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

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Section 1

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

Supertags - labels for tokens encoding syntactic information

Example from [Ouchi et al., 2014]:

```
TREE: John loves Mary
STAGS: subj/R root/L+L_R obj/L
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Supertags are usually predicted by sequence labelers or classifiers.
Supertagging

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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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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

In this presentation - supertagging as a way of incorporating syntactic features to dependency parsers.
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In this presentation - supertagging as a way of incorporating syntactic features to dependency parsers.
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
   ▶ is there any benefit from combining them?
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]:

(Visual representation of a tree: John loves Mary with supertags subj/R, root/L+L, R, obj/L)
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 $\textit{TB}$
  - an in-house implementation using the arc-standard decoding algorithm with a swap transition [Nivre, 2009]

- the graph-based parser $\textit{GB}$
  - TurboParser version 2.0.1

- in this presentation - all plots for the graph-based parser
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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:
    - $\text{hasL}(h) \oplus \text{hdir}(d)$
    - $\text{hasR}(h) \oplus \text{hdir}(d)$
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Section 3

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
  - $STAG^{GB}_B$: 84.81
  - $STACK^{GB}_B$: 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]
  - stacking - [Nivre and McDonald, 2008], [Martins et al., 2008]

- both methods improve the accuracies to the same extent
- the improvements are similar but they might still come about in different ways
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Experiment (1) - in-depth analysis (graph-based parser)

- 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
Experiment (1) - in-depth analysis (graph-based parser)

- The improvements are not restricted to sentences or arcs of particular lengths.
- Conclusion: both methods are indeed doing the same thing.
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- the improvements are not restricted to sentences or arcs of particular lengths
- **Conclusion:** both methods are indeed doing the same thing
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)

- **GTB** slightly behind **SL**
- Conclusion: sequence labelers can be replaced by greedy parsers
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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 positive effects propagate into this setting?
- the English Web Treebank [Bies et al., 2012] converted to Stanford Dependency format
Experiment (6) - graph-based parser

- consistent improvements on the five genres
- Conclusion: staggering and stacking are both good methods to improve parsing accuracies when parsing out-of-domain data
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Section 4

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- a broad range of experiments to compare supertagging with stacking

- conclusions covered by this presentation:
  - supertagging as defined by [Ouchi et al., 2014] is a form of stacking
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  - the intuitive advantage of trees over supertags has no impact in practice (both in realistic and gold scenarios)
  - self-training does not work - neither for stacking nor supertagging
  - combining stacking and supertagging gives improvements only if different tools are used
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Thank you


