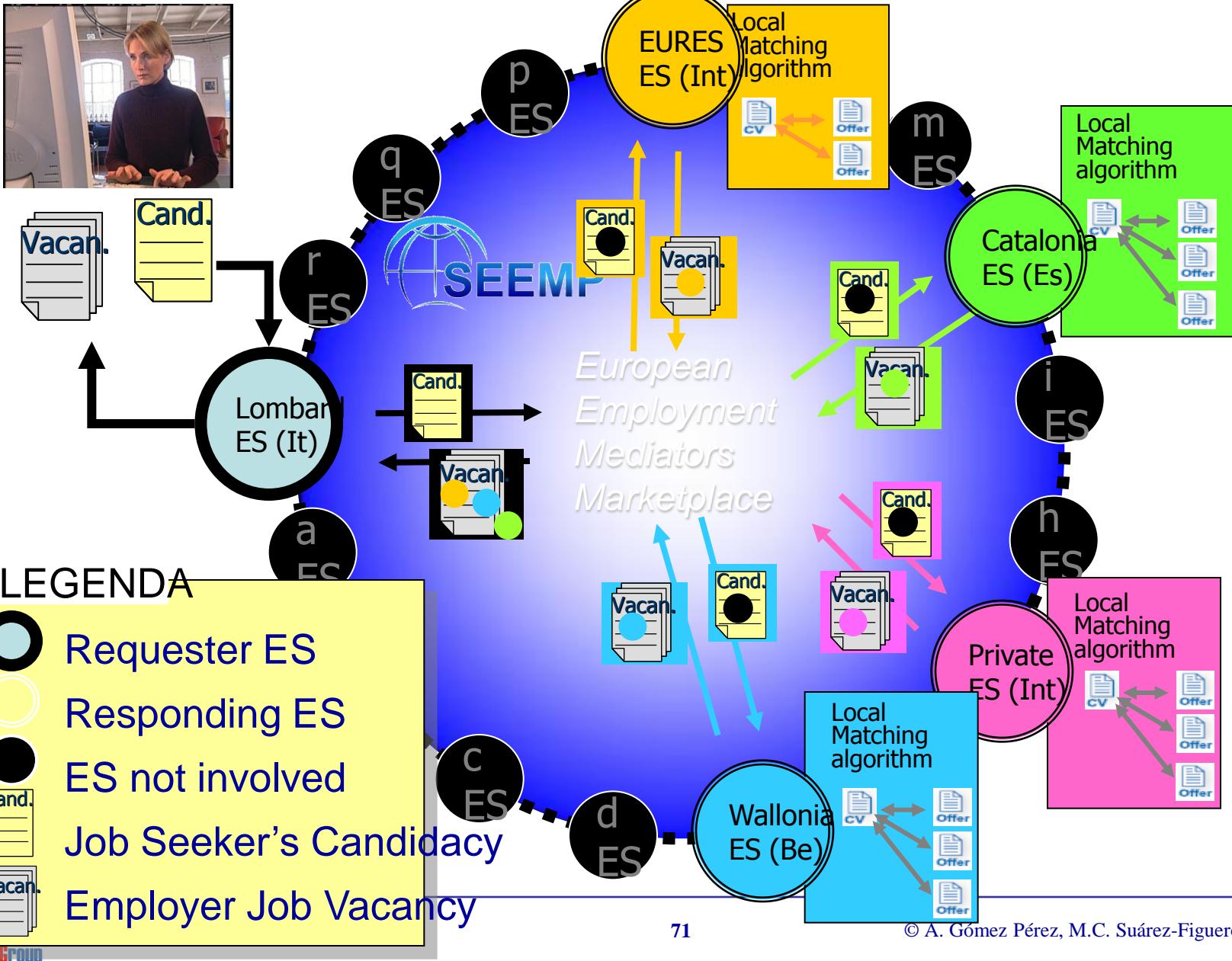


- **Ontological Resource Reuse** is defined as the process of using available ontological resources (ontologies, modules, statements) in the solution of different problems.

# Looking for an European Employment



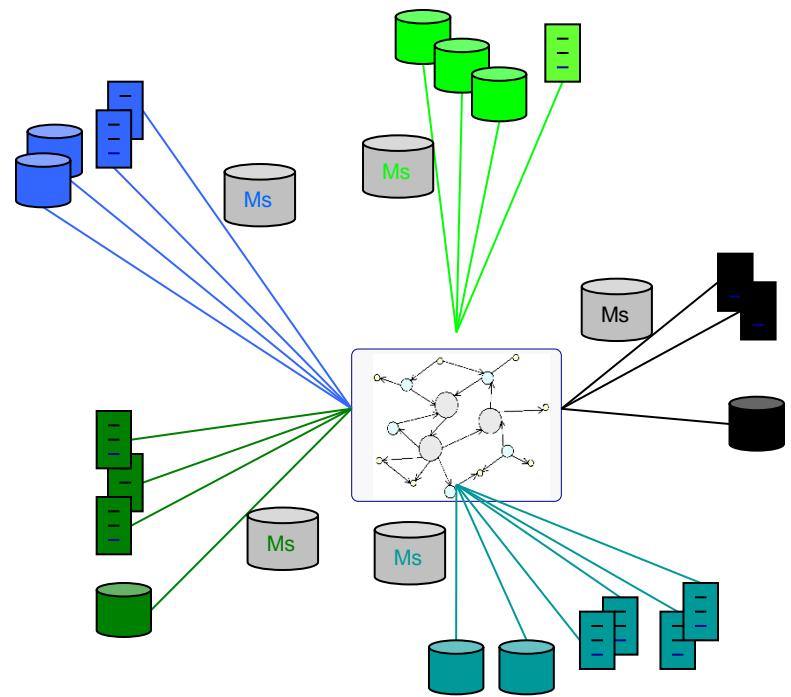
# The Goal: Helping Job Seekers on their way



# Key aspects of Ontological Engineering

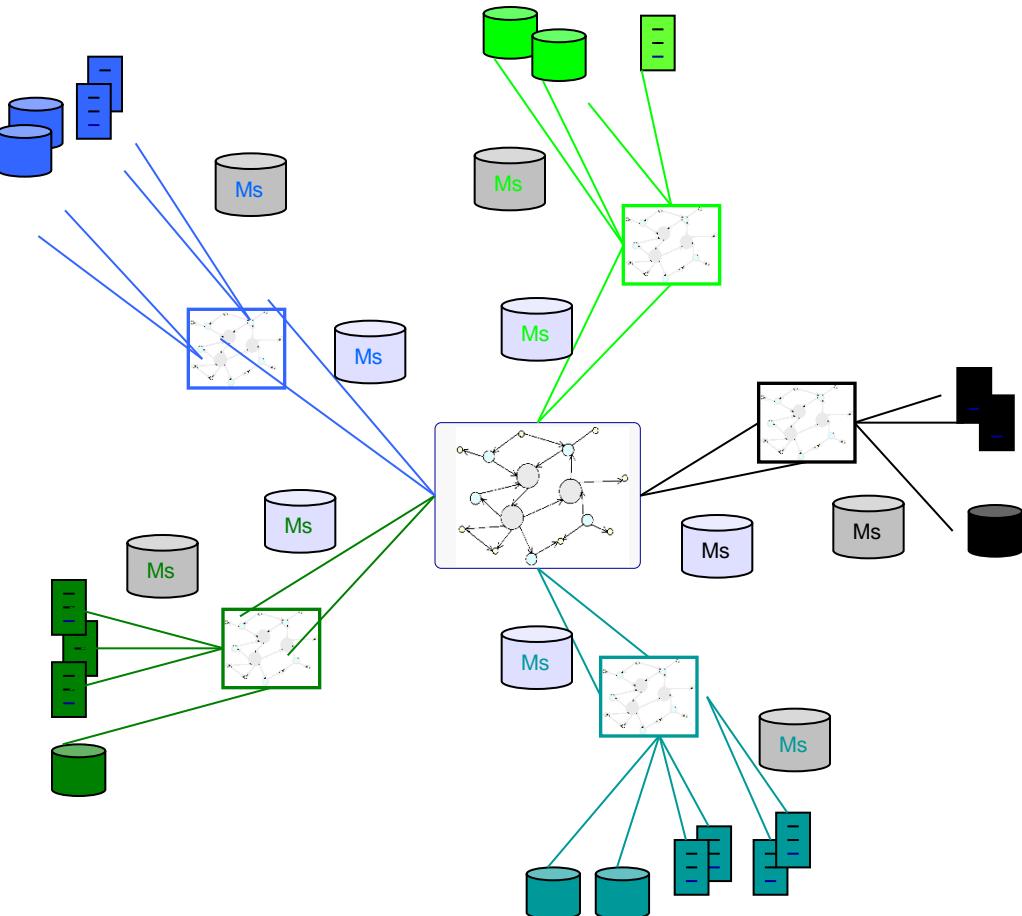
- **Ontologies**
  - Single versus network of ontologies?
  - Are ontologies built from scratch or reusing knowledge-aware resources?
  - Are mappings used for solving conceptual mismatches?
- **Instances**
  - Where are the data/instances?
    - Instances are in the ontology
    - Instances are in RDF files independently of the ontology
    - Data are kept in the original sources
  - Are instances distributed or centralized?
  - Have instances a very high rate of changes?
  - Heterogeneous provenance of instances
  - Degrees of data quality
  - Permissions

## Centralized network of ontologies



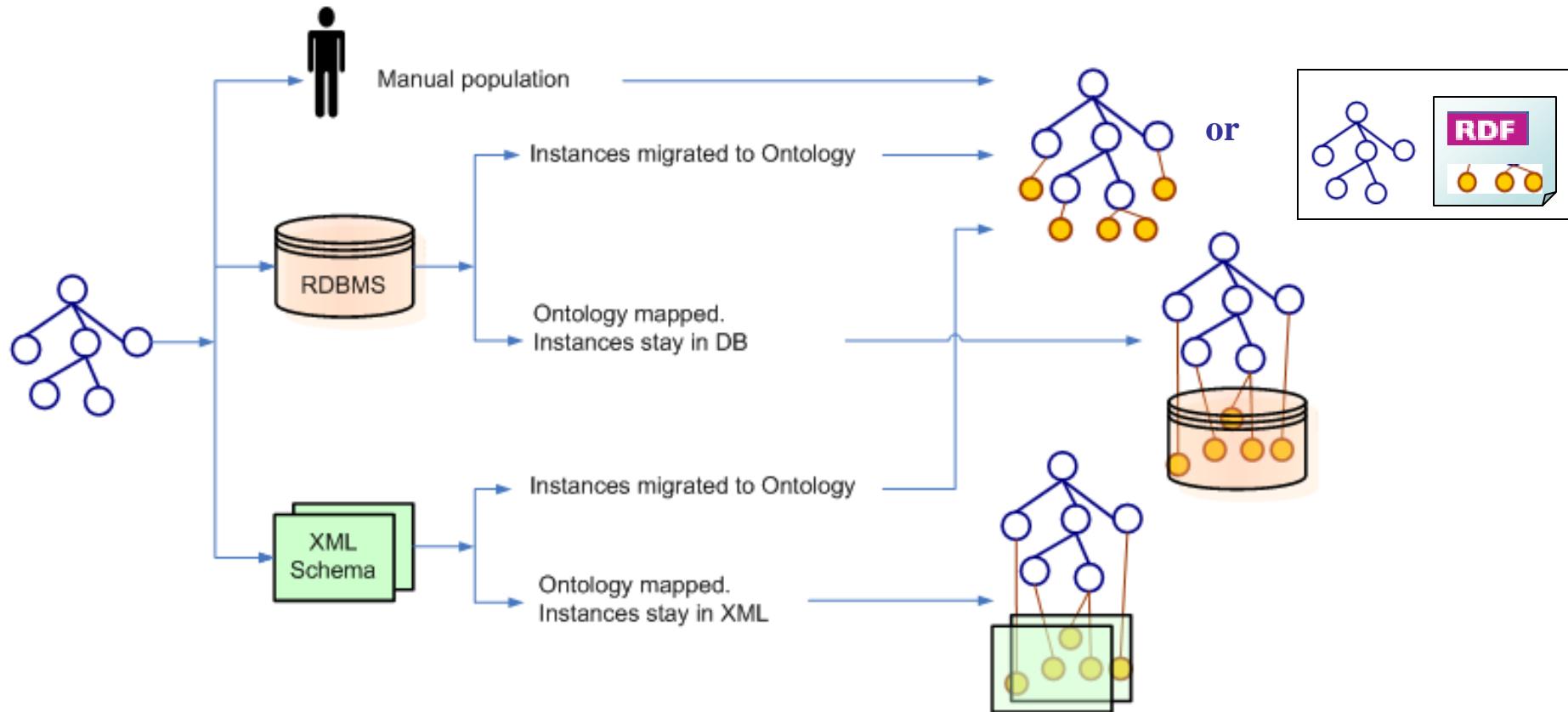
1. Build a reference ontology
2. Build mappings between the reference ontology and the data sources

## Federated network of ontologies

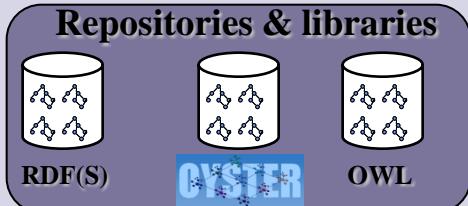


1. Build a reference ontology for the domain
2. Build local ontologies
3. Build mappings between the core and local ontologies
4. Build mappings between the local ontologies and the data sources

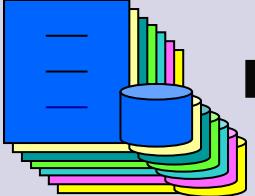
# Where are the instances?



ISCO-88 (COM),  
ONET,  
EURES taxonomy,  
FOET, ISCED97,  
NACE, ISO 4217,  
ISO 3166, ISO 6392,  
HR-XML, ...



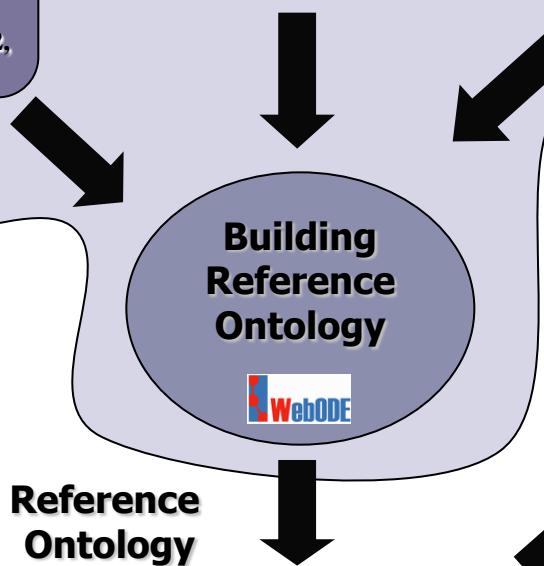
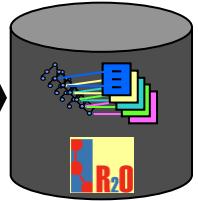
## ES Data Sources



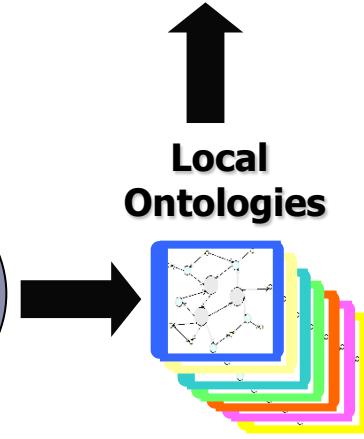
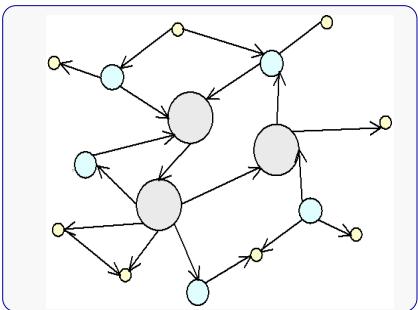
## Building Mappings L.O. - ES Data Sources



**Mappings L.O. - ES Data Sources**



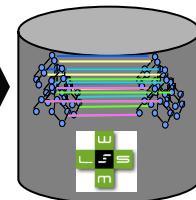
**Reference Ontology**



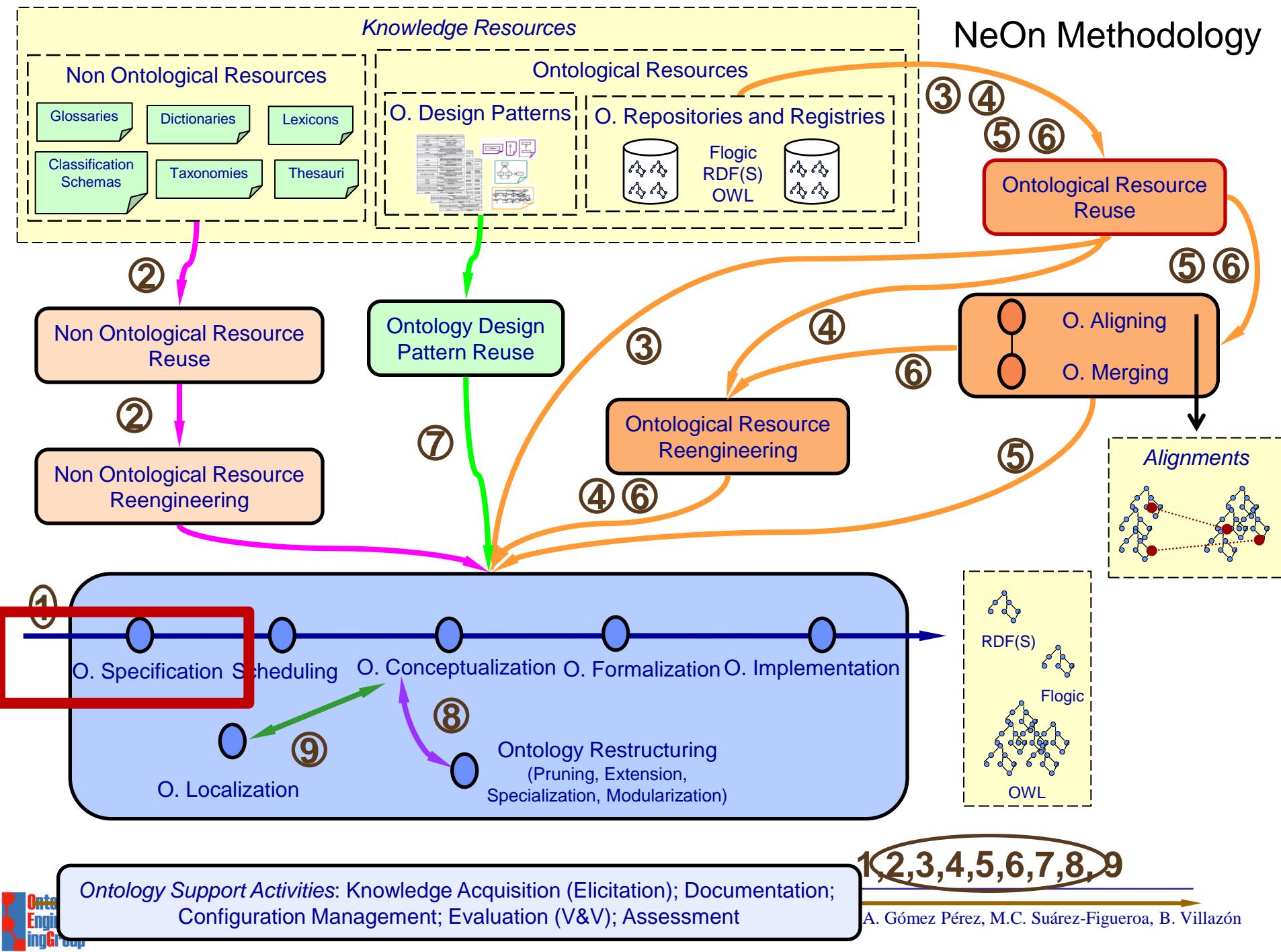
## Building Mappings R.O. - L.O.



**Mappings R.O. - L.O.**

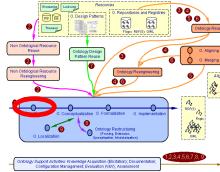


# NeOn Methodology



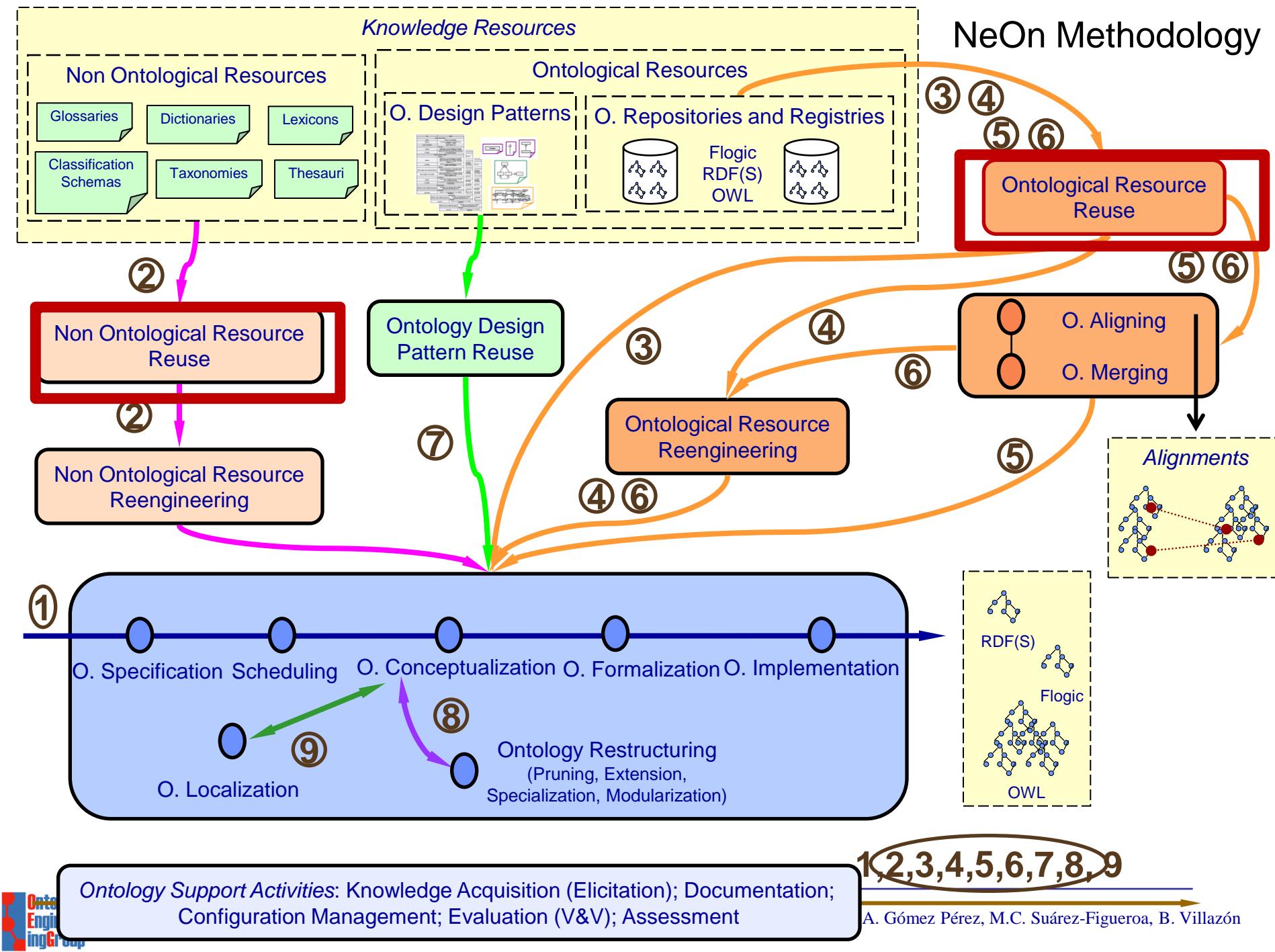
# Ontology Specification.

## The Ontology Requirement Specification Document



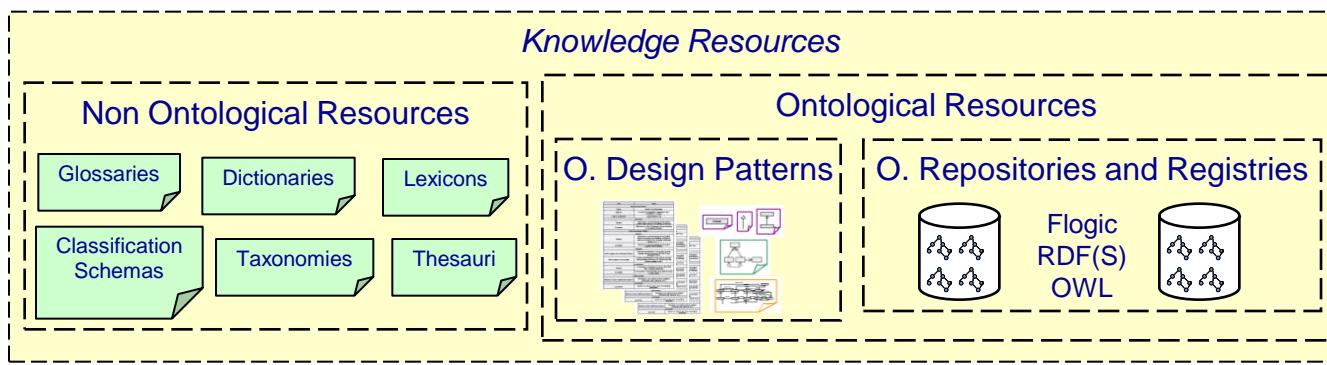
SEEMP Reference Ontology Requirements Specification																																														
1 Purpose	The purpose of building the Reference Ontology is to provide a consensual knowledge model of the employment domain that could be used by public e-Employment services (PES).																																													
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 Level of Formality	The ontology has to be implemented in WSML language																																													
4 Intended Users	User 1. Candidate who is unemployed and searching for a job or searching another occupation for immediate or future purposes User 2. User 3. User 4. User 5. User 6. User 7. Pre-Glossary of Terms																																													
5 Intend	User 1. User 2. User 3. User 4. User 5.																																													
6 Groups of Competency Questions	CQG1. Job Seeker (16 CQ)  CQ1. What is the Job Seeker Name? CQ2. What is the Job Seeker nationality? CQ3. When is the Job Seeker birthday? CQ4. What is the Job Seeker contact information? CQ5. What is the Job Seeker current job? CQ6. What is the Job Seeker desired job? CQ7. What are the Job Seeker desired working conditions? CQ8. What kind of contract does the Job Seeker want?  CQG2. Job Offer (10 CQ)  CQ17. What is the employer information? CQ18. What kind of job does the employer offer? CQ19. What kind of contract does the employer offer? CQ20. How much salary does the employer offer? CQ21. What is the economic activity of the employer?  CQG3. Objects (10 CQ)  Objects in the universe of discourse, which are instances of: <ul style="list-style-type: none"><li>• Job Category<ul style="list-style-type: none"><li>O1. Computer System Designer</li><li>O2. Computer System Analyst</li><li>O3. Programmer</li><li>O4. Computer Engineer</li><li>O5. Computer Assistant</li><li>O6. Computer Equipment Operator</li><li>O7. Industrial Robot Controller</li><li>O8. Telecommunication Equipment Operator</li><li>O9. Medical Equipment Operator</li><li>O10. Electronic Equipment Operator</li><li>O11. Image Equipment Operator</li></ul></li><li>• Nationality<ul style="list-style-type: none"><li>O12. Austrian</li><li>O13. Belgian</li><li>O14. Danish</li><li>O15. Estonian</li><li>O16. Finnish</li><li>O17. French</li><li>O18. German</li><li>O19. Greek</li><li>O20. Italian</li></ul></li><li>• Activity Sector<ul style="list-style-type: none"><li>O21. Telecommunication</li><li>O22. Justice and Judicial</li><li>O23. Public Security and law</li><li>O24. Manufacture of machine tools</li><li>O25. Research and Development</li><li>O26. Hardware Consultancy</li><li>O27. Software Consultancy and Supply</li><li>O28. Data processing</li></ul></li></ul>																																													
7 Pre-Glossary of Terms	<table border="1"> <thead> <tr> <th>Terms</th> <th>Frequency</th> </tr> </thead> <tbody> <tr> <td>a. Job Seeker</td> <td>27</td> </tr> <tr> <td>b. CV</td> <td>2</td> </tr> <tr> <td>c. Personal Information</td> <td>3</td> </tr> <tr> <td>d. Name</td> <td>5</td> </tr> <tr> <td>e. Gender</td> <td>1</td> </tr> <tr> <td>f. Birth date</td> <td>1</td> </tr> <tr> <td>g. Address</td> <td>2</td> </tr> <tr> <td>h. Nationality</td> <td>1</td> </tr> <tr> <td>i. Contact (phone, fax, mail)</td> <td>4</td> </tr> <tr> <td>j. Objective</td> <td>3</td> </tr> <tr> <td>k. Job Category</td> <td>6</td> </tr> <tr> <td>l. Job Offer</td> <td>27</td> </tr> <tr> <td>m. Employer Information</td> <td>1</td> </tr> <tr> <td>n. Vacancy</td> <td>1</td> </tr> <tr> <td>o. Activity Sector</td> <td>1</td> </tr> <tr> <td>p. Location</td> <td>3</td> </tr> <tr> <td>q. Work Condition</td> <td>3</td> </tr> <tr> <td>r. Contract Type</td> <td>3</td> </tr> <tr> <td>s. Salary</td> <td>3</td> </tr> <tr> <td>t. Education</td> <td>3</td> </tr> <tr> <td>u. Work Experience</td> <td>3</td> </tr> </tbody> </table>		Terms	Frequency	a. Job Seeker	27	b. CV	2	c. Personal Information	3	d. Name	5	e. Gender	1	f. Birth date	1	g. Address	2	h. Nationality	1	i. Contact (phone, fax, mail)	4	j. Objective	3	k. Job Category	6	l. Job Offer	27	m. Employer Information	1	n. Vacancy	1	o. Activity Sector	1	p. Location	3	q. Work Condition	3	r. Contract Type	3	s. Salary	3	t. Education	3	u. Work Experience	3
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# NeOn Methodology



# Searching Resources

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



Objects
Objects in the universe of discourse, which are instances of:
<ul style="list-style-type: none"> <li>• Job Category           <ul style="list-style-type: none"> <li>O1. Computer System Designer</li> <li>O2. Computer System Analyst</li> <li>O3. Programmer</li> <li>O4. Computer Engineer</li> <li>O5. Computer Assistant</li> <li>O6. Computer Equipment Operator</li> <li>O7. Industrial Robot Controller</li> <li>O8. Telecommunication Equipment Operator</li> <li>O9. Medical Equipment Operator</li> <li>O10. Electronic Equipment Operator</li> <li>O11. Image Equipment Operator</li> </ul> </li> <li>• Nationality           <ul style="list-style-type: none"> <li>O12. Austrian</li> <li>O13. Belgian</li> <li>O14. Danish</li> <li>O15. Estonian</li> <li>O16. Finnish</li> <li>O17. French</li> <li>O18. German</li> <li>O19. Greek</li> <li>O20. Italian</li> </ul> </li> </ul>

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



# Search and Select 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?

# Searching Ontologies in Watson

## Ontology Requirement Specification Document

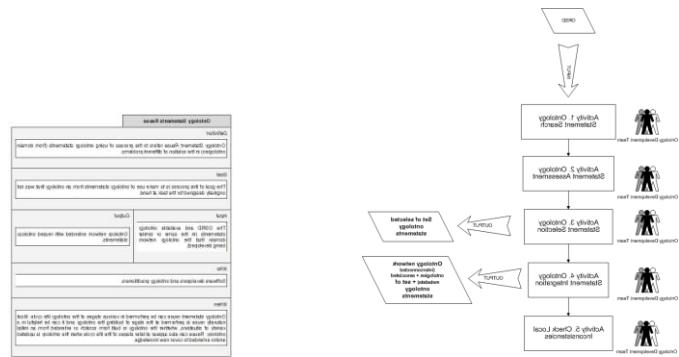
Objects
Objects in the domain of discourse, which are instances of:
Job Category
• Education
029. Life Science
030. Mathematics
031. Computer Science
032. Computer Use
033. Statistics
034. Physics
035. Network Administration
• Languages
036. Swedish
037. Spanish
038. Slovenian
039. Portuguese
040. English
041. French
042. German
• Currency
043. Euro
044. Krone
045. Great British Pound
046. Zlate
047. US Dollar
048. Franc
• Location
049. Austria
050. Belgium
051. Denmark
052. France
053. Finland
054. France
055. Germany
056. Greece
• Nationality
012. Austrian
013. Belgian
014. Danish
015. Estonian
016. Finnish
017. French
018. German
019. Greek
020. Italian
• Activity Sector
021. Telecommunication
022. Justice and Judicial
023. Public Security and law
024. Manufacture & Machine tools
025. Research and Development
026. Hardware Consultancy
027. Software Consultancy and Supply
028. Data processing

The screenshot shows a web browser window titled "Watson Semantic Web Search" with the URL <http://kmi-web05.open.ac.uk/WatsonWUI/>. A red arrow points from the "Job Category" section of the ontology requirement document to the search results. The search results page displays a list of semantic documents found, with the first item being a link to a DAML ontology page.

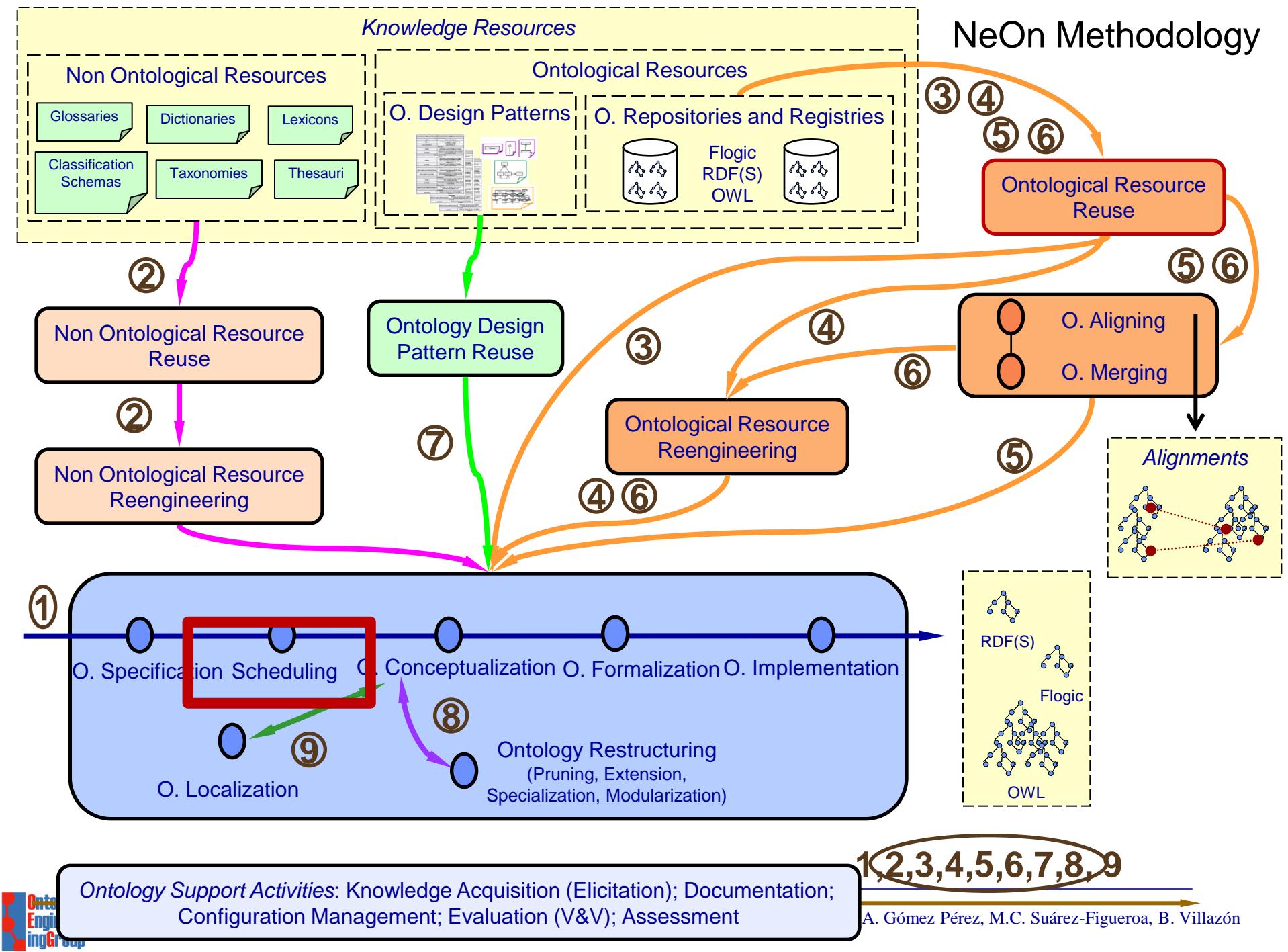
Read this - Check your ontology - Website - Blog  
university researcher student  
Search Watson  
Found 19 semantic documents - [Restrict Search](#)

1- <http://daml.umbc.edu/ontologies/cobra/0.4/academia> □  
5 KB - RDF,OWL (OWL FULL) - ALCH(D)  
    • <http://daml.umbc.edu/ontologies/cobra/0.4/academia#University> □  
        Label: University  
        Comment:  
    • <http://daml.umbc.edu/ontologies/cobra/0.4/academia#Researcher> □  
    • <http://daml.umbc.edu/ontologies/cobra/0.4/academia#GradStudentResearcher> □  
        Label: GradStudentResearcher  
        Comment:  
    • <http://daml.umbc.edu/ontologies/cobra/0.4/academia#Student> □  
    • <http://daml.umbc.edu/ontologies/cobra/0.4/academia#GradStudentResearcher> □  
2- <http://annotation.semanticweb.org/ontologies/iswc.owl> □  
30 KB - OWL,RDF (OWL Lite) - AL(D)  
    • <http://annotation.semanticweb.org/2004/iswc#University> □  
    • [http://annotation.semanticweb.org/2004/iswc#University\\_of\\_Karlsruhe](http://annotation.semanticweb.org/2004/iswc#University_of_Karlsruhe) □  
    • <http://annotation.semanticweb.org/2004/iswc#Researcher> □  
    • <http://annotation.semanticweb.org/2004/iswc#Student> □  
    • <http://annotation.semanticweb.org/2004/iswc#PhDStudent> □  
3- <http://ontobroker.semanticweb.org/ontologies/ka2-onto-2000-11-07.daml> □  
32 KB - DAML+OIL,RDF - AL(D)  
    • <http://kmi-web05.open.ac.uk:81/cache/7f64e14aa3dd17/adbdb1ce20/2653b336ce35ba101#University> □  
    • <http://kmi-web05.open.ac.uk:81/cache/7f64e14aa3dd17/adbdb1ce20/2653b336ce35ba101#Researcher> □  
    • <http://kmi-web05.open.ac.uk:81/cache/7f64e14aa3dd17/adbdb1ce20/2653b336ce35ba101#Student> □  
    • <http://kmi-web05.open.ac.uk:81/cache/7f64e14aa3dd17/adbdb1ce20/2653b336ce35ba101#PhDStudent> □  
4- <http://www.ifi.unizh.ch/ddis/fileadmin/pdf/serviceBroker/swc.daml> □  
32 KB - DAML+OIL,RDF - AL(D)  
    • <http://annotation.semanticweb.org/iswc/iswc.daml#University> □  
    • [http://annotation.semanticweb.org/iswc/iswc.daml#University\\_of\\_Karlsruhe](http://annotation.semanticweb.org/iswc/iswc.daml#University_of_Karlsruhe) □  
    • <http://annotation.semanticweb.org/iswc/iswc.daml#Researcher> □

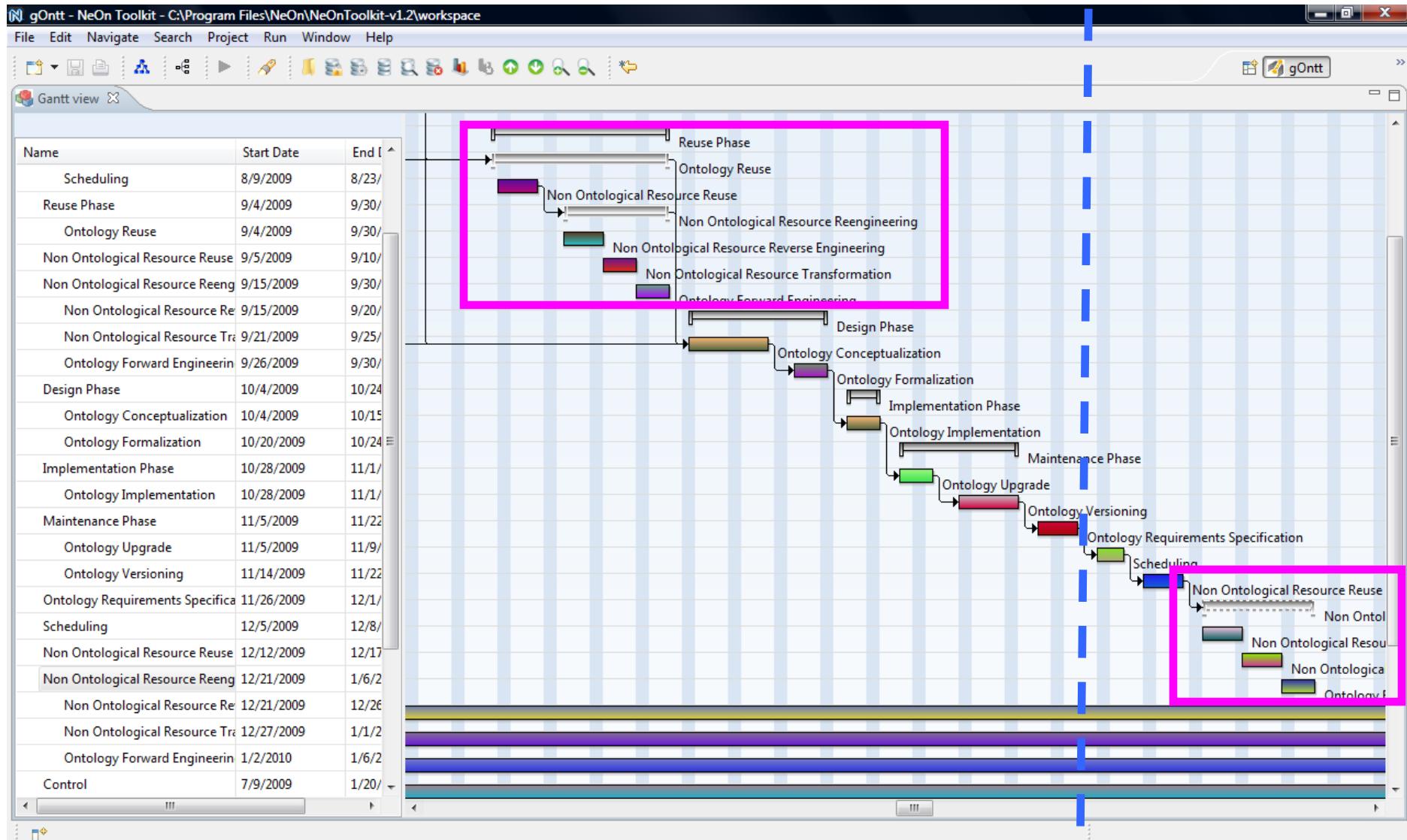
The NeOn methodology includes guidelines for reusing statements



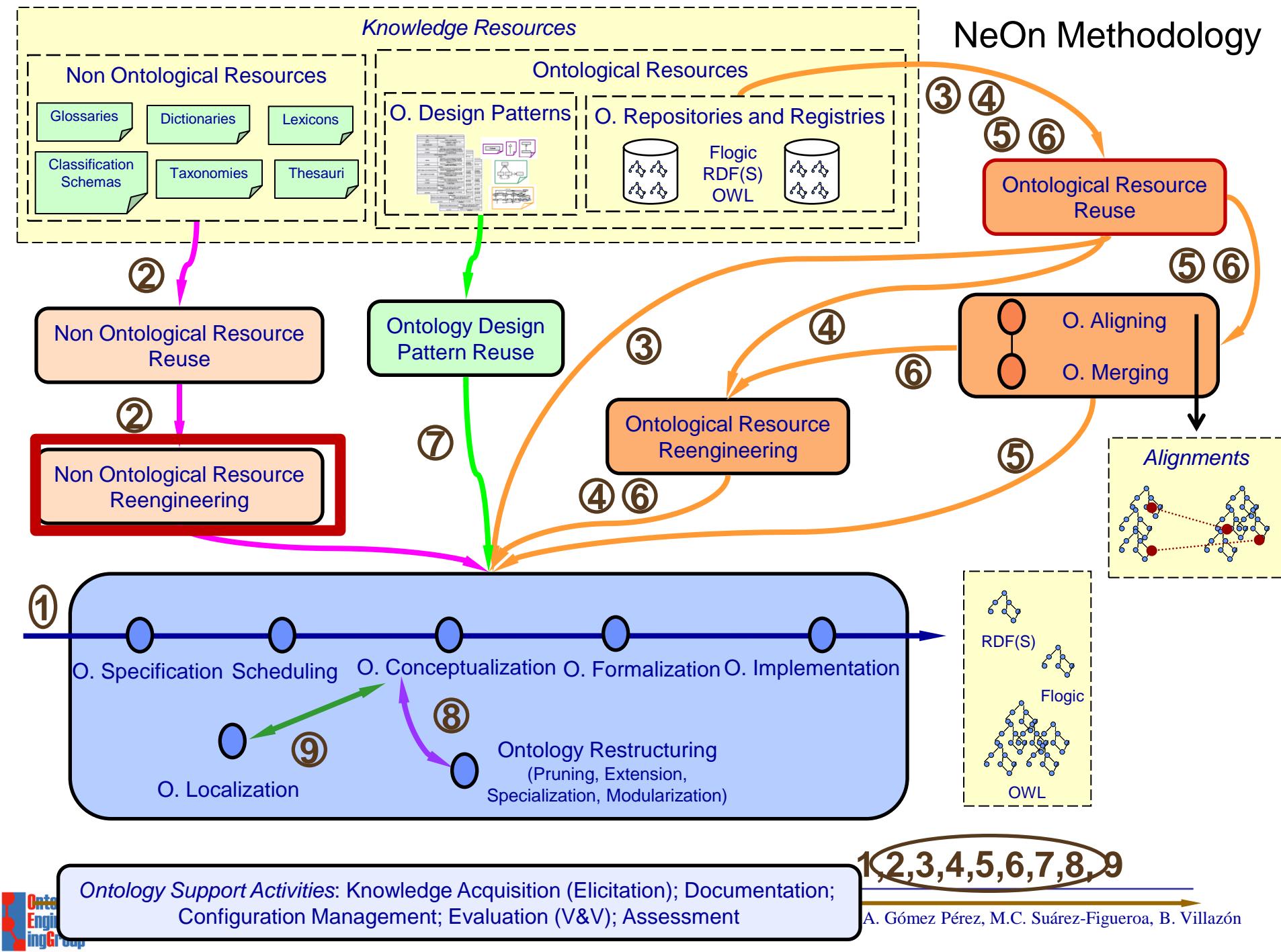
# NeOn Methodology



# Reuse and Re-engineering + Incremental



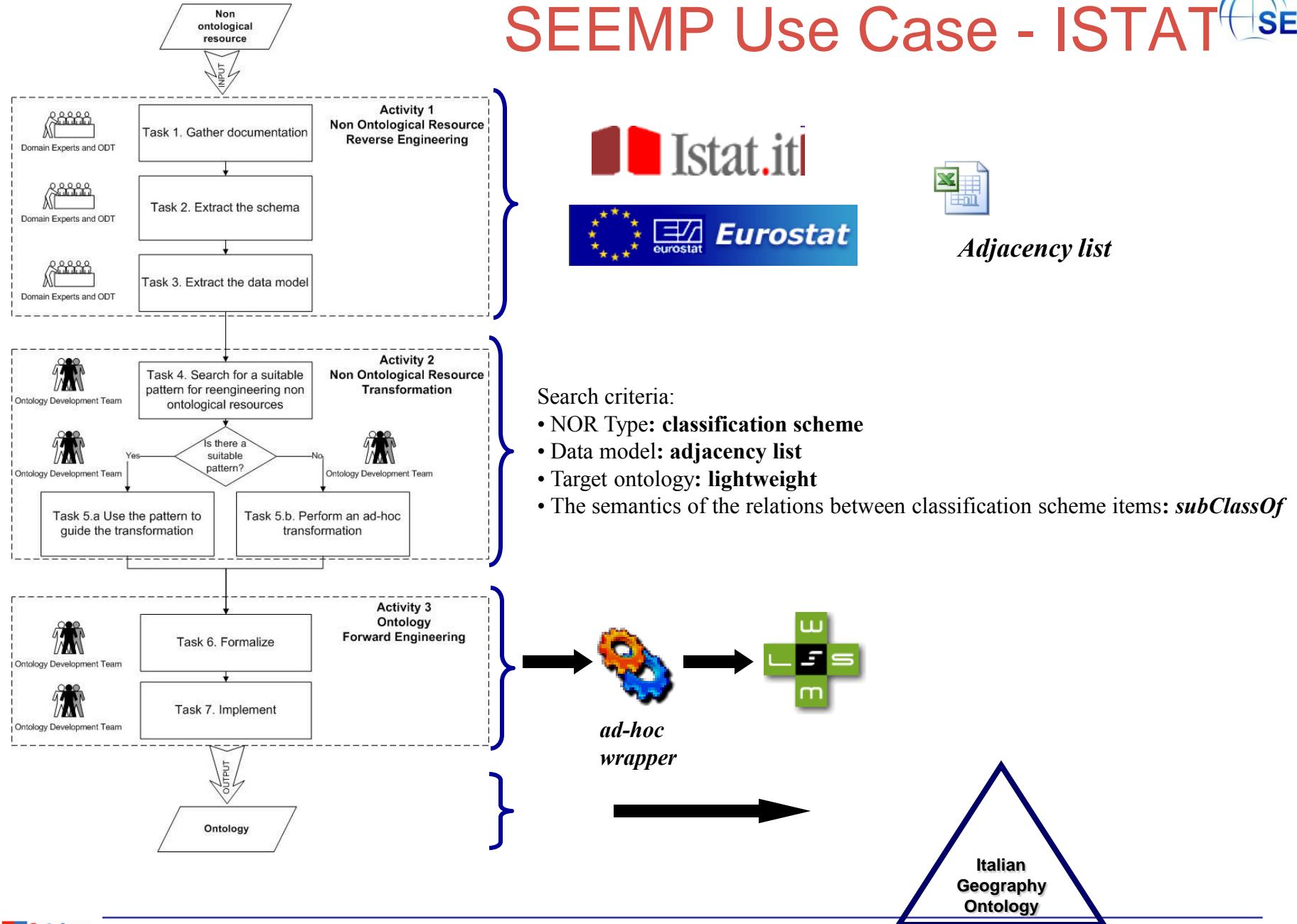
# NeOn Methodology



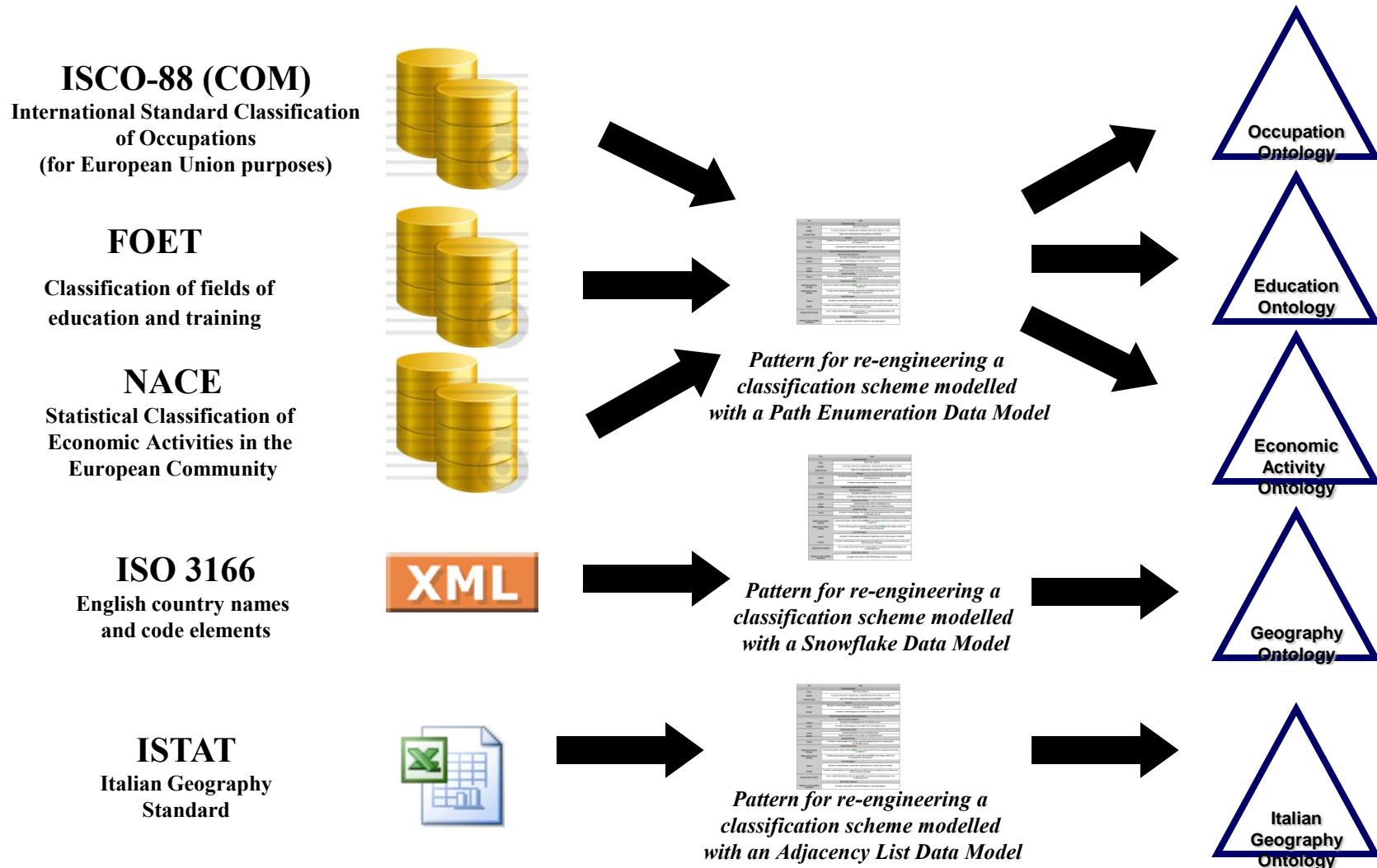
# SEEMP Use Case - ISTAT



SEEMP



# Pattern based approach for re-engineering non ontological resources



# Reengineering and aggregating resources

## EURES Taxonomy

(proprietary)

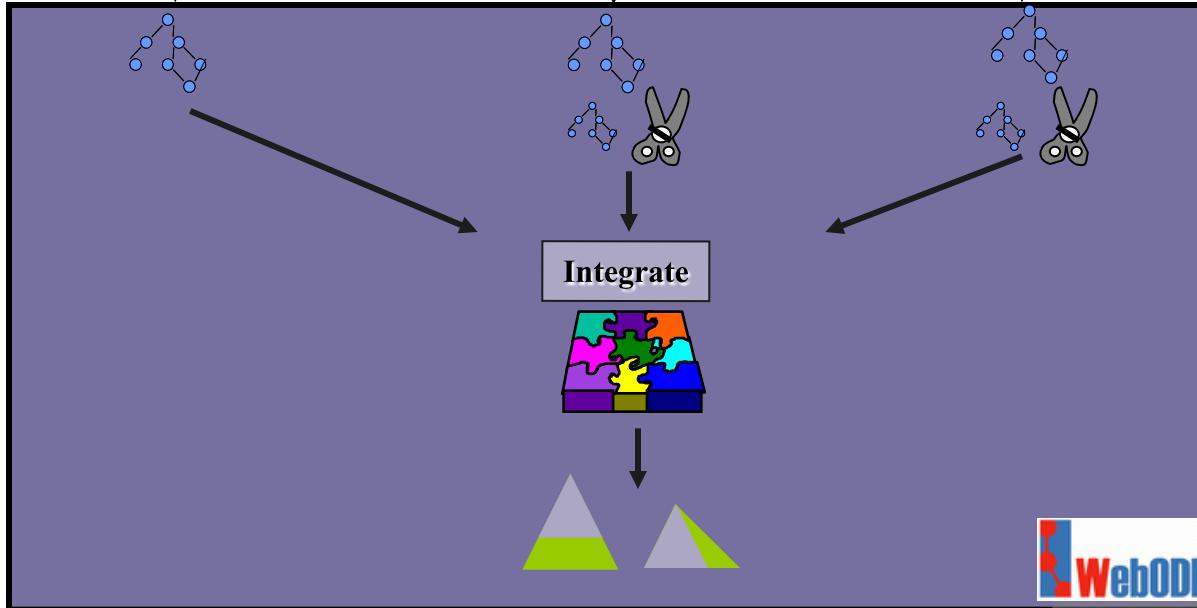
Oracle DB

## ONET

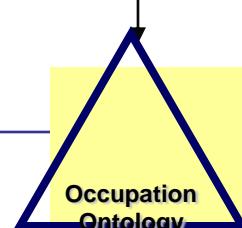
HTML

## ISCO-88 (COM)

MS Access



- Extend
- Specialize
- Prune
- Ad hoc wrapper
- WSML exporter



87

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# Knowledge Resource Re-engineering and Aggregation

## ISO 3166-1 (XML)

```
<ISO_3166-1_Entry>
  <ISO_3166-1_Country_name>SPAIN</ISO_3166-1_Country_name>
  <ISO_3166-1_Alpha-2_Code_element>ES</ISO_3166-1_Alpha-2_Code_element>
</ISO_3166-1_Entry>
...

```

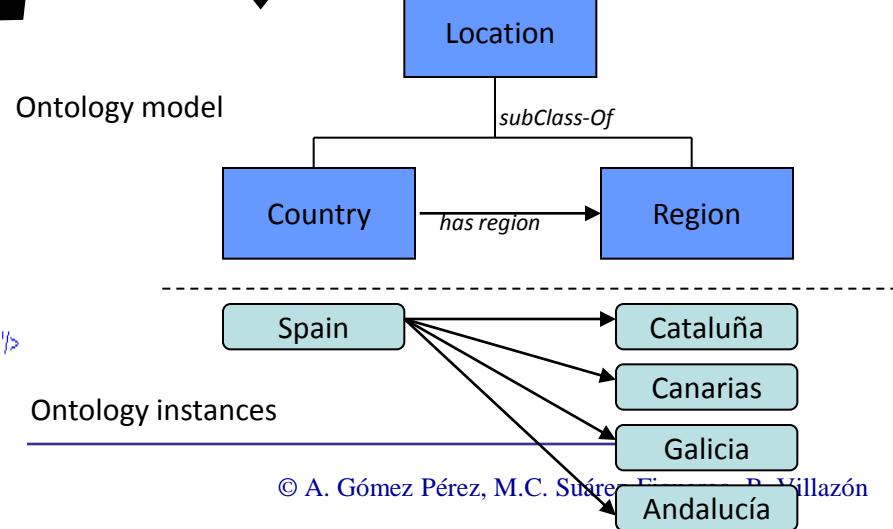
## Excerpt of the Geography Ontology

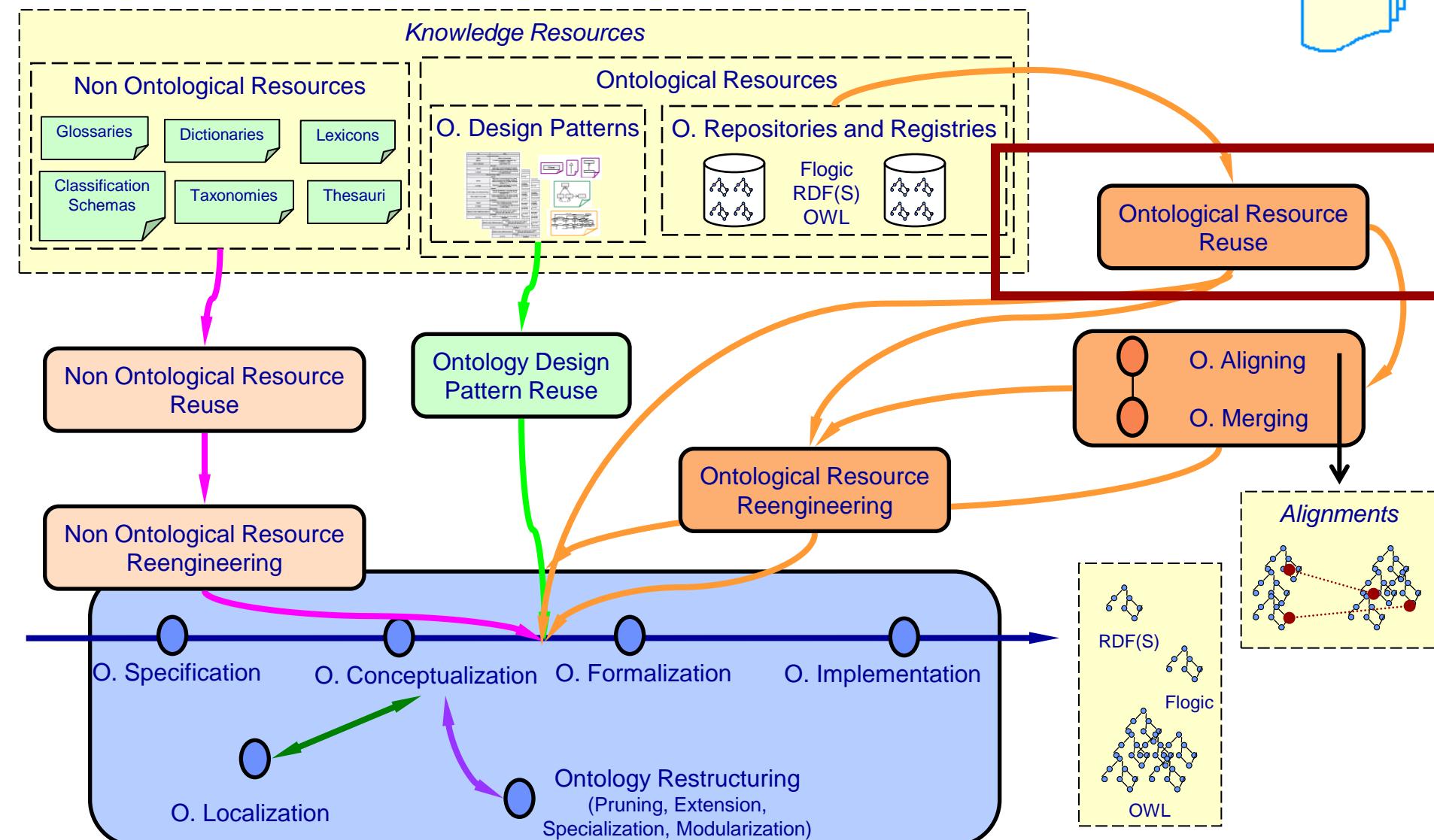
```
<rdf:Description rdf:about="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Country_SPAIN">
  <rdf:type rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Country"/>
  <GeoOnt:Code rdf:datatype="http://www.w3.org/2001/XMLSchema#string">ES</GeoOnt:Code>
  <GeoOnt:Name rdf:datatype="http://www.w3.org/2001/XMLSchema#string">SPAIN</GeoOnt:Name>
  <GeoOnt:is_located_in_Continent rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#EU_Europe"/>
  <GeoOnt:has_region_Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Catalunya"/>
  <GeoOnt:has_region_Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Canarias"/>
  <GeoOnt:has_region_Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Galicia"/>
  <GeoOnt:has_region_Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Andalucia"/>
</rdf:Description>
```

## Regions Table (Eures Oracle DB)

N	ISO3161 Code	Region
100	ES	Cataluña
101	ES	Canarias
102	ES	Galicia
103	ES	Andalucía
104	ES	Navarra
105	ES	Asturias
106	ES	Baleares
107	ES	Murcia
108	ES	Aragon

## Ontology model

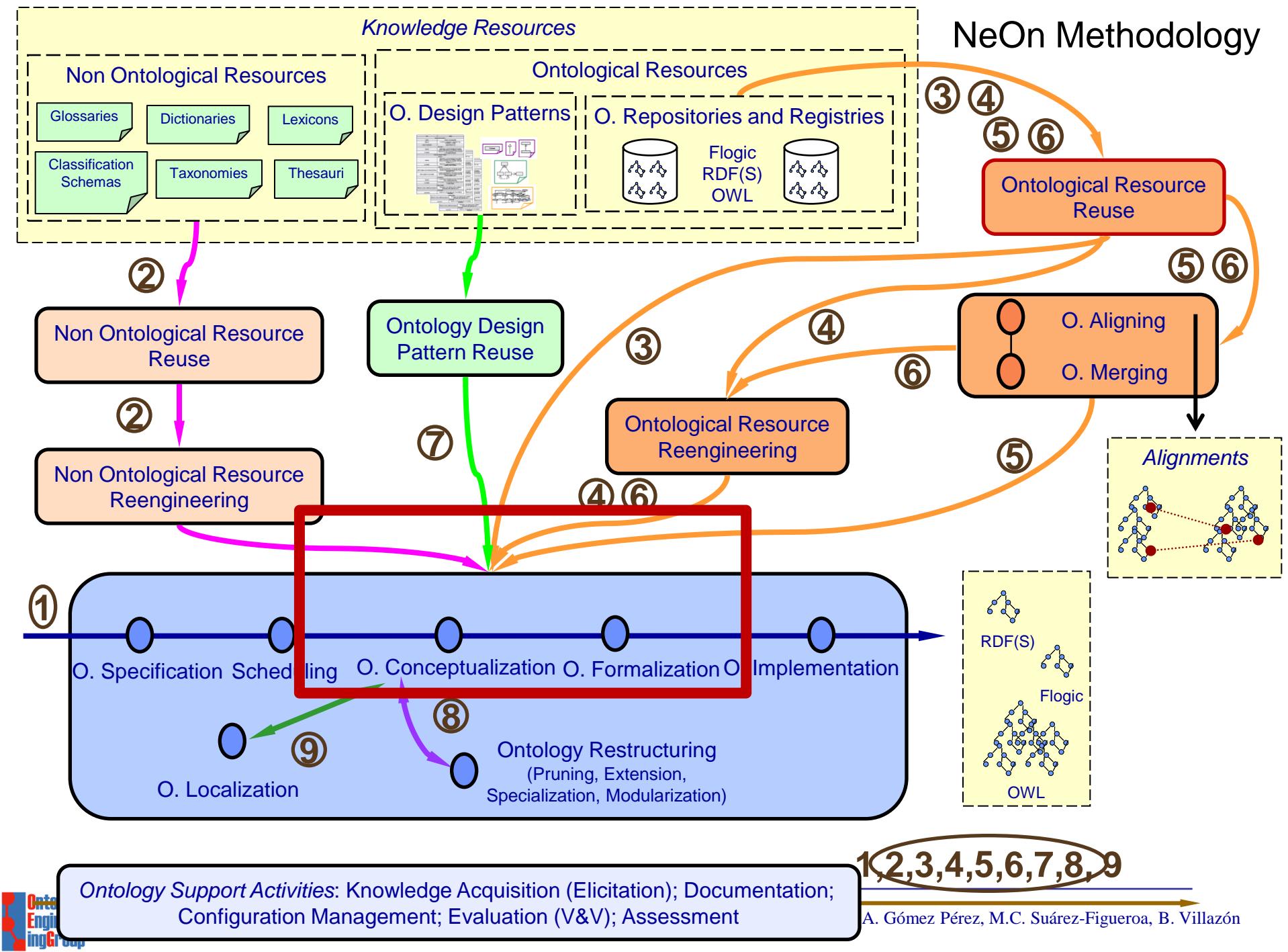




# The Time Ontology Selection

	Cyc's Upper Ontology	Unrestricted Time Ontology	Simple Time Ontology	Reusable Time Ontology	Kestrel Time Ontology	SRI's Time Ontology	SUMO Time Ontology	DAML Time Ontology	AKT Time Ontology
Time Points	<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>				
Time Interval	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Absolute and Relative Time					<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
Relations between time intervals	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Convex and non convex intervals	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Distinction between open and close intervals	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Explicit modeling of proper intervals								<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Concatenation of intervals	<input checked="" type="checkbox"/>					<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Different temporal granularities		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Provides axioms	<input checked="" type="checkbox"/>								

# NeOn Methodology



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

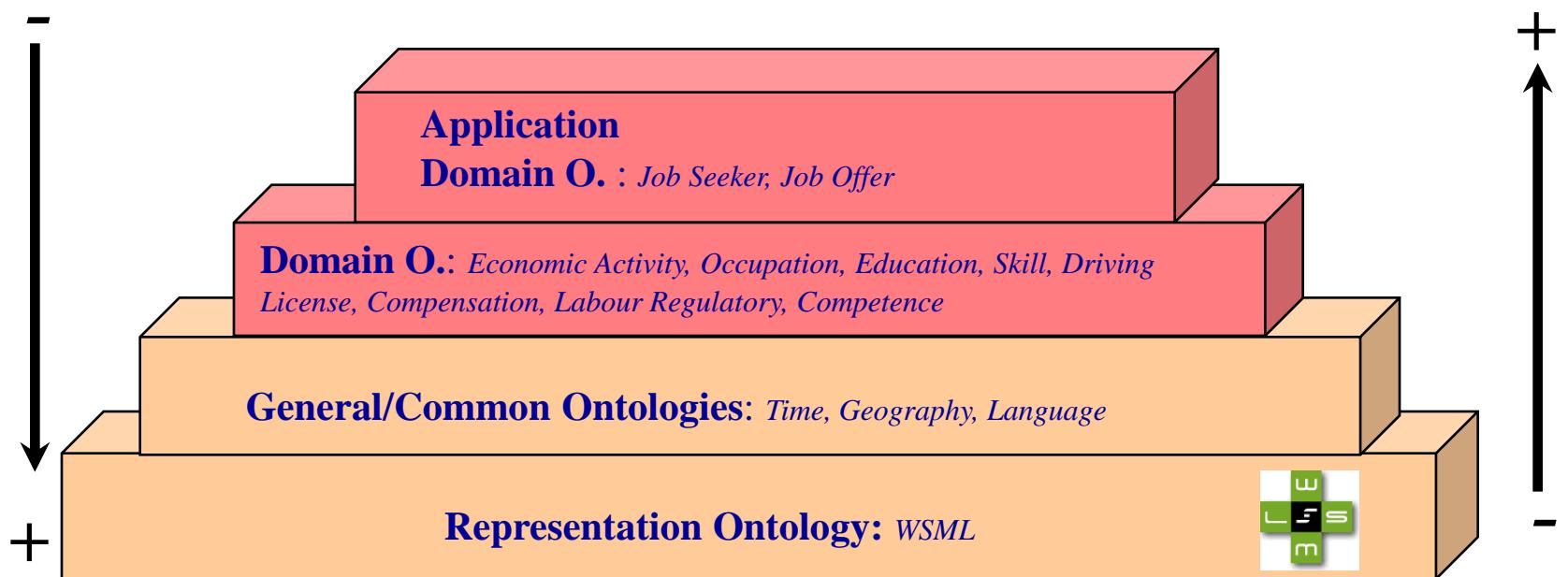
A. Gómez Pérez, M.C. Suárez-Figueroa, B. Villazón

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

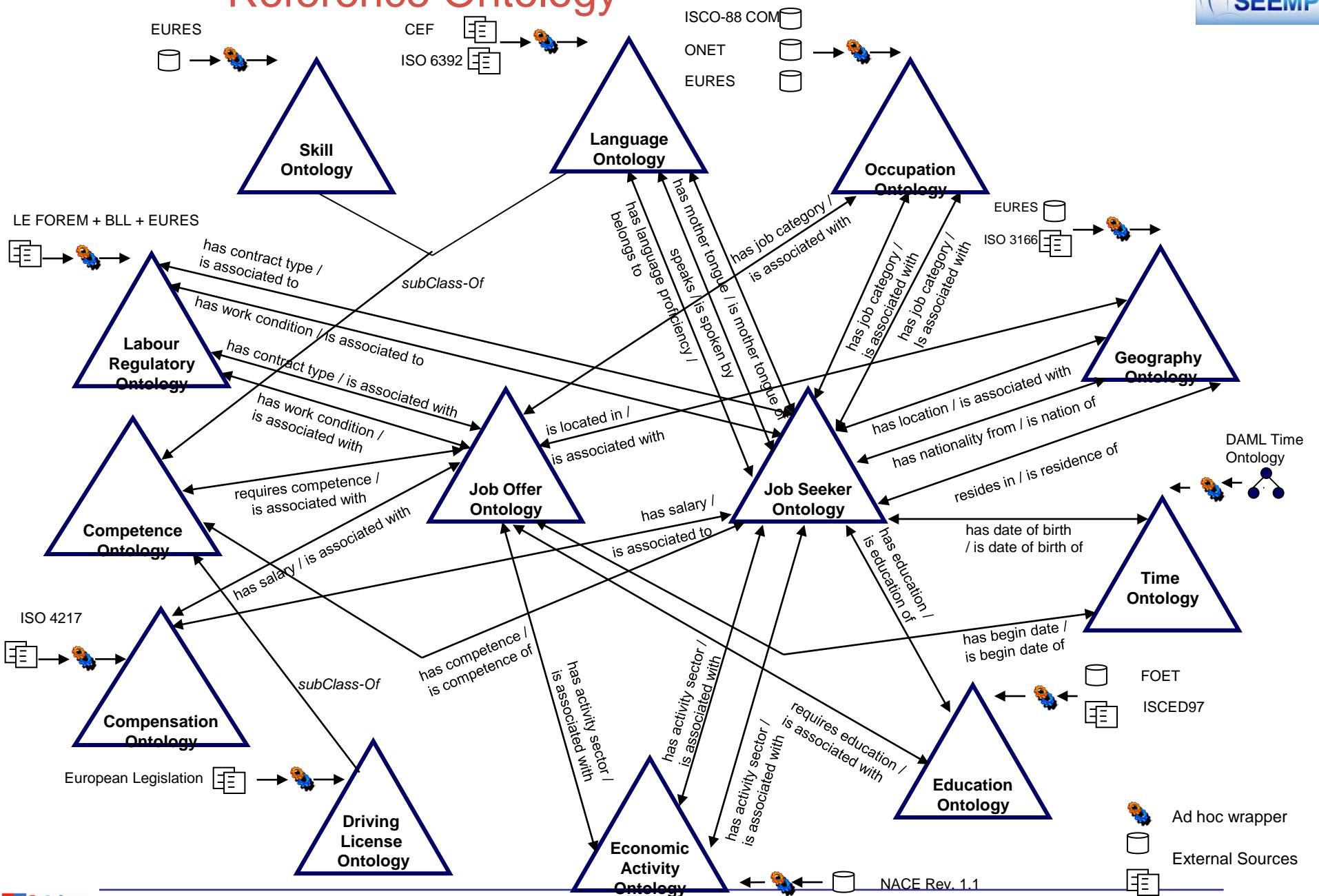
# Conceptualization: Modular approach for ontology construction

Reusability

Usability



# Reference Ontology



# Details of the ontology

