Typological coverage and descriptive precision in grammar engineering

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Overview

- Introduce the Grammar Matrix
- Discuss how a typologically-informed model of coordination has been implemented in a machine-readable grammar
- Address some potentially interesting typological claims that came out of the implementation

Grammar Matrix

- What kind of description?
  - Formal/machine-readable grammars
  - Intended to work for parsing strings so as to assign semantic representations to them
  - Also intended to work generating strings representing linguistic forms from semantic representations

Grammar Matrix

- The Grammar Matrix (Bender et al. 2002) is a machine-readable grammar "starter kit"
- Based on lessons learned from building machine-readable grammars within Head-Driven Phrase Structure Grammar (Pollard and Sag 2004; Sag, Wasow, and Bender 2003)

Grammar Matrix

- Originally, these grammars were designed narrowly for particular languages (e.g., English or Japanese)
- However, it was noticed that many linguistic "universals" were being duplicated across grammars
- It, therefore, made sense to "factor out" what was common to all the grammars so they all could make use of a common foundation

Grammar Matrix

- Some of the relevant "universals"
  - Words and phrases combine to make larger phrases
  - The meaning of a phrase is determined by the words in the phrase and how they are put together
  - Heads of phrases determine which types of arguments they require, and how they combine semantically with those arguments

Grammar Matrix

- What does the Matrix look like?

```
headed-phrase := phrase &
   [ SYNSEM.LOCAL [ CAT.HEAD head & #head,
                    AGR #agr ],
     HEAD-DTR.SYNSEM.LOCAL local &
          [ CAT.HEAD #head,
            AGR #agr ] ].
```

Grammar Matrix

- Or a little prettier...

$$\textit{headed-phrase}: \begin{bmatrix} \textit{phrase} & \\ \text{SYNSEM.LOCAL} & \begin{bmatrix} \text{CAT.HEAD} & \boxed{1}\textit{head} \\ \text{AGR} & \boxed{2} \end{bmatrix} \\ \text{HEAD-DTR.SYNSEM.LOCAL} & \begin{bmatrix} \textit{local} & \\ \text{CAT.HEAD} & \boxed{1} \\ \text{AGR} & \boxed{2} \end{bmatrix} \end{bmatrix}$$

"In any headed phrase, the mother's HEAD value (part of speech and related characteristics) and agreement features come from the head daughter."

Grammar Matrix

- In addition, work has been done within the Grammar Matrix to deal with grammatical phenomena which differ across languages in common ways
  - Negation
  - Word order
  - Yes-no questions
  - Coordination
  - ...

Grammar Matrix

- Such aspects of grammars are handled via modules that extend the core of the Matrix
- Modules consist of
  - Statements of rules describing common grammatical strategies
  - Utilities which take input from the user and configure the modules in an appropriate way for a given language

Grammar Matrix

- Why (we think) the grammar matrix might be good for typology
  - Integrates typological variation with precise descriptions
  - In time could help automate typological classification
  - Allows typologists and descriptive linguists to more easily cooperate with computational linguists

Grammar Matrix

- Computational typology of this sort is still very new
- The typological coverage is, in many respects, quite simplistic
- However, the Matrix has been, and continues to be, tested on more languages in the context of grammar engineering classes

Coordination

- One aspect of grammar for which a Grammar Matrix module has been developed is coordination
- What we mean by "coordination" here is a structure that combines elements of like or similar category into a single larger element
- The current coordination module does not yet make it easy to formalize all types of coordination

Coordination

- Aspects of coordination we are trying to handle at this stage
  - Formal aspects of coordination marking (e.g., "conjunctions", special morphological forms, etc.)
  - Different strategies for different phrase types
  - How often coordination markers appear in the coordinate structure (e.g., monosyndeton vs. polysyndeton)

Coordination

- Monosyndeton:
  John, James, and Matthew
- Polysyndeton (Polish):
  Tomek i Jurek i Maciek przyjechali do Londynu.
  "Tomek and Jurek and Maciek went to London."
  (Example from Haspelmath (to appear: 11))
- Omnisyndeton (Abun, West Papuan):
  Mbos e ndabu e ndam ga sye ne e an fowa sino.
  pigeon & dove & bird REL big DET & 3PL forbidden all
  "Pigeons, doves and birds that are big, they are all forbidden (for women to eat)." (Berry and Berry 1999:96)

Implementation

- Two problems
  - Parsing and generating indefinite numbers of conjuncts
  - Parsing and generating the three different patterns of syndeton

Implementation

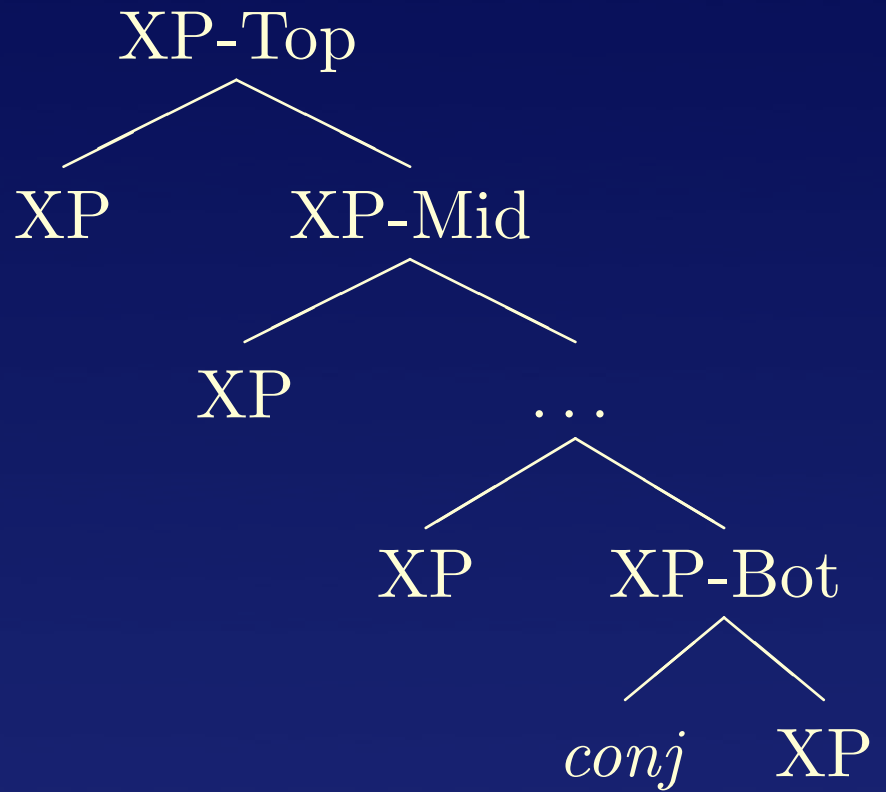
- One way of formalizing "unlimited" numbers of conjuncts
  XP → XP+ *conj* XP
  XP → XP *conj* (XP *conj*)+
- Another way
  XP-Top → XP XP-Mid
  XP-Mid → XP XP-Mid
  XP-Mid → XP XP-Bot
  XP-Bot → *conj* XP
  (for monosyndeton)

Implementation

- We choose the latter for two reasons
  - The parsing and generating system we use, the LKB (Copestake 2002), doesn't allow rules of the first type
  - It makes it easier to create rules to deal with deal with issues like agreement clash resolution in coordinate structures

Implementation

- Lots of constituents are parsed/generated



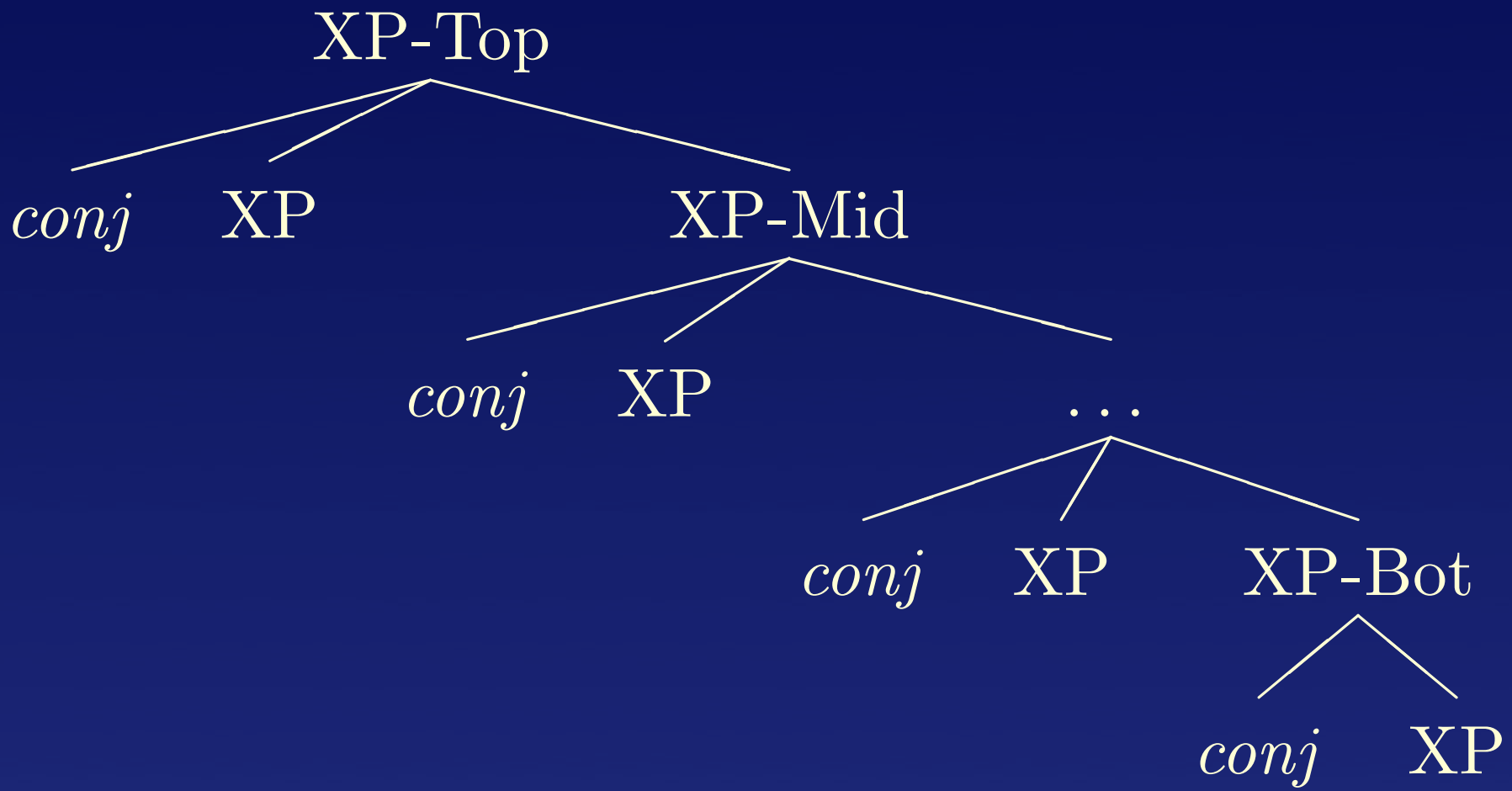
- But, HPSG doesn't put much theoretical significance on tree structures

Implementation

- Monosyndeton
  XP-Top → XP XP-Mid
  XP-Mid → XP XP-Mid
  XP-Mid → XP XP-Bot
  XP-Bot → *conj* XP
- Polysyndeton
  XP-Top → XP XP-Coord
  XP-Coord → *conj* XP-Top
- Omnisyndeton
  XP-Top → *conj* XP XP-Mid
  XP-Mid → *conj* XP XP-Mid
  XP-Mid → *conj* XP XP-Bot
  XP-Bot → *conj* XP

Implementation

- Omnisyndeton tree example



Typology

- The omnisyndeton dilemma: One too many conjunctions
- This means one coordination relation needs to be ignored in our framework
- To handle this we need to posit homophony
  - One "real" conjunction
  - One "expletive" conjunction

Typology

- Omnisyndeton (revised)
  XP-Bot → *expletive-conj* XP
- We have chosen the bottom conjunction as the expletive one since it is the easiest to identify
- We are not yet aware of data favoring the choice of one conjunction as expletive over another

Typology

- These expletive conjunctions are implemented in essentially the same way as other expletives
- The difference: They are the only ones (so far) that obligatorily co-occur in the same construction as their non-expletive homophones
- We think the need to treat omnisyndeton differently is interesting—though we're not sure we have found an ideal solution

Typology

- To this point, we've been using simplistic notation like XP → XP *conj* XP
- But as seen above, the Matrix formalism is much more complex and expressive

headed-phrase:

$$\begin{bmatrix} \textit{phrase} \\ \text{SYNSEM.LOCAL} & \begin{bmatrix} \text{CAT.HEAD} & \boxed{1}\textit{head} \\ \text{AGR} & \boxed{2} \end{bmatrix} \\ \text{HEAD-DTR.SYNSEM.LOCAL} & \begin{bmatrix} \textit{local} \\ \text{CAT.HEAD} & \boxed{1} \\ \text{AGR} & \boxed{2} \end{bmatrix} \end{bmatrix}$$

Typology

- Another fact that came out in implementation: Category-neutral rules using devices like "XP" are inadequate
- A language may have the same basic coordination strategy for noun phrases, verb phrases, and sentences
- But, at least in many languages, separate rules are needed for each major phrasal type

Typology

- This is because many aspects of syntax can differ across superficially similar coordination types
  - Noun phrase coordination: Agreement class of whole structure can be different from agreement class of constituent noun phrases
  - Verb phrase coordination: Agreement class of each coordinated verb phrase typically the same

Typology

- Thus, at the level of implementation, even a language with a multi-purpose conjunction like *and* has many different coordination rules

Conclusion

- Grammar engineering has reached a point where its machine-readable descriptions can be more typologically informed
- This is good for grammar engineering
- It also seems like it may be good for typology

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References

Bender, Emily M. and Dan Flickinger. 2005. Rapid prototyping of scalable grammars: Towards modularity in extensions to a language-independent core. In Proceedings of the 2nd International Joint Conference on Natural Language Processing IJCNLP-05 (posters/demos), Jeju Island, Korea.

Berry, Keith, and Christine Berry. 1999. A description of Abun: a West Papuan language of Irian Jaya. Pacific Linguistics B-115. Canberra: Pacific Linguistics, Research School of Pacific and Asian Studies, The Australian National University.

Copestake, Ann. 2002. Implementing Typed Feature Structure Grammars. Stanford: CSLI.

Bender, Emily M., Dan Flickinger and Stephan Oepen. 2002. The Grammar Matrix: An Open-source starter-Kit for the rapid development of cross-linguistically consistent broad-coverage precision grammars. *Proceedings of the Workshop on Grammar Engineering and Evaluation at the 19th International Conference on Computational Linguistics*. Taipei, Taiwan. pp. 8-14.

Drellishak, Scott and Emily M. Bender. 2005. A coordination module for a crosslinguistic grammar resource. In S. Müller (Ed.) The Proceedings of the 12th International Conference on Head-Driven Phrase Structure Grammar, 108–128, Stanford. CSLI Publications.

Haspelmath, Martin. To appear. Coordination. In Shopen, Timothy (ed.), *Language typology and l inguistic description*. 2nd ed. Cambridge: Cambridge University Press. (Available at: http://email.eva.mpg.de/~haspelmt/coord.pdf)

Carl Pollard and Ivan A. Sag. 1994. Head-Driven Phrase Structure Grammar. University of Chicago Press.

Sag, Ivan A., Thomas Wasow, and Emily M. Bender. 2003. Syntactic Theory: A formal introduction. 2nd Edition. Stanford: CSLI Publications.