



# Reuse and Re-engineering of Multilingual Resources for Building Ontologies

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  - Methodological Guideliness for **Ontology Reuse**
  - Creating the final Ontology Model
  - **Localizing** the Ontology
- Conclusions

# Building ontologies in the 90s

Methodologies for building single ontologies

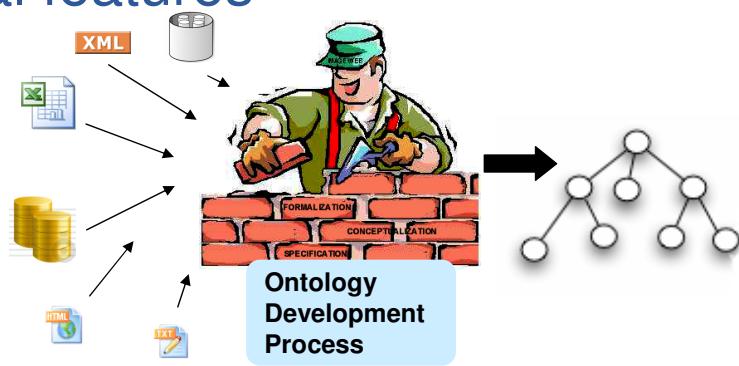
- Uschold and King's method
- Grüninger and Fox's methodology
- KACTUS approach
- METHONTOLOGY
- SENSUS method
- On-To-Knowledge
- DILIGENT

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

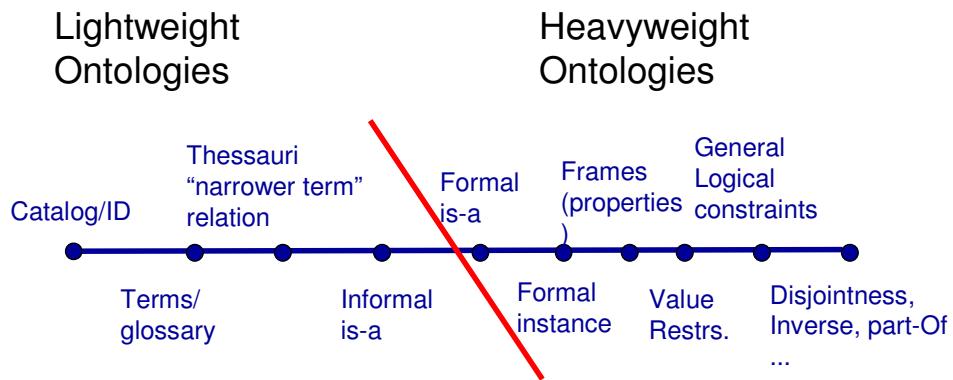
- Are not integrated with current methodologies
- Mainly from non-structured data using NLP techniques

## Current situation

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



## Types of Knowledge-aware resources



Lassila O, McGuiness D. The Role of Frame-Based Representation on the Semantic Web.  
Technical Report. Knowledge Systems Laboratory. Stanford University. KSL-01-02. 2001.

Catalog/ID	Glossary Thesaurus	Informal is-a	Informal is-a						
Term	BT	NT	RT	UF					
Rice	Cereals	Broken rice Basmati rice	Rice straw Oryza	Paddy					
Oryza	Poaceae	Oryza sativa Oryza perennis Oryza rufipogon Oryza longistaminata Wetland rice Oryza glaberrima Upland rice Oryza punctata	Rice fields Cereal crops Rice						
					Thesaurus				
 <p>NOMENCLATOR GEOGRÁFICO ENTIDADES: Nación Región geográfica Capital de Nación Capital de Región Comunidad Autónoma Llanura/Raso Depresión o valle de Autonomía Depresión orográfica Capital de comunidad Autónoma Capital de municipio Pueblo Provincia Accidente marítimo Accidente hidrográfico CoppinCiudad Centro Fluvial Centro de CoppinCiudad Canal Carcasa Embalse Capital de comarca Lago/Laguna Medina Capital de isla Isla marítima Capital de Municipio Capital de Municipio E.A.T.I.M. Lugar/Paraje Calle/Av./C.A.T.I.M. Paso/Collado Población Comunidad de montaña Comunidad de Municipios Puerto comercial Helipuerto comercial Territorio anejado Territorio en construcción Territorio autonómico Estación de ferrocarril Zona neutral</p>	Catalog/ID	XX-YY-ZZ	02-01-02	02: transportation 01: road 02: 3-lines highway					

Formal is-a      Formal instance      Frames (properties)      Value Restrs.      General Logical constraints      Disjointness, Inverse, part-Of ...

**Formal is-a with properties**

```

graph TD
    WaterArea[Water area  
-Code = 20000  
-Name = Water area] --> FishingStatisticalArea[Fishing Statistical area  
-Code = 22000  
-Name = Fishing Statistical area]
    WaterArea --> EnvironmentalArea[Environmental area  
-Code = 21000  
-Name = Environmental area]
    WaterArea --> JurisdictionArea[Jurisdiction area  
-Code = 24020  
-Name = Jurisdiction area]
    FishingStatisticalArea --> InlandMarine[Inland/Marine  
-Code = 210001  
-Name = Inland/Marine]
    FishingStatisticalArea --> Ocean[Ocean  
-Code = 210002  
-Name = Ocean]
    EnvironmentalArea --> NorthSouthEquatorial[North/South/Equatorial  
-Code = 210003  
-Name = North/So ...]
    EnvironmentalArea --> SubOcean[Sub Ocean  
-Code = 210004  
-Name = Sub Ocean]
    EnvironmentalArea --> LargeMarineEcosystem[Large Marine ecosystem  
-Code = 210005  
-Name = Large Mar ...]
    JurisdictionArea --> InlandMarine
    JurisdictionArea --> Ocean
    JurisdictionArea --> NorthSouthEquatorial
    JurisdictionArea --> SubOcean
    JurisdictionArea --> LargeMarineEcosystem
  
```

(define-relation connects (?edge ?source ?target)  
*"This relation links a source and a target by an edge. The source and destination are considered as spatial points. The relation has the following properties: symmetry and irreflexivity."*  
:def (and (SpatialPoint ?source)  
(SpatialPoint ?target)  
(Edge ?edge))  
:axiom-def  
((=> (connects ?edge ?source ?target)  
(connects ?edge ?target ?source)) ;symmetry  
(=> (connects ?edge ?source ?target)  
(not (or (part-of ?source ?target) ,irreflexivity  
(part-of ?target ?source)))))))

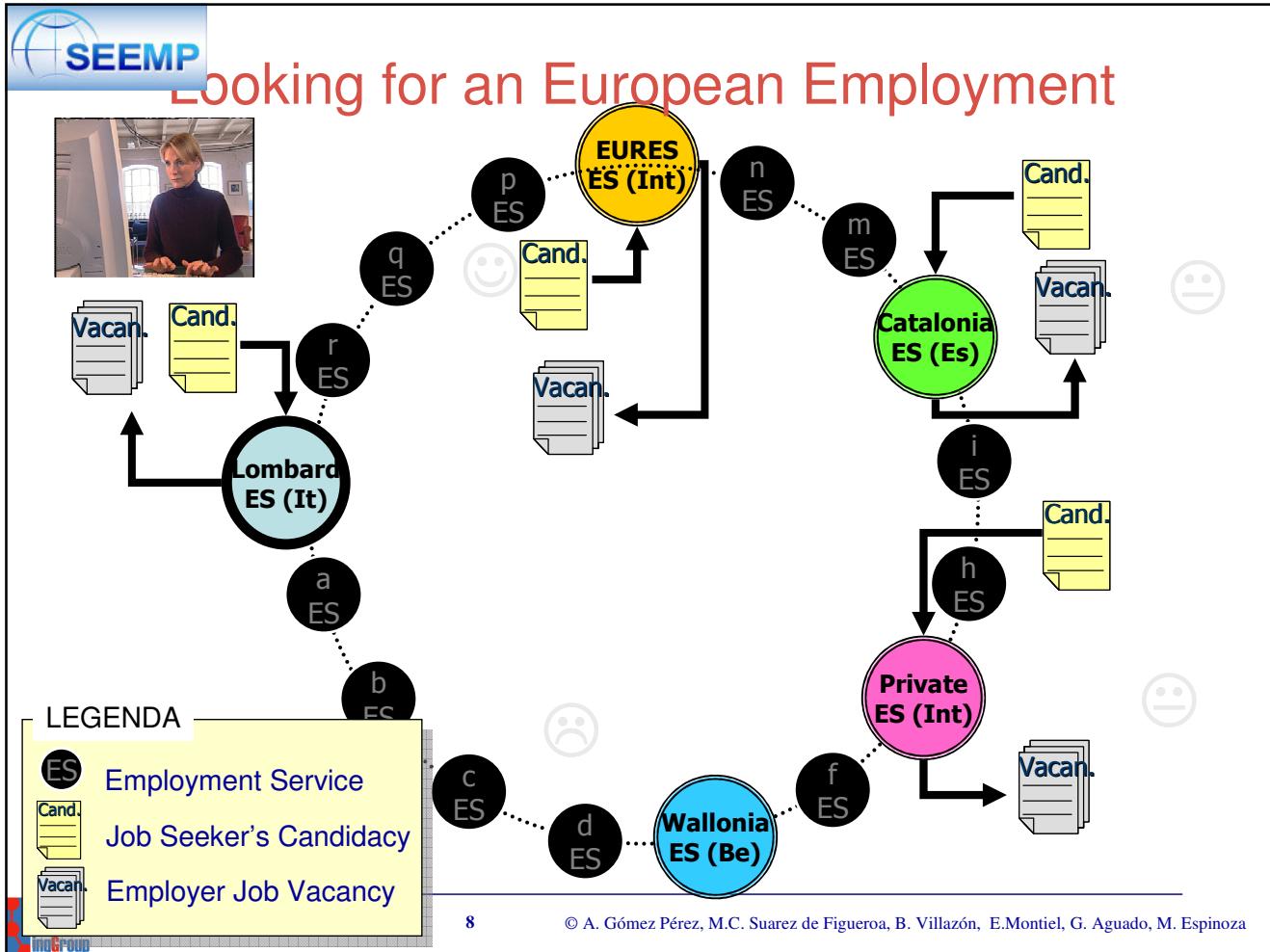
(define-class Travel (?travel)  
*"A journey from place to place"*  
:axiom-def  
(and (Superclass-Of Travel Flight)  
(Template-Facet-Value Cardinality  
arrivalDate Travel 1)  
(Template-Facet-Value Cardinality  
departureDate Travel 1)  
(Template-Facet-Value Maximum-Cardinality  
singleFare Travel 1))  
:def  
(and (arrivalDate ?travel Date)  
(departureDate ?travel Date)  
(singleFare ?travel Number)  
(companyName ?travel String)))

(define-class AmericanAirlinesFlight (?X)  
:def (Flight ?X)  
:axiom-def  
(Disjoint-Decomposition AmericanAirlinesFlight  
(Setof AA7462 AA2010 AA0488)))

(define-class Location (?X)  
:axiom-def  
(Partition Location  
(Setof EuropeanLocation NorthAmericanLocation  
SouthAmericanLocation AsianLocation  
AfricanLocation AustralianLocation  
AntarcticLocation)))

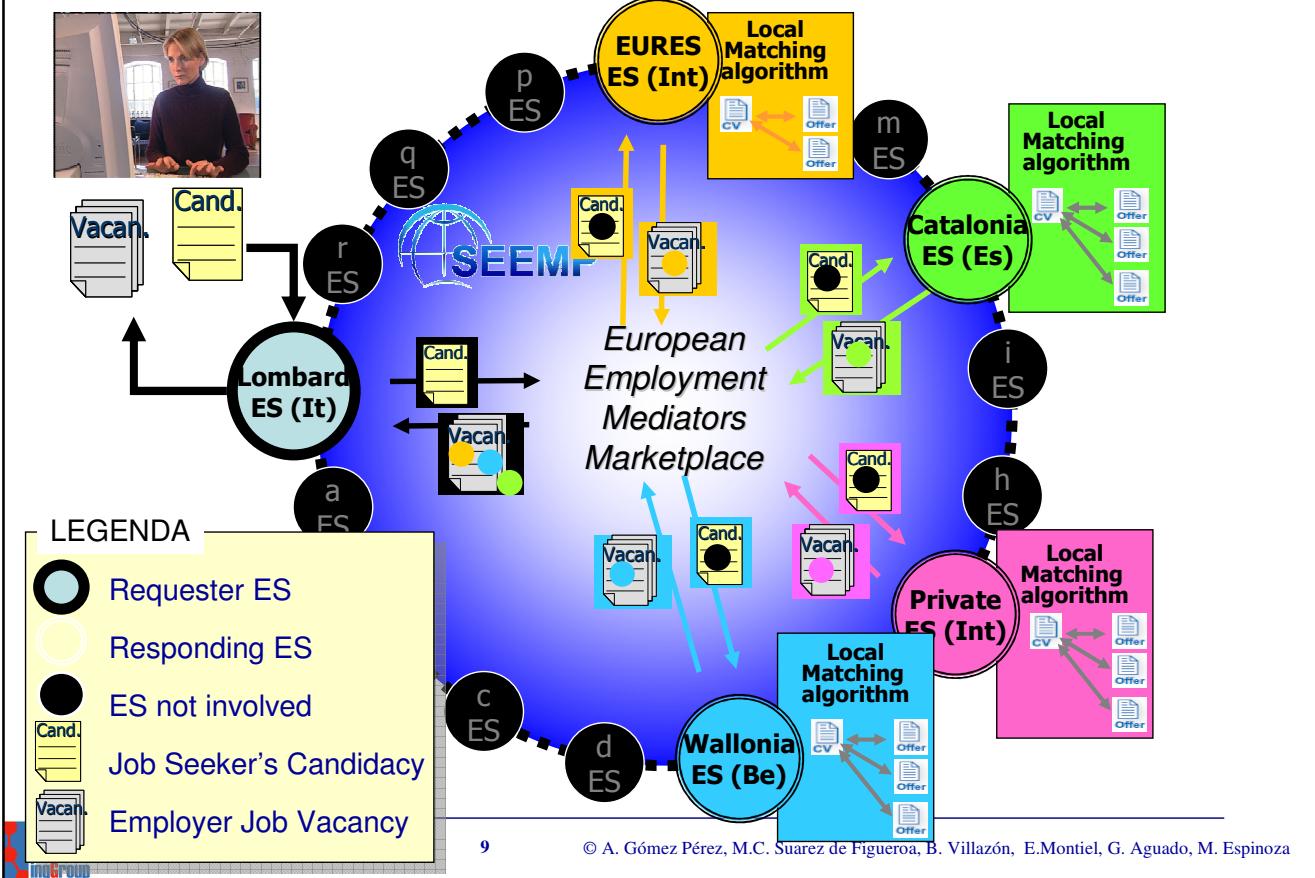
Ontology Engineering Group
Ontological Engineering
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## Looking for an European Employment





## Helping Job Seekers on their way



## Key issues

- Reuse of proprietary knowledge-aware resources
- Heterogeneity
  - Terms are in different languages
  - Different conceptualization (different ways of organizing job categories)
  - Different DB schemas
- Data must be kept in the original sources and in their own language.

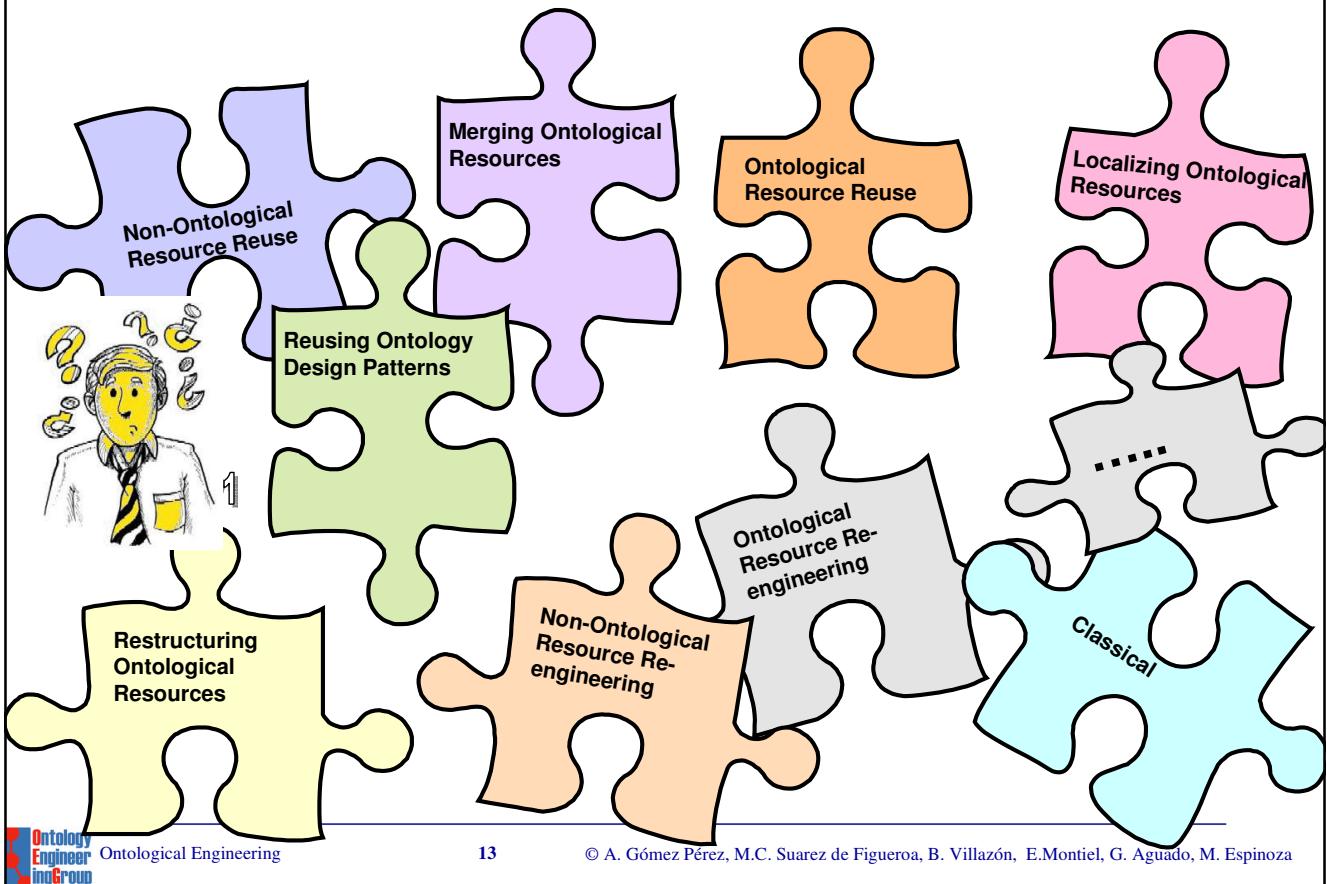
# Key aspects of Ontological Engineering

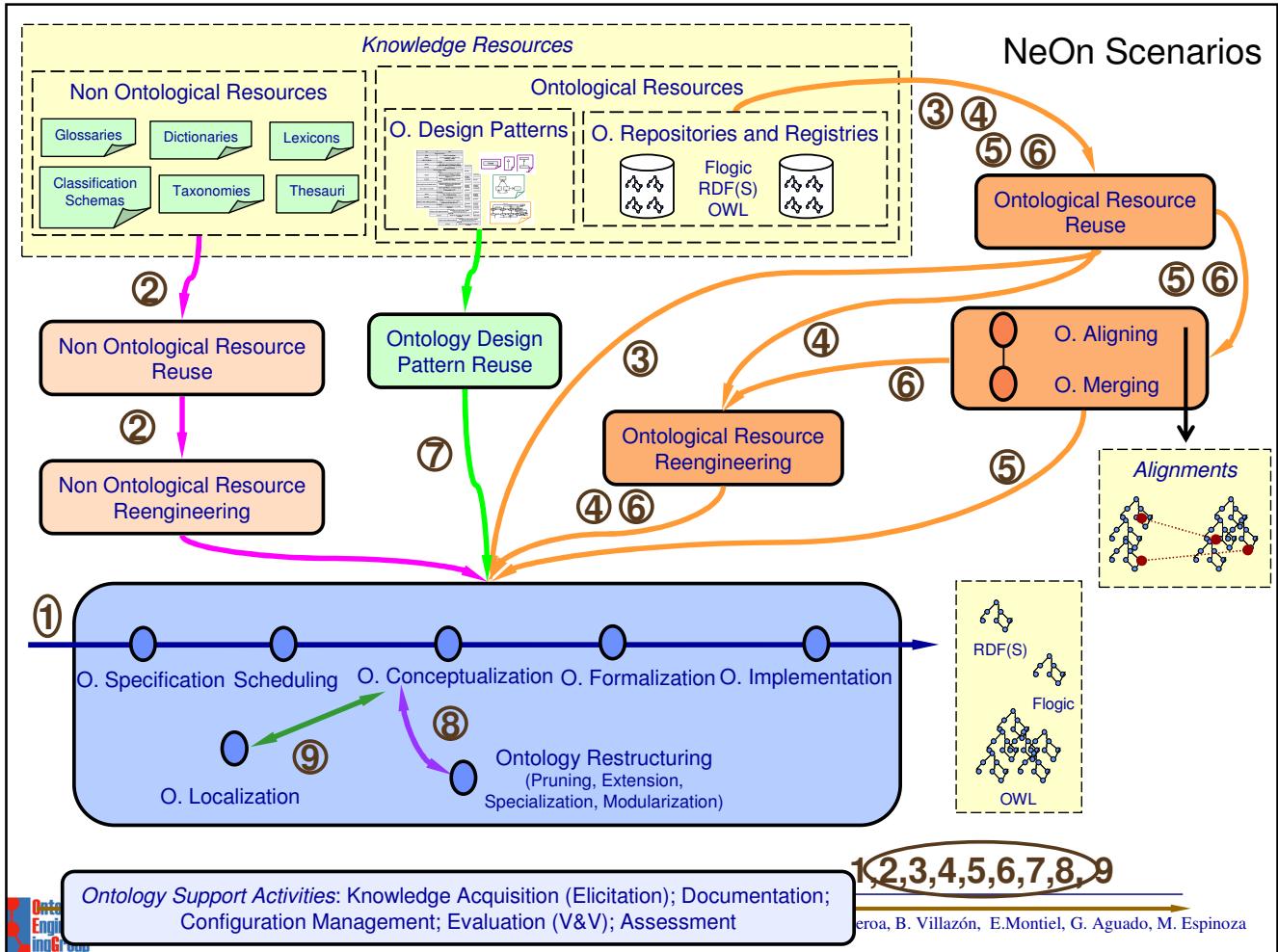
- **Ontologies**
  - Single versus network of ontologies?
  - Are ontologies built from scratch or reusing knowledge-aware resources?
  - Are mappings used for solving conceptual mismatches?
- **Instances**
  - Where are the data/instances?
    - Instances are in the ontology
    - Instances are in RDF 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

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## Which are the Processes and Activities needed?



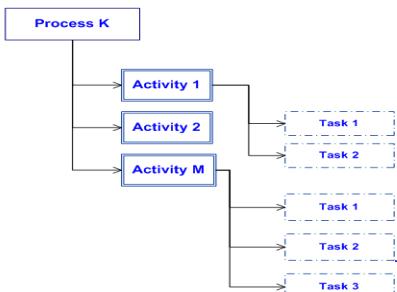




# NeOn Methodology

Process and activities covered:

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

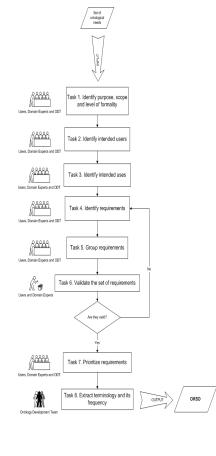


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All processes and activities are described with:

- A filling card
- A workflow
- Examples

Process or Activity Name	
Definition	
Goal	
Input	Output
Who	
When	

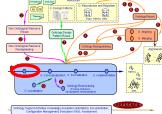


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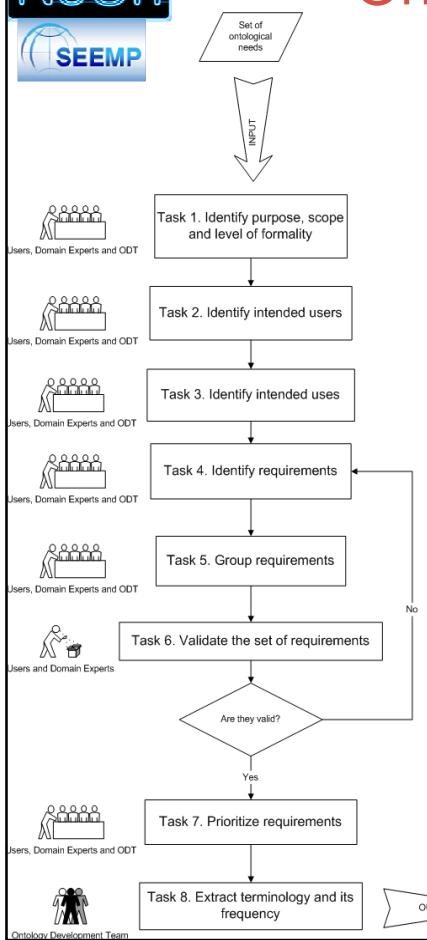
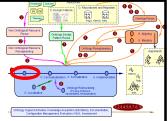
# Ontology Requirement Specification Document



Ontology Requirements Specification Document Template	
<b>1</b>	<b>Purpose</b>
	<i>"Software developers and ontology practitioners should include in this slot the purpose of the ontology"</i>
<b>2</b>	<b>Scope</b>
	<i>"Software developers and ontology practitioners should include in this slot the scope of the ontology"</i>
<b>3</b>	<b>Level of Formality</b>
	<i>"Software developers and ontology practitioners should include in this slot the level of formality of the ontology"</i>
<b>4</b>	<b>Intended Users</b>
	<i>"Software developers and ontology practitioners should include in this slot the intended users of the ontology"</i>
<b>5</b>	<b>Intended Uses</b>
	<i>"Software developers and ontology practitioners should include in this slot the intended uses of the ontology"</i>
<b>6</b>	<b>Groups of Competency Questions</b>
	<i>"Software developers and ontology practitioners should include in this slot the groups of competency questions and their answers, including priorities for each group"</i>
<b>7</b>	<b>Pre-Glossary of Terms</b>
	<b>Terms</b>
	<i>"Software developers and ontology practitioners should include in this slot the list of terms included in the CQs and their frequencies"</i>
	<b>Objects</b>
	<i>"Software developers and ontology practitioners should include in this slot a list of objects and their frequencies"</i>



# Ontology Specification



<b>1 Purpose</b>
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).
<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 Level of Formality</b>
The ontology has to be implemented in WSML language
<b>4 Intended Users</b>
<ul style="list-style-type: none"> <li>1. Candidate who is unemployed and searching for a job or searching another occupation for immediate or future purposes.</li> <li>2. Employer who needs more human resources.</li> <li>3. Public or private employment search service which offers services to gather CVs or job postings and to prepare some data and statistics.</li> <li>4. National and Local Governments which want to analyze the policy.</li> <li>5. European Union to see the governments of the PES which want to analyze the statistics and prepare international agreements.</li> <li>6. PES Portal to offer an Employment statistics portal on education PES Portal.</li> </ul>
<b>5 Intended Uses</b>
<ul style="list-style-type: none"> <li>3. Search for Job Offers. The Employer looks for candidates for the Job Offer through PES Portal.</li> <li>4. Search for Employment information. Job Seeker looks for of general information about employment in a given location at the PES Portal.</li> <li>5. Provide Job Statistics. The PES Portal provides employment statistics to the Job Seeker and Employer.</li> </ul>

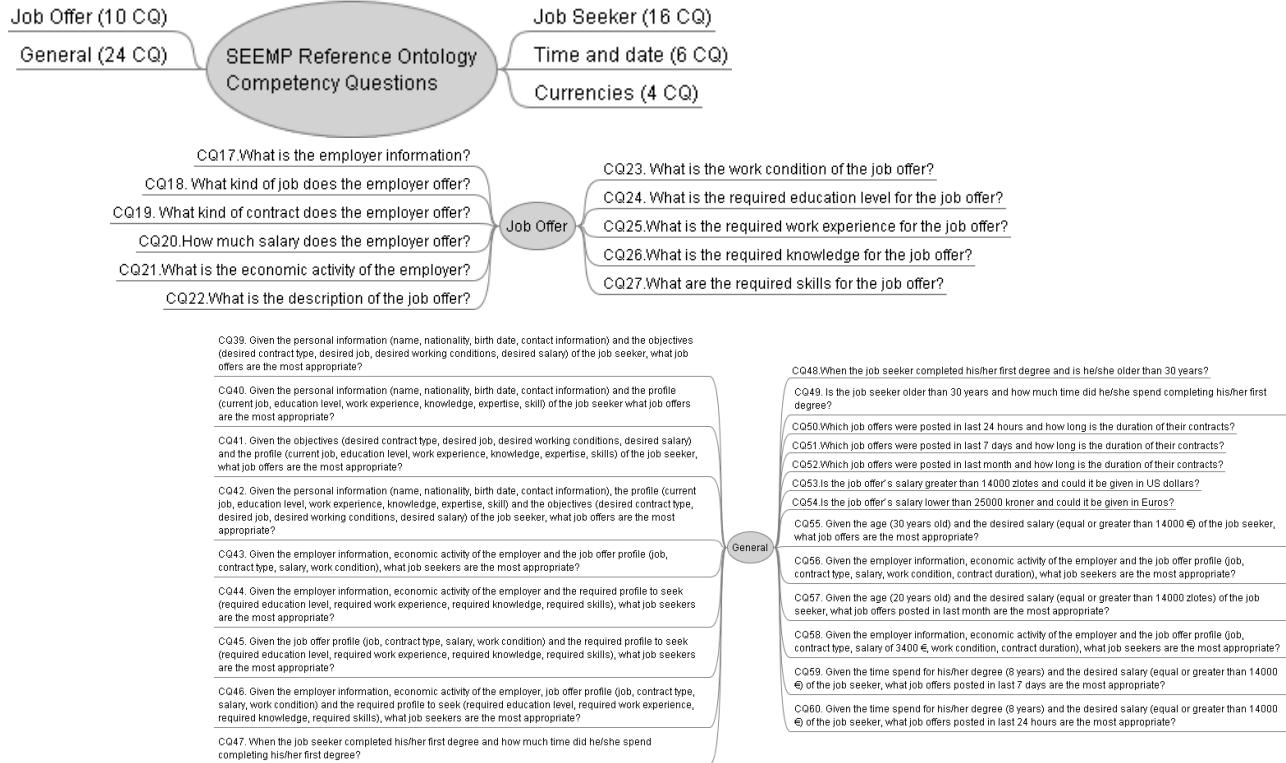
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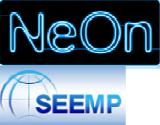
## Ontology Specification: Identify requirements using competency questions

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

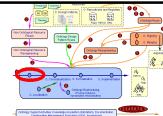


## Ontology Specification: Group requirements.





# Ontology Specification. The Ontology Requirement Specification Document



SEEMP Reference Ontology Requirements Specification	
<b>1 Purpose</b>	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).
<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 Level of Formality</b>	The ontology has to be implemented in WSML language
<b>4 Intended Users</b>	<p>User 1. Candidate who is unemployed and searching for a job or searching another occupation for immediate or future purposes</p> <p>User 2</p> <p>User 3</p>
<b>7 Pre-Glossary of Terms</b>	
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

6 Groups of Competency Questions	
CQG1. Job Seeker (16 CQ)	<p>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?</p> <p><b>Job Seeker</b></p> <p>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?</p>
CQG2. Job Offer (10 CQ)	<p>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?</p> <p><b>Job Offer</b></p> <p>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?</p>
CQG3. Objects	<p>Objects in the universe of discourse, which are instances of:</p> <ul style="list-style-type: none"> <li>Job Category <ul style="list-style-type: none"> <li>01 Computer System Designer</li> <li>02 Computer System Analyst</li> <li>03 Programmer</li> <li>04 Computer Engineer</li> <li>05 Computer Assistant</li> <li>06 Computer Equipment Operator</li> <li>07 Industrial Robot Controller</li> <li>08 Telecommunication Equipment Operator</li> <li>09 Medical Equipment Operator</li> <li>010 Electronic Equipment Operator</li> <li>011 Image Equipment Operator</li> </ul> </li> <li>Nationality <ul style="list-style-type: none"> <li>012 Austrian</li> <li>013 Belgian</li> <li>014 Danish</li> <li>015 Estonian</li> <li>016 Finnish</li> <li>017 French</li> <li>018 German</li> <li>019 Greek</li> <li>020 Italian</li> </ul> </li> <li>Activity Sector <ul style="list-style-type: none"> <li>021 Telecommunication</li> <li>022 Justice and Judicial</li> <li>023 Public Security and law</li> <li>024 Manufacture of machine tools</li> <li>025 Research and Development</li> <li>026 Hardware Consultancy</li> <li>027 Software Consultancy and Supply</li> <li>028 Data processing</li> </ul> </li> <li>Education <ul style="list-style-type: none"> <li>029 Life Science</li> <li>030 Mathematics</li> <li>031 Computer Science</li> <li>032 Computer Use</li> <li>033 Statistics</li> <li>034 Physics</li> <li>035 Network Administration</li> </ul> </li> <li>Languages <ul style="list-style-type: none"> <li>036 Swedish</li> <li>037 Spanish</li> <li>038 Slovenian</li> <li>039 Portuguese</li> <li>040 English</li> <li>041 French</li> <li>042 German</li> </ul> </li> <li>Currency <ul style="list-style-type: none"> <li>043 Euro</li> <li>044 Krone</li> <li>045 Great British Pound</li> <li>046 Zlote</li> <li>047 US Dollar</li> <li>048 Franc</li> </ul> </li> <li>Location <ul style="list-style-type: none"> <li>049 Austria</li> <li>050 Belgium</li> <li>051 Danmark</li> <li>052 Estonia</li> <li>053 Finland</li> <li>054 France</li> <li>055 Germany</li> <li>055 Greece</li> </ul> </li> </ul>

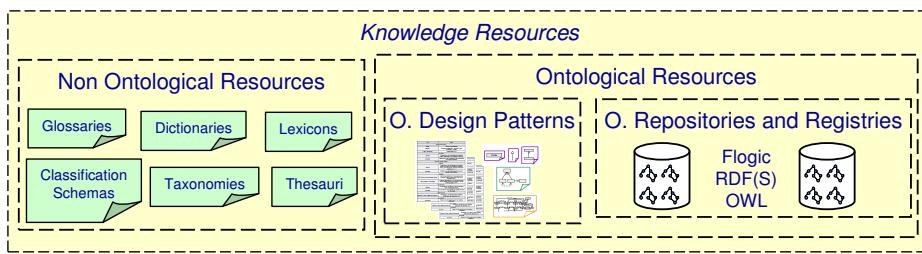
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## Searching Resources

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



Objects
Objects in the universe of discourse, which are instances of:
• Job Category
01. Computer System Designer 02. Computer System Analyst 03. Programmer 04. Computer Engineer 05. Computer Assistant 06. Computer Equipment Operator 07. Industrial Robot Controller 08. Telecommunication Equipment Operator 09. Medical Equipment Operator 010. Electronic Equipment Operator 011. Image Equipment Operator
• Nationality
012. Austrian 013. Belgian 014. Danish 015. Estonian 016. Finnish 017. French 018. German 019. Greek 020. Italian

- 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?**

## 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)

```
<?xml version="1.0" encoding="ISO-8859-1" standalone="yes"?>
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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 ausdrücl deren H:
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 Geburts hilfefachkräfte	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		

## Selection of Ontologies

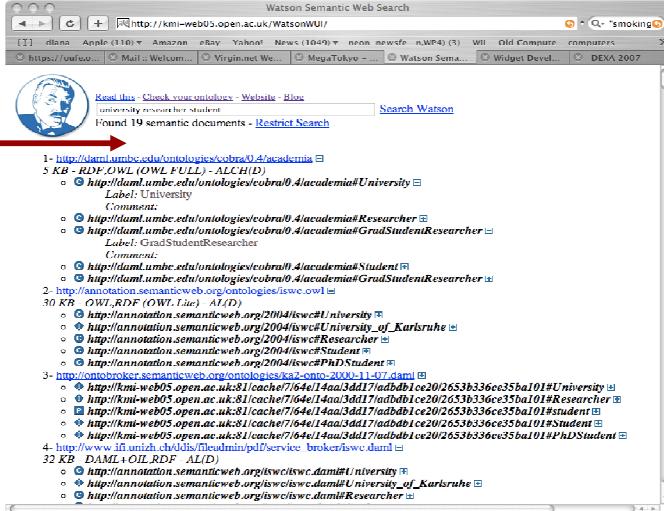
- Search ontologies
- Compare ontologies in the same domain using a set of criteria
- Assess if the ontologies cover the set of competency questions
- Select the best ontology based on
  - Coverage of the domain
  - Expressivity of the Implementation language

# NeOn

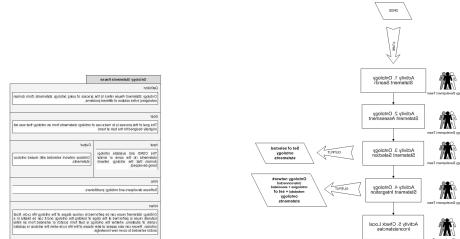
# Searching Ontologies in Watson

# Ontology Requirement Specification Document

- **Objects**
  - **Inst. of** Tdiscourse, which are
    - **Job Category**
      - **Computer System Designer**
      - **Computer System Analyst**
      - **Programmer**
      - **Computer Engineer**
      - **Computer Assistant**
      - **Computer Equipment Operator**
      - **Network Router Control**
      - **Telecommunication Equipment Operator**
      - **Medical Equipment Operator**
      - **Electronic Equipment Operator**
      - **Image Equipment Operator**
    - **Nationality**
      - **Austrian**
      - **Belgian**
      - **Danish**
      - **German**
      - **Finnish**
      - **French**
      - **Irishman**
      - **Greek**
      - **Italian**
    - **Activity Sector**
      - **Telecommunications**
      - **Administrative and Judicial**
      - **Public Security and Law**
      - **Research and other tools**
      - **Research and Development**
      - **Hardware Consultancy**
      - **Data Processing, Computing and Supply**
      - **Data processing**
  - **Education**
    - **Life Science**
    - **Mathematics**
    - **Computer Science**
    - **Computer Use**
    - **Mathematics**
    - **Physics**
    - **Network Administration**
  - **Languages**
    - **Swedish**
    - **Spanish**
    - **Slovenian**
    - **Portuguese**
    - **English**
    - **French**
    - **German**
  - **Currency**
    - **Euro**
    - **Krone**
    - **Great British Pound**
    - **Zero**
    - **Dollar**
    - **Franc**
  - **Location**
    - **Austria**
    - **Denmark**
    - **Danmark**
    - **Estonia**
    - **Iceland**
    - **France**
    - **Germany**
    - **Greece**



The NeOn methodology includes guidelines for reusing statements



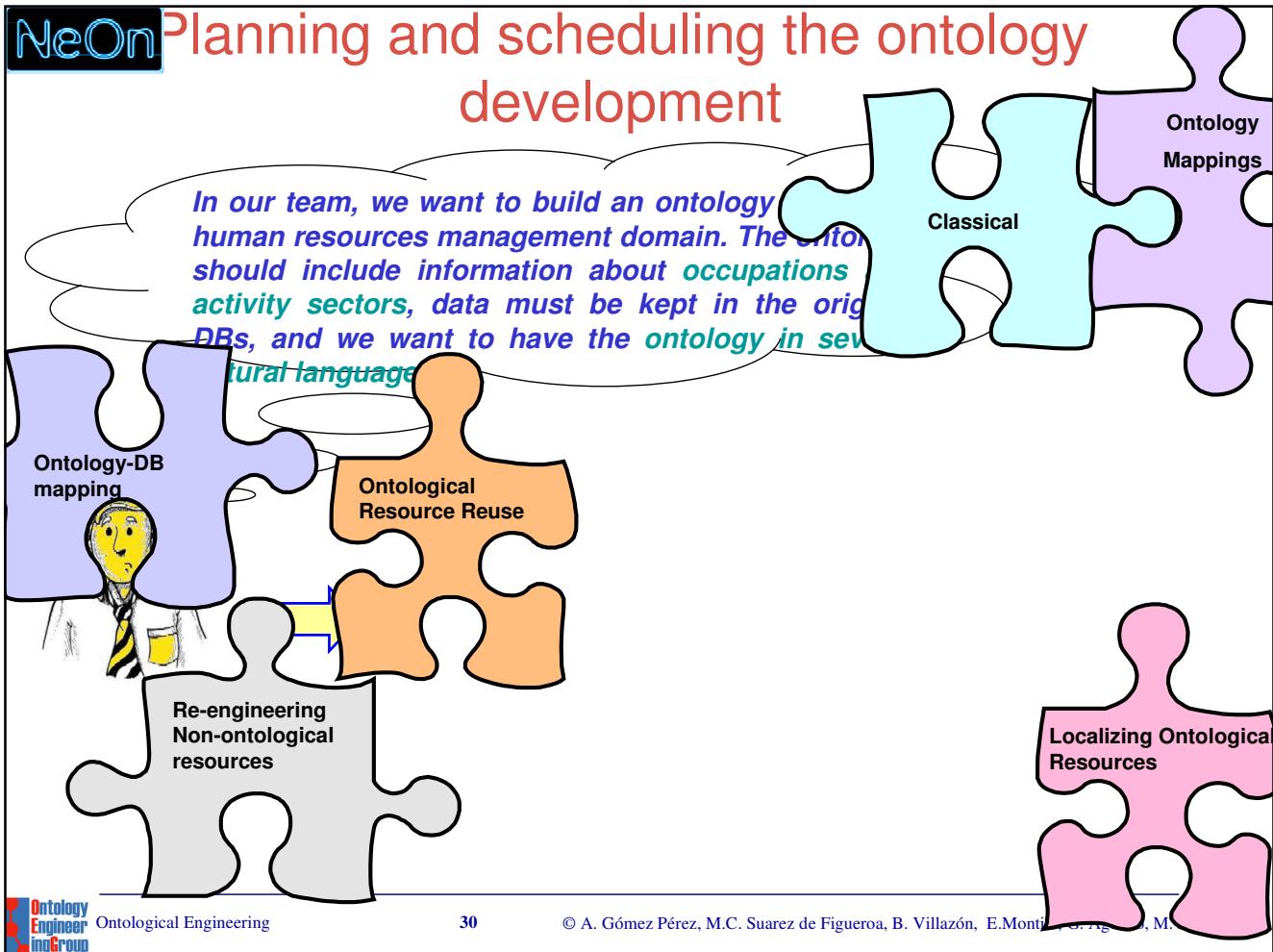
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- Introduction
- **NeOn Methodology**
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  - Methodological Guidelines for Ontology Specification
  - Quick Search of Existing Knowledge Resources
  - **Guidelines for Ontology development project Planning**
  - Methodological Guidelines for Non-Ontological Resource Reuse and Re-engineering
  - Methodological Guideliness for Ontology Reuse
  - Creating the final Ontology Model
  - Localizing the Ontology
- Conclusions



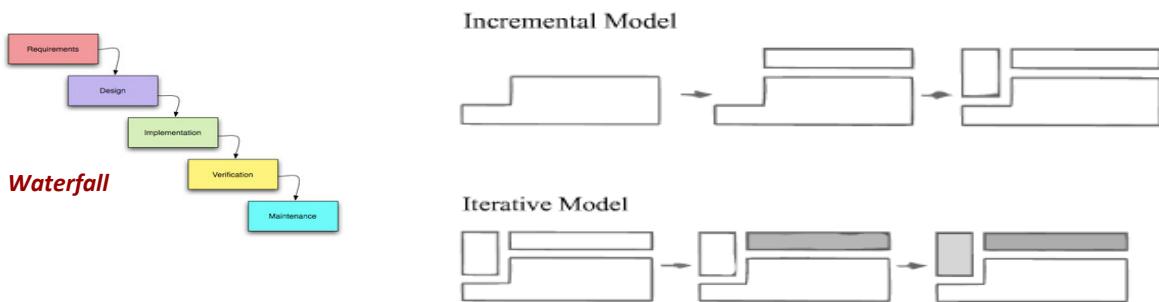
## Planning and scheduling the ontology development

*In our team, we want to build an ontology human resources management domain. The ontology should include information about occupations, activity sectors, data must be kept in the original DBs, and we want to have the ontology in several natural languages.*



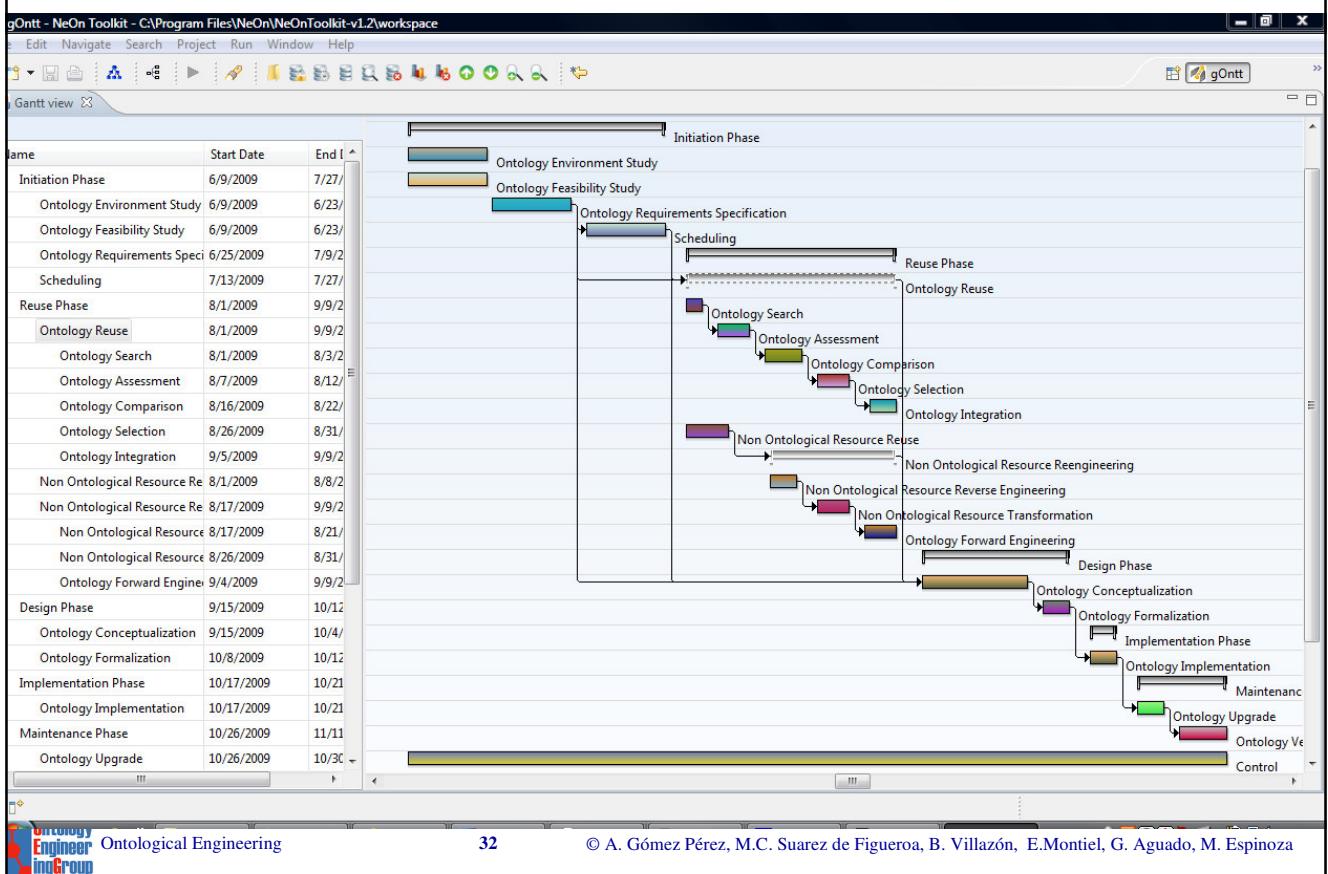
## Life Cycle Models and Life Cycles

- An **ontology life cycle model** is the framework (waterfall, evolving prototyping, spiral, etc.), selected by each organization, on which to map the activities identified in the ontology development process.

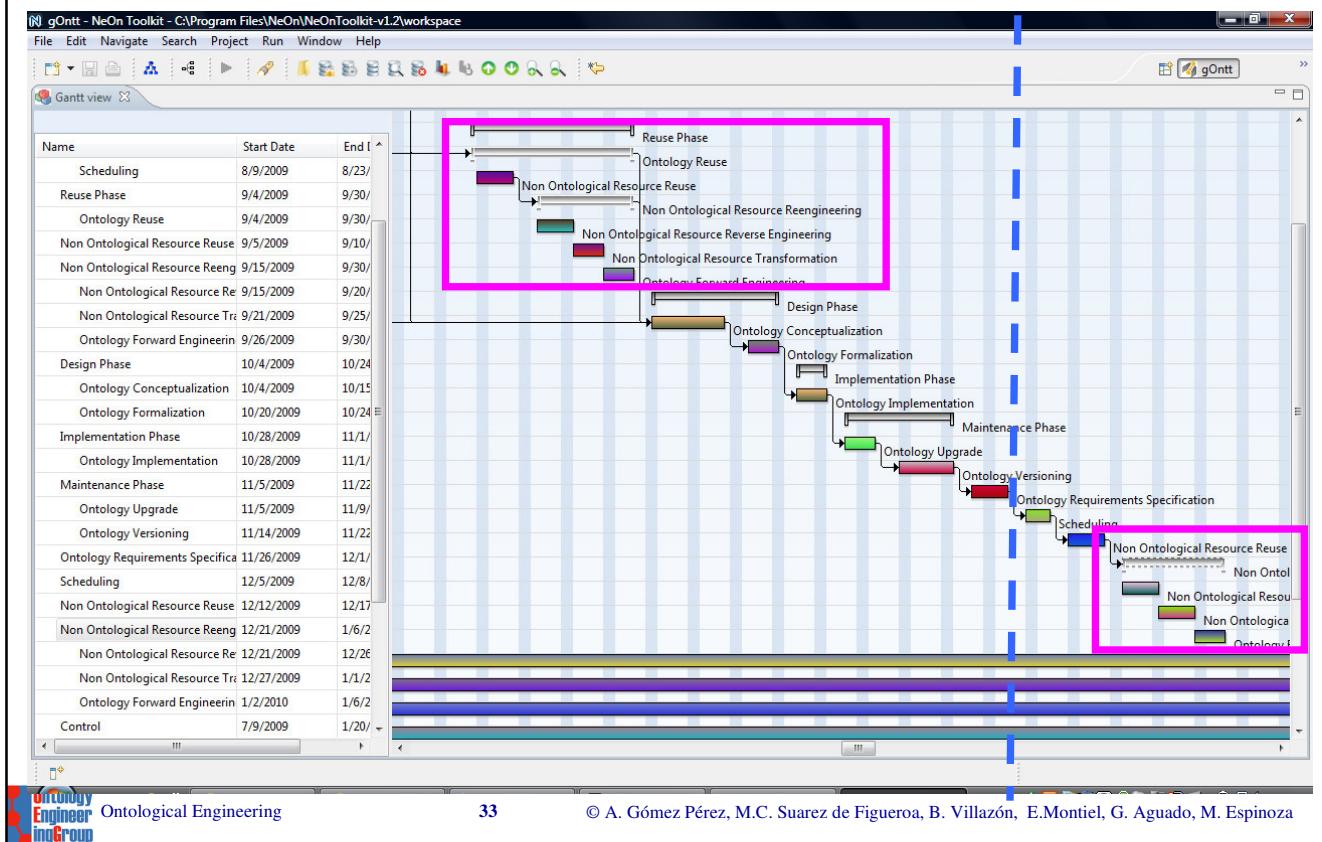


- The **ontology life cycle** is the specific sequence of activities that the ontology practitioners carry out for developing an ontology.
- There is **not a unique life cycle model** valid for all ontology development projects

## Gantt chart for your project. Waterfall model



# Reuse and Re-engineering + Incremental





D5.3.2

## Scheduling. gOntt Plug-in

- gOntt helps in scheduling an ontology network development.

- gOntt integrates the NeOn Methodology and the NeOn Toolkit.

- gOntt provides filling cards, workflows, and methodological guidelines for many activities
- gOntt triggers the NeOn plug-ins associated to each process and activity planned.

The screenshot displays the gOntt interface with several windows open:

- Workflow and Methodological Guidelines:** A tree view showing the methodology structure. Nodes include "Introduction", "Task 1. Select the most appropriate linguistic assets", "Task 2. Select ontology term(s) to be localized", "Task 3. Obtain ontology term translation(s)", "Task 4. Evaluate term translation(s)", and "Task 5. Ontology update".
- Ontology Localization: Filling Card:** A card with the following fields:
  - Definition:** Ontology localization refers to the adaptation of an ontology to particular language and culture.
  - Goal:** To translate an ontology expressed in a source natural language.
  - Input:** An ontology whose ontology terms are expressed in one or several natural languages, from which one is selected as source natural language.
  - Output:** An ontology has been translated to a target natural language.
  - Who:** Software developers and ontology practitioners, who form the development team, on collaboration with domain and application experts.
  - When:** Once the conceptual model of the ontology is stable, spending time and resources in a model that is not defined.
- Cheat Sheets:** A window titled "Ontology Localization: Workflow and Methodological Guidelines" containing the same task list as the main window.
- Top Bar:** Shows the gOntt logo and other standard application icons.

# Index

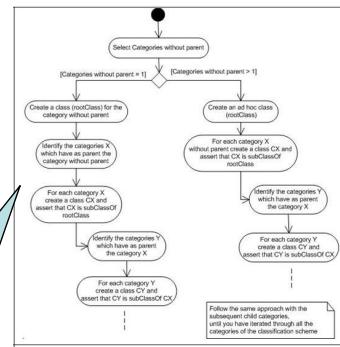
- Introduction
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# resource

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

# Motivation

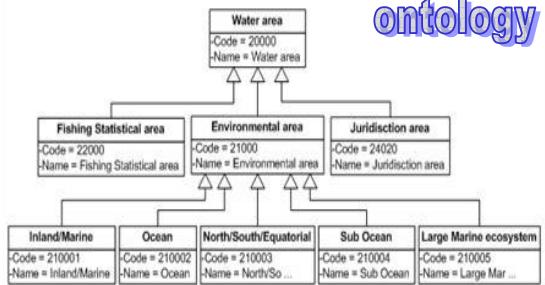
Algorithm



I want to transform my adjacency classification ontology into an

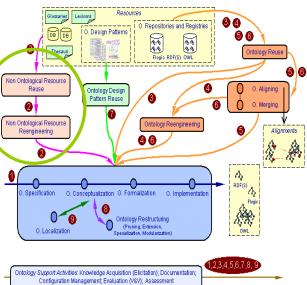


(UML)  
Example Solution  
Ontology

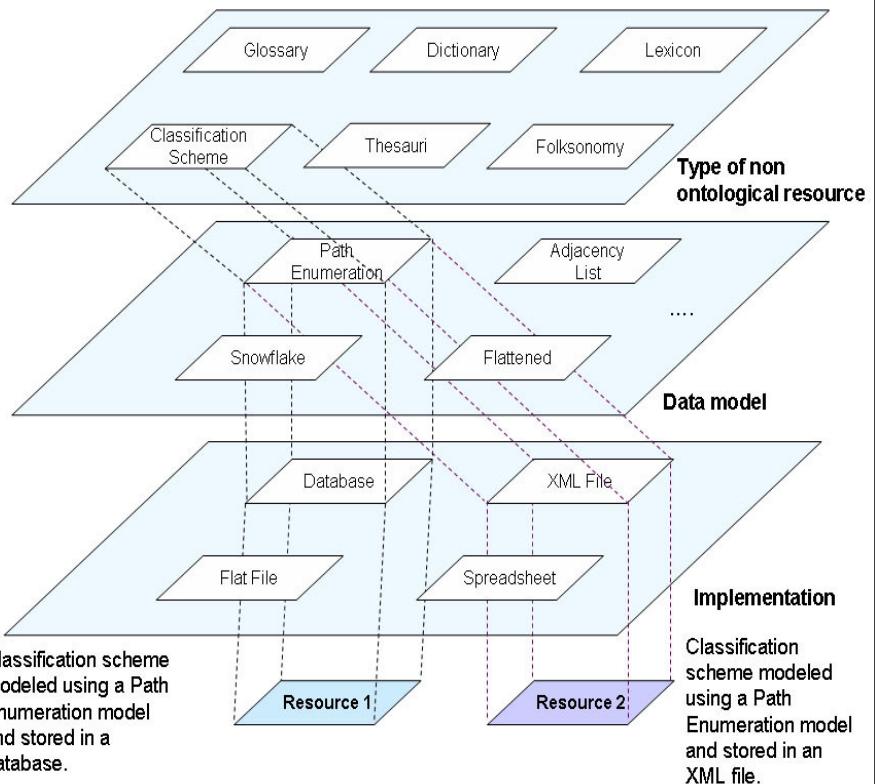


ontology

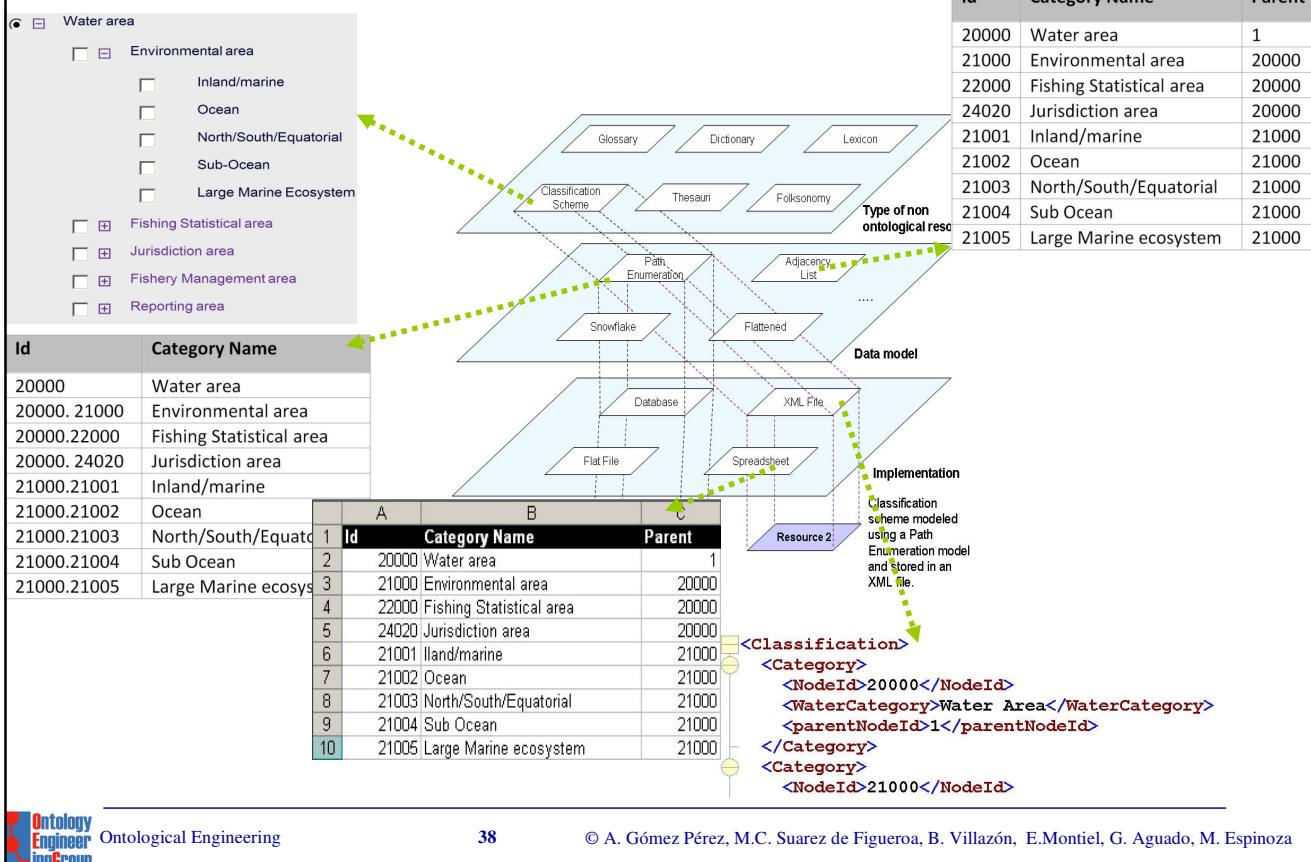
# Types of non-ontological resources



**Non-Ontological Resources** are knowledge-aware resources whose semantics have not been formalized yet by means of an ontology

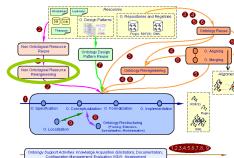
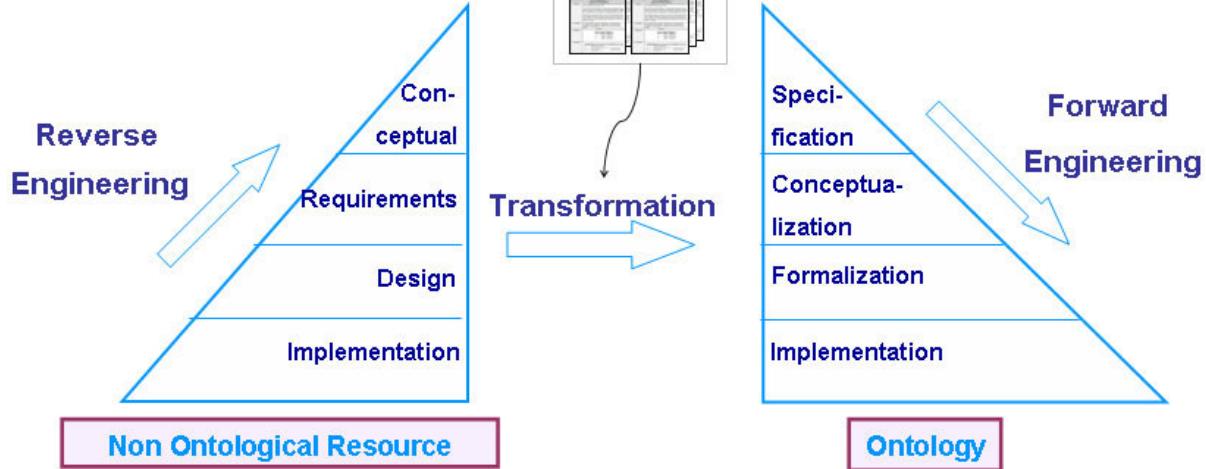


# Types of non-ontological resources



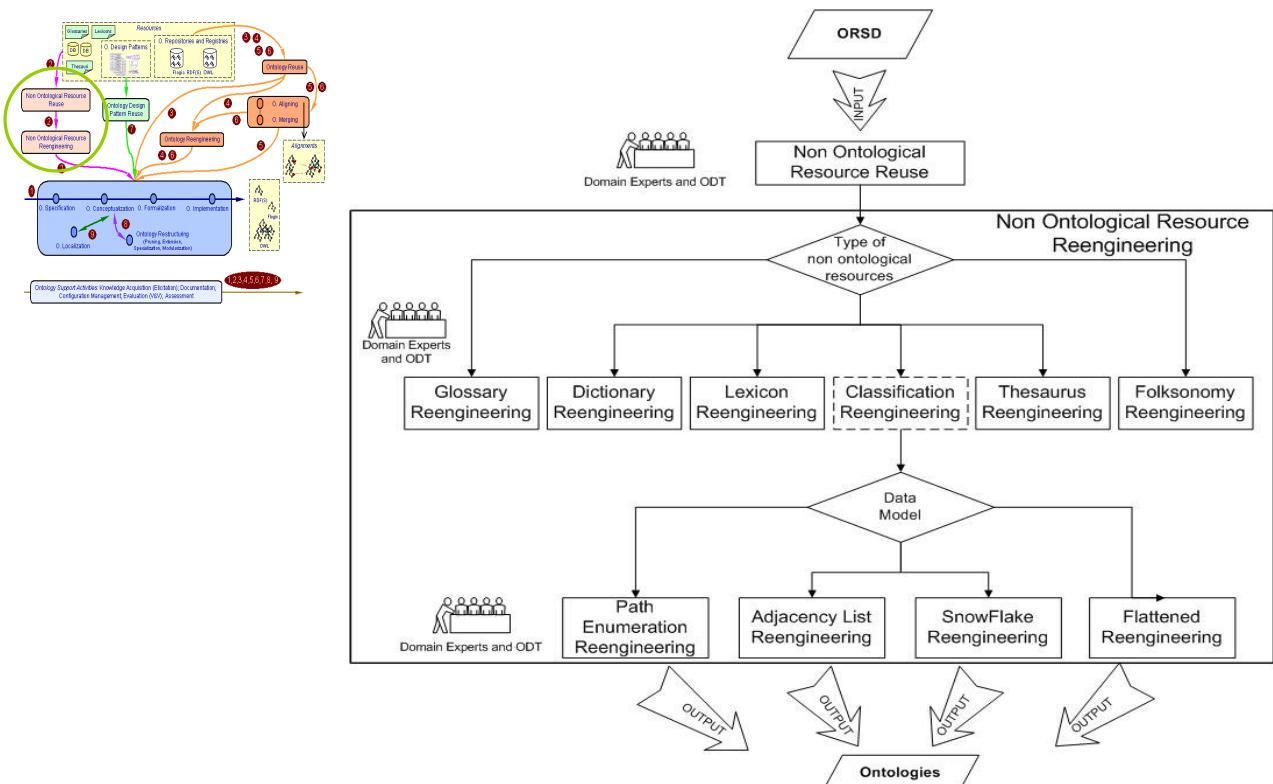
# Approach for Re-engineering Non-Ontological Resources

Patterns for Reengineering  
Non Ontological Resources  
(PR-NOR)



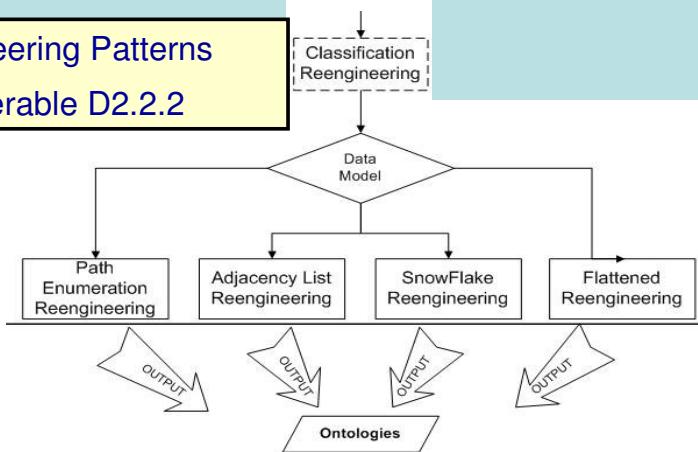


# Reuse and Re-engineering Non-ontological Resources



# A pattern for each resource data model

## NOR Reengineering Patterns are in Deliverable D2.2.2



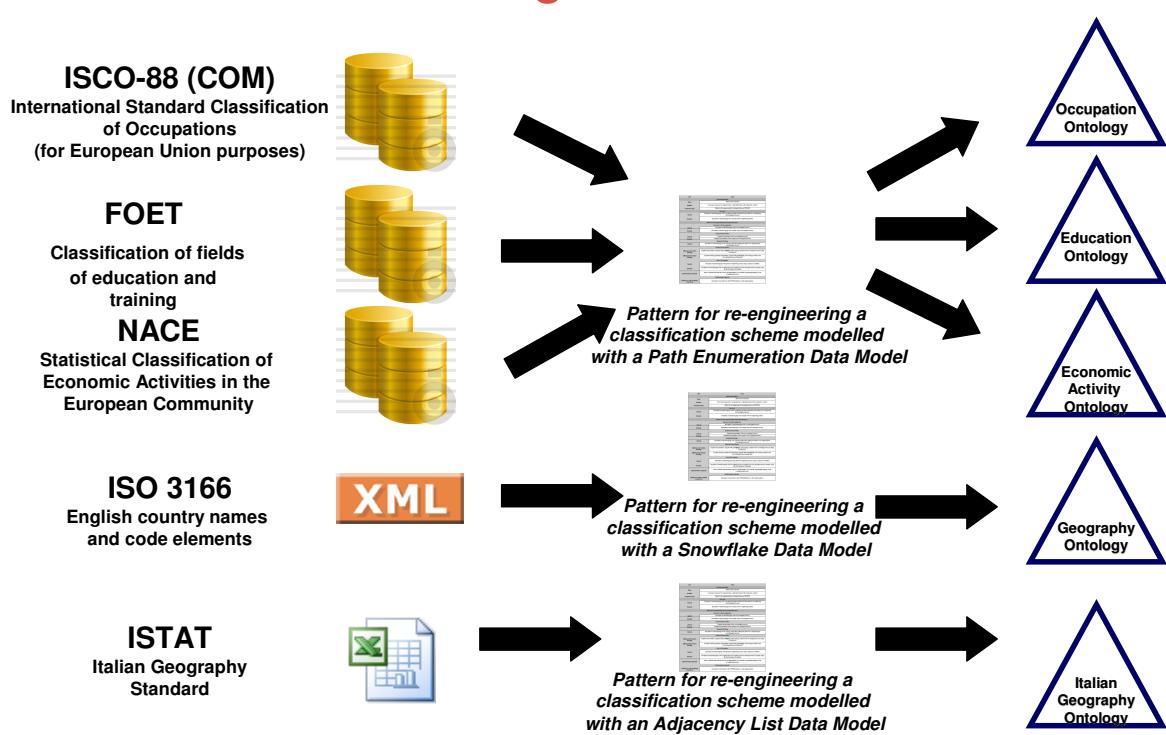
## *Classification to Taxonomy ( Adjacency List)*

## *Classification to Taxonomy ( Path Enumeration Model)*

## *Classification to Taxonomy ( Flattened Model)*

## *Classification to Taxonomy ( Snowflake Model)*

# Pattern based approach for re-engineering non ontological resources



# Knowledge Resource Re-engineering and Aggregation

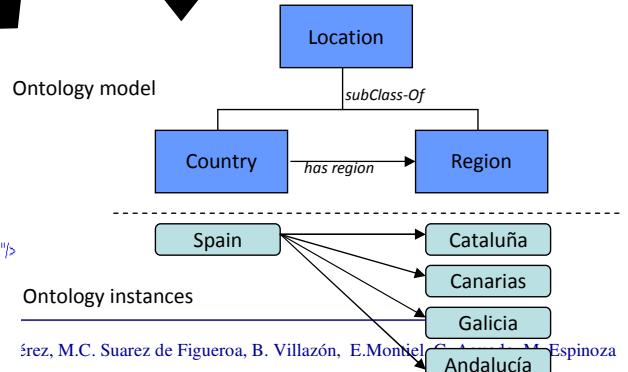
ISO 3166-1 (XML)

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Excerpt of the Geography Ontology

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  <rdf:type rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Country"/>
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  <GeoOnt:Name rdf:datatype="http://www.w3.org/2001/XMLSchema#string">SPAIN</GeoOnt:Name>
  <GeoOnt:is_located_inContinent rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#EU_Europe"/>
  <GeoOnt:hasRegion Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Cataluna"/>
  <GeoOnt:hasRegion Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Canarias"/>
  <GeoOnt:hasRegion Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Galicia"/>
  <GeoOnt:hasRegion Region rdf:resource="webode://mccarthy.dia.fi.upm.es/Geography_Ontology#Andalucia"/>
</rdf:Description>
```

Regions Table (Eures Oracle DB)		
N	ISO31661 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

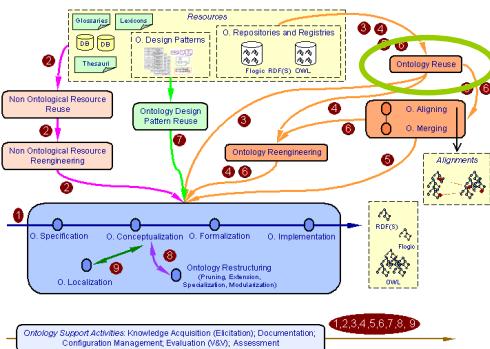


# Index

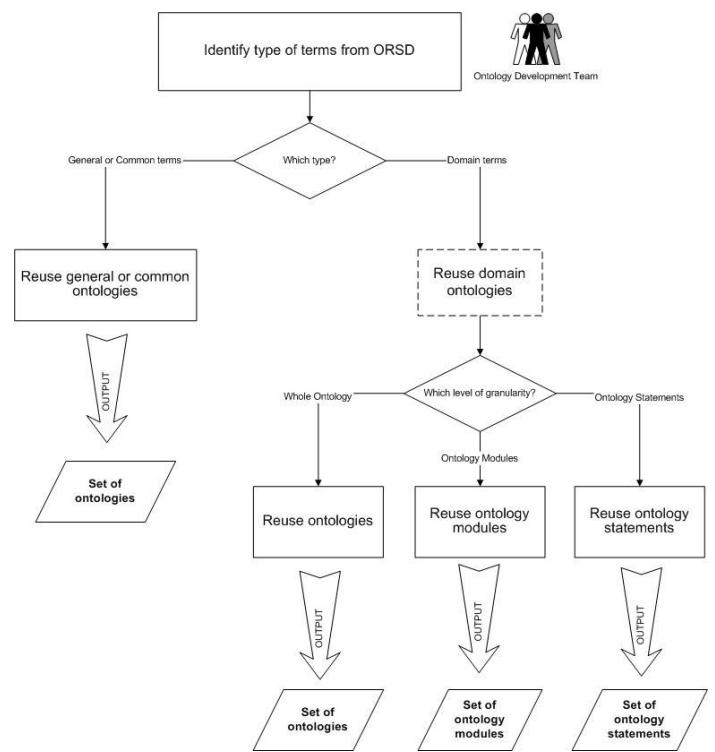
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## Ontological Resource Reuse Process



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





## Detailed descriptions in D5.4.1

### Reuse Common Ontologies

**General or Common Ontology Reuse**

**Definition:** General or Common Ontology Reuse refers to the process of using general or common ontologies in the solution of different problems.

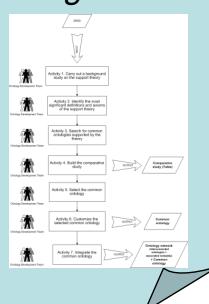
**Goal:** The goal of this process is to find and reuse general or common ontologies to be integrated in the ontology network being developed.

**Input:** Consistency assessment (CAs) included in the ontology network being developed, and the implementation of the reuse process.

**Output:** A general or common ontology integrated in the ontology network being developed.

**Who:** Software developers and ontology practitioners.

**When:** The general or common ontology reuse process should be carried out after the ontology specification activity.



### Reuse Domain Ontologies

**Domain Ontology Reuse**

**Definition:** Domain Ontology Reuse refers to the process of using domain ontologies in the solution of different problems.

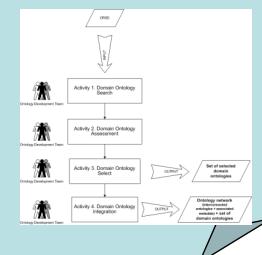
**Goal:** The goal of this process is to find and select one or several domain ontologies related with the domain of the ontology being developed in order to be used in such ontology development.

**Input:** The OSD.

**Output:** Ontology network extended with the reused domain ontology.

**Who:** Software developers and ontology practitioners.

**When:** The domain ontology reuse process should be carried out after the ontology specification activity.



### Reuse Ontology Statements

**Ontology Statements Reuse**

**Definition:** Ontology Statement Reuse refers to the process of using ontology statements from an ontology that was not originally developed for the task at hand.

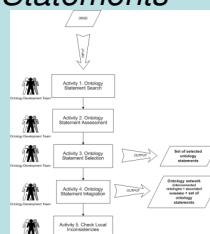
**Goal:** The goal of the process is to make use of ontology statements from an ontology that was not originally developed for the task at hand.

**Input:** The OSD and available ontology statements from other ontologies that are relevant to the domain of the ontology that the ontology network being developed.

**Output:** Ontology network extended with reused ontology statements.

**Who:** Software developers and ontology practitioners.

**When:** Ontology statement reuse can be performed in various stages of the ontology life cycle. Most reuse is more recommended at the stage of ontology design and it can be done in a variety of situations, whether the ontology is built from scratch or extended from an initial ontology. It is also recommended at the end of the life cycle when the ontology is selected and/or extended to cover new knowledge.



Watson plug-in

### Reuse ODPS by naive users

**Ontology Design Patterns (ODPs) Reuse**

**Definition:** Ontology Design Pattern (ODPs) Reuse is defined as the activity of using ontology design patterns in the development of an ontology. This reuse is intended to facilitate the activity of ontology design by reducing knowledge.

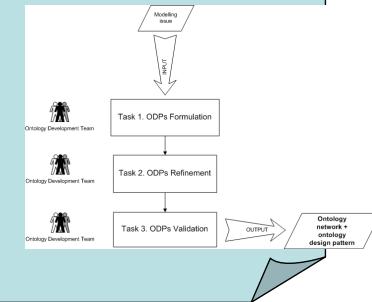
**Goal:** The goal of this process is to reuse the ODPs during the ontology development phase in order to reduce time and effort in the development of the ontology.

**Input:** Ontology design pattern.

**Output:** Ontology design pattern reuse.

**Who:** Software developers and ontology practitioners.

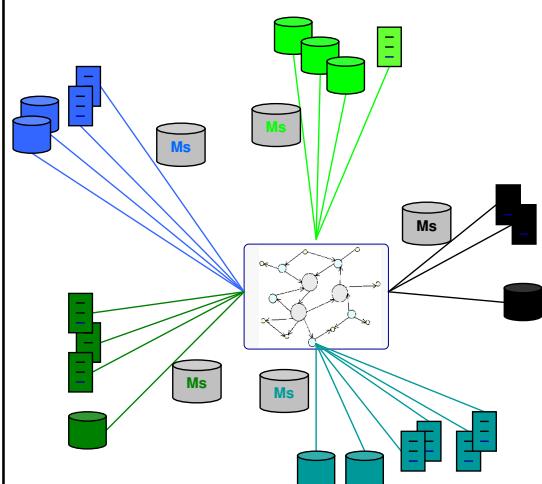
**When:** During the development of the ontology conceptualization activity, the ontology design pattern activity, or the ontology implementation activity.



# Index

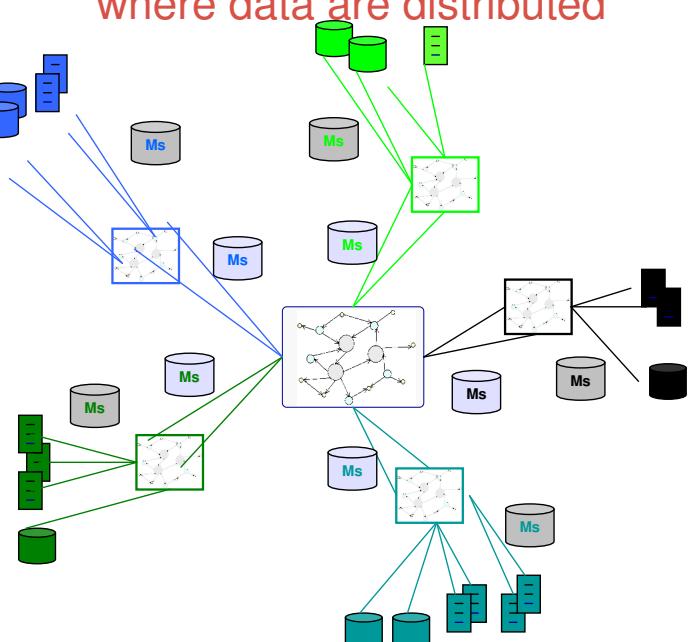
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## Centralized network of ontologies where data are distributed



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

## Federated network of ontologies where data are distributed



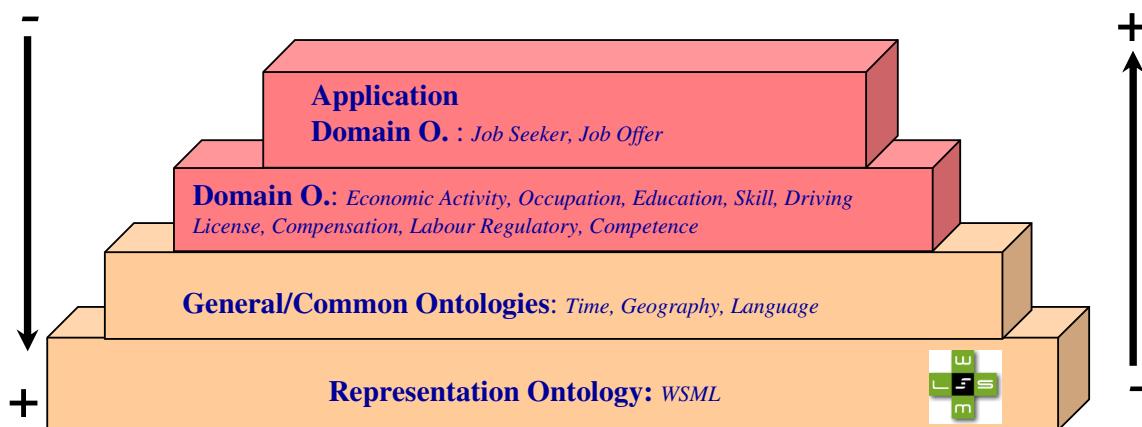
1. Build a reference ontology for the domain
2. Build local ontologies
3. Build mappings between the core and local ontologies
4. Build mappings between the local ontologies and the data sources

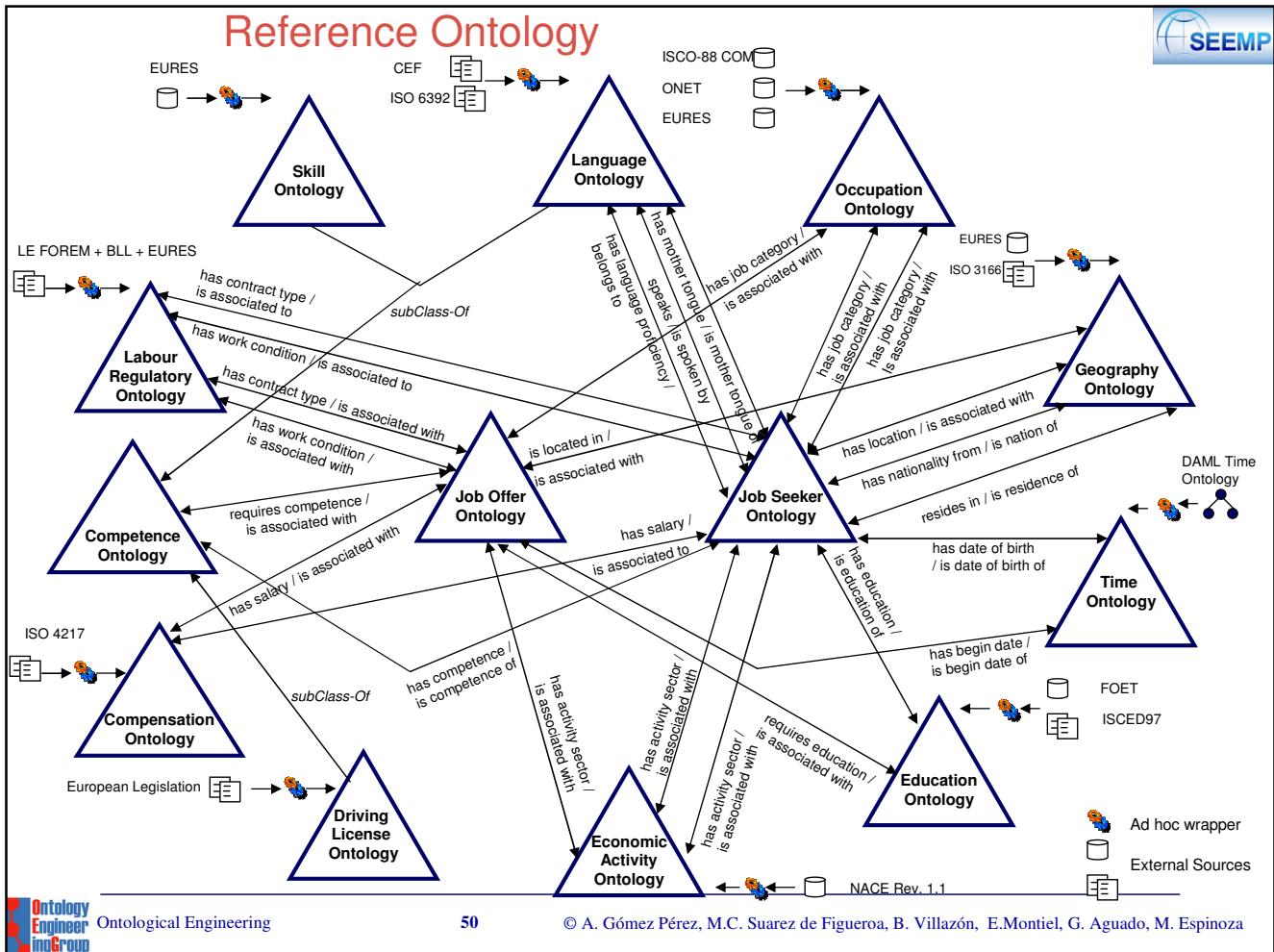
Conceptualization:  
Modular approach for ontology construction



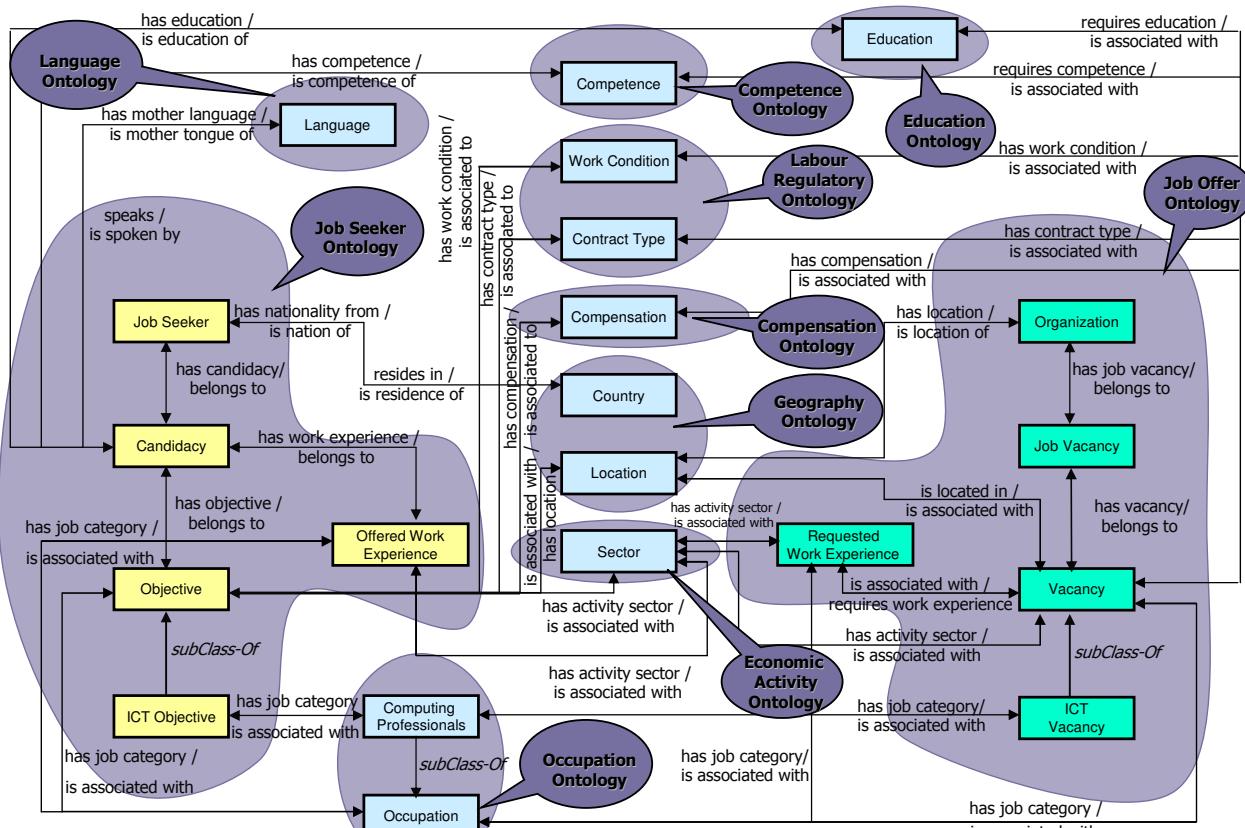
Reusability

Usability





# Details of the ontology



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## Multilingual ontologies

- Multilinguality: what for?
- Characterization of the Ontology Localization problem
- Representing Multilinguality in Ontologies
- External models to associate linguistic information to the ontology
- LabelTranslator NeOn plugin: technological support for the LIR

## Multilinguality: What for? (I)

- Multilinguality is required in different NLP applications
  - Multilingual (or Cross-lingual) Information Retrieval
  - Machine Translation
  - Multilingual Question-Answering systems
  - ...
- Multilinguality is demanded by institutions and organizations worldwide that have to **manage** information in different natural languages

▪ E.g.:

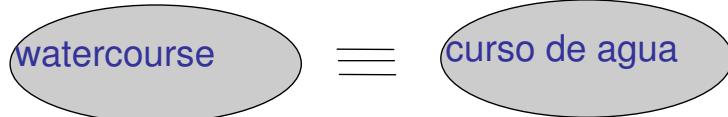


## Characterization of the Ontology Localization problem

- **Ontology Localization** adapting an ontology to a particular language and culture

- **Problems:**

- **Existence of exact equivalence:**



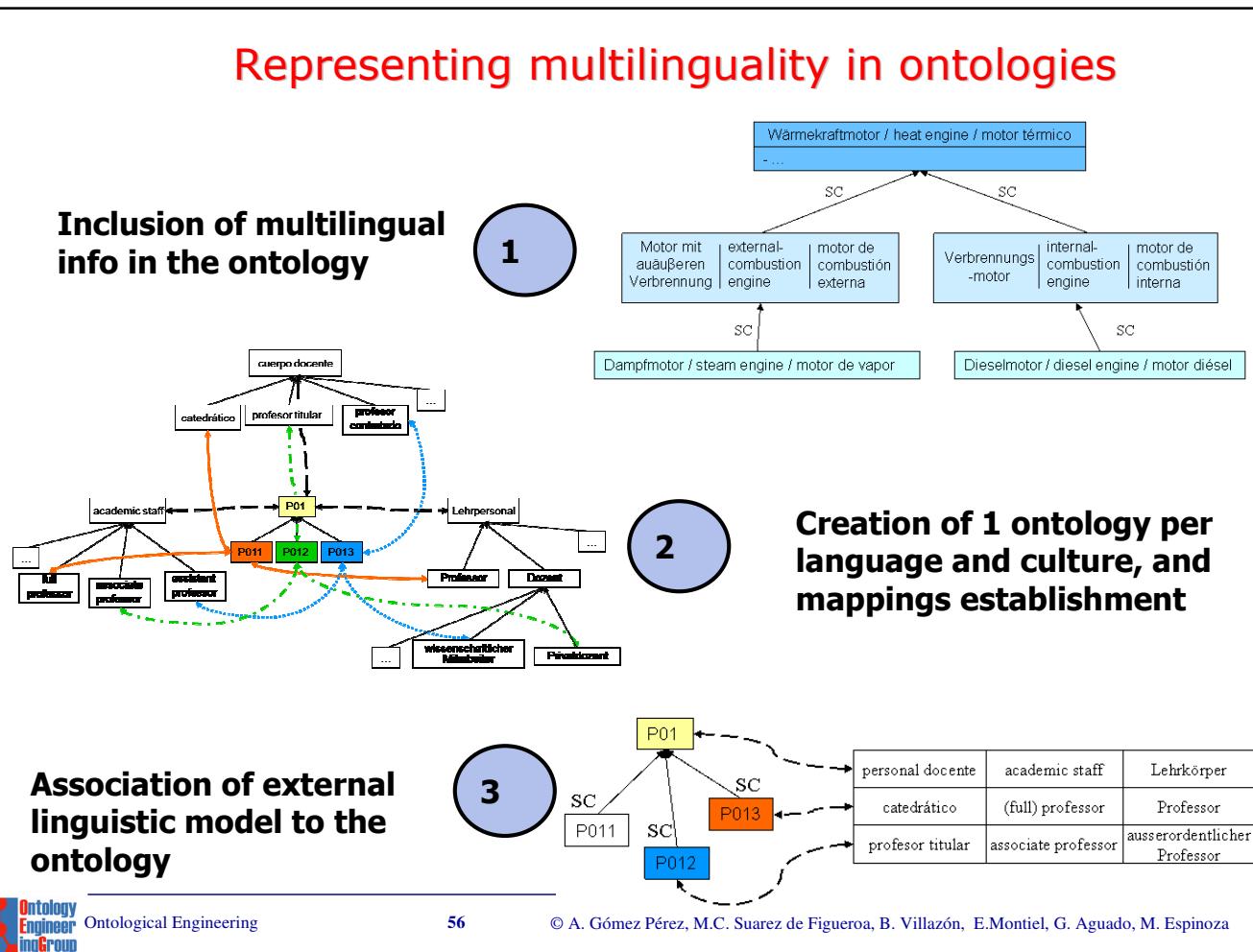
- **Existence of several context-dependent equivalents:**



- **Conceptualization mismatch:**

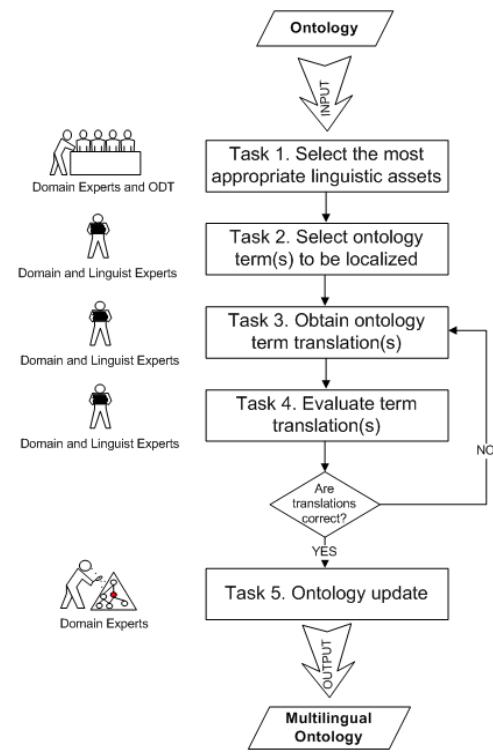


## Representing multilinguality in ontologies



# Ontology Localization

Ontology Localization	
<i>Definition</i> Ontology localization refers to the adaptation of an ontology to particular language and culture	
<i>Goal</i> To translate an ontology expressed in a source natural language into a target natural language.	
<i>Input</i> An ontology whose ontology terms are expressed in one or several natural languages, from which one is selected as source natural language.	<i>Output</i> An ontology whose ontology terms have been translated to the target natural language. The resulting translations are added to available labels of the original ontology already in one or several languages.
<i>Who</i> Software developers and ontology practitioners, who form part of the ontology development team, in collaboration with domain and linguistic experts.	
<i>When</i> Once the conceptual model of the ontology is stable, with the aim of avoiding spending time and resources in a model that is not definitive.	

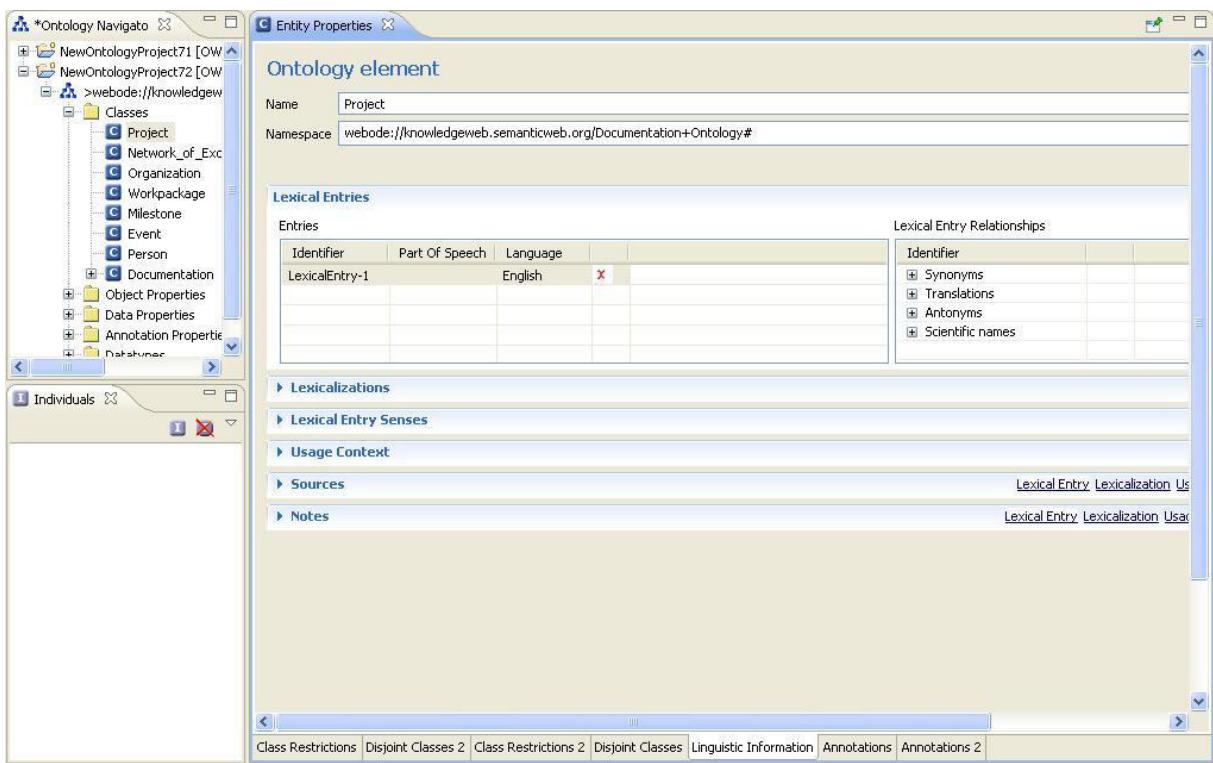


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Suárez-Figueroa, M.C., et al. D5.4.2. Revision and Extension of the NeOn Methodology for Building Contextualized Ontology Networks. NeOn Project. 2009.

# LabelTranslator NeOn plugin



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Ontological Engineering

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# LabelTranslator NeOn plugin

• Localizing an Ontology Label/Ontology

The screenshot shows the Entity Properties window for the 'Person' ontology element. The 'Ontology element' tab is active, displaying the name 'Person' and namespace 'webode://knowledgegeweb.semanticweb.org/Person+Ontology#'. The 'Lexical Entries' tab is also visible, showing a table with one entry: Identifier 'LexicalEntry-1', Part Of Speech 'noun', and Language 'English'. A red 'X' button is present in the table. To the right, there's a 'Lexical Entry Relationships' section with a table for identifiers and links to 'Synonyms', 'Translations', 'Antonyms', and 'Scientific names'. Below the main tabs, there are sections for 'Lexicalizations', 'Lexical Entry Senses', 'Usage Context', 'Sources', and 'Notes'. A tooltip 'Linguistic page associated with each ontology element' points to the 'Usage Context' section. At the bottom, there are tabs for Class Restrictions, Disjoint Classes 2, Class Restrictions 2, Disjoint Classes, Linguistic Information, Annotations, and Annotations 2.

Entity Properties

Ontology element

Name Person

Namespace webode://knowledgegeweb.semanticweb.org/Person+Ontology#

Lexical Entries

Identifier	Part Of Speech	Language
LexicalEntry-1	noun	English

Entries

Lexical Entry Relationships

Identifier

- Synonyms
- Translations
- Antonyms
- Scientific names

Lexicalizations

Lexical Entry Senses

Usage Context

Linguistic page associated with each ontology element

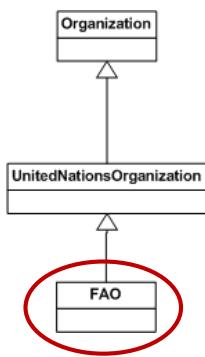
Sources

Notes

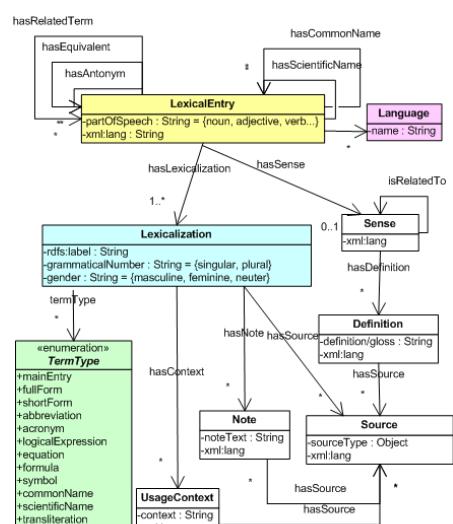
Class Restrictions Disjoint Classes 2 Class Restrictions 2 Disjoint Classes Linguistic Information Annotations Annotations 2

# LIR Instantiation

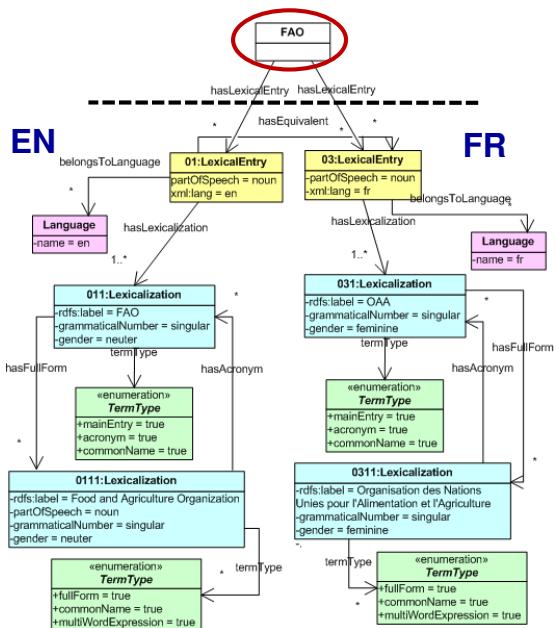
## Ontology



## LIR model



## LIR instantiation for ontology class FAO



# Conclusions

- Which are the key process and activities in ontology development?
  - NeOn Scenarios for Building Ontology Networks
- How do I collect the requirements of my ontology?
  - Ontology Requirements Specification
- Which specific sequence of activities should carry out for building my ontology?
- When should I carry out each activity?
- Where is the relationship of one activity with the others?
  - Ontology Network Life Cycle models
  - Ontology Network Life Cycles
  - Scheduling and gOnt
- How do I reuse existing non-ontological resources to build my ontology?
  - Non Ontological Resource Reuse and Reengineering
- Where can I find ontologies with the goal of reusing them?
  - OMV and Watson
- How do I reuse existing ontological resources to build my ontology?
  - Ontological Resource Reuse
- How do I have my ontology in different natural languages?
  - Ontology Localization
- How can I build the ontology for my application?
  - SEEMP example

## NeOn Methodology Pointers

- ❑ Scenarios for Building Ontology Networks → **D5.3.1 and D5.4.2**
- ❑ NeOn Glossary of Processes and Activities → **D5.3.1 and D5.3.2**
- ❑ Set of Ontology Network Life Cycle Models → **D5.3.2**
- ❑ Methodological Guidelines for Ontology Requirements Specification → **D5.4.1**
- ❑ Methodological Guidelines for Scheduling and gOnt plug-in → **D5.3.2**
- ❑ Methodological Guidelines for Non-Ontological Resource Reuse and Reengineering → **D5.4.1 and D2.2.2**
- ❑ Methodological Guidelines for Ontological Resource Reuse → **D5.4.1**
- ❑ Methodological Guidelines for ODP Reuse → **D5.4.1 and D5.4.2**
- ❑ Methodological Guidelines for Ontology Modularization → **D5.4.2**
- ❑ Methodological Guidelines for Ontology Evaluation → **D5.4.2**
- ❑ Methodological Guidelines for Ontology Evolution → **D5.4.2**
- ❑ Methodological Guidelines for Ontology Localization → **D5.4.2**