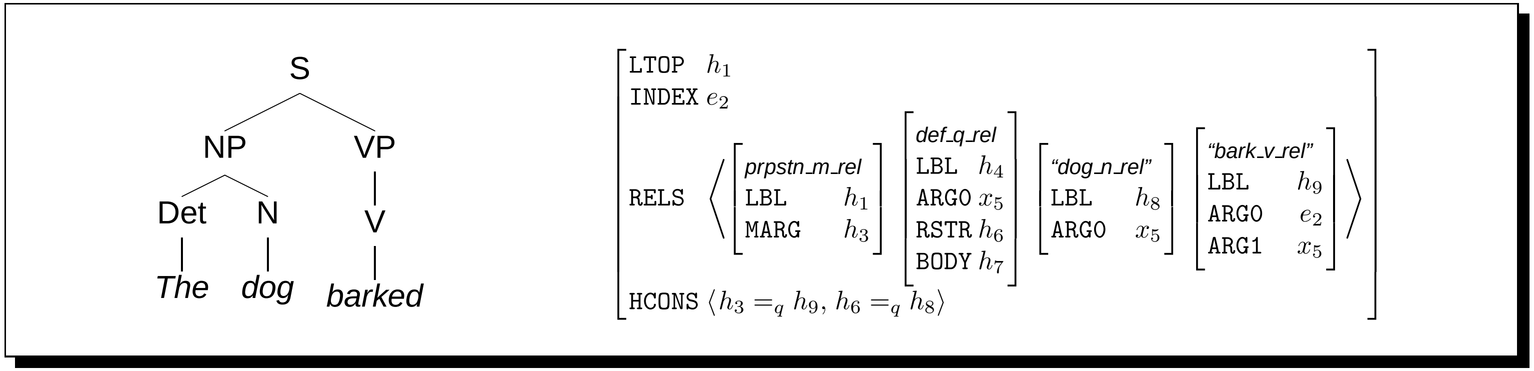

Computational Linguistics (INF2820 — Stochastics)

$$P(S \longrightarrow NP\ VP) = 1.0;\ \ P(NP \longrightarrow Det\ N) = 0.6$$

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Ambiguity Resolution Remains a (Major) Challenge

The Problem

- With broad-coverage grammars, even moderately complex sentences typically have multiple analyses (tens or hundreds, rarely thousands);
- unlike in grammar writing, exhaustive parsing is useless for applications;
- identifying the 'right' (intended) analysis is an 'AI-complete' problem;
- inclusion of (non-grammatical) sortal constraints is generally undesirable.

Typical Approaches

- Design and use statistical models to select among competing analyses;
- for string S, some analyses T_i are more or less likely: maximize $P(T_i|S)$;

$\rightarrow$ Probabilistic Context Free Grammar (PCFG) is a CFG plus probabilities.

Probability Theory and Linguistics?

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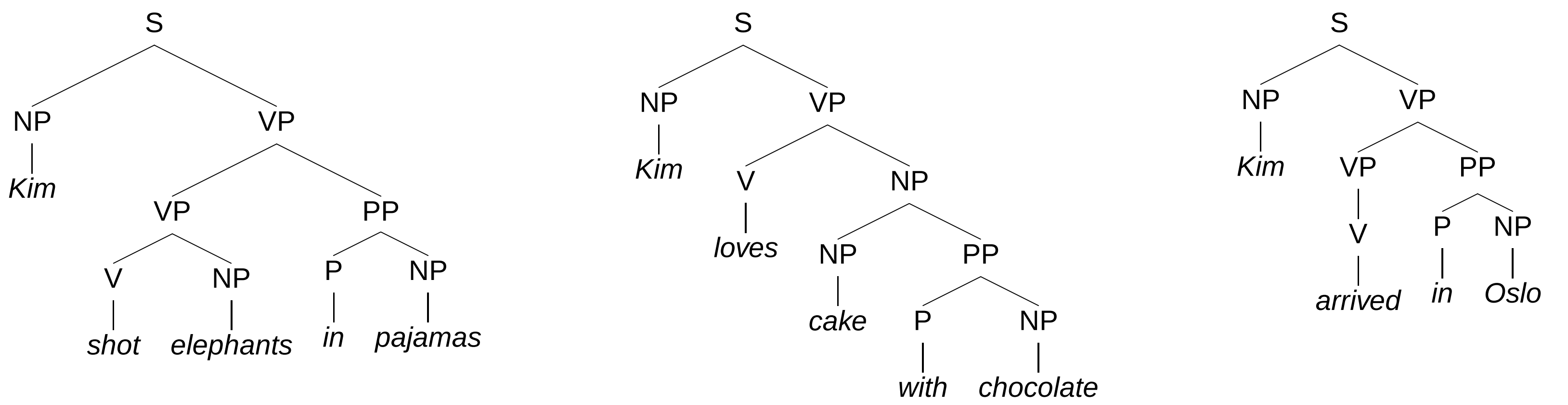
Every time I fire a linguist, system performance improves. (Fredrick Jelinek, 1980s)

Basics of Probability Theory

Probabilistic Context-Free Grammars (Simplified)



P(RHS|LHS)	CFG Rule
	S → NP VP
	VP → VP PP
	VP → V NP
	PP → P NP
	NP → NP PP
	VP → V

- Estimate rule probability from observed distribution;

→ conditional probabilities:

$$P(\text{RHS}|\text{LHS}) = \frac{C(\text{LHS}, \text{RHS})}{C(\text{LHS})}$$

Formally: Probabilistic Context-Free Grammars

- Formally, a *context-free grammar* (CFG) is a quadruple: $\langle C, \Sigma, P, S \rangle$

...

- P is a set of category rewrite rules (aka *productions*), each with a conditional probability P(RHS|LHS), e.g.

...

NP $\rightarrow$ Kim [0.6]
NP $\rightarrow$ snow [0.4]

...

- for each rule '$\alpha \rightarrow \beta_1, \beta_2, ..., \beta_n$' $\in P$: $\alpha \in C$ and $\beta_i \in C \cup \Sigma$; $1 \leq i \leq n$;

...

- for each $\alpha \in C$, the probabilities of all rules R '$\alpha \rightarrow$ ...' must sum to 1.