Data-Driven Approach towards Automated Deep Lexical Acquisition

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Outline

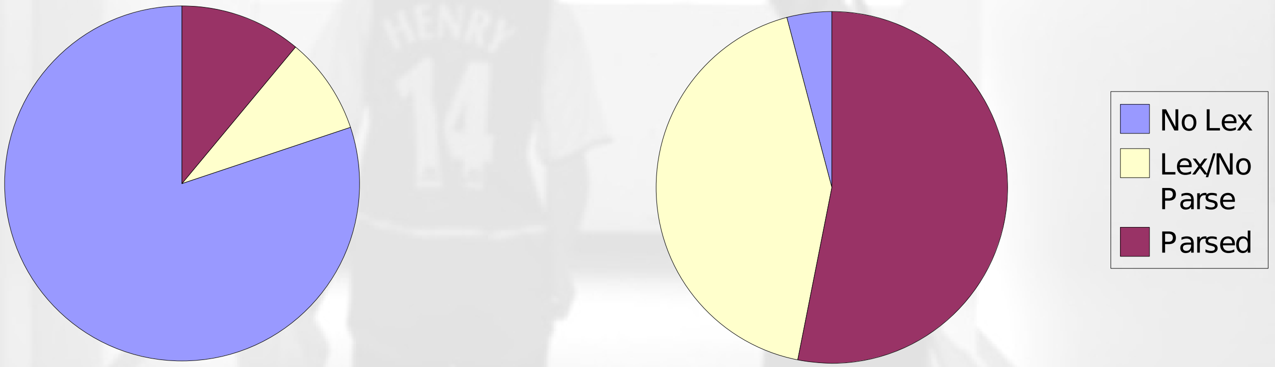
- Why automated DLA
- Previous work
- Data-driven approach
- Experiments
  - LinGO ERG
  - Alpino
- Work in progress/future
- Summary

Why automated DLA

- Broad coverage linguistically deep processing is desirable for advanced NL applications.
- State-of-the-art deep grammars can only achieve moderate coverage:
  - Coverage test of LinGO ERG on BNC shows
    - Full lexical coverage for 32% of strings
    - Of these, parse generated for 57% (83% correct)
    - For parsing failure
      - Missing lexical entries 26%
      - Missing constructions 17%
      - Garbage strings 17%
      - Others

Case Study: Manual Lexical Extension

- Corpus *“Shanghai”*
  - 1600 English sentences/strings about tourism in Shanghai (similar to the *“rondane”* corpus in LOGON).
- Discover new word/MWE; map it to one of the leaf lexical types in ERG



- *1500 entries are merged into official ERG lexicon since Apr-05

Case Study: Manual Lexical Extension

- Amount of work
  - 1575 entries, mostly nouns, adjectives
  - 5 person*days
  - Extension of verbs are much more difficult
    - Extension for 2000 verbs observed in BNC took several months of hard work.
- Conclusion:
  - Lexical extension is crucial for broad coverage text processing
  - Manual extension requires sufficient linguistic sufficiency, and is laborious.

Previous Work in Automated DLA

- Unification-based approach
  - [Erbach(1990)]
    - Parse the sentence with the unknown word
    - Collect the lexical information from the syntactic structure of the parse
    - Create new lexical entry according to the collected lexical information
  - [Barg and Walther(1998)]
    - *Generalizable* and *Revisable* information
  - [Fouvry(2003)]
    - Use external sources to reduce the computational complexity
- Problems
  - Grammar dependent
  - Underspecified lexical entries: overgeneration, comp. complexity

Previous Work in Automated DLA

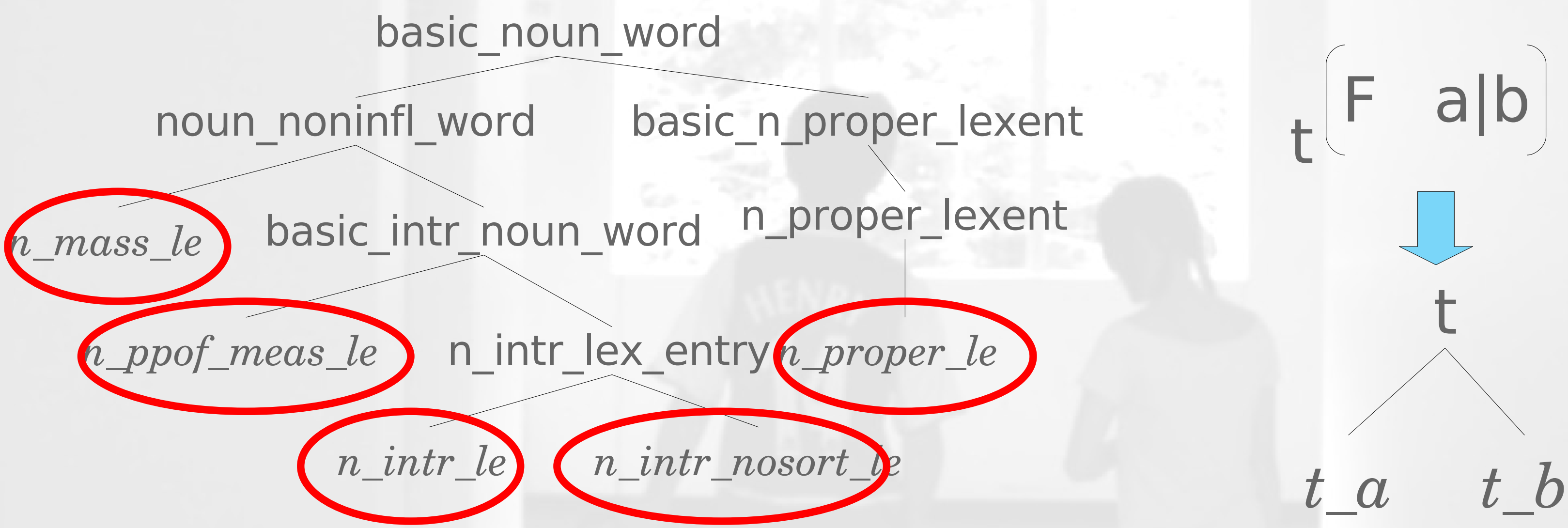
- Corpus-driven approach
  - [Brent(1991)]
    - To learn the SF of verbs from untagged text (Shallow).
  - ... ...
  - [Baldwin(2005)]
    - Bootstrap deep lexicon from secondary language resource, with the help of shallow processing tools
- Problems
  - Most of the approach focuses on some specific aspect of lexicon (SF for verbs, countability for nouns, etc)
  - All relies on the availability of secondary language resource.

Ideas!

Is the grammar itself (plus a set of raw text) capable of predicting unknown words?

DLA as Classification Task

- The lexical entries can be constructed with the lexeme and one of the atomic types.



- DLA assigns an atomic type to each unknown word/lexeme.

Tagger-based Model

- Use general purpose POS tagger
  - *TnT*: HMM-based trigram tagger [Brants(2000)]
  - *MXPOST*: ME-based tagger [Ratnaparkhi(1996)]
- Use atomic lexical types as tag-set
- Train tagger with corpus annotated with lexical types
- Tag the input sequence and use the tagger output for unknowns to create new lexical entries
- *Is general purpose POS tagger capable of handling large tag-set?*

Maximum Entropy based Model

- Maximum Entropy models
  - General feature representation
  - Capable of handling large feature set
  - No independence assumption between features

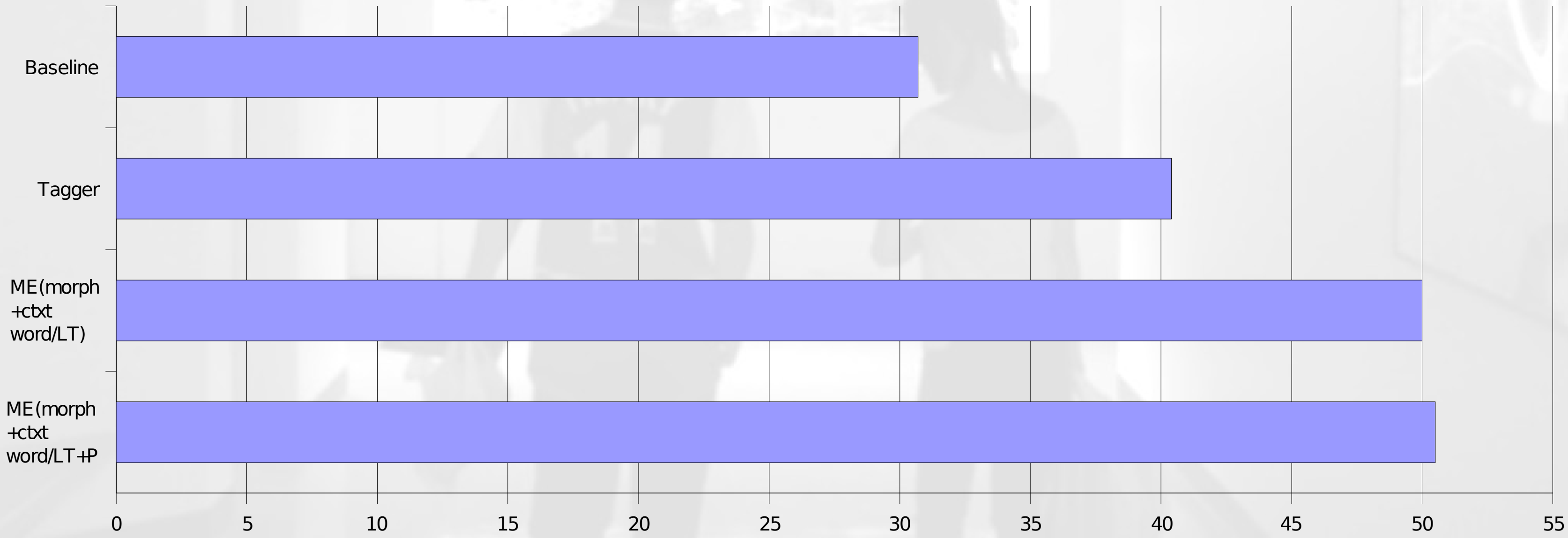
$$p_\Lambda(t|x) = \frac{\exp(\sum_i \lambda_i f_i(x,t))}{\sum_{t' \in T} \exp(\sum_i \lambda_i f_i(x,t'))},\ \Lambda = \{\lambda_i\}.$$

Classification Features

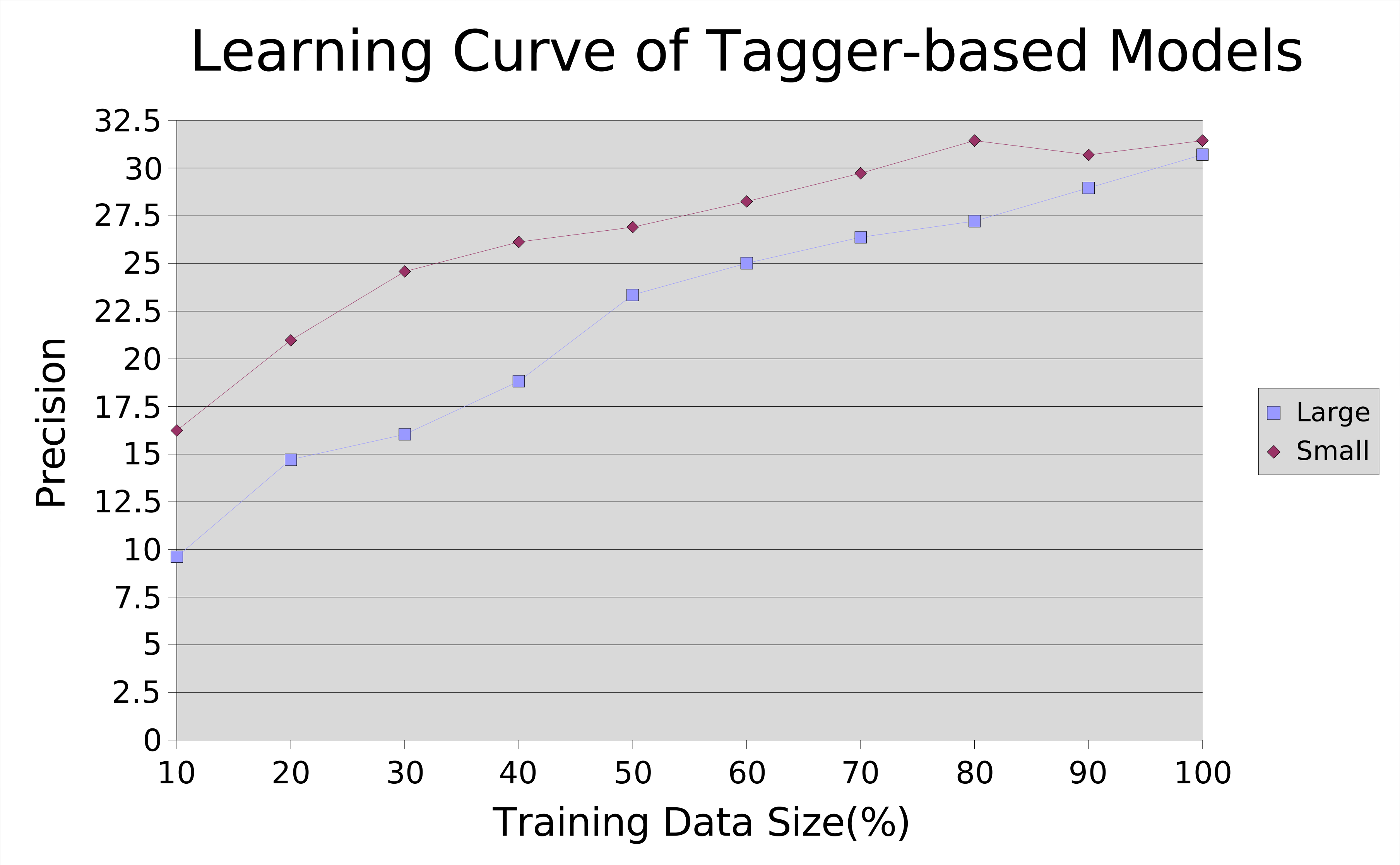
- Morphological features
  - Prefix/Suffix
- Syntactic features
  - Adjacent words/lexical types
  - Partial parse chart/chunks
  - Dependency head/daughters/labels
- Semantic features
  - (R)MRS fragments

Experiment I: LinGO ERG

- More than 700 atomic lexical types
- Redwoods Treebank (5th)
  - 16.5K sentences with 122K tokens
- 10-fold cross validation

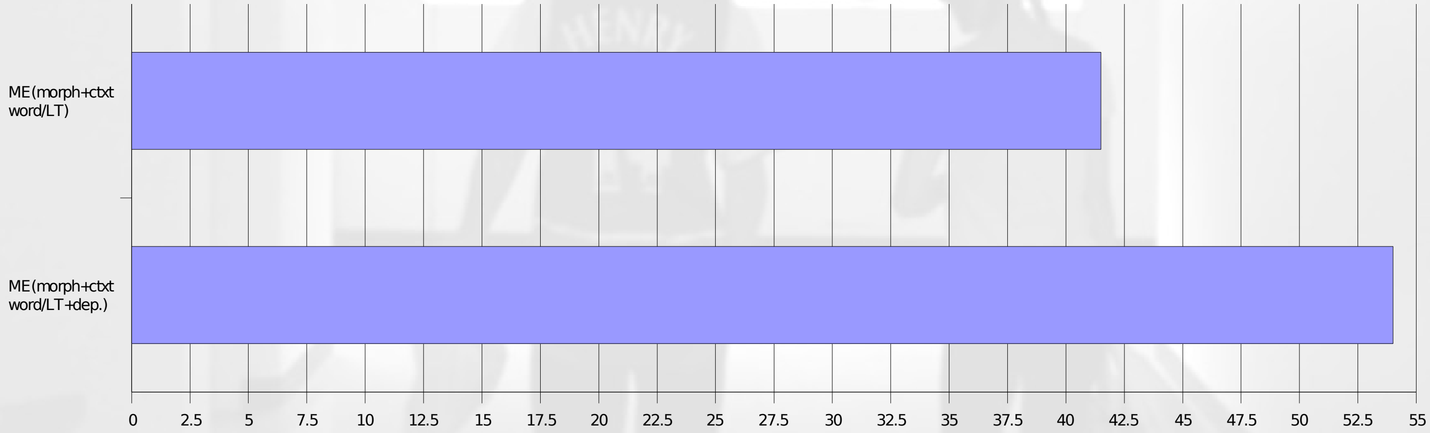


Effect of Large Tag-set



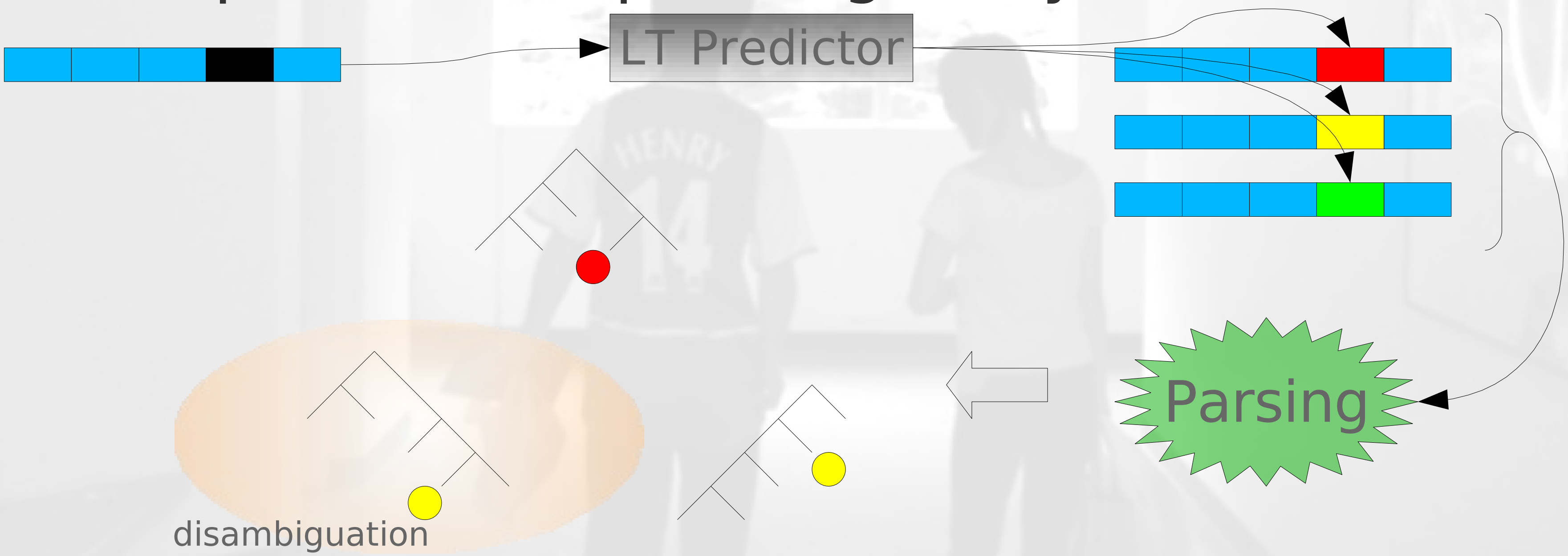
Experiment II: Alpino

- Broad coverage Dutch HPSG grammar
- Large dependency treebank
- Predict ~500 possible SF combinations
- +/- dependency features



Feedback from Full Parsing

- Predictor outputs *n* types
- Full parsing with these new entries
- Select best parse (disambiguation task)
- Keep the corresponding entry



Enhancing Performance with Voting

- Current approach: unknowns are predicted per occurrence
- Most words have no more than five entries
- For the same unknown word in multiple sentences, vote for the best lexical type.

Importing Lexicon

- WordNet 2.0
  - 152,059 words, 203,145 word-sense pairs
- LinGO ERG Apr-05
  - 21,000 entries
- Assumption: Semantically similar (open class) words generally also show syntactic similarity. (vice versa)
- Classifying WordNet word, using sharing lexicon with ERG as training data.

Automated Grammar Extension

- Lexical coverage only counts for part of the *robustness* problem
- Missing construction is another obstacle
- Automated grammar adaption for specific domain

A Larger Theme

- Restricted domain question answering with deep processing
  - More complicated questions
  - Less information redundancy for data intensive approach
  - Domain knowledge available

Summary

- Necessity for automated DLA explained (with manual extension case study)
- Previous works (unification based approach)
- Data-driven models for unknown word prediction
- Experiments with ERG and Alpino
- Work in progress
  - Using Feedback from Full Parsing
  - Improve accuracy with voting
  - Importing lexicon from WordNet
  - Grammar extension
  - Restricted domain question answering with deep processing

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