

Concept Alignment for Multilingual Machine Translation

04.07.2021

Arianna Masciolini

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- ❖ in such systems, **lexical exactness** is as important as grammaticality
 - ❖ need for high-quality **translation lexica** preserving semantics *and* morphological correctness

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- ❖ desire to **automate** this process at least in part
 - ❖ possible when **example parallel data** are available

A parallel corpus

Alice thought she might as well wait, as she had nothing else to do, and perhaps after all it might tell her something worth hearing.

For some minutes it puffed away without speaking, but at last it unfolded its arms, took the hookah out of its mouth again, and said, 'So you think you're changed, do you?'

'I'm afraid I am, sir,' said Alice; 'I can't remember things as I used--and I don't keep the same size for ten minutes together!'

Alice pensò che poteva aspettare, perchè non aveva niente di meglio da fare, e perchè forse il Bruco avrebbe potuto dirle qualche cosa d'importante.

Per qualche istante il Bruco fumò in silenzio, finalmente sciolse le braccia, si tolse la pipa di bocca e disse: — E così, tu credi di essere cambiata?

— Ho paura di sì, signore, — rispose Alice. — Non posso ricordarmi le cose bene come una volta, e non rimango della stessa statura neppure per lo spazio di dieci minuti!

From Lewis Carroll, *Alice's adventures in Wonderland*. Parallel text at paralleltext.io

Alignment

Word alignment:

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nothing else to do, and perhaps after all it might tell
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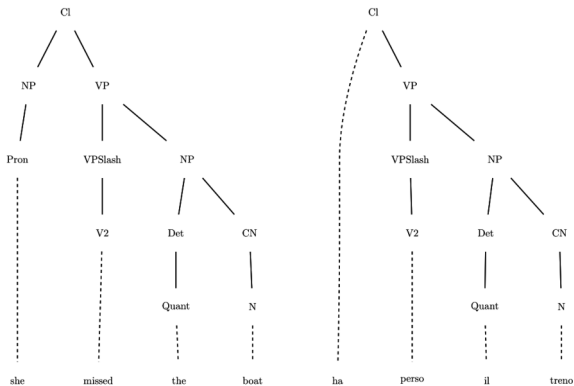
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- ❖ “fixed” level of abstraction (word, phrase or sentence)

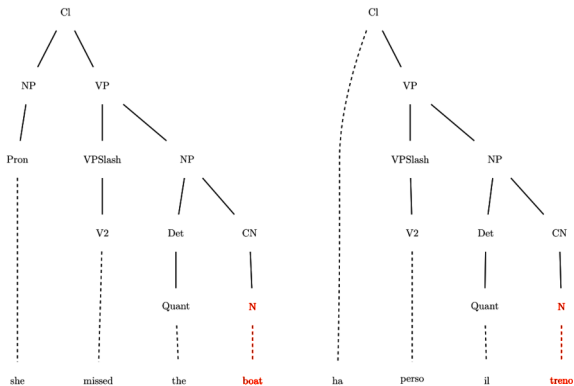
Syntax-based approaches I

Alternative: tree-to-tree alignment.



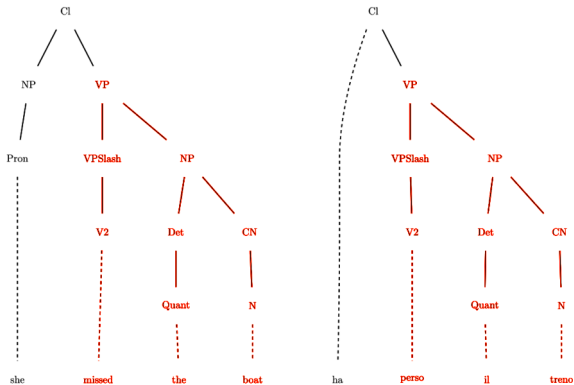
Syntax-based approaches II

Word alignment



Syntax-based approaches III

Phrase alignment



Comparison

statistical	syntax-based
require large amounts of data	work consistently well even on individual sentence pairs
works with raw data	requires the data to be analyzed
correspondences between strings	correspondences between grammatical objects
“fixed” level of abstraction (word or phrase)	all levels of abstraction → concept alignment

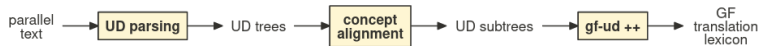
Why not just use GF?

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 - ❖ lack of robust GF parsers
- ❖ dependency trees are an easier target for a parser
 - ❖ neural parsers such as **UDPipe**

Overview

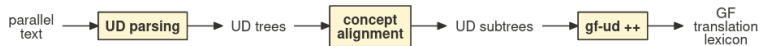


Overview



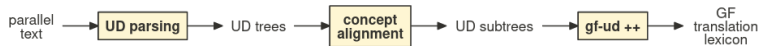
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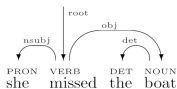
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Overview



1. parse parallel data to UD trees
2. search for aligned UD subtrees
3. convert them to GF trees and then grammar rules

UD trees



text = she missed the boat

1 she she PRON _ _ 2 nsubj _ _

2 missed miss VERB _ _ 0 root _ _

3 the the DET _ _ 4 det _ _

4 boat boat NOUN _ _ 2 obj _ _

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Graphical, CoNNL-U and Rose Tree representation of the same UD tree.

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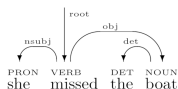
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- dependency-labelled links between words (head-dependent pairs)

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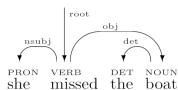
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- ❖ POS tags

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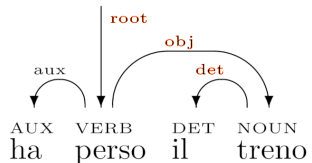
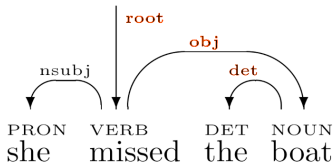
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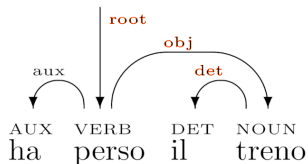
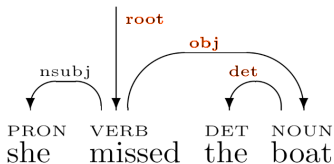
- ❑ dependency-labelled links between words (head-dependent pairs)
- ❑ POS tags
- ❑ ...

Extracting concepts

Matching dependency labels

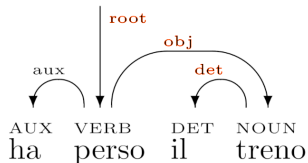
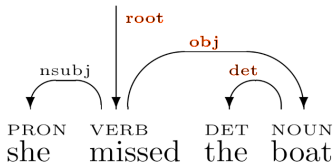


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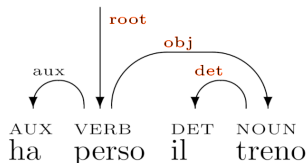
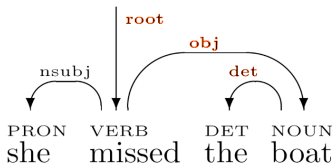
❖ *⟨she missed the boat, ha perso il treno⟩*

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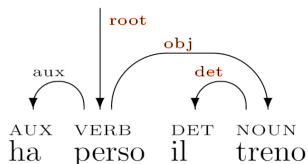
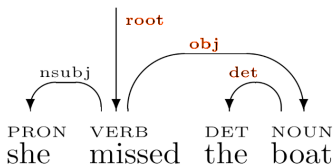
- ❑ *<she missed the boat, ha perso il treno>*
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Matching dependency labels



- ❑ $\langle she \text{ missed the boat, ha perso il treno } \rangle$
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- ❑ $\langle \textit{the, il} \rangle$

Aligning heads of matching trees

❖ $\langle \textit{the boat}, \textit{il treno} \rangle$

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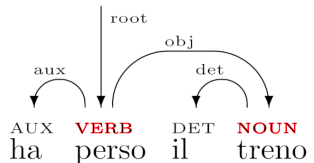
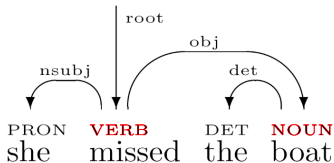
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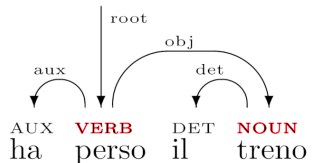
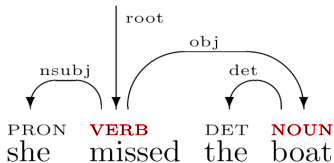
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(including the auxiliary)

Using POS tags

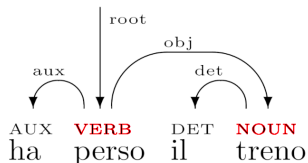
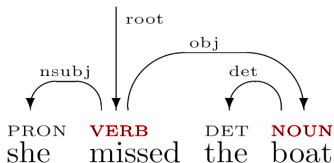


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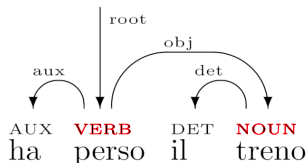
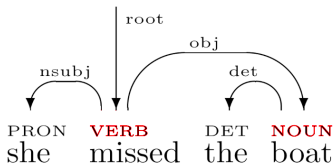
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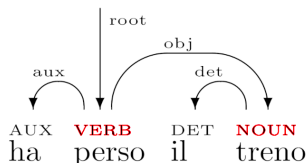
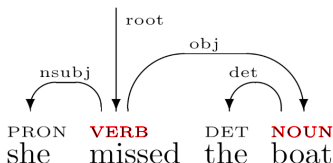
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- ❑ can increase precision if used **in conjunction with labels**

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- ❖ head swapping

- ❖ *⟨Anna **usually** goes for walks, Anna **brukar** promenera⟩*

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❖ ⟨*Anna **usually** goes for walks, Anna **brukar** promenera*⟩

❖ thematic

❖ ⟨***Yana** likes **books**, **A Yana** piacciono **i libri***⟩

Reusing known alignments

- ▣ allows using CA in conjunction with statistical tools

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- iterative application

Searching for specific patterns

- gf-ud pattern matching allows looking for specific syntactic patterns

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- ❑ possible generalization via pattern replacement

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- ❖ possible generalization via pattern replacement

Example predication patterns:

- ❖ $\langle \textit{she missed the boat, ha perso il treno} \rangle \rightarrow \langle [\textit{subj}] \textit{ missed} [\textit{obj}], \textit{ ha perso} [\textit{obj}] \rangle$
- ❖ $\langle \textit{she told you that, hon berättade det för dig} \rangle \rightarrow \langle [\textit{subj}] \textit{ told} [\textit{iobj}] [\textit{obj}], [\textit{subj}] \textit{ berättade} [\textit{obj}] \textit{ för} [\textit{obl}] \rangle$

Propagating concepts to a new language

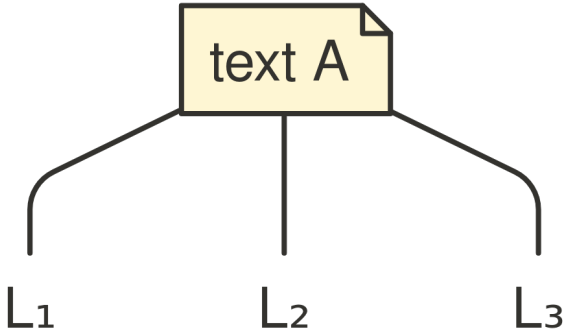
Concept Propagation

- ❖ So far, we focused on how to identify correspondences in bilingual parallel texts (***Concept Extraction***)

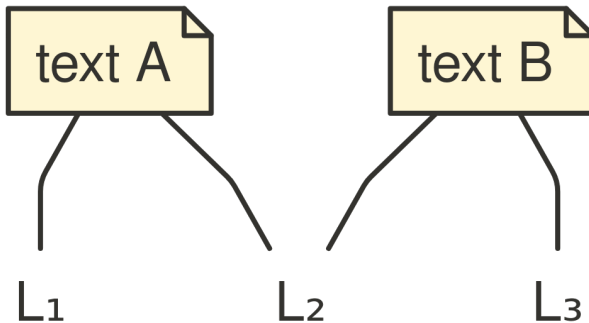
Concept Propagation

- ❖ So far, we focused on how to identify correspondences in bilingual parallel texts (***Concept Extraction***)
- ❖ what happens when we need to handle a third language?
 - ❖ ***Concept Propagation***: finding the expression corresponding to a known concept in a new language

Scenario 1



Scenario 2



Generating grammar rules

Requirements

- ✚ aligned UD trees

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- ❑ dependency configurations for `gf-ud`

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- ❑ **morphological dictionaries**
- ❑ **extraction grammar**

Morphological dictionaries

Purely morphological unilingual dictionaries.

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Example:

```
...  
lin morphologic_A =  
    mkAMost "morphologic" "morphologicly" ;  
lin morphological_A =  
    mkAMost "morphological" "morphologically" ;  
lin morphology_N =  
    mkN "morphology" "morphologies" ;  
...
```

Extraction grammar

Defines the syntactic categories and functions to build lexical entries.

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Example (prepositional NPs):

PrepNP : Prep -> NP -> PP # case head

Lexical rules

Abstract:

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fun in_the_field__inom_området_PP : PP ;
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Lexical rules

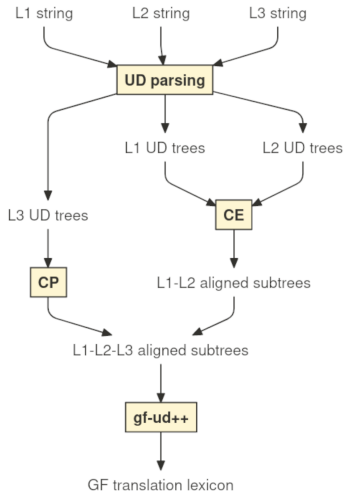
Abstract:

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English concrete:

```
lin in_the_field__inom_område_PP =  
  PrepNP in_Prep (DetCN the_Det (UseN field_N))
```

Detailed view



Refining the generated lexicon

Postprocessing tools:

Refining the generated lexicon

Postprocessing tools:

- ▣ interactive selection

Refining the generated lexicon

Postprocessing tools:

- ❑ interactive selection
- ❑ CoNNL-U synoptic viewer

Summary

❖ (parsing)

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- ❑ (parsing)
- ❑ concept extraction

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- ❑ concept extraction
- ❑ concept propagation

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- ❑ GF lexicon generation

Summary

- ❑ (parsing)
- ❑ concept extraction
- ❑ concept propagation
- ❑ GF lexicon generation
- ❑ postprocessing

Questions?