Towards automatically extracting morphosyntactical error patterns from L1-L2 parallel dependency treebanks

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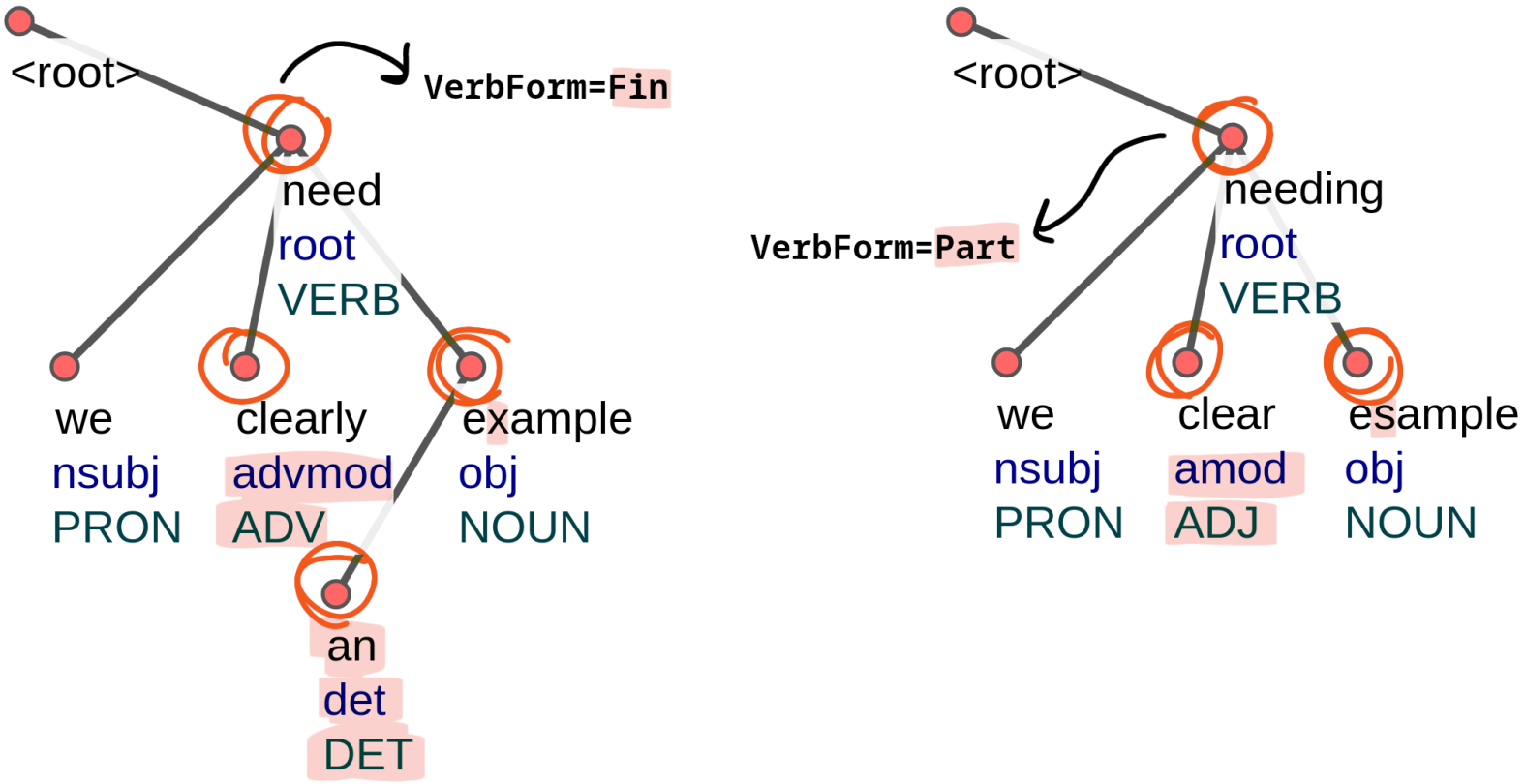
L1-L2 treebanks

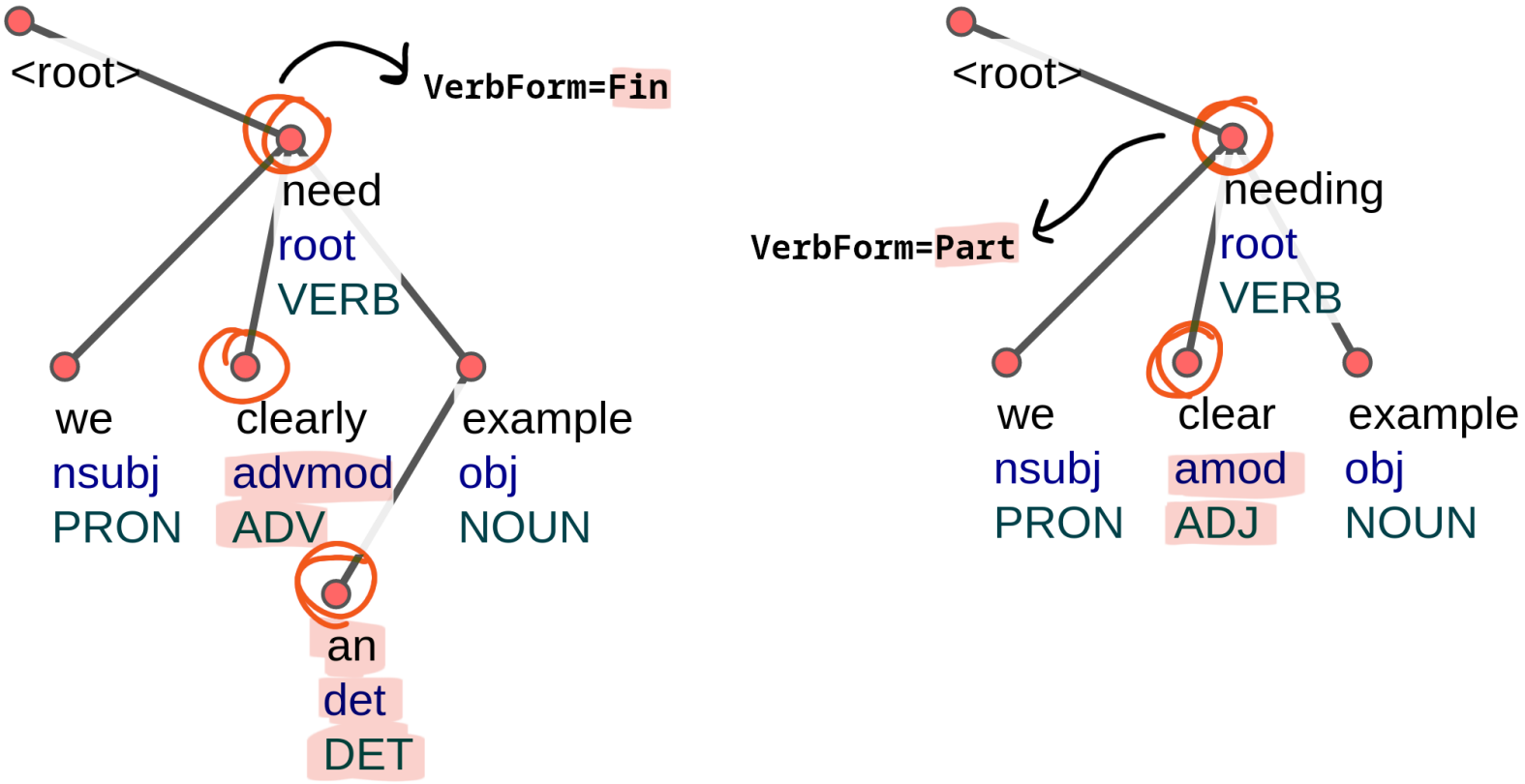
- learner sentences ‖ correction hypotheses
- no explicit error labelling,
  just morphosyntactical annotation
- main design goal: interoperability → UD

Example



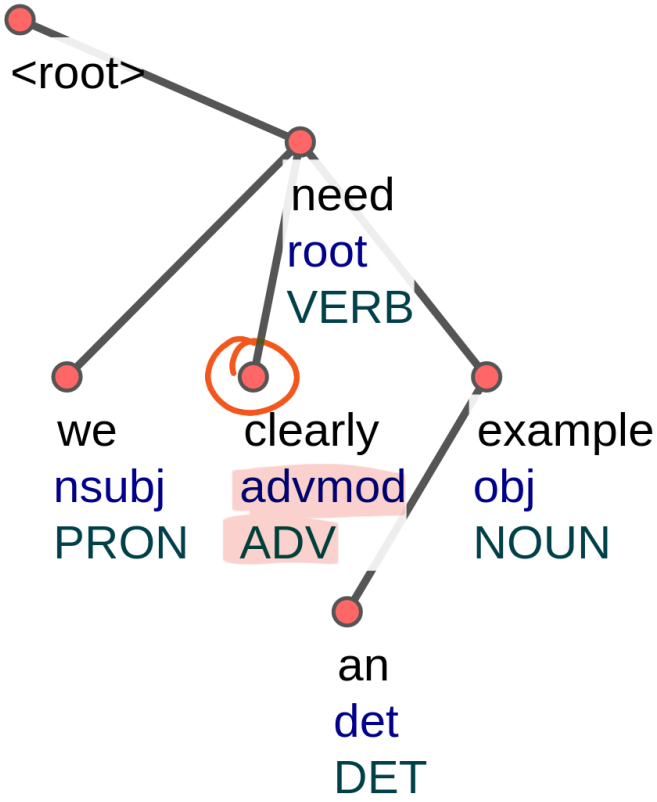
⟨we clear*ly* need~~ing~~ *an* e**x**ample, we clear needing _ esample⟩

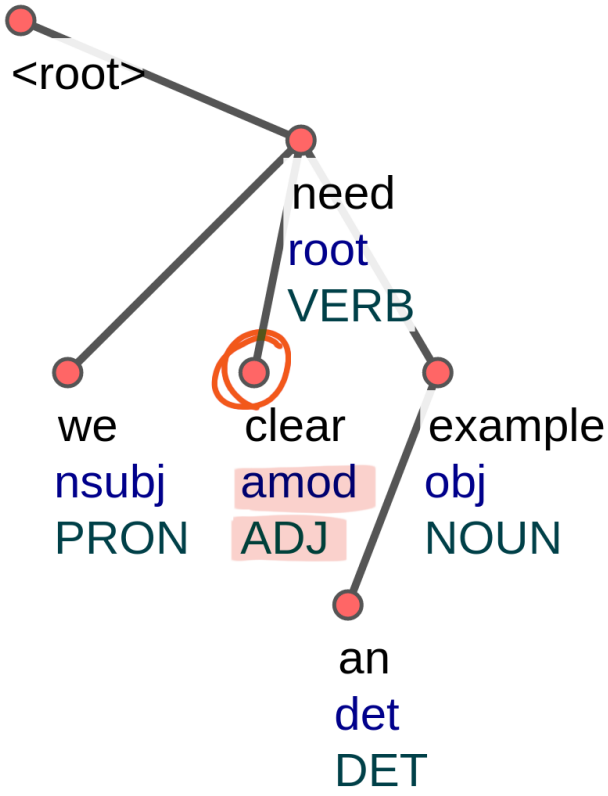
Example



⟨we clear*ly* need~~ing~~ *an* example, we clear needing _ example⟩

Example





⟨we clear*ly* need an example, we clear need an example⟩

Tasks

- find instances of specific error patterns → L2-UD query engine[1]
- automatically classify syntactical errors → SErCL[2]

[1] Masciolini, 2023
[2] Choshen et al., 2020

Tasks

- find instances of specific error patterns → L2-UD query engine[1]
- automatically classify syntactical errors → SErCL[2]
- **extract machine-readable error patterns**

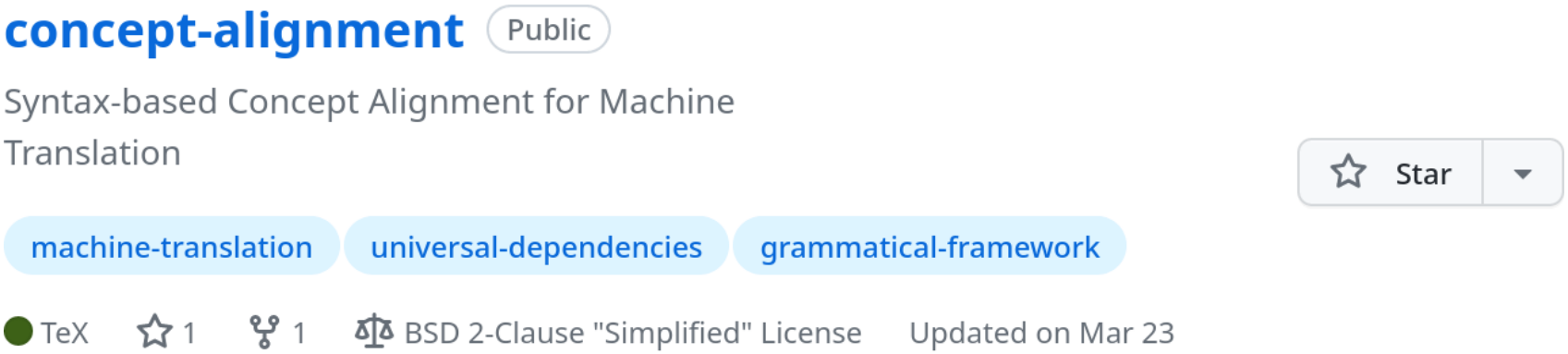
[1] Masciolini, 2023
[2] Choshen et al., 2020

Error pattern extraction

1. **error detection**: align L1-L2 sentences and filter discrepant alignment
2. **pattern generation**: convert pairs of UD subtrees into machine-readable error patterns

Step 1: error detection

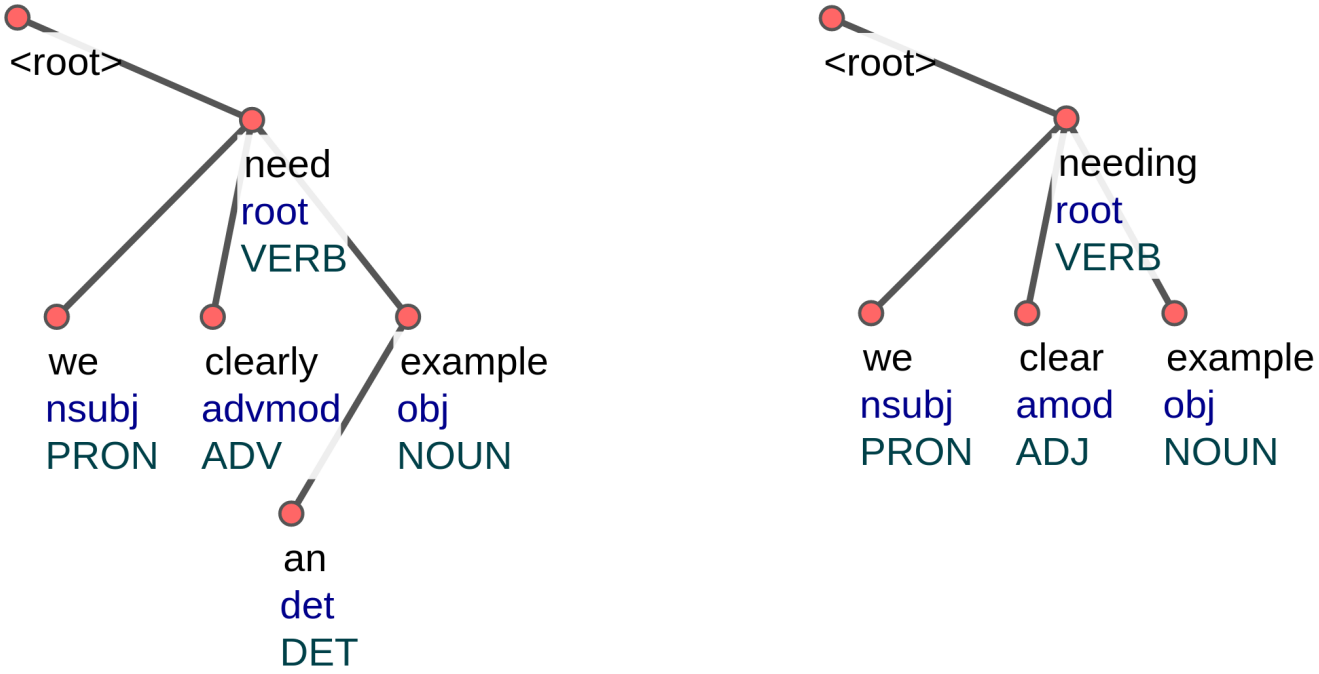
concept-alignment



`github.com/harisont/concept-alignment`

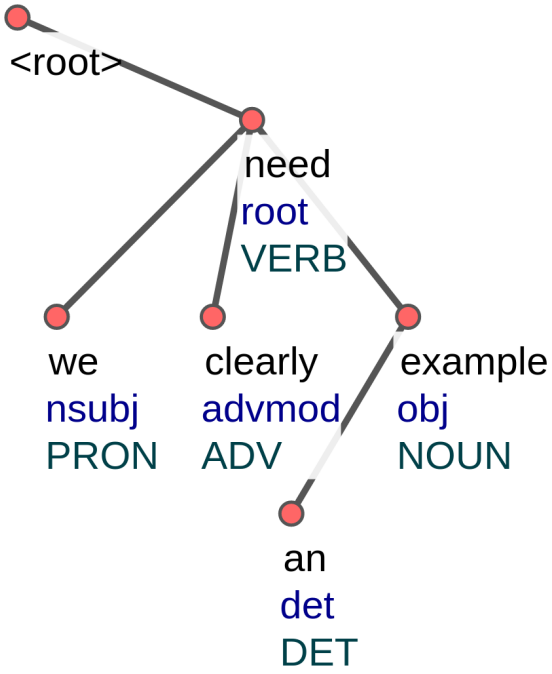
- extracts **subtree alignments** from parallel UD treebanks
- syntax-based but language-agnostic
- designed to generate translation lexica, but easy to adapt to the L1-L2 case

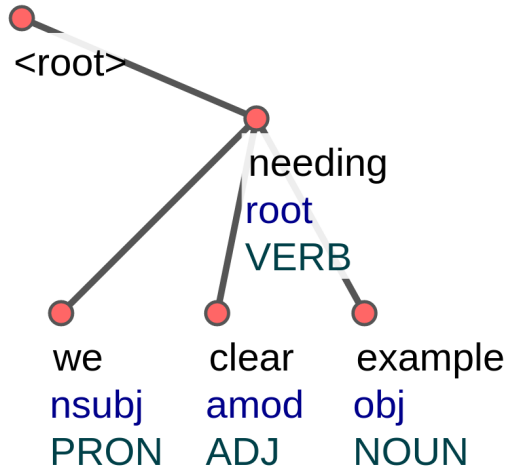
Alignments



- ⟨we clearly need an example, we clear needing example⟩, ⟨need, needing⟩
- ⟨we, we⟩
- ⟨clearly, clear⟩
- ⟨an example, example⟩, ⟨example, example⟩

Errors





- ⟨we **clearly need an example**, we **clear needing example**⟩*, ⟨**need**, **needing**⟩*
- ⟨we, we⟩
- ⟨**clearly**, **clear**⟩*
- ⟨**an example**, **example**⟩*, ⟨example, example⟩

Step 2: pattern generation

Query languages for UD trees

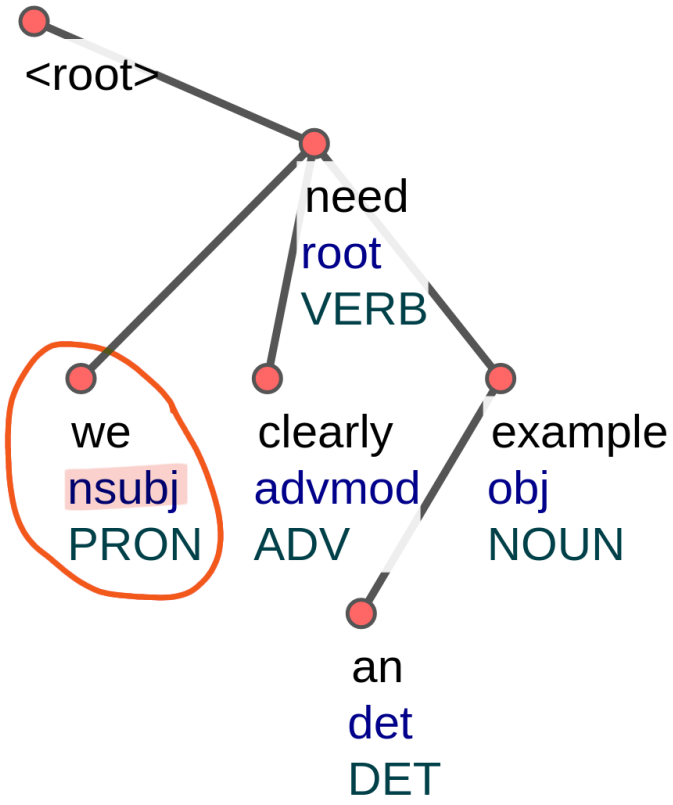
- several options to choose from
  - PML-TQ, Grew-match, UDAPI...
- decided on `gf-ud`'s embedded query language
  - sufficiently expressive and user-friendly
  - easy to use as a library

UD patterns in `gf-ud`

pattern type	**example**
single-token patterns	`DEPREL "nsubj"`
tree patterns	`TREE (POS "NOUN") [DEPREL "det"]`
sequence patterns	`SEQUENCE [DEPREL "advmod", POS "VERB"]`
logical operators[3]	`OR [POS "NOUN", POS "PRON"]`

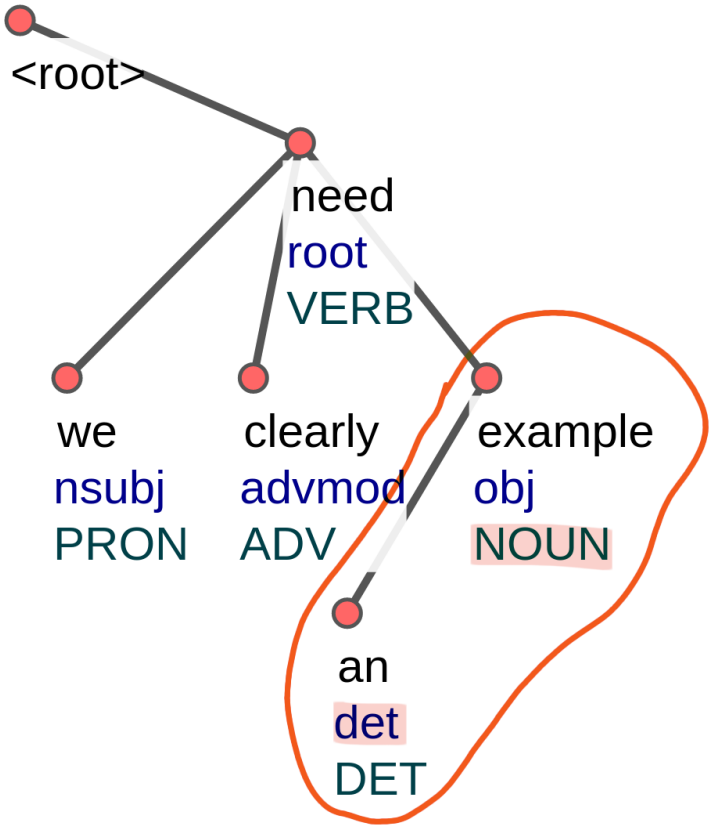
[3] AND, OR, NOT

Single-token patterns



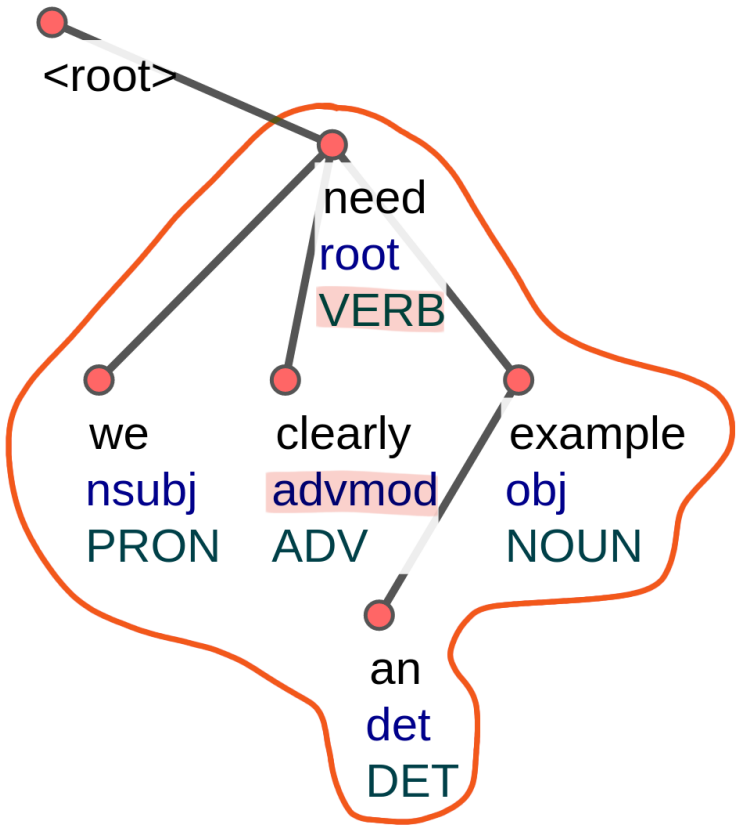

```
DEPREL "nsubj"
```

Tree patterns



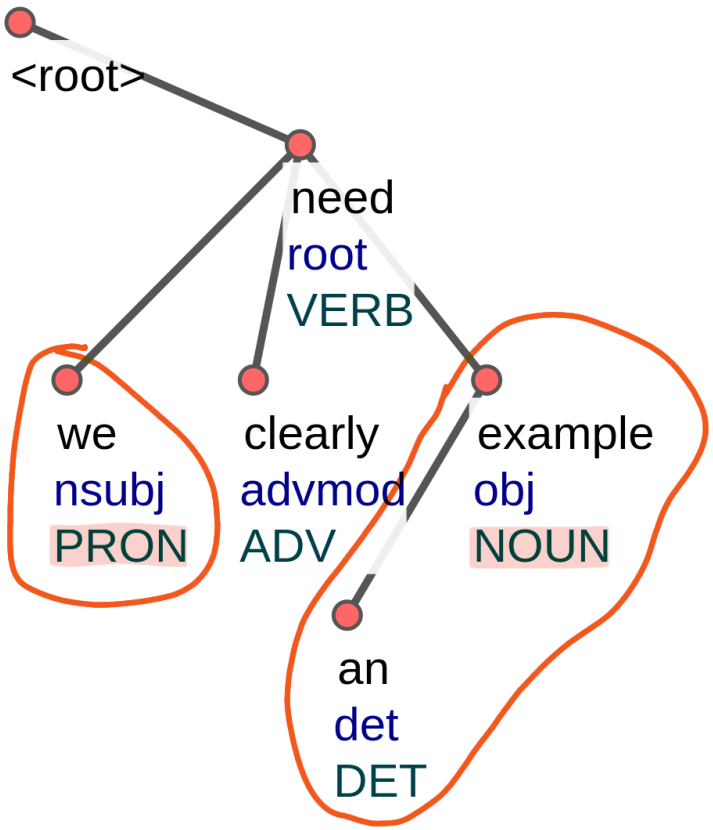

```
TREE (POS "NOUN") [DEPREL "det"]
```

Sequence patterns



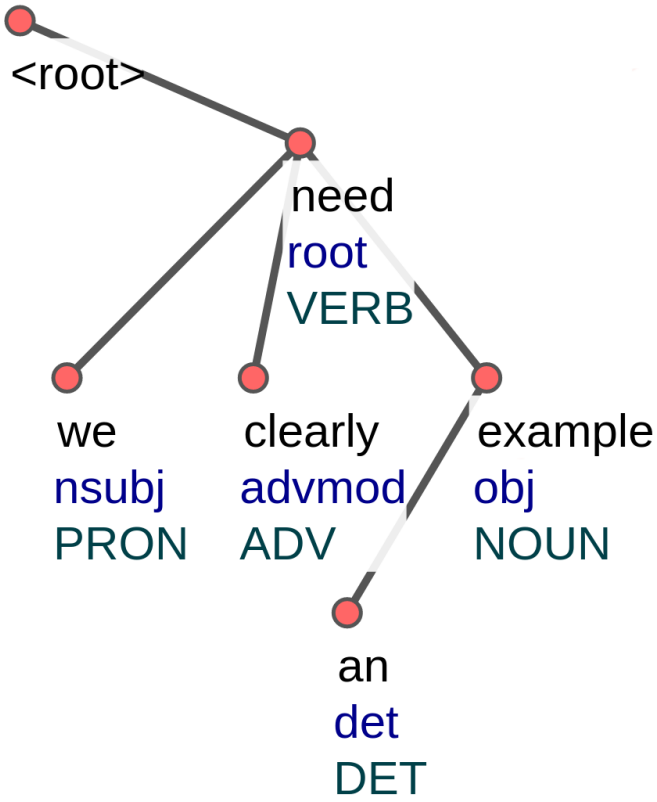

```
SEQUENCE [DEPREL "advmod", POS "VERB"]
```

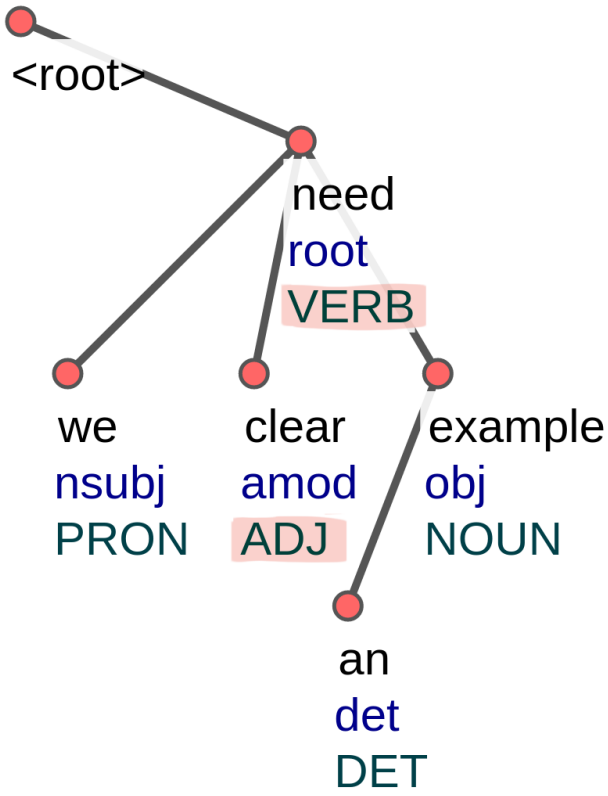
Logical operators




```
OR [POS "NOUN", POS "PRON"]
```

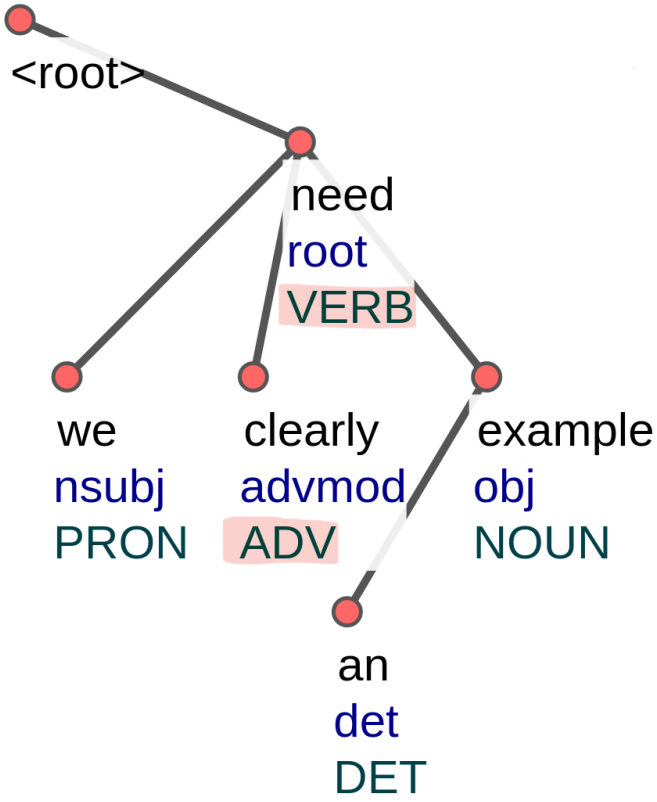
L1-L2 UD patterns

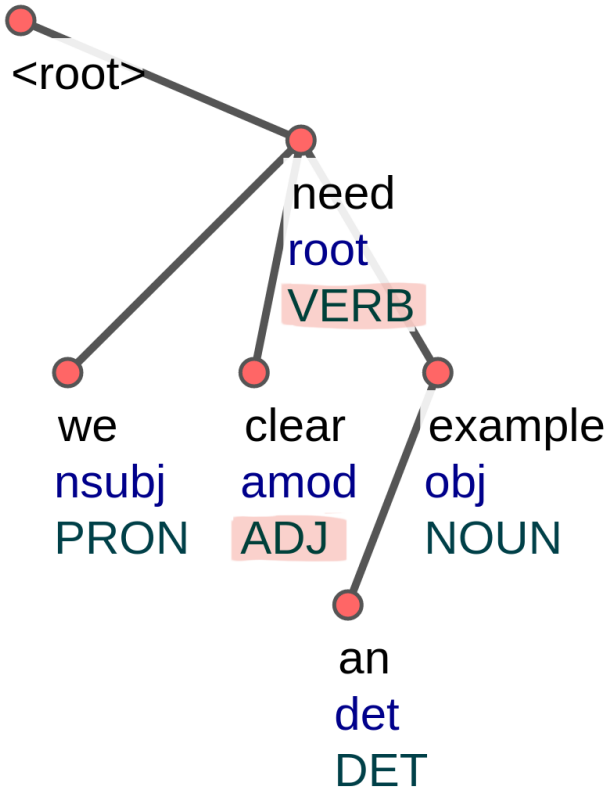





```
TREE_ (POS "VERB") [POS "ADJ"]
```

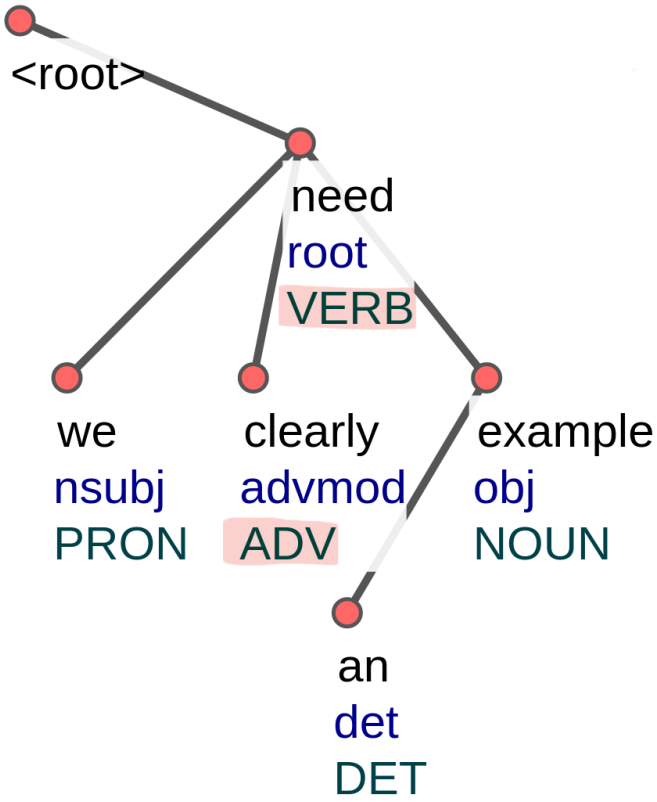
L1-L2 UD patterns

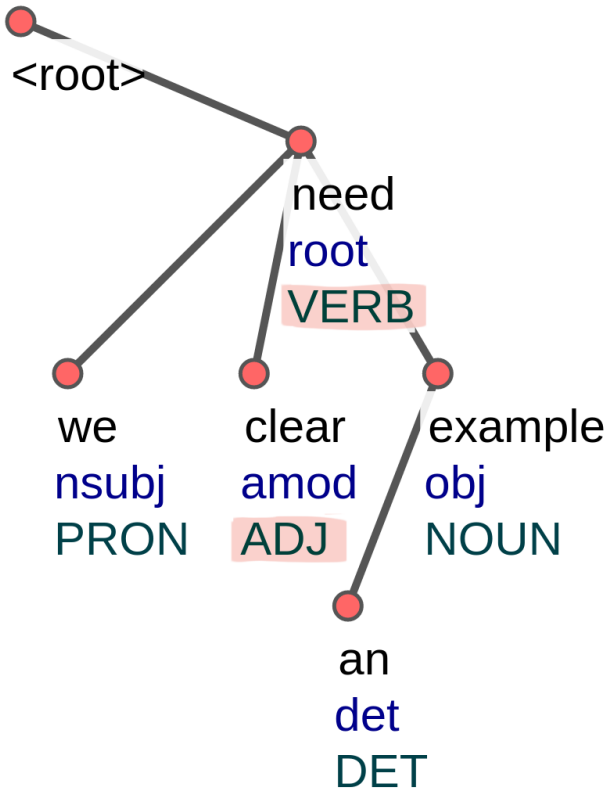





```
⟨TREE_ (POS "VERB") [POS "ADV"], TREE_ (POS "VERB") [POS "ADJ"]⟩
```

L1-L2 UD patterns






```
TREE_ (POS "VERB") [POS "{ADV -> ADJ}"]
```

Simplification strategies

0. Automatically generated L1-L2 pattern

```
TREE
   (AND [FORM "need", LEMMA "need", POS "VERB", XPOS "VBP", DEPREL "root",
        FEATS "Mood=Ind|Number=Plur|Person=1|Tense=Pres|VerbForm=Fin"])
   [AND [FORM "we", LEMMA "we", POS "PRON", XPOS "PRP", DEPREL "nsubj"
        FEATS "Case=Nom|Number=Plur|Person=1|PronType=Prs"],
    AND [FORM {"clearly" -> "clear"}, LEMMA {"clearly" -> "clear"},
        POS {"ADV" -> "ADJ"}, XPOS {"RB" -> "JJ"},
        FEATS {"_" -> "Degree=Pos"}, DEPREL {"advmod" -> "amod"}],
    TREE
      (AND [FORM "example", LEMMA "example", POS "NOUN",
           XPOS "NN", FEATS "Number=Sing", DEPREL "obj"])
      [AND [FORM "an", LEMMA "a", POS "DET", XPOS "DT",
           FEATS "Definite=Ind|PronType=Art", DEPREL "det"]
      ]
   ]
```

Simplification strategies

1. Filtering by CoNNL-U field

Ignoring FORM, LEMMA, XPOS and DEPREL:

```
TREE
   (AND [POS "VERB",
         FEATS "Mood=Ind|Number=Plur|Person=1|Tense=Pres|VerbForm=Fin"])
   [AND [POS "PRON", FEATS "Case=Nom|Number=Plur|Person=1|PronType=Prs"],
    AND [POS {"ADV" -> "ADJ"}, FEATS {"_" -> "Degree=Pos"}],
    TREE
      (AND [POS "NOUN", FEATS "Number=Sing"])
      [AND [POS "DET", FEATS "Definite=Ind|PronType=Art"]]
   ]
```

Simplification strategies

2. Removal of never-discrepant fields

In all alignments, FEATS is either identical both in the L1 and in the L2 or absent in one of the components:

```
TREE
   (AND [POS "VERB"])
   [AND [POS "PRON"],
    AND [POS {"ADV" -> "ADJ"}],
    TREE (AND [POS "NOUN"]) [AND [POS "DET"]]
   ]
```

Simplification strategies

3. Elimination of identical subpatterns

Removing identical subtrees[4]:

```
TREE_
    (AND [POS "VERB"])
    [AND [POS {"ADV" -> "ADJ"}]]
```

[4] optionally, identical roots can be replaced with the wildcard pattern `TRUE` too

Simplification strategies

4. Monolingual single-pattern simplifications

`AND [p]` is equivalent to `p`:

```
TREE_ (POS "VERB") [POS {"ADV" -> "ADJ"}]
```

Preliminary evaluation

Experimental design

- evaluation through a **similar example retrieval task**:
  1. **extract** L1-L2 patterns from an error-correction input pair
  2. **query** an L1-L2 treebank with the extracted patterns
- interactive version available as prototype CALL application

Data

2 **datasets for linguistic acceptability judgments**:

- only one error per sentence
- filtered: only morphosyntactical errors
- automatically parsed with UDPipe 2

name	**language**	**size**[5]	**description**
BLiMP	English	14 996	artificially generated sentences
DaLAJ	Swedish	1 198	postprocessed L2 learner sentences

[5] post-filtering

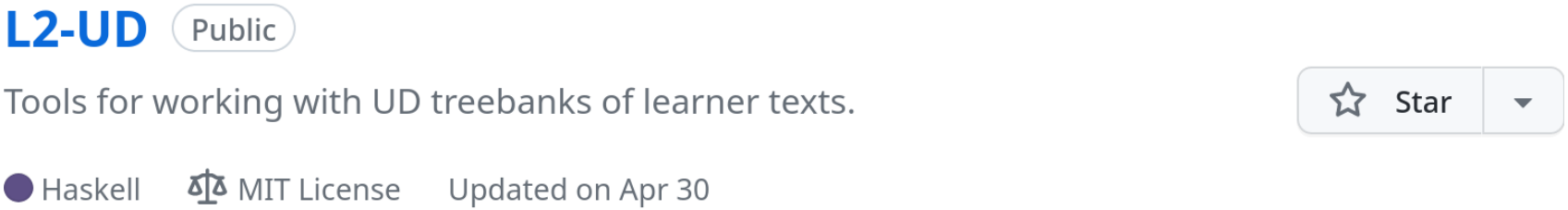
Results

	BLiMP	DaLAJ
R[6]	82%	69%
R_+[7]	82%	63%

[6] retrieval rate

[7] successful retrieval rate

Summarizing



`github.com/harisont/l2-ud`

- novel approach to error pattern extraction
- preliminary, bilingual evaluation on LA datasets giving promising results
- interactive similar example retrieval pipeline available as prototype CALL application

Future work

- extraction method:
  - handle nonexistent word forms
  - deal with real-world L2 data:
    - non-morphosyntactical errors (spelling, lexical. . .)
    - multiple overlapping errors
- example retrieval application:
  - implement pattern selection/ranking
  - build UI
- use L1-L2 patterns from feedback comment generation
- improve automatic annotation of L2 sentences

Thank you!

asynchronous questions/comments: arianna.masciolini@gu.se

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