Application and Research Highlights

Context-Free Grammars

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Applications

Programming languages : syntax of programming languages, automatic construction of compilers

Extensible markup language : syntactic specification

Natural language processing : models of natural language syntax

Programming languages

Programming languages follow a context-free, non-regular structure: curly braces in blocks, if and else in C, etc.

CFG is used as a specification in tools for building compilers: for instance Yacc and Flex

Extensible markup language

XML is a markup language that defines encoding of documents in a format that is both human-readable and machine-readable

Context-free grammar used to describes the allowable HTML tags and the ways in which these tags may be nested (document type definition feature)

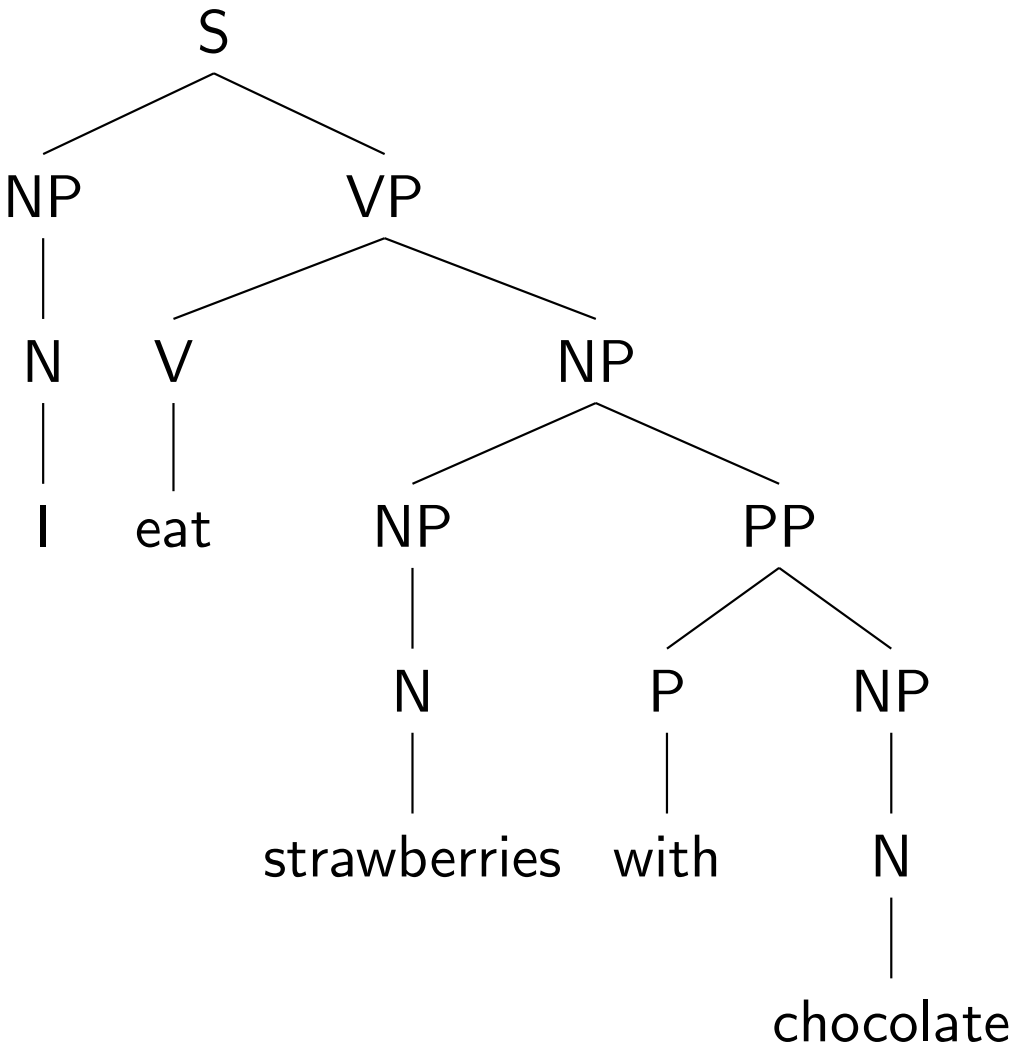
CFG for natural language

CFG for a fragment of English; nonterminals such as NP, VP, PP represent **linguistically informed** syntactic categories

S	$\rightarrow$	NP VP
NP	$\rightarrow$	NP PP $\mid$ Det N $\mid$ N
VP	$\rightarrow$	VP PP $\mid$ V NP
PP	$\rightarrow$	P NP
N	$\rightarrow$	chocolate $\mid$ I $\mid$ fork $\mid$ strawberries
V	$\rightarrow$	eat
Det	$\rightarrow$	a
P	$\rightarrow$	with

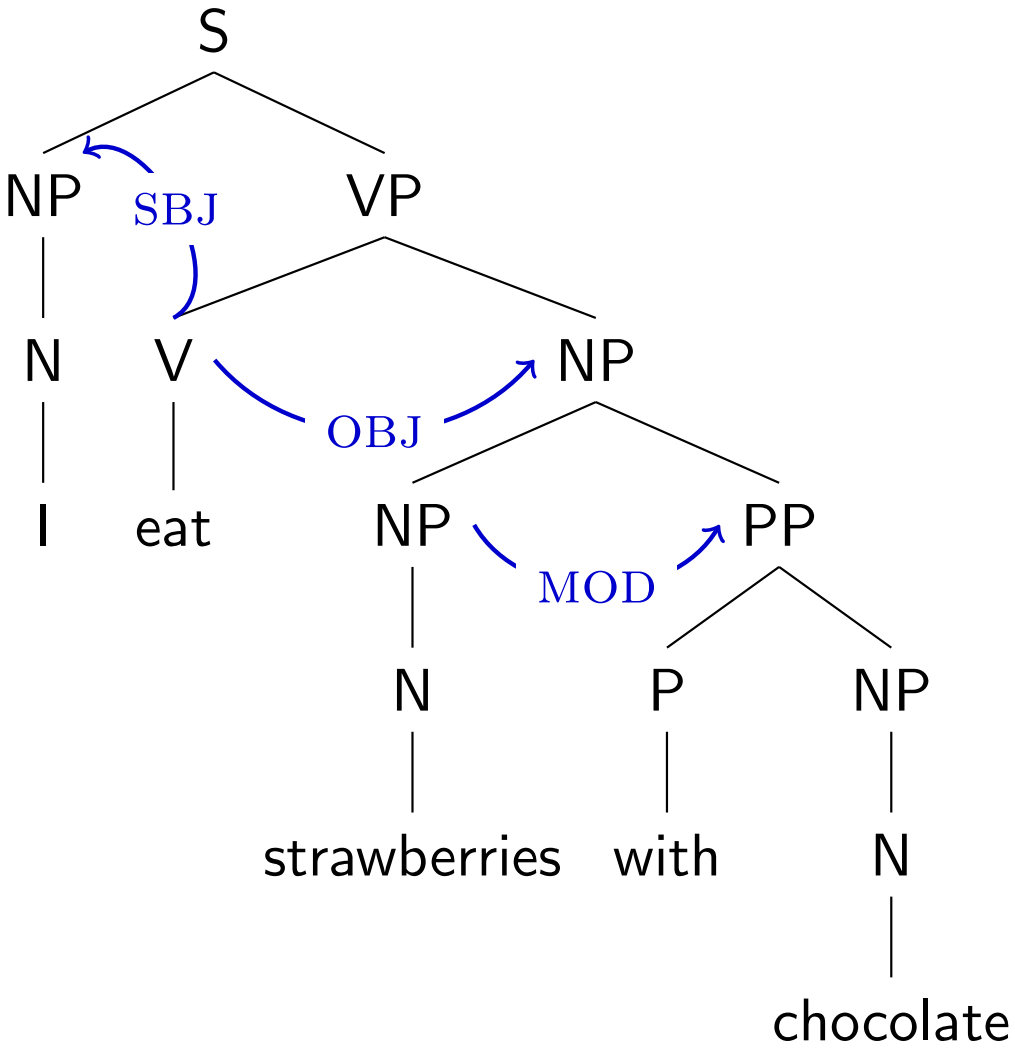
CFG for natural language

Parse tree



CFG for natural language

Underlying **grammatical relations** can be retrieved



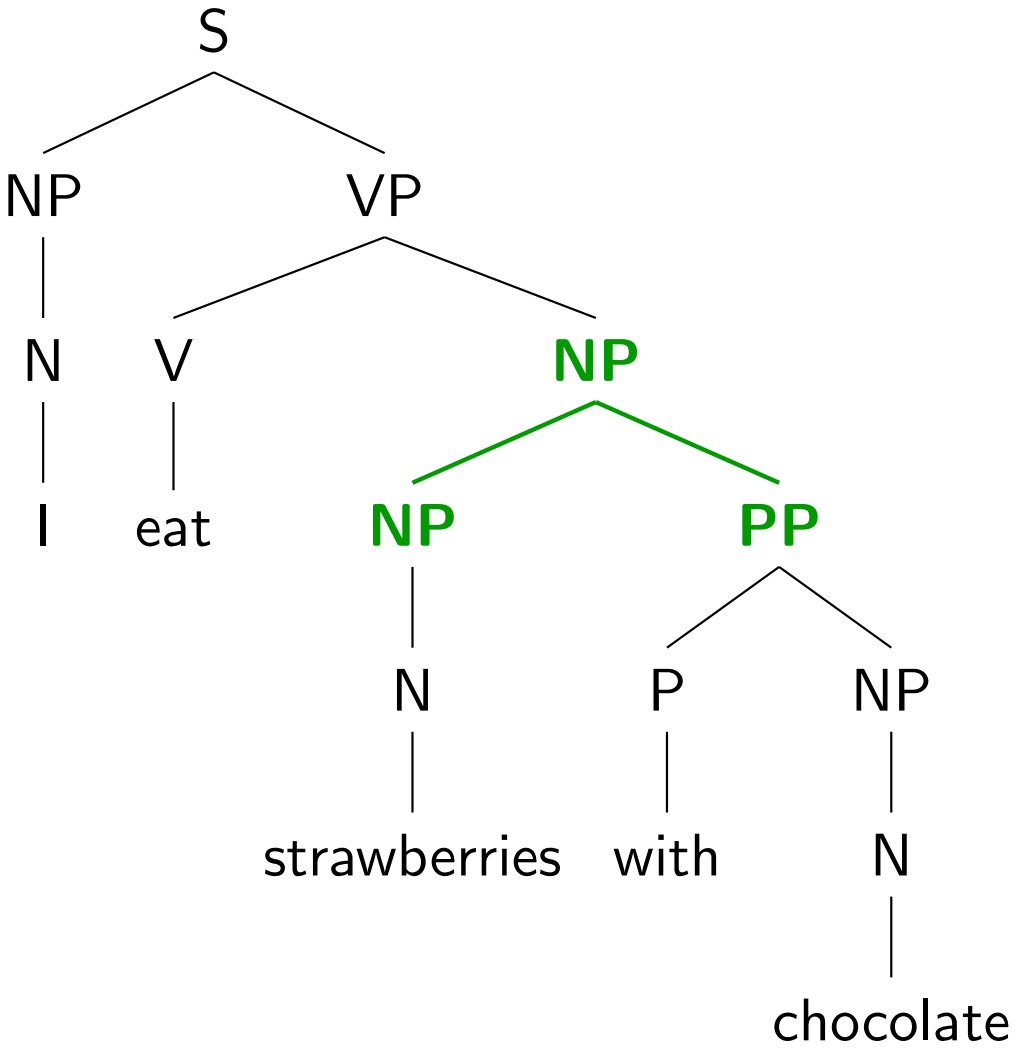
Ambiguity

In contrast with programming languages, natural language is **highly ambiguous**

Lexical, **semantic** and **pragmatic** knowledge needed to rule out undesired/unlikely interpretations

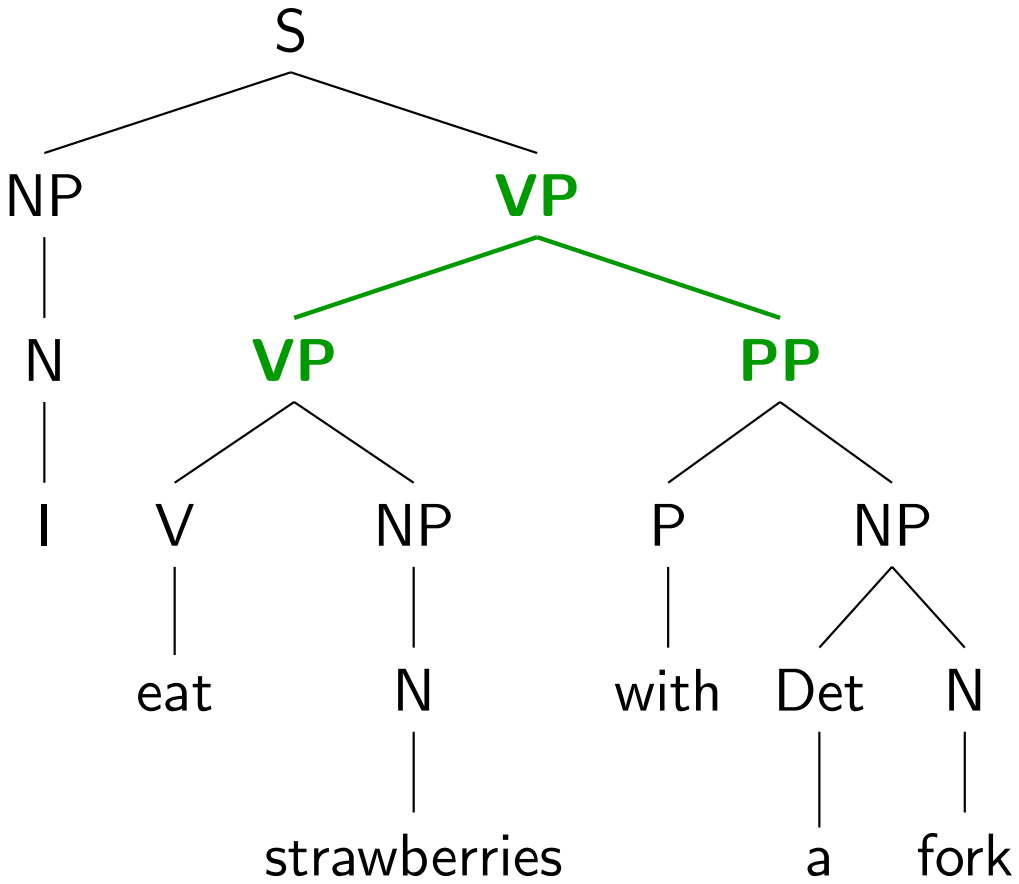
Ambiguity

Correct parse tree



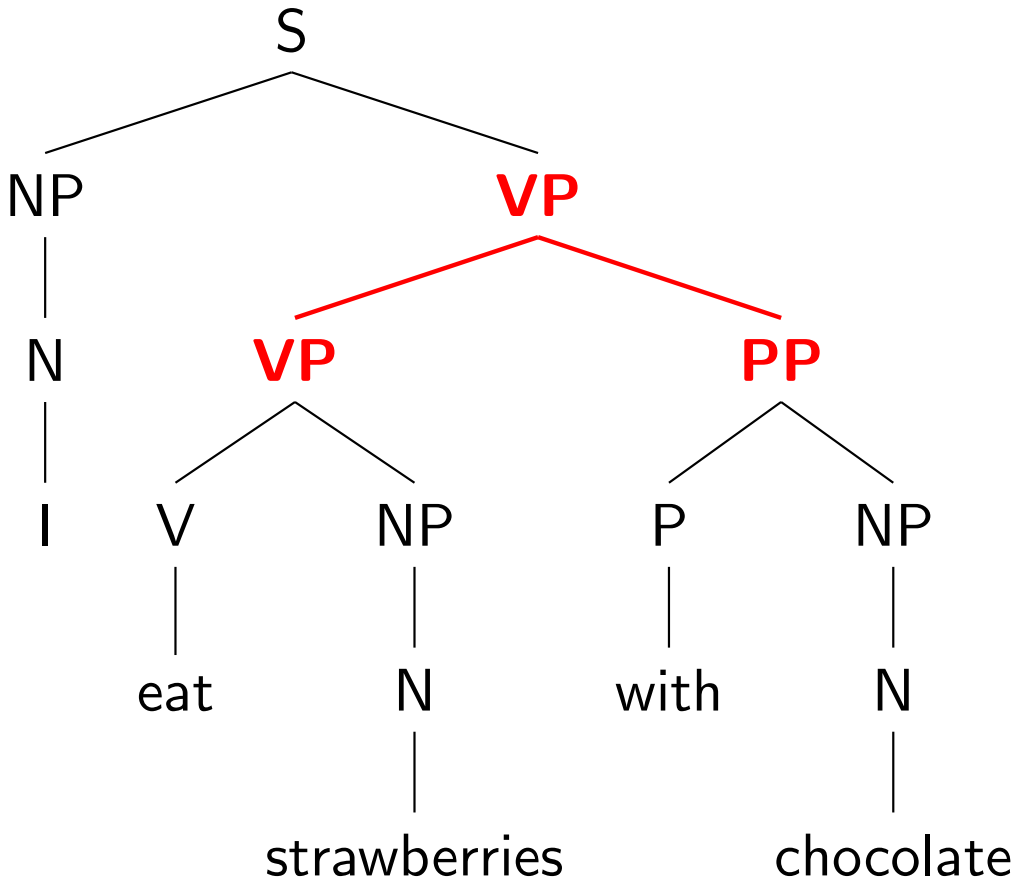
Ambiguity

Correct parse tree



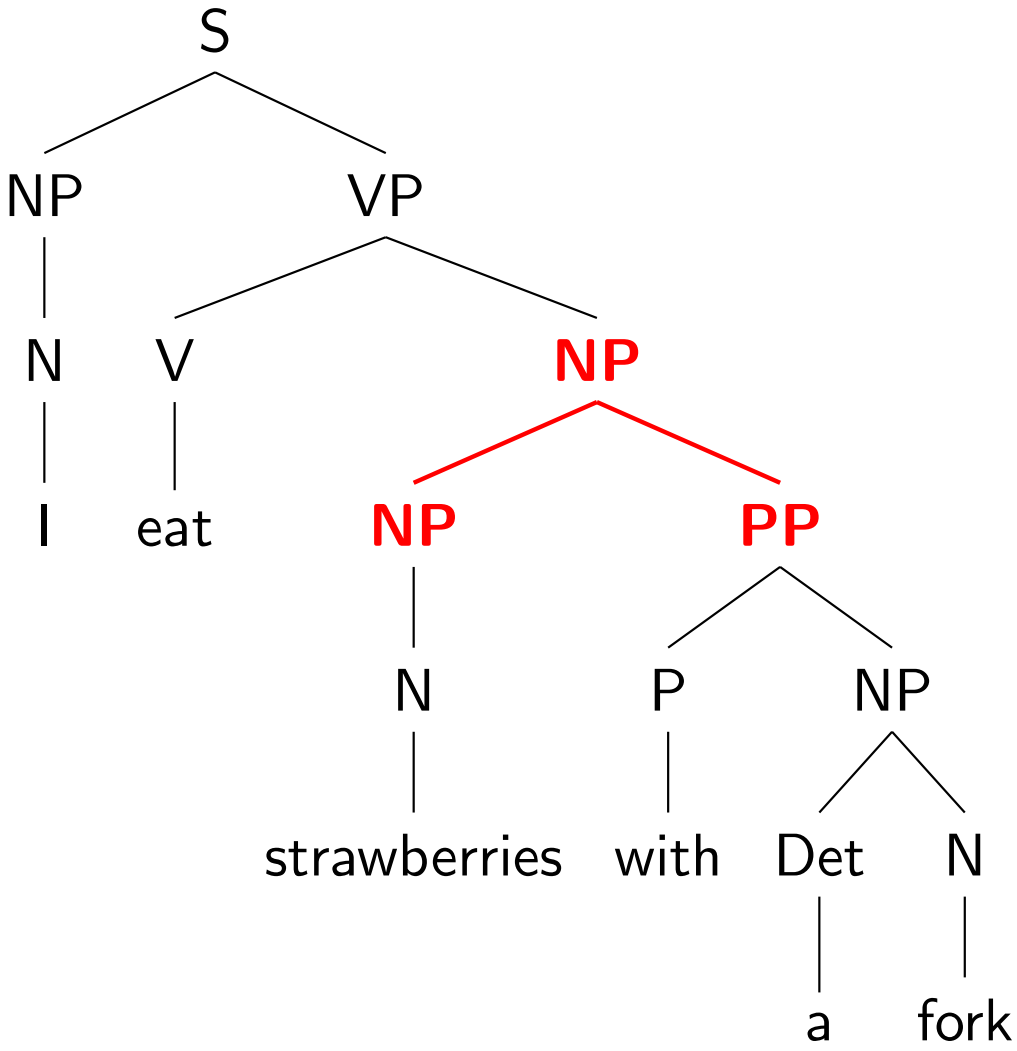
Ambiguity

Wrong parse tree



Ambiguity

Wrong parse tree



Machine learning

CFG productions are associated with **probabilities** that can be estimated by means of

- **supervised** methods: log-likelihood maximization, cross-entropy minimization, convex problem
- **unsupervised** methods: expectation maximization, local maxima