First half of the course:

- Introduction (Aug 27–29)
- Regular expressions (Sept 3–5)
- Edit distance (Sept 8)
- Information theory (Sept 10–12)
- Language models (Sept 15–22)
- Parts of speech and HMMs (Sept 24–Oct 3)
- Parsing (**Oct 6–10**)
- Review (Oct 13–15)
- Midterm (Oct 17)

Parsing unit:

- Constitutents, parsing, and context free grammars (Monday)
- Recursive descent parsing (Wednesday, in lab)
- CKY parsing (**Today**)

Today:

- Limitations of top-down parsing
- Conceptual differences between top-down and bottom-up
- CKY parsing
  - Constraints: Chomsky Normal Form
  - Sample grammar
  - Practice by hand
  - CKY algorithm details

$$
\begin{aligned}
\textit{Sentence} &\rightarrow \textit{NounPhrase Predicate} \\
\textit{NounPhrase} &\rightarrow \textit{ConcNounPhrase} \mid \textit{AbsNounPhrase} \\
\textit{ConcNounPhrase} &\rightarrow \textit{Article AdjectiveList Noun} \\
\textit{AdjectiveList} &\rightarrow \textit{Adjective AdjectiveList} \mid \varepsilon \\
\textit{AbNounPhrase} &\rightarrow \textit{That Sentence} \\
\textit{Predicate} &\rightarrow \textit{VerbPhrase VerbModifier} \\
\textit{VerbPhrase} &\rightarrow \textit{LinkingVerbPhrase} \mid \textit{TransitiveVerbPhrase} \mid \\
&\quad \textit{IntransitiveVerbPhrase} \\
\textit{LinkingVerbPhrase} &\rightarrow \textit{LinkingVerb Adjective} \\
\textit{TransitiveVerbPhrase} &\rightarrow \textit{TransitiveVerb NounPhrase} \\
\textit{IntransitiveVerbPhrase} &\rightarrow \textit{IntransitiveVerb} \\
\textit{VerbModifier} &\rightarrow \textit{PrepositionalPhrase} \mid \textit{Adverb} \mid \varepsilon \\
\textit{PrepositionalPhrase} &\rightarrow \textit{Preposition NounPhrase}
\end{aligned}
$$

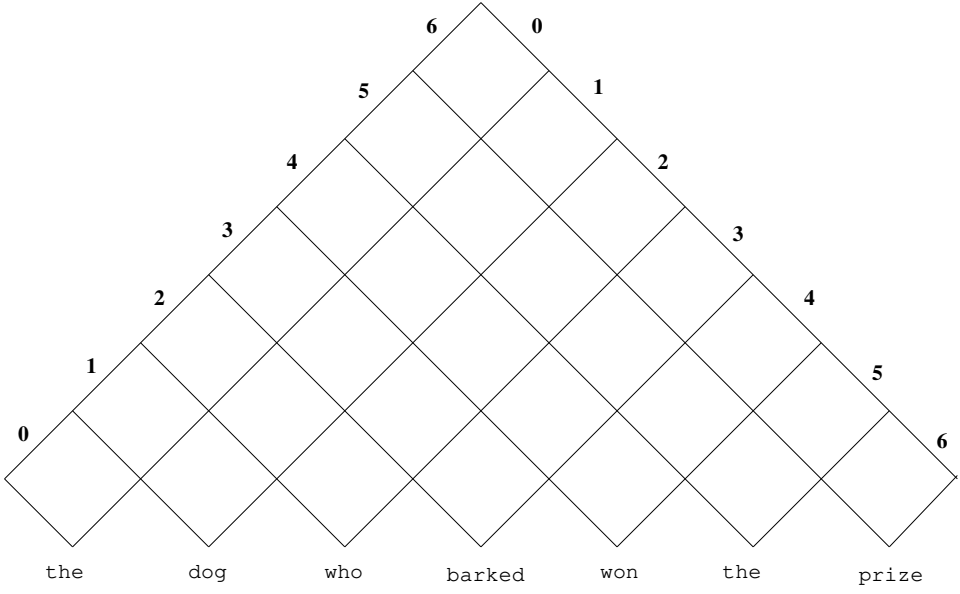
he fed her cat food

[These two approaches] give rise to the two search strategies underlying most parsers: **top-down** *or* **goal-directed search**, *and* **bottom-up** *or* **data-directed search**. *These constraints are more than just search strategies. They reflect two important insights in the western philosophical tradition: the* **rationalist** *tradition, which emphasizes the use of prior knowledge, and the* **empiricist** *tradition, which emphasizes the data in front of us.*

The weakness in top-down parsers arises from the fact that they generate trees before ever examining the input. Bottom-up parsers, on the other hand, never suggest tress that are not at least locally grounded in the input.

Jurafsky and Martin, 2e, pg 429 & 432

$$
\begin{aligned}
\textit{Sentence} &\rightarrow \textit{NounPhrase VerbPhrase} \\
\textit{NounPhrase} &\rightarrow \textit{AbsNounPhrase} \mid \textit{ConcNounPhrase} \\
\textit{AbsNounPhrase} &\rightarrow \textit{That Sentence} \\
\textit{ConcNounPhrase} &\rightarrow \textit{CNPA RelativeClause} \mid \textit{CNPA PrepositionalPhrase} \mid \textit{CNPA} \\
\textit{CNPA} &\rightarrow \textit{PersonalPronoun} \mid \textit{Article Nominal} \\
\textit{Nominal} &\rightarrow \textit{Adjective Nominal} \mid \textit{Noun} \\
\textit{RelativeClause} &\rightarrow \textit{RelativePronoun VerbPhrase} \\
\textit{PrepositionalPhrase} &\rightarrow \textit{Preposition NounPhrase} \\
\textit{VerbPhrase} &\rightarrow \textit{VPA Adverb} \mid \textit{VPA} \\
\textit{VPA} &\rightarrow \textit{VPB PrepositionalPhrase} \mid \textit{VPB} \\
\textit{VPB} &\rightarrow \textit{Verb Adjective} \mid \textit{Verb NounPhrase} \mid \textit{Verb}
\end{aligned}
$$


6
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the
dog
who
barked
won
the
prize

Coming up:

- Do HMMs & POS programming assignment (Wed, Oct 8)
- (Read J&M 17.(0-6). (Mon, Oct 6))
- Take CKY parsing quiz (Fri, Oct 10)
- Do CKY parsing programming assignment (Wed, Oct 15)
- Take midterm (Fri, Oct 17)