RESTORING EMPTY CATEGORIES FOR ARABIC

Ryan Gabbard

What is the empty category problem?

- Various non-word nodes in parse trees
  - Usually indicating non-local syntactic relations
  - Necessary for predicate-argument structure

```
(SQ (WHNP-1 What)
        do
        (NP-2 you)
        (VP want (S (NP *-2)
                    (VP to
                        see
                        (NP *T*-1)))))?
```

In what distribution?

Type	Antecedent	Arabic	English
NP *T*	WHNP	30%	17%
NP *	None	24%	19%
NP *T*	NP	17%	
WHNP *0*	None	14%	3.5%
NP *	NP	12%	36%
ADVP *T*	WHADVP	1.3%	5%
NP *	SBAR	0.5%	
SBAR *ICH*	None	0.4%	
PP *ICH*	None	0.3%	
NP *T*	None (???)	0.2%	

51,068 in Arabic training data; 50, 961 in English
Missing in Arabic: S *T* → S (8%, 4% SBAR), WHADVP 0 (1.1%)

Preliminary Comparison to English

- In some ways, easier
  - No ambiguity between nominal and adverbial for null complementizers
  - NP * without antecedents more common (2:1); in English it's almost the other way around
  - No S traces
- New things
  - Extensive topicalization
  - More wh-traces, but fewer adverbial

Previous work on English

- Parser-integrated approach
  - Collins (1999); Dienes and Dubey (2003); Schmid (2006)
- Post-processing
  - Johnson (2002); Levy and Manning (2004); Campbell (2004); Gabbard, Kulick, and Marcus (2006); Filimonov and Harper (2007)
- Only non-English work is on Chinese by Guo, et. al. (2007)

Approach for Arabic

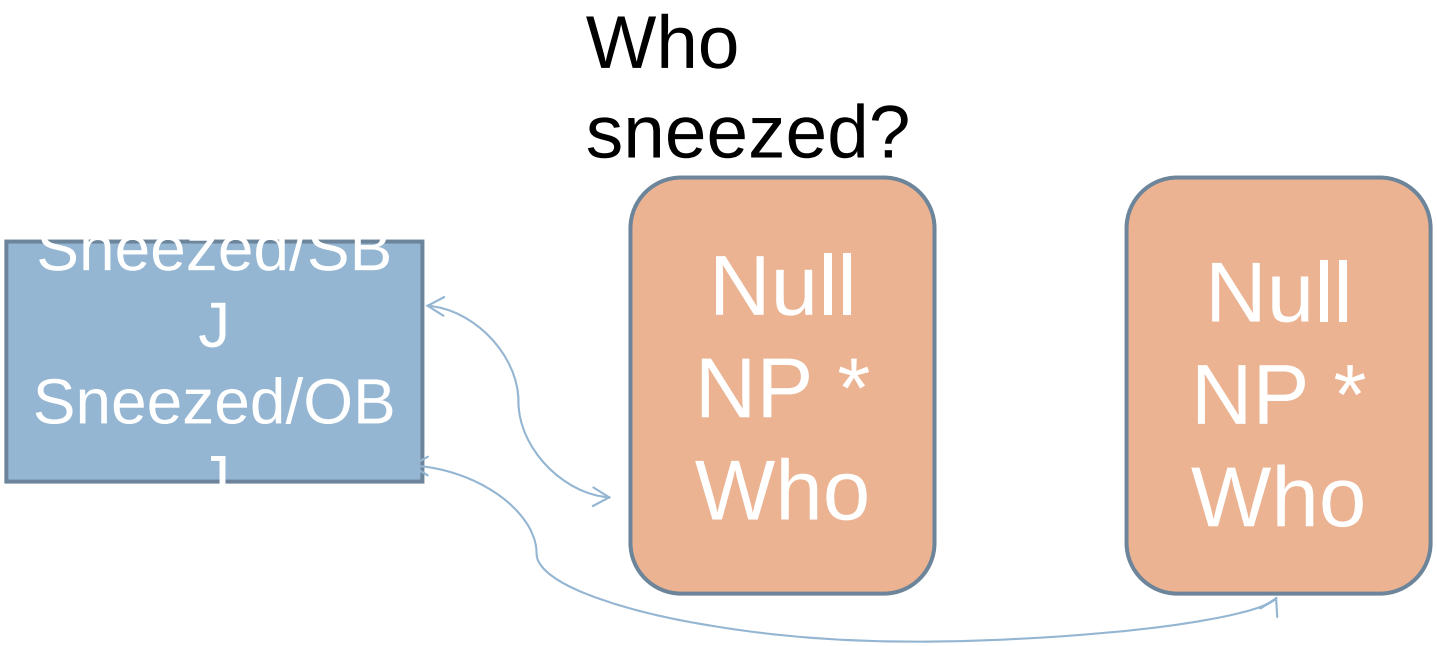
- We adopt basically the model of Gabbard, et. al. (2006)
  - Good performance, flexible
- It applied a series of maximum entropy classifiers to relevant locations in the tree
- However, had a few cascading error problems due to multiple different types competing for the same locations.
- New model: do the inference all at once (CRF)

New Model: Slot Variables

- Assign a **slot variable** to each
  - Unfilled subject and object slot of every verb
  - Unfilled subject of –PRD
  - Unfilled object of PP
- Resumptive pronouns are treated as unfilled
- Each slot variable has the following values
  - Null
  - NP *
  - Each wh-word (variable) which could come from there
  - Each NP which could have topicalized from there

New Model: WH-variables

- Insert a variable for every wh-word
- Its values are all the slots the wh-word could have come from



New model: Path factors

- Between each wh-variable and each of its values, add a path factor
- This factor will add a “mismatch” feature if one variable points to the other, but not vice-versa
- If neither points to the other, it adds no features
- If both match, it adds features based on the path between the trace and antecedent.

New model: Slot Factors

- Every slot variable has an associated slot factor
- This adds features such as:
  - How many argument NPs are present
  - Whether the verb has other arguments: VP, SBAR, etc.
  - Verb's POS tag
  - Path to topicalized NP and features about the topic location
  - Resumptive pronouns

Current Results

Type	F-measure
0	96.7
WHNP 0	99.5
Adverbial Wh-traces	73.7
Nominal Wh-traces	85.5
Nominal topicalization	90.1
*NP * (placement only)*	*72.1*

- NP * is very poor
  - Hasn’t had much attention yet
  - Lacks some of English’s easy cases
- Nominal wh-traces about ten points worse than English
  - Looking into why

Future work

- Increase performance
- function-tagging into the same framework
- Do reranking over trees with empty categories restored
- Ideally you'd like it to be in the parser
  - But attempts to do this for lexicalized parsers have lowered parsing performance