# 61A Lecture 37

Wednesday, December 3

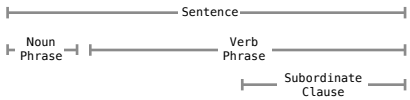
## Announcements

- Homework 10 due Wednesday 12/3 @ 11:59pm
- Quiz 3 released Wednesday, due Thursday 12/4 @ 11:59pm
- No videos for Lecture 38 on Friday 12/5
  - Come to class and take the final survey
  - There will be a screencast of live lecture (http://goo.gl/hyUTca)
- Final exam held on Thursday 12/18 3pm–6pm
  - 30 hours of review sessions next week! Monday – Friday 11am–6pm (mostly in 271 Soda)



## Ambiguity

## Syntactic Ambiguity in English

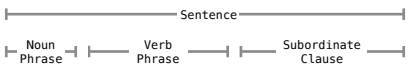



Programs must be written for people to read[1]

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



## Syntactic Ambiguity in English

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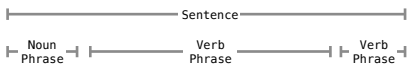


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## Syntactic Ambiguity in English

**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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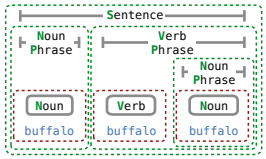



A `Tree` represents a phrase:
- `tag` -- What kind of phrase (e.g., `S`, `NP`, `VP`)
- `branches` -- Sequence of `Tree` or `Leaf` components

A `Leaf` represents a single word:
- `tag` -- What kind of word (e.g., `N`, `V`)
- `word` -- The word

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

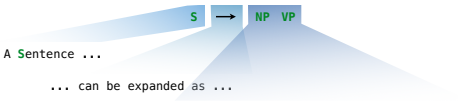
(Demo)



## Grammars

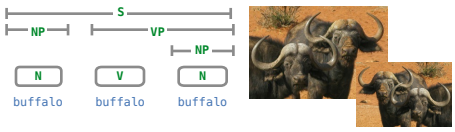
## Context-Free Grammar Rules

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




**Grammar**

```
S  ⟶ NP VP
NP ⟶ N
N  ⟶ buffalo
VP ⟶ V NP
V  ⟶ buffalo
```





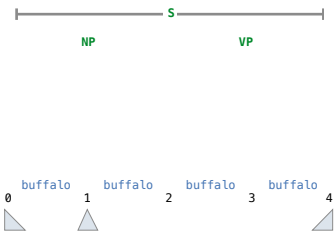

(Demo)



## Parsing

## Exhaustive Parsing

Expand all tags recursively, but constrain words to match input



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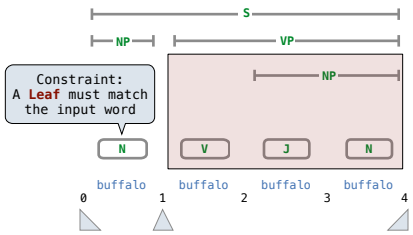




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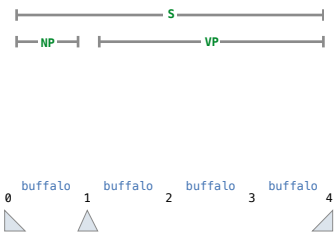




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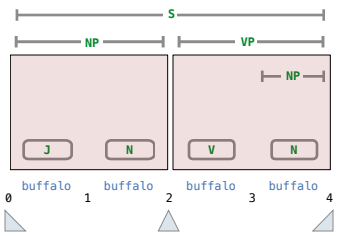


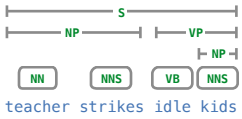

(Demo)

## Learning

(Demo)

## Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common



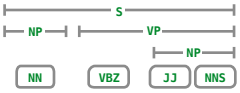

Rule frequency per 100,000 tags

| | | | | | |
|---|---|---|---|---|---|
| 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)