EBMT for SMT: A New EBMT-SMT Hybrid

James Smith[†] and Stephen Clark[*]
[†]Oxford University Computing Laboratory
[*]University of Cambridge Computer Laboratory

DCU, November 2009

Strengths and Weaknesses of EBMT and SMT

- EBMT
  - Translation is good when good example(s) exist
  - Translation is poor when no good examples
- SMT
  - Much better at generalising over example base
  - Not able to directly exploit a good example

UNIVERSITY OF CAMBRIDGE

A New Combination?

- Use EBMT to translate parts of sentence for which it is confident
- Pass the partial translation to Moses and let it do the rest:
  - translate the remainder
  - perform any reordering
- Moses performs the recombination/generation

UNIVERSITY OF CAMBRIDGE

A New Combination?

- Use EBMT to translate parts of sentence for which it is confident
- Pass the partial translation to Moses and let it do the rest:
  - translate the remainder
  - perform any reordering
- Moses performs the recombination/generation
- Very hard to beat the Moses baseline

UNIVERSITY OF CAMBRIDGE

This Work

- EPSRC Case studentship with Sharp Laboratories of Europe – Victor Poznanski, Pete Whitelock
- Focused on the matching phase for the EBMT system:
  - string-based approach
  - dependency-based approach
- Outline:
  - string-based system
  - dependency-based system
  - consequences for EBMT and SMT

UNIVERSITY OF CAMBRIDGE

General Framework

```
Function EBMT-SMT
Input: Word-aligned parallel corpus (example base)
       Index over source sentences in example base
       Input sentence in source language
       Moses phrased-based SMT system

Candidates = Filter(Input, Index)
Foreach Candidate in Candidates
  Score(Candidate) = Similarity(Input, Candidate)
BestMatch = argmax Score(Candidate)

Translations = Matches(Input, BestMatch, Alignment)
Output: MosesConstrained(Translations)
```

UNIVERSITY OF CAMBRIDGE

String-Based Matching

- Similarity measure for two sentences based on word sequences
- Levenshtein distance (edit distance)
  - counts insertions, deletions, substitutions needed to transform one sentence into another
  - standard dynamic programming algorithm
- Investigated alternatives:
  - WordNet-based substitution cost on nouns
  - Comparison of common n-gram sequences

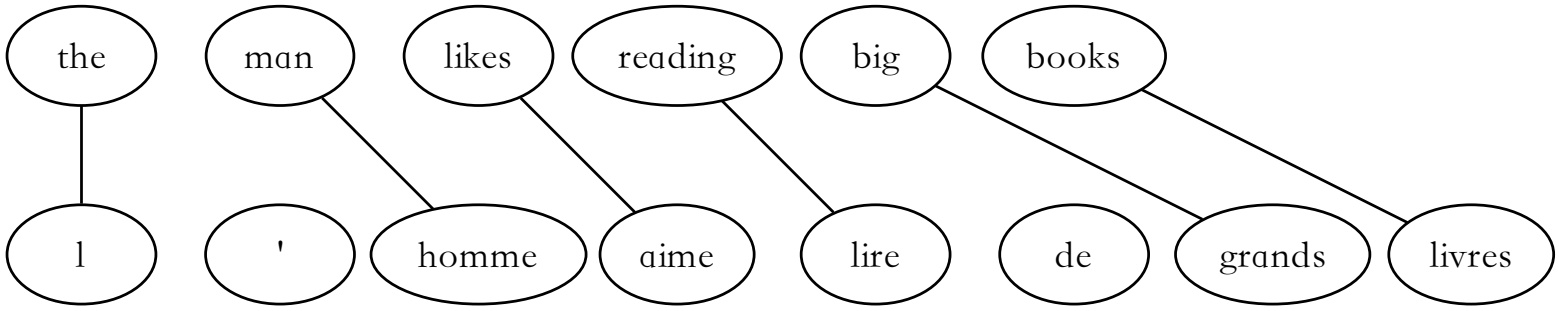
UNIVERSITY OF CAMBRIDGE

Index-Based Filter

- Calculating edit distance for all examples is expensive
- Create an index from n-grams (length 1-5) to example sentences
- Filter score favours longer n-gram matches
- Index contains 42,071,791 n-grams for the EuroParl data set
- Saving of 98% (with an example base of 100,000 sentences and an input of 500 sentences)

UNIVERSITY OF CAMBRIDGE

Alignment-Based Translation



`Input: the clever man likes reading books`

- Only allow n-gram matches above a certain length
- Use translation of `man likes reading`

UNIVERSITY OF CAMBRIDGE

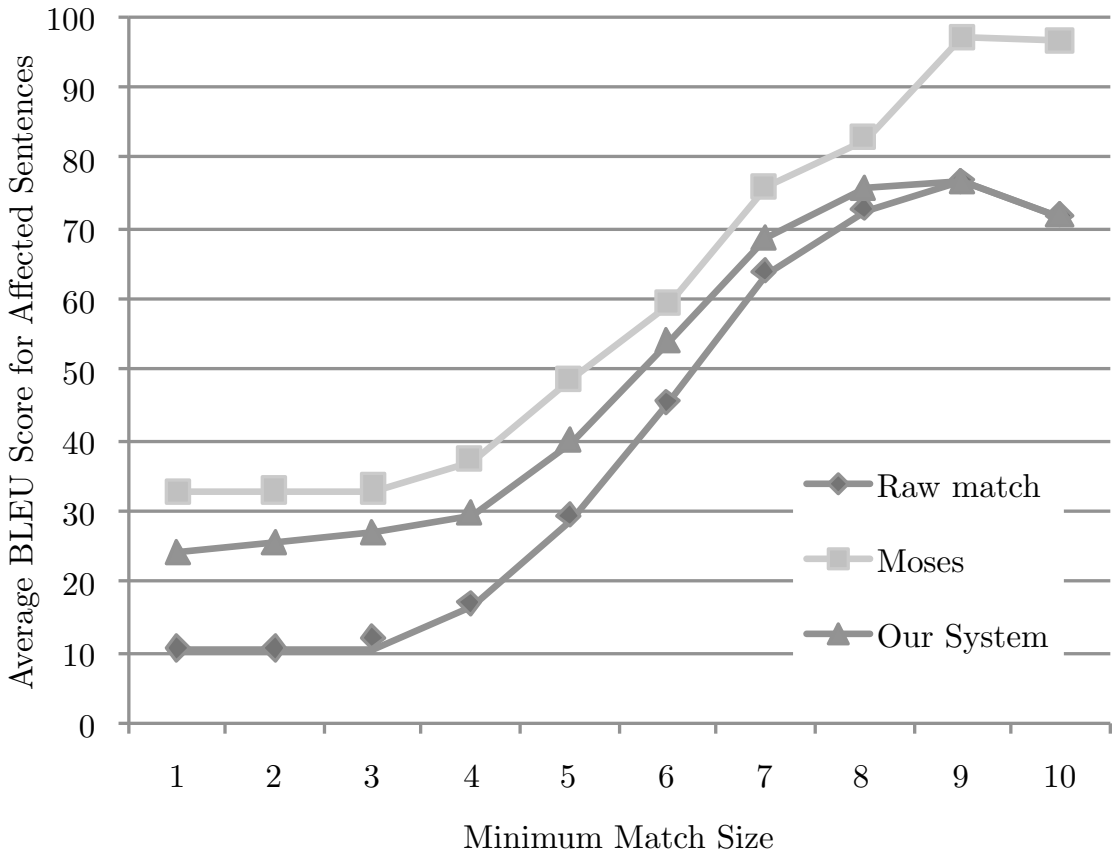
Moses Interface

- Moses already has an XML interface which allows part of the translation to be fixed
- So using Moses was straightforward for the string-based system:

```
Input: the clever man likes reading books
Output: <span foreign="homme aime lire" span="2,4"/>
```

UNIVERSITY OF CAMBRIDGE

Results on English-French Europarl (5-15 words)



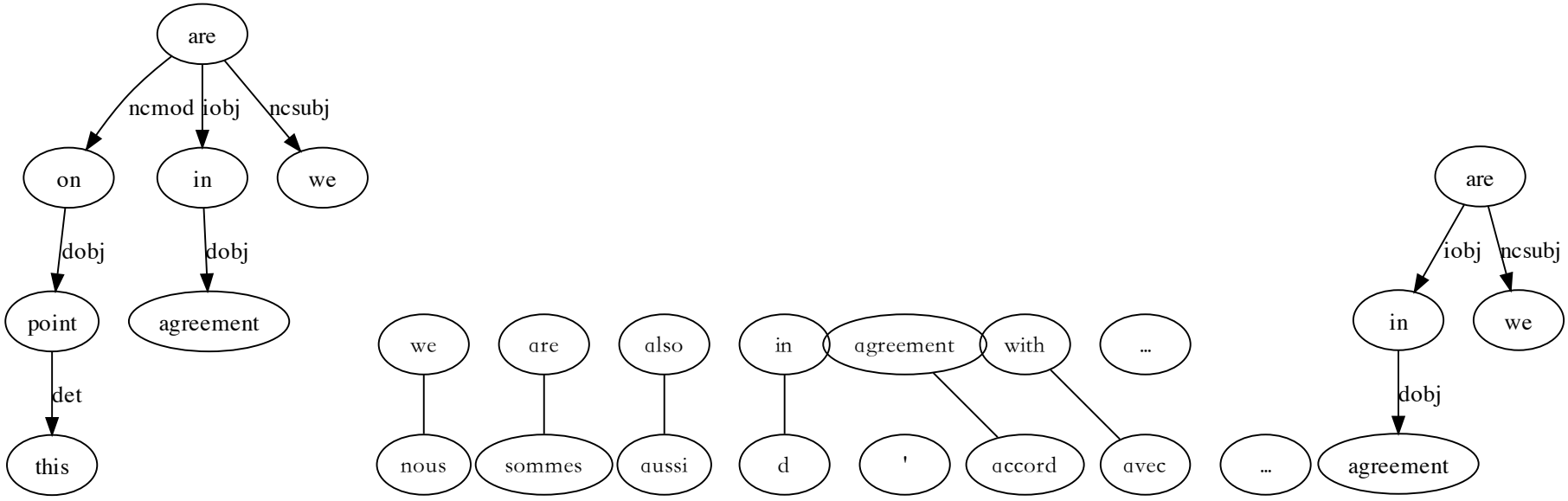
UNIVERSITY OF CAMBRIDGE

Summary of String-Based System

- Filter allows practical EBMT on a large parallel corpus
- String-based hybrid performs worse than Moses
- String-based matching is similar to phrase-based SMT (but without the advantages of generalising over many examples)
- Move away from the phrase-based SMT system by using matches based on dependency trees

UNIVERSITY OF CAMBRIDGE

Dependency-Based Matching



- `Input: On this point we are in agreement`
- Can match discontinuous sequences and word order can be different

UNIVERSITY OF CAMBRIDGE

Comparison to other Work

- We use syntax on the source side only (as part of the EBMT matching phase)
- Others use syntax on both sides, eg as part of a synchronous CFG or TAG, or just use syntax on the target side

UNIVERSITY OF CAMBRIDGE

Parser

- Use the Clark and Curran CCG parser to produce dependency structures for the source side
- One advantage is that it's fast (100s of sentences/second)
- Produces labelled dependency trees, including long-range dependencies

UNIVERSITY OF CAMBRIDGE

General Framework

```
Function EBMT-SMT
Input: Word-aligned parallel corpus with source sentences parsed
       Dependency-based index over source sentences in example base
       Parsed input sentence in source language
       Moses phrased-based SMT system

Candidates = Filter(Input, Index)
Foreach Candidate in Candidates
  Score(Candidate) = Similarity(Input, Candidate)

BestMatches = Greedy(Input, Candidates)

Translations = Matches(Input, BestMatches, Alignment)
Output: MosesConstrained(Translations)
```

UNIVERSITY OF CAMBRIDGE

Interface to Moses

- We would like to supply alternative, potentially overlapping, hypotheses to Moses and let it select the best ones
- Matches can be for discontinuous sequences on the source side
- We don't want Moses to choose one part of a discontinuous match and not the other

UNIVERSITY OF CAMBRIDGE

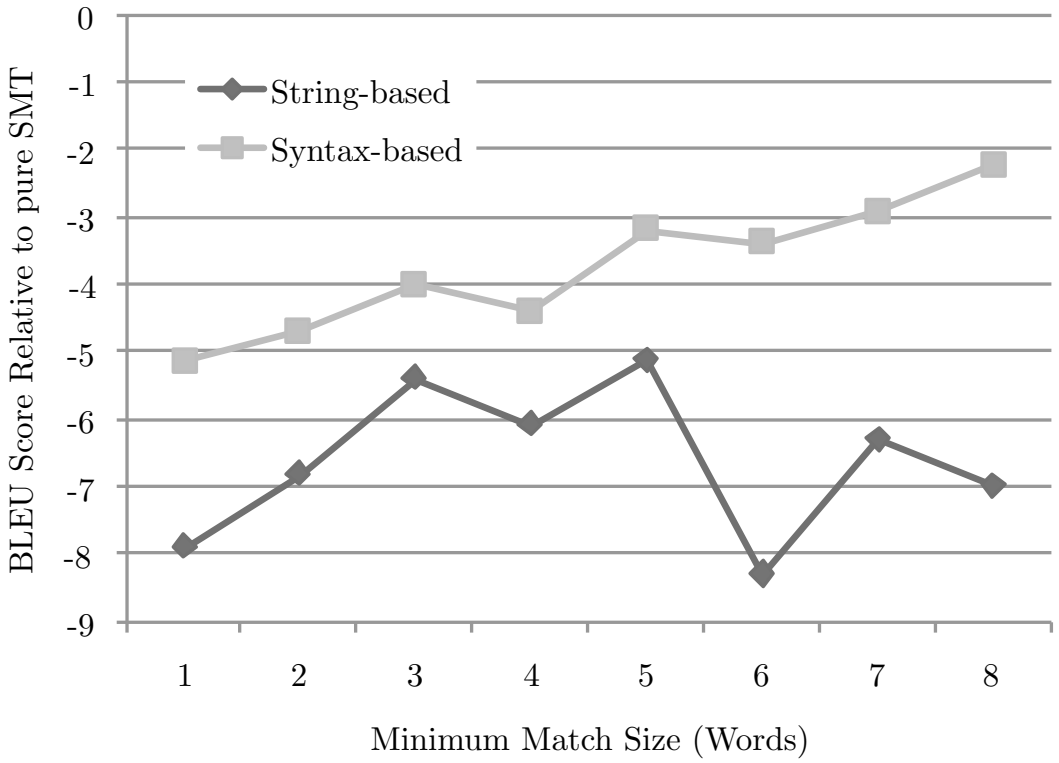
The Linked Tag

```
<linked>
  <span1 foreign="homme intelligent" span="1,2"/>
  <span2 foreign="aime lire" span="4,5"/>
</linked>
<linked>
  <span3 foreign="aime lire" span="4,5"/>
  <span4 foreign="grands livres" span="7,8"/>
</linked>

the clever man certainly likes reading really big books
```

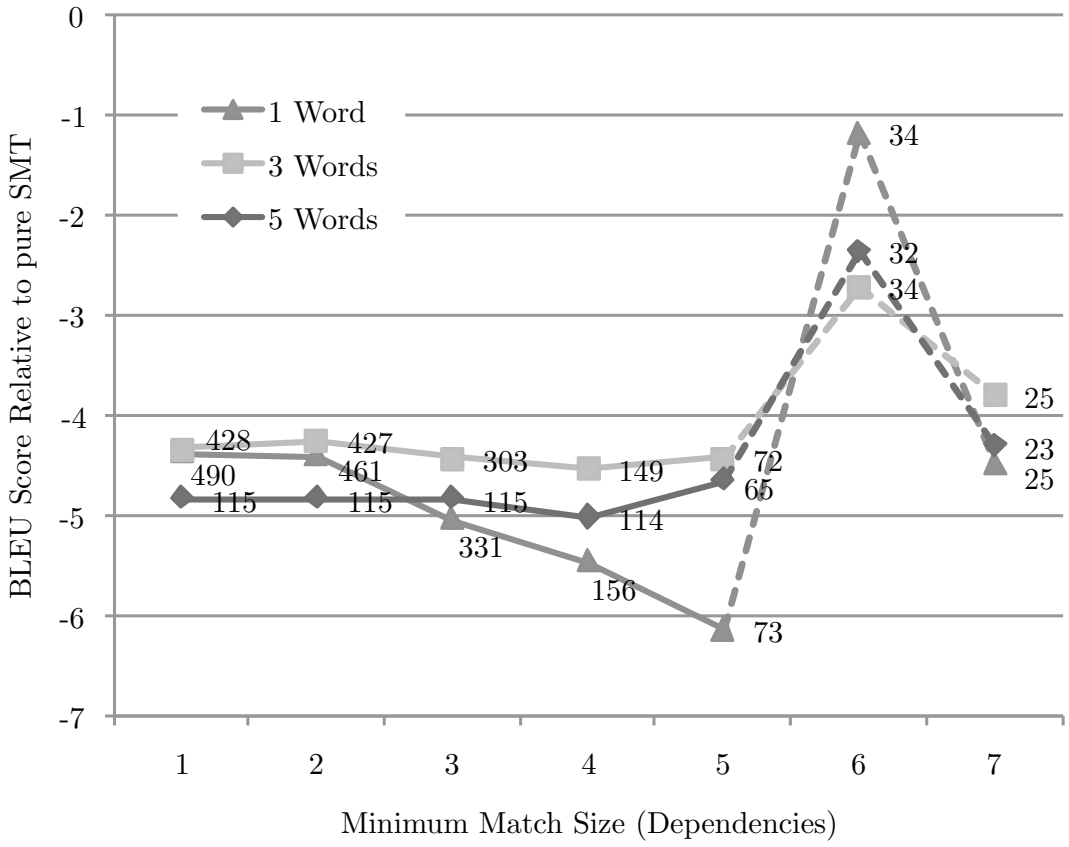
UNIVERSITY OF CAMBRIDGE

Results on English-French Europarl

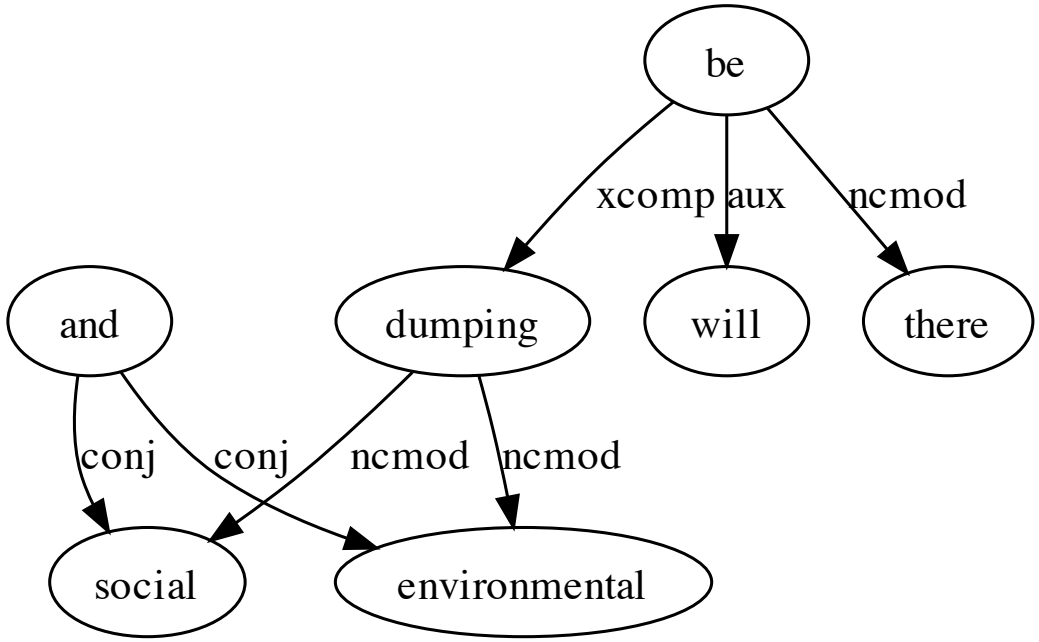


UNIVERSITY OF CAMBRIDGE

Effect of Dependency Threshold

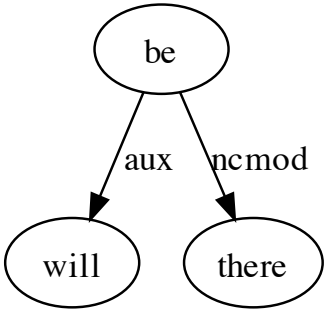


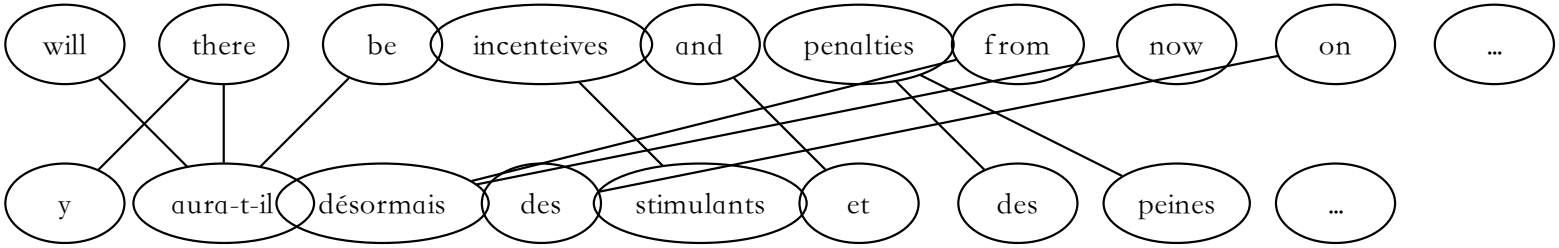
Good EBMT Example



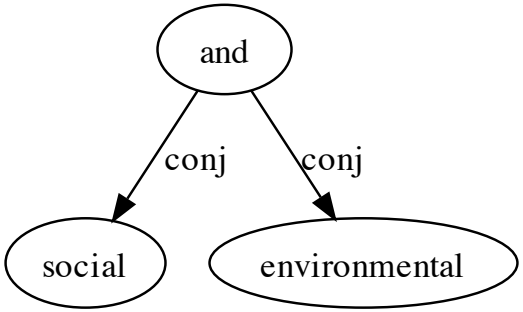
`Will there be environmental and social dumping?`

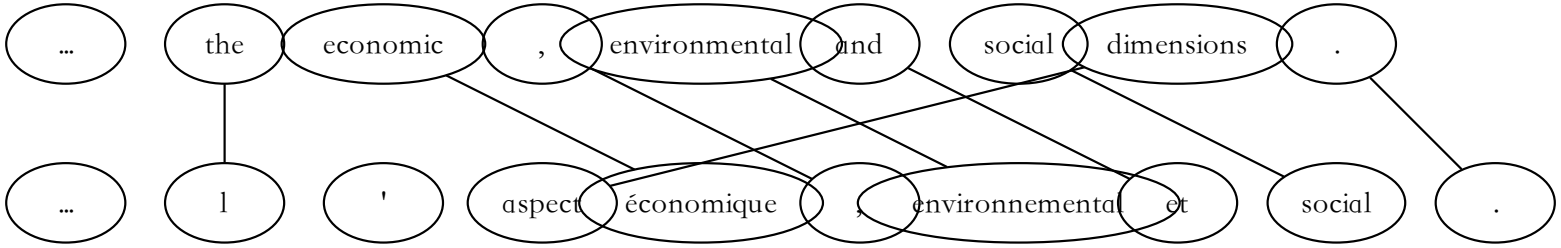
Good EBMT Example



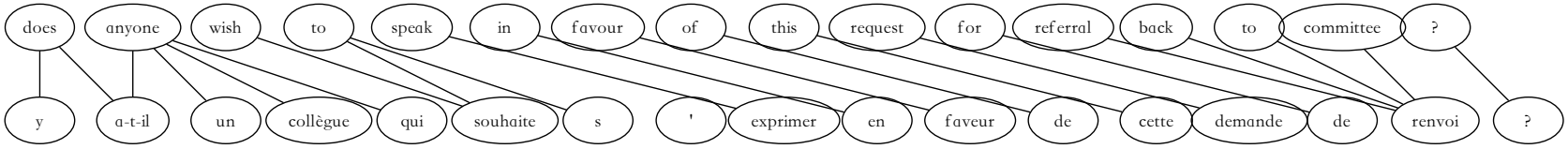


Good EBMT Example





Really Good EBMT Example




```
does anyone wish to speak in favour of this request ?
```

Conclusion

- Problems with the EBMT system:
  - noisy alignments
  - noisy parser ouput
  - EBMT choices need to account for the uncertainty better and be more closely integrated with Moses
- Any ideas we had to improve the EBMT system moved us closer to the SMT model!

UNIVERSITY OF CAMBRIDGE

Conclusion

- Problems with the EBMT system:
  - noisy alignments
  - noisy parser ouput
  - EBMT choices need to account for the uncertainty better and be more closely integrated with Moses
- Any ideas we had to improve the EBMT system moved us closer to the SMT model!
- What can EBMT offer (hierarchical) phrase-based SMT that it doesn't already have?

UNIVERSITY OF CAMBRIDGE