Discontinuous Statistical Machine Translation with Target-Side Dependency Syntax

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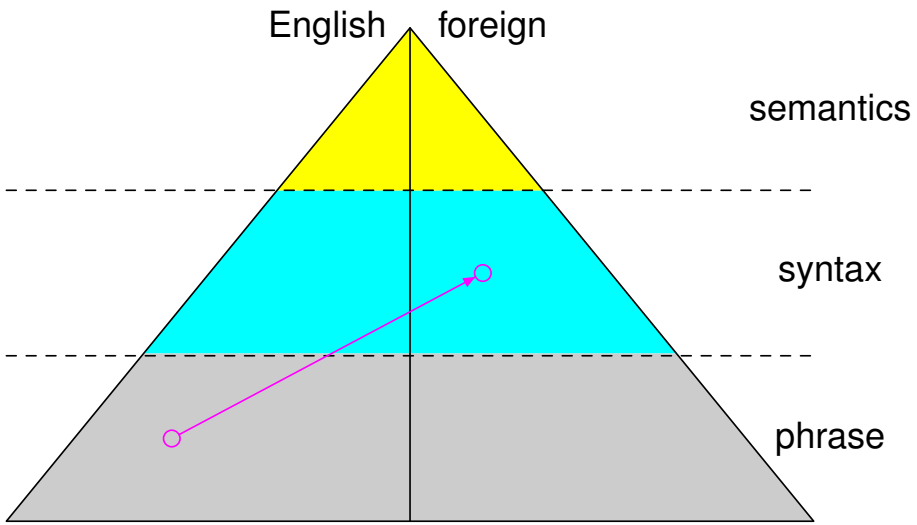
Outline

Syntax-based Machine Translation



- Source language side is a string
- Target language side requires syntactic annotations

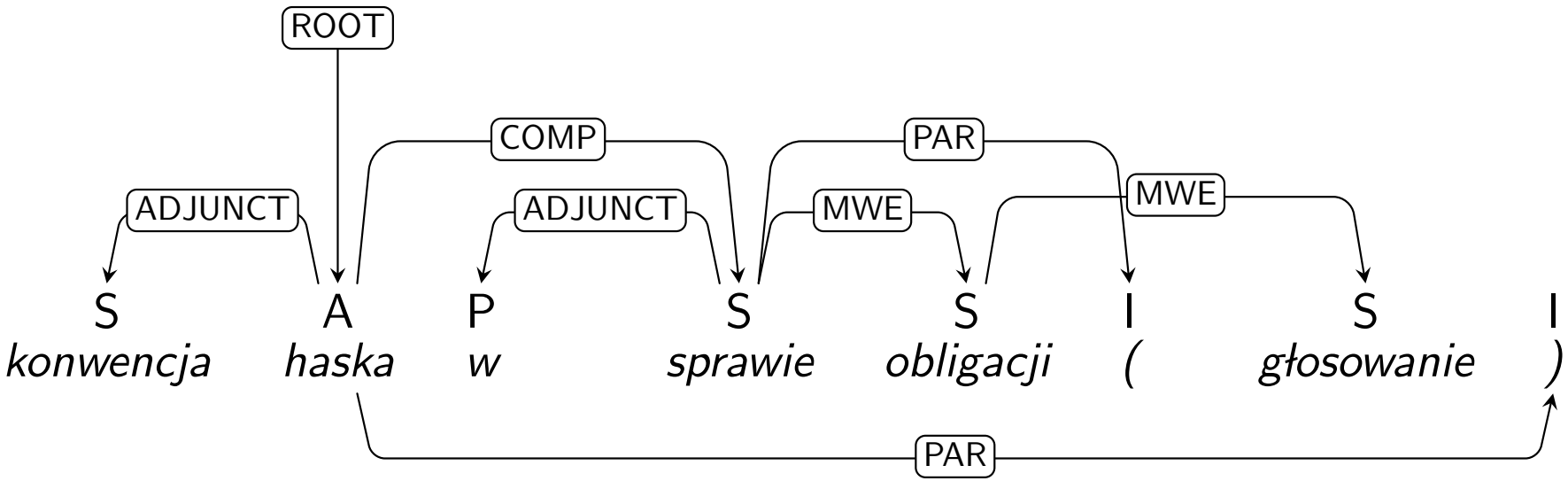
Discontinuous Target Languages

We want to translate from English to Russian and Polish:

- morphologically rich
- free word order languages
- grammatically agreeing parts spread out over whole sentence
- syntax difficult to express in terms of constituency structure
- not parseable by constituency parser
- but by dependency parsers

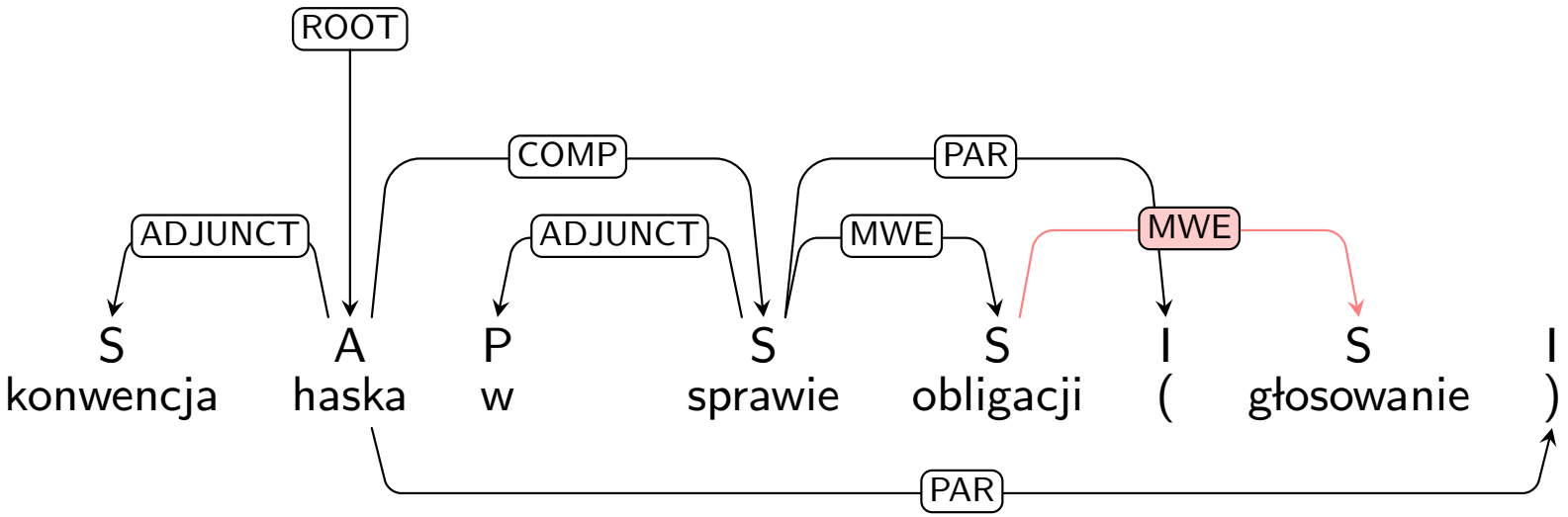
Outline

Dependency Parsing

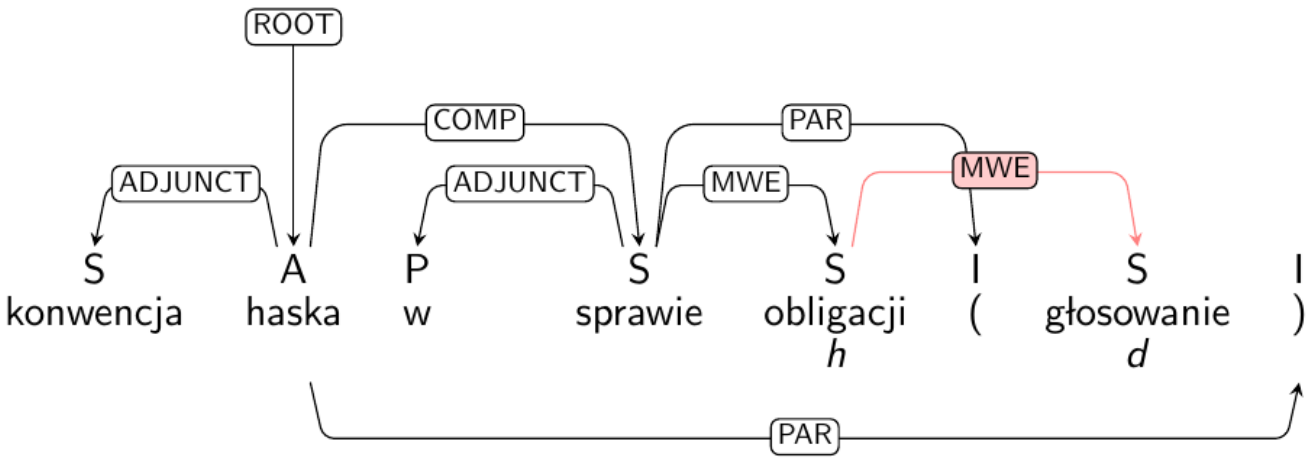


Non-projective Dependency Parse

- $h \rightarrow d$ is *projective* iff h dominates all nodes in the linear span between h and d.
- Dependency parse is projective iff all its edges are projective.



Lifting [Kahane et al., 1998]



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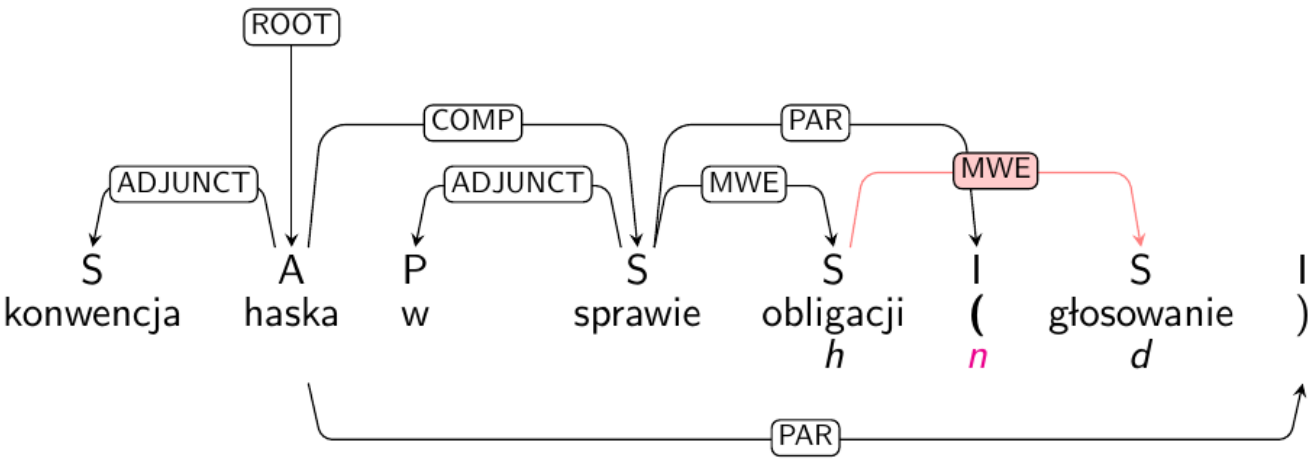

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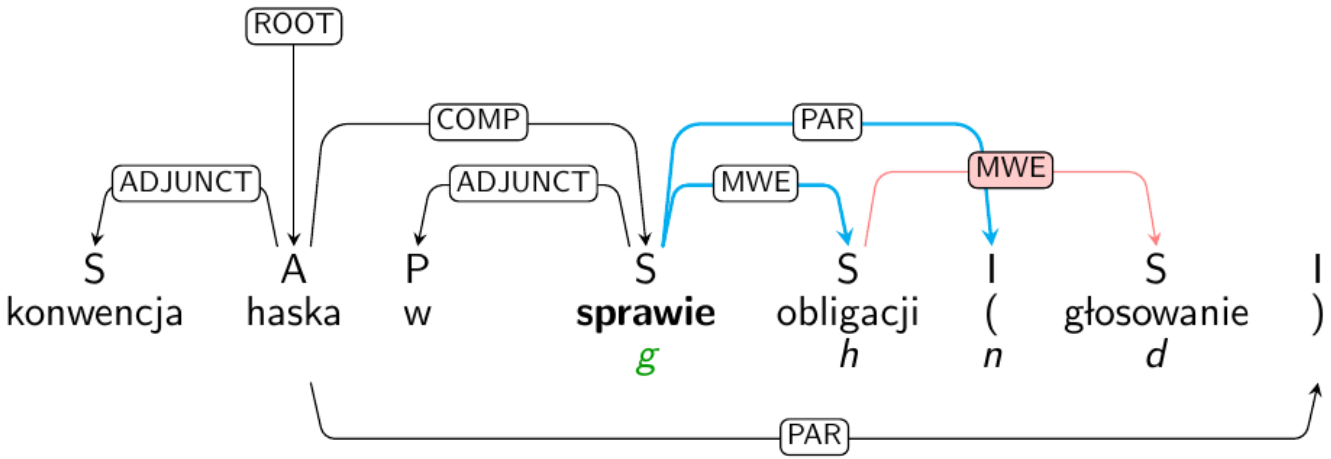

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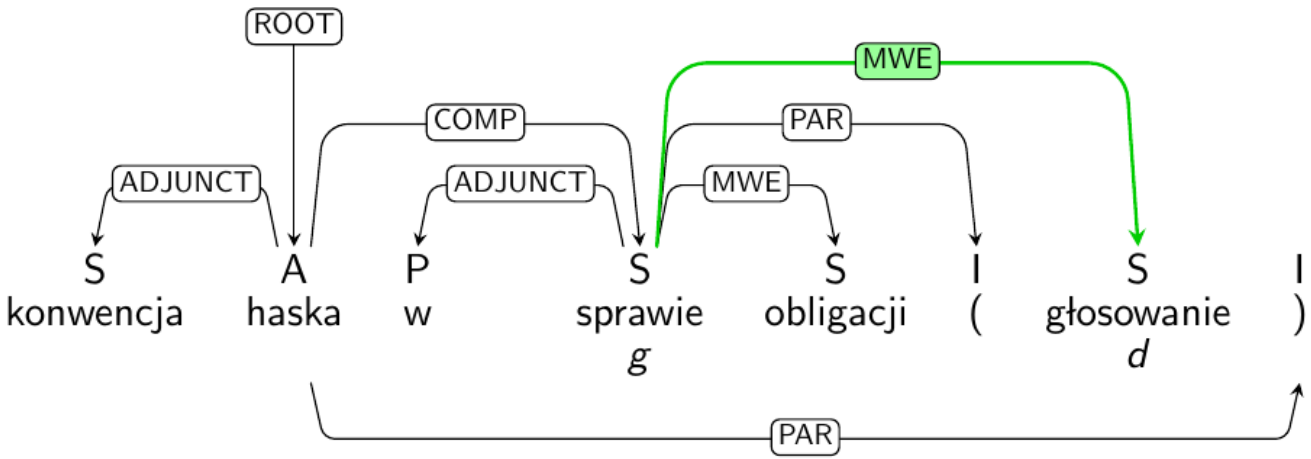
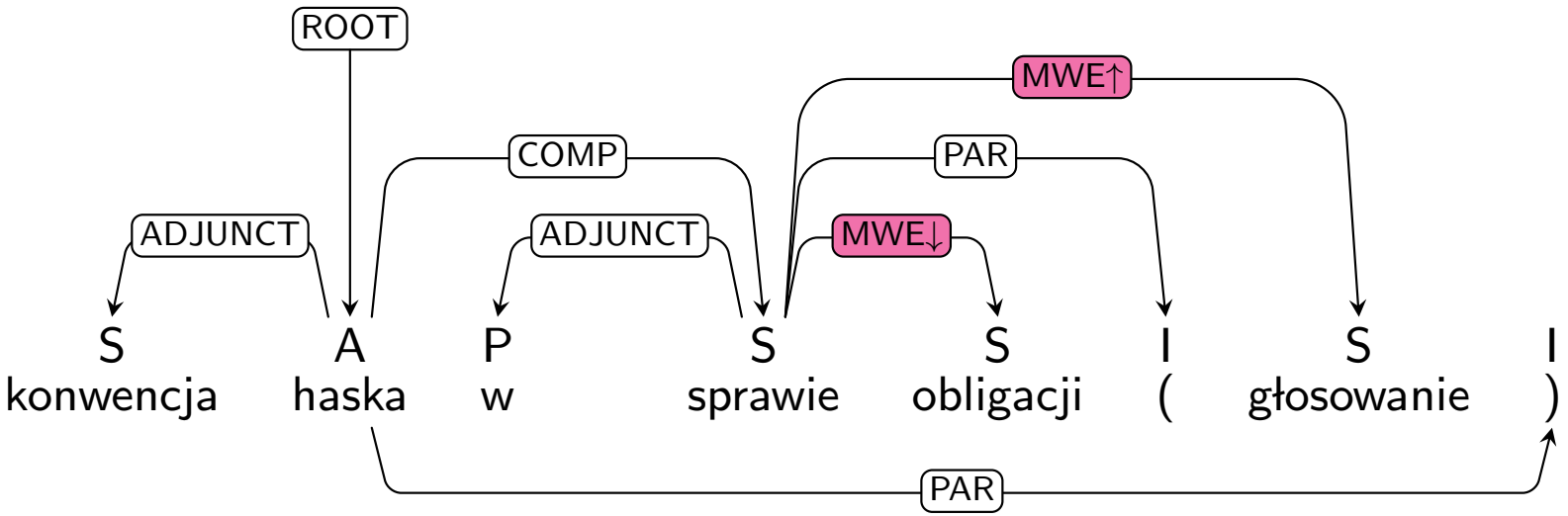
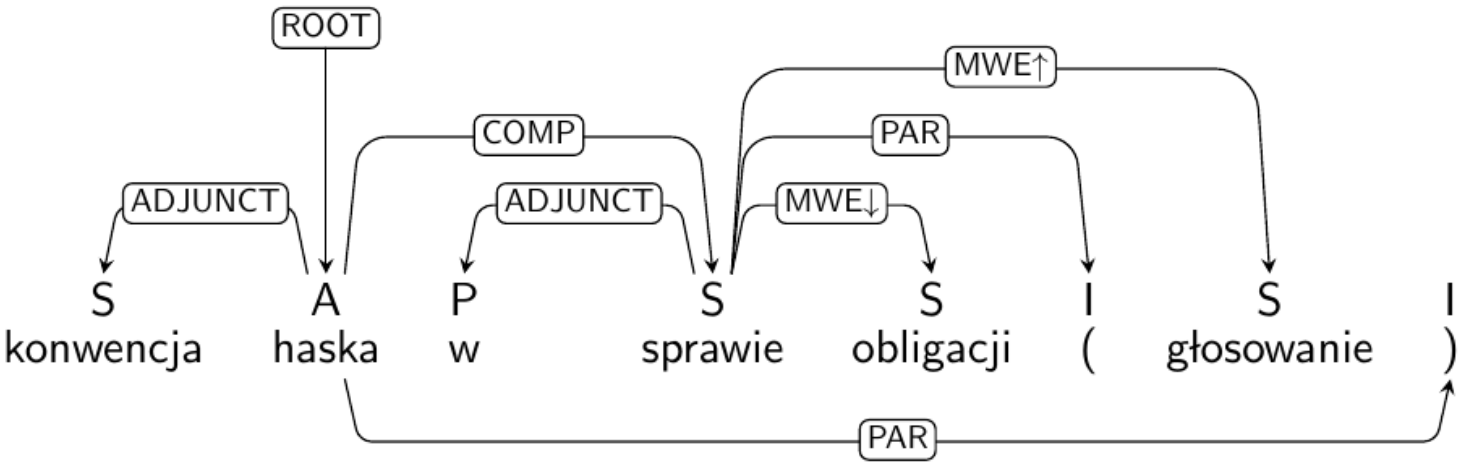


Lifting [Nivre and Nilsson, 2005]

Refined the lifting process by performing the same operation but document the lifting in the labels ⇒ path



Conversion from dependency to constituency tree



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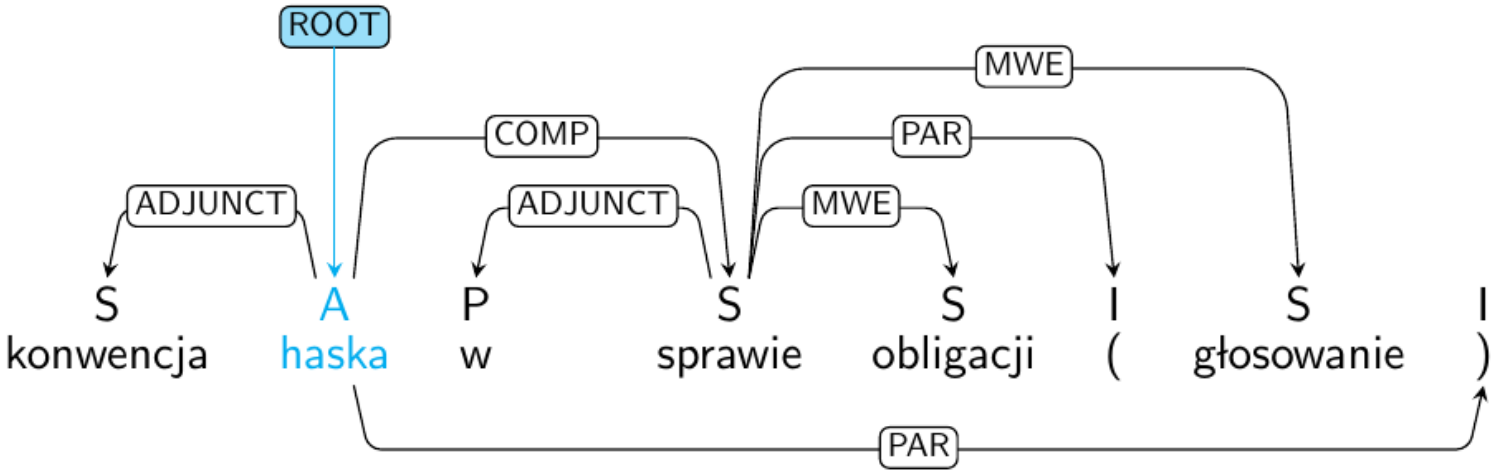

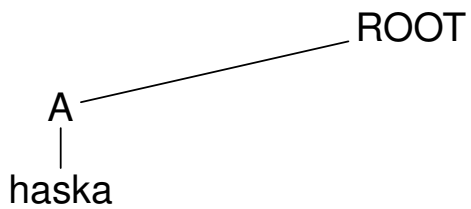

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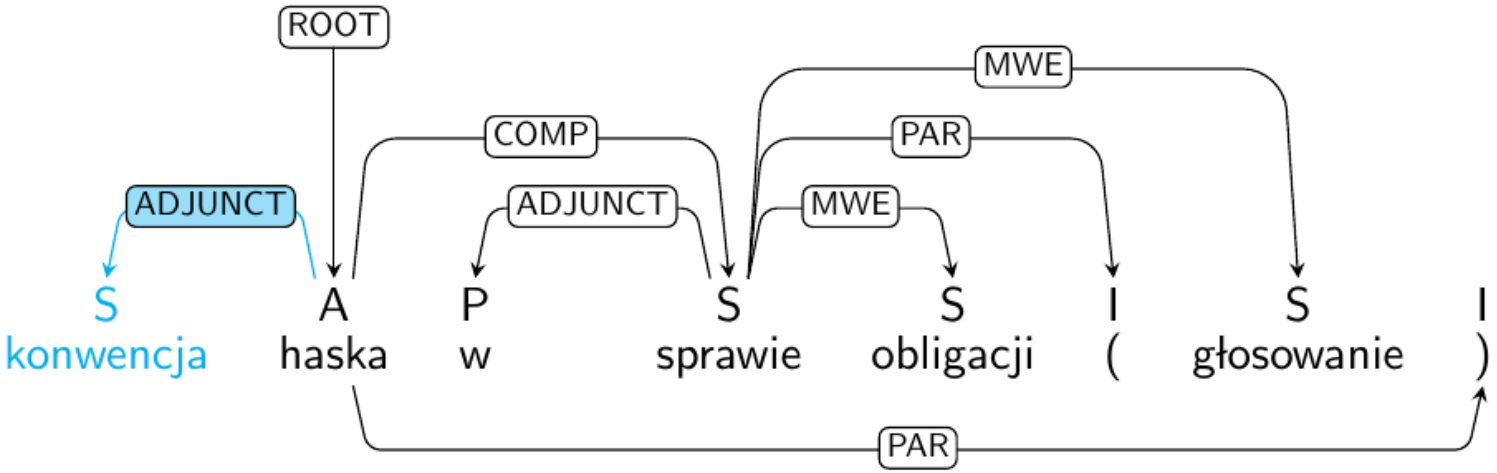

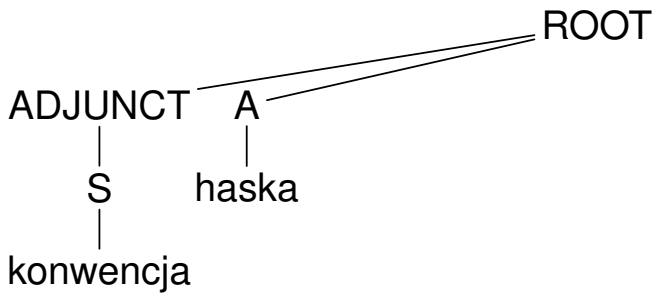

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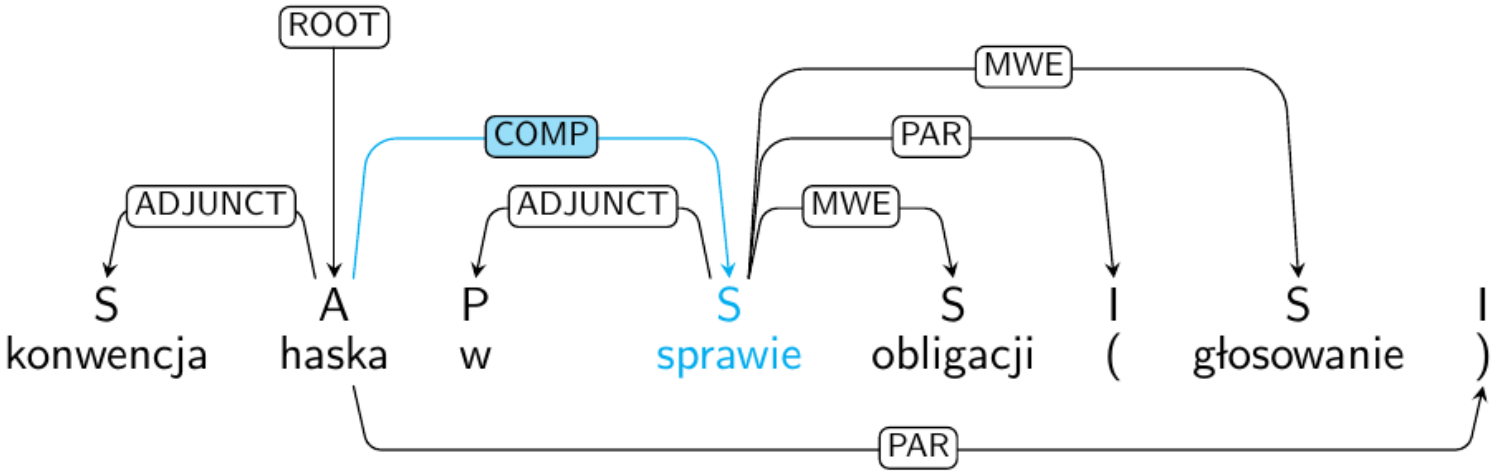
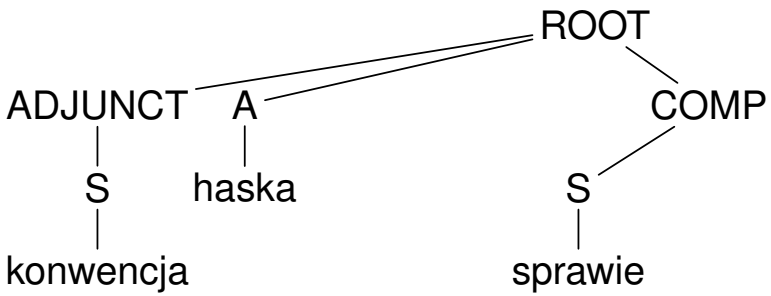
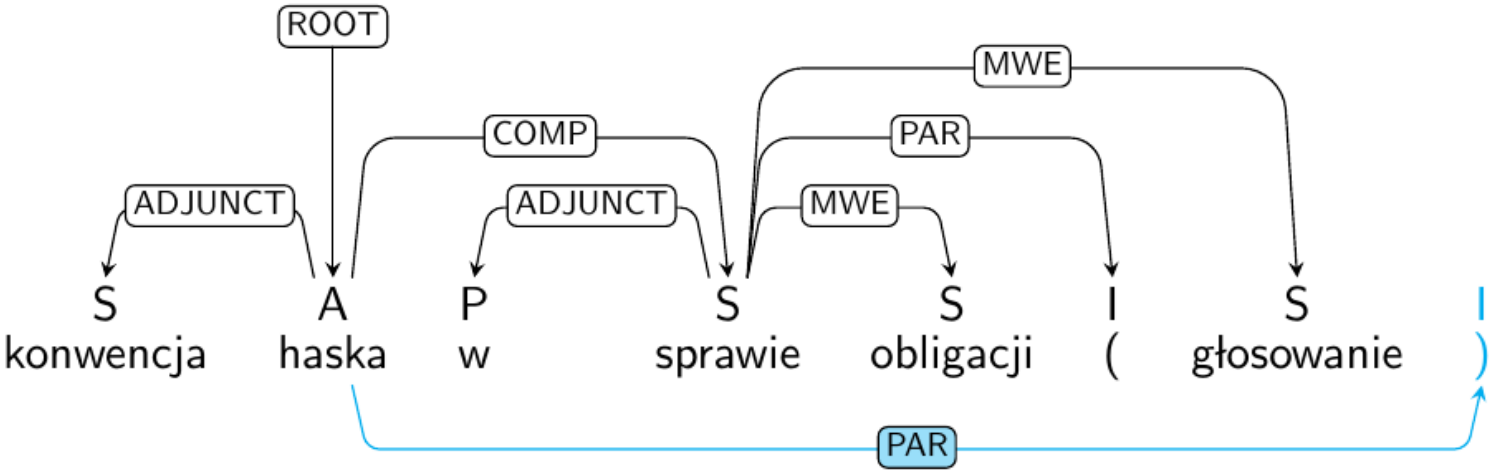
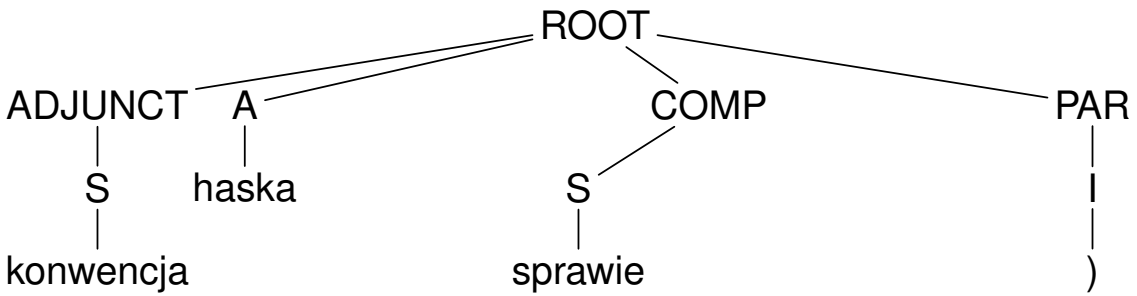




Conversion from dependency to constituency tree





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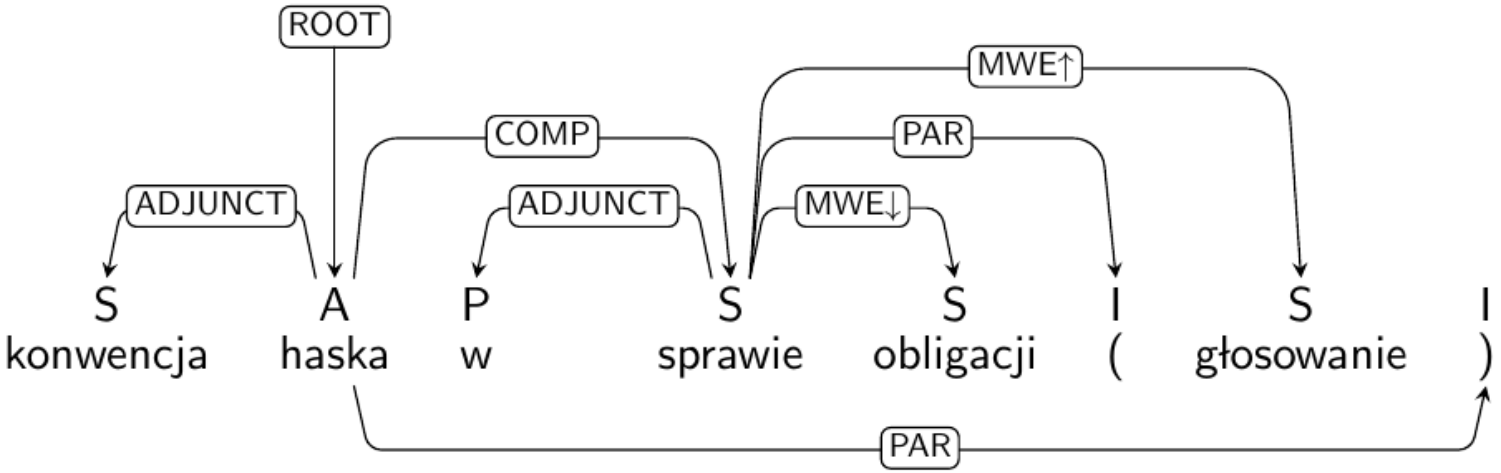
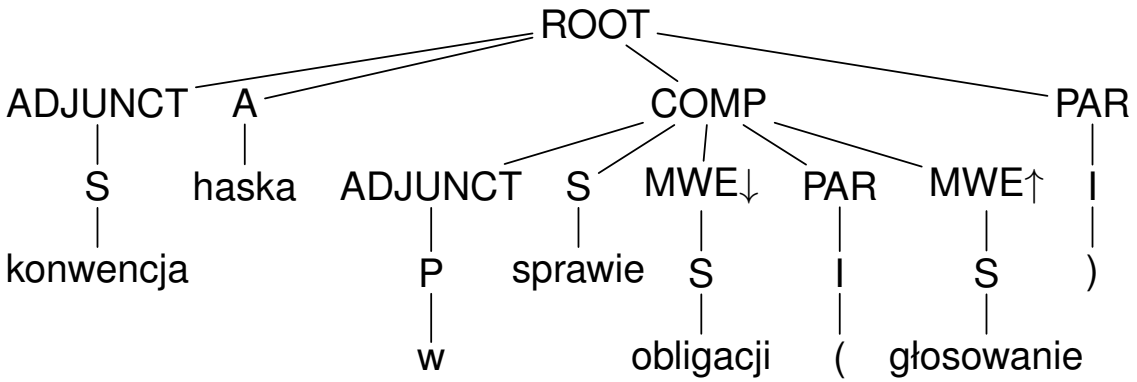


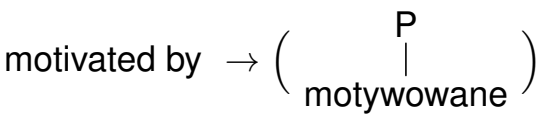


Preserves discontinuities!

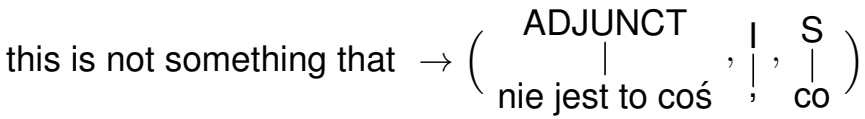
Outline

String-to-Tree Multi Bottom-up Tree Transducer

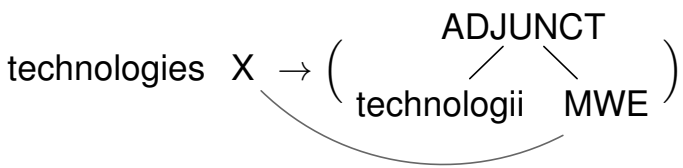
lexical continuous rule:



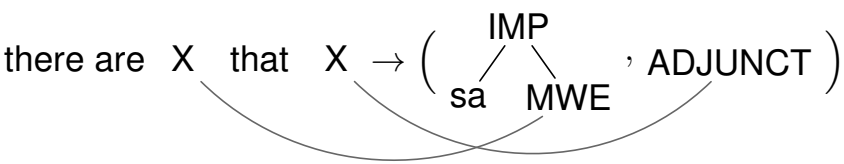
lexical discontinuous rule:

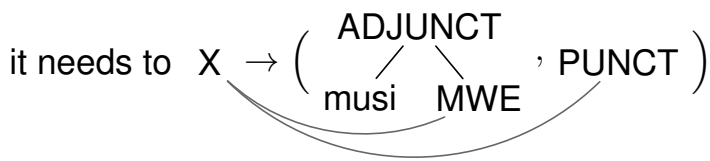


structural continuous rule:



structural discontinuous rules:





Translation Model

Standard log-linear model with the following 8 features:

- ...
- *gap penalty* 100^{1-c} (c is the number of target tree fragments)

We use the MBOT-Moses decoder [Braune et al. 2013]:

- standard MOSES syntax-based decoder
- extended to handle target side discontinuities

Outline

Setup

	English to Polish	**English to Russian**
training data	7th EuroParl corpus	WMT 2014
language model	5-gram SRILM	
tuning data	cut from EuroParl ($\approx$ 3k)	WMT 2014
test data	cut from EuroParl($\approx$ 3k)	WMT 2014

Training Pipeline

Target side:

- TreeTagger [Schmid 1996]
- MaltParser [Nivre et al. 2006, Sharoff & Nivre 2011]
- Path-Lifting
- Conversion into constituency tree

Parallel Data:

- tokenized and lowercased
- length-ratio filtered up to length 80
- word alignments by GIZA++ [Och & Ney 2003] with *grow-diag-final-and*

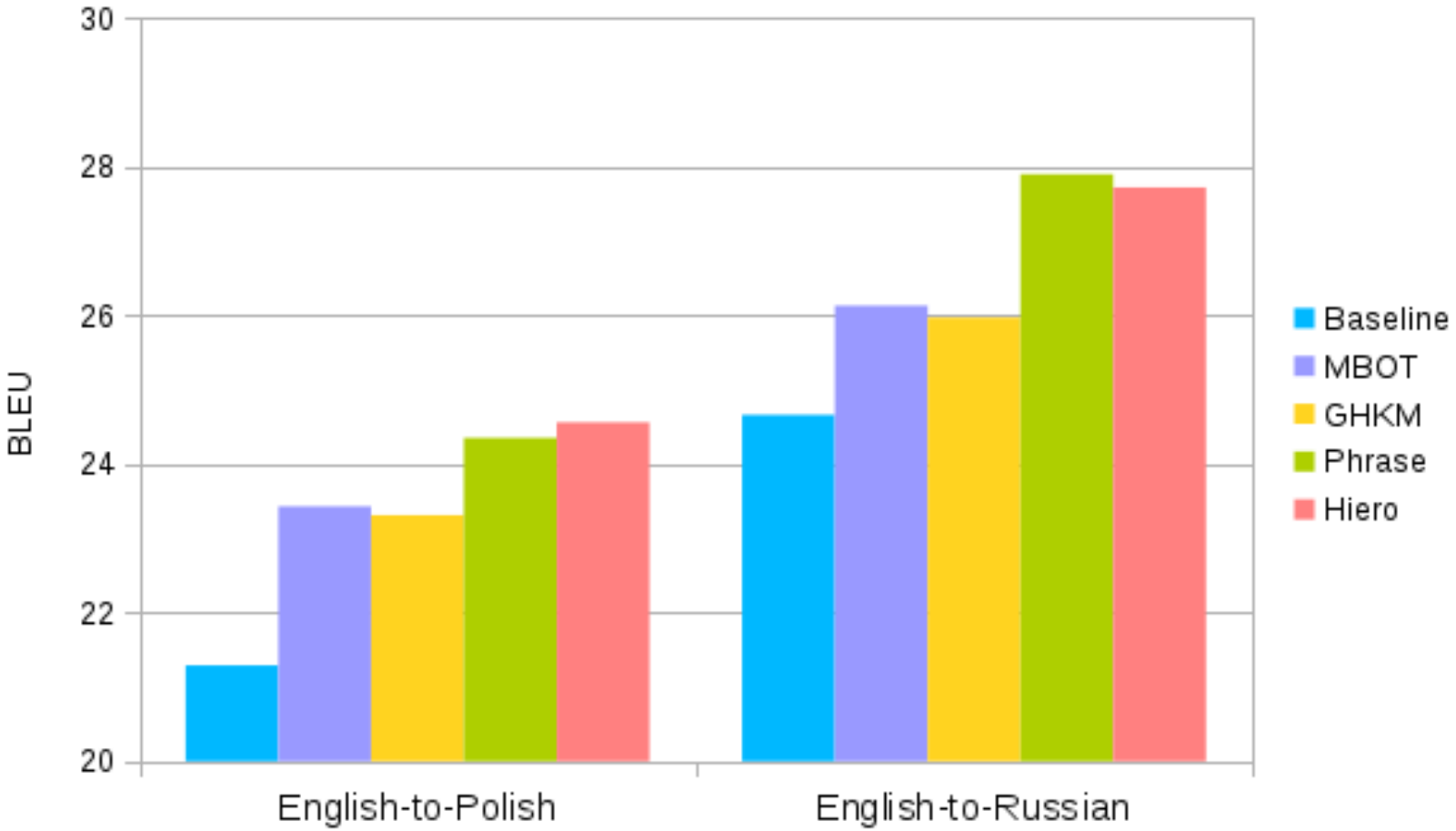
Tuning:

Minimum error rate training [Och 2003]

Experimental Results

Translation task	System	BLEU
English-to-Polish	Baseline	21.29
	MBOT	**23.43**
	GHKM	23.31
	Phrase-based	24.35
	Hiero	24.56
English-to-Russian	Baseline	24.66
	MBOT	**26.13**
	GHKM	25.97
	Phrase-based	27.90
	Hiero	27.72

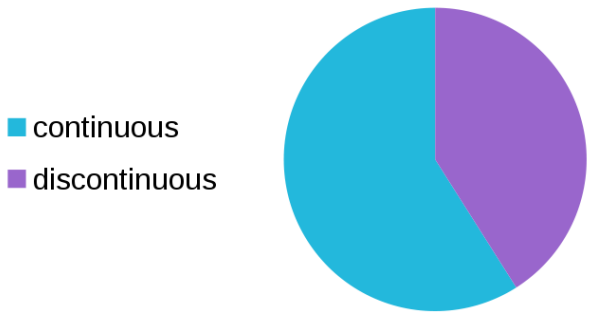
Losses across the systems



Analysis of rules used during decoding

English-to-Polish

All rules:



Structural rules:

English-to-Russian

All rules:

Structural rules:

Outline

Recap

- Translation into free word order languages
- Discontinuous constituents
- Dependency parsers producing non-projective parses:
  1. Projectivize by lifting technique documenting process
  2. Transform projective dependency trees into constituent-like trees
- String-to-tree local multi bottom-up tree transducers
- Discontinuous translation model

Conclusion

- MBOT avoids large quality drop between (hierarchical) phrase-based system and continuous string-to-tree one
- Discontinuous tree fragments yield significant improvements
- Overall performance similar to (hierarchical) phrase-based systems
- But, outscoring (hierarchical) phrase-based remains a challenge
- Can syntactic information actually help the translation quality in those translation tasks?

Thank you!

Questions?!?

Related Work

Xie et al., 2011:

- dependency-to-string model with head-dependent rules
- custom-made decoder

Li et al., 2014:

- transform dependency trees into (a kind of) constituency trees
- use the conventional syntax-based models of Moses

Sennrich et al., 2015:

- transform (non-projective) dependency trees into constituency trees
- using the syntactic functions provided by the parser
- string-to-tree GHKM model of Moses

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