Treebank Usage

Martin Volk
Stockholm University

Usage - Overview

1. Training a chunker / parser on a treebank
   = Learning a probabilistic context-free grammar from a treebank
2. Evaluating a parser against a treebank
3. Using a treebank in education
   - for language learning
   - for linguistics education

Training a chunker / parser

Good introduction

- Manning and Schütze: Foundations of Statistical NLP. MIT Press. 1999.
  - Chap 11: Probabilistic Context Free Grammars
  - Chap 12: Probabilistic Parsing

Parser usages

Three ways to use a probabilistic parser:

1. Probabilities for determining the best sentence
   - When the actual input is uncertain (e.g. word lattice in speech recognition), to determine the most probable sentence.
2. Probabilities for faster parsing
   - To find the best parse more quickly.
3. Probabilities for choosing between parses
   - To choose the most likely parse tree among the many parse trees for the input string.

Grammar Learning

- Automatic learning of grammars based solely **on text input** is impossible / hard.
  - unless negative evidence is included!
- But automatic learning of grammars based **on treebanks** is easy …
- and provides probabilities on grammar rules.

Grammar learning from a treebank

- Count all derivations.
- Compute the probabilities based on the frequencies.
- The probabilities of all derivations with the same mother node must sum to 1.
- Penn Treebank
  - > 10,000 rules
  - ~4,000 appear more than once
  - Which rule is the most frequent?

NP → Det NN	2533
NP → Det AP NN	1255
NP → NN	501
NP → NE	388
…	

Problems with rule probabilities

Lexicalization needs to be taken into account.

In a pure PCFG the probability of a rule like

VP → V NP NP

is independent of the verb. This is clearly wrong from a linguistic point of view.

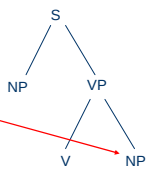
Problems with rule probabilities

Rule probabilities depend on **grammatical functions**.

- Compare subject and object positions in English:
  An NP is much more likely
  - to be realized as pronoun in **subject position**, (NP → Pron) and
  - to be realized as NP with a prepositional attribute in **object position** (NP → NP PP).

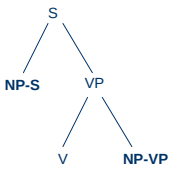
One solution: The grandparent node

- consider the tree on the right with one NP in subject position and one NP in object position

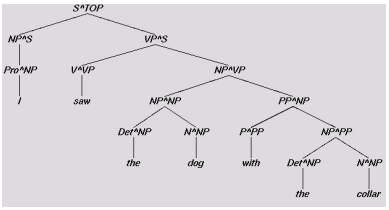


One solution: The grandparent node

- Distinguishing local trees based on the grandparent node
- → via node relabeling leads to improved parsing results.
- This is a way to take the derivation history into account!

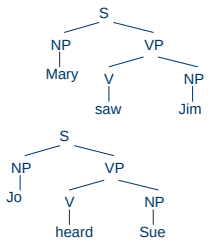


- "Transform" treebank trees, and proceed with PCFG extraction (Johnson, 1997)
- ~80% labeled precision and recall



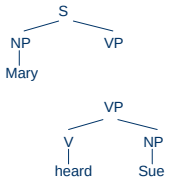
Relatives of probabilistic cf parsing

- DOP: Data oriented parsing (Rens Bod) is parsing via the re combination of parse trees of arbitrary depth.



DOP: Data-oriented parsing

- Example:
  Mary heard Sue.



DOP: Data-oriented parsing

- Problems
  - How to store all possible trees.
  - Slow parsing since the highest probability tree cannot be found efficiently. Viterbi algorithm cannot be used.
- is similar to parsing with
  Probabilistic Tree Adjoining Grammars

Parser Evaluation: PARSEVAL

Precision

$$P = \frac{\text{\# Correct Constituents}}{\text{\# Constituents in parser output}}$$

Recall

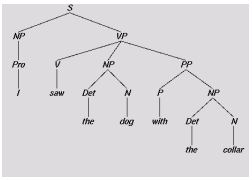
$$R = \frac{\text{\# Correct Constituents}}{\text{\# Constituents in gold standard}}$$

Crossing branches

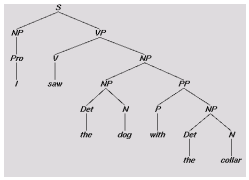
Parser evaluation

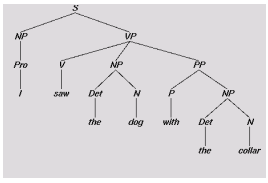
- Labeled Precision and Recall of constituents

Our parser gives:

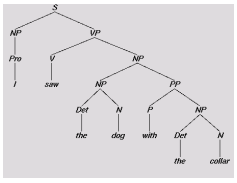


The Treebank says:





S	1	7
NP	1	1
VP	2	7
NP	3	4
PP	5	7
NP	6	7



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- Precision

$$P = \frac{\text{\# Correct Constituents}}{\text{\# Constituents in parser output}}$$

- Recall

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In our example:

Precision = 6/6 = 1.0 Recall = 6/7 = 0.86

Problems of PARSEVAL

PARSEVAL measures are not very discriminating.

- Charniak's ('96) vanilla PCFG which ignores all lexical content worked well.
  - PARSEVAL measure is quite easy at reproducing the tree structures given by the Penn Treebank.
- PARSEVAL measures the success at the level of individual decisions.
- In NLP consecutive decisions are more important and harder.

Evaluation

- Penn Treebank's problem
  - Too flat.
  - Non-standard adjunct structure given to post noun-head modifiers
- PARSEVAL measure seems too harsh on some specific problems.

Language / Linguistics Learning

Learning tasks over treebanks

- Viewing / searching trees
- Labeling trees
- Combining subtrees
- Comparing trees
- Evaluating trees
- Drawing trees

easy

difficult

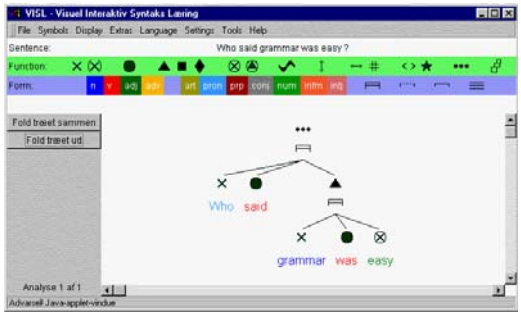
Language / Linguistics Learning

Some problems

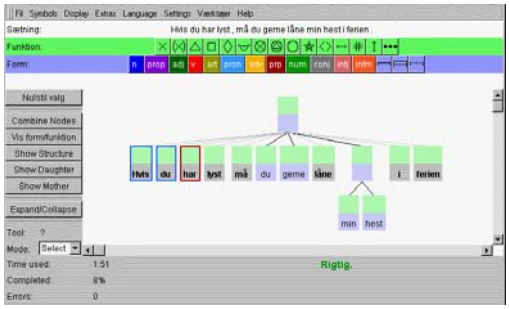
- How to find rare constructions?
- How to avoid confusing the student with ungrammatical examples?

Interactive syntactic trees

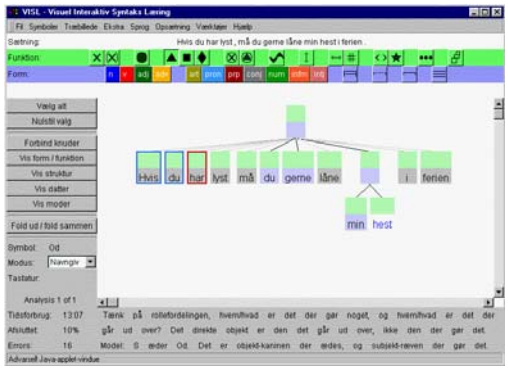
(from Eckhard Bick)



BuildTree: Drag & drop constituents



LabelTree: Drag & drop syntactic function



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Treebanks in Linguistics Courses

- H.v.Halteren ”Syntactic Databases in the Classroom”
  in: *Excursions into Syntactic Databases*. Rodopi. 1997.
- Experiments in English syntax courses at Nijmegen University based on the TOSCA Treebank
- CLUES: Computer Library of Utterances for Exercises in Syntax

CLUES Exercise Types

1. Mark empty node, ask for label
   - What is the label for node X?
2. Give label, ask for node (unlabeled tree)
   - Which node is a prepositional complement?
3. Show partial tree, ask for reconstruction
4. Show incorrect tree, ask for correction

Studien-CD Linguistik

- an introduction to (German) linguistics
- developed at the University of Zurich (2001-2004)
- published with an introductory linguistics book
- contains 100 German syntax trees across 10 different text genres (novel, medical abstract, weather report, interview, newspaper report, fairy tale)
- in two views (complex vs. ”easy”)
- to be used in self-learning as
  - examples for word classes
  - examples for syntax structures

Summary

- There is a straight-forward way to derive a probabilistic contextfree grammar from a treebank. But this PCF grammar will need optimization (e.g. lexicalisation, context) for high accuracy parsing.
- It is difficult to establish a good measure for parser evaluation (ie. tree comparison). PARSEVAL is the measure with wide-spread use.
- Treebanks can be used in syntax education.