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How can we build ontologies? Methods, Techniques and Methodologies

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Main References

Gómez-Pérez, A.; Fernández-López, M.; Corcho, O. **Ontological Engineering.** *Springer Verlag. 2003*

http://www.ontoweb.org

Deliverables
•D1.4
•D1.5

http://knowledgeweb.semanticweb.org

Research deliverables
Industry deliverables

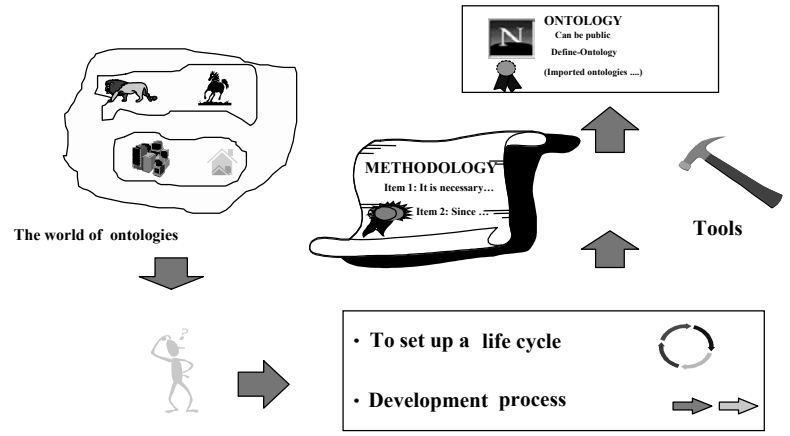
Acknowledgements

- Asunción Gómez-Pérez and Mariano Fernández-López
  - Most of the slides have been done jointly with them
- Jeremy Roberts (University of Manchester)
  - Knowledge elicitation techniques

Outline

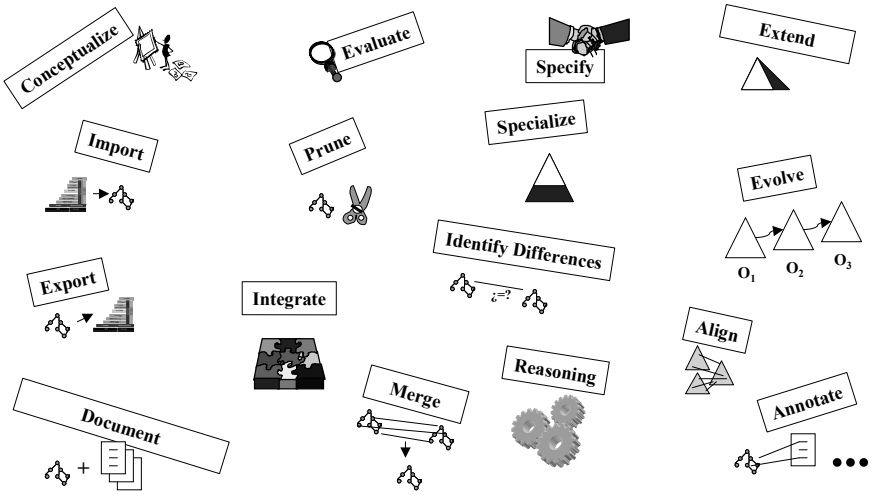
- The Ontology Development Process
- Methodologies for building ontologies
- Methods (and tools) for
  - Conceptualization
  - Learning of ontologies
  - Merge
  - Evaluation
  - Annotation

The Framework



Gómez-Pérez, A. *Knowledge Sharing and Reuse.* **In the Handbook of Applied Expert Systems.** CRC Press. 1998.

Building ontologies



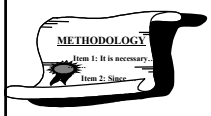
METHONTOLOGY Framework

Ontology Development Process (which activities)
Management, Development, Support

Life Cycle (order of activities)
- Evolving Prototype

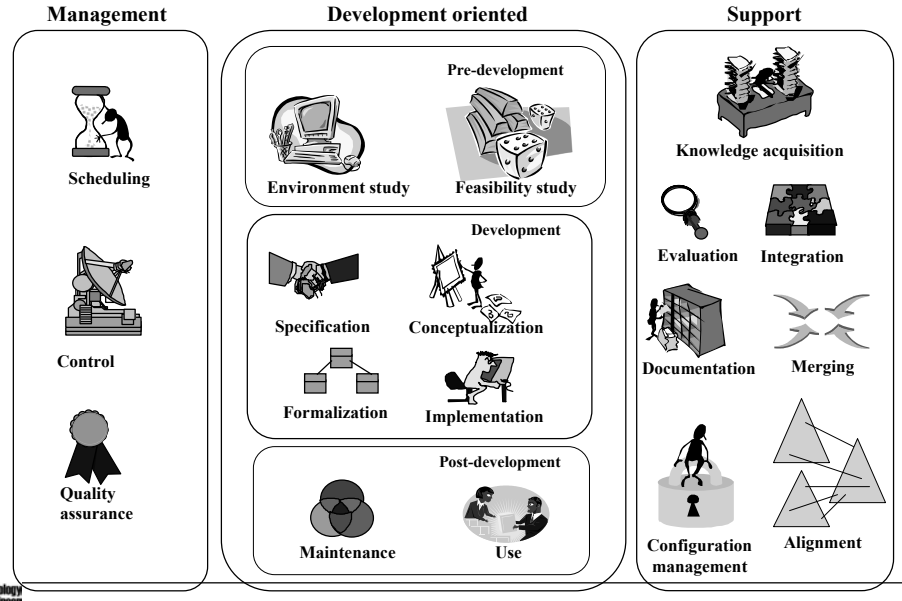
Methodology (how to carry out the activities)
Specification
Knowledge Acquisition
Conceptualization
Integration
Implementation.
Evaluation
Documentation

Ontology Building Tools

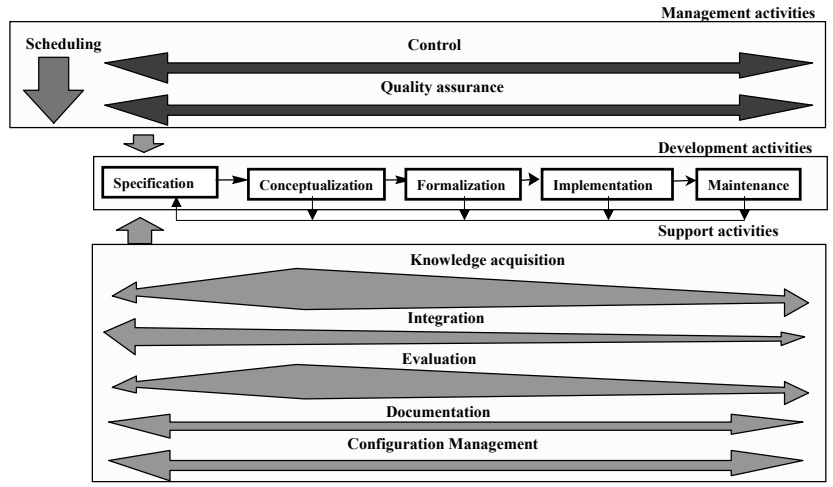


Gómez-Pérez, A. *Knowledge Sharing and Reuse.* **In the Handbook of Applied Expert Systems.** CRC Press. 1998.

Ontology Development Process

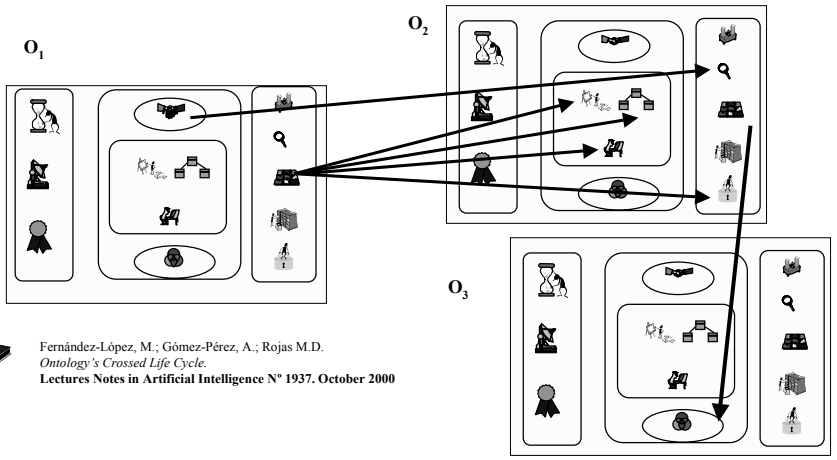


Ontology Life Cycle. Intra-dependencies



Ontology Life Cycle. Inter-dependencies

Inter-dependencies refer the relationship between activities carried out when building different ontologies



Fernández-López, M.; Gómez-Pérez, A.; Rojas M.D.
Ontology's Crossed Life Cycle.
Lectures Notes in Artificial Intelligence Nº 1937. October 2000

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Methodologies and methods for building ontologies from scratch

Methods and Methodologies (analysed in OntoWeb D1.4):

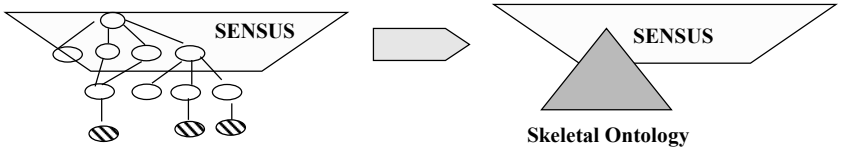
- **Cyc method**
- **Uschold and King's method**
- **Grüninger and Fox's methodology**
- **KACTUS method**
- **METHONTOLOGY**
- **SENSUS method**
- **On-To-Knowledge methodology**

- **Framework for comparing methodologies**
- **Methodology/method description**
- **Comparison of the approaches against the framework**
- **Conclusions**

SENSUS method (I)

Linking Domain Specific Terms to a broad Coverage Ontology

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



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

SENSUS method (II)

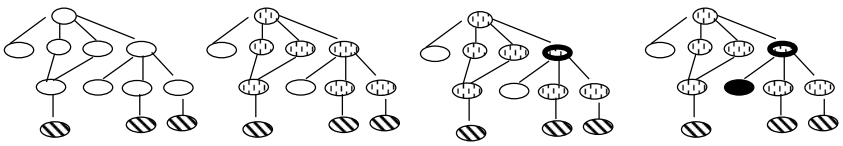
METHOD

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

   If many nodes in a subtree are relevant,

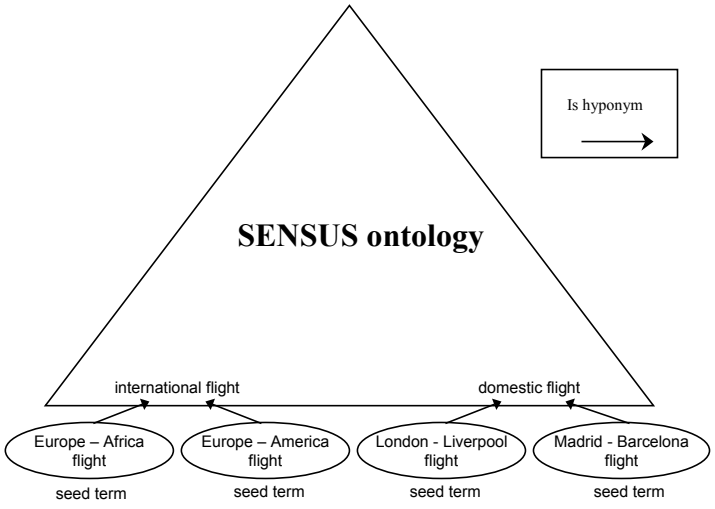
   the other nodes in the subtree are relevant

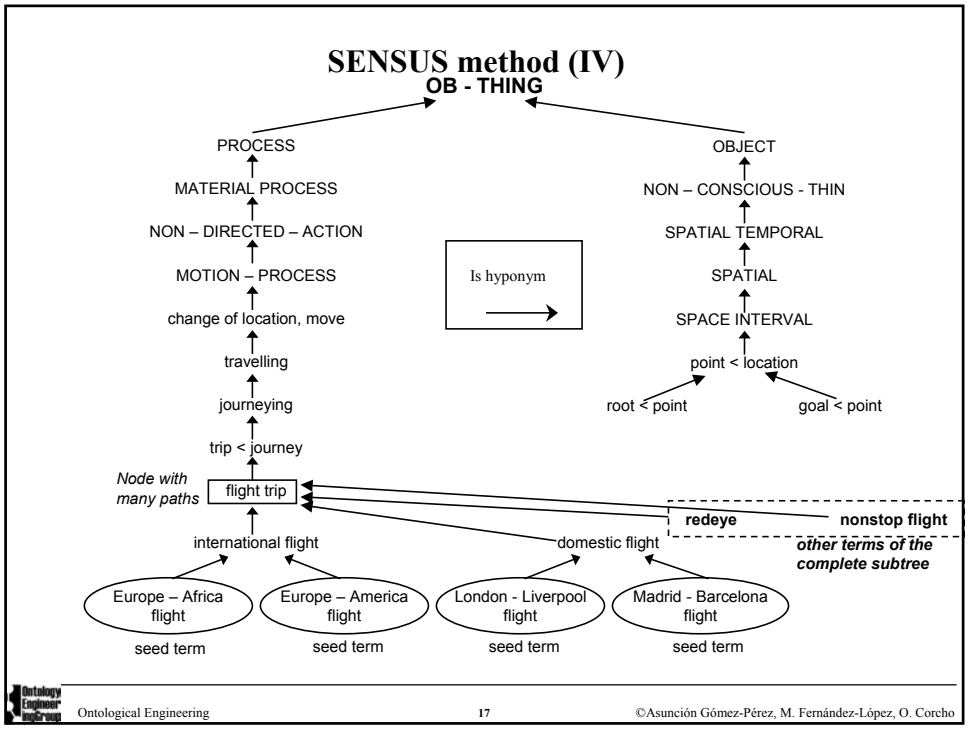
- **Sensus Term**
- **Seed**
- **Path to root**
- **Frequent Parent**
- **Subtree Term**



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

SENSUS method (III)




SENSUS method (IV)
OB - THING
PROCESS
MATERIAL PROCESS
NON – DIRECTED – ACTION
MOTION – PROCESS
change of location, move
travelling
journeying
trip < journey
Node with many paths
flight trip
international flight
domestic flight
Europe – Africa flight
Europe – America flight
London - Liverpool flight
Madrid - Barcelona flight
seed term
seed term
seed term
seed term
Is hyponym
OBJECT
NON – CONSCIOUS - THIN
SPATIAL TEMPORAL
SPATIAL
SPACE INTERVAL
point < location
root < point
goal < point
redeye
nonstop flight
other terms of the complete subtree
Ontological Engineering
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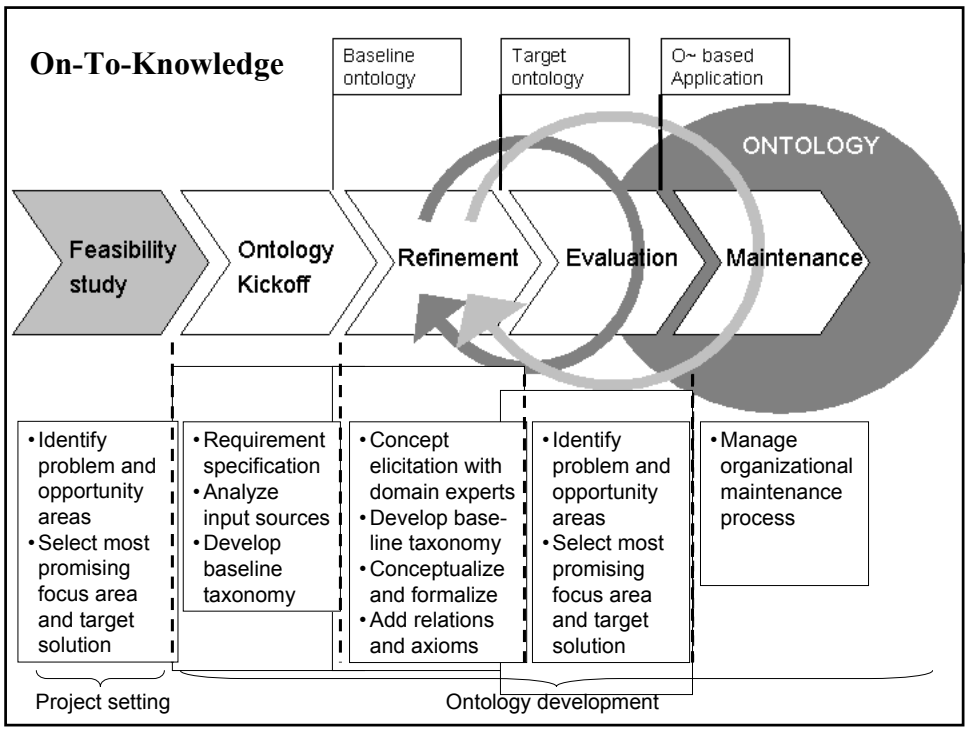
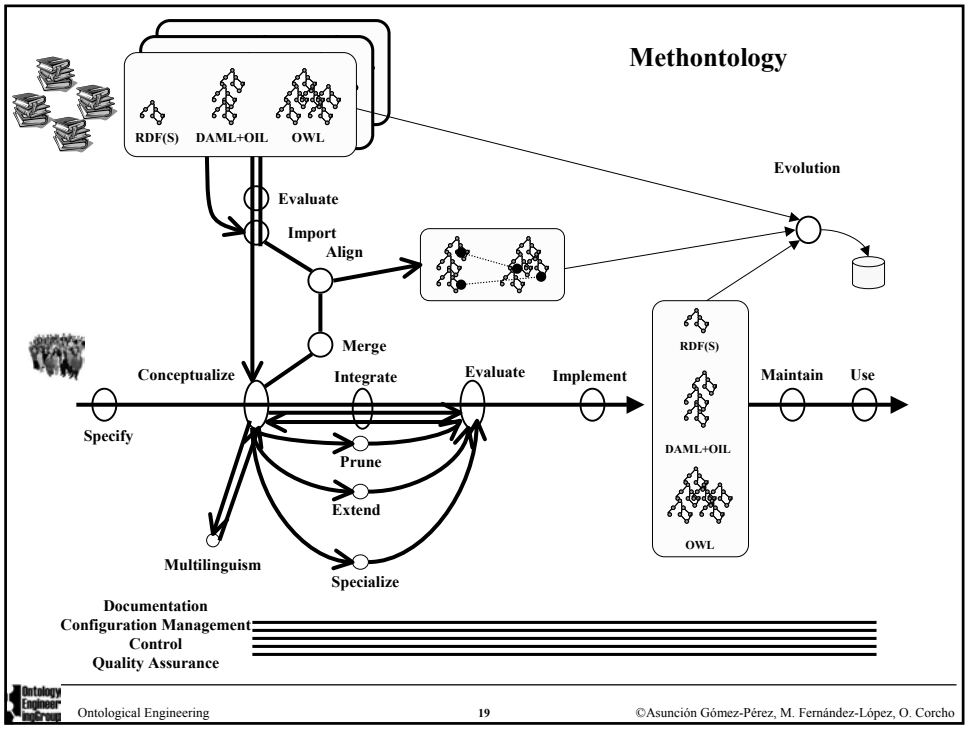
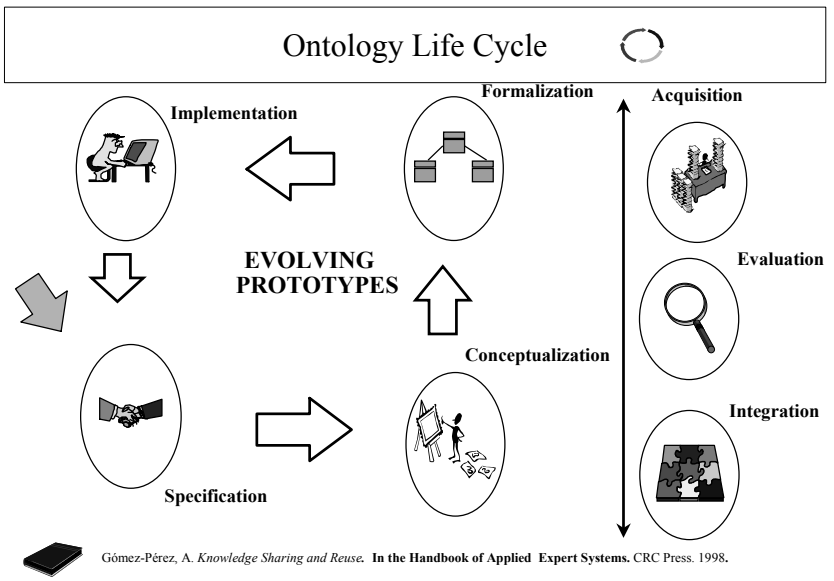

On-To-Knowledge
Baseline ontology
Target ontology
O~ based Application
ONTOLOGY
Feasibility study
Ontology Kickoff
Refinement
Evaluation
Maintenance
• Identify problem and opportunity areas
• Select most promising focus area and target solution
• Requirement specification
• Analyze input sources
• Develop baseline taxonomy
• Concept elicitation with domain experts
• Develop base-line taxonomy
• Conceptualize and formalize
• Add relations and axioms
• Identify problem and opportunity areas
• Select most promising focus area and target solution
• Manage organizational maintenance process
Project setting
Ontology development





Gómez-Pérez, A. *Knowledge Sharing and Reuse.* **In the Handbook of Applied Expert Systems.** CRC Press. 1998.

Evaluation framework for methodologies and methods

- **Construction Strategy**
  - **Life Cycle Proposal**
  - **Strategy with respect to the application**
  - **Use of core ontologies**
  - **Strategy to identify concepts**
- **Proposed ontology development process**
  - **Project Management processes**
  - **Ontology development-oriented processes**
  - **Integral Processes**
- **Use of the methodology by other groups**

Summary of the ontology development process

Feature			Cyc	Uschold & King	Grüninger & Fox	KACTUS	METHONTOLOGY	SENSUS	On-To-Knowledge
Ontology management activities	Scheduling		NP	NP	NP	NP	*Proposed*	NP	*Described*[3]
	Control		NP	NP	NP	NP	*Proposed*	NP	*Described*
	Quality assurance		NP	NP	NP	NP	NP	NP	*Described*
Ontology development-oriented activities	Pre-development processes	Environment study	NP	NP	NP	NP	NP	NP	*Proposed*
		Feasibility study	NP	NP	NP	NP	NP	NP	*Described*
	Development processes	Specification	NP	*Proposed*	*Described in detail*	*Proposed*	*Describe in detail*	*Proposed*	*Describe in detail*
		Conceptualization	NP	NP	*Described in detail*	*Proposed*	*Described in detail*	NP	*Proposed*
		Formalization	NP	NP	*Described in detail*	*Described*	*Described*	NP	*Described*
		Implementation	*Proposed*	*Proposed*	*Described*	*Proposed*	*Described in detail*	*Described*	*Described*
	Post-development processes	Maintenance	NP	NP	NP	NP	*Proposed*	NP	*Proposed*
		Use	NP	NP	NP	NP	NP	NP	*Proposed*
Ontology support activities	Knowledge acquisition		*Proposed*	*Proposed*	*Proposed*	NP	*Described in detail*	NP	*Described*
	Evaluation		NP	Proposed	*Described in detail*	NP	*Described in detail*	NP	*Proposed*
	Integration		*Proposed*[3]	*Proposed*	*Proposed*	*Proposed*	*Proposed*	NP	*Proposed*
	Configuration management		NP	NP	NP	NP	*Described*	NP	*Proposed*
	Documentation		*Proposed*	*Proposed*	*Proposed*	NP	*Described in detail*	NP	*Described*
	Merging and Alignment		NP	NP	NP	NP	NP	NP	NP

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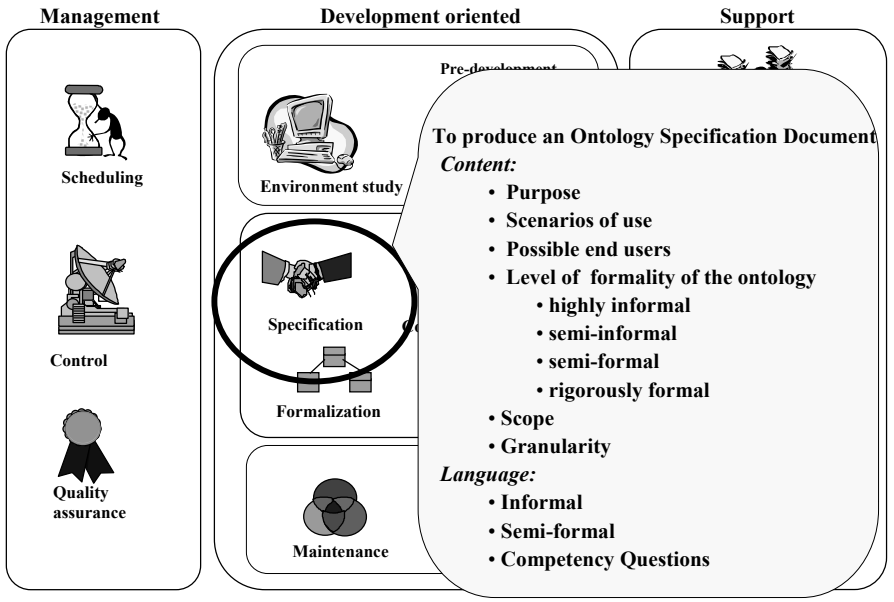
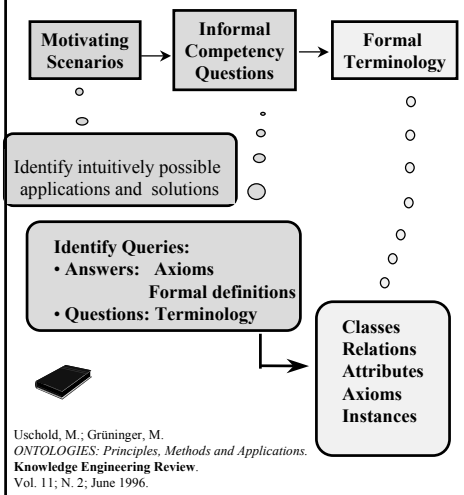


Getting terminology using Competency Questions



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

Find stories which include Person P

Identify Queries:
• Questions: Story, Person, involved-in, includes
• Answers: Story S1 includes person P

Classes: Story, Person
Relations: Involved-in, includes
Attributes: ---
Axioms
Instances: P, S1

Getting terminology using Competency Questions

Find all the events attended by participants working on semantic web projects

Each project has a property storing its type

•Taxonomy of Topics
•There is a relation that connects projects and topics

Identify Queries:
Questions: Event, Researcher, Project, works at, attends, type of project
Answers: ISWC, EKAW, K-CAP, ...

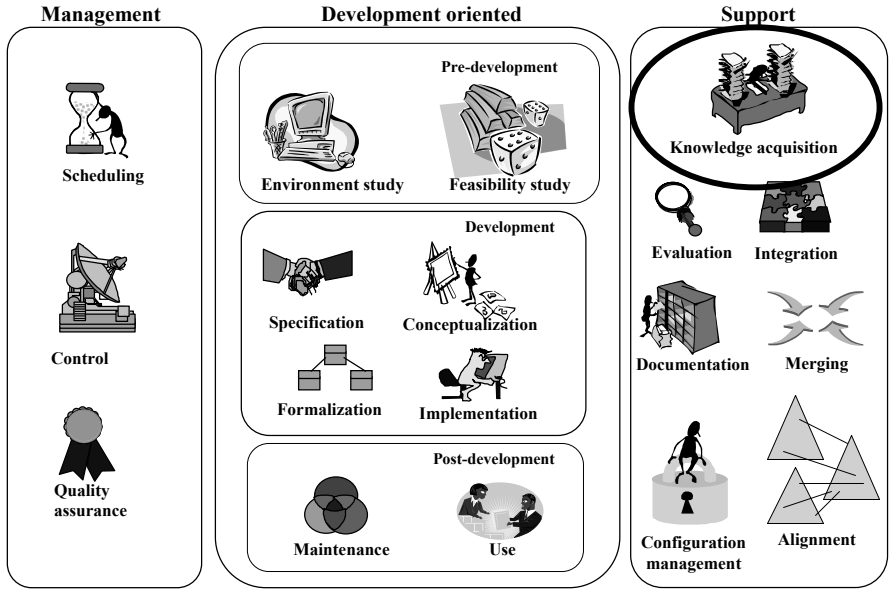
Classes: Event, International Conference, National Conference, Workshop, Project Meetings, Researcher, Person, Project,
Relations: works at, attends
Attributes: type of project
Axioms: For all...
Instances: ISWC, EKAW, K-CAP, ...

Identify Queries:
Questions: Event, Researcher, Project, works at, attends, Semantic Web Topics, main topics
Answers: ISWC, EKAW, K-CAP, ...

Classes: Event, International Conference, National Conference, Workshop, Project Meetings, Researcher, Person, Project, Topics, Ontologies, markup languages, semantic web services, annotations, ...
Relations: Works at, attends, main topics, topic of
Attributes: ---
Axioms: For all .....
Instances:ISWC, EKAW, K-CAP, ...

Exercise

- **Objective**
  - **Create an ontology specification document for a specific domain (to be selected by the audience)**
- **Tasks**
  - **Select a domain to create an ontology**
  - **Identify scenarios where the ontology could be used in an application**
  - **Identify competency questions**
  - **Extract a very first set of relevant terms**



Elicitation Techniques

- Rules of thumb
  - Take experts off the job for short time periods
  - Focus on the essential knowledge
  - Collate knowledge from different experts
- Results
  - Non-experts can understand the knowledge
  - Knowledge can be validated and maintained

Elicitation techniques. Types (I)

- Protocol-generation techniques
  - Various types of interviews: unstructured, semi-structured and structured
  - Various types of reporting techniques: self-report and shadowing
  - Various types of observational techniques
- Protocol analysis techniques
  - Used with transcripts of interviews or other text-based information
  - Useful to identify various types of knowledge (goals, decisions, relationships and attributes).
  - They act as a bridge between the use of protocol-based techniques and knowledge modelling techniques.
- Hierarchy-generation techniques (laddering)
  - Useful for building taxonomies or other hierarchical structures (goal trees and decision networks).

Elicitation techniques. Types (II)

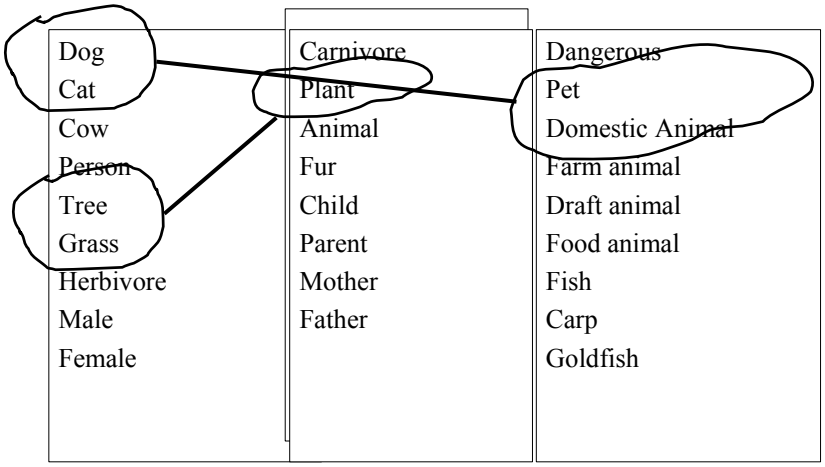
- Matrix-based techniques
  - Construction of grids indicating such things as problems encountered against possible solutions.
  - Example: frames for representing the properties of concepts and the repertory grid technique used to elicit, rate, analyse and categorise the properties of concepts.
- Sorting techniques
  - Used to capture the way people compare and order concepts.
  - It can lead to the revelation of knowledge about classes, properties and priorities.
- Limited-information and constrained-processing tasks
  - They either limit the time and/or information available to the expert when performing tasks.
  - Example: the twenty-questions technique provides an efficient way of accessing the key information in a domain in a prioritised order.
- Diagram-based techniques
  - Generation and use of concept maps, state transition networks, event diagrams and process maps.
  - Usefule to capture the "what, how, when, who and why" of tasks and events.

Card sorting. Collect and organise the concepts

- Write down each concept/idea on a card
- Organise them into piles
- Link the piles together
- Do it again, and again

- Example. Create an ontology for an index of a children's book of animals including
  - Where they live
  - What they eat
    - Carnivores, herbivores and omnivores
  - How dangerous they are
  - How big they are
  - A bit of basic anatomy
    - numbers of legs, wings, toes, etc.

Card sorting. Example



Laddering. Extend the concepts

- Take a group of things and ask what they have in common
  - Then what other 'siblings' there might be
- e.g.
  - Plant, Animal → Living Thing
    - Might add Bacteria and Fungi but not now
  - Cat, Dog, Cow, Person → Mammal
    - Others might be Goat, Sheep, Horse, Rabbit,…
  - Cow, Goat, Sheep, Horse → Farm animal
    - What others are there? Do they divide amongst themselves?
  - Wild, Domestic → Domestication
    - What other states – "Feral" (domestic returned to wild)

Vocabulary note:
"Sibling" = "brother or sister"

Laddering. Choose Some Main Axes

- Add abstractions where needed
  - e.g. “Living thing”
- identify relations
  - e.g. “eats”, “owns”, “parent of”
- Identify definable things
  - e.g. “child”, “parent”, “Mother”, “Father”
    - Things where you can say clearly what it means
      - Try to define a dog precisely – very difficult
        - A “natural kind”
- make names explicit

Laddering. Example

- Living Thing
  - Animal
    - Mammal
      - Cat
      - Dog
      - Cow
      - Person
    - Fish
      - Carp
      - Goldfish
  - Plant
    - Tree
    - Grass
    - Fruit

- Modifiers
  - domestic
    - pet
    - Farmed
      - Draft
      - Food
  - Wild
  - Health
    - healthy
    - sick
  - Sex
    - Male
    - Female
  - Age
    - Adult
    - Child

- Relations
  - eats
  - owns
  - parent-of
  - …

- Definable
  - Carinvore
  - Herbivore
  - Child
  - Parent
  - Mother
  - Father
  - Food Animal
  - Draft Animal

Exercise

•**Objective**

- **Combine some typical elicitation techniques for identifying ontology terms and building taxonomies ("card sorting" and laddering).**

•**Tasks**

- **Divide into small groups (2-4 people). This technique works better with small groups.**
- **Use the card sorting technique to identify and group relevant terms (some terms were already identified in the previous step).**
- **Use laddering to organise terms in hierarchies.**

Ontology Learning is the set of methods and techniques used for building an ontology from scratch, enriching, or adapting an existing ontology in a semi-automatic fashion using several sources. It aims to reduce the time and the effort necessary in the knowledge acquisition process.

•Approaches:

- **•Ontology learning from text**
- **•Ontology learning from dictionary**
- **•Ontology learning from knowledge bases**
- **•Ontology learning from semi-structured schemata**
- **•Ontology learning from relational schemata**

Support

Knowledge acquisition

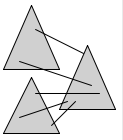
Evaluation

Integration

Documentation

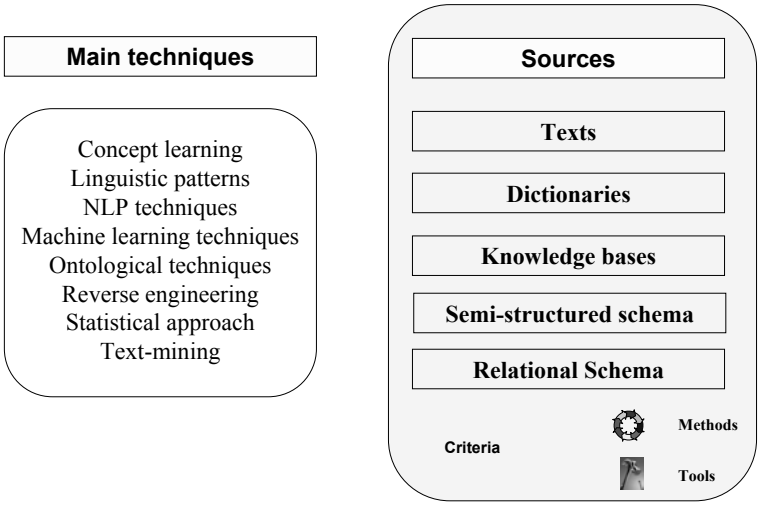
Merging

Configuration management



Alignment

Approaches for Ontology Learning



Techniques used in different OL approaches

OL from text

- **Natural Language Techniques**
- **Clustering techniques**
- **Machine learning**
- **Statistical aproach**

OL from dictionary

- **Natural Language Processing**
- **Statistical aproach**

OL from knowledge bases

- **Rules**

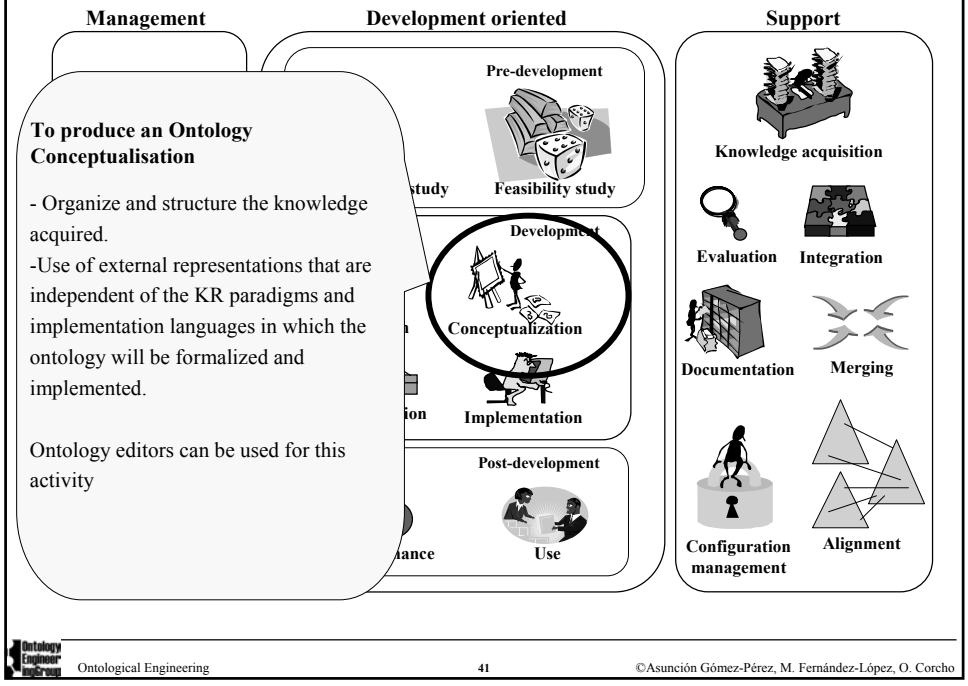
OL from semi-structured schemata

- **Graph Theory**
- **Machine Learning**
- **Pattern Recognition**
- **Clustering**
- **Ontological Techniques**

OL from relational schemata

- **Mapping Techniques**
- **Reverse Engineering**

All of them described and compared in OntoWeb deliverable D1.5

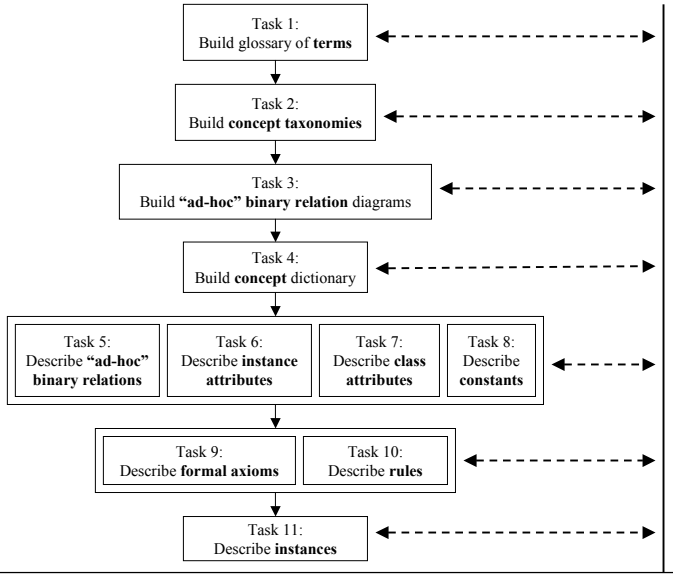


To produce an Ontology Conceptualisation

- Organize and structure the knowledge acquired.
-Use of external representations that are independent of the KR paradigms and implementation languages in which the ontology will be formalized and implemented.

Ontology editors can be used for this activity

Methontology. Tasks of the conceptualization



Terms glossary

Name	Synonyms	Acronyms	Description	Type
American Airlines Flight	--	AA Flight	Flight operated by American Airlines.	Concept
Bed and Breakfast	--	--	An establishment (as an inn) offering lodging and breakfast	Concept
British Airways Flight	--	BA Flight	Flight operated by British Airways.	Concept
Business Trip	--	--	A special package for businessmen, consisting of a flight and a good quality hotel.	Concept
Camping	--	--	Temporal lodging in a camp.	Concept
Economy Trip	--	--	An economic package, usually costing less than 1000$.	Concept
European Location	--	--	A location in Europe.	Concept
Five-stars Hotel	--	--	High quality hotel.	Concept
Flight	--	--	A journey by plane identified by a flight number.	Concept
Hotel	--	--	An establishment that provides lodging and usually meals, entertainment, and various personal services for the public	Concept
Iberia Flight	--	IB Flight	Flight operated by Iberia.	Concept
Japan Location	--	--	A location in Japan.	Concept
Location	Place	--	A position or site occupied or available for occupancy or marked by some distinguishing feature.	Concept
Lodging	Accommodation	--	A temporary place to stay during a trip, sleeping accommodations.	Concept
Luxury Trip	--	--	A luxury and expensive trip.	Concept
Spain Location	--	--	A location in Spain.	Concept
Train Travel	Rail Travel	--	A journey by train.	Concept
Travel	--	--	A journey from place to place.	Concept
Travel Package	--	--	A travel package that a person can ask for. It consists of one or several means of transport and one or several accommodations.	Concept

Primitives for Modelling Taxonomies

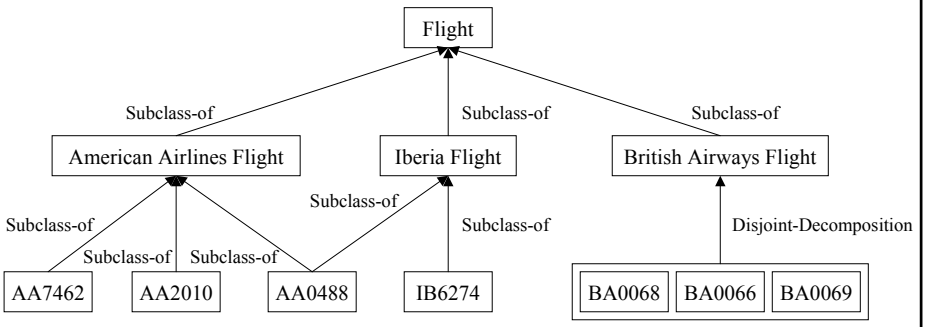
Subclass-of:

Disjoint decomposition: a set of subclasses of C that do not have common instances and do not cover C

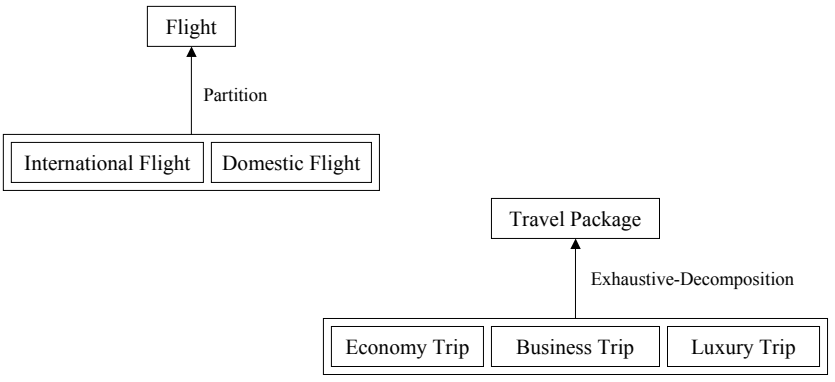
Partition: a set subclasses of C that cover C and do not have common instances or subclasses

Exhaustive-Decomposition: a set subclasses of C that cover C and may have common instances or subclasses

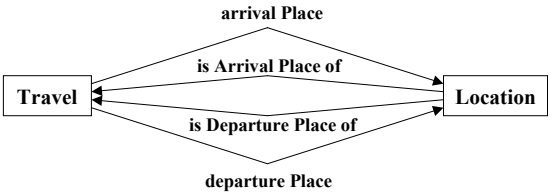
Example of a Taxonomy (I)



Example of a Taxonomy (II)



Identify Ad-hoc relations



Define a Concept Dictionary

Concept name	Class attributes	Instance attributes	Relations
AA7462	--	--	same Flight as
American Airlines Flight	company Name	--	--
British Airways Flight	company Name	--	--
Five-stars Hotel	number of Stars	--	--
Flight	--	--	same Flight as
Location	--	name size	is Arrival Place of is Departure Place of
Lodging	--	price of Standard Room	placed in
Travel	--	arrival Date company Name departure Date return Fare single Fare	arrival Place departure Place
Travel Package	--	budget final Price name number of Days travel Restrictions	arrival Place departure Place accommodated in travels in
USA Location	--	--	--

Define Instance Attributes

Instance attribute name	Concept name	Value type	Measurement unit	Precision	Range of values	Cardinality
budget	Business Trip	Float	Currency Quantity	0.01	1000...3000	(0,1)
budget	Economy Trip	Float	Currency Quantity	0.01	0....1000	(0,1)
name	Location	String	--	--	--	(1,N)
size	Location	Integer	Square Meters	1	--	(1,1)
price of Standard Room	Lodging	Float	--	--	--	(0,1)
budget	Luxury Trip	Float	Currency Quantity	0.01	--	(0,1)
arrival Date	Travel	Date	--	--	--	(0,1)
company Name	Travel	String	--	--	--	(0,N)
departure Date	Travel	Date	--	--	--	(0,1)
return Fare	Travel	Float	Currency Quantity	0.01	--	(0,1)
single Fare	Travel	Float	Currency Quantity	0.01	--	(0,1)
budget	Travel Package	Float	Currency Quantity	0.01	--	(0,1)
final Price	Travel Package	Float	Currency Quantity	0.01	--	(0,1)
number of Days	Travel Package	Integer	days	1	--	(0,1)
travel Restrictions	Travel Package	String	--	--	--	(0,1)

Define Class Attributes

Attribute name	Defined at concept	Value type	Measurement unit	Precision	Cardinality	Values
company Name	American Airlines Flight	String	--	--	(1,1)	AA
company Name	British Airways Flight	String	--	--	(1,1)	BA
company Name	Iberia Flight	String	--	--	(1,1)	IB
number of Stars	Five-stars Hotel	Integer	star	1	(1,1)	5
number of Stars	Four-stars Hotel	Integer	star	1	(1,1)	4
number of Stars	Three-stars Hotel	Integer	star	1	(1,1)	3
number of Stars	Two-stars Hotel	Integer	star	1	(1,1)	2
number of Stars	One-stars Hotel	Integer	star	1	(1,1)	1

Define Formal Axioms

Axiom name	Train inside Europe
Description	Every train that departs from a European location must arrive at another European location
Expression	forall(?X,?Y,?Z) ([Train Travel](?X) and [departure Place](?X,?Y) and [arrival Place](?X,?Z) and [European Location](?Y) ->) [European Location](¿Z))
Concepts	Train Travel European Location
Referred attributes	--
Ad-hoc binary relations	departure Place arrival Place
Variables	?X ?Y ?Z

Define Rules

Rule name	Costa Cruises rule
Description	Every ship that departs from Europe is arranged by the company Costa Cruises
Expression	if [European Location](?Y) and Ship(?X) and [departure Place](?X,?Y) then [company Name](?X, "Costa Cruises")
Concepts	Ship European Location
Referred attributes	company Name
Ad-hoc binary relations	departure Place
Variables	?X ?Y

Define Instances

Instance Name	Concept Name	Attribute	Values
AA7462_Feb08_2002	AA7462	company Name	American Airlines
		departure Date	02/08/2002
		arrival Date	02/08/2002
		single Fare	300
AA7462_Feb16_2002	AA7462	company Name	American Airlines
		departure Date	02/16/2002
		arrival Date	02/16/2002
		single Fare	300

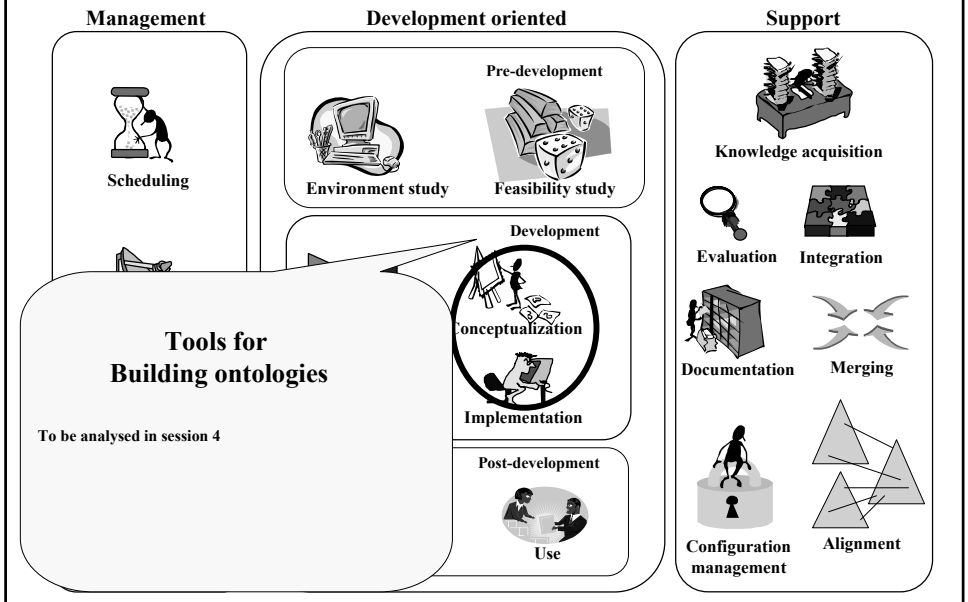
Exercise

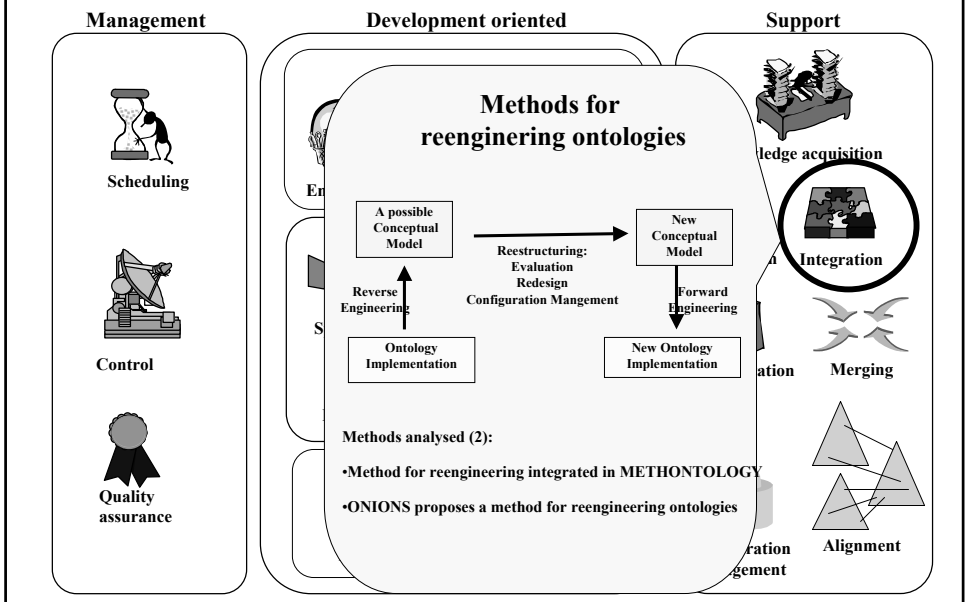
•Objective

- **Create a first draft of an ontology conceptualisation.**

•Tasks

- **Divide into small groups (2-4 people).**
- **Select one class, one instance attribute, one class attribute, etc.**
- **Describe each of them using the intermediate representations proposed by Methontology.**


Management
Development oriented
Support
Scheduling
Pre-development
Environment study
Feasibility study
Development
Conceptualization
Implementation
Post-development
Use
Knowledge acquisition
Evaluation
Integration
Documentation
Merging
Configuration management
Alignment
Tools for Building ontologies
To be analysed in session 4


Management
Development oriented
Support
Scheduling
Control
Quality assurance
Integration
Merging
Alignment
Methods for reengineering ontologies
A possible Conceptual Model
Reestructuring:
Evaluation
Redesign
Configuration Mangement
New Conceptual Model
Reverse Engineering
Forward Engineering
Ontology Implementation
New Ontology Implementation
Methods analysed (2):
•Method for reengineering integrated in METHONTOLOGY
•ONIONS proposes a method for reengineering ontologies

Libraries of Ontologies

OWL ontologies

Protégé ontology library	**http://protege.stanford.edu/download/ontologies.html**
OWL ontology library	**http://www.daml.org/ontologies/**
SWOOGLE	**http://swoogle.umbc.edu/**
Oyster	**http://oyster.ontoware.org/oyster/oyster.html**

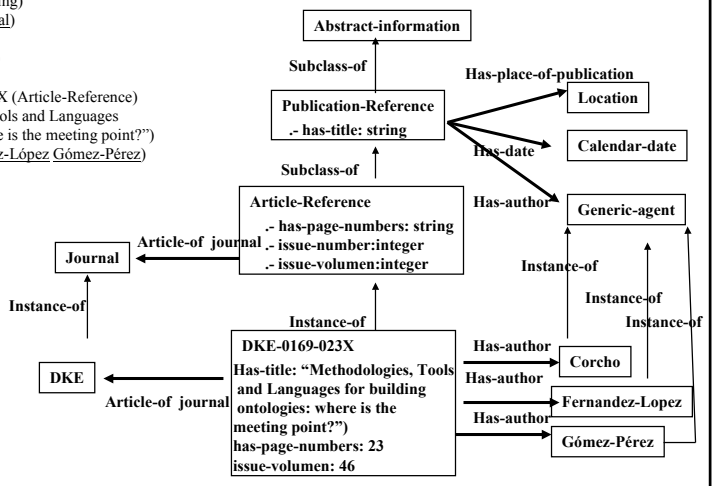
Other ontologies

SHOE ontology library	**http://www.cs.umd.edu/projects/plus/SHOE/onts/index.html**
Ontolingua ontology library	**http://ontolingua.stanford.edu/**
WebOnto ontology library	**http://webonto.open.ac.uk**
WebODE ontology library	**http://webode.dia.fi.upm.es/**
(KA)² ontology library	**http://ka2portal.aifb.uni-karlsruhe.de/**

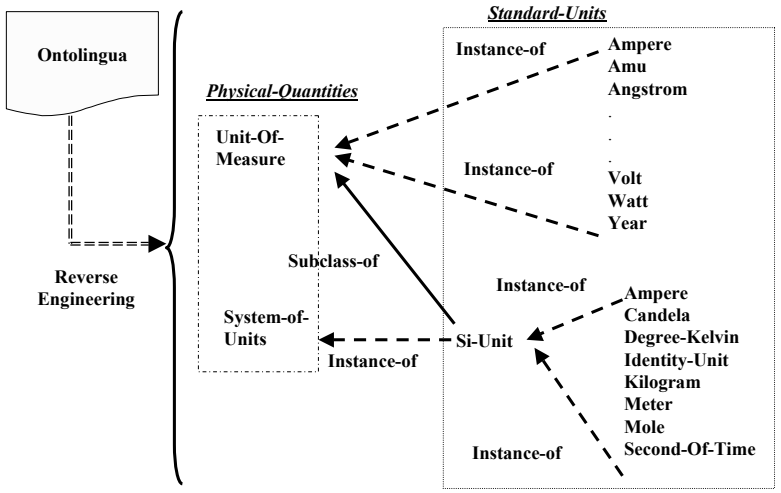
(def-class PUBLICATION-REFERENCE (abstract-information)
"we have decided that a publication reference is an intangible, abstract information"
((has-title :type string)
(has-author :type generic-agent)
(has-date :type calendar-date)
(has-place-of-publication :type location)))

(def-class ARTICLE-REFERENCE (Publication-Reference)
((has-page-numbers :type string)
(article-of-journal :type journal)
(issue-number :type integer)
(issue-volume :type integer)))

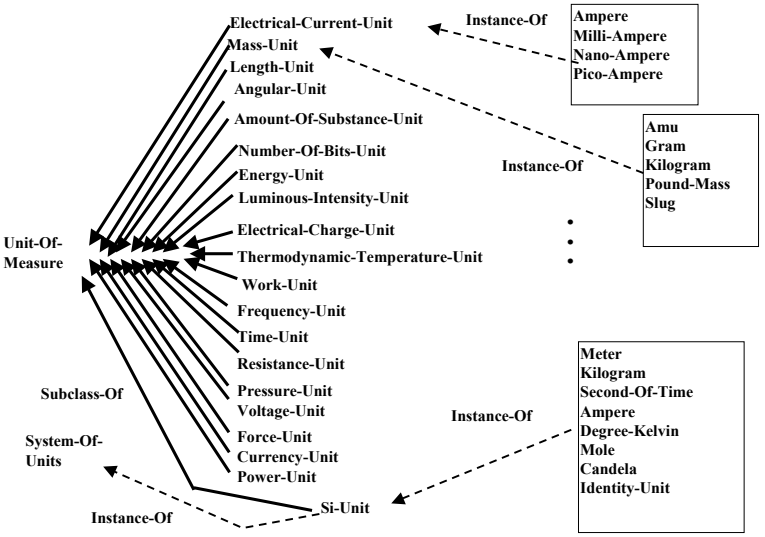
(def-instance DKE-0169-023X (Article-Reference)
(has-title "Methodologies, Tools and Languages
for building ontologies: where is the meeting point?")
(has-author Corcho Fernández-López Gómez-Pérez)
(has-date July-2003)
(has-page-numbers 23)
(article-of-journal DKE)
(issue-volume 46))



Standard-Units Reverse Engineering



Restructuring Standard-Units Conceptual Model



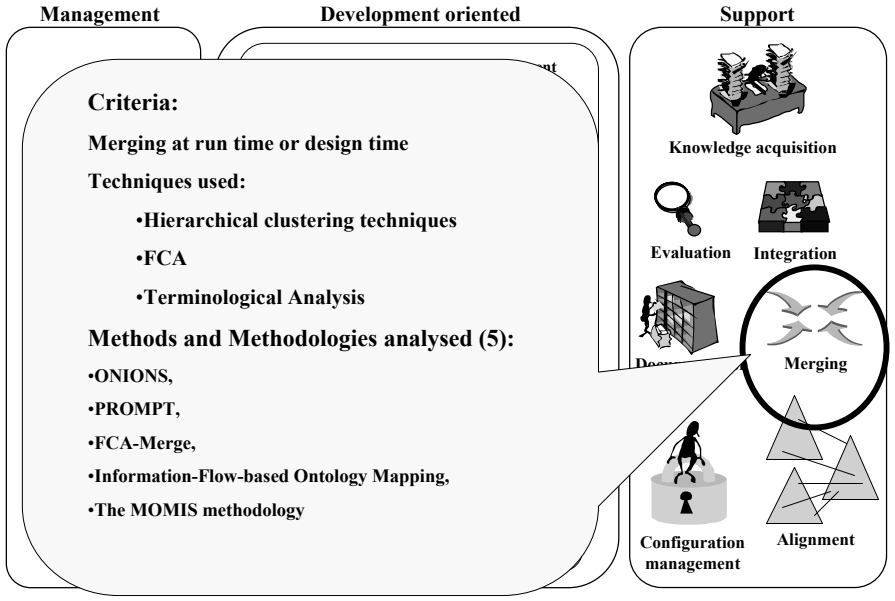
Exercise

•**Objective**

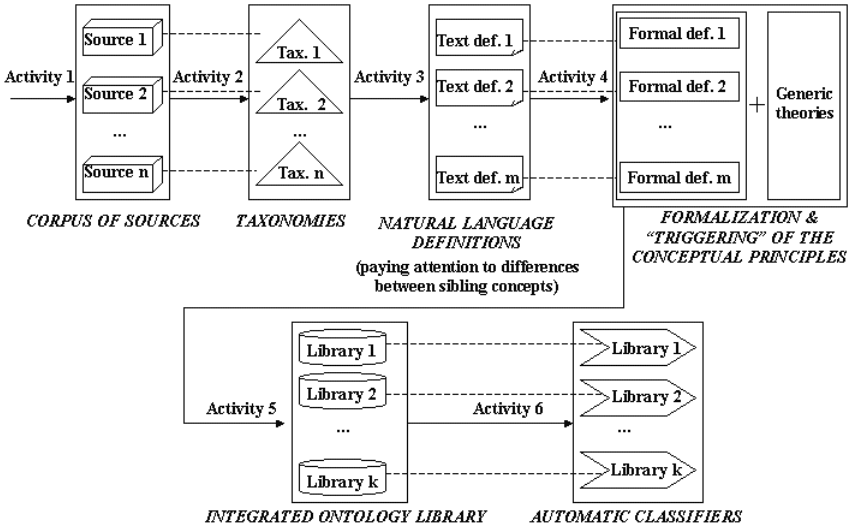
- **Reenginer one of the ontologies developed by another group so as to make it suitable for its use in your ontology.**

•**Tasks**

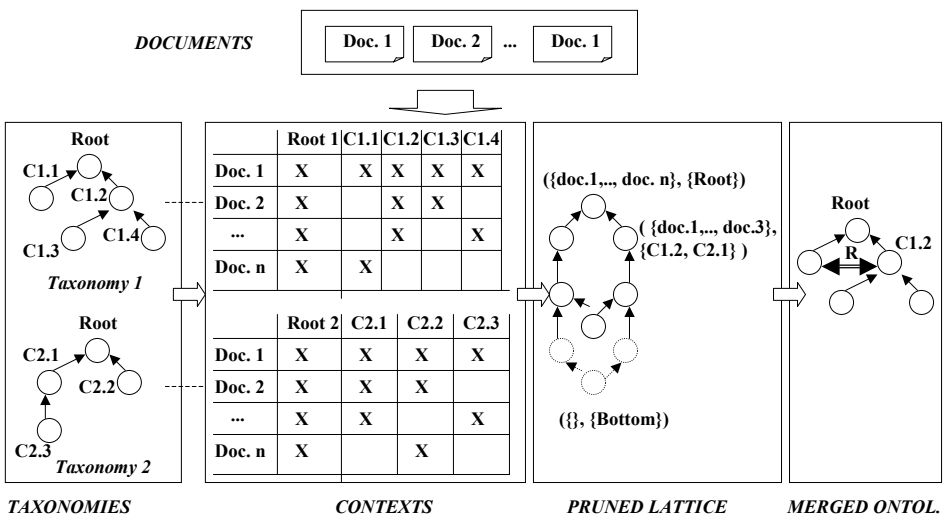
- **Select one group whose ontology you will be working with.**
- **Restructure it if needed, so that it can fit easily in your ontology.**

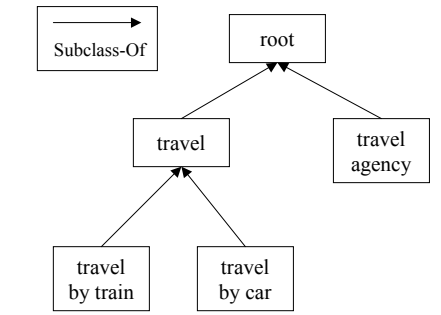


ONIONS

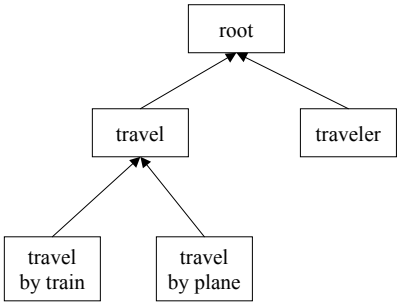


FCA-Merge

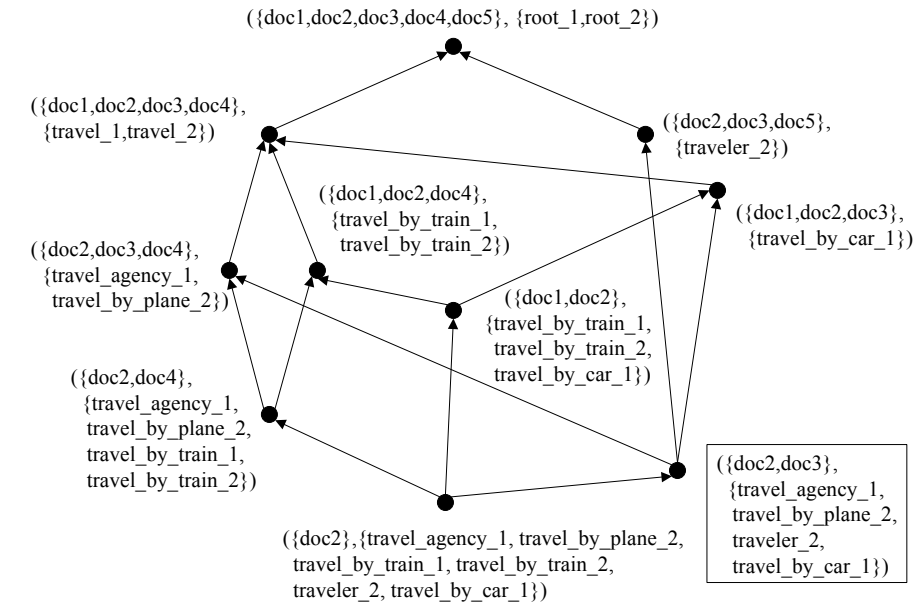


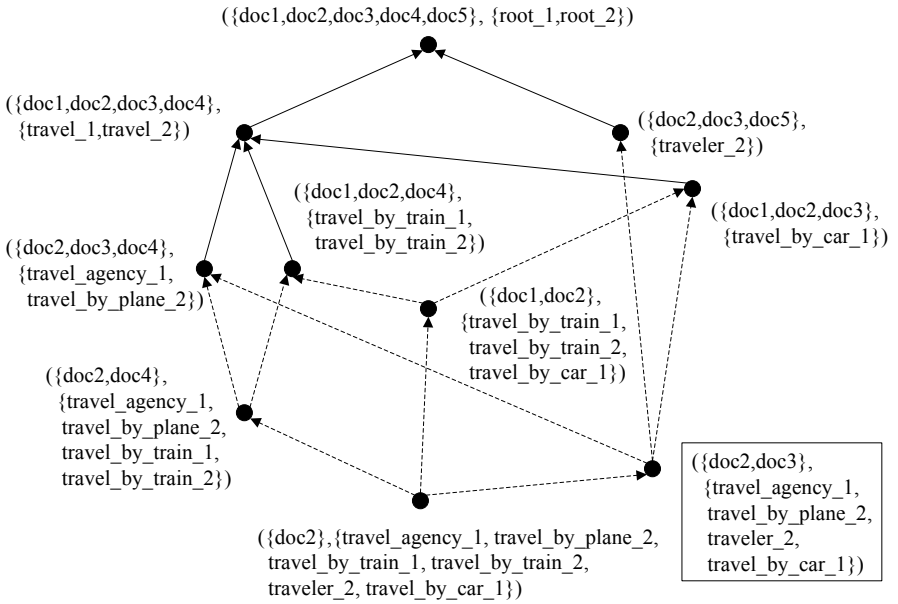


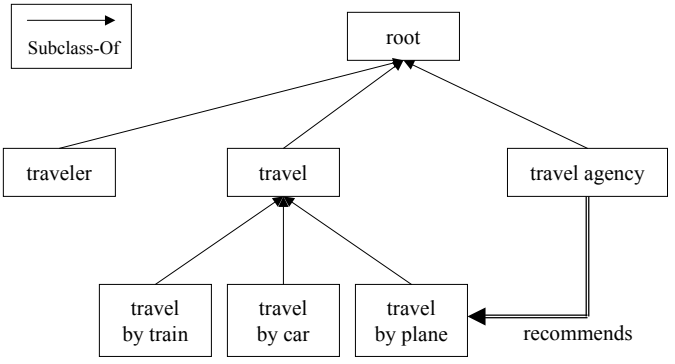
	root	travel	travel agency	travel by train	travel by car
doc1	X	X		X	X
doc2	X	X	X	X	X
doc3	X	X	X		X
doc4	X	X	X	X	
doc5	X				



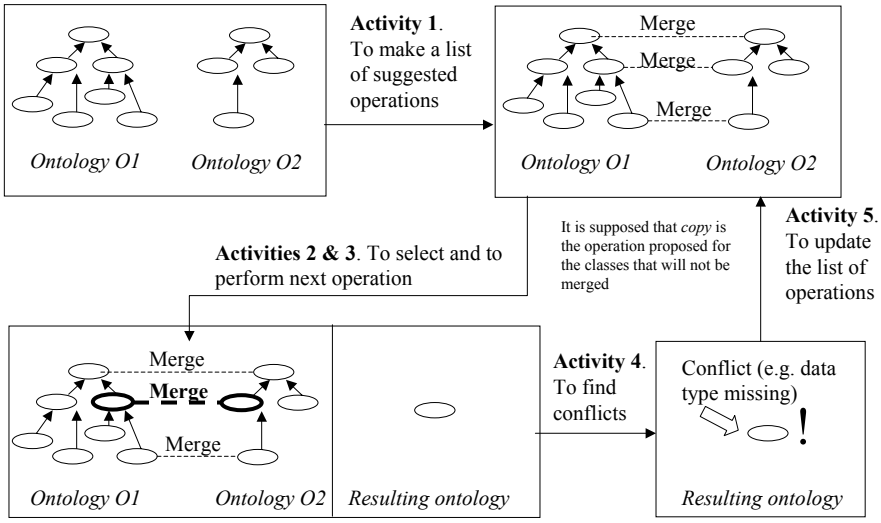
	root	travel	traveler	travel by train	travel by plane
doc1	X	X		X	
doc2	X	X	X	X	X
doc3	X	X	X		X
doc4	X	X		X	X
doc5	X		X		




({doc1,doc2,doc3,doc4,doc5}, {root_1,root_2})
({doc1,doc2,doc3,doc4},
{travel_1,travel_2})
({doc2,doc3,doc5},
{traveler_2})
({doc1,doc2,doc4},
{travel_by_train_1,
travel_by_train_2})
({doc1,doc2,doc3},
{travel_by_car_1})
({doc2,doc3,doc4},
{travel_agency_1,
travel_by_plane_2})
({doc1,doc2},
{travel_by_train_1,
travel_by_train_2,
travel_by_car_1})
({doc2,doc4},
{travel_agency_1,
travel_by_plane_2,
travel_by_train_1,
travel_by_train_2})
({doc2,doc3},
{travel_agency_1,
travel_by_plane_2,
traveler_2,
travel_by_car_1})
({doc2},{travel_agency_1, travel_by_plane_2,
travel_by_train_1, travel_by_train_2,
traveler_2, travel_by_car_1})


Subclass-Of
root
traveler
travel
travel agency
travel
by train
travel
by car
travel
by plane
recommends

The Prompt Method



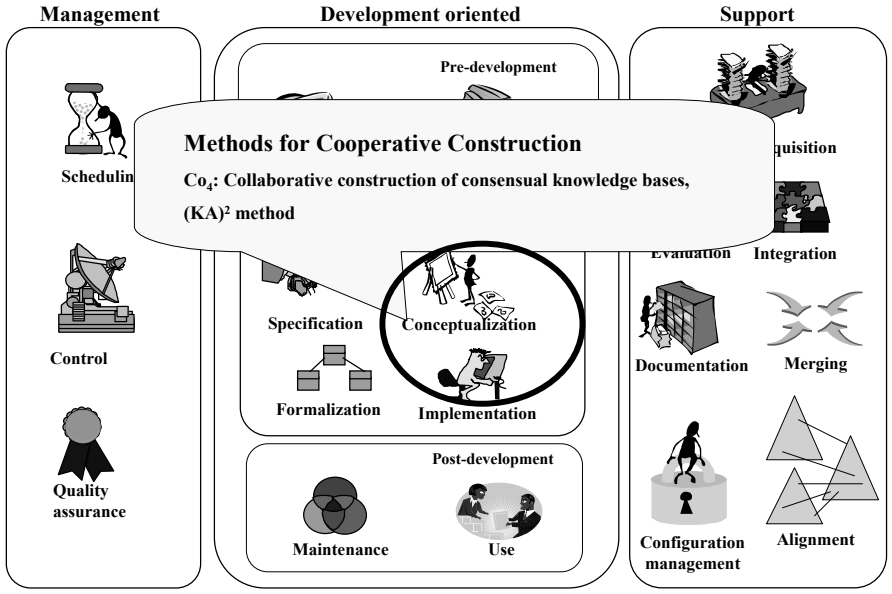
Exercise

•Objective

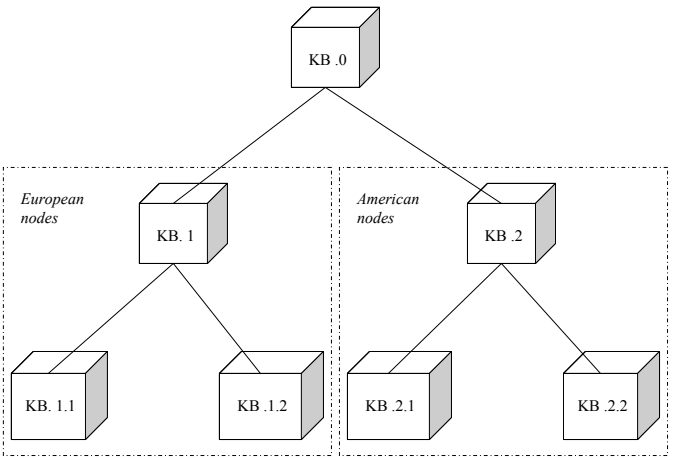
- **Merge one of the ontologies developed by another group with the ontology resulting from the conceptualisation and the integration activities.**

•Tasks

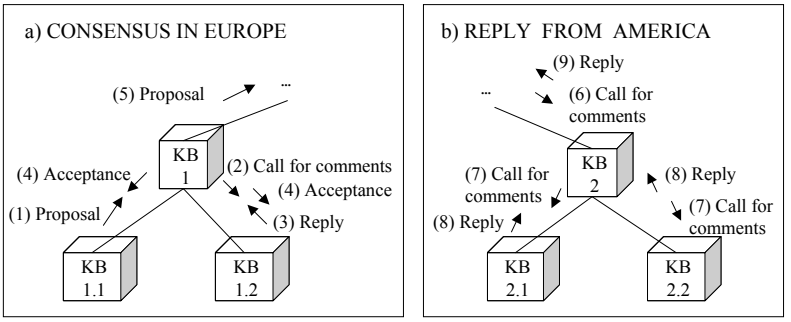
- **Select another group whose ontology you will be working with (it cannot be the previous group).**
- **Apply the steps proposed by PROMPT to merge it with your ontology.**

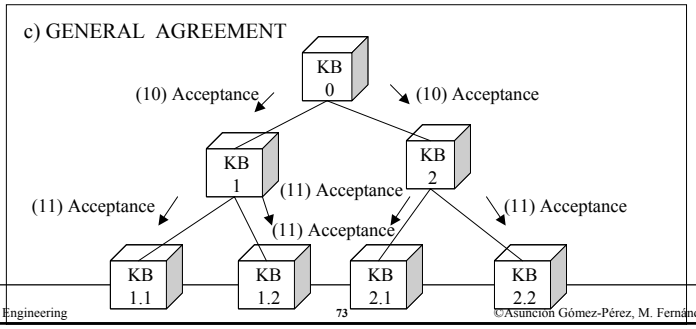


Co4. Structure of agreement



Co4. Agreement protocol



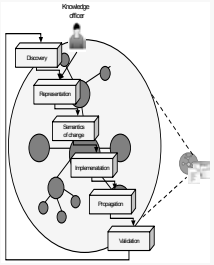


Management | **Development oriented** | **Support**

Ontology Evolution:
The ability to manage ontology changes and their effects by creating and maintaining different variants of the ontology [Noy and Klein, 02].

Approaches

1. **METHONTOLOGY,**
   - **Activity during the life cycle [Fernández-López et al., 97]**
   - **Identification of the elements to be controlled [Gómez-Pérez and Rojas, 99]**
   - **Control of changes**
   - **Generation of status reports.**
2. **Types of changes [Noy and Klein, 02].**
3. **Klein and Fensel [Klein and Fensel, 01]:**
   - **Identification**
   - **Change specification**
   - **Transparent evolution**
4. **Stojanovic's Process [Stojanovic et al., 02]:**



Knowledge acquisition

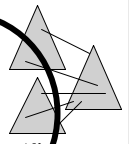
Evaluation

Integration

Documentation

Merging

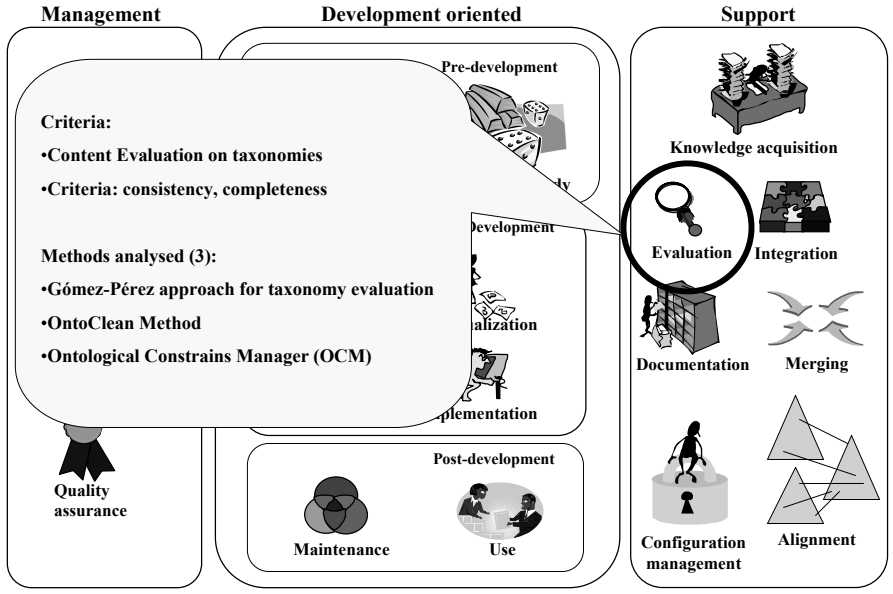
Configuration management



Alignment

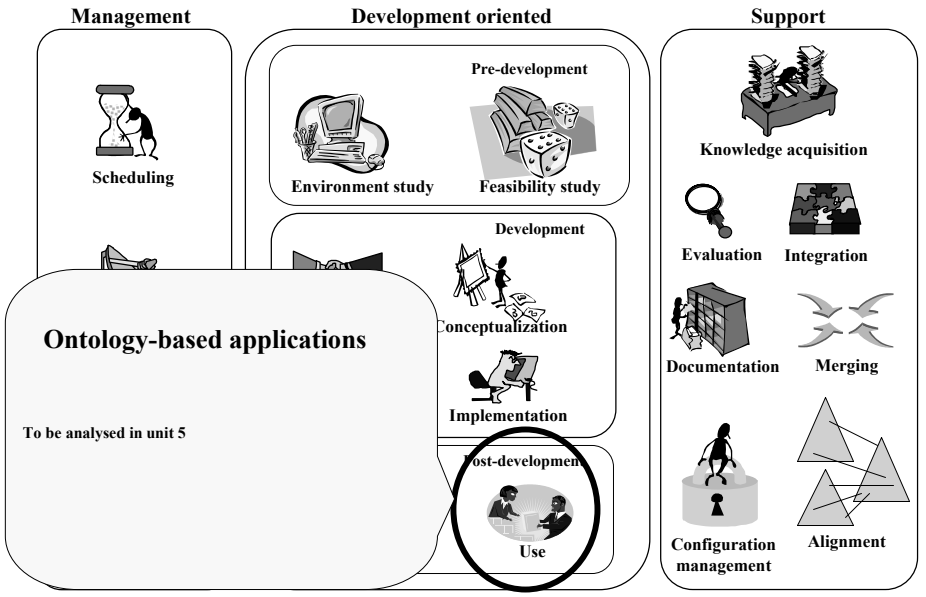
Exercise

- **Objective**
  - **Compare different versions of an ontology and compare different ontologies in one domain**
- **Tasks**
  - **Use Protégé PROMPT to compare two different versions of an ontology.**
  - **Use Protégé PROMPT to compare two different ontologies in the same domain.**



Gómez-Pérez approach for taxonomic evaluation

- **Inconsistency**
  - Circularity Errors
  - Partition Errors
    - Common classes in disjoint decompositions and partitions
    - Common instances in disjoint decompositions and partitions
    - External instances in exhaustive decompositions and partitions
  - Semantic Errors
- **Incompleteness**
  - Incomplete Concept Classification
  - Partition errors
    - Disjoint knowledge omission
    - Exhaustive knowledge omission
- **Redundancy**
  - Grammatical
    - Redundancies of subclass of relations
    - Redundancies of instance of relations
  - Identical formal definition of some classes
  - Identical formal definition of some instances



Conclusions

- **There are stable methodologies and tools for building ontologies, but normally they do not cover all the process of the ontology development process.**
  - **Methontology (the recommended methodology to ontology development by FIPA)**
  - **On-To-Knowledge**
- **There are methods and tools for specific tasks**
  - **Reengineering**
  - **Collaborative construction**
  - **Merge**
  - **Evaluation**
  - **Evolution**
  - **Ontology Learning**
- **Integration of specific methods in methodologies are needed**
- **Technological support for the whole ontology development process**

How can we build ontologies? Methods, Techniques and Methodologies

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