

Ontology Lifecycle

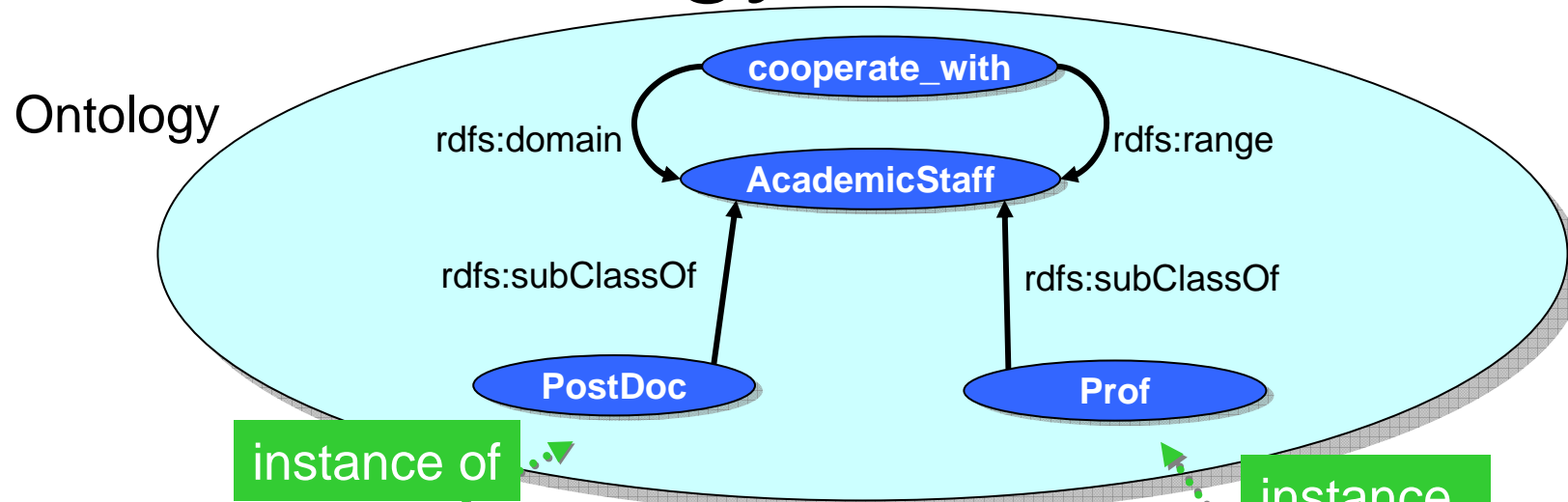
Ontology


„People can't **share knowledge** if they do not speak a **common language**.“ [Davenport & Prusak, 1998]

„An ontology is an **explicit specification** of a **conceptualization**.“ [Gruber, 1993]

- Ontologies enable a **better communication** between Humans/Machines
- Ontologies **standardize** and **formalize** the meaning of words through concepts

Ontology & Metadata



Anno- tation	<pre> <swrc:PostDoc rdf:ID="sha"> <swrc:name>Siegfried Handschuh</swrc:name> <swrc:cooperate_with rdf:resource = "http://www.aifb.uni- karlsruhe.de/WBS/sst#sst" /> ... </pre>	<pre> <swrc:Prof <swrc:name>Steffen Staab </swrc:name> ... </swrc:Prof> </pre>
Web Page	<p>Siegfried Handschuh</p>  <p>He is working together with Steffen Staab in the Knowledge Management Group</p>	<p>Research:</p> <p>Semantic Web, Knowledge Management, Natural Language,</p>
URL	<p>http://www.aifb.uni-karlsruhe.de/WBS/sha</p>	<p>http://www.uni-koblenz.de/~staab</p>

instance of

instance of

Cooperate_with

Links have explicit meanings!



Explicit vs. Implicit Knowledge

Implicit
Knowledge

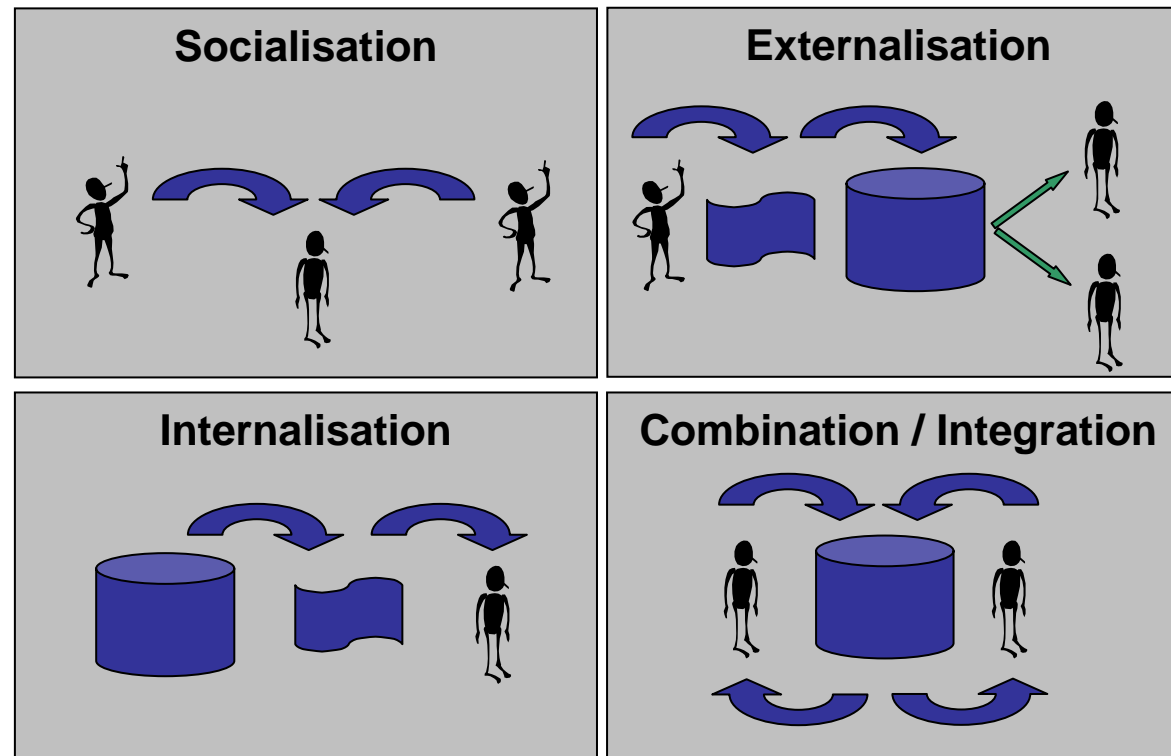
to

Explicit
Knowledge

Implicit
Knowledge

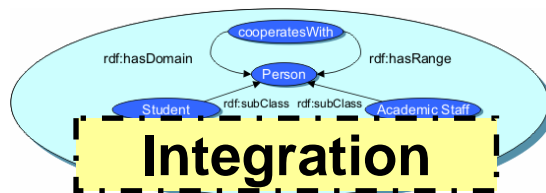
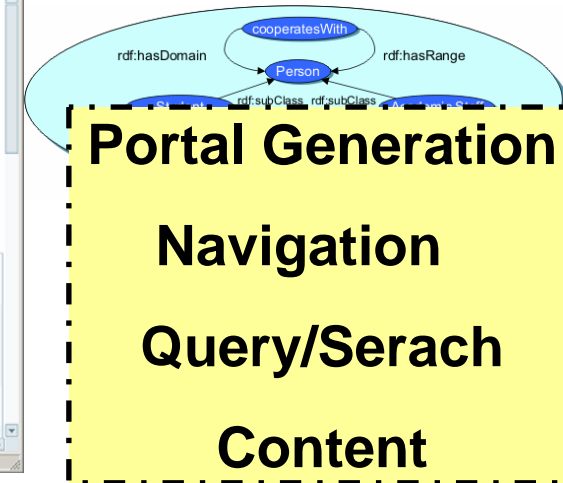
From

Explicit
Knowledge

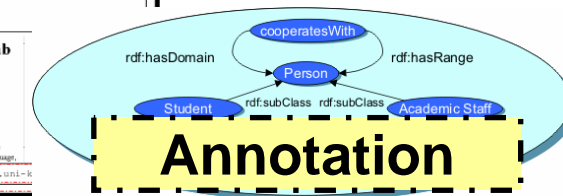




Case study: OntoWeb.org



Collect metadata from participating partners



Ontology-based Processes

Knowledge Meta Process

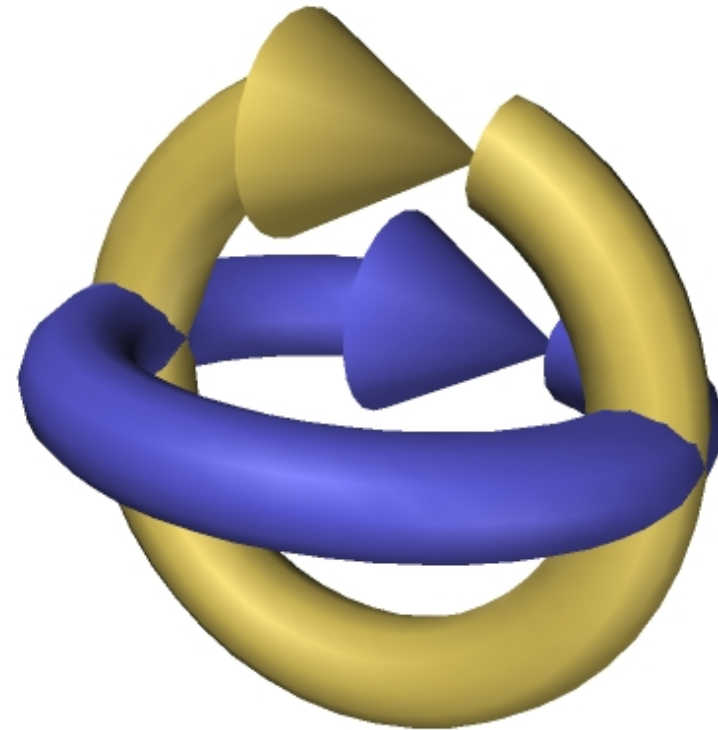


Design, Implementation,
Evolution of Ontology

Knowledge Process



Usage of Ontology

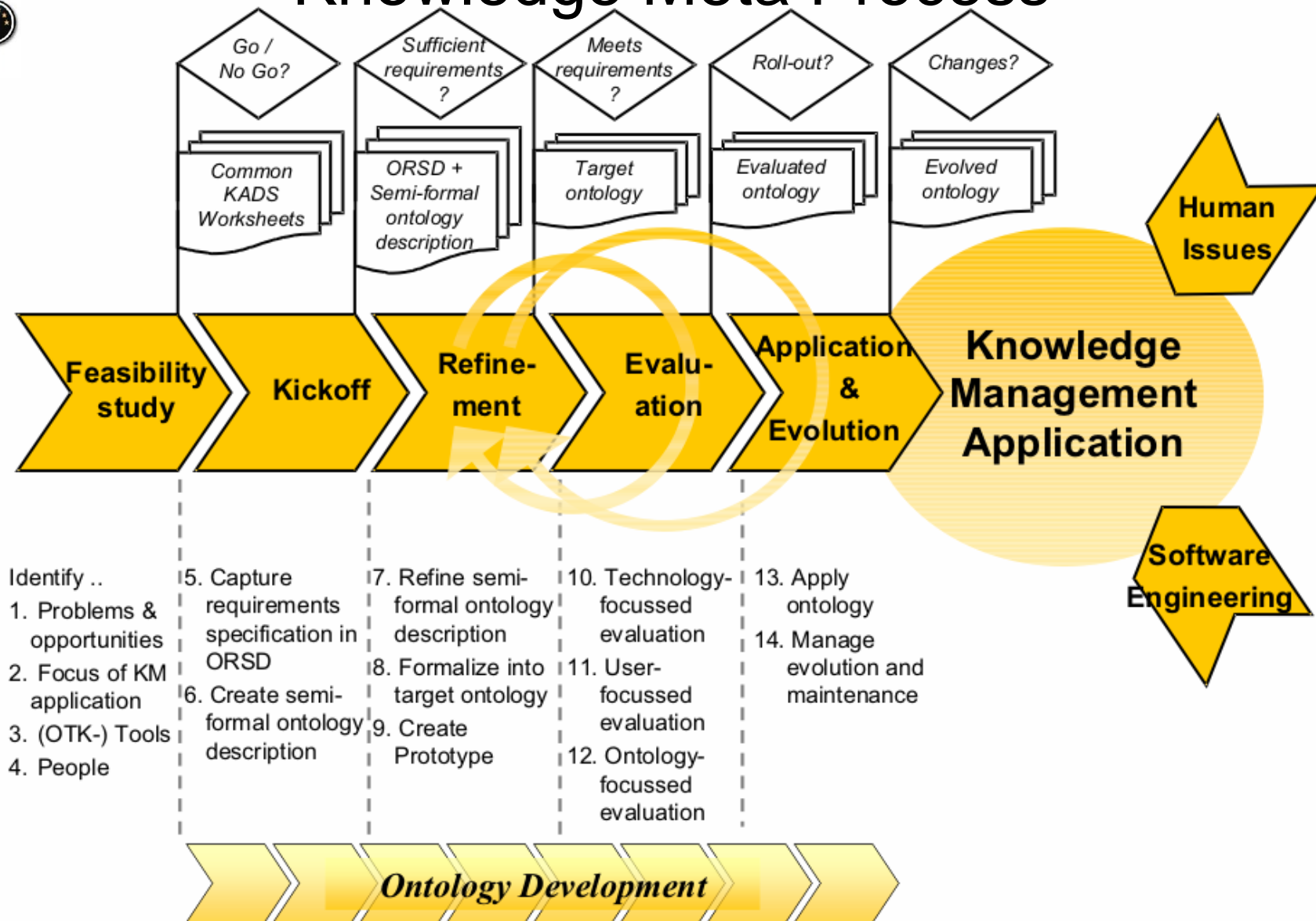


OTK Methodology: Knowledge Meta Process

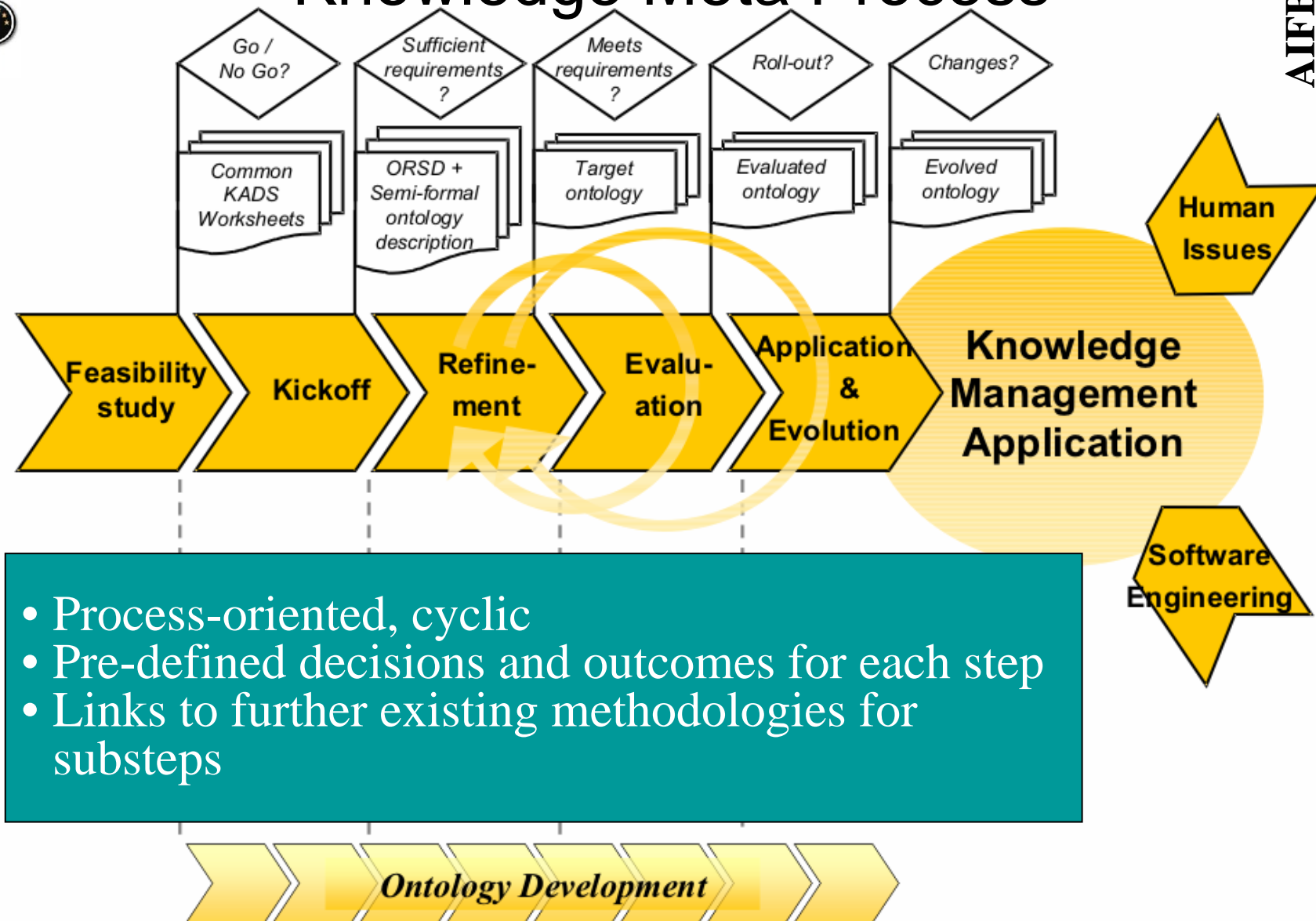
- **Task:** Build ontology based KM applications
- **Problems:**
 - **Collaboration** between domain experts and knowledge engineers
 - **Evaluation** of ontologies

- Process-oriented, cyclic
- Pre-defined decisions and outcomes for each step
- Links to further existing methodologies for substeps

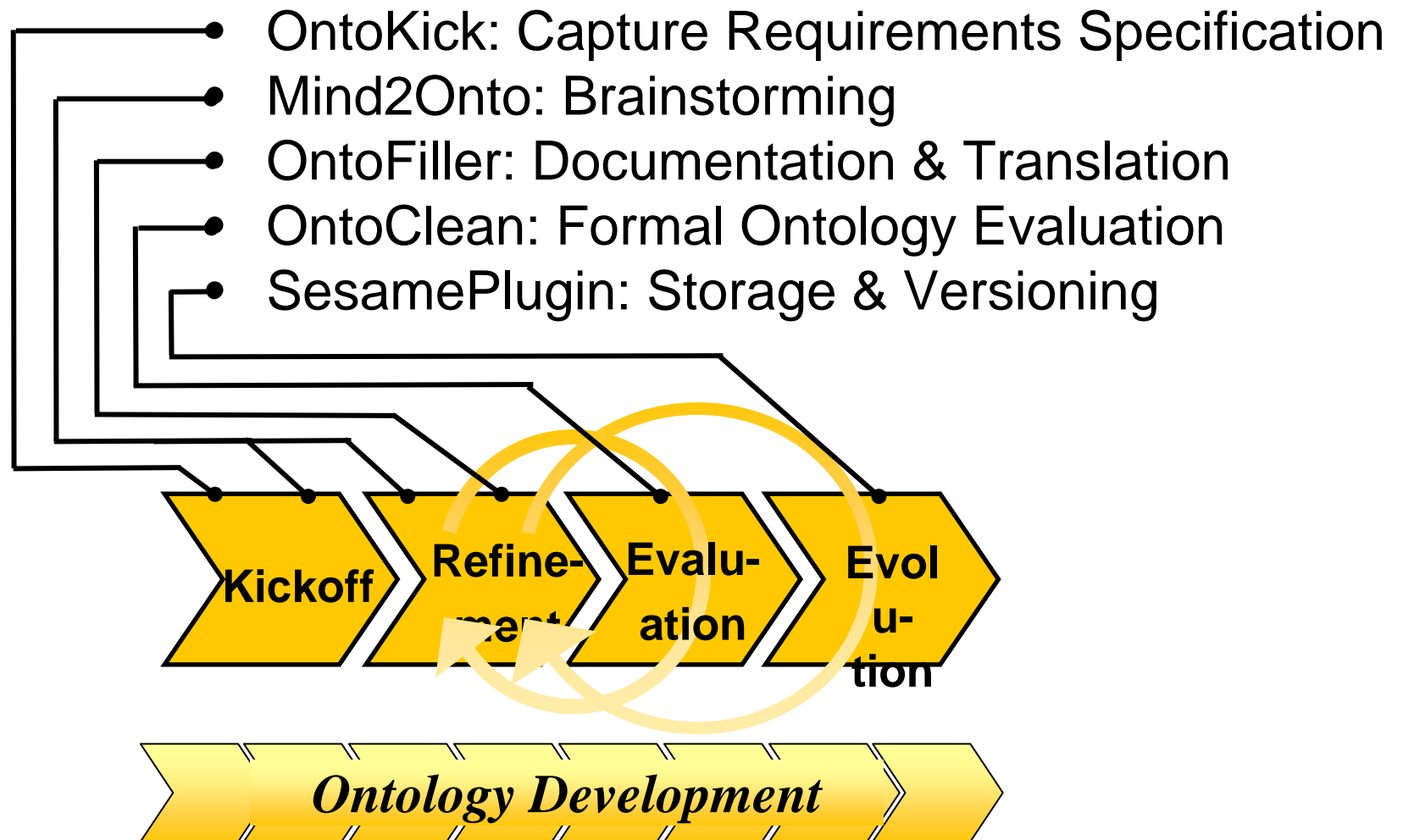
OTK Methodology: Knowledge Meta Process



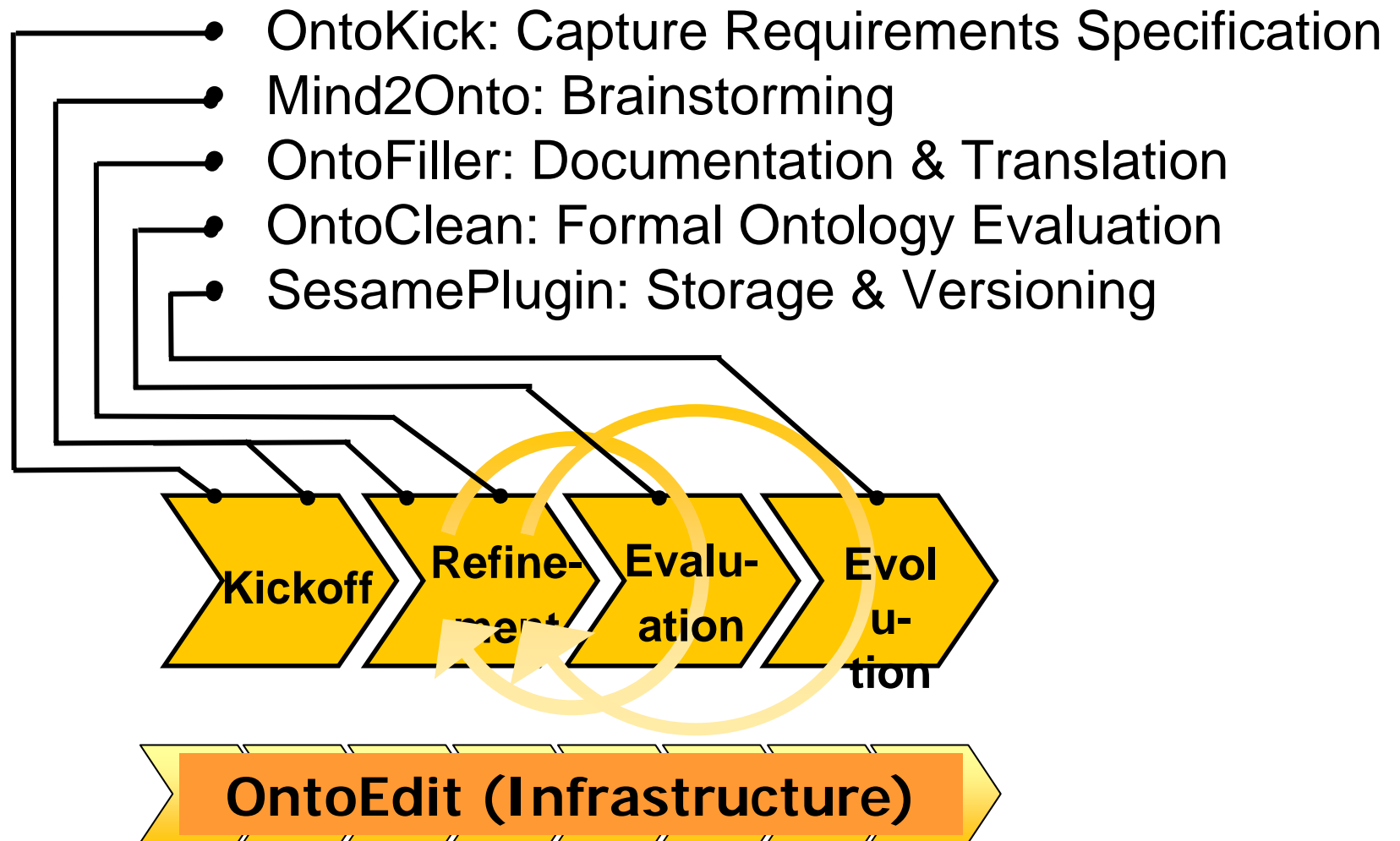
OTK Methodology: Knowledge Meta Process



Tools



Tools



Feasibility Study

- KM systems only function satisfactorily if they are properly integrated into the organization
- Many factors other than technology determine the success of such a system
- (Based on CommonKADS)

- Focus domain for ontology
- Identify people involved
- GO / No GO decision



Feasibility study

Current State: Skills Management

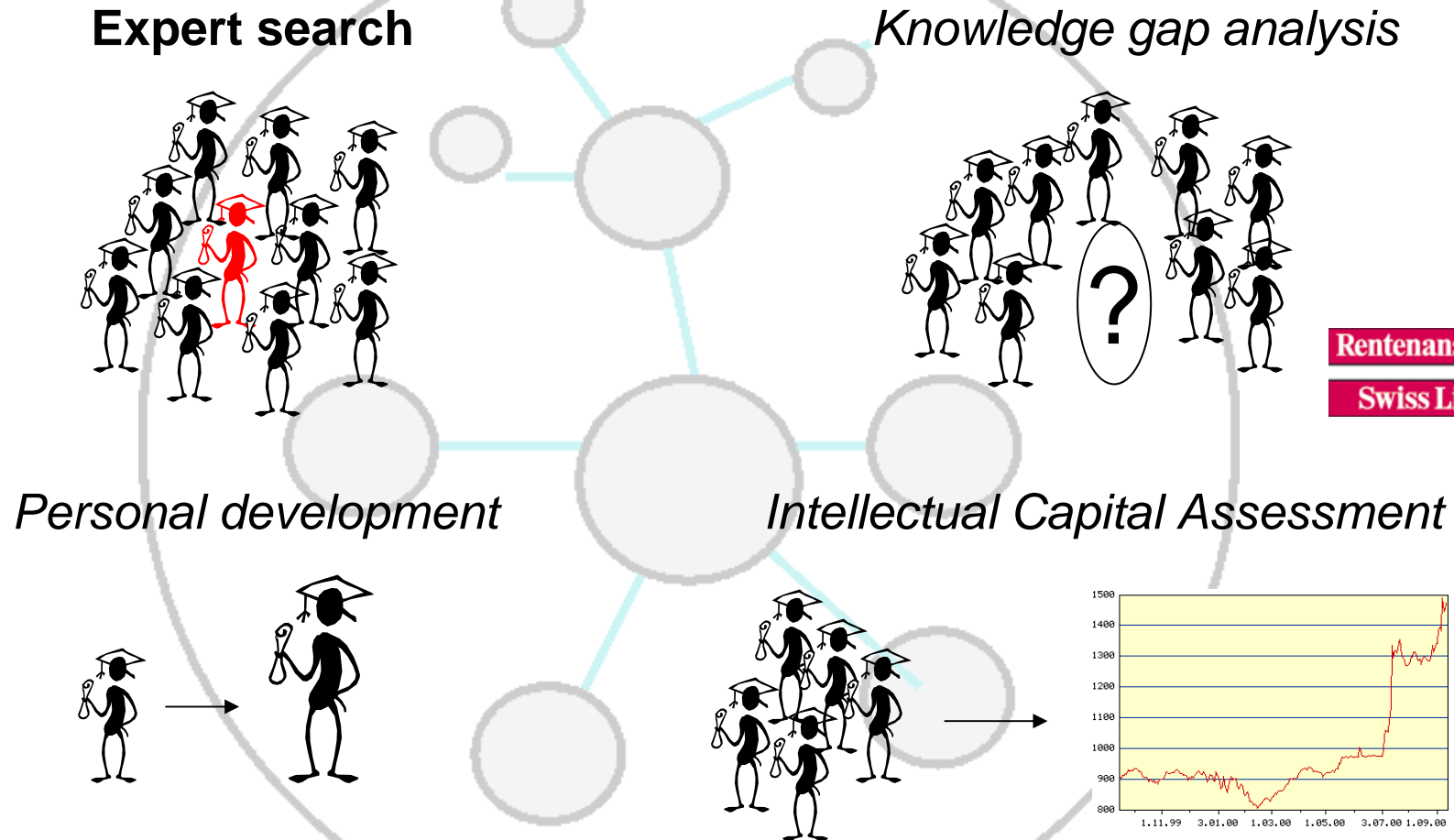
- Employee data distributed over many systems
- Different schemata for data
- Incomplete data

Rentenanstalt 

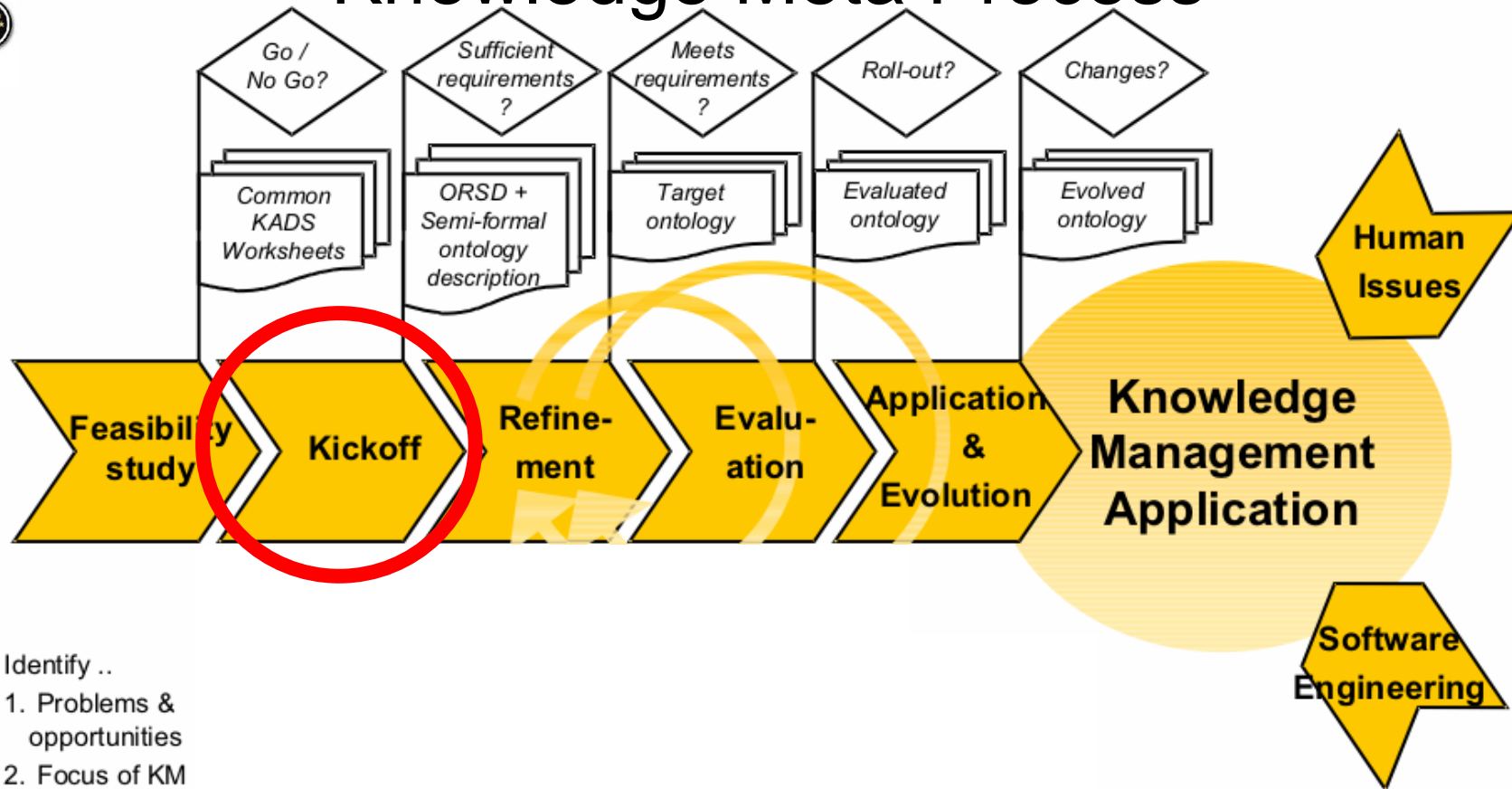
Swiss Life 

Feasibility study

Intended state: Skills Management



OTK Methodology: Knowledge Meta Process



Identify ..

1. Problems & opportunities
2. Focus of KM application
3. (OTK-) Tools
4. People

Ontology Development

Ontology Kickoff

- Ontology Requirements Specification Document (ORSD)

1. *Domain & Goal*
2. *Design guidelines*
3. *Available knowledge sources*
4. *Potential users and user scenarios*
5. *Applications supported by the ontology*

E.g.
Competency
questions

Ontology
Learning!

- Analyze knowledge sources
- Develop **baseline ontology description**

Draft version, typically most important concepts and relations are identified and described as an untyped graph

ORS – Ontology Requirements Specification

- **Goal of the ontology:**
 - Tracking and analyzing corporate business histories
- **Domain and Scope:**
 - Merger & acquisition, restructurings, management changes and other strategic activities in the chemical industry
- **Supported Applications:**
 - Web-based Corporate History Analyzer
- **Knowledge Sources:**
 - Research analysts (domain experts)
 - Document: c:/mydocuments/superdokument.doc
 - URL: <http://www.webpage.com>
- **Users and Use Cases:**
 - Users: Research analysts, strategic consultants
 - Use Case 1: Track strategies of specific companies
 - Use Case 2: Analyze strategic moves of competitors
- **Competency Questions:**
 - Attached Competency Questionnaire
- **Potentially reusable ontologies:**
 - not known

CQ – Competency Questionnaire

CQ Nr.	Competency Question	Concepts	Relation
CQ1	What are the subsidiaries, divisions and locations of company X?	company, subsidiary, division, location	company <i>has</i> subsidiary company <i>has</i> division company <i>has</i> location
CQ2	Which companies acquired company X?	company, acquisition	company <i>makes</i> acquisition acquisition <i>has</i> buyer acquisition <i>has</i> seller
CQ3	Which companies merged in 1990 in the rubber industry?	company, merger, year, industry	company <i>makes</i> merger company <i>isPartOf</i> industry merger <i>happensIn</i> year
CQ4	Who is CEO of company X?	CEO, company,	company <i>has</i> CEO



Kick-Off

- Ontology workshop to train domain experts in ontology modelling for
 - .. IT
 - .. Private customer insurance
 - .. Human Resource Management
- First version of domain ontology by expert
 - Manual development of ontology
 - Brainstorming (Mind Maps)
 - Middle-out approach
- Result: approx 700 Concepts in about 4 weeks

Rentenanstalt 

Swiss Life 



Requirement specification

Requirement specification

New Ontology

Concepts & Relations | Instances | Relation axioms | Disjoint concepts | **Requirement Specification** | Identification | Metadata

Domain & Goal

Domain description

Sports & Recreation

Food / Food Processing

Hotel & Restaurant Equipment

Industrial Equipment, Services & Supplies

Information Technology / Robotics / Telecommunications

Materials

Medical / Scientific Products & Equipment

Mining, Oil & Gas

Sports & Recreation

Kick-Off date

08-01-2001

Completion deadline

12-31-2001

< Back Forward >

Domain & Goal

Design Guidelines

Knowledge Sources

Users & Use Cases

Deployment

Requirement specification

New Ontology

Concepts & Relations | Instances | Relation axioms | Disjoint concepts | Requirement Specification | Identification | Metadata

Design Guidelines

Design instructions

- Write all concepts with capital letters.
- Write all relations with small letters.
- If you are using more than one word for defining a concept or relation, use an underscore (e.g. "Power_plant")
- If you have only one concept as a subconcept, rethink your modelling decision!

Estimated number of concepts

500

Maximal depth of concept hierarchy

4

Domain & Goal

Design Guidelines

Knowledge Sources

Users & Use Cases

Deployment

< Back Forward >

Knowledge Sources

OntoPrise Ontology Engineering Workbench OntoEdit V1.0.3

File Edit Windows Help

C:\Programme\VisualAge for Java\ide\project_resources\OntoEdit\5-14 getess.xml

Concepts & Relations | Instances | Relation axioms | Disjoint concepts | Identification | Requirement Specification | About...

Knowledge Sources

Source List

Source	Type	Status
CQ Cloud Review 5.21.2001	Competency Questionnaire	NEW SOURCE
univer	Ontology	NEW SOURCE
wordD	Word Document	NEW SOURCE
xmlD	XML Document	NEW SOURCE
rdfD	RDF Document	NEW SOURCE
textD	Text Document	NEW SOURCE

1 Domain & Goal

Design Guidelines

Knowledge Sources

Users & Use Cases

Deployment

2 < Back Forward >

3

New source

Source type

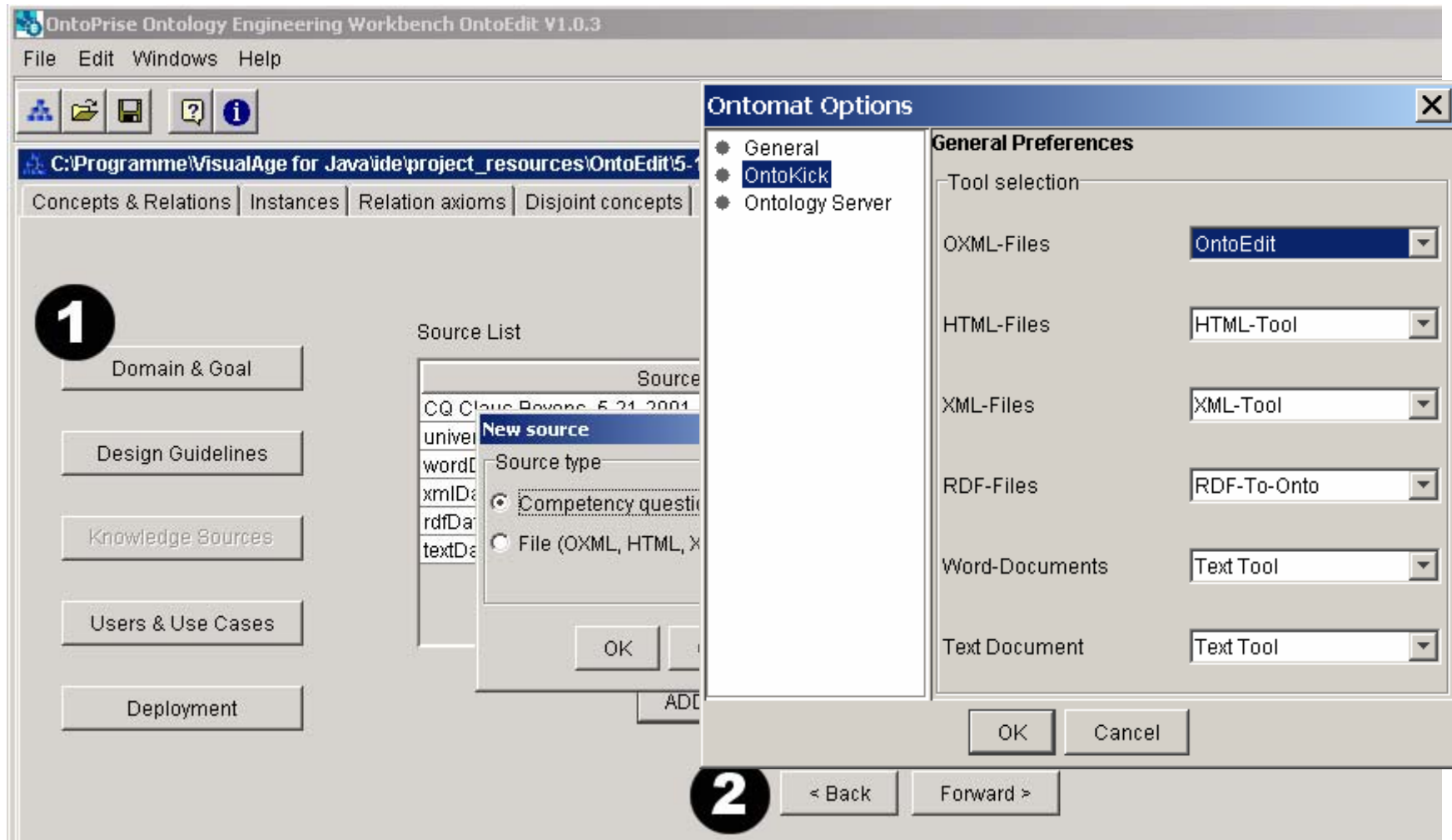
☒ Competency questionnaire

☐ File (OXML, HTML, XML, DOC, TXT)

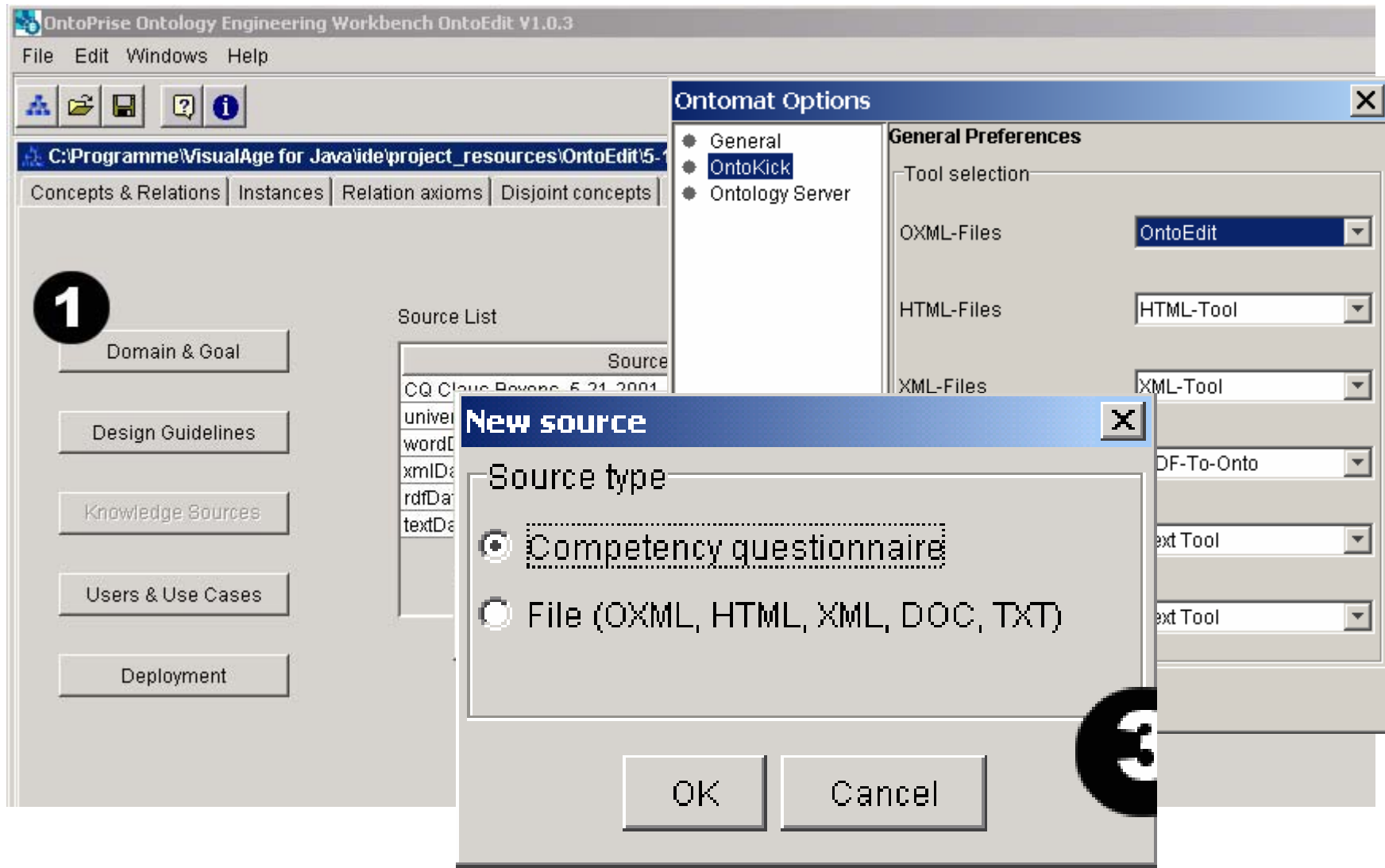
OK Cancel

ADD... EDIT DELETE ANALYZE

Knowledge Sources



Knowledge Sources



Competency questions

New competency questionnaire

Concept hierarchy

- Root
 - Ding
 - Immaterielles
 - Massen_Konzept
 - Mathematisches_Konzept
 - Räumliches_Konzept
 - Situation
 - Zählbares_Konzept

Knowledge Engineer: York Sure

Domain Expert: Claus Boyens

Edition Date: 10-7-2001

Match Pattern! 4 letters ☐ Activate stemming Reset

Edit Question: Gibt es ein Luxushotel in Rostock?

Concepts: Relations:

ADD TO LIST CHANGE REMOVE IMPORT...

Question List

#	Question
1	Gibt es ein Luxushotel in Rostock?
2	Welche touristischen Attraktionen gibt es in Schwerin?
3	Wo ist das beste Restaurant in Warnemünde?
4	Gibt es eine Surfschule auf Usedom?
5	Gibt es einen weißen Sandstrand auf Rügen?

DONE CANCEL

Competency questions

New competency questionnaire

Concept hierarchy

- Root
 - Ding
 - Immaterielles
 - Massen_Konzept
 - Mathematisches_Konzept
 - Räumliches_Konzept
 - Situation
 - Zählbares_Konzept

Knowledge Engineer: York Sure

Domain Expert: Claus Boyens

Edition Date: 10-7-2001

Match Pattern! 4 letters ☐ Activate stemming

Reset

Edit Question: Gibt es ein Luxushotel in Rostock?

Concepts:

Relations:

ADD TO LIST

CHANGE

REMOVE

IMPORT...

Question List

#	Question
1	Gibt es ein Luxushotel in Rostock?
2	Welche touristischen Attraktionen gibt es in Schwerin?
3	Wo ist das beste Restaurant in Warnemünde?
4	Gibt es eine Surfschule auf Usedom?
5	Gibt es einen weißen Sandstrand auf Rügen?

DONE CANCEL

Competency questions

New competency questionnaire

Concept hierarchy

- Root
 - Ding
 - Immaterielles
 - Massen_Konzept
 - Mathematisches_Konzept
 - Raeumliches_Konzept
 - Situation
 - Zaehlbare_Konzept

Knowledge Engineer: York Sure

Domain Expert: Claus Boyens

Edition Date: 10-7-2001

Match Pattern! 4 letters ☐ Activate stemming

Reset

Edit Question: Gibt es ein Luxushotel in Rostock?

Concepts:

Relations:

ADD TO LIST

CHANGE

REMOVE

IMPORT...

Context Menu:

- Add as concept
- Add as relation
- Show similar concepts
 - Luxus
 - Hotelsafe
 - Tophotel
 - Flug_und_Hotel
 - Hotelgarten
 - Mittelklassehotel
 - Hotel
 - Motel
- Add as synonym
- Add as instance
- Ignore

2 Welche to

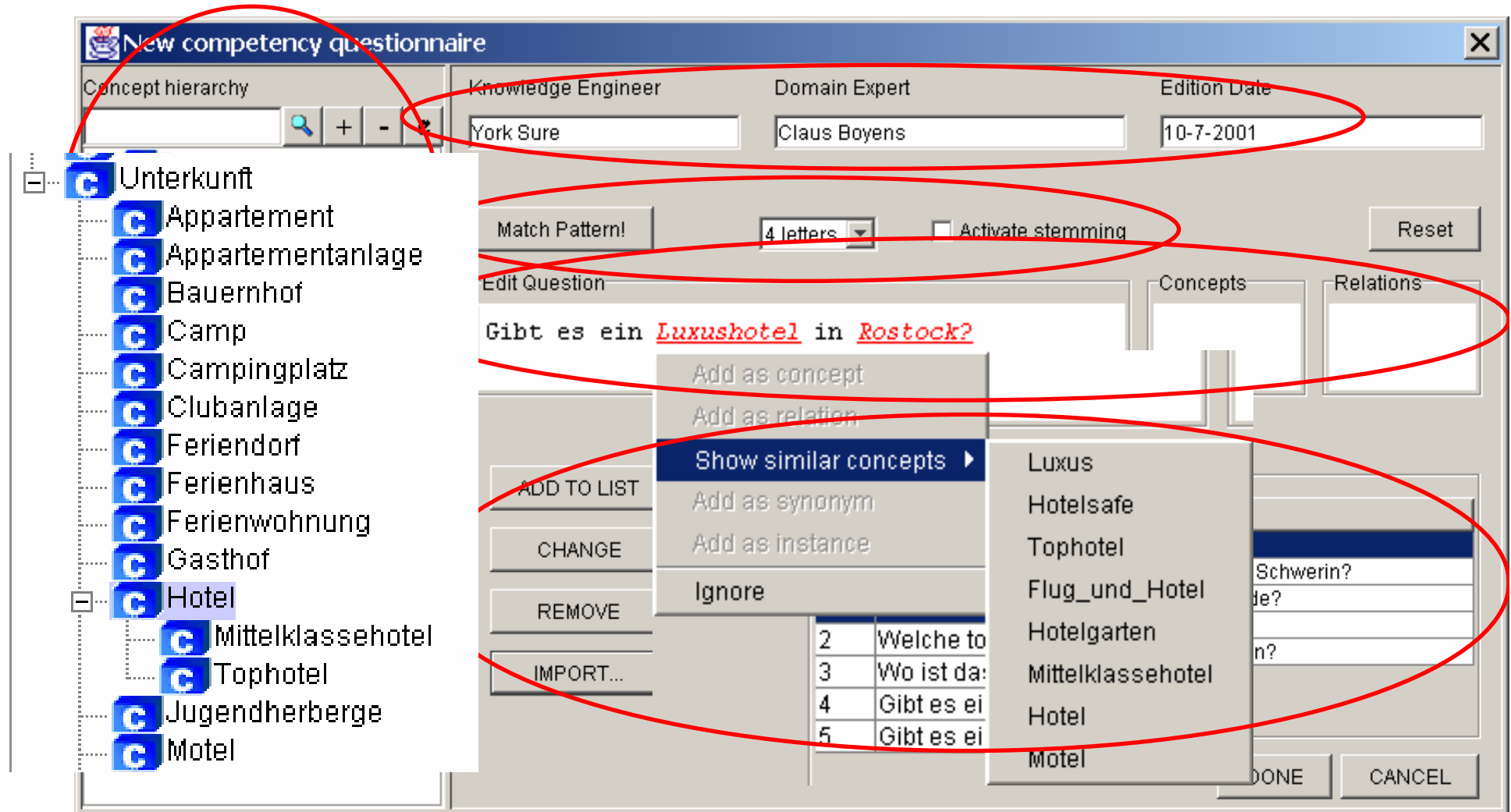
3 Wo ist da:

4 Gibt es ei

5 Gibt es ei

DONE CANCEL

Competency questions



Competency questions

New competency questionnaire

Concept hierarchy

- Unterkunft
 - Appartement
 - Appartementanlage
 - Bauernhof
 - Camp
 - Campingplatz
 - Clubanlage
 - Ferendorf
 - Ferienhaus
 - Ferienwohnung
 - Gasthof
 - Hotel
 - Mittelklassehotel
 - Tophotel
 - Jugendherberge
 - Motel

Knowledge Engineer: York Sure

Domain Expert: Claus Boyens

Edition Date: 10-7-2001

Match Pattern! 4 letters ☐ Activate stemming

Reset

Edit Question: Gibt es ein Luxushotel in Rostock?

ADD TO LIST CHANGE REMOVE IMPORT...

Context Menu:

- Add as subconcept of HOTEL
- Add as relation of HOTEL
- Show similar concepts
- Add as synonym
- Add as instance of HOTEL
- Ignore

3	Wo ist da:	Mittelklassehotel
4	Gibt es ei	Hotel
5	Gibt es ei	Motel

DONE CANCEL

Competency questions

New competency questionnaire

Concept hierarchy

- Hafen
- Kindergarten
- Reiseveranstalter
- Unterkunft
 - Appartement
 - Appartementanlage
 - Bauernhof
 - Camp
 - Campingplatz
 - Clubanlage
 - Feriendorf
 - Ferienhaus
 - Ferienwohnung
 - Gasthof
 - Hotel
 - Luxushotel
 - Mittelklassehotel
 - Tophotel
 - Jugendherberge
 - Motel
 - Pension
 - Sanatorium
 - Seminarhaus

Knowledge Engineer: York Sure

Domain Expert: Claus Boyens

Edition Date: 10-7-2001

Match Pattern! 4 letters ☐ Activate stemming Reset

Edit Question: Gibt es ein Luxushotel in Rostock?

Concepts: Luxushotel

Relations:

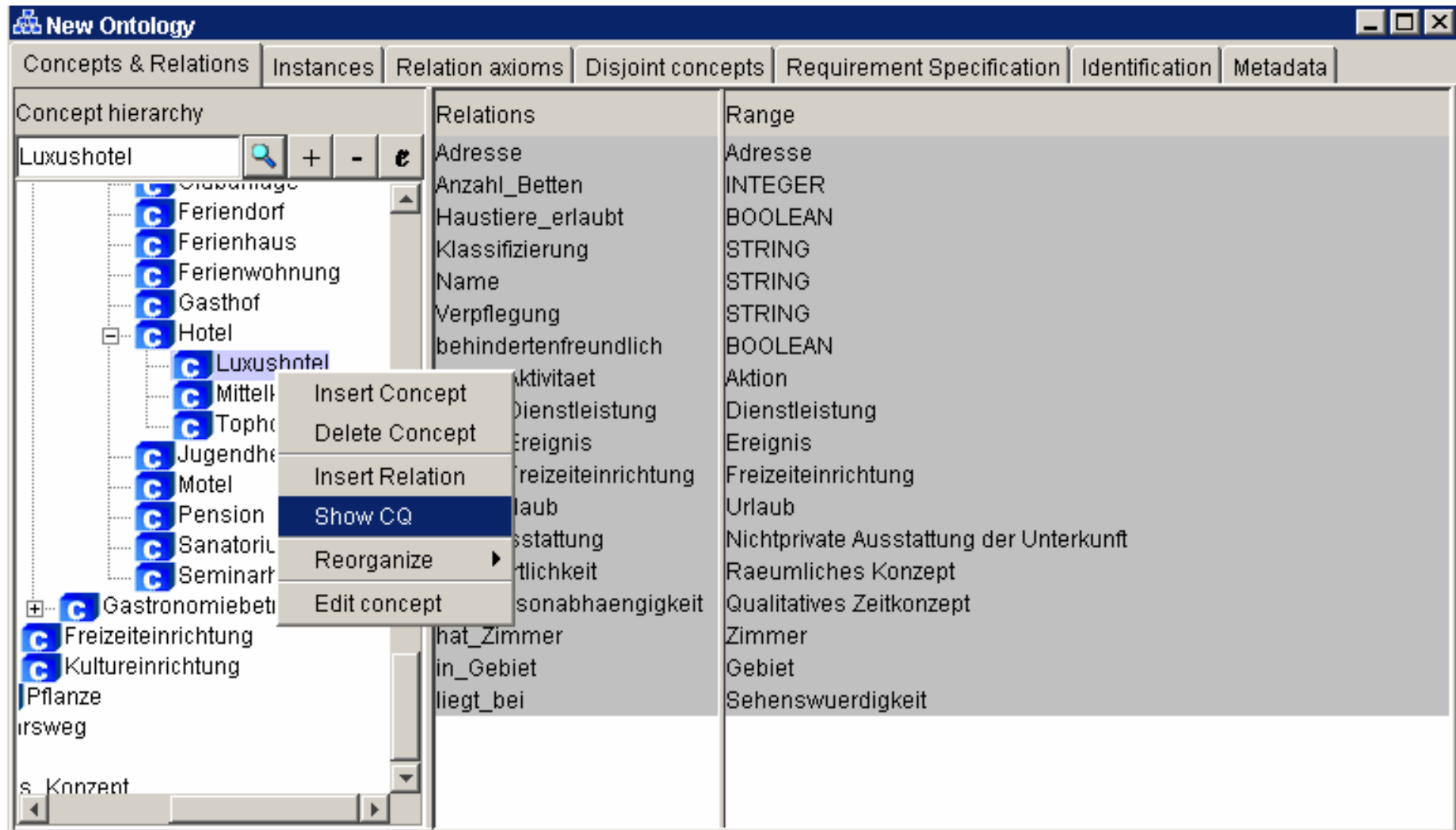
ADD TO LIST CHANGE REMOVE IMPORT...

Question List

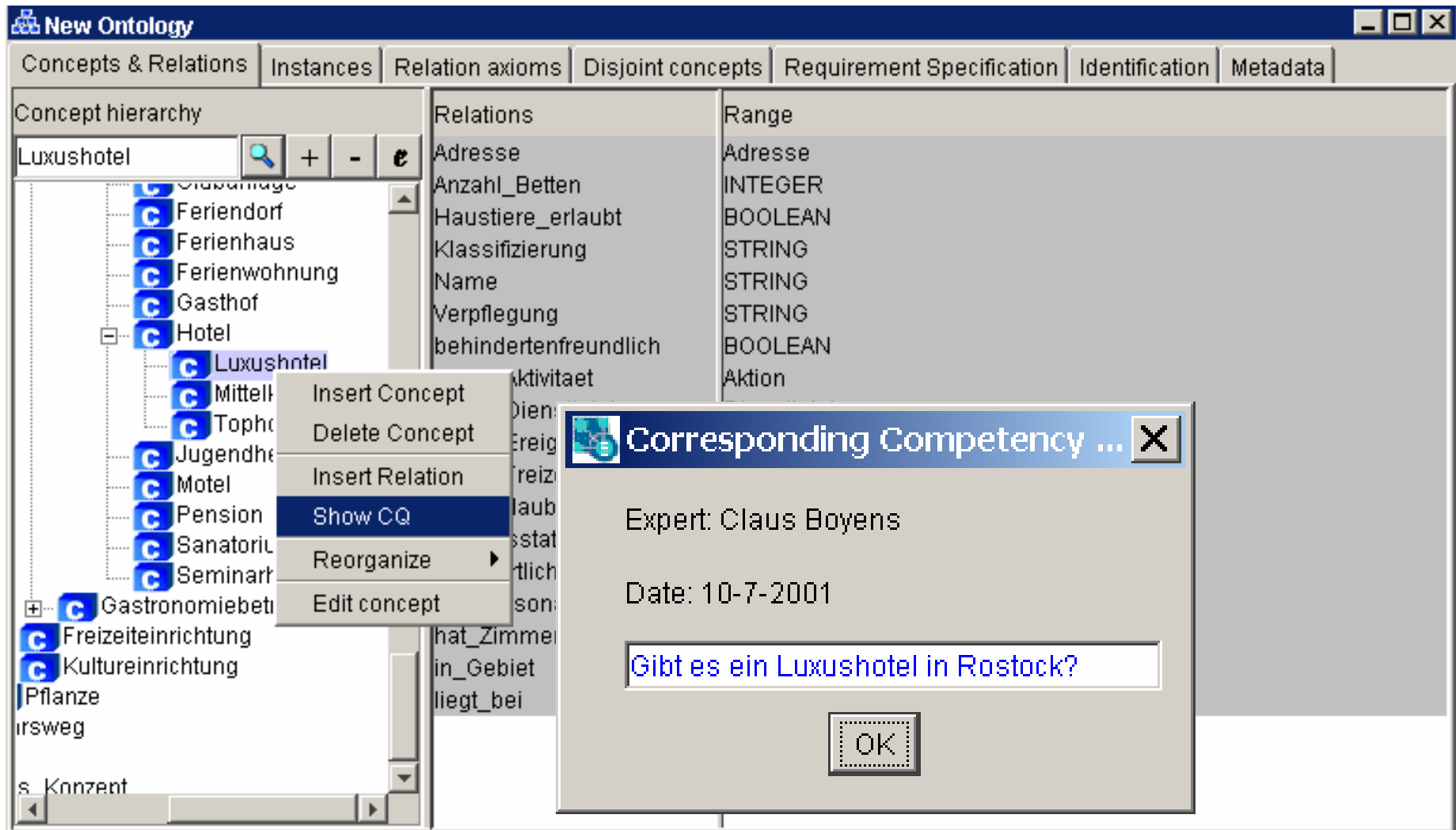
#	Question
1	Gibt es ein Luxushotel in Rostock?
2	Welche touristischen Attraktionen gibt es in Schwerin?
3	Wo ist das beste Restaurant in Warnemünde?
4	Gibt es eine Surfschule auf Usedom?
5	Gibt es einen weißen Sandstrand auf Rügen?

DONE CANCEL

Traceability

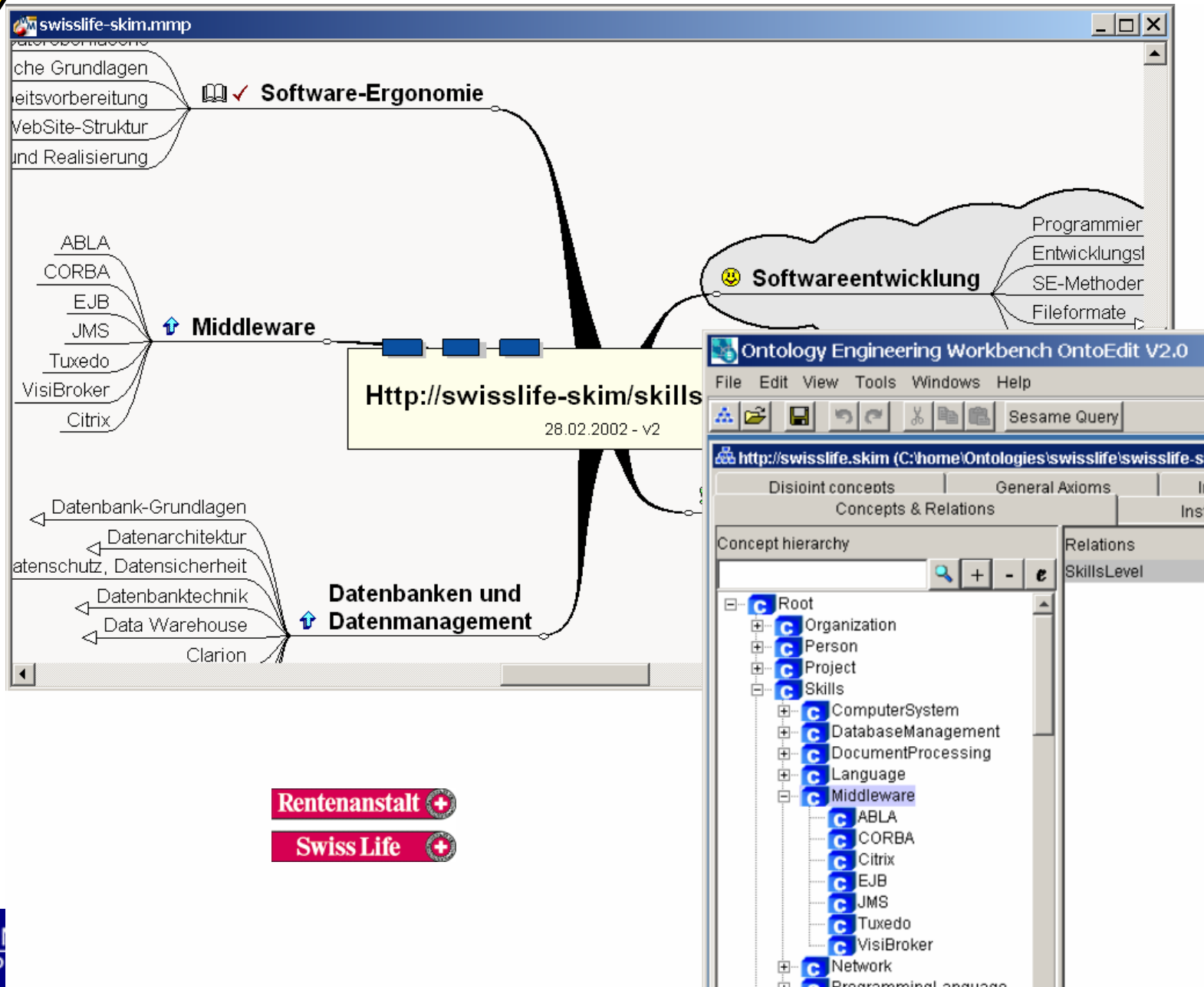


Traceability



Kick-off

Brainstorming, Structuring, Formalisation



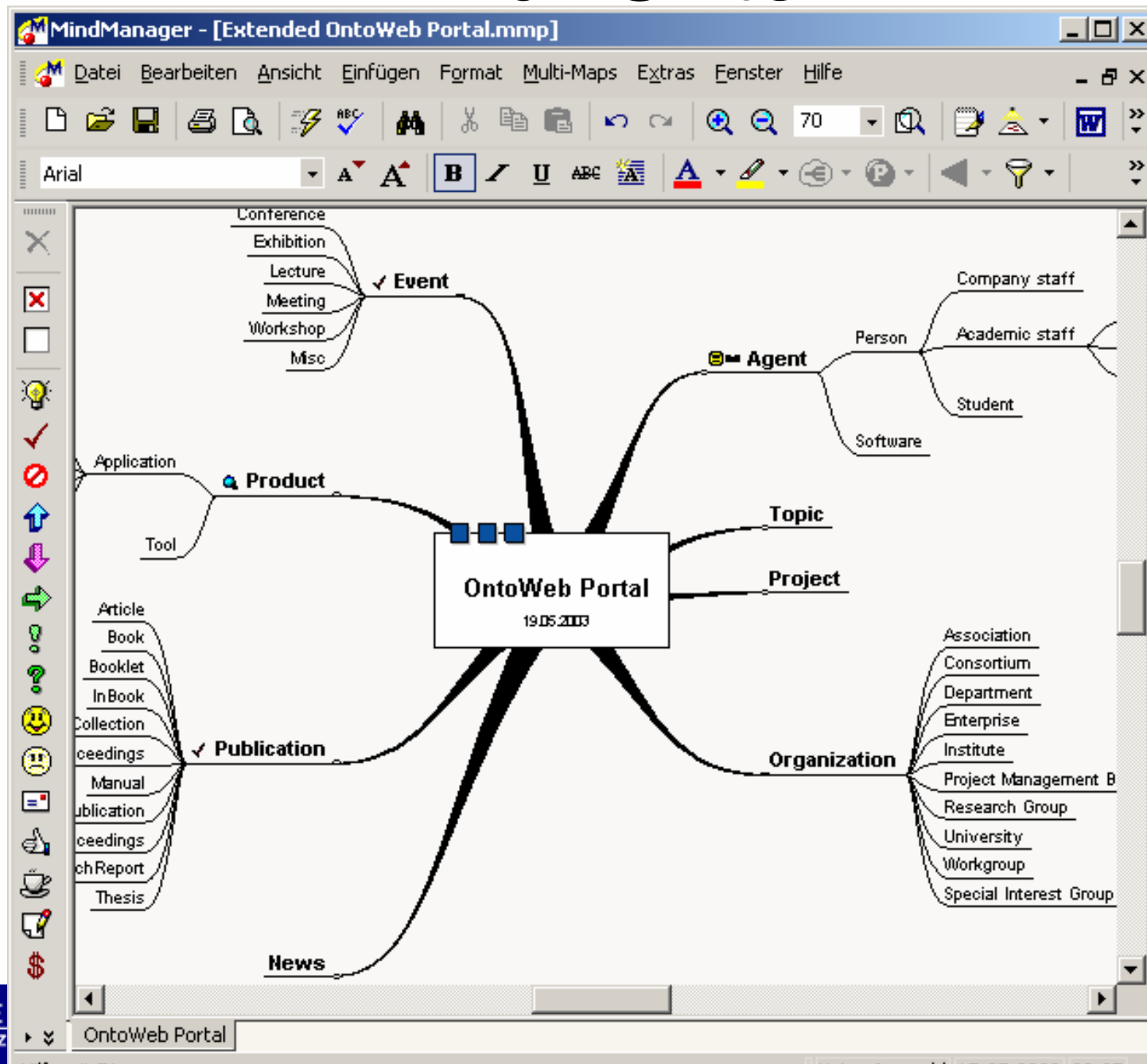


Mind2Onto

- **Task:** Collaborative capturing of domain knowledge through domain experts and modelling experts
- **Problem:** Collaboration with domain experts who have:
 - **No experience** with modelling
 - **No time** for modelling

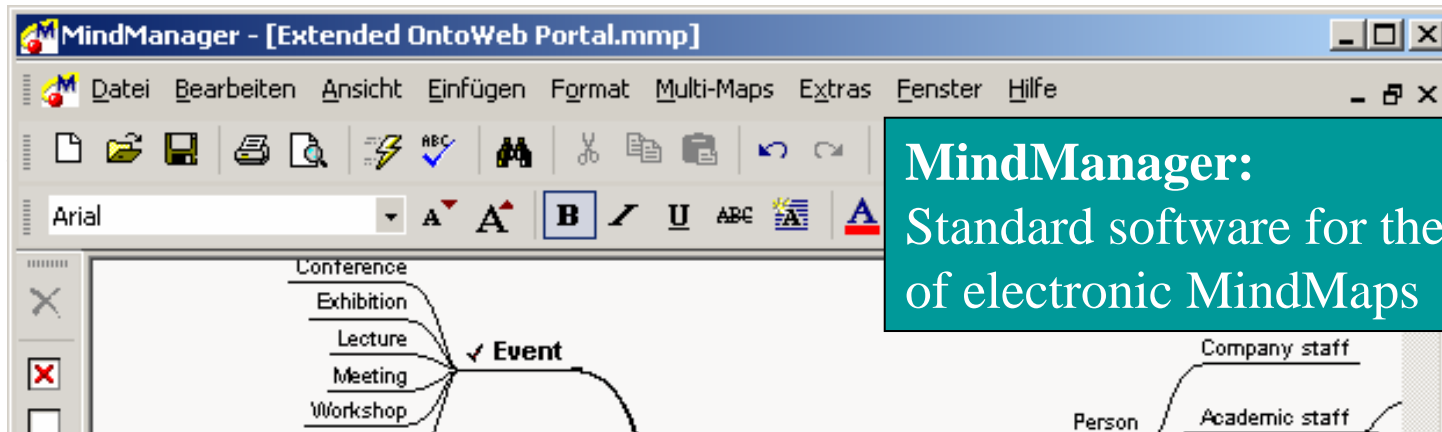


Mind2Onto



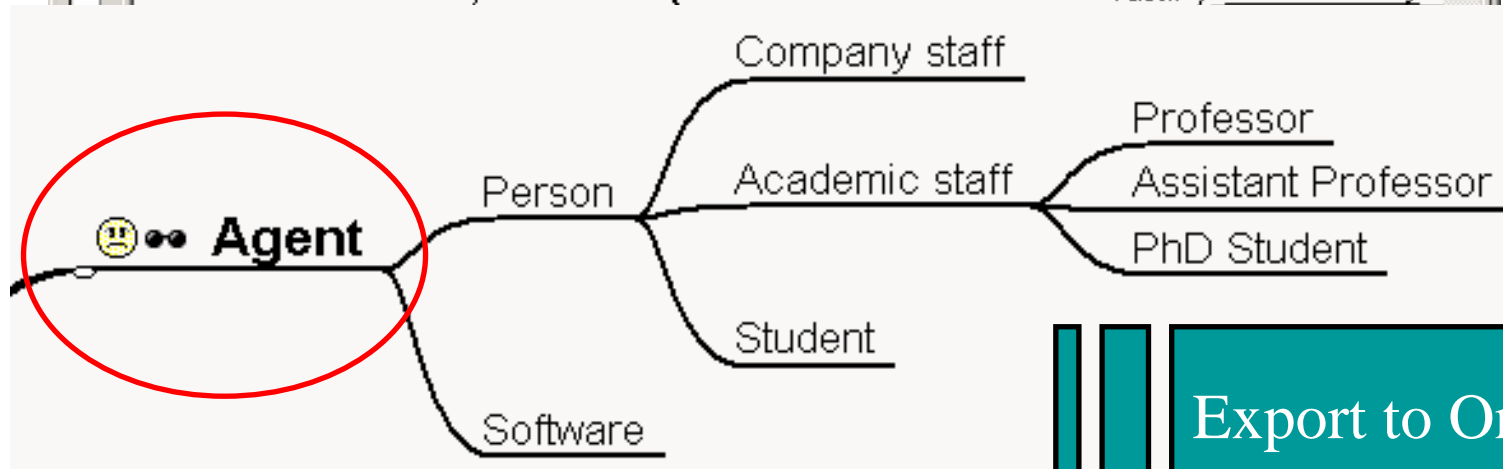


Mind2Onto



MindManager:

Standard software for the creation of electronic MindMaps



Export to OntoEdit

Advantage:

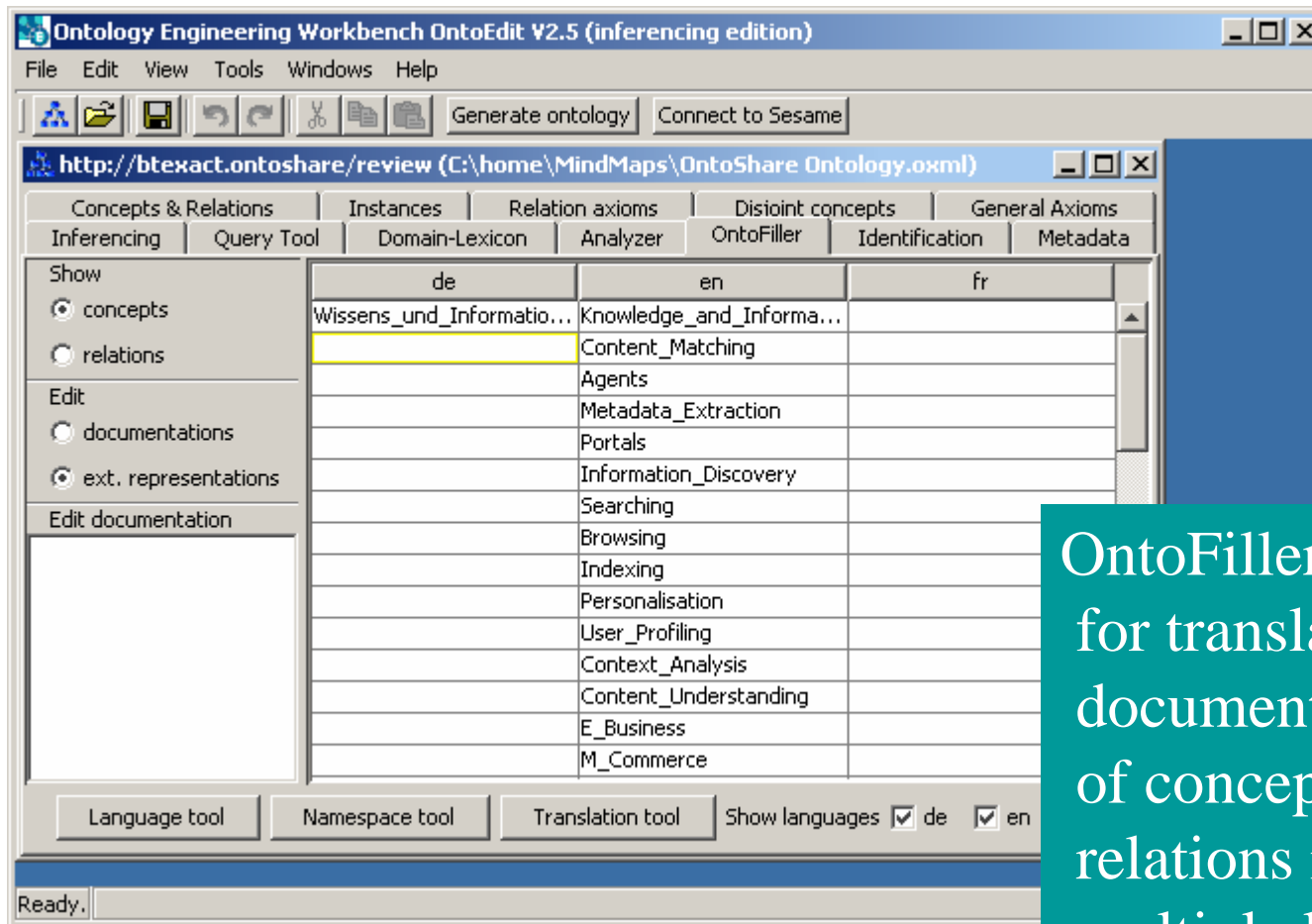
Intuitive, understandable

Problem:

Semantics of MindMaps only vaguely defined

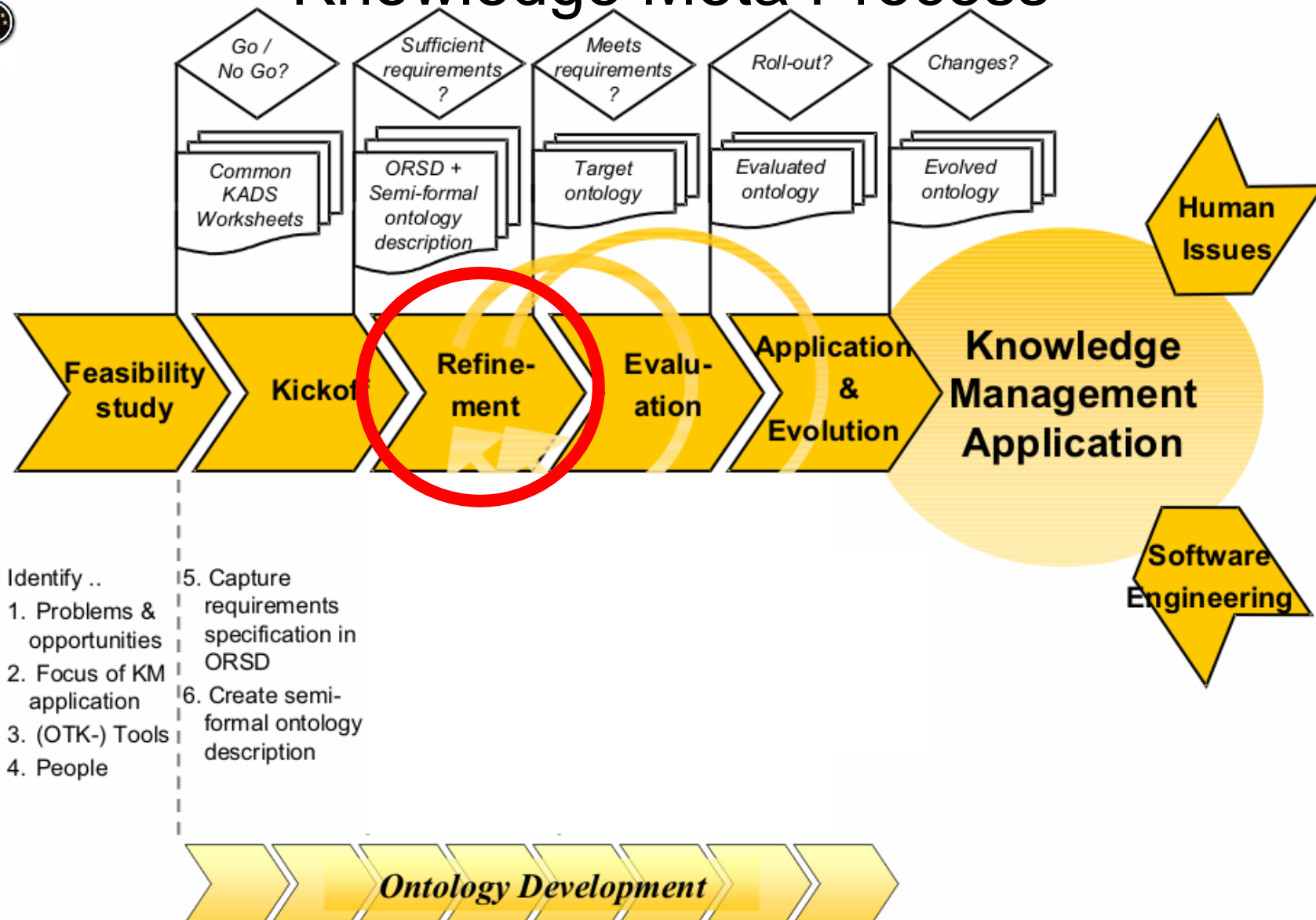


OntoEdit/OntoFiller



OntoFiller: Support for translation and documentation of concepts and relations in multiple languages

OTK Methodology: Knowledge Meta Process





Refinement

- Knowledge elicitation with domain experts
 - Refine concepts and relations
 - Typically axioms are identified
- Formalize
 - E.g. F-Logic, DAML+OIL
 - Axioms depend on language capabilities
- Develop and refine ***ontology***

Refinement

Mind2Onto

OntoEdit for Beta Tester

File Edit View Tools Windows Help

Connect to Sesame Generate ontology

check

<http://www.OntoWeb.org/extended> (C:\home\projects\ontoweb\ExtendedOntoWeb.owl)

Inferencing Analyzer Visualizer Debugger Domain-Lexicon OntoFiller Or

Concepts & Relations Instances Relation axioms Query Tool Disjoint concept

Concept hierarchy

- [-] C DEFAULT_ROOT_CONCEPT
 - [-] C OntoWebPortal
 - [-] C Agent
 - + C Person
 - + C Software
 - + C Event
 - + C News
 - + C Organization
 - + C Project
 - + C Publication
 - + C Topic
 - + C Methodology
 - + C BusinessScenario
 - + C Language
 - + C Ontology
 - + C EducationalResource
 - + C Product

Relations

Relations	Range
author	STRING
dcContributor	STRING
dcCoverage	STRING
dcCreator	STRING
dcDate	STRING
dcDescription	STRING
dcFormat	STRING
dcIdentifier	STRING
dcLanguage	STRING
dcPublisher	STRING
dcRelation	STRING
dcRights	STRING
dcSource	STRING
dcSubject	STRING
dcTitle	STRING
dcType	STRING

Refinement

Mind2Onto

OntoEdit for Beta Tester

File Edit View Tools Windows Help

Connect to Sesame Generate ontology

check

<http://www.OntoWeb.org/extended> (C:\home\projects\ontoweb\ExtendedOntoWeb.owl)

Inferencing Analyzer Visualizer Debugger Domain-Lexicon OntoFiller Or

Concepts & Relations Instances Relation axioms Query Tool Disjoint concept

Concept hierarchy

- [-] C DEFAULT_ROOT_CONCEPT
 - [-] C OntoWebPortal
 - [-] C Agent
 - + C Person
 - C Software
 - + C Event
 - C News
 - + C Organization
 - C Project
 - + C Publication
 - C Topic
 - + C Methodology
 - C BusinessScenario
 - + C Language
 - + C Ontology
 - C EducationalResource
 - + C Product

Relations

author	STRING
dcContributor	STRING
dcCoverage	STRING
dcCreator	STRING
dcDate	STRING
dcDescription	STRING
dcFormat	STRING
dcIdentifier	STRING
dcLanguage	STRING
dcPublisher	STRING

Range

C Agent

- + C Person
- C Software

Inferencing

Theoretical Issues

- F-Logic
 - Object-oriented
 - Deductive Database-oriented
 - Well-founded semantics

Practical Issues

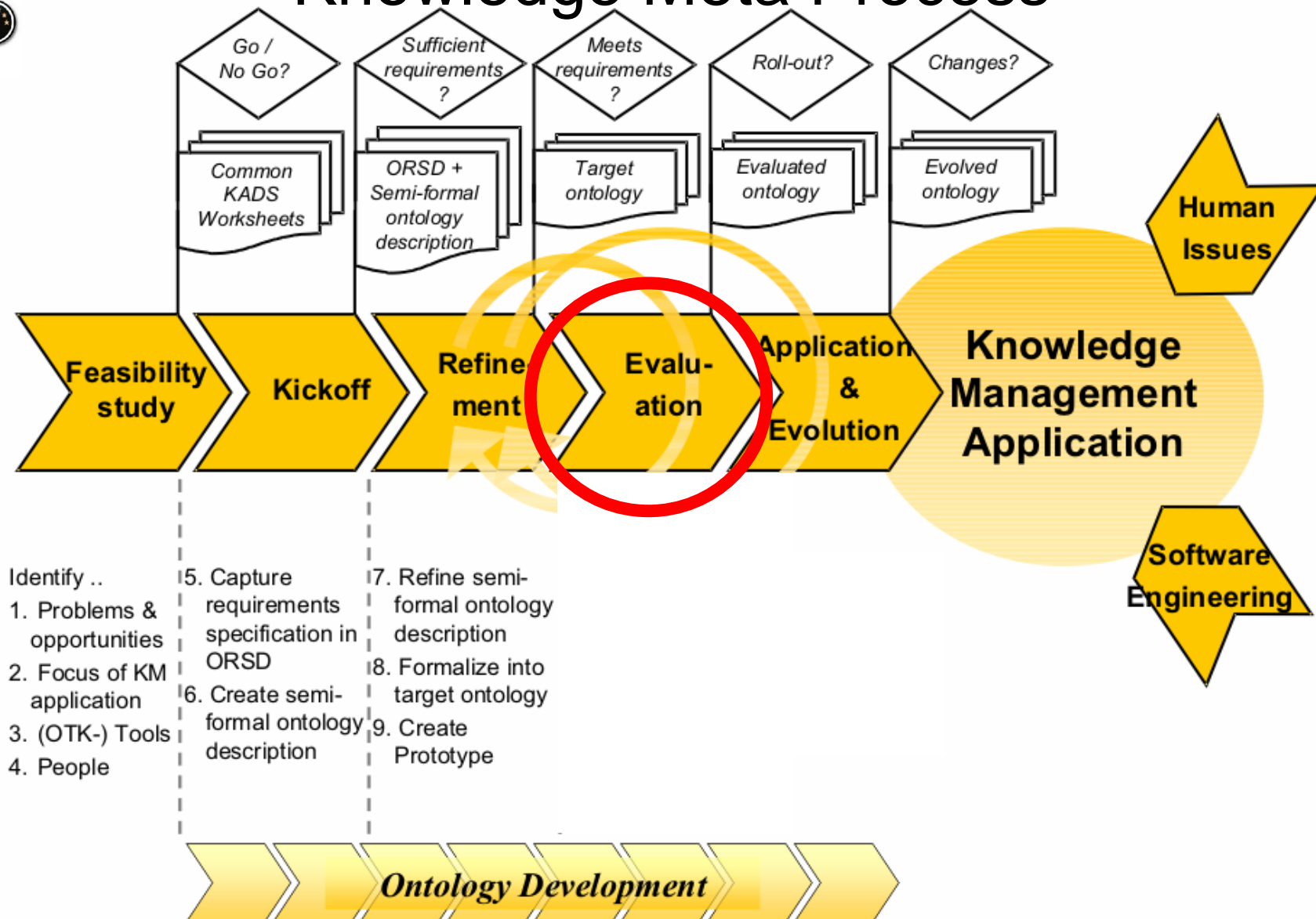
- Namespace mechanism:
Ontologies/Ontology Parts -> modules
- Switch-off definitions:
 - For testing
 - For fast executions without consistency checks
- DB Connectors: map DB tables via JDBC
- User-definable built-Ins
- Extensive API:
 - remotely connect to the inference engine
 - import and export several standards (e.g., RDF(S))

Exploit Inferencing

- Hook in existing resources with inferencing
 - Jdbc
 - Rules
- Construct axiom libraries
 - Temporal reasoning
 - PartWhole reasoning
 - ...
- Selective axiom applications
 - F-Logic semantics: E.g. type coercion at concept level
 - Domain specific consistency: non-cyclic hasPart
 - Axioms for modeling policies
 - Debugging

Contrast: OilEd

OTK Methodology: Knowledge Meta Process



Evaluation

- Check requirements (ORSD)
 - Are all CQs answered?
 - Is the ontology within the scope?
- Test in target application
 - Analyze usage pattern
- Deploy application(s)



OntoClean

- **Task:** Formal evaluation of ontologies
- Well-known methodology:
OntoClean [Welty & Guarino, 2001]
 - Aims at „**cleaning**“ of hierarchies
 - Based on philosophical notions
 - „essence“, „rigidity“, „identity“, „unity“ ...
etc.
- **Implementations:** For F-Logic & OWL

OntoClean: Definitions

„**Essence**“: A property is essential for an individual *iff.* it necessarily holds for that individual.

Example: York is *necessarily* a person.

„Rigidity“

- A property is „rigid“ (+R) *iff.* it is **necessarily essential for all** its individuals.
- A property is „non-rigid“ (-R) *iff.* it is **not essential for some** of its individuals.
- A property is „anti-rigid“ (\sim R) *iff.* it is **not essential for all** its individuals.

Example: „Person“ is necessarily an essential property for all its individuals.

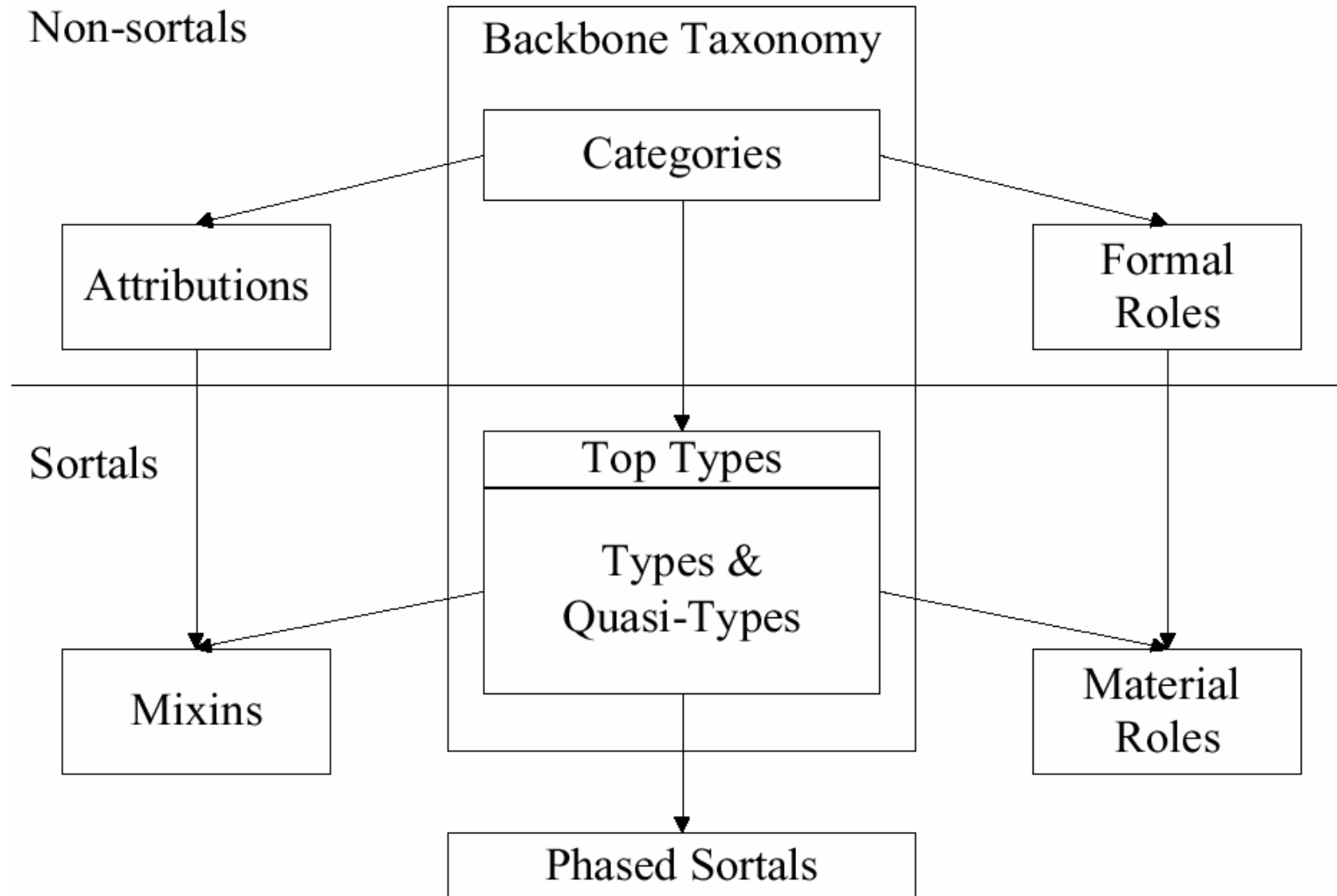
- There exist similar definitions for „identity“ (+I, -I, +O, -O), „unity“ (+U, -U, \sim U), „dependency“ (+D, -D), ... etc. ...

OntoClean: Classification & ideal structure

+O	+I	+R	+D	Type	Sortal
			-D		
-O	+I	+R	+D	Quasi-type	
			-D		
-O	+I	~R	+D	Material role	
-O	+I	~R	-D	Phased sortal	
-O	+I	¬R	+D	Mixin	
			-D		
-O	-I	+R	+D	Category	Non-sortal
			-D		
-O	-I	~R	+D	Formal Role	
-O	-I	~R	-D	Attribution	
		¬R	+D		
			-D		
+O	-I			incoherent	
	+I	~R			
		-R			

See:
[Welty & Guarino, 2001]

OntoClean: Classification & ideal structure



See: [Welty & Guarino, 2001]

OntoClean: Layering

meta ontology

Type

Formal Role

Instance of

Instance of

ontology

...

Subclass of

Agent

+D -I ~R -U

Subclass of

-D +O +R +U

Person

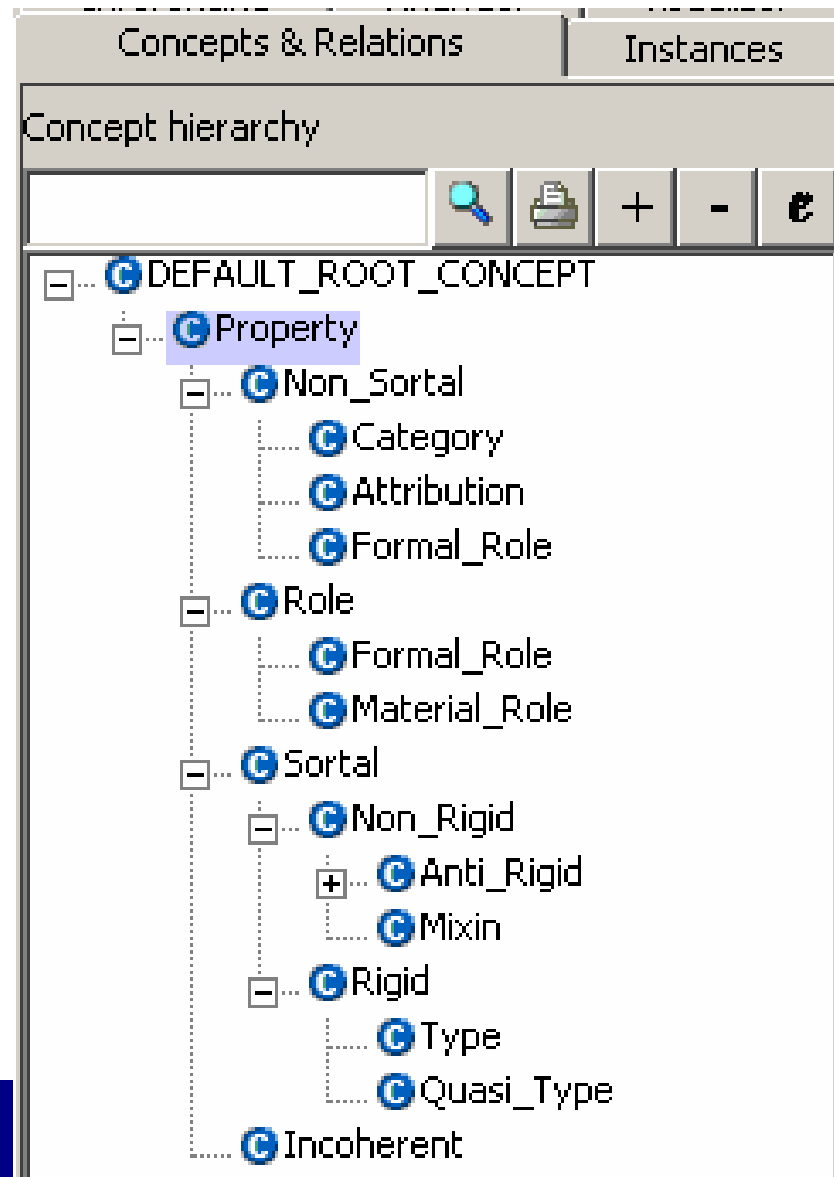
Instance of

metadata

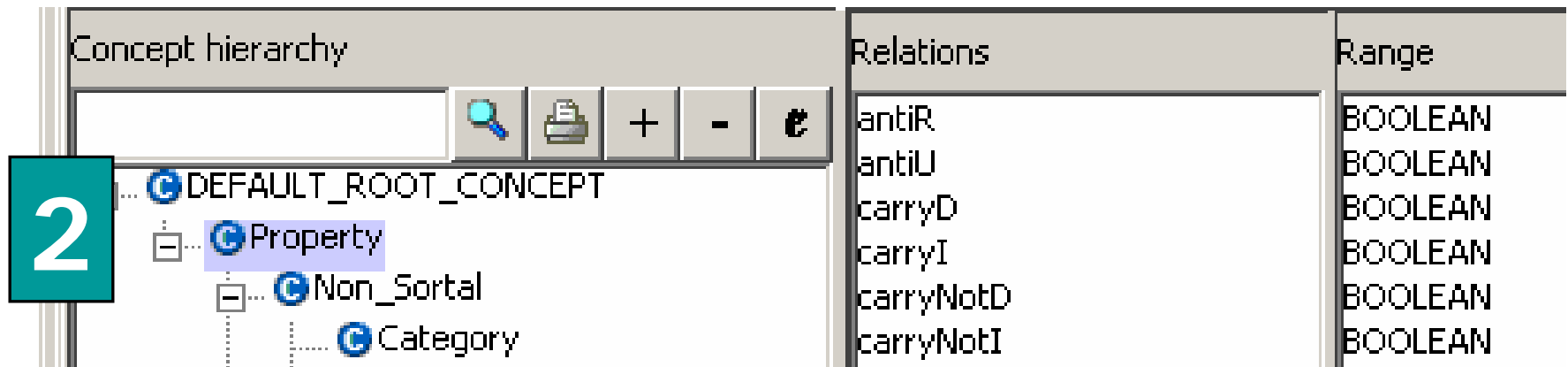
York

OntoCleanPlugin: Formalisation of meta ontology

1



OntoCleanPlugin: Formalisation of meta ontology



Uppermost concept „Property“ of the *meta ontology* has attached all relations necessary for classifying concepts of an *ontology*

OntoCleanPlugin: Formalisation of axioms

Concepts & Relations | Instances | Relation axioms | Query Tool | Disjoint concepts | Rule Editor

Logic Axioms

Axioms

- inverse
- symmetric
- transitive
- rigidity_subsumption
- unity_subsumption
- definition_4_5
- definition_6_7
- definition_4_5_6_7
- check_rigidity_constraint_1
- check_identity_constraint_1

3

Logic syntax

```
FORALL B ( check("Error: ",B," (~R) can't subsume ",C," (+R)!")
  <- ( EXISTS C((C::B
    and (B[#antiR->>"true"]
    and C[#carryR->>"true"]))) ).
```

Documentations

Language	Documentati
en	An anti-rigid property cannot subs

- Anti-rigid concepts ($\sim R$) cannot have rigid subconcepts ($+R$)
- *Etc.*

OntoCleanPlugin: Cleaning example

OntoEdit for Beta Tester

File Edit View Tools Windows Help

Connect to Sesame Generate ontology

check

<http://www.OntoWeb.org/extended> (C:\home\projects\ontoweb\ExtendedOntoWeb.owl)

Concepts & Relations		Instances	Relation axioms		Query Tool		Disjoint concepts		Rule Editor		General Axioms		
Inferencing	Analyzer	Visualizer	Debugger	Domain-Lexicon	OntoFiller	OntoClean	Identification	Metadata					
ID	en	+D	-D	+I	-I	+O	-O	+R	-R	~R	~U	+U	-U
DEFA...		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Onto...	OntoWebPortal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Agent	Agent	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Event	Event	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
News	News	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Organi...	Organization	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Person	Person	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Project	Project	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Public...	Publication	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Topic	Topic	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Applic...	Application	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Tool	Tool	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Metho...	Methodology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Busine...	BusinessScen...	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Langu...	Language	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Ontology	Ontology	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Educa...	EducationalRe...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Confe...	Conference	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Exhibit...	Exhibition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lecture	Lecture	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Meeting	Meeting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Works...	Workshop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Misc	Misc	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Associ...	Association	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Conso...	Consortium	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Depar...	Department	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Enterp...	Enterprise	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Institute	Institute	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Projec...	ProjectManag...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Resea...	ResearchGroup	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Univer...	University	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Work...	Workshop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

en
de
fr
it

Ready.

2507.0k free

OntoCleanPlugin: Cleaning example

Def.: Being an active participant in some event.

+D -I ~R -U

Agent

Agent

Person

Person

-D +O +R +U

OntoCleanPlugin: Cleaning example

Concepts & Relations		Instances	Relation axioms	Query Tool	Disjoint concepts	
Inferencing	Analyzer	Visualizer	Debugger	Domain-Lexicon	OntoFiller	OntoCle

Axioms

- inverse
- symmetric
- transitive
- rigidity_subsumption
- unity_subsumption
- definition_4_5
- definition_6_7
- definition_4_5_6_7
- ..._constraint_1

```
FORALL V,W,X,Y,Z <- check(V,W,X,Y,Z).
```

Evaluating the query FORALL V,W,X,Y,Z <- check(V,W,;

Error: Agent (~R) can't subsume Person (+R) !



„Is York an agent?“

OntoCleanPlugin: Cleaning example

Concepts & Relations	Instances	Relation axioms	Query Tool	Disjoint concepts
Inferencing	Analyzer	Visualizer	Debugger	Domain-Lexicon
			OntoFiller	OntoCle

Axioms

- inverse
- symmetric
- transitive
- rigidity_subsumption
- unity_subsumption
- definition_4_5
- definition_6_7
- definition_4_5
- check_rigidity_0

```
FORALL V,W,X,Y,Z <- check(V,W,X,Y,Z).
```

Evaluating the query FORALL V,W,X,Y,Z <- check(V,W,;

Error: Agent (~R) can't subsume Person (+R) !

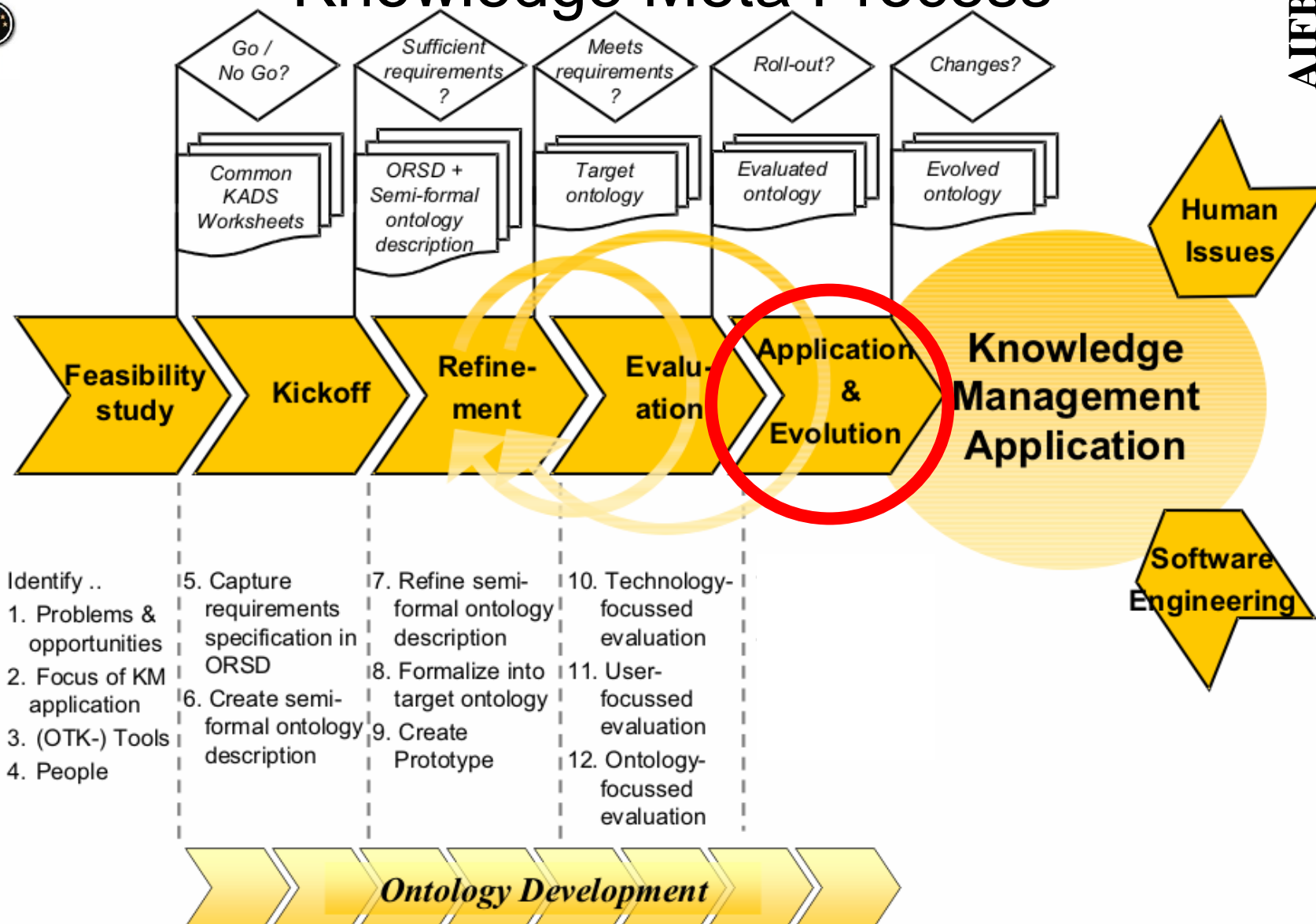


Person should not be a subconcept of Agent!

Interpretation: Persons *can be* agents, but persons are not necessarily agents.

„Is York an agent?“

OTK Methodology: Knowledge Meta Process





Worksheet for life cycle aspects of ontology

- Who is going to maintain it?
- Who is going to pay for it?
- What is the resulting quality (increase, decrease)?
- How large are the network costs (cost of negotiation grows quadratic with number of participants)?
- What is the expected life time of the ontology?
- How brittle is it with regard to updates?
- What error types will occur/are relevant?



Worksheet for life cycle aspects of metadata

- ala ontology

Rule of thumb – costs:

- Hardware 1
- Software 10
- Daten 100

- Co-ordinated change of data and metadata?
- Co-ordinated change of ontology and metadata?
- Cold start (chicken-and-egg) problem: A problem? How to overcome?
- Granularity of metadata envisaged: classification, identification of people/events/relationships/etc.



Coordination of metadata & ontology

- Match or mismatch between the two,
 - E.g. classification only, but ontology about transitive relationships

Type-1 Error

- False Positive
 - Often dominating problem in company internal IR
 - It can be more costly to learn about all low-price provider of pens than to just select from a sample

Type-2 Error

- False negative: Positive example not detected as such
 - Often not critical for information retrieval
 - „show me bookstores who sell the `CommonKADS` book“
 - Often critical for B2B operations
 - „whether `6000 computer` is mapped to `IBM RS/6000 SP system` or to `HP OmniBook Laptop 6000` is a large difference with regard to price and performance“

Refined Error types (Halo Project)

- 1. (MOD) Knowledge Modeling: the ability of the knowledge engineer to model information/write axioms
- 2. (IMP) Knowledge Implementation/Modeling Language: the ability of the representation language to accurately represent axioms
- 3. (INF) Inference and Reasoning: the ability of the inference engine to “find the needle in the haystack”
- 4. (KFL) Knowledge Formation and Learning: the ability of the system (KB + inference engine) to acquire and merge knowledge through automated and semi-automated techniques
- 5. (SCL) Scalability: the ability of the KB to scale

– <http://www.haloproject.com>



Refined Error types II (Halo Project)

- 6. (MGT) Knowledge Management: the ability of the system to maintain, track changes, test, organize, document; the ability of the knowledge engineer to search for knowledge
- 7. (QMN) Query Management: the ability of the system to robustly answer queries
- 8. (ANJ) Answer Justification: the ability of the system to provide justifications for answers in the correct context and resolution
- 9. (QMT) Quality Metrics: the ability of the developers to determine how “good” the knowledge base is at any given point in its evolution
- 10. (MTA) Meta Capabilities: the system's ability to utilize meta-reasoning or meta-knowledge



Ontology Evolution: Technical aspects

- Ontology development is necessarily an **iterative** and a **dynamic process**
- Ontologies must be able to **evolve** for a number of reasons:
 - Application domains and user's needs are changing
 - System can be improved
- Developing ontologies is expensive, but evolving them is even **more expensive**



Requirements for ontology evolution

Basic
requirement

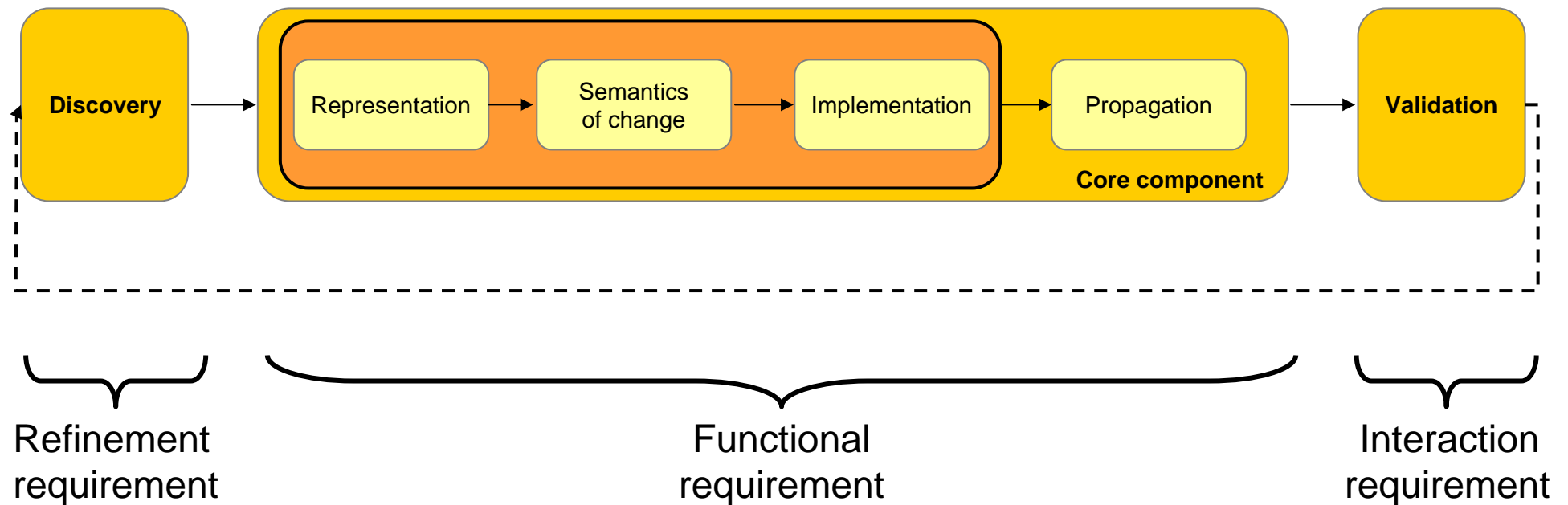
- **Functional requirement:**
 - enable the handling of the required changes
 - ensure the consistency of the underlying ontology and all dependent artifacts

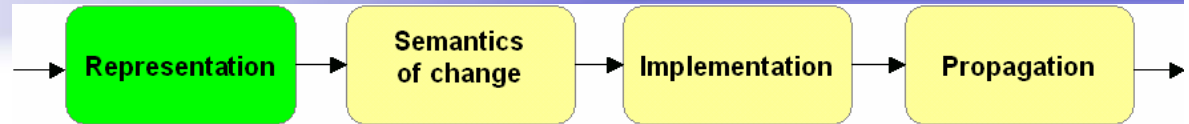
Extended
requirements

- **Interaction requirement** – supports the user to manage changes more easily
- **Refinement requirement** – offers advice to the user for continual system refinement



Ontology Evolution Process



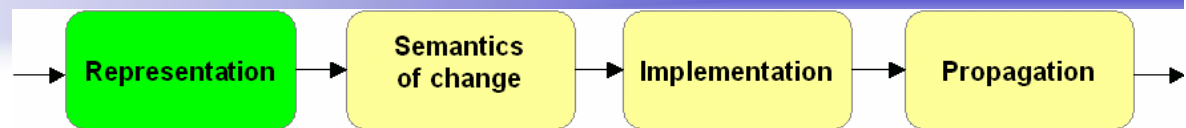


Ontology Evolution – Change representation

- Elementary changes
 - They can not be decomposed into simpler ones
 - They heavily depend on the underlying ontology model

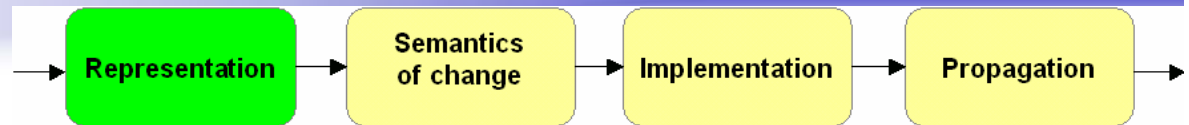
MoveConcept \neq (RemoveSubConcept + AddSubConcept)

- Composite changes
 - They are more powerful
 - They have coarser granularity
 - They have often more meaningful semantics



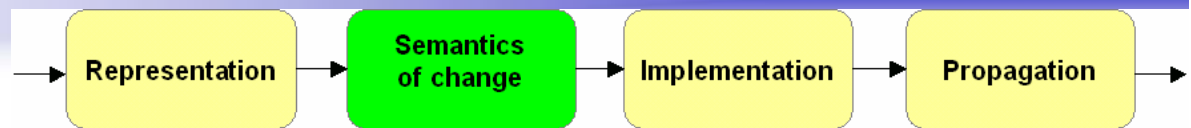
Ontology Evolution – Change representation

Composite change	Description
Move concept	Move a concept from one parent to another.
Merge concepts	Replace several concepts with one and aggregate all instances.
Extract subconcepts	Split a concept into several subconcepts and distribute properties among them.
Extract superconcept	Create a common superconcept for a set of unrelated concepts and transfer common properties to it.
Extract related concept	Extract related information into a new concept and relate it to the original concept.
Shallow concept copy	Duplicate a concept with all its properties.
Deep concept copy	Recursively apply shallow copy to all subconcepts of a concept.
Pull up properties	Move properties from a subconcept to a superconcept.
Pull down properties	Move properties from a superconcept to a subconcept.
Move properties	Move properties from one concept to another concept.
Shallow property copy	Duplicate a property with same domain and range.
Deep property copy	Recursively apply shallow copy to all subproperties of a property.
Move Instance	Moves an instance from one concept to another.



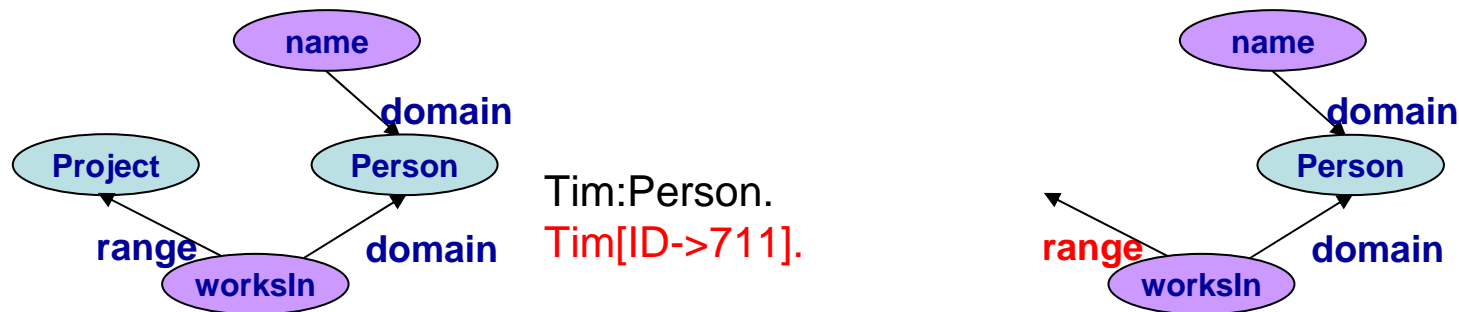
Ontology Evolution – Change representation

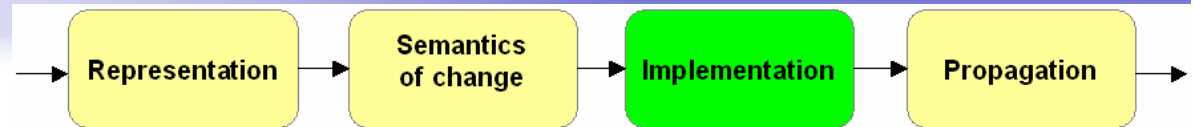
Composite change	Description
Move concept	Move a concept from one parent to another
Merge concepts	Replace several concepts with one and aggregate all instances.
Extract superconcept	properties among them. Create a common superconcept for a set of unrelated concepts and transfer common properties to it
Extract related concept	Extract related information into a new concept and relate it to the original concept.
Deep concept copy	Recursively apply shallow copy to all subconcepts of a concept.
Pull up properties	Move properties from a subconcept to a superconcept.
Pull down properties	Move properties from a superconcept to a subconcept.
Move properties	Move properties from one concept to another concept.
Shallow property copy	Duplicate a property with same domain and range.
Deep property copy	Recursively apply shallow copy to all subproperties of a property.
Move Instance	Moves an instance from one concept to another.



Ontology Evolution – Semantics of change

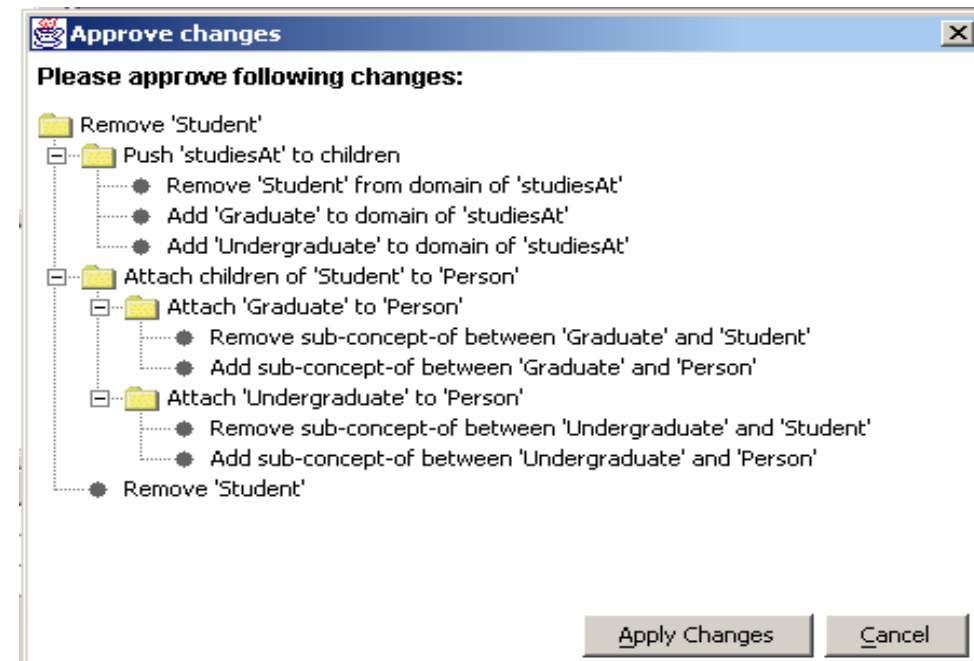
- Enables resolution of changes in a systematic manner, ensuring consistency of the whole ontology



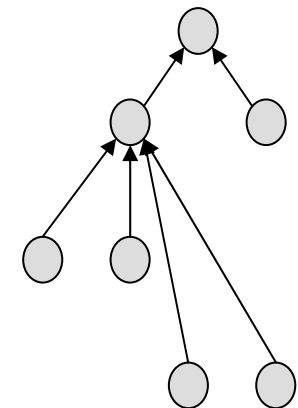
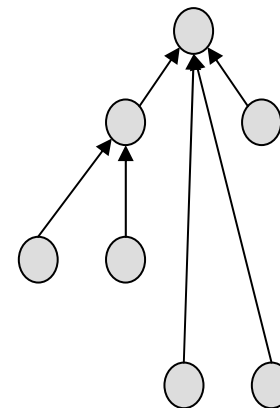
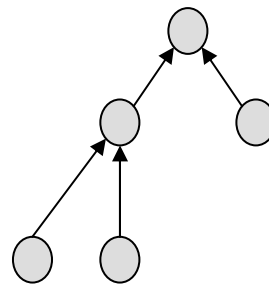
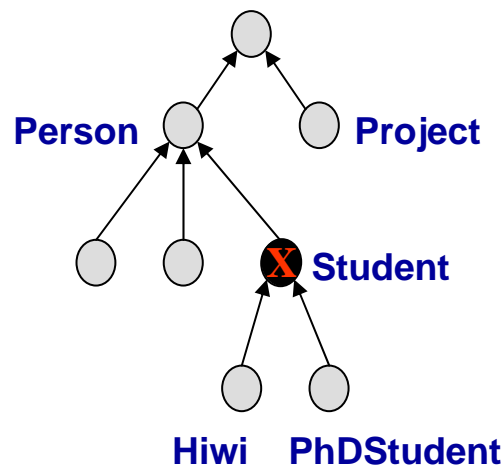
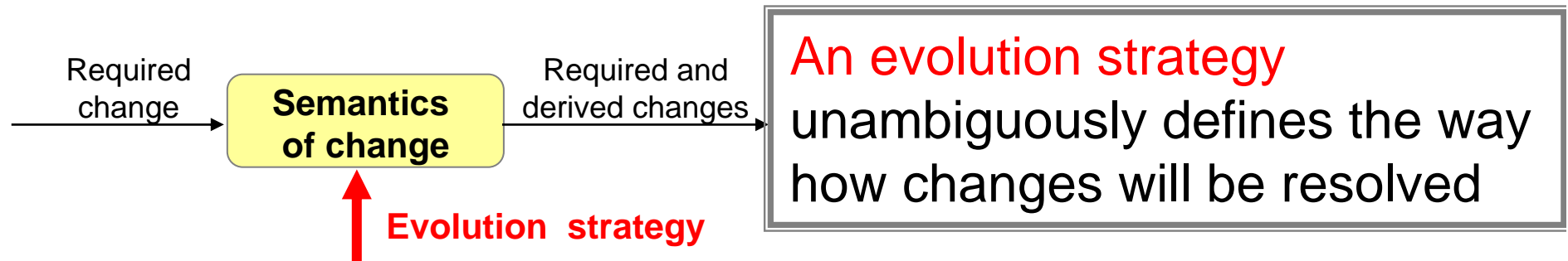


Ontology Evolution – Change implementation

- After **user's approval** all changes are applied to the ontology
- Since it is necessary to perform several changes together, the **transaction server** is needed.



Evolution Strategies



Evolution Strategies

Elementary evolution strategies

Resolution points:

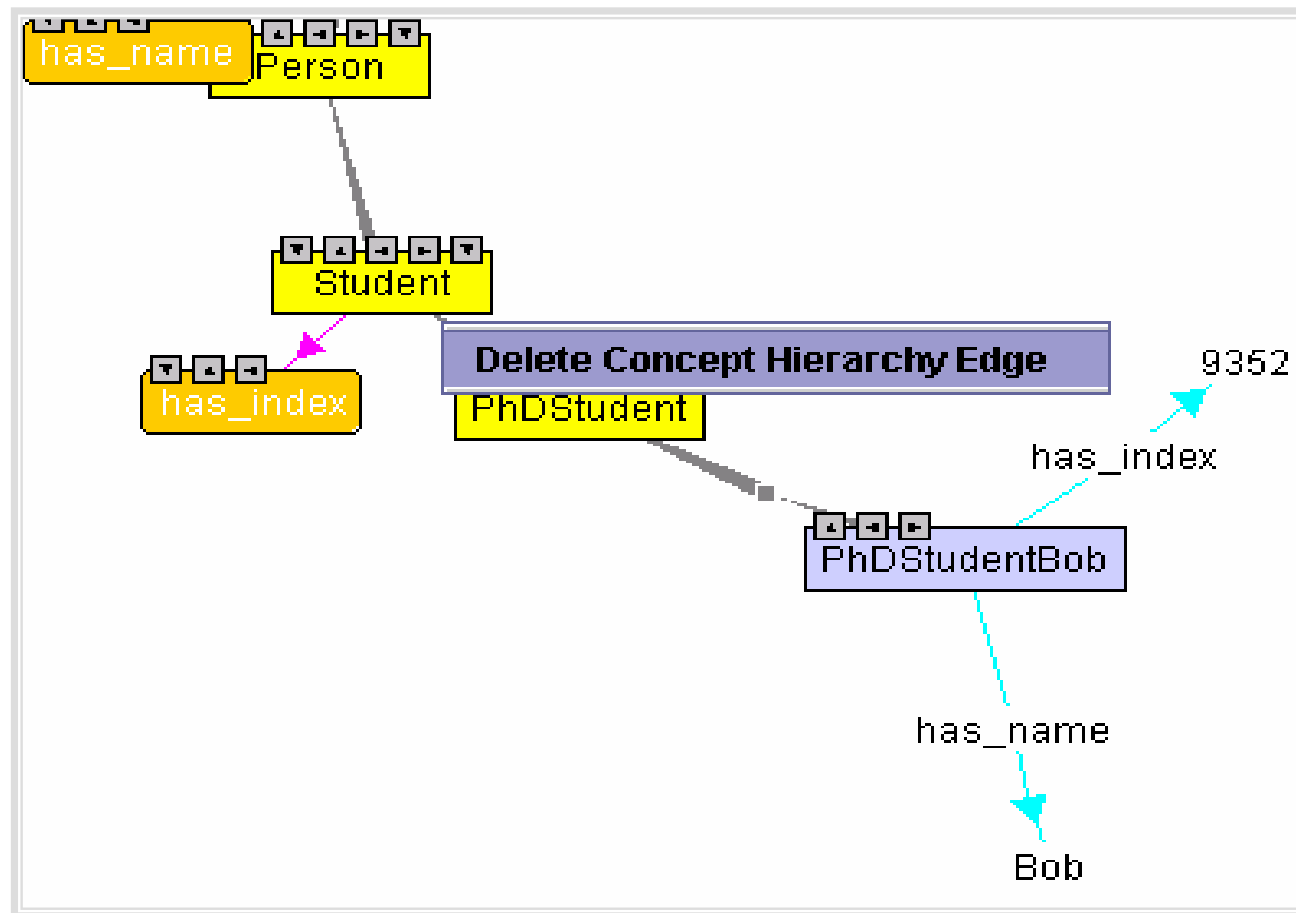
- how to handle orphaned concepts;
- how to handle orphaned properties;
- how to propagate properties to the concept whose parent changes;
- what constitutes a valid domain of a property;
- what constitutes a valid range of a property;
- whether a domain (range) of a property can contain a concept that is at the same time a subconcept of some other domain (range) concept;
- the allowed shape of the concept hierarchy;
- the allowed shape of the property hierarchy;
- ...

- delete
- reconnect to the root
- reconnect to the superconcepts

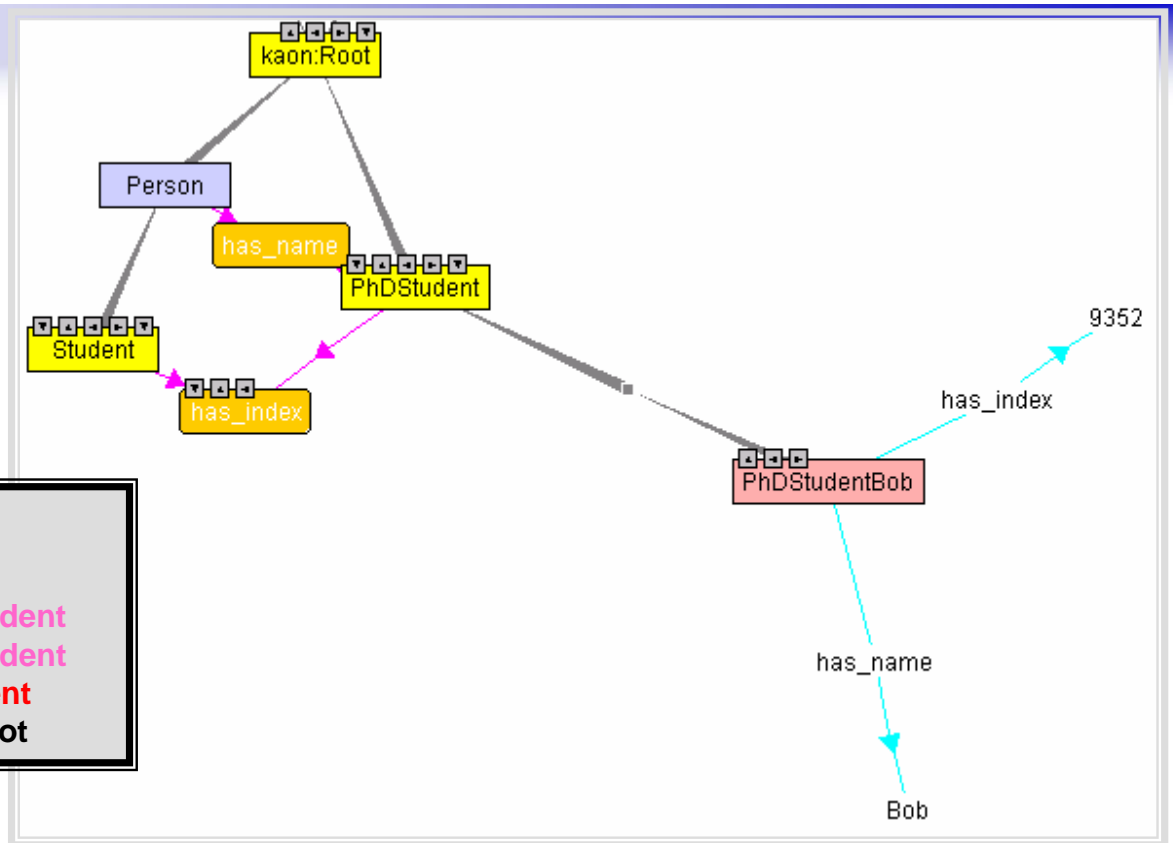
Common policy consisting of a set of elementary evolution strategies, each giving an answer for one resolution point, is an

evolution strategy

Example

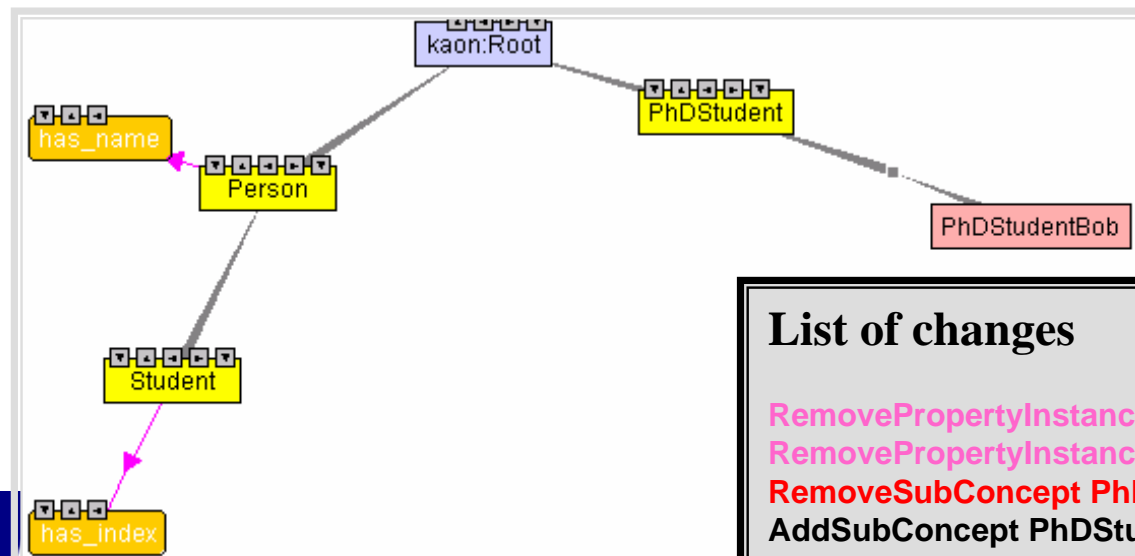


Evo- lution



List of changes

AddPropertyDomain has_name, PhDStudent
 AddPropertyDomain has_index, PhDStudent
 RemoveSubConcept PhDStudent, Student
 AddSubConcept PhDStudent, KAON:Root



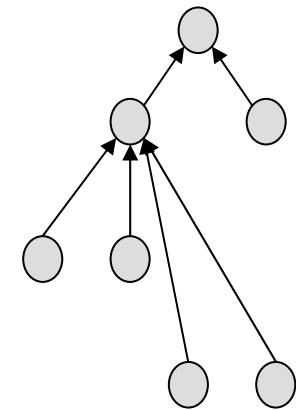
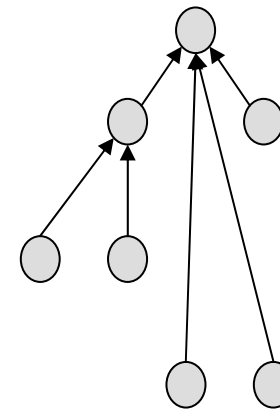
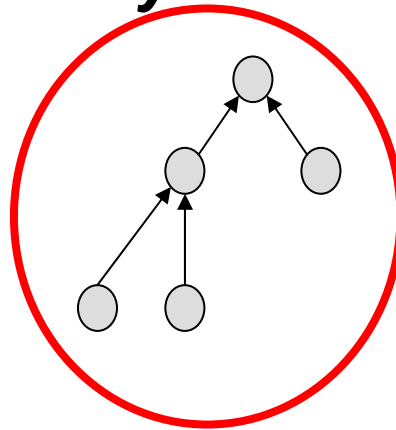
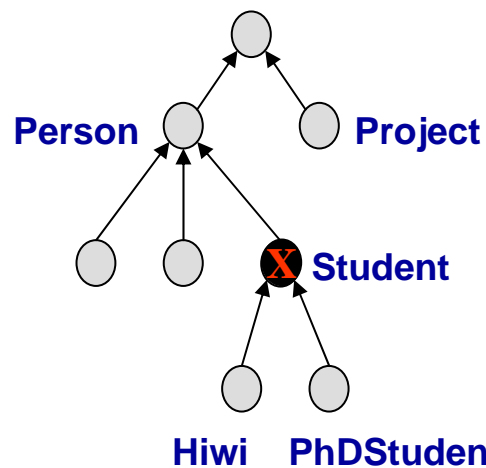
List of changes

RemovePropertyInstance has_name, PhDStudentBob, Bob
 RemovePropertyInstance has_index, PhDStudentBob, 9352
 RemoveSubConcept PhDStudent, Student
 AddSubConcept PhDStudent, KAON:Root

Advanced evolution strategies

Mechanism to prioritize and arbitrate among different evolution strategies, relieving the user of choosing them individually:

- ***structure-driven strategy***
- ***process-driven strategy***
- ***instance-driven strategy***
- ***frequency-driven strategy***





Implementation



<http://kaon.semanticweb.org>

Applications & Services

**OIModeler - Ontology and
Metadata Engineering Tool**

**KAON Portal and other User
Interface Applications and Services**

Middleware

KAON Access Interface			
		Change Discovery	Interaction Logging
Evolution Strategy	Reversibility Services	Evolution Logging	
KAON API			
RDF API			KAON RDF Server

Data and Remote Services

Persistence, Transactions, Security

KAON Workbench

File Edit View Procedures

Ol-modeler - file:/C:/MyDocuments/Konferencije/EKAW2002/Final/EKAWExample.kaon

Zoom:

Search for:

Search

Name

Clipboard:

Clear

file:/C:/MyDocuments/Konferencije/EKAW2002/Final/EKAWExample#Person

Superconcepts

Person <http://kaon.semanticweb.org/2001/11/kaon-lexical#Root>

Subconcepts

- Person
 - Assistant
 - Student
 - PhDStudent
 - Professor

Properties From Concept

Property Name	Minimum Cardinality	Maximum Cardinality
has_name	0	2147483647

Properties To Concept

Property Name
http://kaon.semanticweb.org/2001/11/kaon-lexical#references

Resolution points

The screenshot shows the KAON Workbench interface with the 'Evolution Strategy Set-up' dialog box open. A black box with the text 'Resolution points' in red has several red arrows pointing to specific options in the dialog:

- From the 'kaon.Root' node in the ontology graph to the '...reconnected to superconcepts.' option in the 'Orphaned concepts will be...' section.
- From the 'kaon.Root' node to the '...deleted.' option in the 'Orphaned properties should be...' section.
- From the 'kaon.Root' node to the '...may contain subconcepts of other domain/range concepts.' option in the 'Domain/range of a property...' section.
- From the 'Student' node to the '...should be deleted from the OI-model.' option in the 'Properties without any range concepts...' section.
- From the 'has_intex' property to the '...should be enforced.' option in the 'Instance consistency...' section.
- From the 'has_intex' property to the '...nothing special should be done.' option in the 'When creating a hierarchy path which already exists...' section.

Evolution Strategy Set-up

Orphaned concepts will be...

- ☐ ...deleted.
- ☐ ...reconnected to ontology root.
- ☒ ...reconnected to superconcepts.

Orphaned properties should be...

- ☐ ...deleted.
- ☐ ...reconnected to superproperties.
- ☒ ...left as they are.

When concept's parent is removed...

- ☒ ...properties will not be propagated.
- ☐ ...all inherited properties will be added to the concept.
- ☐ ...only parent's properties will be added to the concept.

Domain/range of a property...

- ☒ ...may contain subconcepts of other domain/range concepts.
- ☐ ...may not contain subconcepts of other domain/range concepts.

Properties without any domain concepts...

- ☐ ...may exist in the OI-model.
- ☒ ...should be deleted from the OI-model.

Properties without any range concepts...

- ☐ ...may exist in the OI-model.
- ☒ ...should be deleted from the OI-model.

Instance consistency...

- ☒ ...should be enforced.
- ☐ ...should not be enforced.

When creating a hierarchy path which already exists...

- ☒ ...nothing special should be done.
- ☐ ...the shorter path should be removed.
- ☐ ...an error should be raised.

Properties From Concept

Property Name	Minimum Cardinality	Maximum Cardinality
has_name	0	2147483647

Properties To Concept

Property Name
http://kaon.semanticweb.org/2001/11/kaon-lexical#references

OK **Cancel**

KAON Workbench

File Edit View Procedures

Ol-modeler - file:/C:/MyDocuments/Konferenc

Zoom: 100%

kaon.Root

Student

has_intex

Resolution points

Orphaned concepts will be...

- ☐ ...deleted.
- ☐ ...reconnected to ontology root.
- ☒ ...reconnected to superconcepts.

Elementary evolution strategies

...properties will not be propagated.

☐ ...all inherited propertis will be added to the concept.

☐ ...only parent's properteis will be added to the concept.

Properties without any domain concepts...

☐ ...may exist in the Ol-model.

☒ ...should be deleted from the Ol-model.

Instance consistency...

☒ ...should be enforced.

☐ ...should not be enforced.

Properties without any range concepts...

☐ ...may contain subconcepts of other domain/range concepts.

☐ ...may not contain subconcepts of other domain/range concepts.

☐ ...may exist in the Ol-model.

☒ ...should be deleted from the Ol-model.

When creating a hierarchy path which already exists...

☒ ...nothing special should be done.

☐ ...the shorter path should be removed.

☐ ...an error should be raised.

OK Cancel

Superconcepts

file:/C:/MyDocuments/Konferencije/EKAW200

http://kaon.semanticweb.org/2001/11/kaon-lexical#references

Properties From Concept

Property Name	Minimum Cardinality	Maximum Cardinality
has_name	0	2147483647

Properties To Concept

Property Name
http://kaon.semanticweb.org/2001/11/kaon-lexical#references

Clear

KAON Workbench

File Edit View Procedures

Ol-modeler - file:/C:/MyDocuments/Konferenc

Zoom: 100%

kaon:Root

Resolution points

Orphaned concepts will be...

- ☐ ...deleted.
- ☐ ...reconnected to ontology root.
- ☒ ...reconnected to superconcepts.

Elementary evolution strategies

...properties will not be propagated.

...may contain subconcepts of other domain/range concepts.

Evolution Details

All Changes

- Delete concept **Student**.
- Remove value **Student** of property **kaon:references** for instance **o:1033038854508-915157117**.
 - Delete instance **o:1033038854508-915157117**.
 - Remove value **kaon:en** of property **kaon:inLanguage** for instance **o:1033038854508-915157117**.
 - Remove value **Student** of property **kaon:value** for instance **o:1033038854508-915157117**.
 - Remove instance **o:1033038854508-915157117** from concept **kaon:Label**.
 - Remove instance **o:1033038854508-915157117** from concept **kaon:Root**.
- Remove instance **Student** from concept **kaon:Root**.
- Add concept **PhDStudent** to the domain of property **has_name**.
- Add concept **PhDStudent** to the domain of property **has_index**.
- Remove concept **Student** from the domain of property **has_index**.
 - Remove value **9352** of property **has_index** for instance **PhDStudentBob**.
- Remove concept **PhDStudent** from subconcepts of **Student**.
- Make concept **PhDStudent** subconcept of **kaon:Root**.
- Remove concept **Student** from subconcepts of **Person**.

Apply Changes Cancel

OK Cancel

Clear

KOBLENZ · LANDAU

ISWeb – Lecture „Semantic Web“ (84)

TP 4

KAON Workbench

File Edit View Procedures

Ol-modeler - file:/C:/MyDocuments/Konferenc

Zoom: 100%

kaon.Root

Orphaned concepts will be...

- ☐ ...deleted.
- ☐ ...reconnected to ontology root.
- ☒ ...reconnected to original parent.

Elementary evolution strategies

Resolution points

Evolution Details

All Changes

- Delete concept **Student**.
- Remove value **Student** of property **kaon:ref**.
- Delete instance **o:1033038854508-915**.
 - Remove value **kaon:en** of property **kaon:ref**.
 - Remove value **Student** of property **kaon:ref**.
 - Remove instance **o:1033038854508-915**.
 - Remove instance **o:1033038854508-915**.
- Remove instance **Student** from concept **kaon:ref**.
- Add concept **PhDStudent** to the domain of **kaon:ref**.
- Add concept **PhDStudent** to the domain of **kaon:ref**.
- Remove concept **Student** from the domain of **kaon:ref**.
 - Remove value **9352** of property **has_ind**.
- Remove concept **PhDStudent** from subconcept **kaon:ref**.
- Make concept **PhDStudent** subconcept of **kaon:ref**.
- Remove concept **Student** from subconcept **kaon:ref**.

o:Change

o:RemoveChan...

o:RemoveEntity

o:causesChange

Remove Studen...

Remove value S...

AddSubConcept...

RemoveSubCo...

Remove instanc...

RemoveSubCo...

Add PhDStudent...

RemoveSubCo...

Add PhDStudent...

Delete concept ...

o:has_Reference

Student

o:time

02:43 CEST

o:date

25/09/02

KOBLENZ · LANDAU

ISWe

Evolution wrap-up

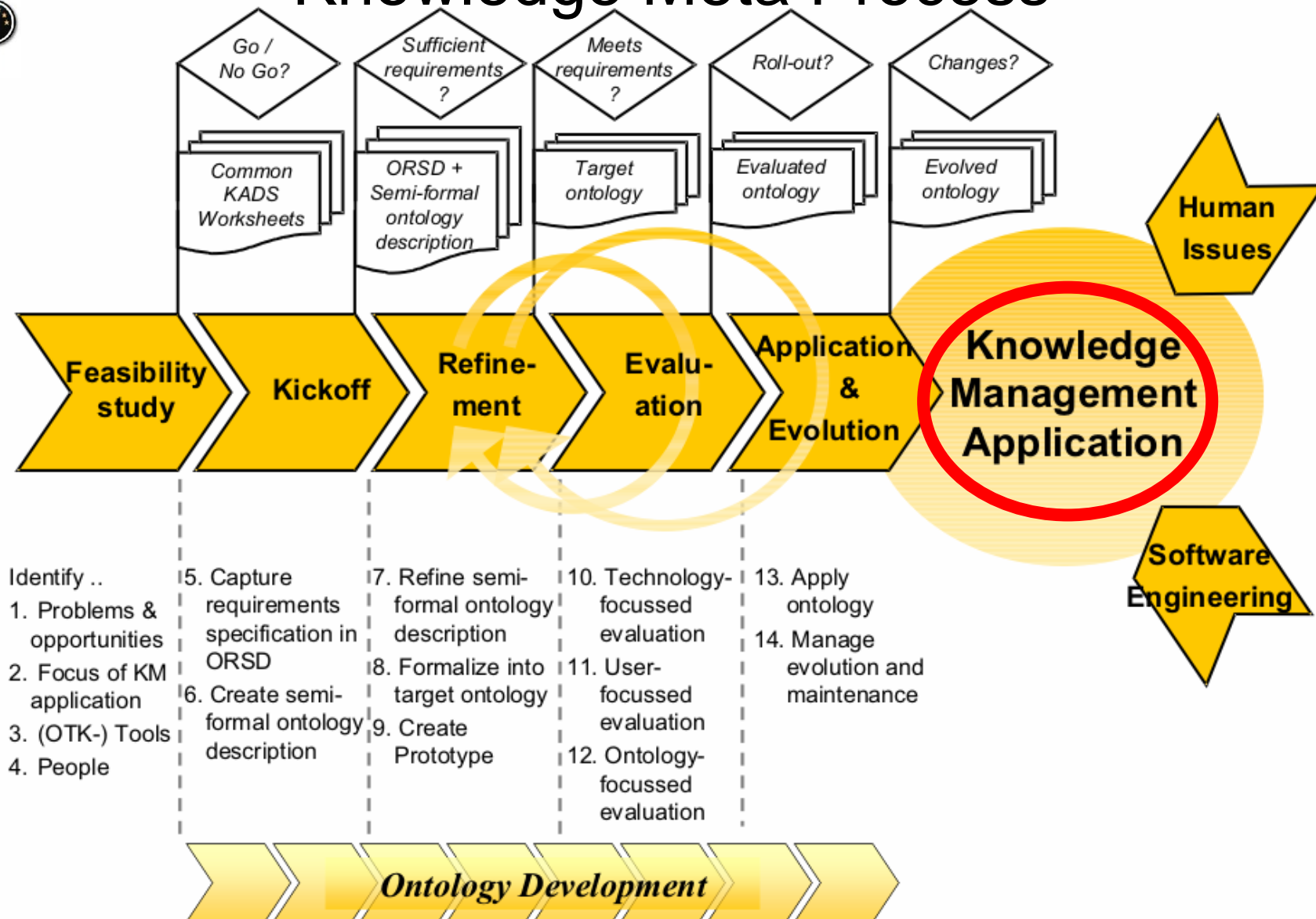
OntoLogging:

- process-based approach for ontology evolution
- Evolution strategies that enable the customisation of the ontology evolution process
- Implementation in KAON framework

Ongoing work:

- Evolution between distributed ontologies
- Change discovery

OTK Methodology: Knowledge Meta Process

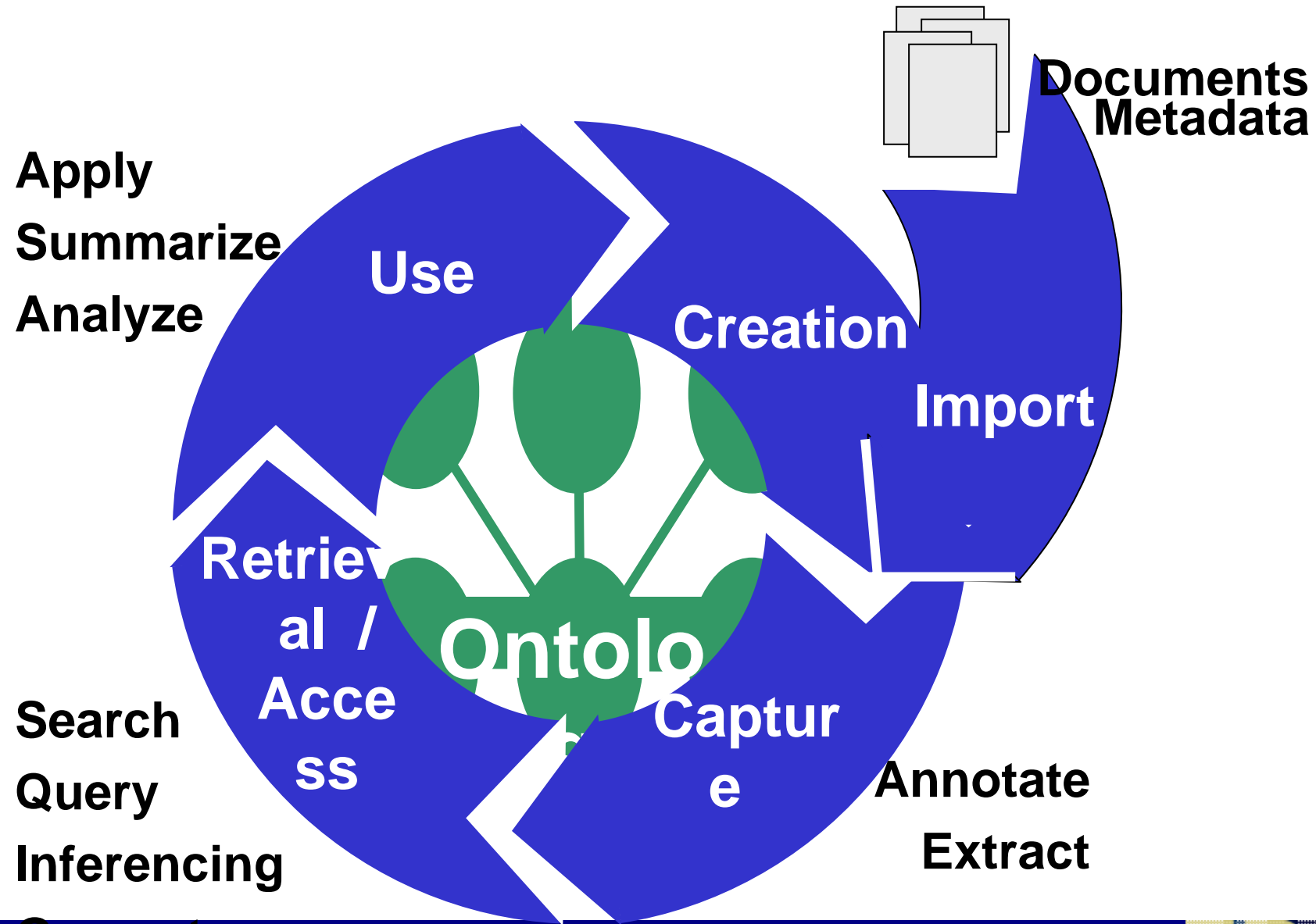


Conclusions on Knowledge Meta Process

Experiences from OTK Case Studies

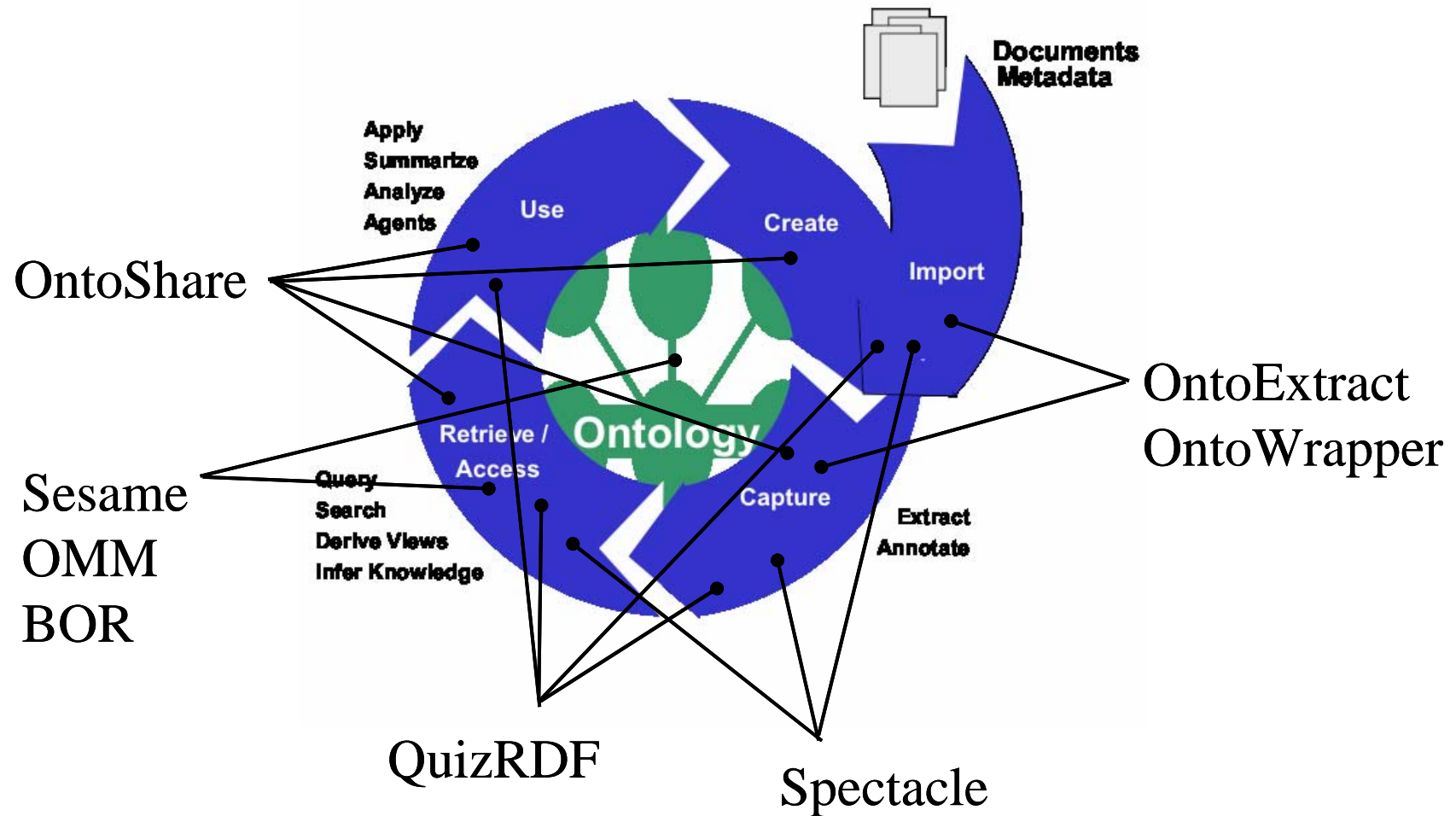
- **Guidelines** for domain experts from industry have to be pragmatic
 1. Train the user about ontologies
 2. Show the concrete advantage of the KMS
 3. Model precisely – but allow for imprecise views (most users cannot distinguish classes vs instances or isa vs partOf)
- **Plan for Maintenance**
- **Avoid/Reduce chicken-and-egg problem**
 1. Plan für content that makes KMS interesting
 2. Show quick win
- **Collaborative ontology engineering** requires sophisticated tool support *and* physical presence
- **Brainstorming** is a valuable add-on during the early stages of ontology engineering

Knowledge Process

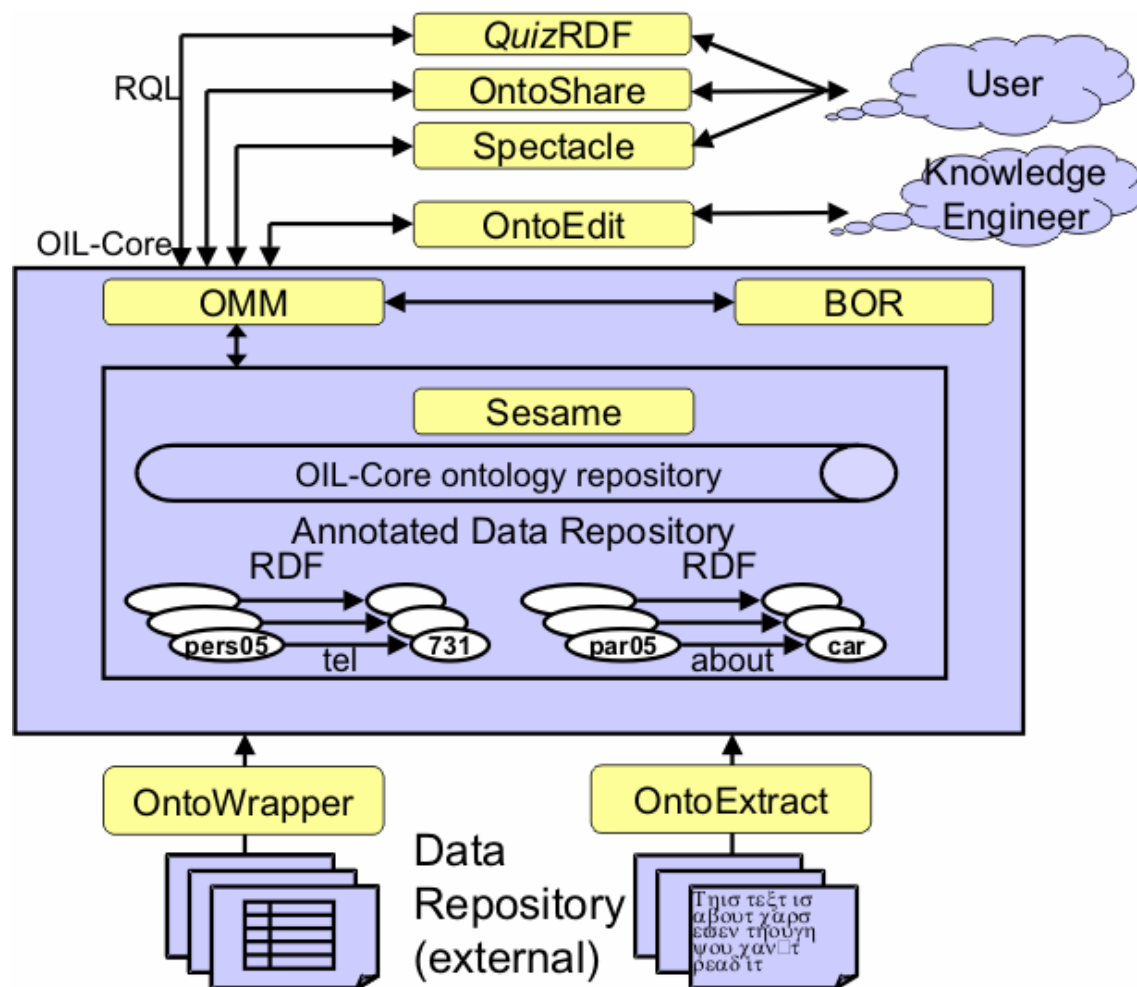


OTK Case Study @ BT

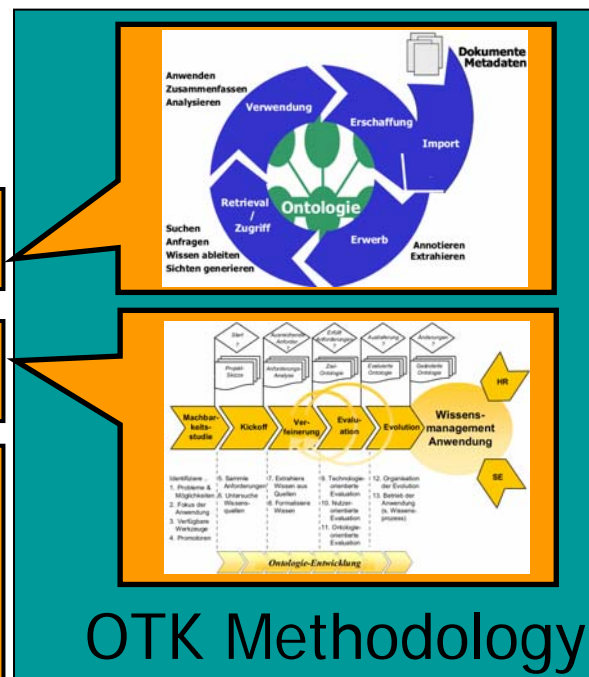
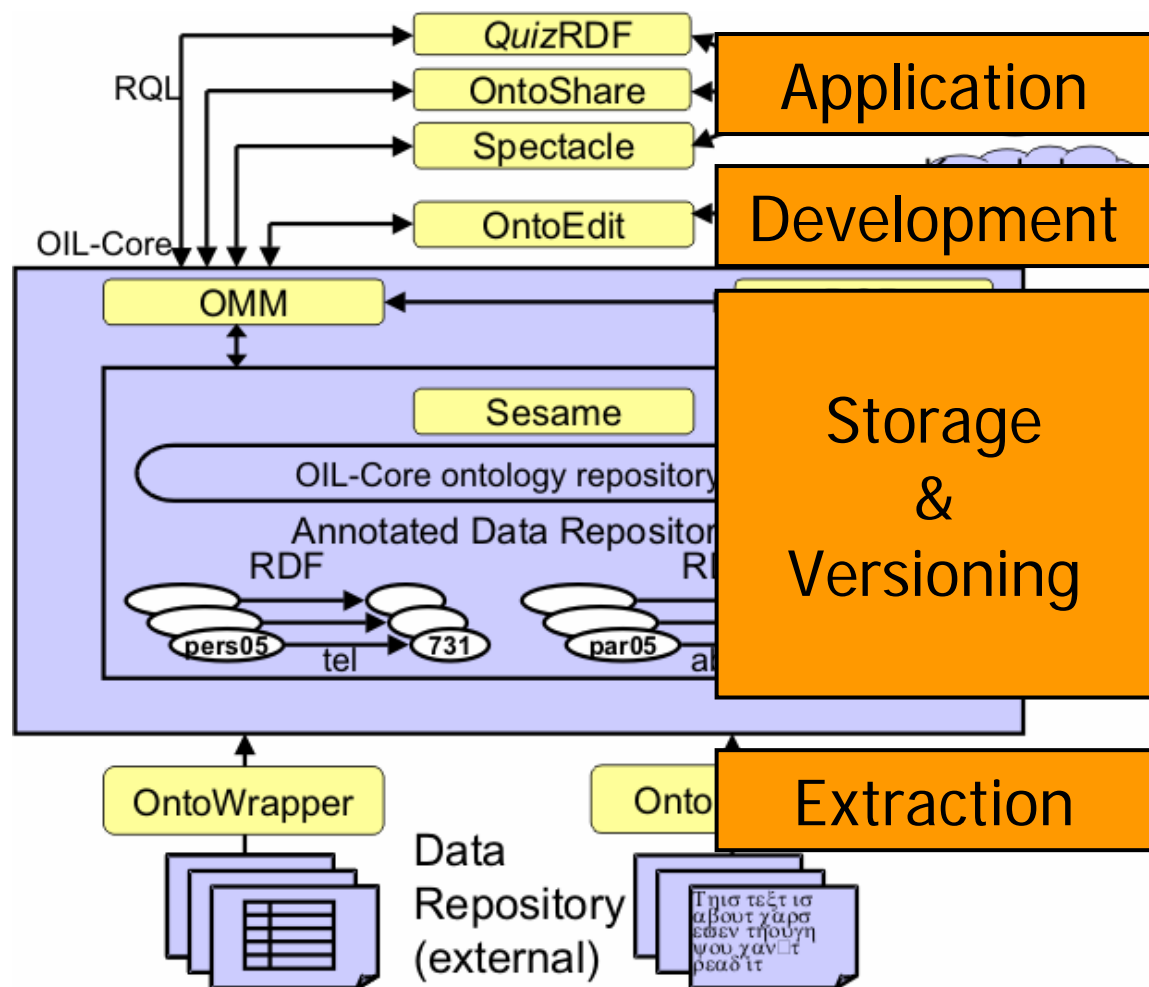
Users Portal



OTK Architecture



OTK Architecture



OTK Methodology