# 61A Lecture 37

# Announcements

# Ambiguity

# Syntactic Ambiguity in English

Sentence

Noun Phrase

Verb Phrase

Subordinate Clause

Programs must be written for people to read[1]

[1]Preface of **Structure and Interpretation of Computer Programs**
by Harold Abelson and Gerald Sussman with Julie Sussman

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# Syntactic Ambiguity in English

```
pro•gram (noun)
  a series of coded software instructions

pro•gram (verb)
  provide a computer with coded instructions
```

Programs must be written for people to read

```
must (verb)
  be obliged to

must (noun)
  dampness or mold
```

Definitions from the New Oxford American Dictionary

# Syntax Trees

# Representing Syntactic Structure

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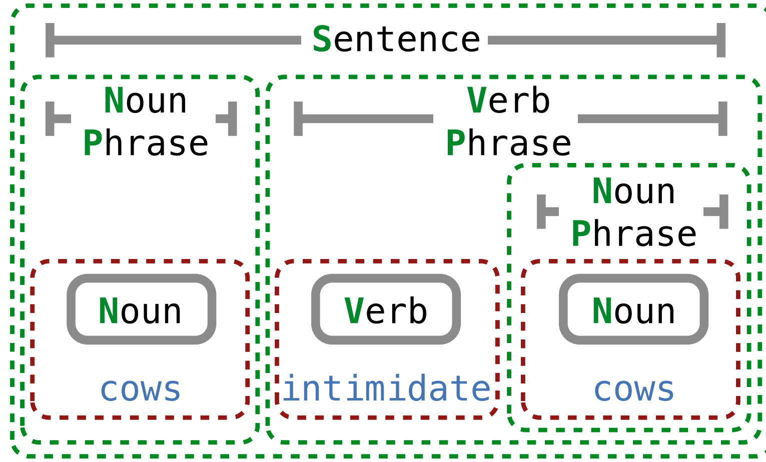



A **Tree** represents a phrase:

- **tag** -- What kind of phrase (e.g., **S**, **NP**, **VP**)
- **branches** -- Sequence of **Tree** or **Leaf** components

A **Leaf** represents a single word:

- **tag** -- What kind of word (e.g., **N**, **V**)
- **word** -- The word

```
cows = Leaf('N', 'cows')
intimidate = Leaf('V', 'intimidate')
S, NP, VP = 'S', 'NP', 'VP'
Tree(S, [Tree(NP, [cows]),
         Tree(VP, [intimidate,
                   Tree(NP, [cows])])])
```

(Demo)

# Grammars

# Context-Free Grammar Rules

A grammar rule describes how a tag can be expanded as a sequence of tags or words

**S** ⟶ **NP VP**

A **S**entence ...

... can be expanded as ...

... a **N**oun **P**hrase then a **V**erb **P**hrase.

**Grammar**

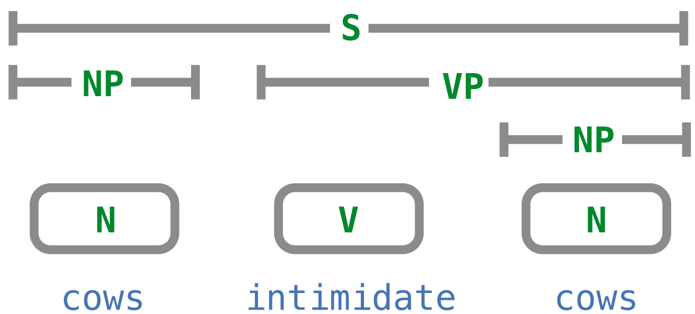
**S** ⟶ **NP** **VP**

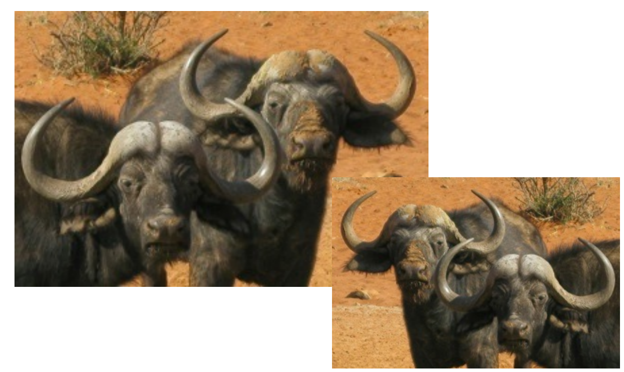
**NP** ⟶ **N**

**N** ⟶ cows

**VP** ⟶ **V** **NP**

**V** ⟶ intimidate



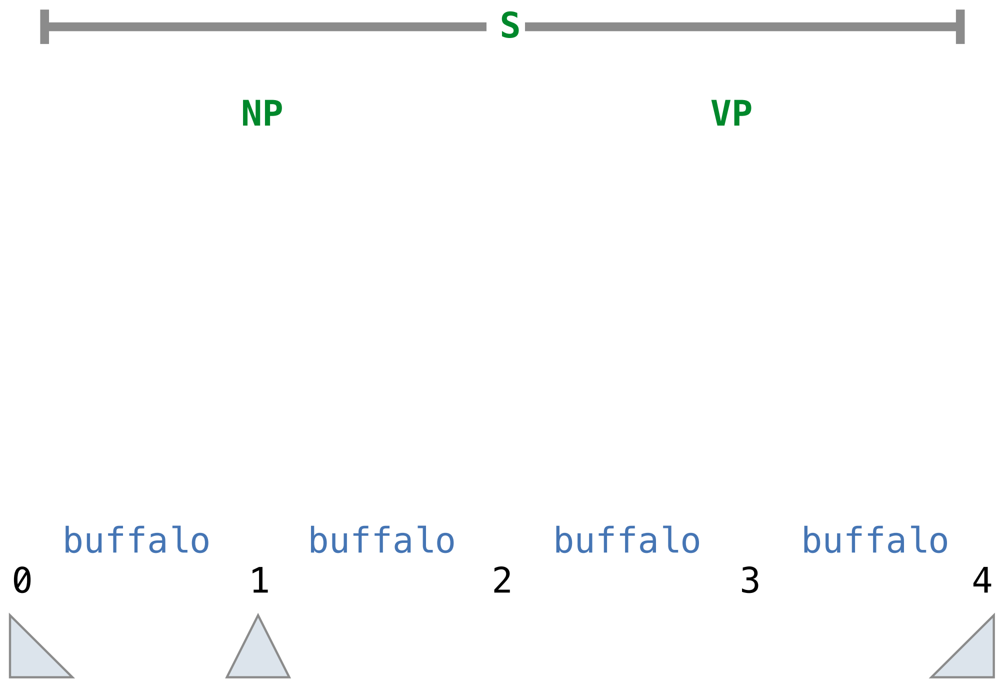



(Demo)

# Parsing

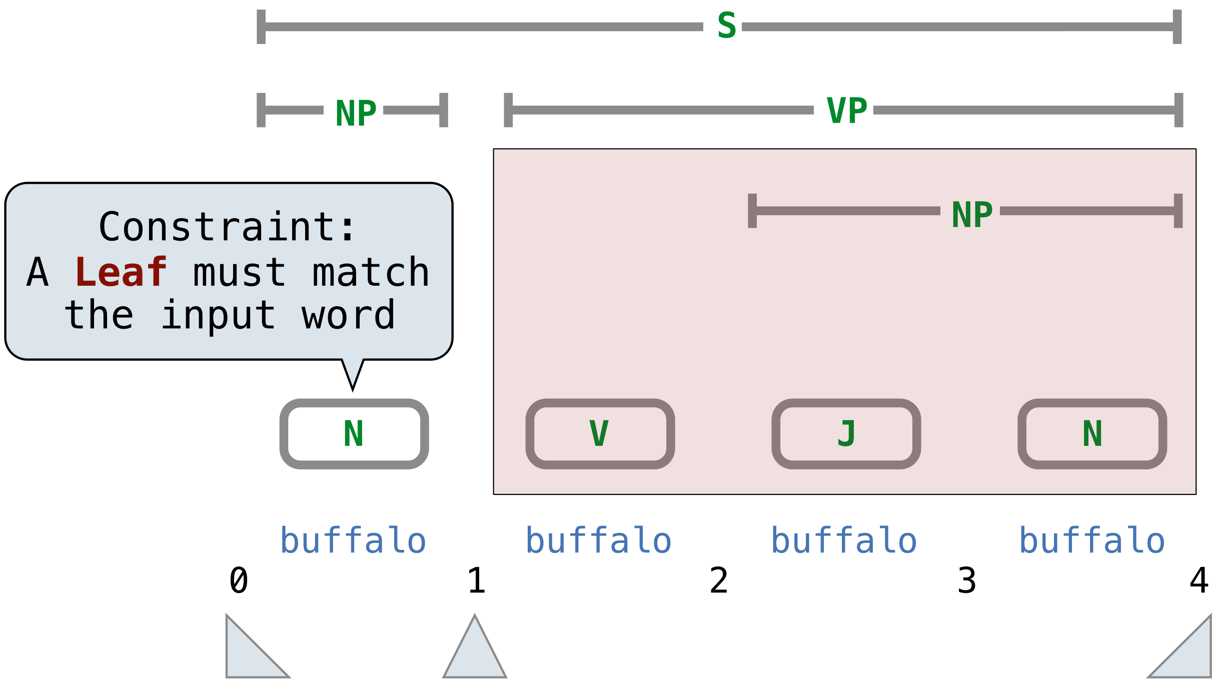
# Exhaustive Parsing

Expand all tags recursively, but constrain words to match input



# Exhaustive Parsing

```
Expand all tags recursively, but constrain words to match input
```



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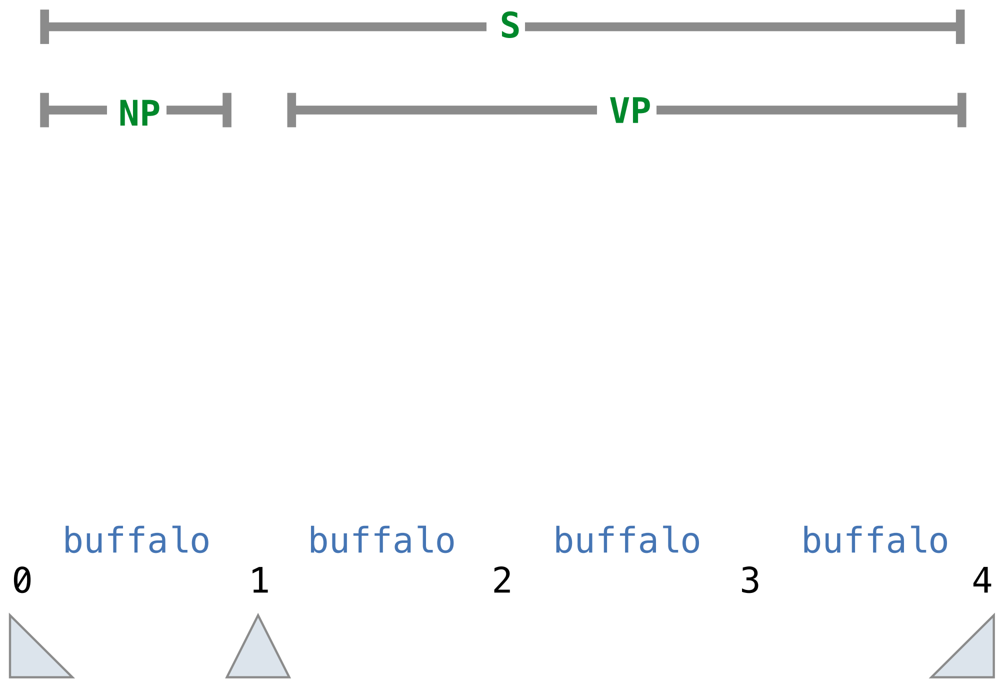

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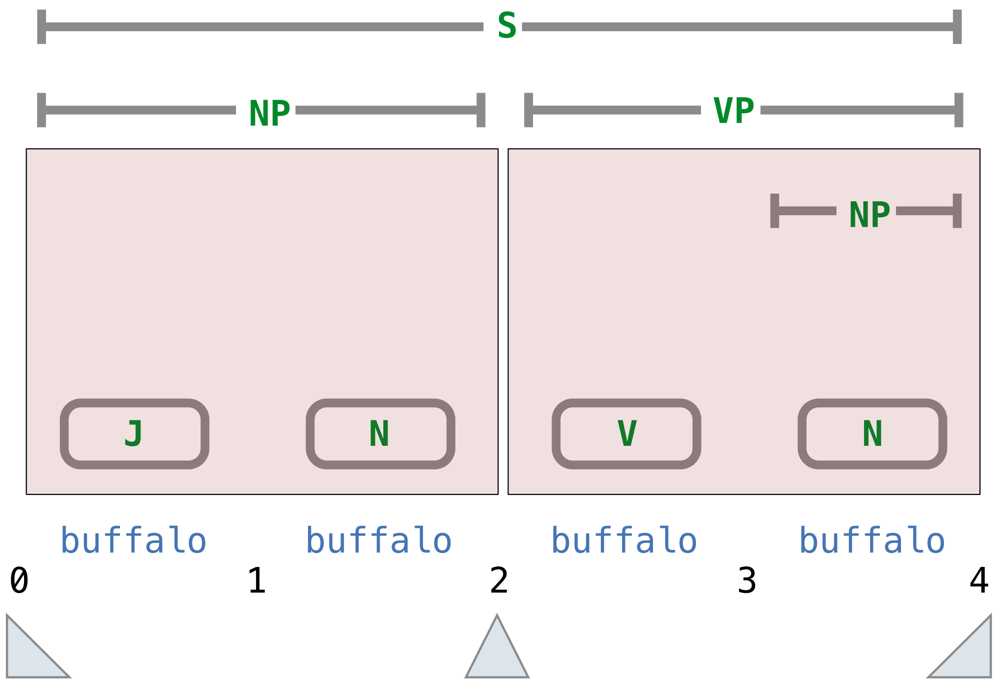


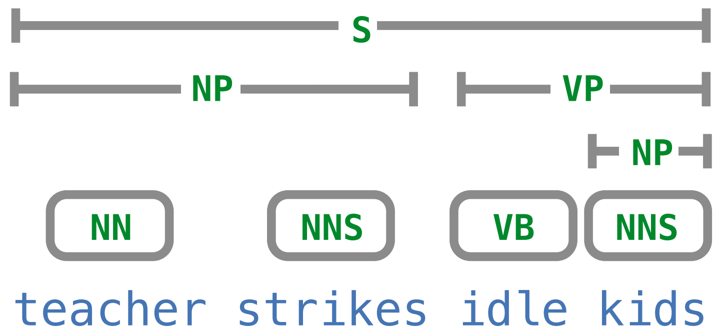

(Demo)

# Learning

(Demo)

## Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common

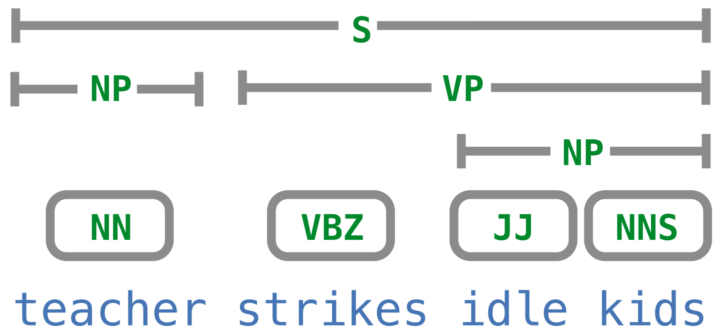



Rule frequency per 100,000 tags

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S | ⟶ | NP VP | 25372 | | NN | ⟶ | teacher | 5 |
| NP | ⟶ | NN NNS | 1335 | | NNS | ⟶ | strikes | 25 |
| VP | ⟶ | VB NP | 6679 | | VB | ⟶ | idle | 26 |
| NP | ⟶ | NNS | 4282 | | NNS | ⟶ | kids | 32 |

# Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common




Rule frequency per 100,000 tags

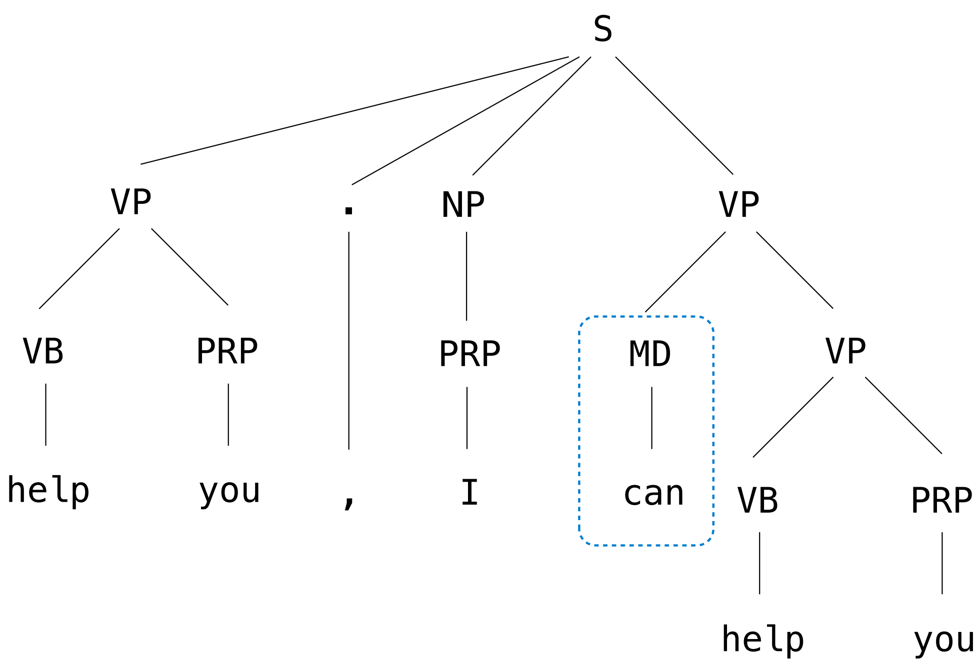
| | | | | | |
|---|---|---|---|---|---|
| S ⟶ NP VP | 25372 | | NN ⟶ teacher | 5 | |
| NP ⟶ NN | ~~1335~~ | 4358 | VBZ ⟶ strikes | ~~25~~ | 19 |
| VP ⟶ VBZ NP | ~~6679~~ | 3160 | JJ ⟶ idle | ~~26~~ | 18 |
| NP ⟶ JJ NNS | ~~4282~~ | 2526 | NNS ⟶ kids | 32 | |

(Demo)

# Translation

# Syntactic Reordering

**English** ⇨ **Yoda-English**




(Demo)