Monte Carlo Syntax Marginals for Exploring and Using Dependency Parses (NAACL'18)

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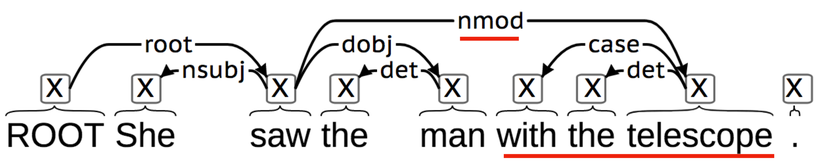
Summary

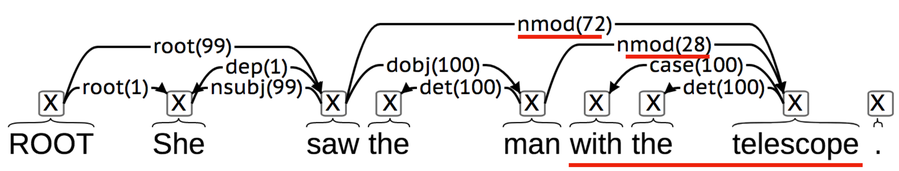
- **Goal:** Communicate inherent syntactic ambiguity
- **Key idea:** Replace greedy algorithm with fast and simple method—*transition sampling* from the full joint distribution of parse trees
- **New task:** Introduce *dependency path prediction,* predicting a set of length-*d* dependency paths for a sentence
- **Evaluation:** Our method (1) dominates the greedy algorithm on above task, (2) provides better error analysis, (3) improves performance on two downstream tasks

Example of inherent ambiguity

Greedy



100-sample marginals



Transition-sampling for dependency parsing

To get one parse tree sample, $y(a_1, \cdots, a_n)$

- Initialize state S_0
- For $n = 1, 2, \ldots$:
  - (A) Choose a_n
  - (B) $S_n := \text{Update}(S_{n-1}, a_n)$
  - (C) Break if $\text{InEndState}(S_n)$

Greedy

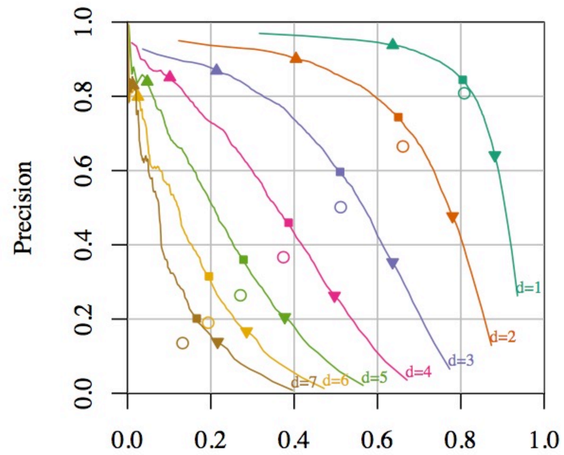
$$a_n := \arg\max_{a_n} p(a_n \mid S_{n-1})$$

Transition sampling

$$a_n \sim p(a_n \mid S_{n-1})$$

Dependency *path* prediction task

Previous work only evaluated length-1 paths (LAS)



Path Len.	Greedy F1	Marginal Max F1	Marginal Thresh.	MC-MAP F1
1	0.808	0.824	0.45	0.807
2	0.663	0.694	0.44	0.660
3	0.506	0.550	0.34	0.501
4	0.370	0.420	0.28	0.363
5	0.268	0.314	0.25	0.262
6	0.192	0.241	0.25	0.188
7	0.134	0.182	0.17	0.131

▲ Conf≥0.9 ▼ Conf≥0.1

F1-scores for retrieved set of all length-*d* paths with 100 MC samples against gold (UD 1.3 dev set) parse tree

Error analysis via entropy calculations

Sentence	Domain Size	Top 3 Freq.	Entropy
In Ramadi , there was a big demonstration .	3	[98, 1, 1]	0.112
US troops there clashed with guerrillas in a fight that left one Iraqi dead .	40	[33, 11, 6]	2.865
The sheikh in wheel - chair has been attacked with a F - 16 - launched bomb .	98	[2, 2, 1]	4.577

Whole-tree entropy

$$H(p) = -\sum_{y \in \mathcal{Y}(x)} p(y \mid x) \log p(y \mid x)$$

$$\approx H(\tilde{p}) = -\sum_{y \in \tilde{\mathcal{Y}}(x)} \frac{c(y)}{S} \log \frac{c(y)}{S}.$$

Improving downstream applications

(1) Classifying names of persons killed by police (Keith et al. 2017)

Method	F1
RPI-JIE	0.170
Greedy	0.215
1 samp.	0.212
10 samp.	0.219
100 samp.	**0.222**

(2) Semantic role assignment

English OntoNotes v5.0

Method	Accuracy
Baseline (most common arg)	0.393
Greedy	0.496
100-sample	**0.529**