**Lecture 11**

1. Generative grammars, PCFG
   1. CYK algorithm
2. Limitations of PCFG
   1. Lexicalized PCFG
   2. Other grammars
3. Dependency parsing: Graph-based parsing
   1. Scoring
   2. Inference
   3. Learning

**Two inference problems for PCFG**

1. ; parsing
2. ; language modeling

Recall that any PCFG can be written in Chomsky Normal Form:

,

,

Advantage of PCFG: Efficient calculation via dynamic programming

Limitation: Can only capture short term dependencies

**CYK Algorithm**

max probability of a tree that starts at position and ends at position from non-terminal

Assume non-terminals are numbered: ,

Want to find .

Base Case:

Recursive Case:

Complexity: , can be made

# of subproblems:

Time per subproblem:

How can we modify the algorithm for language modeling? Take sum instead of max in recursion.

**Limitations**

She ate pasta with a fork.

She ate pasta with butter.

The grammars do not care about the actual words in the sentence – it only says which tree is more likely. So in the ambiguity above, it will always parse one of the sentences above incorrectly.

**Lexicalization**

Recursively propagate head information

How to compute? Compute as normal, but do some linear interpolation as well.