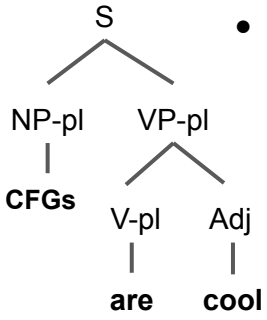
Student Abstract & Poster Session AAAI-21

Comparing Symbolic Models of Language via Bayesian Inference

Annika Heuser & Polina Tsvilodub

Massachusetts Institute of Technology
Universität Osnabrück

Symbolic Models: Context-free grammars

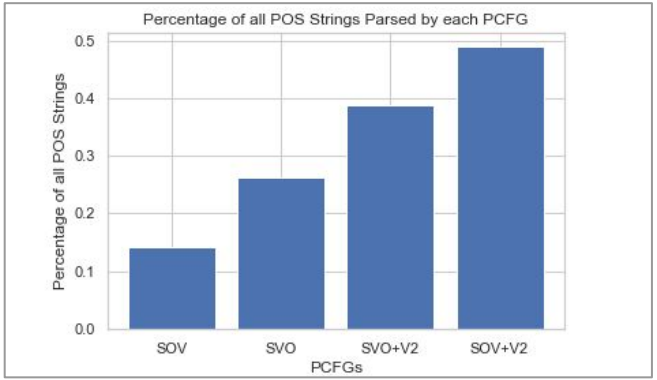


- Symbolic models might represent human-like linguistic knowledge

Probabilistic CFGs (PCFGs)

S -> NP-pl VP-pl 0.5
S -> NP-s VP-s 0.5

Can CFGs Generate German Data?



Challenges

P(CFG, Type | Data) $\propto$ P(Data | CFG, Type) P(CFG | Type) P(Type)

P(Data | CFG, Type) = product of probability of each rule needed to parse each sentence

→ PCFG likelihoods are not directly comparable because they parse different data subsets

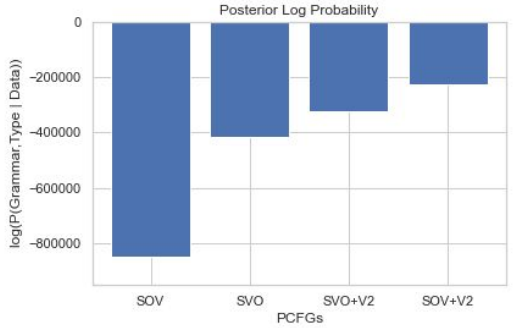
PCFGs still penalized for parsing more sentences because:

1. Longer sentences = lower likelihood
2. More generalizable = less probability mass per sentence type

Errors in data: 31.65% of the total POS strings are ungrammatical

Solution

1. Normalize by sentence length
2. Weight by parseable sentence type



Contributions

- Method for more flexible comparison of symbolic models, specifically CFGs
- Revealed troubling number of errors resulting from transcription and part-of-speech (POS) tagging

References

[1] Chomsky, N. 1965. Aspects of the theory of syntax. *Cambridge, MA: MIT Press*(1977): 71–132.
[2] Crain, S.; and Nakayama, M. 1987. Structure dependence in grammar formation.*Language* 522–543.
[3] Lake, B. M.; Ullman, T. D.; Tenenbaum, J. B.; and Gershman, S. J. 2017. Building machines that learn and think like people. *Behavioral and brain sciences* 40.
[4] MacWhinney, B. 2000. *The CHILDES Project: Tools for analyzing talk. Transcription format and programs*, volume 1. Psychology Press.
[5] Pelletier, F. J. 1994. The principle of semantic compositionality. *Topoi* 13(1): 11–24.
[6] Perfors, A.; Tenenbaum, J. B.; and Regier, T. 2011. The learnability of abstract syntactic principles. *Cognition* 118(3): 306–338.
[7] Tenenbaum, J. B.; Kemp, C.; Griffiths, T. L.; and Goodman, N. D. 2011. How to grow a mind: Statistics, structure, and abstraction. *Science* 331(6022): 1279–1285.
[8] Xu, F.; and Tenenbaum, J. B. 2007. Word learning as Bayesian inference.*Psychological review* 114(2): 245.