Pattern Comparison of *is-a* Concepts for Ontology Localisation

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Within an OWL ontology:

• There is a commitment to a conceptualisation by its logical language, using some natural language ($L_1$) for each concept name, property name, and other axioms

• When making the ontology multilingual for another natural language ($L_2$), $L_2$-specific labels are added to each concept and property name

• The underlying axioms remain unchanged, and it is assumed there is a 1-1 mapping from $L_1$ to $L_2$

• $L_2$ is only a translation
Ontology localisation

The “process of adapting a given ontology to the needs of a certain community, which can be characterized by a common language, a common culture or a certain geopolitical environment.” [1]

- Adaptation is typically done in the annotation layer
- The underlying axioms remain unchanged

Localisation approach

\[ O, \text{ for domain } D, \text{ and language } L_1. \]

\[ C_S \subseteq O, \text{ for concept } C_0, \text{ domain } D, \text{ and language } L_n. \]

\[ C_S', \text{ for concept } C_0, \text{ domain } D, \text{ and language } L_n, \text{ where } C_S' \text{ is also an ontology.} \]
Types of concepts for a language pair

1. A concept which has a lexical realisation for the natural languages used for both the source and target language.

2. A concept which has a lexical realisation in the source language; in the target language, there is no lexical realisation however the concept is known.

3. Similar to (2), except that the concept is not known in the target language.

4. For both the source and target language, the concept is known, however neither have a lexical realisation. The concept is known in a third language.

For 2-4, this is known as a lexical gap.
## Language examples as use cases

<table>
<thead>
<tr>
<th>Source</th>
<th>Target</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UC1</strong></td>
<td>traffic light (en)</td>
<td>robot (en-sa)</td>
</tr>
<tr>
<td><strong>UC2</strong></td>
<td>spoon (en)</td>
<td>lepel (af)</td>
</tr>
<tr>
<td><strong>UC3</strong></td>
<td>river (en)</td>
<td>rivière, fleuve (fr)</td>
</tr>
<tr>
<td><strong>UC4</strong></td>
<td>city, town, village, hamlet (en)</td>
<td>ville, village, bourg, bourgade, hameau (fr)</td>
</tr>
</tbody>
</table>
Concepts in OWL

LINGUISTIC LAYER

- Annotations
  - Metadata
  - Label(s)

SEMANTIC LAYER, TBox

- Axiom Pattern
  - Class name(s)
  - Axioms for its ontological commitment

- Individual(s)

Source Concept

Target Concept

ABox

Annotations

Label(s)

Superclass

Superclass

Axiom Pattern

Class name(s)

Axioms for its ontological commitment

Individual(s)
Abstraction of a superclass

### Pattern Comparison of isa Concepts for Ontology Localisation

**6th November 2023**

<table>
<thead>
<tr>
<th>Source</th>
<th>Target</th>
<th>Source</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC1</td>
<td>$A_m$</td>
<td>$A'_m$</td>
<td>SC2</td>
</tr>
<tr>
<td>SC3</td>
<td>$A_1$</td>
<td>$A'_m$</td>
<td>SC4</td>
</tr>
<tr>
<td>SC5</td>
<td>$A_0$</td>
<td>$B'_0$</td>
<td>SC6</td>
</tr>
<tr>
<td>SC7</td>
<td>$A_1$</td>
<td>$B'_0$</td>
<td>SC8</td>
</tr>
</tbody>
</table>
**Superclass patterns**

- **P-SC1**: Equal source and target superclass
- **P-SC2**: Unequal source and target superclass at same depth, and shared parent
- **P-SC3**: Unequal source and target superclass at different depth, and shared parent
- **P-SC4**: Unequal source and target superclass, and no shared parent
- **P-SC5**: No source and target superclass
Example superclass pattern

P-SC3: Unequal source and target superclass at different depth, and shared parent

- *alignment pattern name:* sc-unequal-differentDepth-sharedParent
- *pattern element variations:*
  1. \( \text{Src} = \{A_m\}, \text{Trg} = \{A'_0\}, \text{where } m \neq 0 \)
  2. \( \text{Src} = \{A_{m,n}\}, \text{Trg} = \{A'_n\}, \text{where } m \neq 0 \text{ and } n \geq 1 \)
  3. \( \text{Src} = \{A_{m,n}\}, \text{Trg} = \{A'_0\}, \text{where } m \neq 0 \text{ and } n \geq 1 \)
  4. \( \text{Src} = \{A_{m,n}\}, \text{Trg} = \{\text{owl:Thing}\}, \text{where } m, n \geq 0 \)
  5. Same as (1)–(4), but mirrored
- *equality of PE:* \( \text{Src} \neq \text{Trg} \)
- *refactoring required:* for the \( \text{Src} \) or \( \text{Trg} \) with the least depth, this is possibly a lexical gap. Options include:
  1. Add a pseudo-class as a translation of the opposite superclass.
  2. Remove the extra classes, taking care to refactor any subclasses and individuals.
Abstraction of an axiom pattern

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Axiom patterns

• **P-AP1**: Equal source and target axiom pattern, same superclass
• **P-AP2**: Equal source and target axiom pattern, different superclass
• **P-AP3**: Unequal source and target axiom pattern, some shared classes
• **P-AP4**: Unequal source and target axiom pattern, no shared classes
Example axiom pattern

P-AP1: Equal source and target axiom pattern, same superclass

- alignment pattern name: ap-equal-sameSuperclass
- pattern element variations:
  1. \( \text{Src} = \{ \circ C \}, \text{Trg} = \{ \circ C' \} \), where \( \circ \) is the same for \( \text{Src} \) and \( \text{Trg} \)
  2. \( \text{Src} = \{ \nabla R_x.C \}, \text{Trg} = \{ \nabla R_x.C' \} \), where \( \nabla \) and \( x \) are each the same for \( \text{Src} \) and \( \text{Trg} \)
  3. \( \text{Src} = \{ C \square D \}, \text{Trg} = \{ C' \square D' \} \), where \( \square \) is the same for \( \text{Src} \) and \( \text{Trg} \)
- superclass pattern variations: P-SC1, P-SC3
- equality of PE: \( \text{Src} \equiv \text{Trg} \)
- refactoring required: none
Abstraction of an annotation

- **P-Ann1**: Both source and target have a label of similar content
- **P-Ann2**: Both source and target do not have a label
- **P-Ann3**: Both source and target do not have a label of similar content
- **P-Ann4**: Target uses the source label
- **P-Ann5**: Both source and target use a lexicalisation from another language
Example annotation pattern

P-Ann3: Both source and target do not have a label of similar content

- *alignment pattern name*: ann-unequal-annotation
- *pattern element variations:*
  1. $Src = \text{lexicalisation}, \ Trg = \text{meta/paraphrase}$
  2. $Src = \text{lexicalisation}, \ Trg = \text{explanation}$
### Language examples revisited

<table>
<thead>
<tr>
<th>Concept</th>
<th>Pattern</th>
<th>SC</th>
<th>SC'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic light (en)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robot (en-sa)</td>
<td></td>
<td></td>
<td>P-AP1 and P-SC1, P-Ann1</td>
</tr>
<tr>
<td>Spoon (en)</td>
<td></td>
<td></td>
<td>P-AP2 and P-SC3, P-Ann1</td>
</tr>
<tr>
<td>Lepel (af)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>River (en)</td>
<td></td>
<td></td>
<td>P-AP4 and P-SC1, P-Ann1</td>
</tr>
<tr>
<td>Ville, village, bourg, bourgade, hameau (fr)</td>
<td></td>
<td></td>
<td>AP-3 and P-SC1, P-Ann1</td>
</tr>
</tbody>
</table>
Ontology Localisation

```owl
1 pcs:cs_uc2 a :PairedConceptSpace ;
2 :targetViewpoint vp:AFViewpoint ;
3 :sourceConcept ont:Spoon ;
4 :targetConcept micro:UC2 ;
5 :semanticCategory :IndirectEquivalent ;
6 :hasPattern :P-AP2 , :P-SC3 , :P-Ann1 ;
7 :hasProcess pcs:cs_uc2_action1 .
8
9 pcs:cs_uc2_action1 a :RefactorAction , :ChangeSuperclassOfTarget ;
10 :targetNode micro/UC2:Spoon ;
11 :targetSuperclass ont:Utensil .
```

RDF to localise a concept from a source to a target language, region or other viewpoint

Thank You!