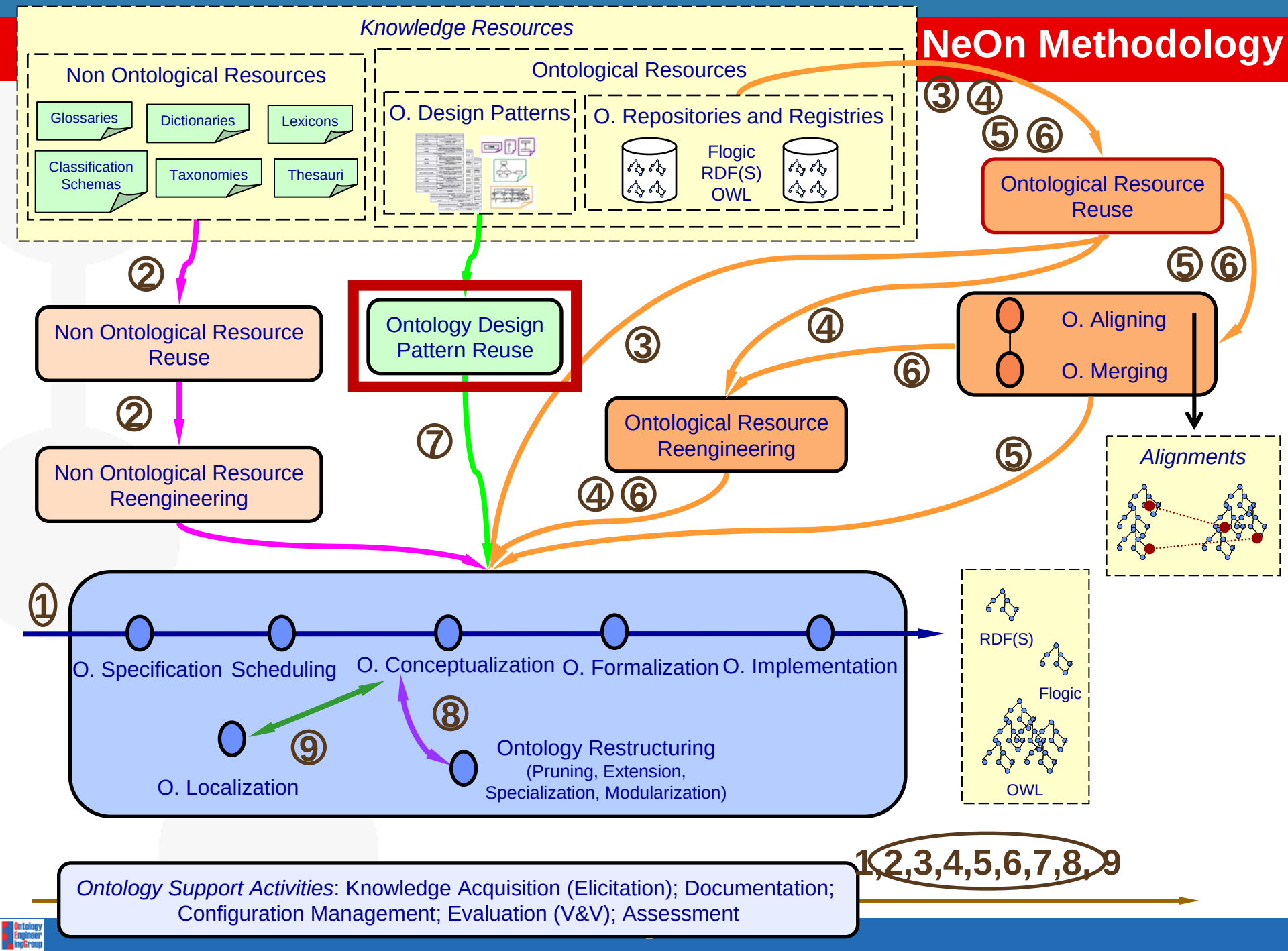
Methodological Guidelines for Reusing ODPs

Mari Carmen Suárez-Figueroa

Date: 24/10/2011

NeOn Methodology



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- **Ontology Design Patterns (ODPs): Introduction**
- Methodological Guidelines for Reusing ODPs

Ontology Design Patterns

- **Pattern** is something proposed for imitation.

- **Design Pattern** refers to shared guidelines that help solve design problems.

- **Ontology Design Pattern (ODP)** is a modeling solution to solve a recurrent ontology design problem.

  - How to represent the following problems?

    - *"Mariano Fernández-López and Mari Carmen Suárez-Figueroa are senior researchers. Mariano is also associate professor and Mari Carmen is teaching assistant"*

    - *"Mariano and Mari Carmen co-participate at the CAEPIA 2007 conference"*

- The **goal of the ODPs reuse** is

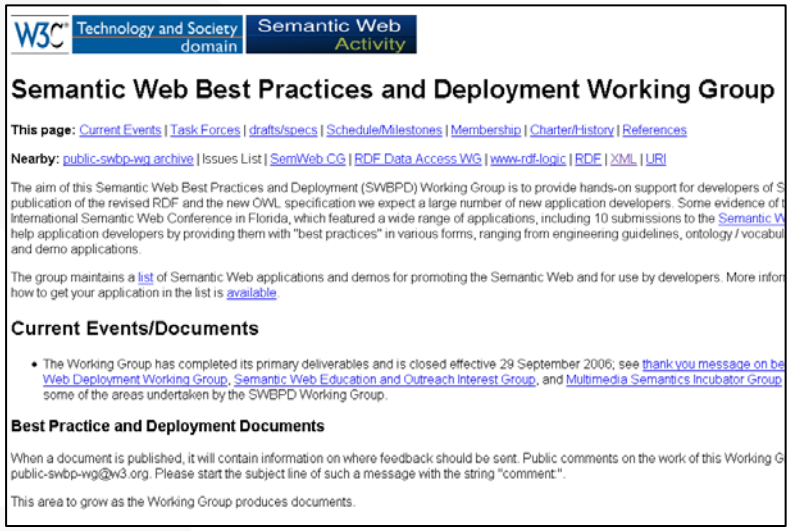
  - to facilitate the solution of modelling issues

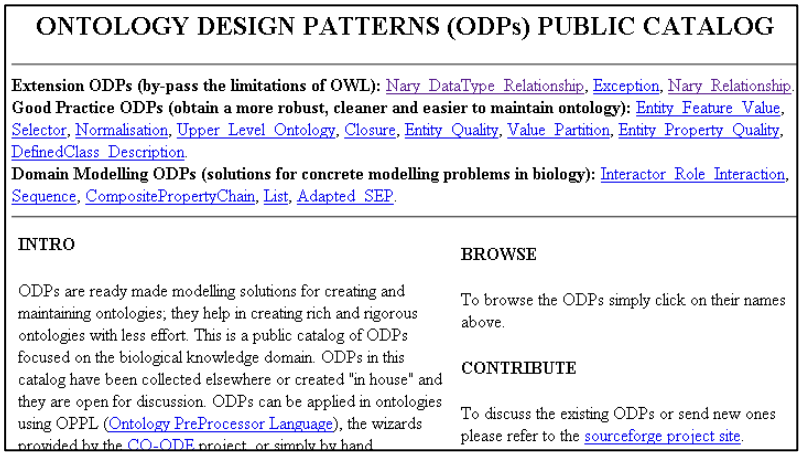
  - to improve interoperability through using well-proven solutions and best practices, in the form of patterns

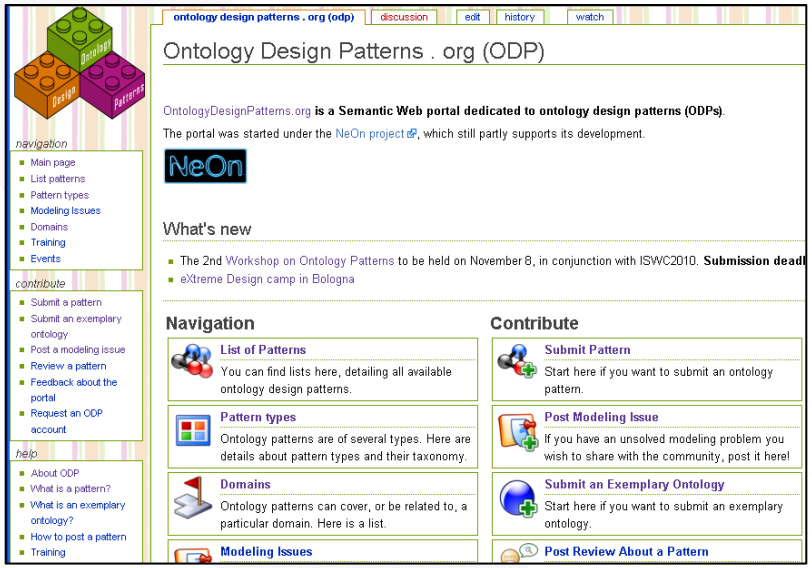
- The **idea of applying patterns for modelling ontologies** was proposed by [Clark et al., 2000]

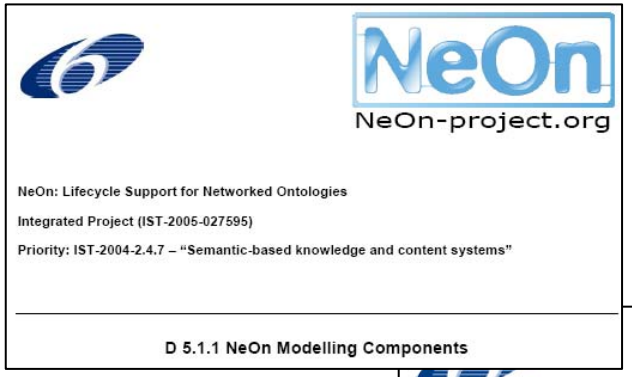
Clark, P., Thompson, J., & Porter, B. W. *Knowledge Patterns*. In KR2000: Principles of Knowledge Representation and Reasoning. pp. 591-600. 2000

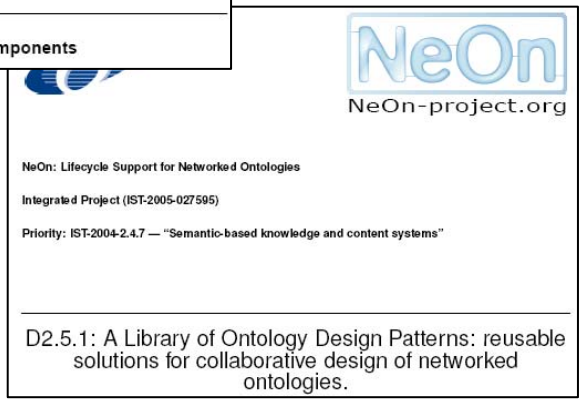
Ontology Design Patterns: Catalogues (I)











Ontology Design Patterns: Catalogues (II)

http://ontologydesignpatterns.org

navigation

- Main page
- List patterns
- Pattern types
- Modeling Issues
- Domains
- Training
- Events

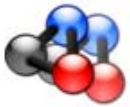
contribute

- Submit a pattern
- Submit an exemplary ontology
- Post a modeling issue
- Review a pattern
- Feedback about the portal
- Request an ODP account

help

community:listpatterns | discussion | view source | history

Community:ListPatterns



These are lists for available ODP catalogues.

Submissions

This area aims at collecting Ontology Design Pattern proposals from ODP users.

After the author has finished the submission and asked for a review, the proposals are assigned to at least two members of the ODP Quality Committee, review.

Positive reviews can be accompanied with guidelines for fixing possible problems of the proposed Content OP.

Once such problems have been addressed, the proposed Content OP can be certified and published in the official catalogue.

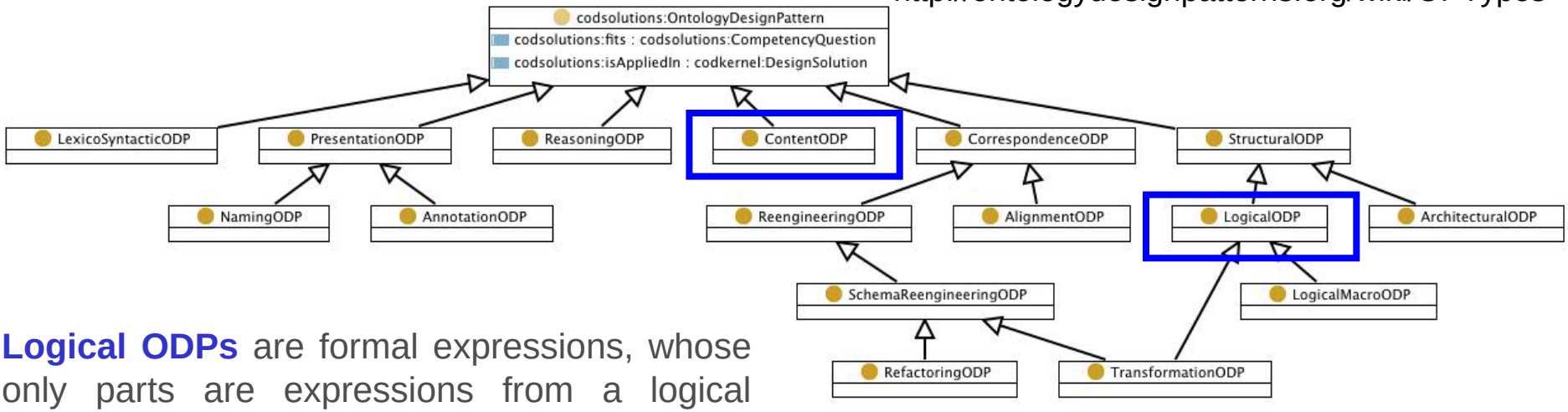
See the submissions list:

- Content ODPs
- Reengineering ODPs
- Alignment ODPs
- Logical ODPs
- Architectural ODPs
- Lexico-Syntactic ODPs

Types of Ontology Design Patterns (I)

- ODPs can be classified into **six families**
  - Each family addresses different kinds of problems, and can be represented with different levels of formality.

http://ontologydesignpatterns.org/wiki/OPTypes



Logical ODPs are formal expressions, whose only parts are expressions from a logical vocabulary e.g., OWL DL, that solve a problem of expressivity

- Logical ODPs are independent from a specific domain of interest, i.e. they are content-independent
- Logical ODPs solve design problems where the primitives of the representation language do not directly support certain logical constructs

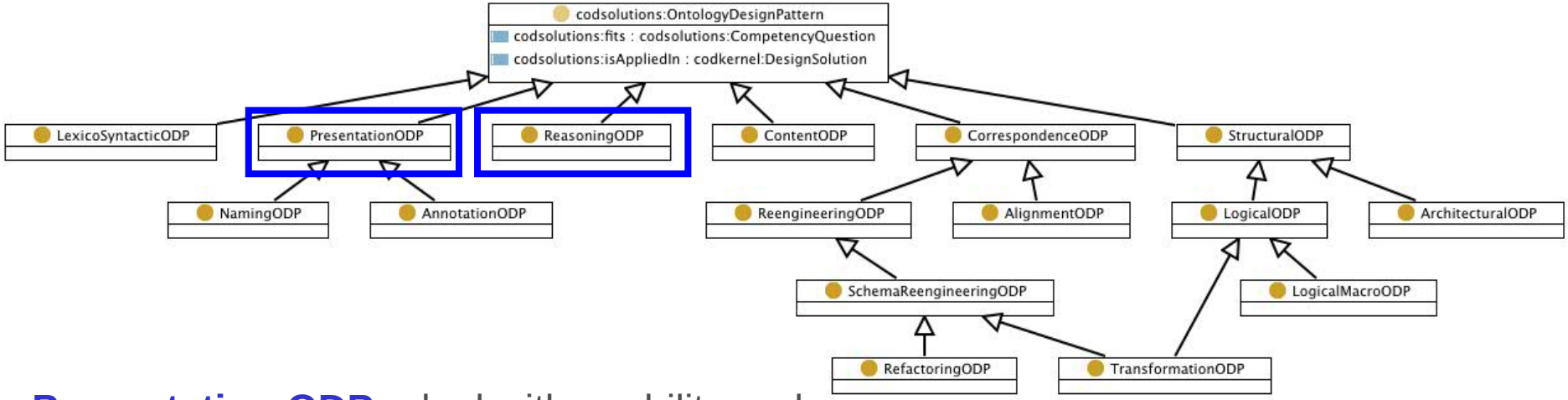
(E.g., *N-Ary Relation*)

Content OPs (CPs) encode conceptual, rather than logical design patterns.

- CPs propose patterns for solving design problems for the domain classes and properties that populate an ontology. They address content problems.

(E.g. *Agent-Role*)

Types of Ontology Design Patterns (II)



Presentation ODPs deal with usability and readability of ontologies from a user perspective

Reasoning ODPs are applications of Logical ODPs oriented to obtain certain reasoning results, based on the behavior implemented in a reasoning engine

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- Ontology Design Patterns (ODPs): Introduction
- **Methodological Guidelines for Reusing ODPs**

ODPs Reuse: Methodological Guidelines (I)

Ontology Design Pattern Reuse

Definition

Ontology Design Patterns (OPs) Reuse is defined as the activity of using available ontology design patterns in the solution of different modeling problems during the development of new ontologies.

Goal

The goal is to allow the reuse of ODPs during the ontology development in order to facilitate the solution of modeling issues and to improve interoperability.

Input

Requirements from the Ontology Requirements Specification Document.

Output

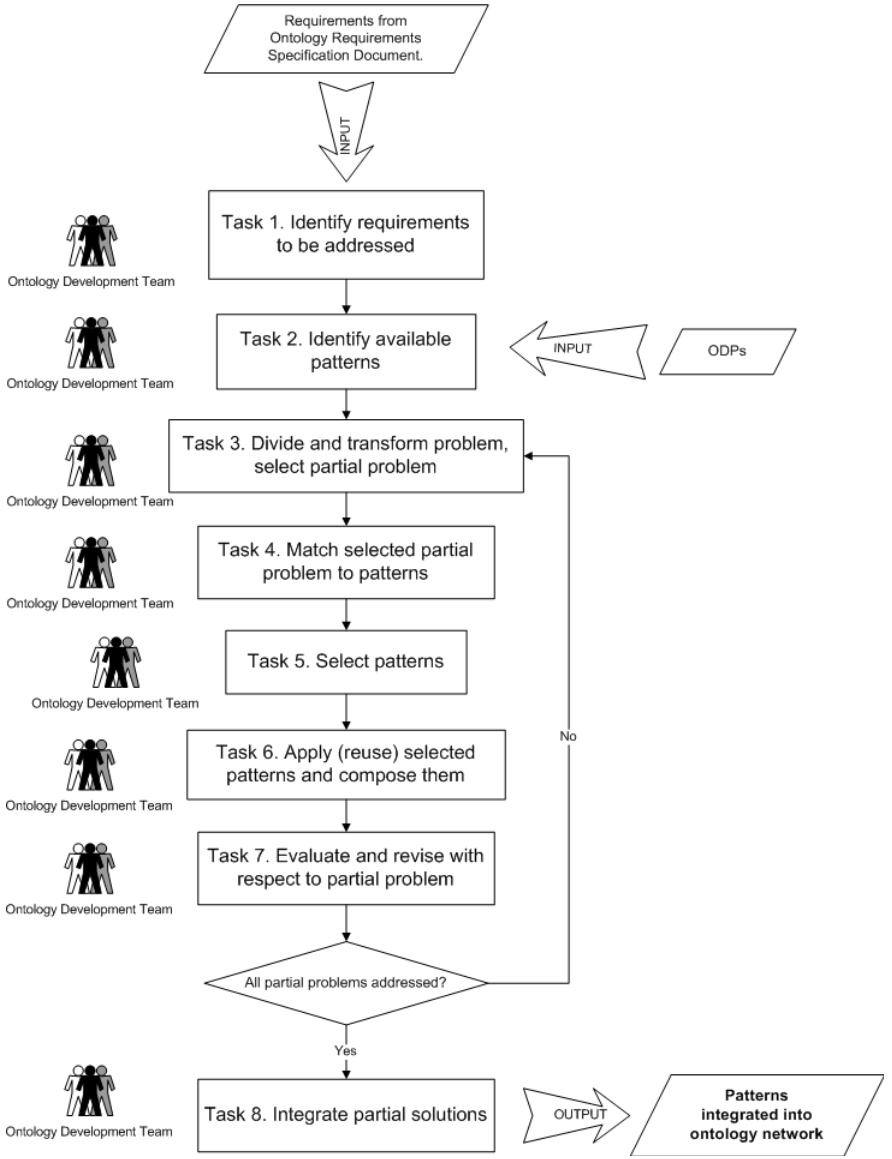
Ontology design patterns integrated into the ontology network being developed.

Who

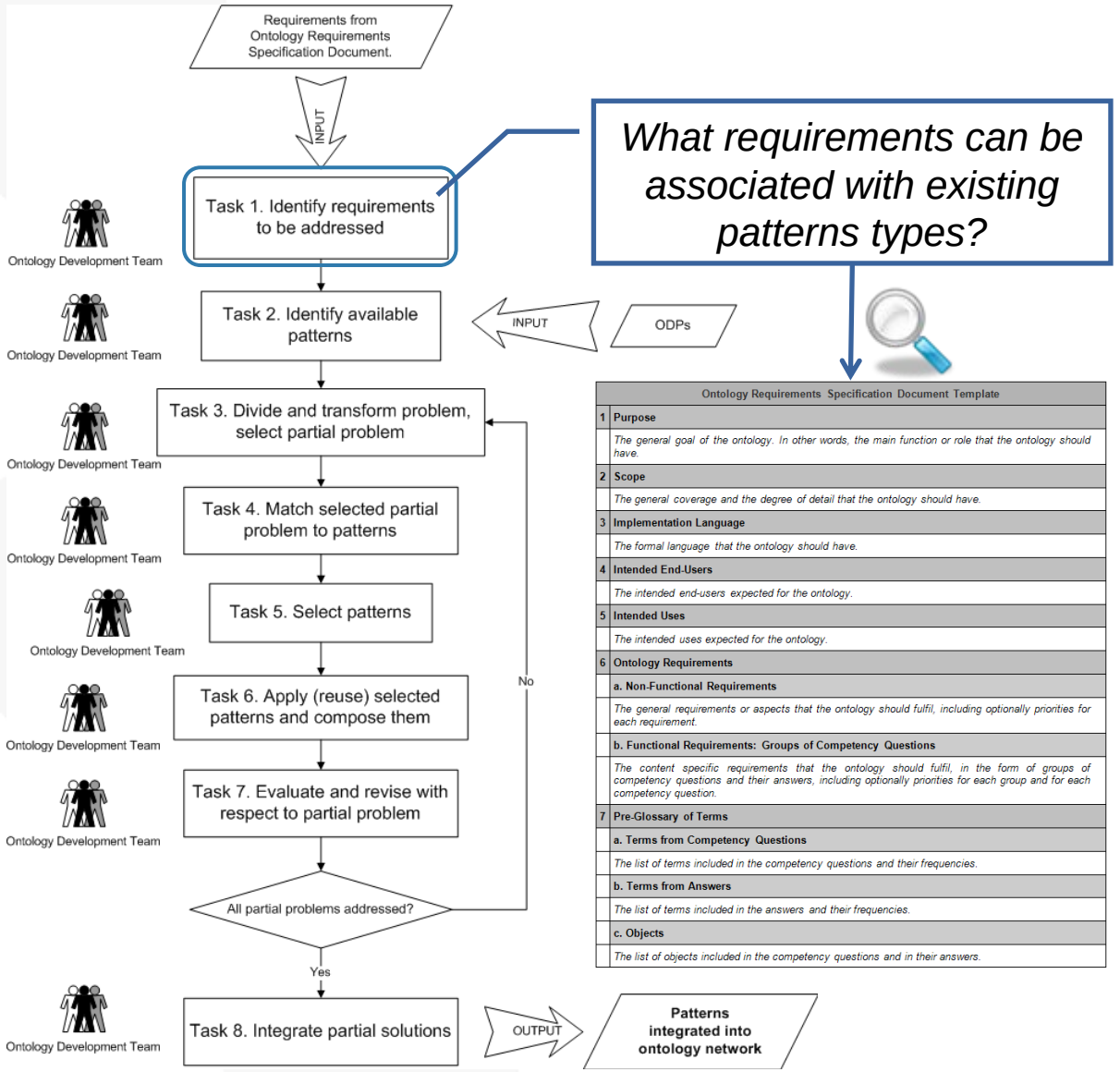
The ontology development team.

When

During the development of the Ontology Conceptualization activity, the Ontology Formalization activity, and/or the Ontology Implementation activity.



ODPs Reuse: Methodological Guidelines (II)

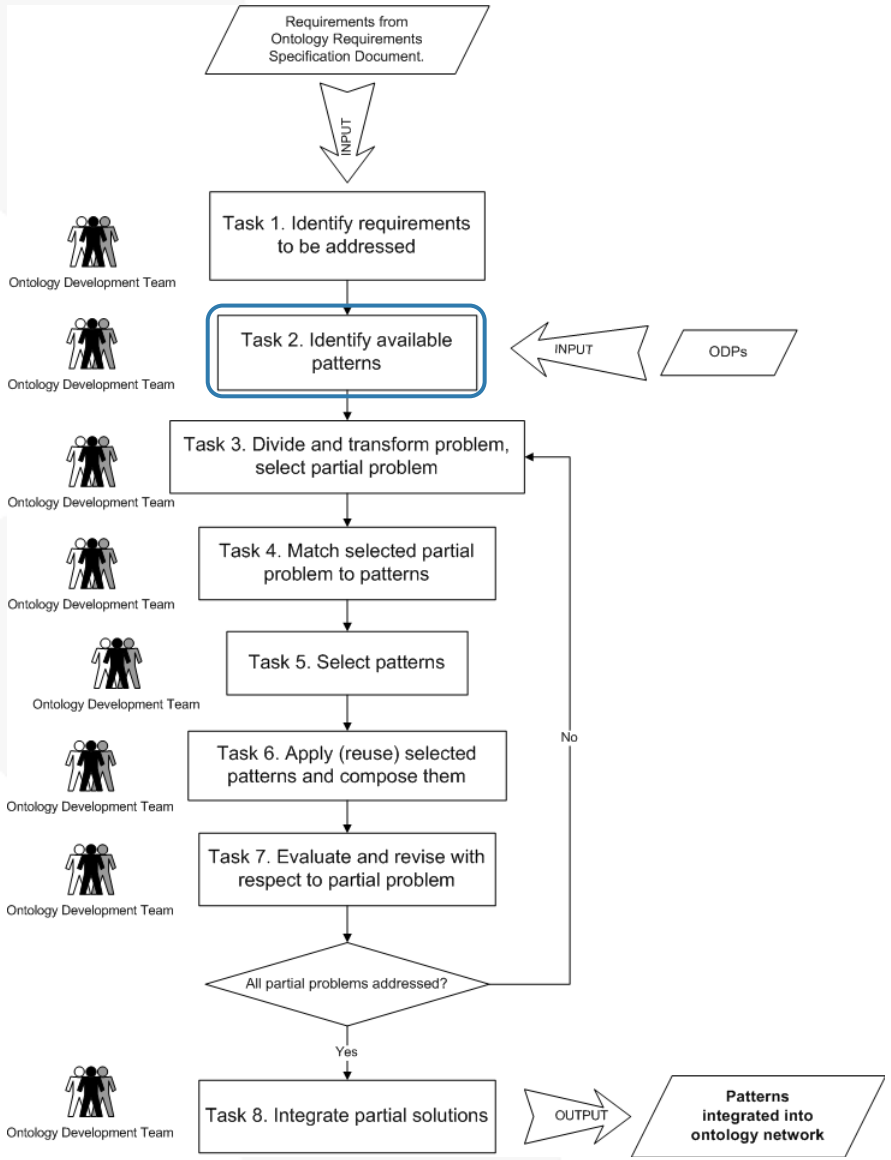


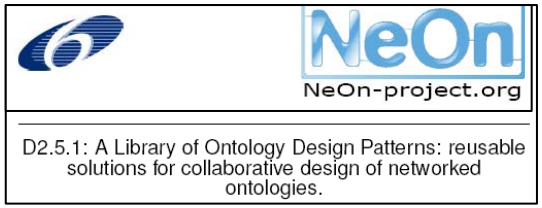
What requirements can be associated with existing patterns types?

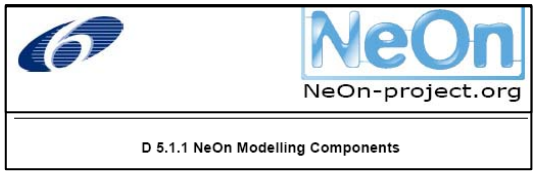
Ontology Requirements Specification Document Template	
1	**Purpose**
	The general goal of the ontology. In other words, the main function or role that the ontology should have.
2	**Scope**
	The general coverage and the degree of detail that the ontology should have.
3	**Implementation Language**
	The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

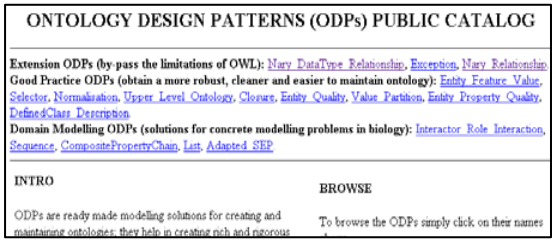
Non-functional requirements	
• The ontology should be modular.	
Functional requirements	
Requirement identifier	**Requirement**
CQ identifier	**CQ and its response**
DSP_PC7	What devices exist? Display, touchscreen, balise, keyboard, trackball, pulse oximeter, glucose meter, emvironmental temperature sensor, environmental humidity/pressure sensor, Anemometer, CO2 level sensor, printer, camera, GPS Receiver, short distance communication module (NFC. ZigBee, Bluetooth), long distance communication module (GPRS, UMTS, WiFi), processing module, memory module, loudspeaker, microphone and reading/writing module NFC
DSP_PC9	What are the components of a display? A display is composed by: - input interfaces - presentation surface - control interfaces - power system
DSP_PC49	What are the components of a CO2 level sensor? A CO2 level sensor is composed by: - source - power system - detector - amplifier - output /download data port (optional)
DSP_PC61	What are the components of a printer? A printer is composed by: - leaf storage receptacle - printhead - ink container - storage device - processing device - communication interface - screen
DSP_PC71	What are the components of a camera? A camera is composed by: - lens - image capture device - image processing device - storage device - communication interface - positioning device - lighting device - screen - microphone
DSP_PC83	What are the components of a GPS receiver? A GPS receiver is composed by: - antenna - signal processor - processing module - communication interface - screen - speaker - microphone
DSP_PC96	What are the components of a speaker? A speaker is composed by: - communication interface - amplifier - decoder - signal processing module - active element - casing
DSP_PC102	What are the components of a microphone? A microphone is composed by: - diaphragm - coil - permanent magnet A condenser microphone is composed by: - diaphragm of lightweight and flexible membrane - rigid backplate - cable to the preamplifier - bias voltage feeder
TMP_PC4	What are the days of the week? Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday
LOC_PC14	When was the last time that the user was in the location X? The day Z from xx: xx: xx to yy: yy: yy
NL sentence identifier	**Affirmative NL Sentence**
INT_CA3	The interfaces types are: - conversational - gestural - graphic - natural language - command line - multi screen - touch - textual - vocal - web
USR_CA7	A user will be in a specific location at any given time. The possible physical movement of the user is associated with this aspect

ODPs Reuse: Methodological Guidelines (III)

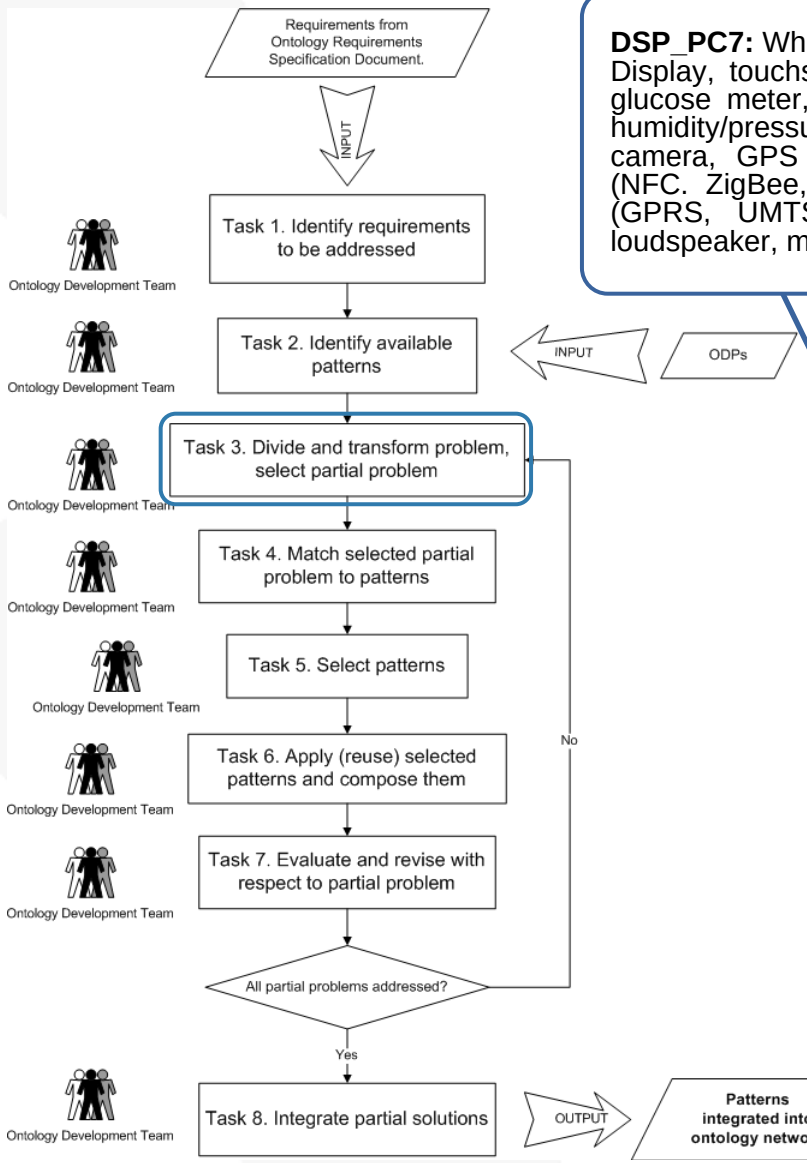








ODPs Reuse: Methodological Guidelines (IV)



DSP_PC7: What devices exist?
Display, touchscreen, balise, keyboard, trackball, pulse oximeter, glucose meter, environmental temperature sensor, environmental humidity/pressure sensor, Anemometer, CO2 level sensor, printer, camera, GPS Receiver, short distance communication module (NFC. ZigBee, Bluetooth), long distance communication module (GPRS, UMTS, WiFi), processing module, memory module, loudspeaker, microphone and reading/writing module NFC

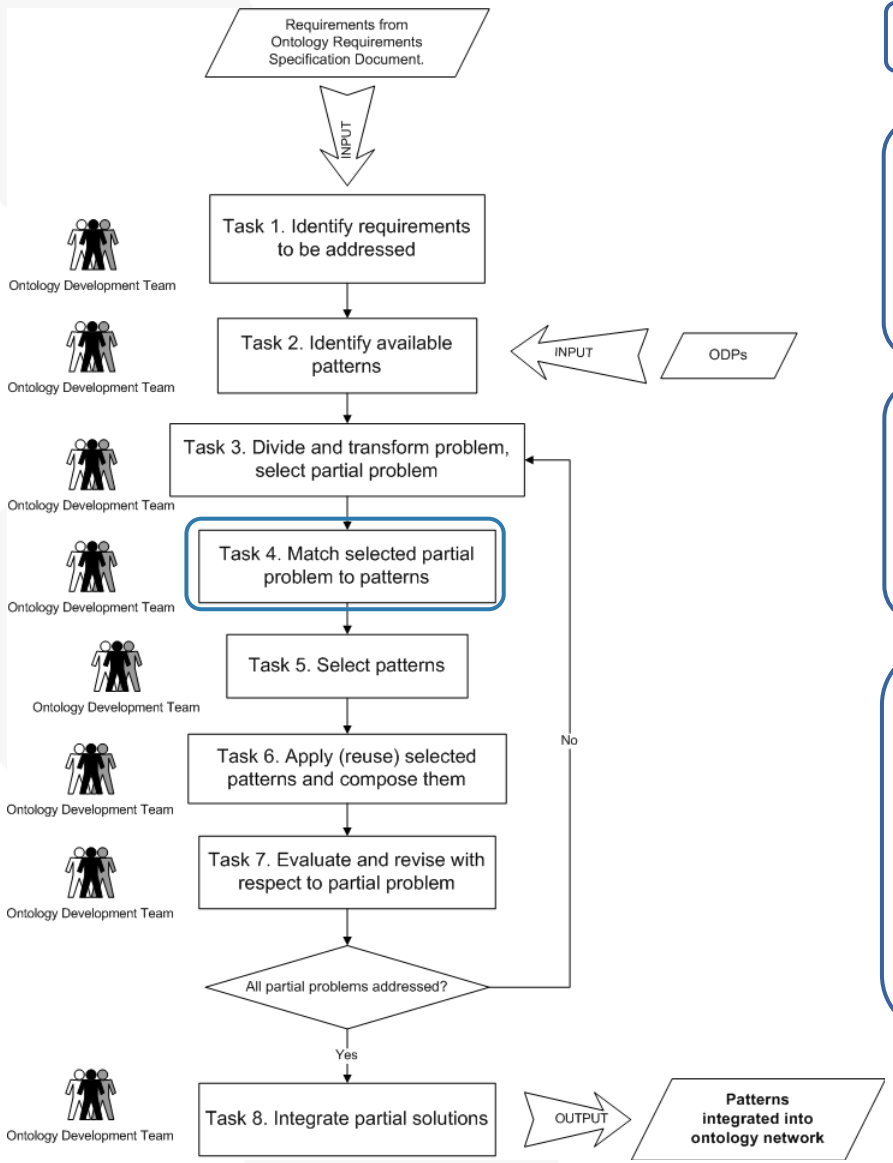
DSP_PC61: What are the components of a printer? ...

DSP_PC71: What are the components of a camera? ...

DSP_PC83: What are the components of a GPS receiver? ...

Requirement identifier	Transformation
INT_CA3	Perform categorization/classification of interface types at different extents of granularity.
DSP_PC7	Perform categorization/classification of devices at different extents of granularity.
DSP_PC9 DSP_PC49 DSP_PC61 DSP_PC71 DSP_PC83 DSP_PC96 DSP_PC102	What are the components of this device? *Response*: A list containing the parts of the device.
TMP_PC4	List the days that make up the week.
LOC_PC14	What is the location of a particular user at a particular time?
USR_CA7	*Response*: A structure containing the location of the user in a given point of time.

ODPs Reuse: Methodological Guidelines (V)



Some heuristics

If a requirement is about *types and subtypes of a given concept*,

then the "**Taxonomy (AP-TX-01)**" pattern could be reused

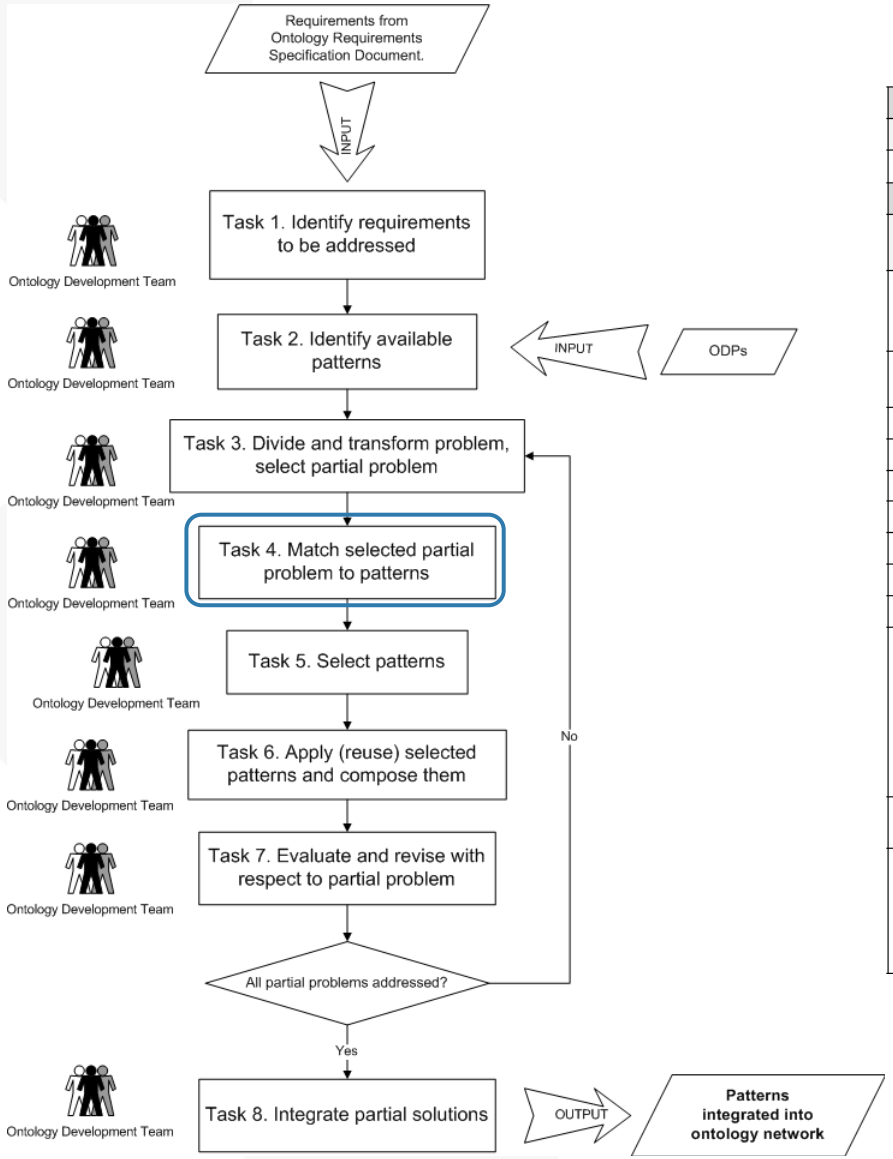
If a requirement is about *parts of something*,

then the "**Componency**", "**Componency (CP-COM-01)**" or "**Part-Whole Relation (CP-PW-01)**" patterns could be reused

If a requirement mentions *something about a list of values*,

then the "**Specified Values in OWL: "value partitions" and "value sets"**", the "**Specified Values: Set of Individuals (LP-SV-01)**" or the "**Specified Values: Subclasses (LP-SV-02)**" patterns could be reused.

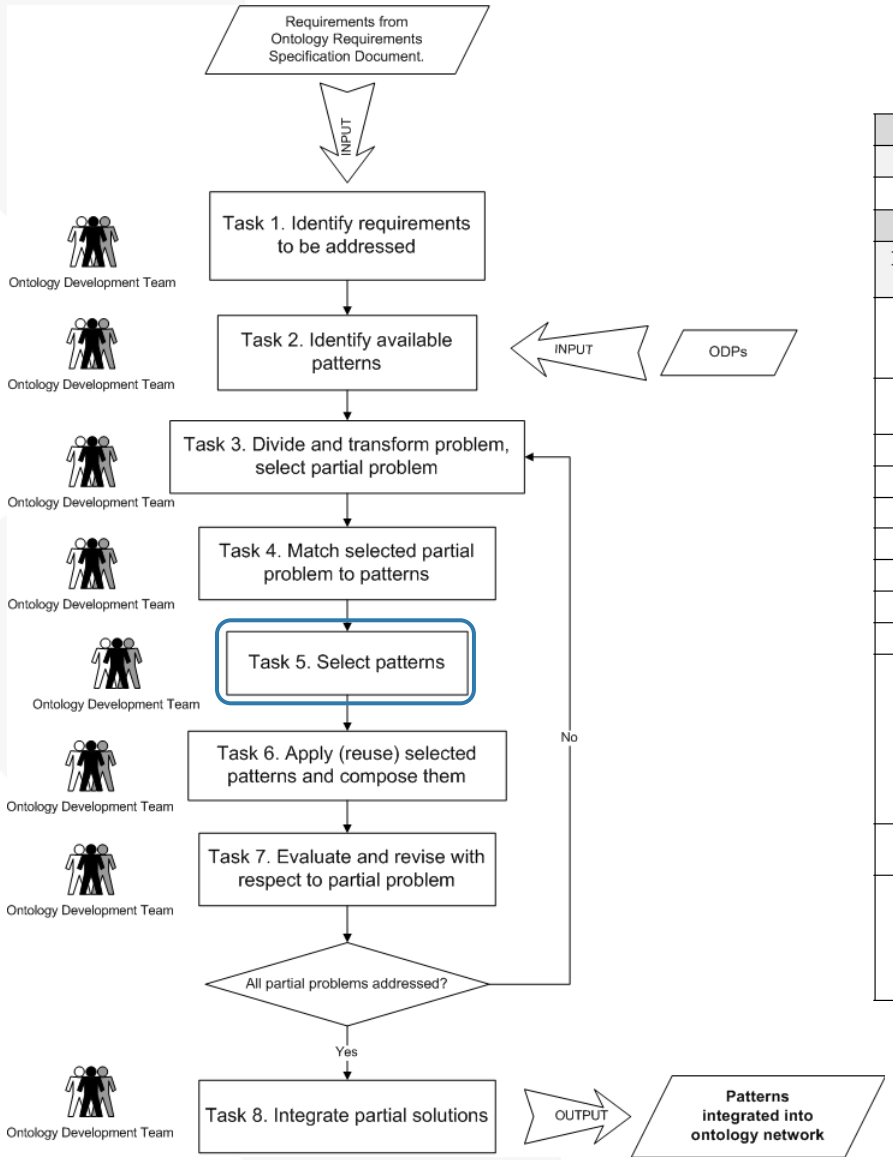
ODPs Reuse: Methodological Guidelines (V)



Non-functional requirements	
Requirement	**Suitable pattern(s)**
• The ontology should be modular.	• Modular Architecture (AP-MD-01)

Functional requirements		
Requirement identifier	**Transformation**	**Suitable pattern(s)**
INT_CA3	Perform categorization/classification of interface types at different extents of granularity.	• Taxonomy (AP-TX-01)
DSP_PC7	Perform categorization/classification of devices at different extents of granularity.	• Taxonomy (AP-TX-01)
DSP_PC9 DSP_PC49 DSP_PC61 DSP_PC71 DSP_PC83 DSP_PC96 DSP_PC102	What are the components of this device?	• Componency • Componency (CP-COM-01) • Part-Whole Relation (CP-PW-01)
TMP_PC4	List the days that make up the week.	• Specified Values in OWL: "value partitions" and "value sets" • Specified Values: Set of Individuals (LP-SV-01) • Specified Values: Subclasses (LP-SV-02)
LOC_PC14 USR_CA7	What is the location of a particular user at a particular time?	• N-Ary Participation • N-ary Relations. Pattern 1: Introducing a new class for a relation • N-ary Participation (CP-NPAR-01) • N-ary Relation: New Class (LP-NR-01)

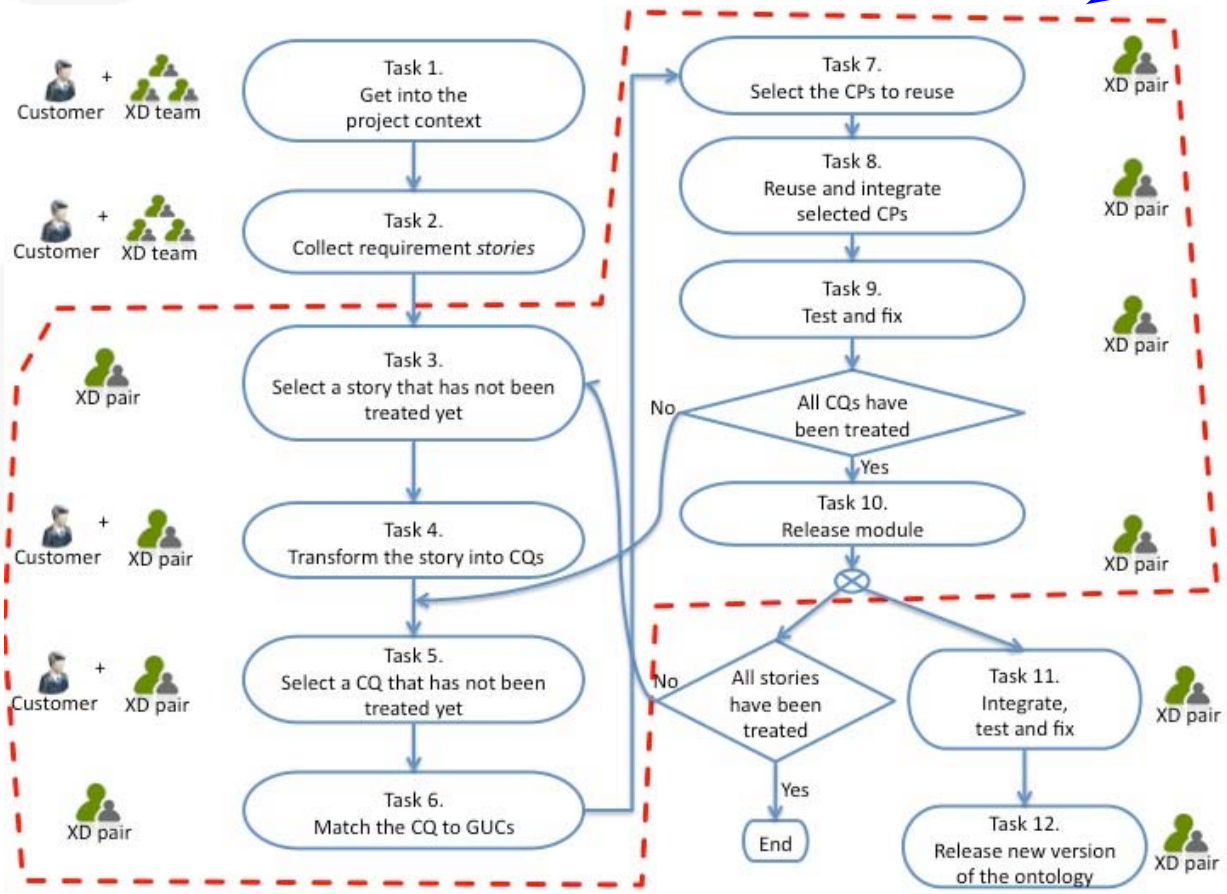
ODPs Reuse: Methodological Guidelines (VI)



Non-functional requirements	
Requirement	**Suitable pattern(s)**
• The ontology should be modular.	• Modular Architecture (AP-MD-01) ✓

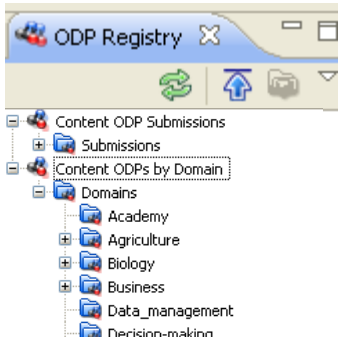
Functional requirements		
Requirement identifier	**Transformation**	**Suitable pattern(s)**
INT_CA3	Perform categorization/classification of interface types at different extents of granularity.	• Taxonomy (AP-TX-01) ✓
DSP_PC7	Perform categorization/classification of devices at different extents of granularity.	• Taxonomy (AP-TX-01) ✓
DSP_PC9 DSP_PC49 DSP_PC61 DSP_PC71 DSP_PC83 DSP_PC96 DSP_PC102	What are the components of this device?	• Componency ✓ • Componency (CP-COM-01) ✓ • Part-Whole Relation (CP-PW-01) ✗
TMP_PC4	List the days that make up the week.	• Specified Values in OWL: "value partitions" and "value sets" ✓ • Specified Values: Set of Individuals (LP-SV-01) ✓ • Specified Values: Subclasses (LP-SV-02) ✗
LOC_PC14 USR_CA7	What is the location of a particular user at a particular time?	• N-Ary Participation ✗ • N-ary Relations. Pattern 1: Introducing a new class for a relation ✓ • N-ary Participation (CP-NPAR-01) ✗ • N-ary Relation: New Class (LP-NR-01) ✓

Content Pattern Reuse: XD Method



Tool Support

XD Tools



Content Pattern Reuse: Basic Operations

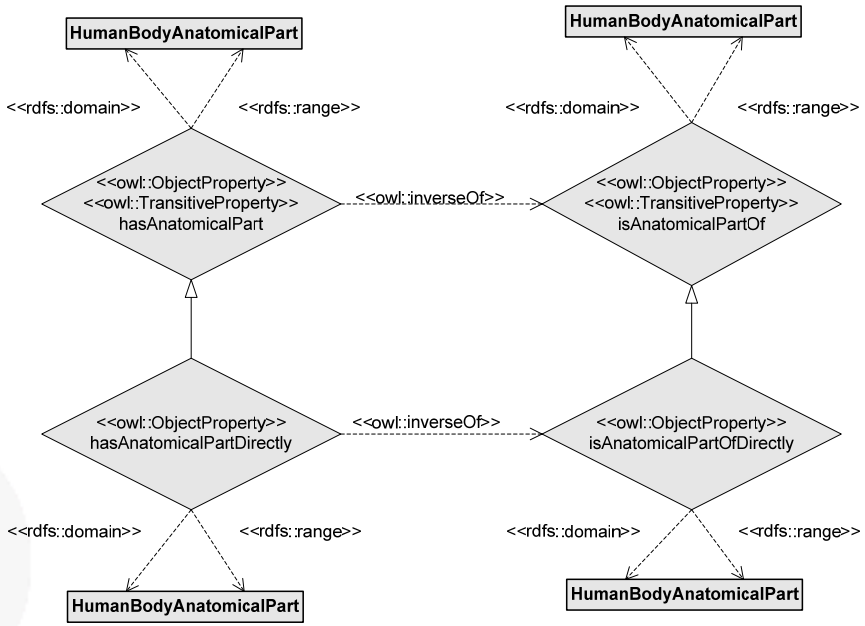
- **Covering** is related to the requirements that are to be solved by a model, or a pattern. A pattern covers a set of requirements, if it is expressive enough to store the necessary knowledge to answer the full set of competency questions (CQs) representing the requirements.
- **Cloning** involves making a duplicate of an ontology element, in some cases including all axioms defining the element or in some cases only making a partial clone.
- **Composition** is the way of combining two or more patterns, where the result in case of content patterns is the union of the axioms of all the patterns together with any additional axioms used to link the elements of the different patterns.
- **Specialization** and generalization are relations among patterns, as well as among elements. Specialization is also a way of reusing a content pattern, when the elements are specialized and thereby form a new ontology tailored to some specific requirements.
- **Expansion** is when a pattern is extended with additional elements or axioms.
- **Importing** is a basic operator for content pattern reuse (since already available in OWL) and is the standard way of reusing such OPs.

Example 1

We are going to **model** the following problem within the Anatomy Ontology:

- The Knee is part of the Leg
- The Front of the Knee is part of the Knee
- The Front of the Knee also forms part of the Leg
- The same for other parts of the body

The **Content Pattern for modelling a Part-Whole Relation** (CP-PW-01) was reused to structure the different parts of the body and the relation among them.

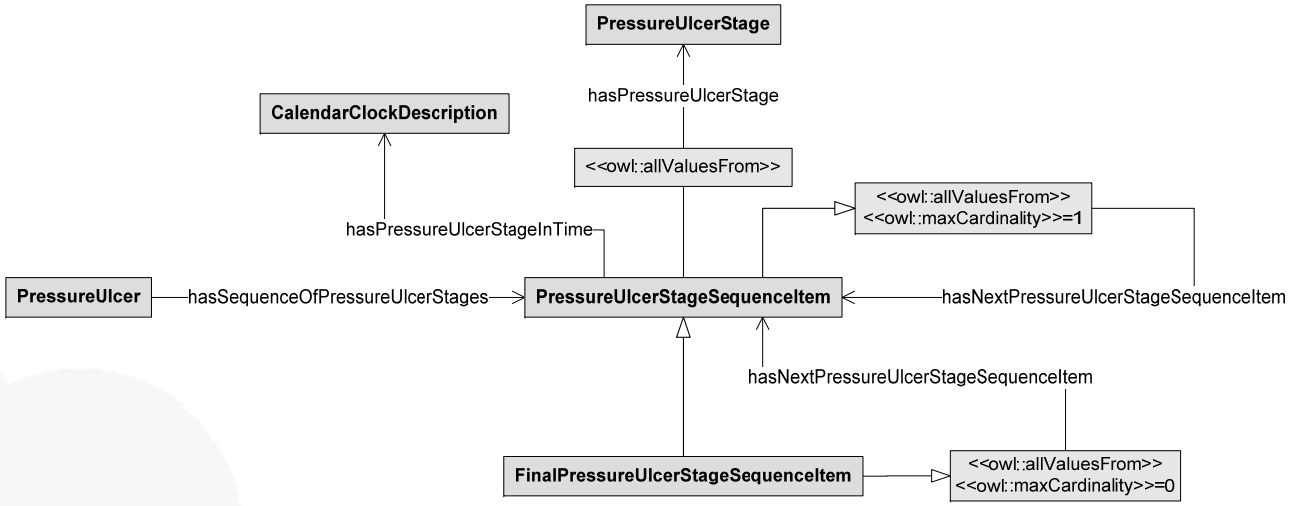


Example 2

We are going to **model** the following problem within the Anatomy Ontology:

- A pressure ulcer has a certain stage at a certain point in time
- Such stage can change to the next stage (higher or lower) later in time

The **Logical Pattern for Modelling N-ary Relation Using Lists for Arguments in the Relation** (LP-NR-02) [7] has been reused for modelling sequences in the stages a pressure ulcer can go through).

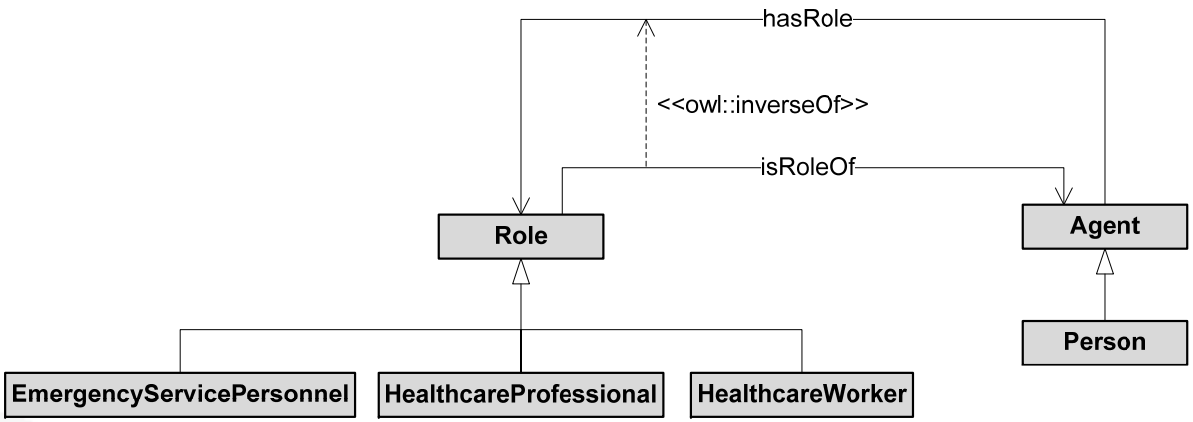


Example 3

We are going to **model** the following problem within the Anatomy Ontology:

- A person can be a patient at a certain point in time and visitor at another point in time
- A person can play different roles in the Hospital Personnel

The **Agent Role Content Pattern (CP-AR-01)** has been reused to model the different roles that a person can have in a hospital setting.



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Mari Carmen Suárez-Figueroa

Date: 24/10/2011