# FST Trimming: Ending Dictionary Redundancy in Apertium

Francis Tyers[0] Matthew Marting[1] Kevin Unhammer[2]

[0]UiT Norgga árktalaš universitehta
Romssa, Norga
ftyers@prompsit.com

[1]St. David's School
Raleigh, NC.
∅

[2]Kaldera språkteknologi
Stavanger, Noreg
unhammer+apertium@mm.st

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# Outline of talk

## Introduction and background

## Implementation of `lt-trim`

## Ending Dictionary Redundancy

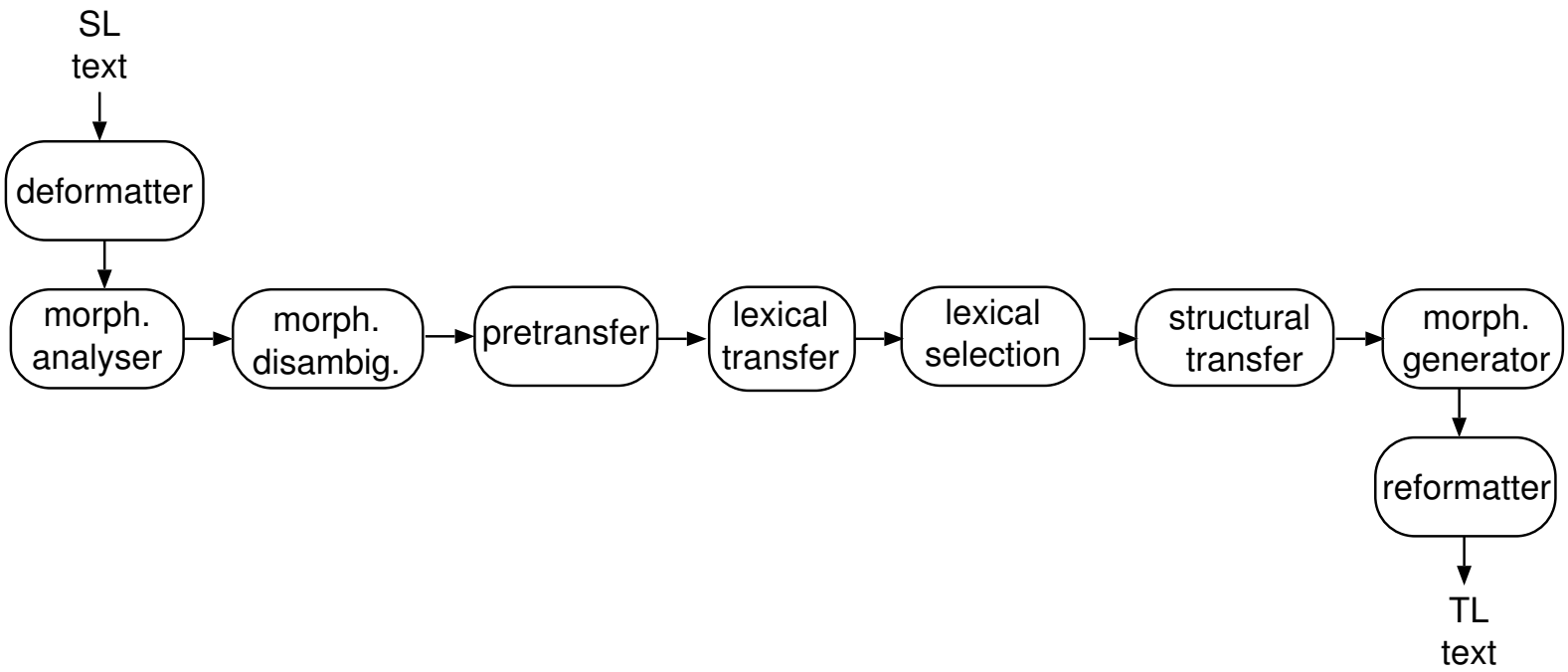
## Conclusion

# Introduction and background

- Apertium: Free/Open Source, Rule-based Machine Translation platform
- Goals include:
  - supporting lesser-resourced languages
  - wide coverage
  - post-editable output
  - reusable resources
- Language data (dictionaries, etc.) typically organised in language *pairs* (Catalan-Spanish, Portuguese-Spanish, etc.)
  - historically: each with its own copy of monolingual data

# Apertium pipeline architecture

- lttoolbox Finite State Transducers used for, among others:
  - morph. analysis: ‘fishes’ to `fish<n><pl>/fish<vblex><pres>`
  - lex. transfer: `fish<n><pl>` to `fisk<n><m><pl>`
  - morph. generation: `fisk<n><m><pl><def>` to ‘fiskane’



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# Multiword support

lttoolbox FST's support a variety of multiwords

An lttoolbox "lexical unit" is one token, and can be:

- simple non-multi-words: 'fish'
- simple space-separated words: 'hairy frogfish' as a single token
- multiwords with **inner inflection**: 'takes out', analysed as `take<vblex><pri><p3><sg># out`, converted to `take# out<vblex><pri><p3><sg>` before lexical transfer



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# Multiword support

- **joined** multiwords: ‘they’ll’;
  analysed as single token
  `prpers<prn><subj><p3><mf><pl>+will<vaux><inf>`,
  then split into two tokens
  `prpers<prn><subj><p3><mf><pl>` and
  `will<vaux><inf>` before lexical transfer
- **compounds**: ‘frogfish’;
  analysed as single token `frog<n><sg>+fish<n><pl>`,
  then split into two tokens `frog<n><sg>` and `fish<n><pl>`
  before lexical transfer



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- combinations (space-separated + joined + inner inflection):
  ‘creure-ho que’,
  analysed as single token
  `creure<vblex><inf>+ho<prn><enc><p3><nt># que`,
  then moved and split into two tokens
  `creure# que<vblex><inf>` and
  `ho<prn><enc><p3><nt>` before lexical transfer

# The Problem: Redundant data

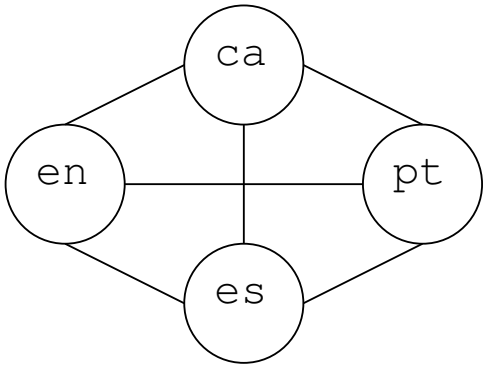


Figure: Ideal number of monodixes with four languages

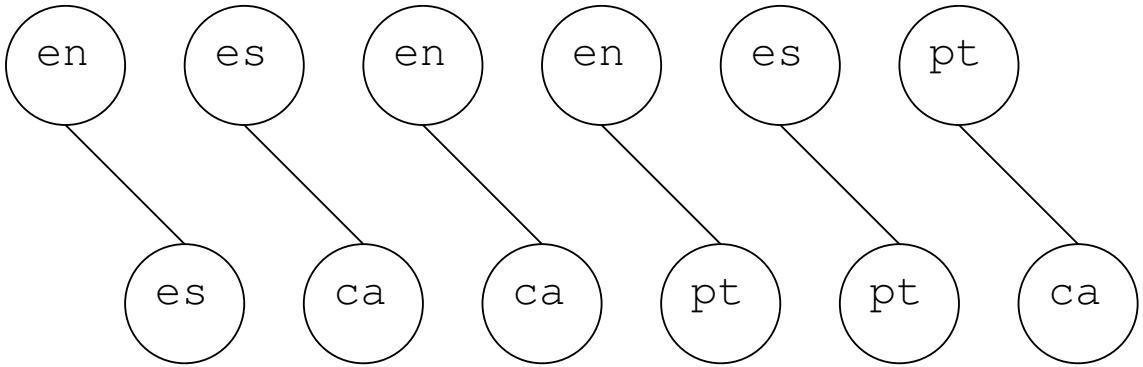


Figure: Current number of monodixes with pairs of four languages



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Words in analyser but missing from lexical transfer can be problematic:

- ‘fishes’ to ‘@fish’: loses the inflection
- ‘gikk til hundene’ “went to the dogs” to ‘went to @hund’ “went to dog”: losing the inflection hides the idiomatic meaning
- ‘öldürmedi’ “did not kill” to ‘@öl’ “kill”: loses the *negation*
- lexical transfer is also tag transfer – structural transfer thus needs exceptions for half-translated tags

But, most importantly, multiword tokenisation means that

‘He takes out the trash’ translates to ‘Han @take out søpla’ *even though both ‘take’-‘ta’ and ‘out’-‘ut’ are in the bilingual dictionary*.

Adding more words makes the translator worse!

# A Solution: Intersection

Compile a *trimmed* analyser-FST containing only entries from monolingual FST that would pass through bilingual FST.

Goal: One big monolingual dictionary, trimmed during compile to language-pair specific analysers.

- We know we can do: FSA1 ∩ FSA2 = FSA3
- We want: output of FST1 ∩ input of FST2 = FST3



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With some exceptions:

- First need to append .* to FST2
  (because lexical transfer only needs a match on the start of the string)
- And reorder #-multiwords in FST2
  (so they look like FST1, otherwise they won't match)
- And let a + in FST1 mean transition-to-start in FST2
  (since single token `a+b` in FST1 is split into two tokens `a b` before lexical transfer)

# Implementation of `lt-trim`

Tool takes two compiled FST's, produces a new, *trimmed* FST

- Preprocess bilingual FST
  - Append .*
  - Reorder #-multiwords
- Depth-first intersection of output of FST1 with input of FST2
  - with an exception on seeing +

# Preprocessing the bilingual dictionary

# Prefixing the bilingual dictionary

# Moving uninflected lemma parts

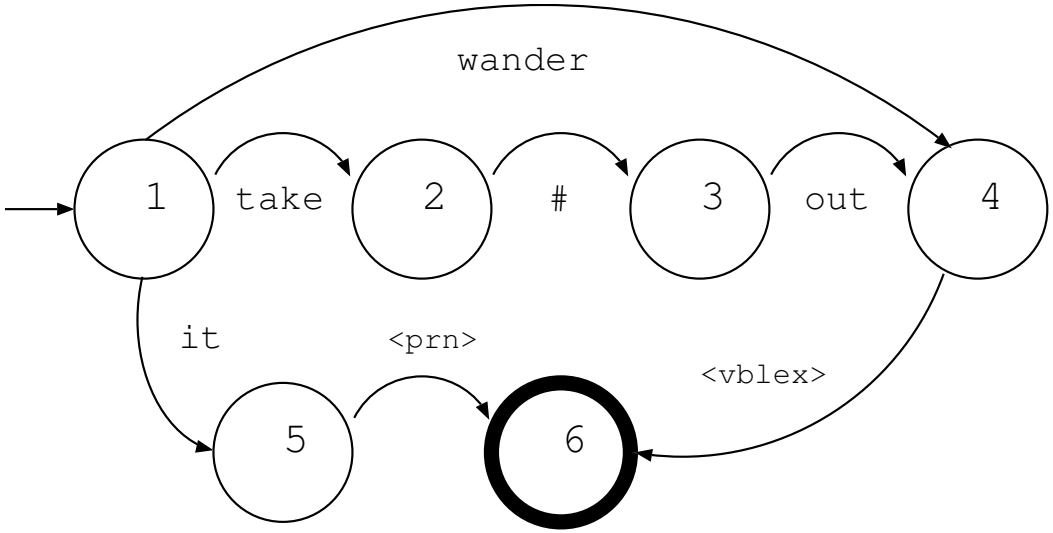
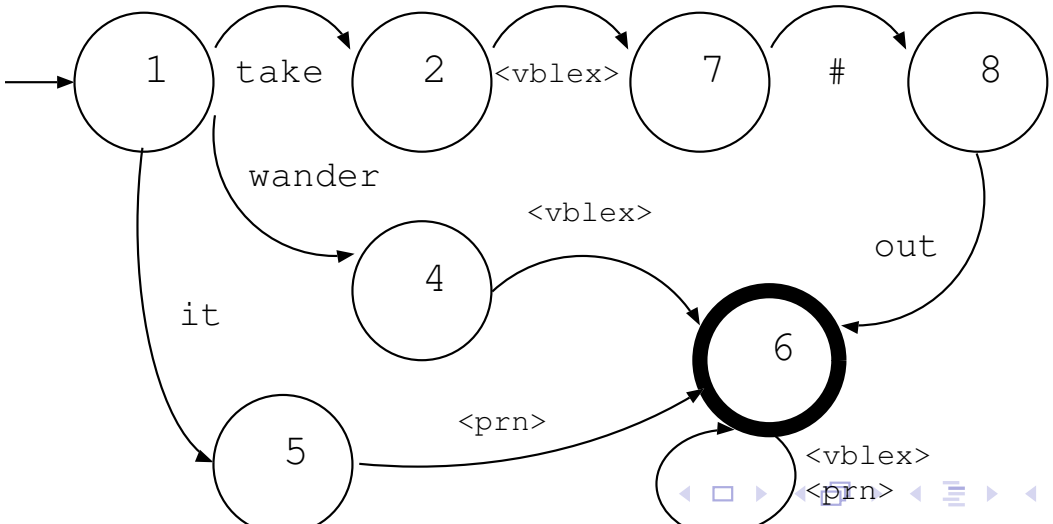



Figure: Input bilingual FST (letter transitions compressed to single arcs)



# Intersection

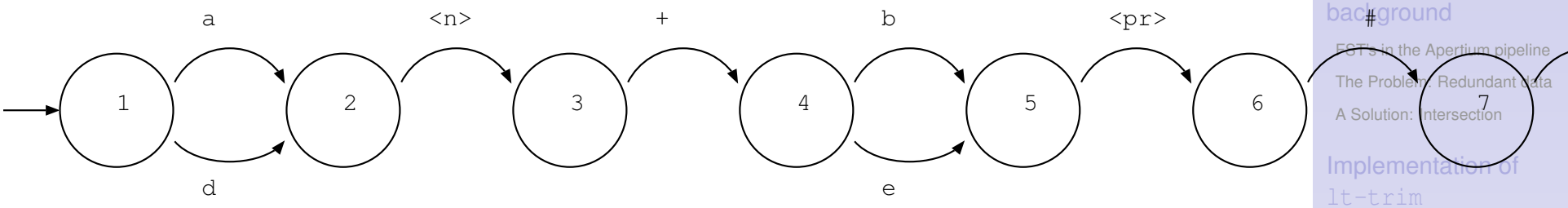



Figure: Input monolingual FST

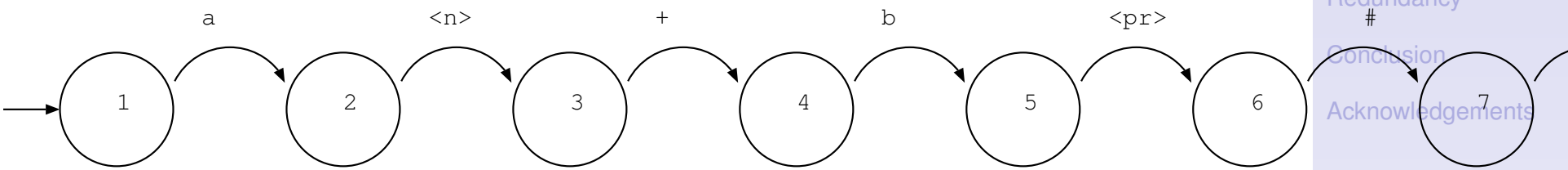



Figure: Trimmed monolingual FST

# lt-trim in use

# Ending Dictionary Redundancy

# Conclusion

# Acknowledgements