Stacking or Supertagging for Dependency Parsing
What's the Difference?

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Section 1

Introduction

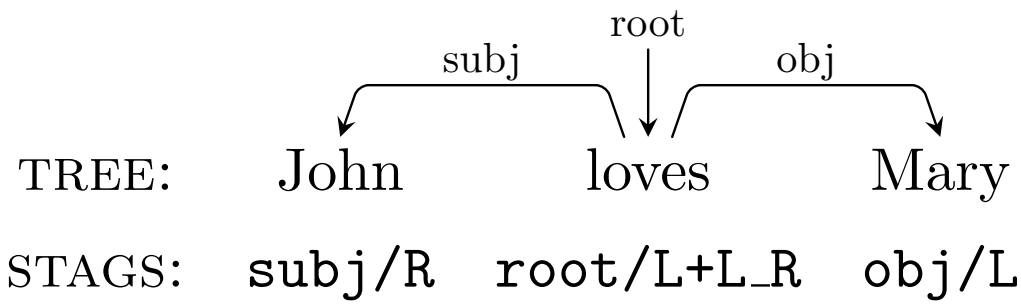
Introduction - the title

Stacking or Supertagging for Dependency Parsing – What's the Difference?

Supertagging

Supertags - labels for tokens encoding syntactic information

Example from [Ouchi et al., 2014]:



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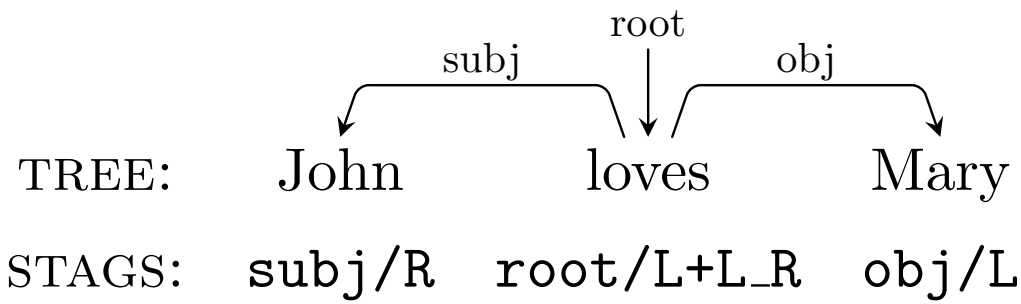

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Supertagging - background

- Joshi and Bangalore [1994] - elementary structures associated with a lexical item
- Bangalore and Joshi [1999]
  - a supertagger assigns supertags to each word of a sentence
  - a parser combines these structures into a full parse
  - they speed up the parser
- Clark and Curran [2004] - Combinatory Categorial Grammars
- Foth et al. [2006] - dependency parsing context
  - supertags as soft constraints in rule-based parser

Traditional use:

- reduce the search space
- score possible analyses

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Supertagging - background (2)

Recently - a method to provide syntactic information to the feature model of a statistical dependency parser:

- Ambati et al. [2013, 2014] - CCG categories improve a dependency parser (English, Hindi)
- Ouchi et al. [2014] - supertags extracted from a dependency treebank (English)
- Björkelund et al. [2014] - nine other languages

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Stacking

Stacking - one parser uses the output of the second parser as features (for example, whether a particular arc was predicted)

- introduced by Nivre and McDonald [2008]
- Martins et al. [2008] - extend feature set with non-local information
- Surdeanu and Manning [2010] - the diversity of the parsing algorithms is an important factor while stacking

What's the Difference?

- two ways of improving a statistical dependency parser
- two separate ideas successful independently

- intuitively - they have much in common
- hypothesis: supertagging is a form of stacking
- questions:
  - does stacking give higher improvements than supertagging?
  - what is the best/fastest way to realize those methods?
  - is there any benefit from combining them?

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Three groups of experiments

1. Comparing supertagging and stacking
   - does stacking give higher improvements than supertagging?
2. Supertagging without parsers
   - what is the best/fastest way to realize those methods?
3. Combining supertagging and stacking
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Three groups of experiments

1. Comparing supertagging and stacking
   - (1) accuracy
   - (2) oracle experiments
   - (3) self-application
2. Supertagging without parsers
   - (4) a CRF sequence labeller
   - (5) a greedy transition-based parser
   - (6) out-of-domain application
3. Combining supertagging and stacking
   - (7) combining the same source
   - (8) combining different sources

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Section 2

Experimental Setup

Data Sets and Preprocessing

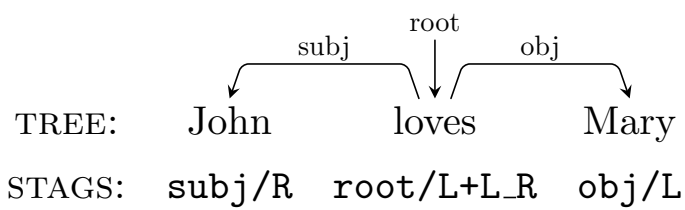
- 10 languages:
  - the SPMRL 2014 Shared Task's data sets:
    - Arabic
    - Basque
    - French
    - Hebrew
    - German
    - Hungarian
    - Korean
    - Polish
    - Swedish
  - \+ English Penn Treebank converted to Stanford Dependencies
- automatically predicted preprocessing
  - POS tags and morphological features by MarMoT [Müller et al., 2013]
  - the mate-tools for lemmatization

Supertag Design

Multiple options for supertags model design:

- Foth et al. [2006] - richer supertags improve parser's accuracy (but are harder to predict)
- Ouchi et al. [2014] - difference between models on tests sets not significant

Model 1 from [Ouchi et al., 2014]:



Notation

- $STACK^{y}_{x}$ - y uses output of x in stacking
- $STAG^{y}_{x}$ - y uses supertags provided by x
- x - Level 0 tool
  y - Level 1 tool

Parsers

- the transition-based parser *TB*
  - an in-house implementation using the arc-standard decoding algorithm with a swap transition [Nivre, 2009]
- the graph-based parser *GB*
  - TurboParser version 2.0.1
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Feature Models

- a simpler feature set is more useful for a comparison
- the supertag features mimic the information provided by stacking (to the best extent possible)
- *GB* example (h, d - the head and the dependent):
  - stacking: $\text{head}(d) = h$
  - supertagging:
    - $\text{hasL}(h) \oplus \text{hdir}(d)$
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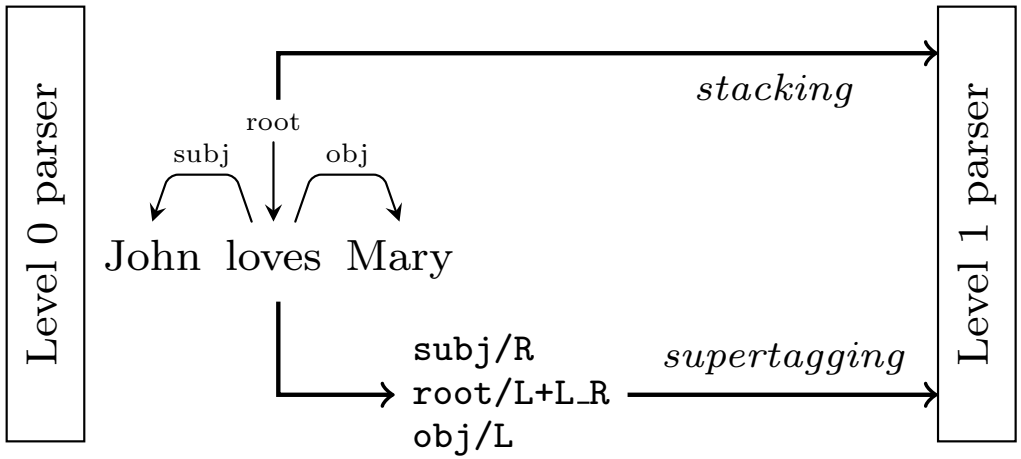
Experiments

Comparing Supertagging and Stacking

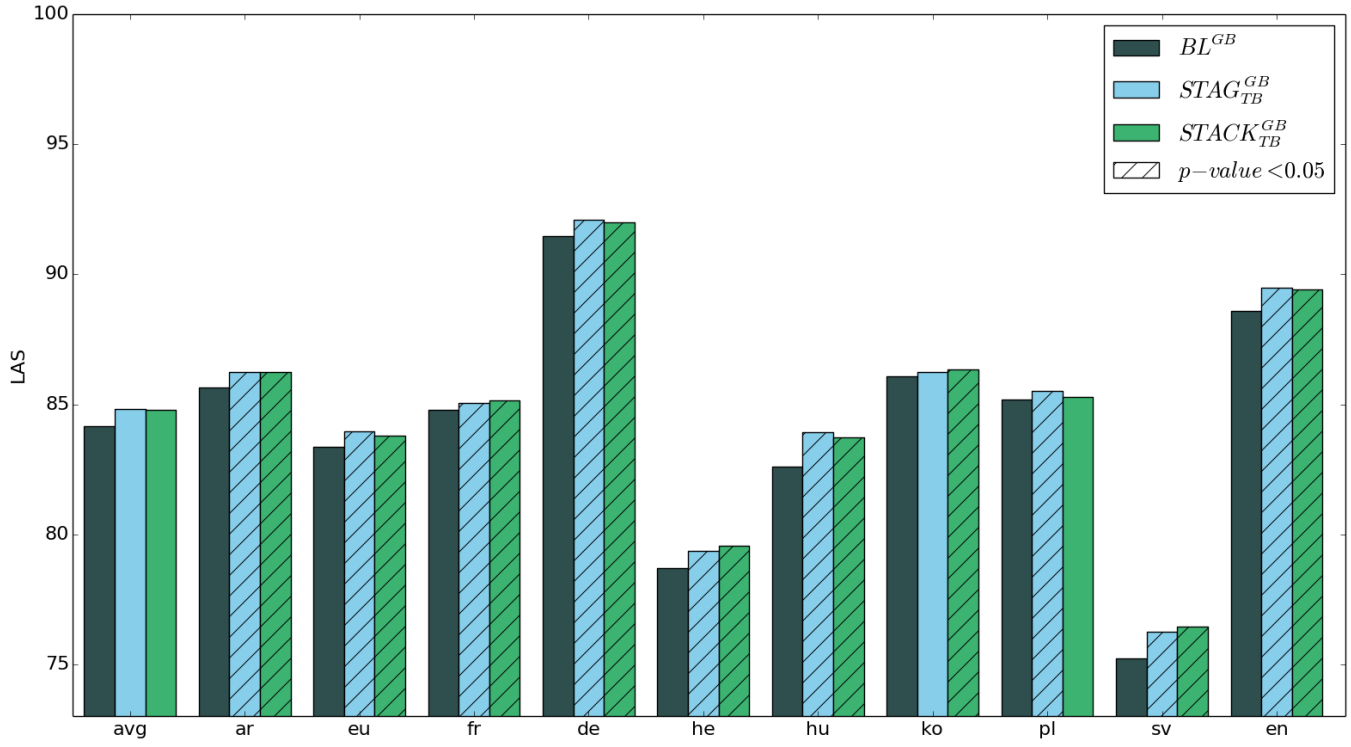


- Level 0 tool is a parser
- focusing on the means by which the information is given to the Level 1 parser

Experiment (1) - supertagging and stacking accuracy

- Purpose - to convince ourselves that both strategies improve over the baseline.
- The baseline setting (BL) - the parser is run without any additional information.

Experiment (1) - the graph-based parser



- averages:
  - BL^{GB} 84.16
  - $STAG^{GB}_{TB}$ 84.81
  - $STACK^{GB}_{TB}$ 84.79
- significance testing - Wilcoxon signed-rank test

Experiment (1) - conclusions

- results confirm the previous findings:
  - supertagging - [Ouchi et al., 2014], [Ambati et al., 2014]
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- both methods improve the accuracies to the same extent
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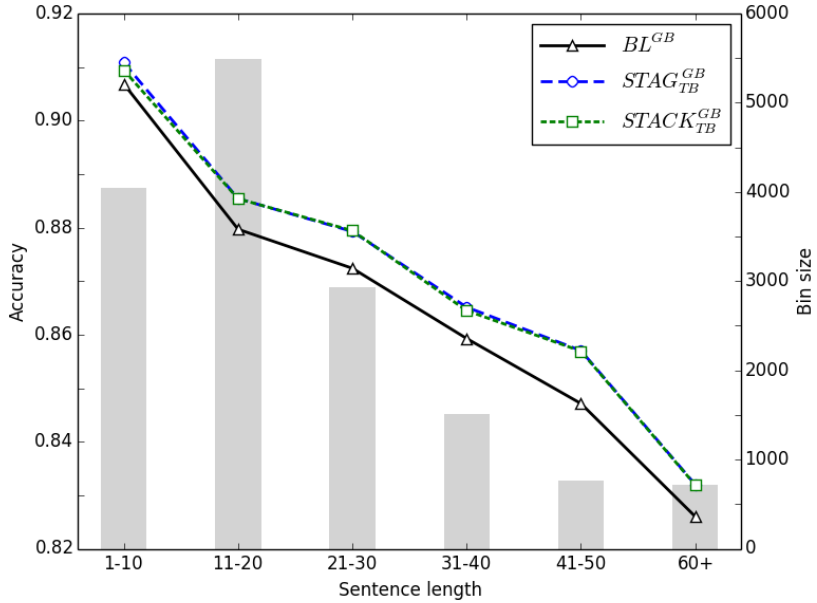

- bins of size 10
- both systems show a consistent improvement over the baseline
- the curves of the stacked and supertagged systems are mostly parallel and close to each other

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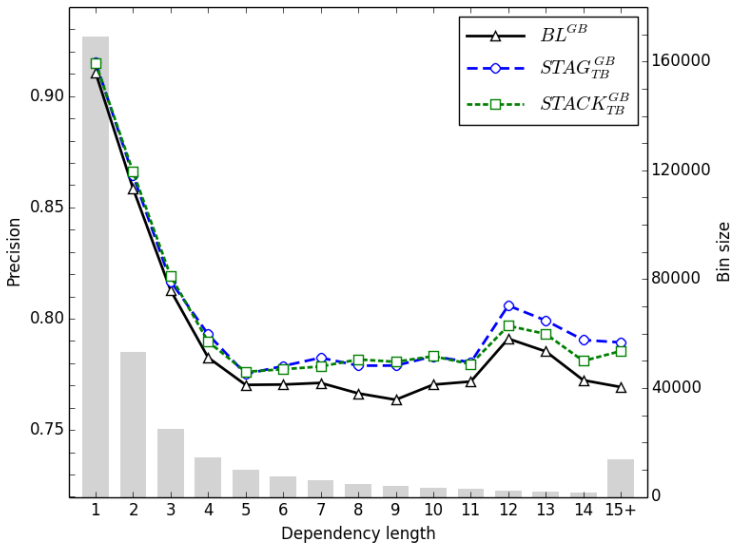

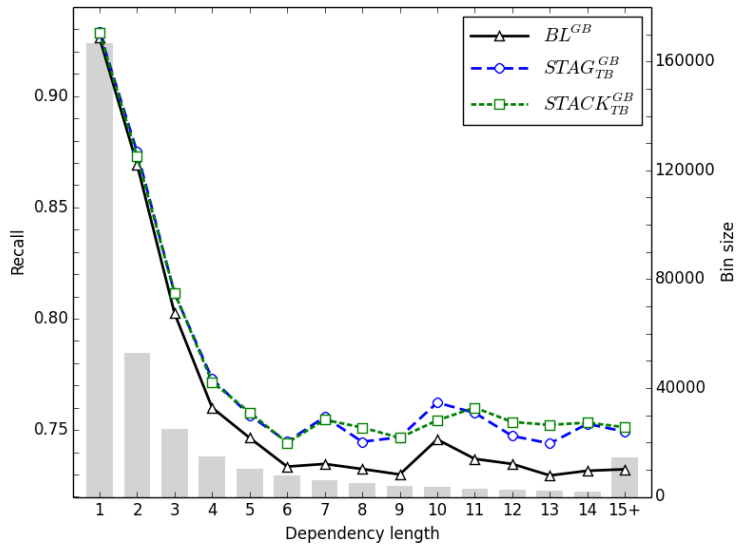

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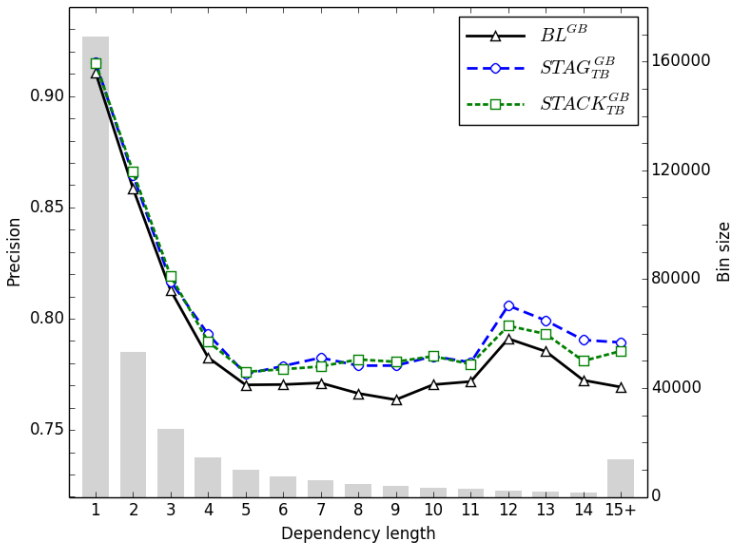

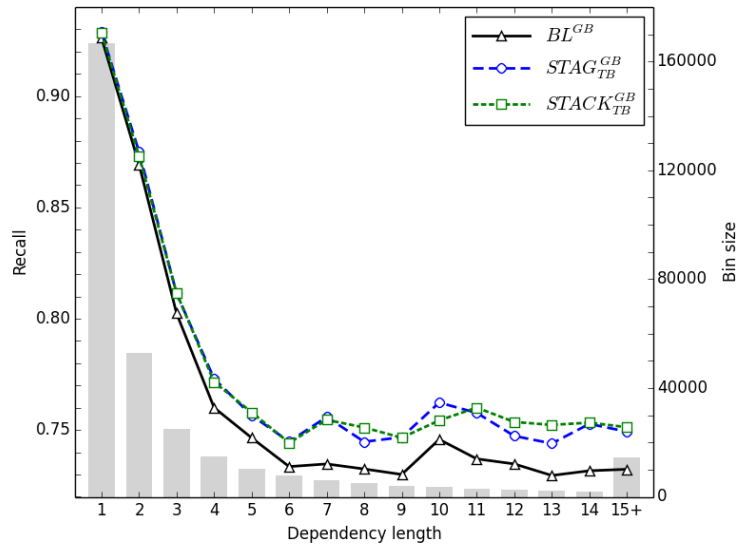

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Supertagging Without Parsers

Purpose - what is the best way to realize supertagging and stacking?

- most previous work predicts supertags using classifiers or sequence models

Options:

- regular parser (*GB*, *TB*)
- sequence labeler - MarMoT (*SL*)
- fast greedy arc-standard parser (*GTB*)
  - on Arabic 18 times faster than *SL*

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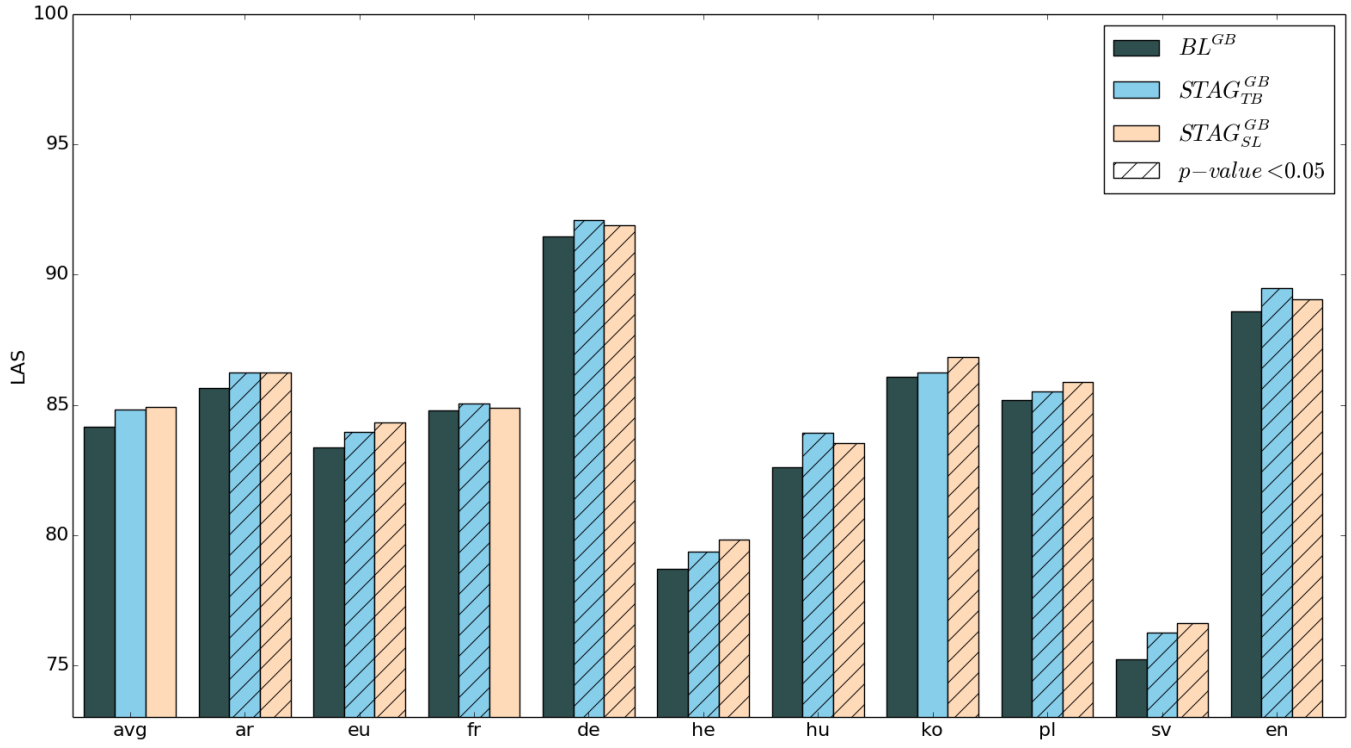
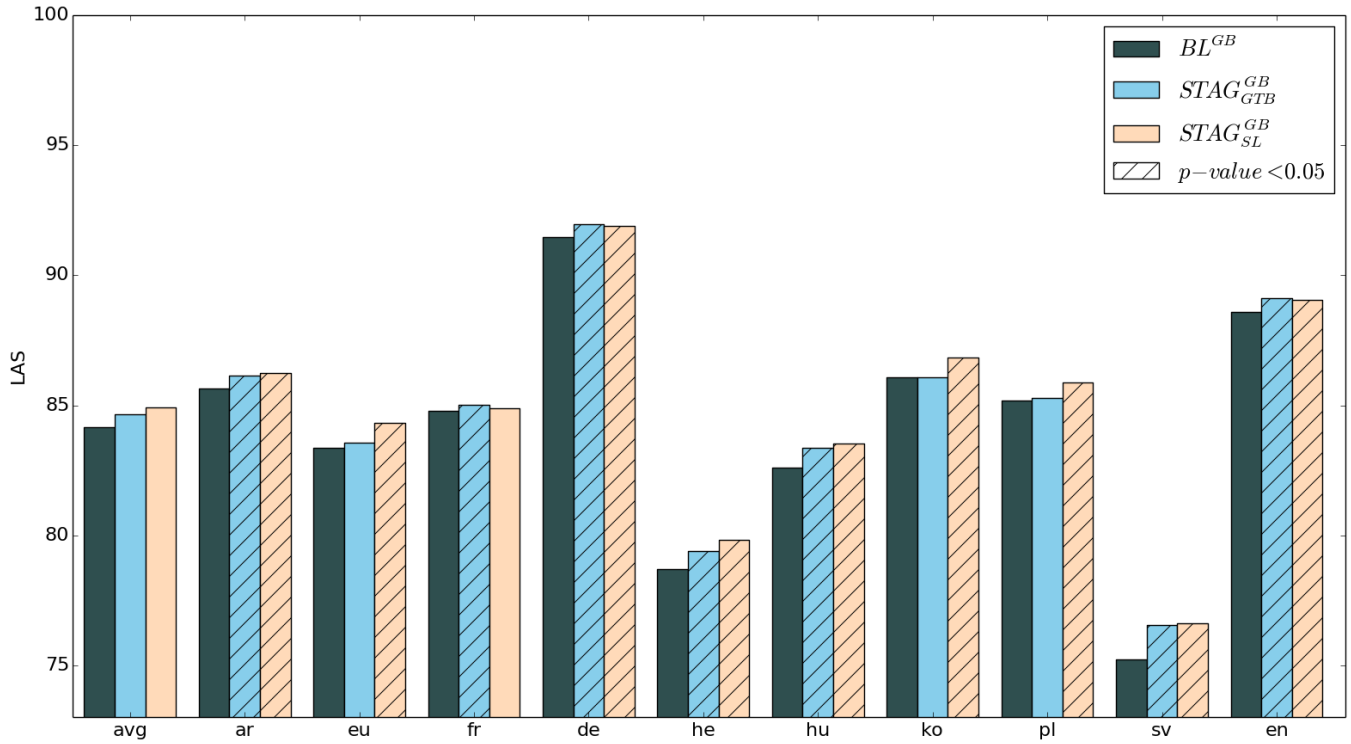
Experiment (4) - *TB* v. *SL* (graph-based parser)



- *SL* is better than the baseline
- on average *SL* is as good as a regular parser
- is *SL* more useful? it depends on the dataset

Experiment (5) - *SL* v. *GTB* (graph-based parser)



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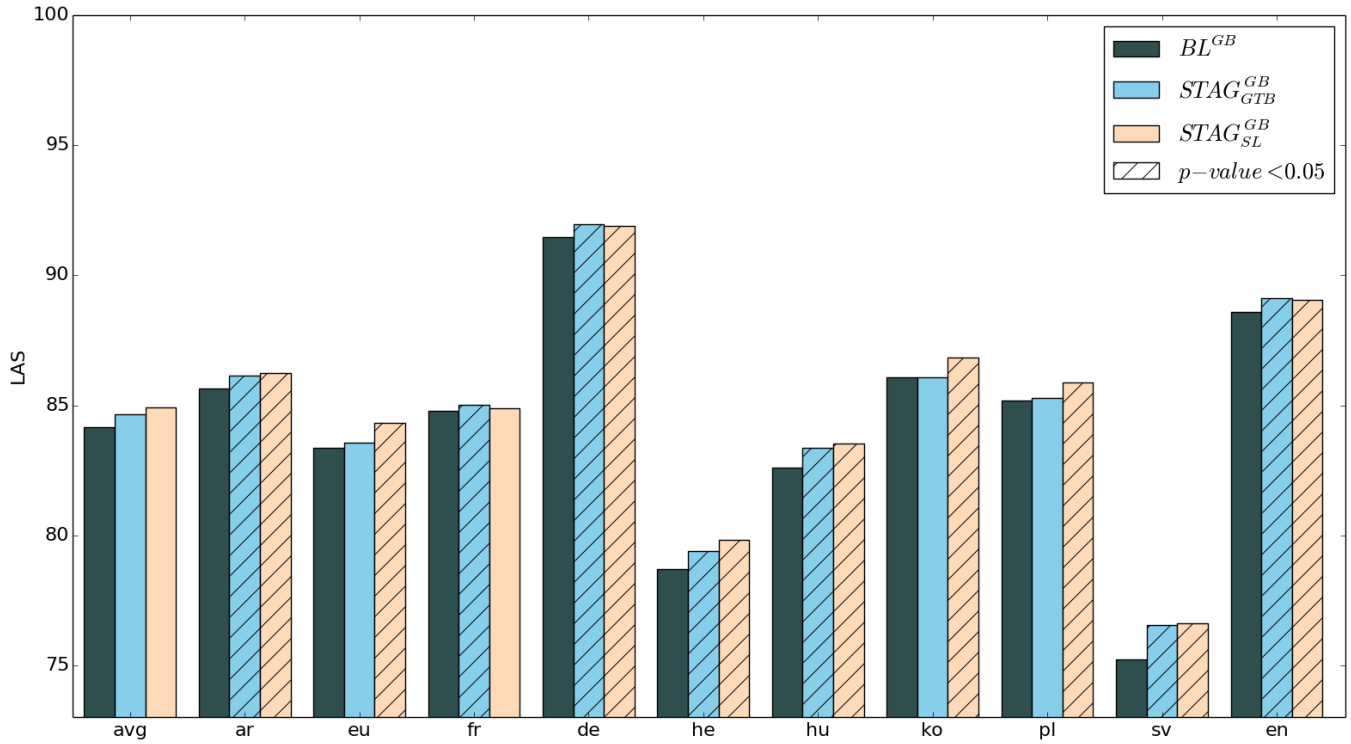

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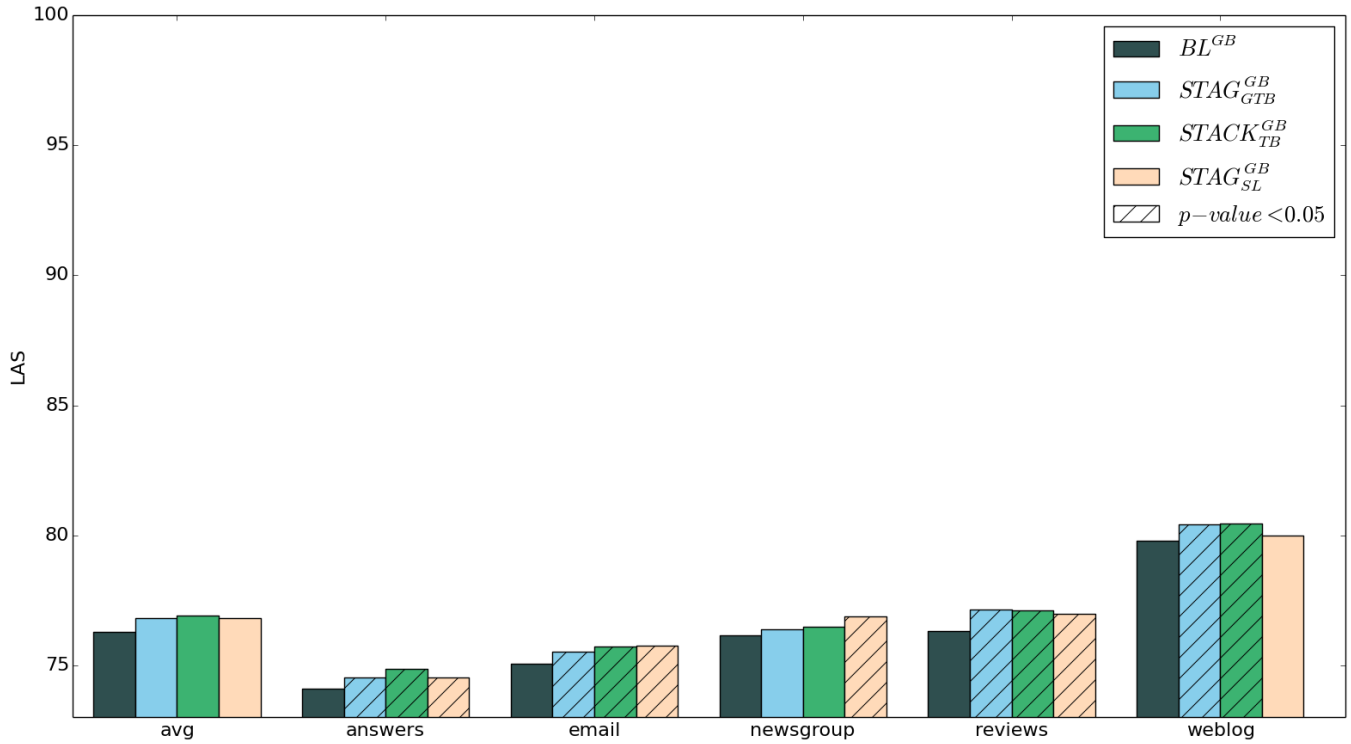
Experiment (6) - out-of-domain application

- having fast predictors suggests an application where speed matters
- example - a web data - will the possitive effects propagate into this setting?
- the English Web Treebank [Bies et al., 2012] converted to Stanford Dependency format

Experiment (6) - graph-based parser



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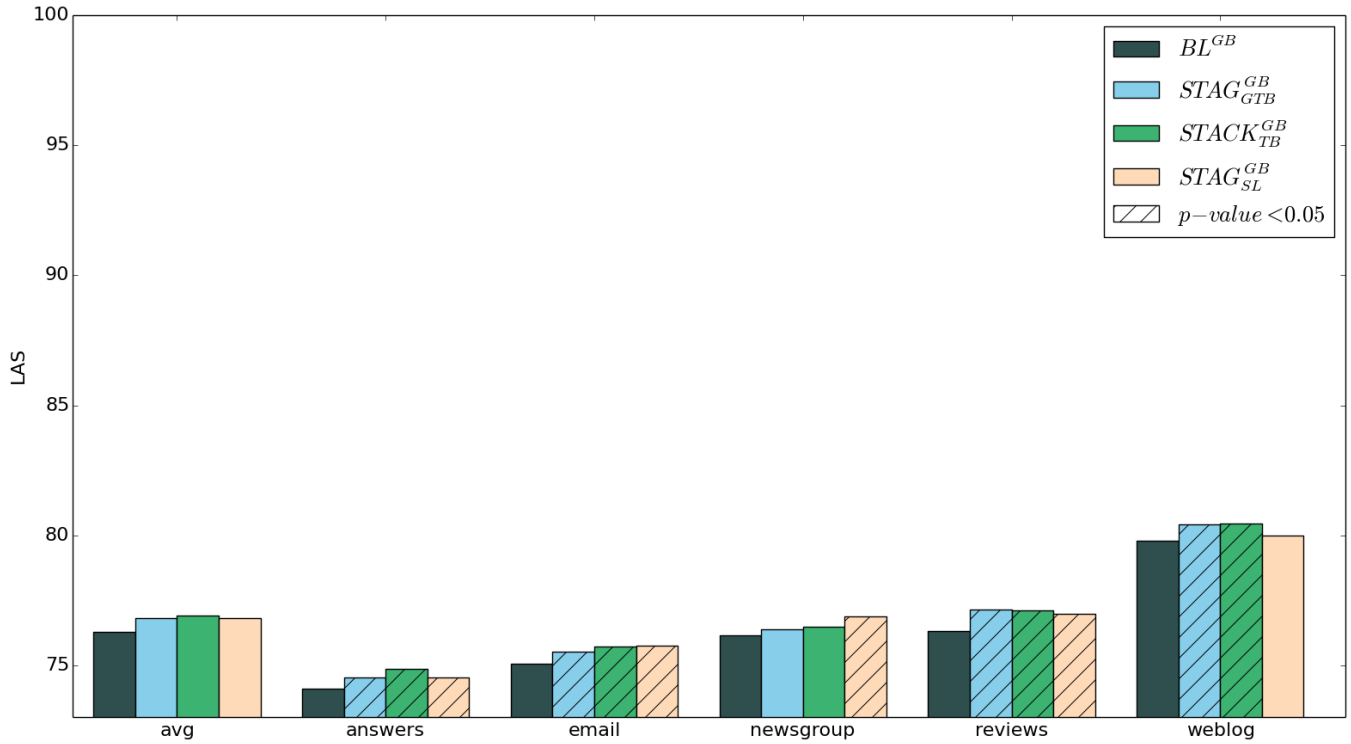

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