Reuse and Re-engineering of Multilingual Resources for Building Ontologies

Asunción Gómez-Pérez (asun@fi.upm.es)

Credits to:
Mari Carmen Suárez-Figueroa (mcsuarez@fi.upm.es)
Boris Villazón-Terrazas (bvillazon@fi.upm.es)
Elena Montiel (emontiel@fi.upm.es)
Guadalupe Aguado (lupe@fi.upm.es)
Mauricio Espinoza (mespinoza@fi.upm.es)

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  - Methodological Guidelines 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

Lightweight Ontologies

- Thesauri
  - "narrower term" relation

- Catalog/ID

- Terms/
glossary

Heavyweight Ontologies

- Formal
  - is-a

- Frames
  - properties

- General
  - Logical
  - constraints

- Formal
  - instance

- Value
  - Restrs.

- Disjointness,
  - Inverse,
  - part-Of

<table>
<thead>
<tr>
<th>Term</th>
<th>BT</th>
<th>NT</th>
<th>RT</th>
<th>UF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Cereals</td>
<td>Broken</td>
<td>Rice straw</td>
<td>Paddy</td>
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<tr>
<td>Oryza</td>
<td>Poaceae</td>
<td>Oryza sativa</td>
<td>Oryza pumila</td>
<td>Oryza punctata</td>
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<td>Oryza perennis</td>
<td>Oryza radiata</td>
<td>Oryza longistaminata</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wetland rice</td>
<td>Rice fields</td>
<td>Cereal crop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oryza glaberrima</td>
<td>Upland rice</td>
<td>Rice</td>
</tr>
</tbody>
</table>

**Thesaurus**

**Implicit knowledge coded in numbers**

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

:define (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))))))
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
Index

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- **NeOn Methodology**
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Which are the Processes and Activities needed?

- Ontological Resource Re-engineering
- Non-Ontological Resource Re-engineering
- Merging Ontological Resources
- Ontological Resource Reuse
- Localizing Ontological Resources
- Restructuring Ontological Resources
- Reusing Ontology Design Patterns
- Non-Ontological Resource Reuse
- Classical Re-engineering
Ontological Engineering

Knowledge Resources
- Non Ontological Resources
  - Glossaries
  - Dictionaries
  - Lexicons
  - Classification Schemas
  - Taxonomies
  - Thesauri
- Ontological Resources
  - O. Design Patterns
  - O. Repositories and Registries

Ontological Support Activities:
- Knowledge Acquisition (Elicitation)
- Documentation
- Configuration Management
- Evaluation (V&V)
- Assessment

NeOn Scenarios
- Ontological Resource Reuse
- Ontology Design Pattern Reuse
- Ontological Resource Reengineering
- O. Aligning
- O. Merging
- Alignments
- RDF(S)
- Flogic
- OWL
- NeOn Scenarios

Ontology Support Activities:
- Specification
- Scheduling
- Conceptualization
- Formalization
- Implementation
- Localization
- Restructuring (Pruning, Extension, Specialization, Modularization)
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

All processes and activities are described with:

- A filling card
- A workflow
- Examples
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- Conclusions
<table>
<thead>
<tr>
<th></th>
<th>Ontology Requirements Specification Document Template</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Purpose</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot the purpose of the ontology”</td>
</tr>
<tr>
<td>2</td>
<td><strong>Scope</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot the scope of the ontology”</td>
</tr>
<tr>
<td>3</td>
<td><strong>Level of Formality</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot the level of formality of the ontology”</td>
</tr>
<tr>
<td>4</td>
<td><strong>Intended Users</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot the intended users of the ontology”</td>
</tr>
<tr>
<td>5</td>
<td><strong>Intended Uses</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot the intended uses of the ontology”</td>
</tr>
<tr>
<td>6</td>
<td><strong>Groups of Competency Questions</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot the groups of competency questions and their answers, including priorities for each group”</td>
</tr>
<tr>
<td>7</td>
<td><strong>Pre-Glossary of Terms</strong>&lt;br&gt;<strong>Terms</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot the list of terms included in the CQs and their frequencies”&lt;br&gt;<strong>Objects</strong>&lt;br&gt;“Software developers and ontology practitioners should include in this slot a list of objects and their frequencies”</td>
</tr>
</tbody>
</table>
# Ontology Specification

## 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).

## 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.

## Level of Formality

The ontology has to be implemented in WSML language.

## Intended Users

1. Candidate who is unemployed and searching for a job or searching another occupation for immediate or future purposes
2. Employer who needs more human resources.
3. Public or private employment search service which offers services to gather CVs or job postings and to prepare some data and statistics.
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.
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.

## Intended Uses

1. Publish CV. Job seeker places his/her CV on the PES Portal.
5. Provide Job Statistics. The PES Portal provides employment statistics to the Job Seeker and Employer.
Ontology Specification:
Identify requirements using competency questions

<table>
<thead>
<tr>
<th>A</th>
<th>Competency Questions</th>
<th>B</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CQ1</td>
<td>What is the Job Seeker name?</td>
<td>Lewis Hamilton</td>
</tr>
<tr>
<td>2</td>
<td>CQ2</td>
<td>What is the Job Seeker nationality?</td>
<td>British, Spanish, Italian, French, German</td>
</tr>
<tr>
<td>3</td>
<td>CQ3</td>
<td>When is the Job Seeker birthdate?</td>
<td>13/06/1984, 30/03/1970, 15/04/1978</td>
</tr>
<tr>
<td>4</td>
<td>CQ4</td>
<td>What is the Job Seeker contact information?</td>
<td>Programmer, Computer Engineer, Computer Assistant</td>
</tr>
<tr>
<td>5</td>
<td>CQ5</td>
<td>What is the Job Seeker current job?</td>
<td>Radar engineer, Hardware Designer, Software Engineer</td>
</tr>
<tr>
<td>6</td>
<td>CQ6</td>
<td>What is the Job Seeker desired job?</td>
<td>Autonomous, Seasonal Job, Trainee, Consultant</td>
</tr>
<tr>
<td>7</td>
<td>CQ7</td>
<td>What are the Job Seeker desired working conditions?</td>
<td></td>
</tr>
</tbody>
</table>
Ontology Specification: Group requirements.

**Job Offer (16 CQ)**

- SEEMP Reference Ontology
- Competency questions
- Job Seeker (16 CQ)
- Time and date (6 CQ)
- Currencies (4 CQ)

**CQ01.** What is the employer information?

**CQ02.** What kind of job does the employer offer?

**CQ03.** How much salary does the employer offer?

**CQ04.** What is the economic activity of the employer?

**CQ05.** What is the description of the job offer?

**CQ06.** What is the required education level for the job offer?

**CQ07.** What is the required work experience for the job offer?

**CQ08.** What is the required knowledge for the job offer?

**CQ09.** What are the required skills for the job offer?
Ontology Specification.
The Ontology Requirement Specification Document

<table>
<thead>
<tr>
<th>SEEMP Reference Ontology Requirements Specification</th>
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<tr>
<td><strong>1 Purpose</strong></td>
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<tr>
<td>The purpose of building the Reference Ontology is to provide a common shared knowledge model of the employment domain that could be used by public employment services (PES).</td>
</tr>
<tr>
<td><strong>2 Scope</strong></td>
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<tr>
<td>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.</td>
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<tr>
<td><strong>3 Level of Formality</strong></td>
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<td>The ontology has to be implemented in WSMO language</td>
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<table>
<thead>
<tr>
<th>User 2</th>
<th>User 3</th>
<th>User 4</th>
<th>User 5</th>
</tr>
</thead>
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<td>Terms</td>
<td>Terms</td>
<td>Terms</td>
</tr>
<tr>
<td>Purpose</td>
<td>Scope</td>
<td>Level</td>
<td>Formality</td>
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<td>Candidate who is unemployed and searching for a job or searching another occupation for immediate or future purposes</td>
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<td></td>
</tr>
<tr>
<td>User 2</td>
<td>Job Seeker</td>
<td>27</td>
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</tr>
<tr>
<td>User 3</td>
<td>CV</td>
<td>2</td>
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<tr>
<td>User 4</td>
<td>Personal Information</td>
<td>3</td>
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</tr>
<tr>
<td>User 5</td>
<td>Name</td>
<td>5</td>
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</tr>
<tr>
<td>a.</td>
<td>Gender</td>
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</tr>
<tr>
<td>b.</td>
<td>Birth Date</td>
<td>1</td>
<td></td>
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<tr>
<td>c.</td>
<td>Address</td>
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<td></td>
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<tr>
<td>d.</td>
<td>Nationality</td>
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<td></td>
</tr>
<tr>
<td>e.</td>
<td>Contact (phone, fax, mail)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Objective</td>
<td>3</td>
<td></td>
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<tr>
<td>g.</td>
<td>Job Category</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td>Job</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Employer Information</td>
<td>1</td>
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</tr>
<tr>
<td>j.</td>
<td>Vacancy</td>
<td>1</td>
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<td>l.</td>
<td>Location</td>
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<td>m.</td>
<td>Work Condition</td>
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<td>n.</td>
<td>Contract Type</td>
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<td>o.</td>
<td>Salary</td>
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<td>p.</td>
<td>Education</td>
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<tr>
<td>q.</td>
<td>Work Experience</td>
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<table>
<thead>
<tr>
<th>Groups of Competency Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>QG01. Job Seeker (16 CQ)</td>
</tr>
<tr>
<td>QG02. Job Officer (10 CQ)</td>
</tr>
<tr>
<td>QG03. Job Application (15 CQ)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objects in the universe of discourse, which are instances of</th>
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</thead>
<tbody>
<tr>
<td>Job Category</td>
</tr>
<tr>
<td>Computer System Designer</td>
</tr>
<tr>
<td>Computer System Analyst</td>
</tr>
<tr>
<td>Programmer</td>
</tr>
<tr>
<td>Computer Engineer</td>
</tr>
<tr>
<td>Computer Support</td>
</tr>
<tr>
<td>Computer Equipment Operator</td>
</tr>
<tr>
<td>Industrial Plant Operator</td>
</tr>
<tr>
<td>Telecom Equipment Operator</td>
</tr>
<tr>
<td>Medical Equipment Operator</td>
</tr>
<tr>
<td>Electronic Equipment Operator</td>
</tr>
<tr>
<td>Image Equipment Operator</td>
</tr>
</tbody>
</table>

| Education |
| Life Sciences | 029 |
| Mathematics | 030 |
| Computer Science | 031 |
| Computer Use | 032 |
| Statistics | 033 |
| Physics | 034 |
| Network Administration | 035 |

| Languages |
| Swedish | 036 |
| Spanish | 037 |
| Italian | 038 |
| Portuguese | 039 |
| English | 040 |
| French | 041 |
| German | 042 |

| Currency |
| Euro | 043 |
| Dollar | 044 |
| Swiss Franc | 045 |

| Location |
| Austria | 049 |
| Belgium | 050 |
| Denmark | 051 |
| Norway | 052 |
| Estonia | 053 |
| Sweden | 054 |
| Greece | 055 |

| Objects |
| Education |
| Life Sciences | 029 |
| Mathematics | 030 |
| Computer Science | 031 |
| Computer Use | 032 |
| Statistics | 033 |
| Physics | 034 |
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| Languages |
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| Dollar | 044 |

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Searching Resources

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

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

<table>
<thead>
<tr>
<th>Entity</th>
<th>Currency</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFGHANISTAN</td>
<td>Afghan</td>
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<tr>
<td>ALBANIA</td>
<td>Lek</td>
<td>ALL</td>
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<tr>
<td>ALGERIA</td>
<td>Algerian Dinar</td>
<td>DZD</td>
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<tr>
<td>AMERICAN SAMOA</td>
<td>US Dollar</td>
<td>USD</td>
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<tr>
<td>ANDORRA</td>
<td>Euro</td>
<td>EUR</td>
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<tr>
<td>ANGUILLA</td>
<td>East Caribbean Dollar</td>
<td>XCD</td>
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<tr>
<td>ANTARCTICA</td>
<td>No national currency</td>
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<tr>
<td>ANTIGUA AND BARBUDA</td>
<td>East Caribbean Dollar</td>
<td>XCD</td>
</tr>
<tr>
<td>ARGENTINA</td>
<td>Argentine Peso</td>
<td>ARS</td>
</tr>
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<td>ARMENIA</td>
<td>Armenian Dram</td>
<td>AMD</td>
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<td>AUSTRIA</td>
<td>Euro</td>
<td>EUR</td>
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<td>Euro</td>
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<td>Azerbaijani Manat</td>
<td>AZN</td>
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<td>BAHAMAS</td>
<td>Bahamian Dollar</td>
<td>BSD</td>
</tr>
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<td>BAHSAN</td>
<td>Bahraini Dinar</td>
<td>BHD</td>
</tr>
<tr>
<td>BAHRAIN</td>
<td>Takar</td>
<td>BDT</td>
</tr>
<tr>
<td>BANGLADESH</td>
<td>Bangladeshi Taka</td>
<td>TAK</td>
</tr>
</tbody>
</table>

### ISO 3166 (countries)

<table>
<thead>
<tr>
<th>Entity Name</th>
<th>Country Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
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<tr>
<td>Albania</td>
<td>AL</td>
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<td>DZ</td>
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<tr>
<td>American Samoa</td>
<td>AS</td>
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<tr>
<td>Andorra</td>
<td>AD</td>
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<tr>
<td>Anguilla</td>
<td>AI</td>
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<tr>
<td>Antartica</td>
<td>AT</td>
</tr>
<tr>
<td>Antigua and Barbuda</td>
<td>AW</td>
</tr>
<tr>
<td>Argentina</td>
<td>AR</td>
</tr>
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<td>Armenia</td>
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<tr>
<td>Belarussia</td>
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</table>
## Non-ontological resources - ISCO-88 (COM)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description EN</th>
<th>Description FR</th>
<th>Description DE</th>
<th>Task auto EN</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Religious professionals</td>
<td>Membres du clergé</td>
<td>Geistliche, Staatsempfänger</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von kirchlicher oder gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Public service administrative professionals</td>
<td>Cadres administratifs des services publics</td>
<td>Wissenschaftliche Verwaltungsfachkräfte des öffentlichen Dienstes</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Das Engagement und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Physical and engineering science technicians</td>
<td>Techniciens des sciences physiques et techniques</td>
<td>Material- und ingenieurtechnische Fachkräfte</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Computer associate professionals</td>
<td>Personnels informatiques</td>
<td>Datenverarbeitungsfachkräfte</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Optical and electronic equipment operators</td>
<td>Techniciens d'appareils optiques et électroniques</td>
<td>Beijeger optischer und elektronischer Anlagen</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Ship and aircraft controllers and technicians</td>
<td>Techniciens des moyens de transport maritime et aérien</td>
<td>Schiffs- und Flugzeugführer und verwandte Berufe</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Safety and quality inspectors</td>
<td>Inspecteurs immobiliers, de sécurité, d'hygiène et de qualité</td>
<td>Sicherheits- und Qualitätskontrollberufe</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>LH science technicians and related associate professional</td>
<td>Techniciens et techniciens associés des sciences de la vie et de la santé</td>
<td>Biotechniker und verwandte Berufe</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Health associate professionals (except nursing)</td>
<td>Professions intermédiaires de la médecine moderne (à l'exception du personnel infirmier)</td>
<td>Medizinische Fachberufe (ohne Krankenpflege)</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Nursing and midwifery associate professionals</td>
<td>Personnel infirmier et sage-femmes (niveau intermédiaire)</td>
<td>Nicht-wissenschaftliche Krankenpflege- und Geburts hilfsfachkräfte</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Primary education teaching associate professionals</td>
<td>Professions intermédiaires de l'enseignement primaire</td>
<td>Nicht-wissenschaftliche Lehrkräfte des Primarbereichs</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Pre-primary education teaching associate professionals</td>
<td>Professions intermédiaires de l'enseignement préprimaire</td>
<td>Nicht-wissenschaftliche Lehrkräfte des Vorstufendbereichs</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
<tr>
<td>3</td>
<td>Special education teaching associate professionals</td>
<td>Professions intermédiaires de l'éducation des handicapés</td>
<td>Nicht-wissenschaftliche Sonderpädagogische Fachkräfte</td>
<td>Hier handelt es sich um eine neu erstellte Gruppe. Die Tätigkeit und die zugehörigen Aufgaben sind in der Regel von gesellschaftlicher Bedeutung.</td>
</tr>
</tbody>
</table>
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

The NeOn methodology includes guidelines for reusing statements
Index

- Introduction

- **NeOn Methodology**
  - 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 Re-engineering
  - Methodological Guidelines 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 about the 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
- **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.

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**Ontology Localization: Workflow and Methodological Guidelines**

- **Introduction**
- Task 1. Select the most appropriate linguistic assets
- Task 2. Select ontology term(s) to be localized
- The goal of this task is to select the ontology term(s) to be localized. Domain experts and the ontology development team carry out this task taking as input an ontology whose terms expressed in a natural language need to be localized to a target natural language. The task output is a set of ontology terms with information of the text to be translated and its context.
- Since there are no methodological guidelines for guiding in the selection of the ontology terms, we believe that the user is the one who has to choose the space of candidates to be localized. At this stage, the user may choose to localize the complete ontology or certain terms only.
- **Click when complete**
  
  - Task 3. Obtain ontology term translation(s)
  - Task 4. Evaluate term translation(s)
  - Task 5. Ontology update
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- Conclusions
Motivation

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

<table>
<thead>
<tr>
<th>Id</th>
<th>Category Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>20000</td>
<td>Water area</td>
</tr>
<tr>
<td>21000</td>
<td>Environmental area</td>
</tr>
<tr>
<td>22000</td>
<td>Fishing Statistical area</td>
</tr>
<tr>
<td>24020</td>
<td>Jurisdiction area</td>
</tr>
<tr>
<td>21001</td>
<td>Inland/marine</td>
</tr>
<tr>
<td>21002</td>
<td>Ocean</td>
</tr>
<tr>
<td>21003</td>
<td>North/South/Equatorial</td>
</tr>
<tr>
<td>21004</td>
<td>Sub Ocean</td>
</tr>
<tr>
<td>21005</td>
<td>Large Marine ecosystem</td>
</tr>
</tbody>
</table>

Implementation
Classification scheme modeled using ePath Engineering model and stored in an XML file.

Data model

Resource:

```
<Classification>
  <Node Id="20000"/>
  <WaterCategory Water Area/>
  <parentNode Id="1"/>
</Classification>

<Classification>
  <Node Id="21000"/>
  <parentNode Id="20000"/>
</Classification>

<Classification>
  <Node Id="22000"/>
  <parentNode Id="20000"/>
</Classification>

<Classification>
  <Node Id="24020"/>
  <parentNode Id="20000"/>
</Classification>

<Classification>
  <Node Id="21001"/>
  <parentNode Id="21000"/>
</Classification>

<Classification>
  <Node Id="21002"/>
  <parentNode Id="21000"/>
</Classification>

<Classification>
  <Node Id="21003"/>
  <parentNode Id="21000"/>
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<Classification>
  <Node Id="21004"/>
  <parentNode Id="21000"/>
</Classification>

<Classification>
  <Node Id="21005"/>
  <parentNode Id="21000"/>
</Classification>
```
Approach for Re-engineering Non-Ontological Resources

Patterns for Reengineering Non Ontological Resources (PR-NOR)

Reverse Engineering
- Requirements
- Design
- Implementation

Transformation

Forward Engineering
- Specification
- Conceptualization
- Formalization
- Implementation

Non Ontological Resource

Ontology
A pattern for each resource data model

NOR Reengineering Patterns are in Deliverable D2.2.2
Pattern based approach for re-engineering non ontological resources

ISCO-88 (COM)
International Standard Classification of Occupations
(for European Union purposes)

FOET
Classification of fields of education and training

NACE
Statistical Classification of Economic Activities in the European Community

ISO 3166
English country names and code elements

ISTAT
Italian Geography Standard

Pattern for re-engineering a classification scheme modelled with a Path Enumeration Data Model

Pattern for re-engineering a classification scheme modelled with a Snowflake Data Model

Pattern for re-engineering a classification scheme modelled with an Adjacency List Data Model
Ontological Engineering

ISO 3166-1 (XML)

Excerpt of the Geography Ontology

Regions Table (Eures Oracle DB)

Knowledge Resource Re-engineering and Aggregation
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  - **Methodological Guideliness for Ontology Reuse**
  - Creating the final Ontology Model
  - Localizing the Ontology
- Conclusions
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

Reuse Domain Ontologies

Reuse Ontology Statements

Reuse ODPs by naive users

Watson plug-in
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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

Application Domain O.: Job Seeker, Job Offer

Domain O.: Economic Activity, Occupation, Education, Skill, Driving License, Compensation, Labour Regulatory, Competence

General/Common Ontologies: Time, Geography, Language

Representation Ontology: WSML
Ontological Engineering

Ontology Engineering

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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:**
      - watercourse = curso de agua
    - **Existence of several context-dependent equivalents:**
      - swimming pool = piscina, alberca
        - Spain, Mexico
    - **Conceptualization mismatch:**
      - river ≠ rivière, fleuve
Representing multilinguality in ontologies

1. Inclusion of multilingual info in the ontology

2. Creation of 1 ontology per language and culture, and mappings establishment

3. Association of external linguistic model to the ontology
Ontology Localization

**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 into a target 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 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.

**Who**
Software developers and ontology practitioners, who form part of the ontology development team, in collaboration with domain and linguistic experts.

**When**
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.

---

LabelTranslator NeOn plugin
LabelTranslator NeOn plugin

Localizing an Ontology Label/Ontology

<table>
<thead>
<tr>
<th>Ontology element</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Person</td>
<td></td>
</tr>
<tr>
<td>Namespace</td>
<td>webdav://knowledgeweb.semanticweb.org/Person#Ontology/</td>
<td></td>
</tr>
</tbody>
</table>

Lexical Entries

<table>
<thead>
<tr>
<th>Entries</th>
<th>Lexical Entry Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifier</td>
<td>Part Of Speech</td>
</tr>
<tr>
<td>LexicalEntry-1</td>
<td>noun</td>
</tr>
</tbody>
</table>

Linguistic page associated with each ontology element
LIR Instantiation

**Ontology**

- Organization
- United Nations Organization

**LIR model**

- hasRelatedTerm
- hasEquivalent
- hasForm
- hasTitle
- hasDescription
- hasRelated
- hasRelatedTo
- hasTopic

**LIR instantiation for ontology class FAO**

- EN
  - hasForm
  - hasTitle
  - hasDescription
  - hasRelated
  - hasRelatedTo
  - hasTopic

- FR
  - hasForm
  - hasTitle
  - hasDescription
  - hasRelated
  - hasRelatedTo
  - hasTopic
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 gOntt
– 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 gOntt 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