


Multilingual Dependency Parsing with Incremental Integer Linear Programming

Data Intensive Linguistics 2005

Sebastian Riedel, Ruket Çakici and Ivan Meza-Ruiz

9. June 2006

McDonald et al.'s (2005) original approach defines scores over **single attachment decisions** and can produce:



root Ik kom om twaalf en dan krijg je wat je verdient
I'll come at twelve and then you'll get what you deserve

because attachment decisions are made **indendepend of each other**.

- Inspired by Roth and Yih (2005): formulate Maximum Spanning Tree problem using an Integer Linear Program:

$$\max \sum_{(i,j,l) \in \text{Parse}} \text{dep}_{i,j,l} \cdot s(i,j,l)$$

- for each token add a constraint to ensure there is **exactly one head** (or no head for the root)
- for each possible subset of tokens c ensure that its induced subgraph **is not a cycle**
- for each coordination add a constraint to ensure that **nouns are not coordinated with verbs**
- for each verb add a constraint to ensure that it **has not more than one subject**
- ...

- Inspired by Roth and Yih (2005): formulate Maximum Spanning Tree problem using an Integer Linear Program:

$$\max \sum_{(i,j,l) \in Parse} dep_{i,j,l} \cdot s(i,j,l)$$

- for each token add a constraint to ensure there is exactly one head (or no head for the root)
- for **each possible subset of tokens** c ensure that its induced subgraph is not a cycle
- for each coordination add a constraint to ensure that nouns are not coordinated with verbs
- for each verb add a constraint to ensure that it has not more than one subject
- ...

There is an **exponential number of possible subsets**. (Other formulations aren't much better, see Williams (2002)). So we follow Warme (1998) and

- 1: add all but cycle constraints
- 2: solve the ILP
- 3: **while** any cycles found in the solution **do**
- 4: add a constraint for each cycle to forbid the cycle
- 5: solve the ILP
- 6: **end while**

- Applied to 4 languages but no improvements because
 - needs a bit of understanding of language and annotation
 - sometimes constraints were not violated in the first place
 - noisy POS tags
 - some bugs in our code
- Our Chinese parser performed very well, but not due to constraints
- In Riedel and Clarke(2006, to appear) we show significant improvements