KNOWLEDGE ORGANISATION AND TERMINOLOGY: APPLICATION TO CORK

THESIS DEFENCE
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PURPOSE AND SUPERVISION OF THE THESIS

Thesis defence to fulfil the requirements for obtaining the double doctorate degree in

**Linguistics**: specialisation in **Lexicology, Lexicography and Terminology**

and

**Information and Communication Sciences**

Under the co-supervision of Professor **Rute Costa** (NOVA FCSH) and Professor **Christophe Roche** (LISTIC USMB)

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- Professor Frieda Steurs, Katholieke Universiteit Leuven and INT Leiden (Institute for the Dutch language)

- Professor Joana Paulo, Instituto Superior de Agronomia | Universidade de Lisboa (expert of the domain)
PRESENTATION

From the (1) linguistic and (2) conceptual analysis of textual DEFINITIONS, to the building of a domain-ontology

THE GOAL OF THE METHODOLOGY

A starting point for building ONTOLOGIES and KNOWLEDGE ORGANISATION

FUTURE WORK

Multimodal TERMINOLOGICAL e-dictionary - several resources linked
TOPICS OVERVIEW

Domain
Corpus
Text mining
Linguistic analysis
Conceptual analysis
Knowledge organisation
Future work
# ROADMAP OF TERM Cork FOLLOWING THE CLASSIC CYCLE TO BUILD AN ONTOLOGY

## Domain
- Corpus
- Text mining
- Linguistic analysis
- Conceptual analysis

## Knowledge organisation
- Ontology

## Scope of knowledge
- Resource
- Knowledge capture

## Naming concepts
- Coding in Manchester OWL DL
- Competency questions (DL-Q)
- Metalanguage; Github

## SPECIFICATION
## CONCEPTUALISATION
## FORMALISATION
## IMPLEMENTATION
## EVALUATION
## DOCUMENTATION
DOMAIN: CORK, A MULTIFACETED SCOPE OF INTERESTS

Cork oak forests have a high economic, social and environmental value in Portugal

✓ Production (“montados”)  
✓ Biodiversity and CO\textsuperscript{2} capture  
✓ Transformation (industry)  
✓ Leader in the world ranking of international market shares

➔ An endless field of terminological study
The Scope of Knowledge: Cork Stoppers

- **Cork Stoppers**, the backbone of the industry of cork
- Stoppers are submitted to several operations and finishing treatments
PURPOSE OF THIS STUDY: BUILDING AN ONTOLOGY FOR THE INDUSTRY OF CORK

Domain: cork

Scope of knowledge

Purpose: Tool for experts, future experts, translators...
A CORPUS BUILT FROM SCRATCH AS A RESOURCE TO GRASP EXPERTS’ CONCEPTUALISATIONS

**Domain:** cork

**Cork Corpus**

**Scope of knowledge:** stoppers

**Non-ontological resource**
CORPUS BUILDING AND PROCESSING: OVERVIEW

1. Domain corpus compilation
   - Domain understanding
   - Text capture (pdf.; OCR; web crawling)
   - Text typology

2. Corpus management
   - Meta-data edition
   - POS tagging

3. Text mining
   - Word sketch
   - CQL + REGEX
   - Extraction of linguistic data

4. Analysis
   - CQL results
   - REGEX refinement
The more significant the knowledge gap between the author-expert and his audience, the more definitions and contextual definitions are observed in specialised texts.

**THE CORPUS OF ANALYSIS**

**Communicative setting of text production**

- Scientific : expert-expert
- Regulatory: semi-expert - expert
- Marketing : semi-expert - non-expert
- Narrative-Informative : semi-expert - non-expert
- Economics : expert- semi-expert
- Technical-explanatory & normative : expert - quasi-expert / professional

1. Glossaries
2. Definitions written by experts
   *a priori* validation

**corpus of analysis = 43 texts**

Remaining texts = reference corpus

n=98

**corpus of analysis = 43 texts**

**Remaining texts = reference corpus**

**THE CORPUS OF ANALYSIS**

The more significant the knowledge gap between the author-expert and his audience, the more definitions and contextual definitions are observed in specialised texts.
TEXT MINING: THE 1ST TASK OF KNOWLEDGE CAPTURE (ONTOLOGY’S CYCLE)

Domain: cork
Cork Corpus
Text mining

Scope of knowledge: stoppers
Non-ontological resource
Knowledge capture:
1. Textual data extraction

SPECIFICATION
CONCEPTUALISATION
TEXT MINING STRATEGIES: AN ITERATIVE PROCESS

<table>
<thead>
<tr>
<th>Nº</th>
<th>CQL construct</th>
<th>hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>[word=&quot;[:upper:]<em>&quot;[tag=&quot;Fd.</em>&quot;]</td>
<td>614</td>
</tr>
<tr>
<td>2</td>
<td>[word=&quot;[:upper:]<em>&quot;&amp;(lemma=&quot;rolha.</em>&quot;)][tag=&quot;Fd.*&quot;]</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>[word=&quot;[:upper:]<em>&quot;&amp;(lemma=&quot;rolha.</em>&quot;)[[0,6] [tag=&quot;Fd.*&quot;]</td>
<td>208</td>
</tr>
<tr>
<td>4</td>
<td>&quot;rolha&quot;[(tag=&quot;V.P.*&quot;)</td>
<td>(tag=&quot;A.*&quot;)]</td>
</tr>
<tr>
<td>5</td>
<td>&quot;rolha&quot;[(tag=&quot;V.P.*SF&quot;)</td>
<td>(tag=&quot;A.*&quot;)]</td>
</tr>
<tr>
<td>6</td>
<td>&quot;rolha&quot;[tag=&quot;V.P.*SF&quot;]</td>
<td>69</td>
</tr>
<tr>
<td>7</td>
<td>&quot;rolha&quot;[(tag=&quot;D.*&quot;)</td>
<td>(tag=&quot;S.*&quot;)?</td>
</tr>
<tr>
<td>8</td>
<td>&quot;rolha&quot;[(tag=&quot;D.*&quot;)</td>
<td>(tag=&quot;S.*&quot;)?&quot;cortiça&quot;?][0,4]</td>
</tr>
</tbody>
</table>

CQL7 evolved from CQL 6, but was also inspired on CQL 3 results: N+ det + ADJ + ? + VPP

CQL4 was inspired on CQL3 results: N+VPP / ADJ

After CQL 6, we decided to match the structure of intensional definitions, where the generic term is repeated in the definiens.

<table>
<thead>
<tr>
<th>left-hand side context</th>
<th>KWIC</th>
<th>right-hand side context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolha de cortiça aglomerada por moldagem : rolha obtida</td>
<td>rolha formada</td>
<td>por um corpo em cortiça aglomerada e um ou dois discos</td>
</tr>
</tbody>
</table>

1 of the KWIC matched with CQL8
Contextual definitions and definitional contexts (descriptions)

Recurrent patterns were observed in context:

_Rolha_ que _foi submetida a_ um _tratamento químico_ com o objectivo de desinfectar e/ou homogeneizar a cor e/ou branquear.

_Stopper that was submitted to chemical treatment with the aim of disinfecting and/or homogenising the colour and/or bleaching._

Linguistic expressions that commonly _relate terms_ and _denote domain knowledge_: LEXICAL MARKERS
### 4 Definitions Selected to Demonstrate Our Methodology

<table>
<thead>
<tr>
<th>4 definitions (literal translations from pt)</th>
<th>4 definitions (pt) extracted from the Cork corpus</th>
</tr>
</thead>
<tbody>
<tr>
<td>stopper Product obtained from natural cork and / or agglomerated cork, consisting of one or more pieces, intended to seal bottles or other containers and to preserve their contents. (5.1 - NORM)</td>
<td>rolha Producto obtido da cortiça natural e / ou de cortiça aglomerada, constituído por uma ou mais peças, destinado a vedar garrafas ou outros recipientes e a preservar o seu conteúdo. (5.1 - NORM)</td>
</tr>
<tr>
<td>STOPPER piece of cork, usually cylindrical, conical or prismatic quadrangular, sometimes with rounded or chamfered lateral edges, consisting of one or several glued elements and intended to seal the containers or contribute to their water tightness. (7.8 - TECH)</td>
<td>ROLHA peça de cortiça, em geral cilíndrica, troncocônica ou prismática quadrangular, por vezes de arestas laterais boleadas ou chanfradas, constituída por um ou vários elementos colados e destinada a vedar os recipientes ou a contribuir para a sua <em>estanquicidade</em> (7.8 – TECH)</td>
</tr>
<tr>
<td>natural cork stopper Stopper consisting entirely of natural cork</td>
<td>rolha de cortiça natural Rolha totalmente constituída por cortiça natural.</td>
</tr>
<tr>
<td>Note: Natural cork stoppers that have been submitted to the sealing operation (see 6.5.5) are commonly referred to as colmatated natural stoppers. (5.5 – NORM)</td>
<td>Nota: As rolhas naturais que tenham sido submetidas à operação de colmatagem (ver 6.5.5) são comumente designadas por rolhas naturais colmatadas. (5.5 – NORM)</td>
</tr>
<tr>
<td>colmatated natural cork stopper The colmatated natural cork stopper is a stopper made of natural cork in which its lenticels are filled with a mixture of glues and cork powder from the dimensional finishing processes of natural cork stoppers. (6.1 – REP)</td>
<td>rolha de cortiça natural colmatada A rola de cortiça natural colmatada é uma rola feita de cortiça natural em que são obturadas as suas lenticelas com uma mistura de colas e pó de cortiça proveniente dos acabamentos dimensionais das rolhas de cortiça natural. (6.1 – REP)</td>
</tr>
</tbody>
</table>
LINGUISTIC ANALYSIS: THE 2\textsuperscript{ND} TASK OF KNOWLEDGE CAPTURE

**Domain:** cork

**Cork Corpus**

**Text mining**

**Linguistic analysis**

**Scope of knowledge: stoppers**

**Non-ontological resource**

**Knowledge capture:**
1. Textual data extraction
2. Terms and Lexical-semantic R

**SPECIFICATION**

**CONCEPTUALISATION**
Language is the vehicle of the thought, mirroring the conceptualisation, where cognitive operations are performed.

A conceptual systematisation underlies term systematisation

1. Linguistic analysis of textual definitions
   - Identify linguistic expressions relating terms
   - Infer lexical-semantic relations linguistically expressed by what we call lexical markers
   - Organise the interpretation of texts in the form of lexical maps
### LINGUISTIC ANALYSIS: LEXICAL-SEMANTIC RELATIONS SYSTEMATISED AFTER THE DECONSTRUCTION OF THE DEFINITIONAL SENTENCE

<table>
<thead>
<tr>
<th>Analysis Definition 3</th>
<th>Lexical marker observed</th>
<th>Lexical-semantic relation</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>natural cork stopper [is a] stopper</td>
<td>‘is a’ = Ø</td>
<td>HYPERNYMY - HYPONYMY</td>
<td>stopper [GENERIC] natural cork stopper [SPECIFIC]</td>
</tr>
<tr>
<td>natural cork stopper [consists entirely of] natural cork</td>
<td>‘consisting entirely of’</td>
<td>HOLONYMY-MERONYMY</td>
<td>natural cork stopper [OBJECT] natural cork [STUFF]</td>
</tr>
<tr>
<td>natural cork stopper [is submitted to] the sealing operation</td>
<td>‘submitted to’</td>
<td>HOLONYMY-MERONYMY</td>
<td></td>
</tr>
<tr>
<td>colimated natural stopper [is a] natural cork stopper</td>
<td>‘commonly referred to as’ same as = ‘is a’</td>
<td>HYPERNYMY - HYPONYMY</td>
<td></td>
</tr>
<tr>
<td>colimated natural stopper [results from] the sealing operation</td>
<td>results from = inferred from ‘submitted to’</td>
<td>HOLONYMY-MERONYMY</td>
<td></td>
</tr>
</tbody>
</table>

The meaning of “natural cork” points to the meaning of raw material, while the meaning of “stopper” points to the meaning of an object.

→ HOLONYMY-MERONYMY subtype: [OBJECT-STUFF]
Linguistic Analysis: **co-text and context** are crucial to interpret LM and identify sub-types of meronymy.

<table>
<thead>
<tr>
<th>Lexical marker (pt)</th>
<th>Lexical marker (en)</th>
<th>Lexical-semantic relations</th>
<th>Sub-type of relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>'constituída por'</td>
<td>‘consisting of’</td>
<td>HOLONYMY-MERONYMY</td>
<td>object-components</td>
</tr>
<tr>
<td>'totalmente constituída por'</td>
<td>‘consisting entirely of’</td>
<td>HOLONYMY-MERONYMY</td>
<td>object-stuff</td>
</tr>
</tbody>
</table>

- **term A in context = object**
  - “piece of cork” **consisting of** “one or several glued elements”
  - meaning = components

- **term A in co-text = object**
  - “stopper” **consisting entirely of** “natural cork”
  - **term B in co-text = stuff**
Lexical Map 3 - Representation of Definition 3:

natural Cork Stopper

stopper consisting entirely of natural cork

Note: Natural cork stoppers that have been submitted to the sealing operation are commonly referred to as colmated natural stoppers.
CONCEPTUAL ANALYSIS: THE 3RD TASK OF KNOWLEDGE CAPTURE

- Domain: Cork
- Cork Corpus
- Text mining
- Linguistic analysis
- Conceptual analysis

**Scope of knowledge: stoppers**

**Non-ontological resource**

**Knowledge capture:**
1. Textual data extraction
2. Terms and Lexical-semantic R.
3. Concepts, conceptual R. and characteristics [X=Y+DC]

**SPECIFICATION**

**CONCEPTUALISATION**
CONCEPTUAL ANALYSIS: X=Y+DC, A MECHANISM TO INFER KNOWLEDGE FROM TEXTS

Aristotelian formula X [SPECIES] = Y [GENUS] + DC [DIFFERENTIAL CHARACTERISTICS]

1. We can systematically infer:
   - **Characteristics**
     colmatated natural stopper [SPECIES] = natural stopper [GENUS]+ colmatated [DC]
   - **concept’s place**
     - *proximum* genus
     - species
     colmatated natural cork stopper [SPECIES] = natural cork stopper [GENUS] + sealing operation [DC]

2. **Propose conceptual relations identifiers** to mirror how concepts relate
   - **Conceptual relations**
     - Subsumption
     - Associative
     - Partitive
   
   has_process [corresponds to LM ‘submitted to’]

ASSOCIATIVE relation [PROCESS-RESULT]

The starting point to name concepts and domain descriptive relations to build the ontology
## Conceptual Analysis: Finding Axes of Analysis to Build an Ontology

<table>
<thead>
<tr>
<th>Lexical marker (en)</th>
<th>Lexical-semantic relation</th>
<th>Conceptual relation identifier</th>
<th>Conceptual relation</th>
<th>Axis of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘usually’</td>
<td>HYPERNYMY - HYPONYMY</td>
<td>has_shape</td>
<td>ASSOCIATIVE object-shape</td>
<td>Shape</td>
</tr>
<tr>
<td>‘sometimes with’</td>
<td>HYPERNYMY - HYPONYMY</td>
<td>has_process</td>
<td>ASSOCIATIVE process-result</td>
<td>Finishing Process</td>
</tr>
<tr>
<td>‘commonly referred to as’</td>
<td>HYPERNYMY - HYPONYMY</td>
<td>is_a</td>
<td>SUBSUMPTION</td>
<td></td>
</tr>
<tr>
<td>‘consisting of’</td>
<td>HOLONYMY-MERONYMY object-components</td>
<td>has_part</td>
<td>PARTITIVE</td>
<td>Parts</td>
</tr>
<tr>
<td>‘obtained from’</td>
<td>HOLONYMY-MERONYMY object-stuff</td>
<td>has_raw_material</td>
<td>ASSOCIATIVE product-raw material</td>
<td>Substance</td>
</tr>
<tr>
<td>‘consisting entirely of’</td>
<td>HOLONYMY-MERONYMY object-stuff</td>
<td>has_substance</td>
<td>ASSOCIATIVE matter/substance - property</td>
<td>Substance</td>
</tr>
<tr>
<td>‘have been submitted to’</td>
<td>HOLONYMY-MERONYMY activity-feature</td>
<td>has_process</td>
<td>ASSOCIATIVE process-result</td>
<td>Finishing Process</td>
</tr>
<tr>
<td>‘is made of’</td>
<td>HOLONYMY-MERONYMY object-stuff</td>
<td>has_substance</td>
<td>ASSOCIATIVE product-raw material</td>
<td>Substance</td>
</tr>
<tr>
<td>‘are filled with’</td>
<td>HOLONYMY-MERONYMY activity-feature</td>
<td>has_process</td>
<td>ASSOCIATIVE process-result</td>
<td>Finishing Process</td>
</tr>
<tr>
<td>‘from the’</td>
<td>HOLONYMY-MERONYMY activity-feature</td>
<td>has_process</td>
<td>ASSOCIATIVE process-result</td>
<td>Finishing Process</td>
</tr>
<tr>
<td>‘intended to’</td>
<td>---</td>
<td>has_function</td>
<td>ASSOCIATIVE object-function</td>
<td>Function</td>
</tr>
</tbody>
</table>
Concepts are organised by specific differentiation considering 3 axes of analysis: Substance, Parts and Process.

PROPOSAL OF A CONCEPTUAL MAP
OF THE 3 MAIN TYPES OF STOPPERS

THESIS DEFENCE OF PH.D. CANDIDATE MARGARIDA RAMOS | NOVA CLUNL; USMB LISTIC | COLÉGIO ALMADA NEGREIROS (CAN), LISBOA

23/11/2020
KNOWLEDGE ORGANISATION: NAMING CONCEPTS AND RESTRICTIONS TO BUILD THE ONTOLOGY

**Domain:** Cork

**Cork Corpus**

**Text mining**

**Linguistic analysis**

**Conceptual analysis**

**Knowledge organisation - Ontology**

**Scope of knowledge:** stoppers

**Non-ontological resource**

**Knowledge capture:**
1. Textual data extraction
2. Terms and Lexical-semantic R.
3. Concepts, conceptual R. and characteristics \[X=Y+DC\]

**Naming concepts + restrictions**

**SPECIFICATION**

**CONCEPTUALISATION**

**FORMALISATION**
KNOWLEDGE ORGANISATION: NAMING RESTRICTIONS BASED ON THE 5 AXES OF ANALYSIS

Conceptual relation identifiers
- has_shape
- has_process
- has_part
- has_raw_material
- has_substance
- has_function

Domain description relations = 5 axes of analysis
- hasShape
- hasFinishingProcess
- hasStructure
- IsMadeOf
- hasFunction
KNOWLEDGE ORGANISATION: NAMING CONCEPTS ACCORDING TO THE (I) WHOLE SET OF CHARACTERISTICS OR (II) THE STAGE IN THE MANUFACTURE PROCESS
KNOWLEDGE ORGANISATION: NAMING CONCEPTS ACCORDING TO THEIR PURPOSE

Conceptual Map of <Finishing_processes>: the starting point for naming the associative relations [PROCESS-RESULT]
Knowledge organisation coding in Manchester OWL DL

- Domain: Cork
- Cork Corpus
- Text mining
- Linguistic analysis
- Conceptual analysis

Knowledge organisation:
- Ontology

Scope of knowledge: stoppers

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Naming concepts + restrictions

Coding in Manchester OWL DL

SPECIFICATION

CONCEPTUALISATION

FORMALISATION

IMPLEMENTATION
OntoCork is a micro domain-ontology of cork stoppers according to their structure, substance, function, shape and finishing treatments, within the scope of the transformation sector in the industry of cork.

This ontology seeks to respond to two typologies:
1. **the type of cork stopper** compared to the type of cork (raw material) with which it is produced; and
2. **the typology of operations** that belong to the finishing processes.

Finally, this ontology should also respond to **the state of completion** – in the sense of finished product – of the cork stopper, depending on the last operation to which it was submitted.
hasFinishingProcesses is a restriction used to express the conceptual relation [PROCESS-RESULT]

owl:domain and owl:range restrictions dictate the classification of concepts in the manufacturing process.

rdfLabel: WashedMono-PieceNaturalCorkStopper
OntoCork
KNOWLEDGE ORGANISATION: SOME COMPETENCY QUESTIONS

Domain: Cork
Cork Corpus
Text mining
Linguistic analysis
Conceptual analysis

Knowledge organisation
- Ontology

**Scope** of knowledge: stoppers

Non-ontological **resource**

**Knowledge capture:**
1. Textual data extraction
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3. Concepts, conceptual R. and characteristics \[X=Y+DC\]

**Naming** concepts + restrictions

**Coding** in Manchester OWL DL

Competency questions (DL-Q)

SPECIFICATION

CONCEPTUALISATION

FORMALISATION

IMPLEMENTATION

EVALUATION
1. Which stoppers have “final finishing processes”?
   OK

2. What is a “semi-finished stopper”?
   Almost OK:
   The answer includes FinishedStopper because it’s a species of the previous.
   Yet again, it’s OK! The goal of this decision is getting a switch of status as soon as the description includes a restriction with the domain set to <FinishedStopper> 😊
THE BUILDING BLOCKS OF TERMCORK

Domain: Cork
Cork Corpus
Text mining
Linguistic analysis
Conceptual analysis

Knowledge organisation
- Ontology

Scope of knowledge: stoppers
Non-ontological resource
Knowledge capture:
1. Textual data extraction
2. Terms and Lexical-semantic R.
3. Concepts, conceptual R. and characteristics [X=Y+DC]

Naming concepts + restrictions
Coding in Manchester OWL DL
Competency questions (DL-Q)

SPECIFICATION
CONCEPTUALISATION
FORMALISATION
IMPLEMENTATION
EVALUATION
DOCUMENTATION
Model of the methodology following the classic cycle to build an ontology
FUTURE WORK: A PROJECT TO BUILD A LEXICOGRAPHIC RESOURCE PAIRED WITH AN ONTOLOGY

TermCork methodology will underpin the design of a project to build a multimodal (multimedia) terminological resource:

- Linking several resources with SKOS (1) Core Vocabulary– a W3C recommendation for interoperability in the Web Semantic, to express a concept scheme as an RDF graph:
  - CorkCorpus (specialised texts and images)
  - OntoCork
  - Lexonomy (e-Dictionary)

(1) Simple Knowledge Organisation System
FROM FORMAL OWL TO A LESS FORMAL MODEL: SKOS

For triples involving the rdf:type property, the RDF/XML syntax allows a shortened form to model multilingual SKOS labels and link resources to the concept.

<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:skos="http://www.w3.org/2004/02/skos/core#"
  xmlns:foaf="http://xmlns.com/foaf/0.1#">
  <skos:Concept
    rdf:about="http://www.clunl.fchsh.unl.pt/OntoCork#ColmatedWashedMono-pieceNaturalCorkStopper">
    <skos:prefLabel xml:lang="pt">rolha de cortiça natural colmatada</skos:prefLabel>
    <skos:prefLabel xml:lang="en">colmated natural cork stopper</skos:prefLabel>
    <skos:prefLabel xml:lang="fr">bouchon en liège naturel colmaté</skos:prefLabel>
    <skos:altLabel xml:lang="pt">rolha colmatada</skos:altLabel>
    <skos:definition xml:lang="pt">rolha de cortiça natural submetida a operação de colmatagem</skos:definition>
    <foaf:isPrimarySubject rdf:resource="https://www.lexonomy.eu/k4ysn6um/edit/entry"/>
    <foaf:isSubject rdf:resource="http://www.clunl.fchsh.unl.pt/OntoCork"/>
    <foaf:SubjectOf rdf:resource="http://www.clunl.fchsh.unl.pt/CorkCorpus"/>
  </skos:Concept>
</rdf:RDF>
Specialised texts are an undeniable source of rich knowledge contexts
- Particularly definitional contexts;
- The expert’s choices in discourse tend to mirror how concepts relate with each other.

Getting familiarised with the domain is essential for the capture and interpretation of specialised texts
- Some texts do not convey the whole information that a non-expert needs to grasp the concept.

The methodology CorkTerm is not designed for the domain of cork exclusively
- Textual data is the starting point of knowledge access
- Linguistic and conceptual analysis of textual data allows us to model information systematically
- Dichotomic labels, e.g. [PROCESS-RESULT] can be integrated in future lexicographic work, e.g., encoding domain tags; semantic tags; ...

Special field knowledge resources can be shared through the interoperability exchange formats used for encoding information
- SKOS Core Vocabulary and other RDF applications such as FOAF are encoding that facilitates machine-readability between resources
- Documents indexation is another complementary resource that can be thought of to be included

Knowledge modelling in the form of an ontology – a common and shared terminology – is an added-value for both experts and non-experts settings of communication
- Intensional definitions of concepts in natural language and corresponding formal descriptions, along with their visualisation in the form of an OntGraf, are complementary resources for knowledge acquisition and/or dissemination.