61A Lecture 37

Wednesday, April 29

Announcements

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  - If at least 60% of students respond, everyone gets an extra credit point
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  - Two TAs are available every hour
  - One room will be a review session going over topic-specific problems
  - The other room is unstructured; staff will answer any questions you have

Ambiguity

Syntactic Ambiguity in English

Programs must be written for people to read

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

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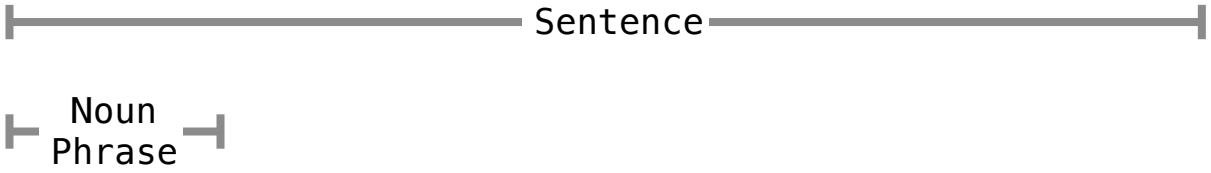

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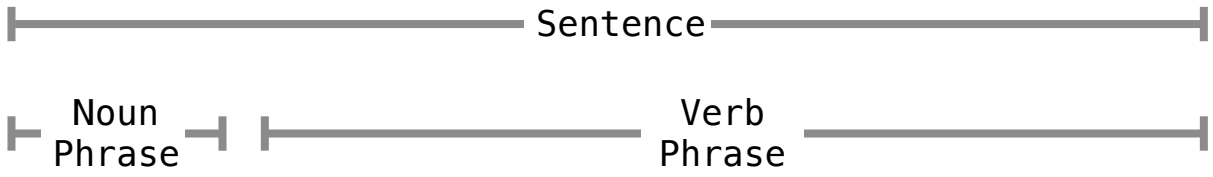

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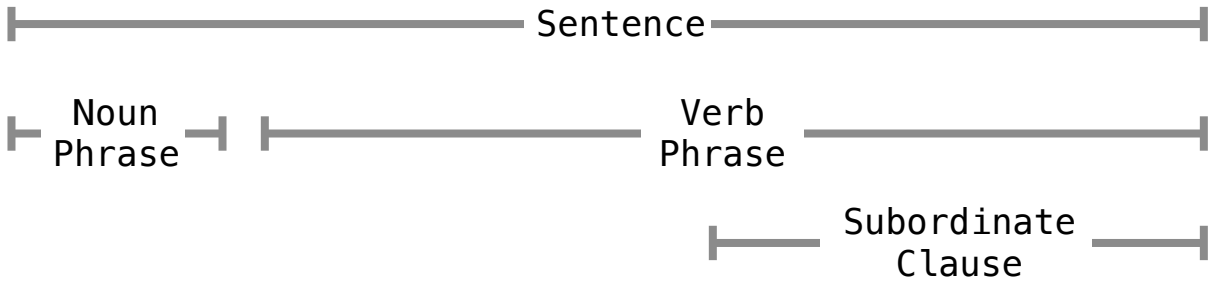

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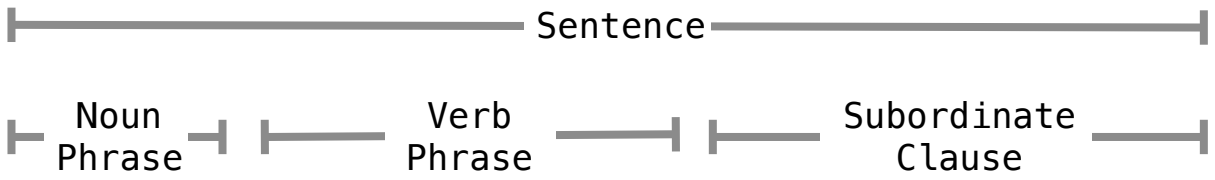

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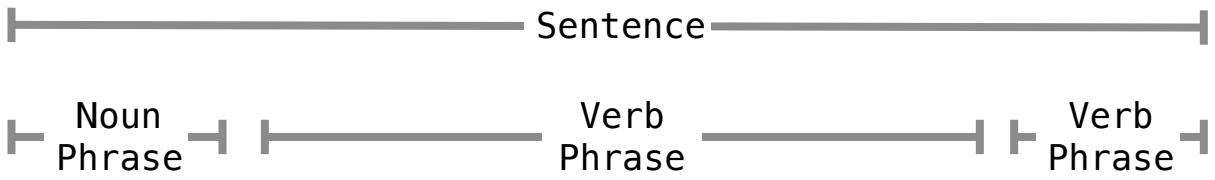

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Syntactic Ambiguity in English

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

Representing Syntactic Structure

cows

Representing Syntactic Structure

Representing Syntactic Structure

Noun

cows

Representing Syntactic Structure

Noun

cows intimidate

Representing Syntactic Structure

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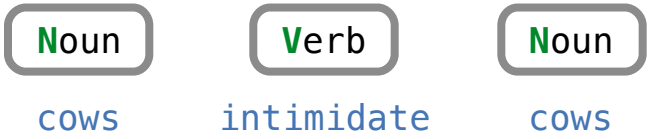

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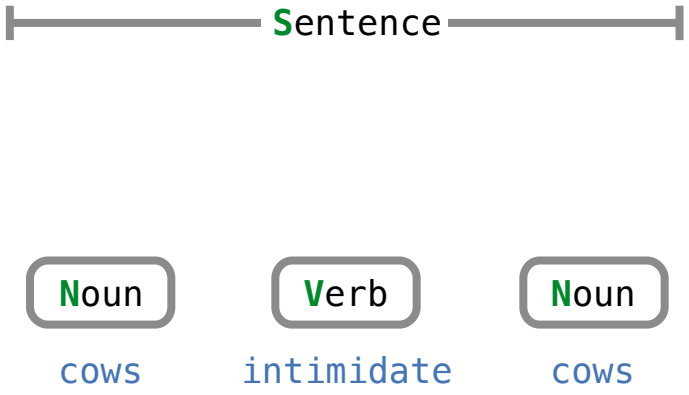

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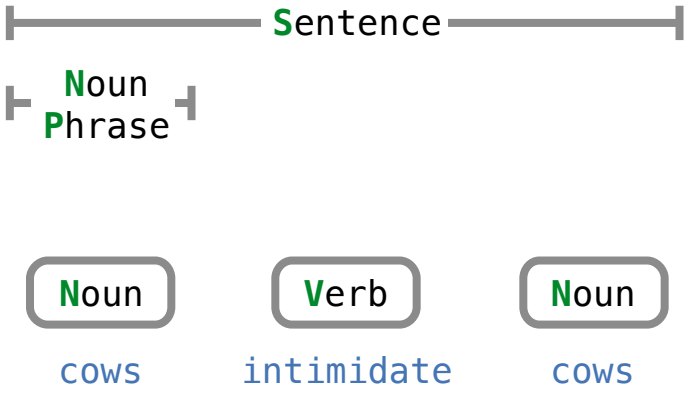

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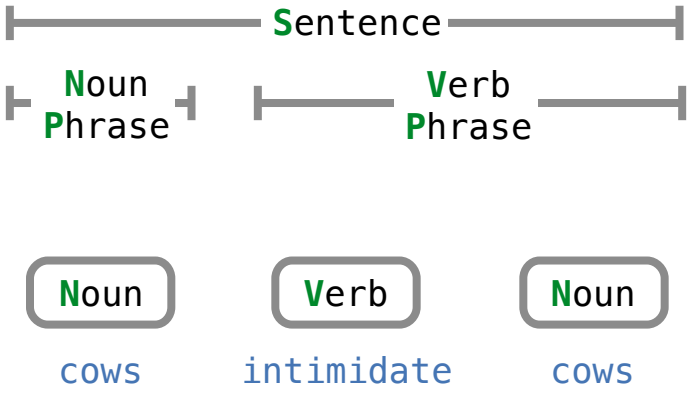

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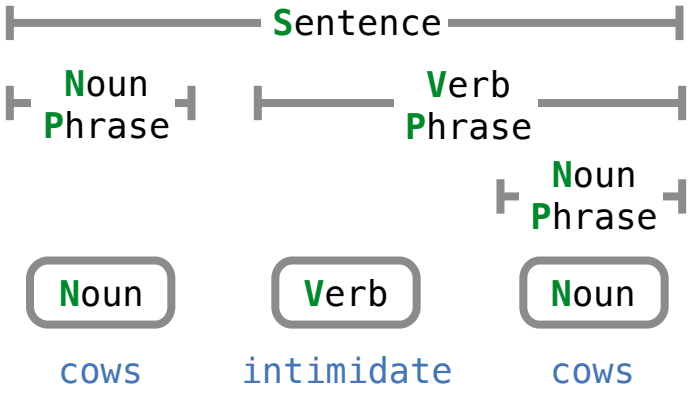

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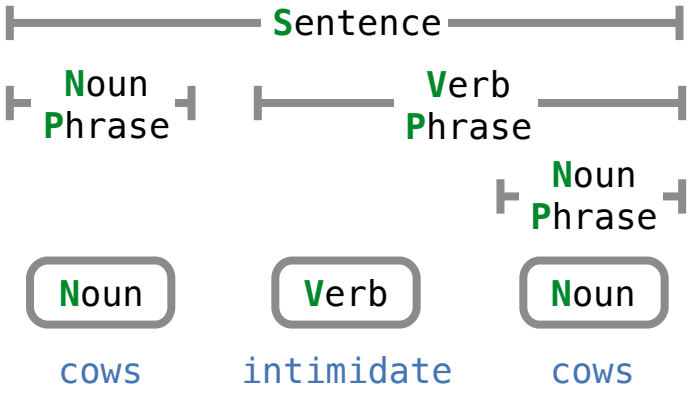

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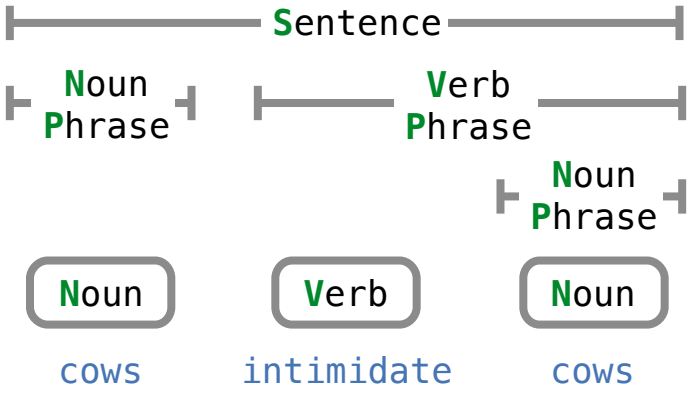

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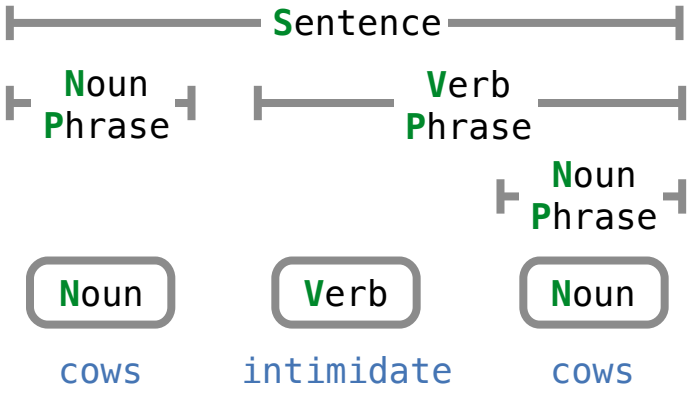

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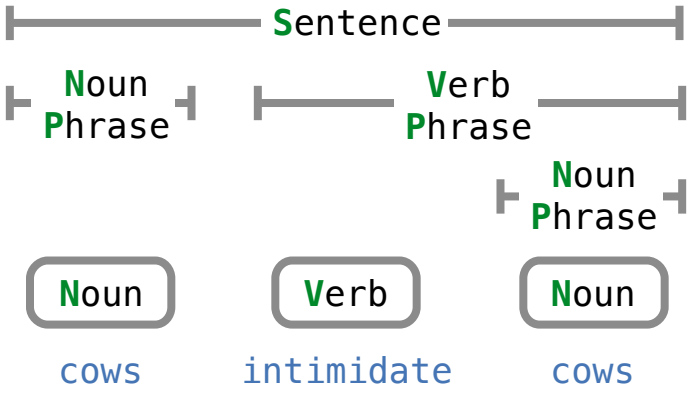

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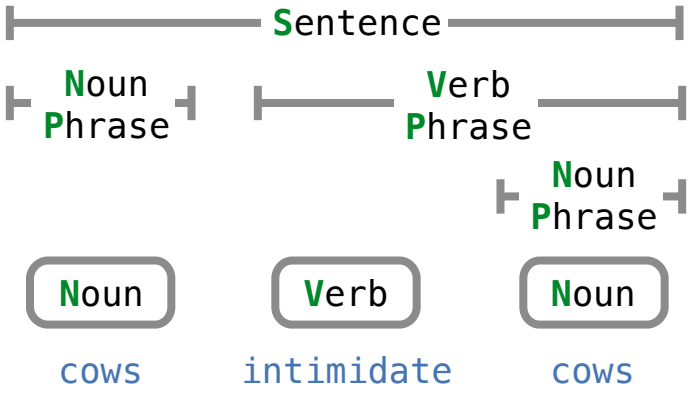

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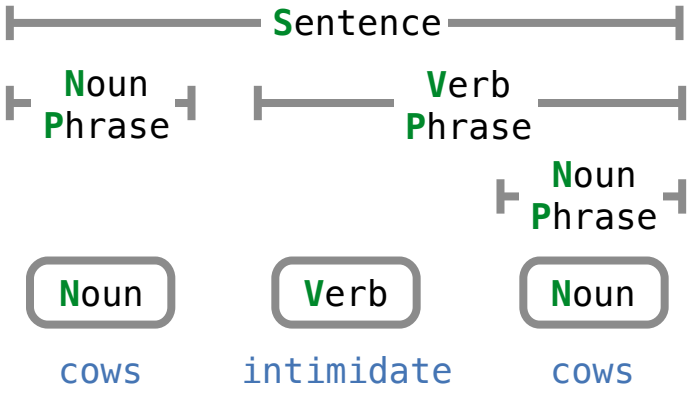

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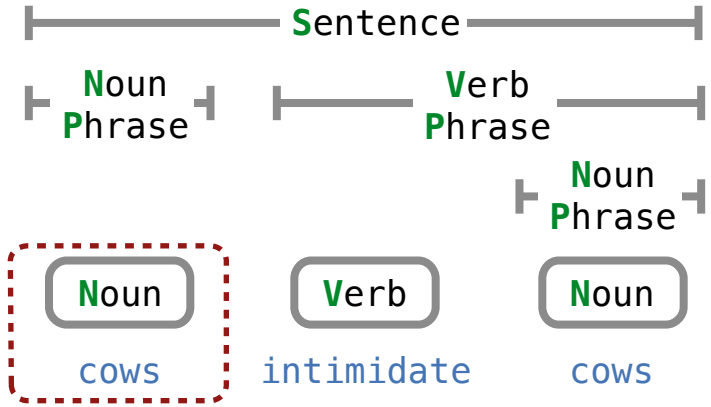

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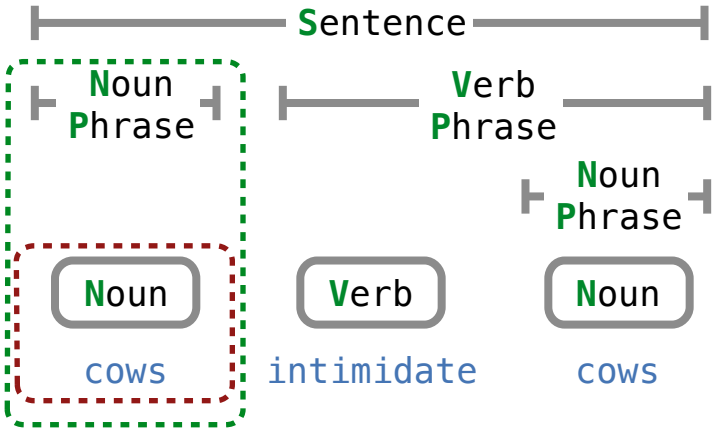

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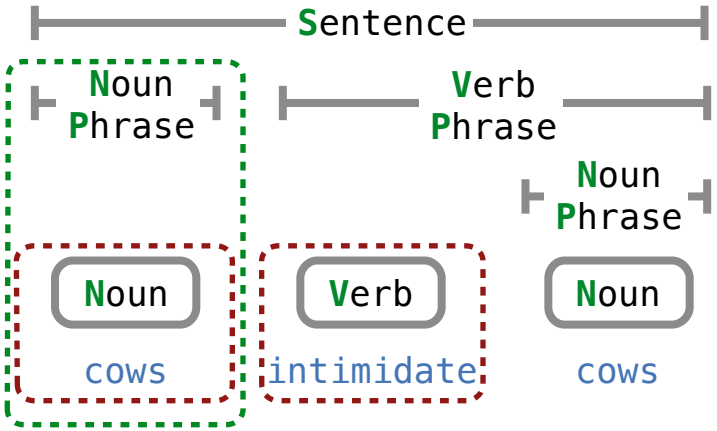

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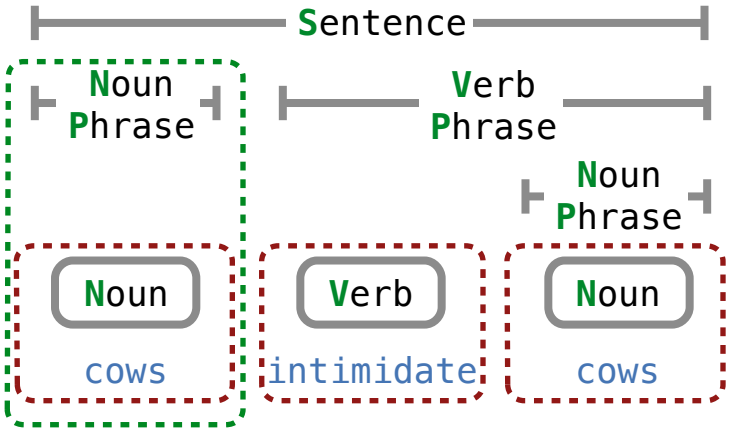

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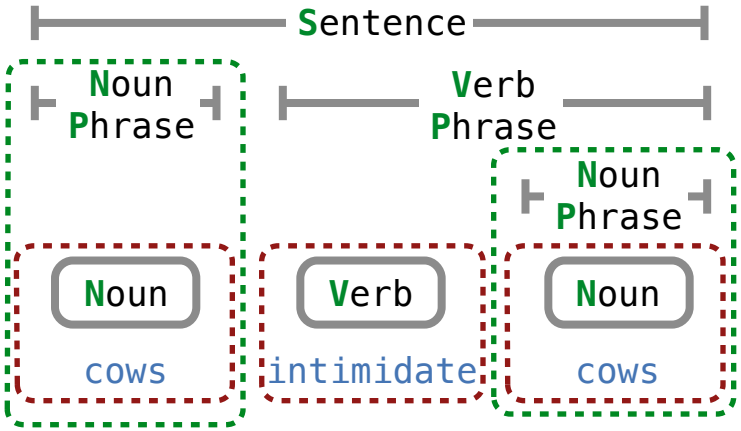

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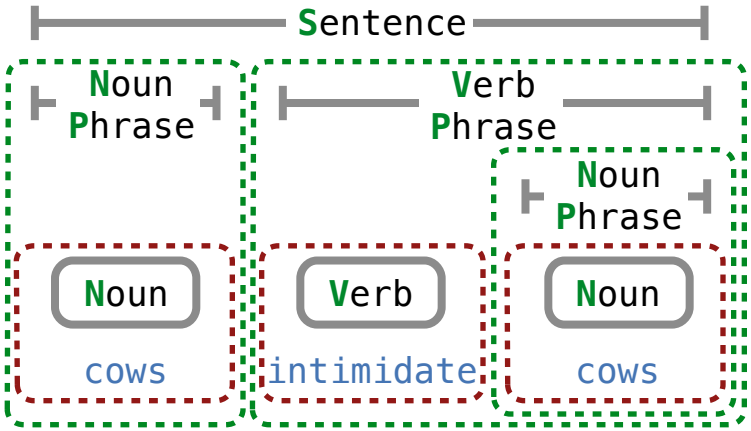

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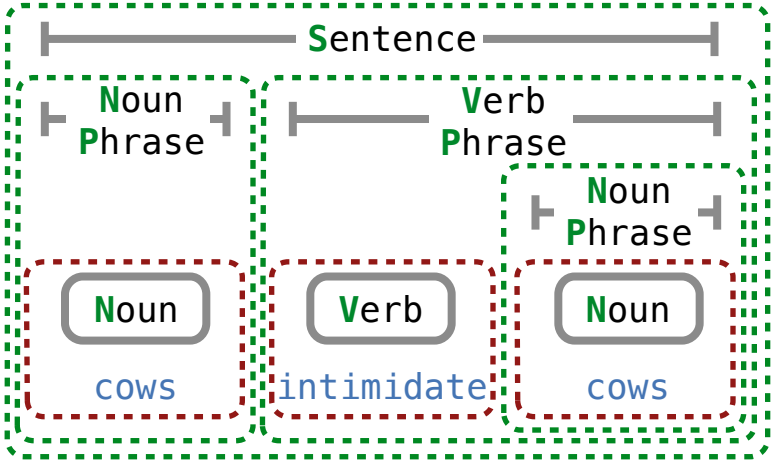

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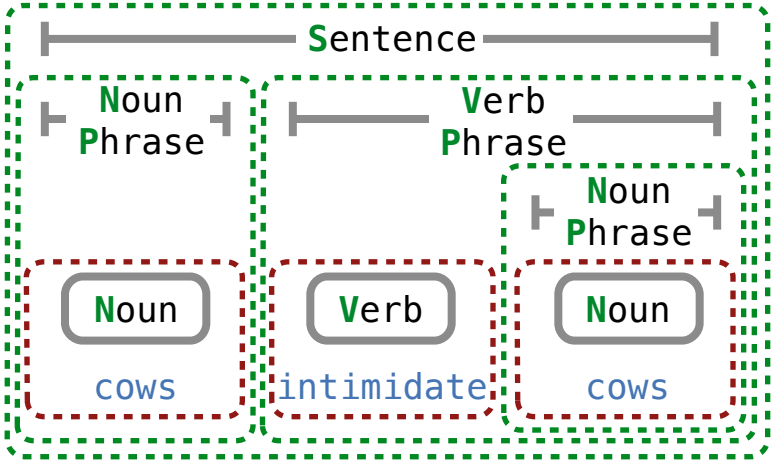

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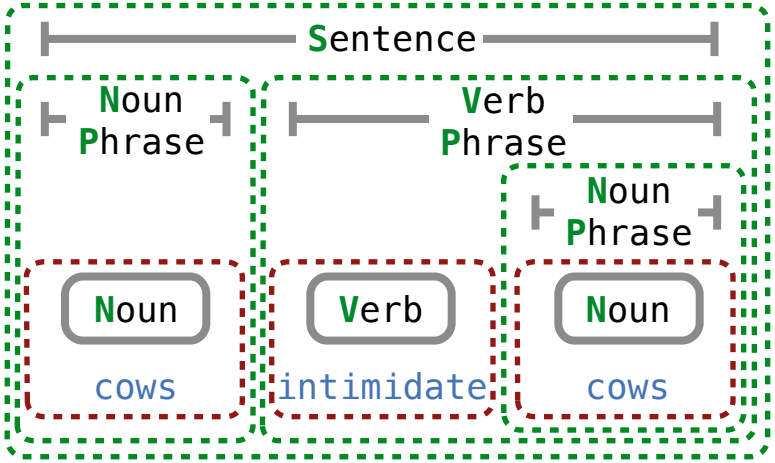

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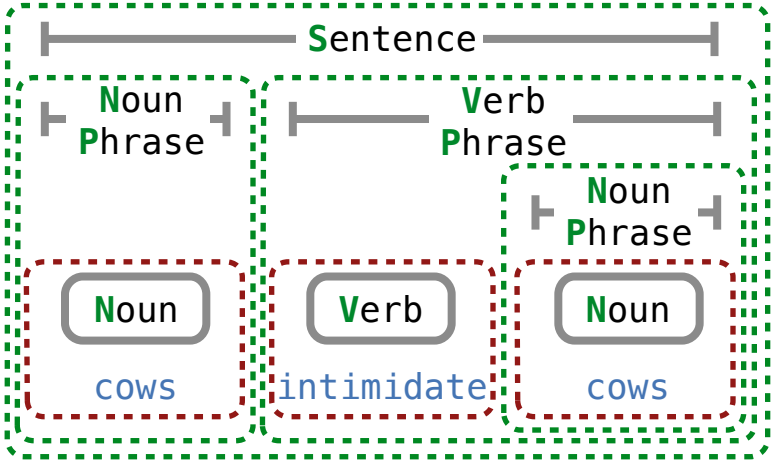

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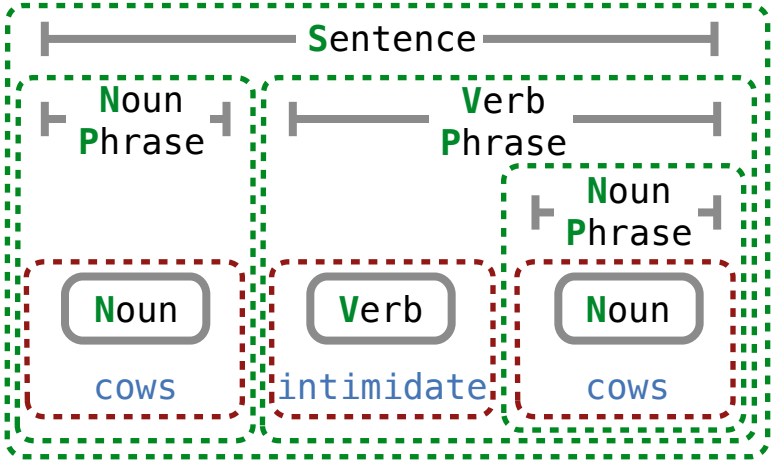

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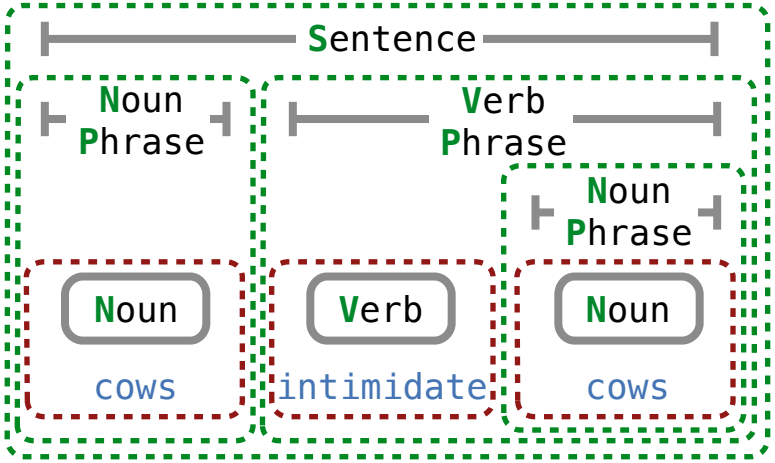
cows = Leaf('N', 'cows')
intimidate = Leaf('V', 'intimidate')
S, NP, VP = 'S', 'NP', 'VP'
Tree(S, [Tree(NP, [cows]),
```

Representing Syntactic Structure



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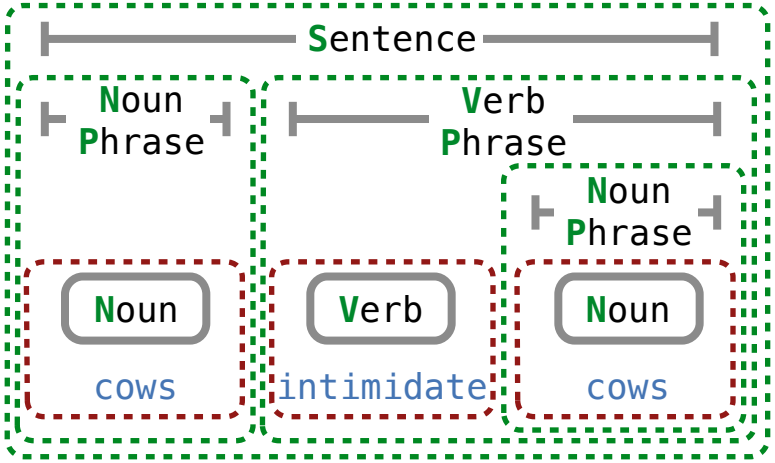

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Tree(S, [Tree(NP, [cows]),
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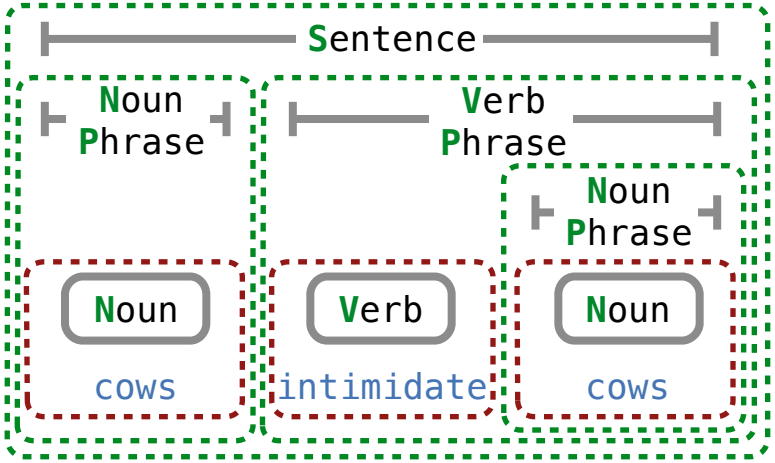
Representing Syntactic Structure



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Tree(S, [Tree(NP, [cows]),
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(Demo)

Grammars

Context-Free Grammar Rules

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

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$$\mathbf{S} \longrightarrow \mathbf{NP}\ \mathbf{VP}$$

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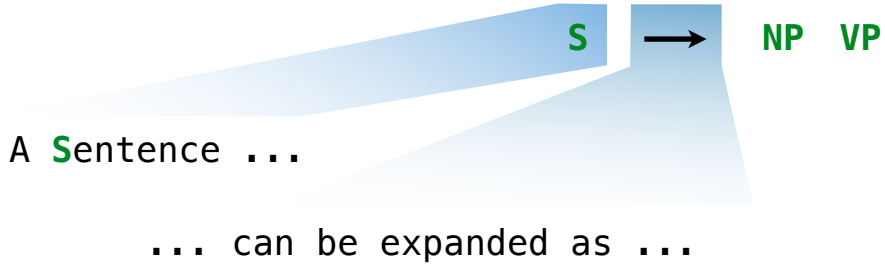

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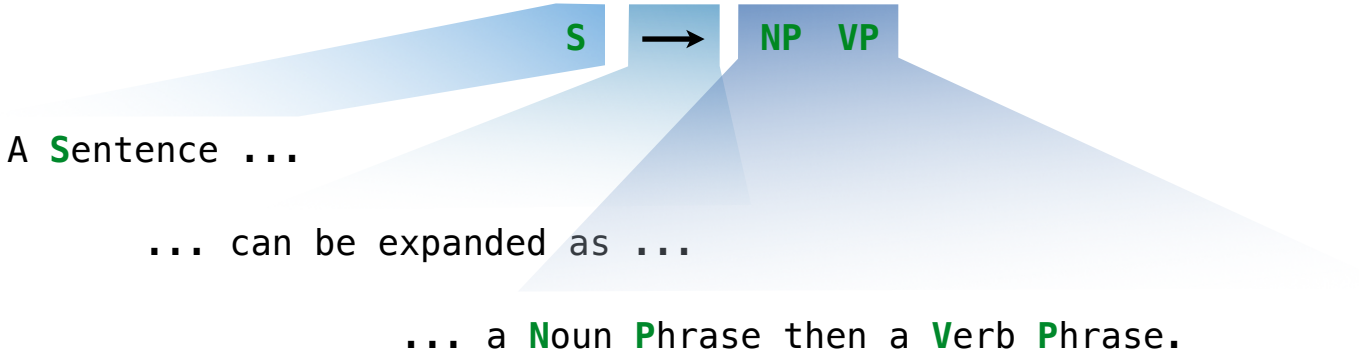

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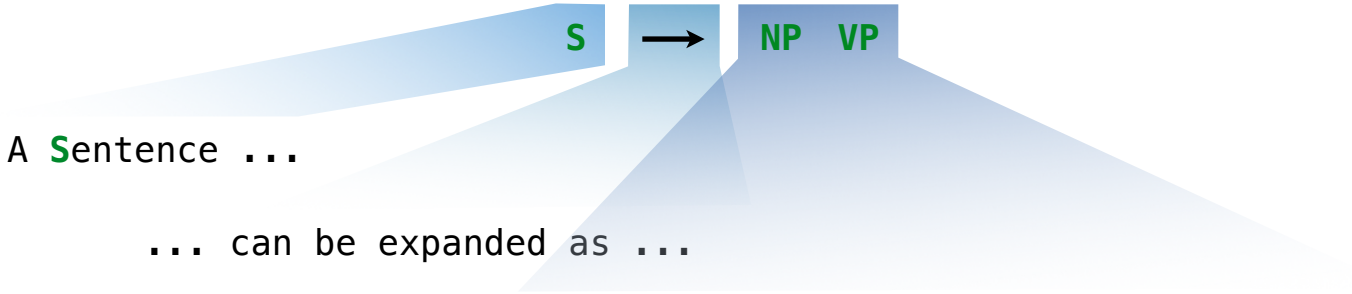

Grammar

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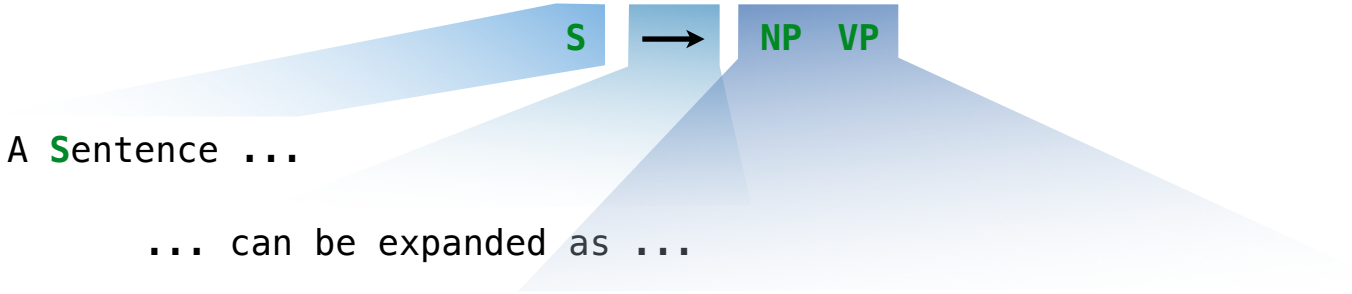

Grammar

S ⟶ NP VP

Context-Free Grammar Rules

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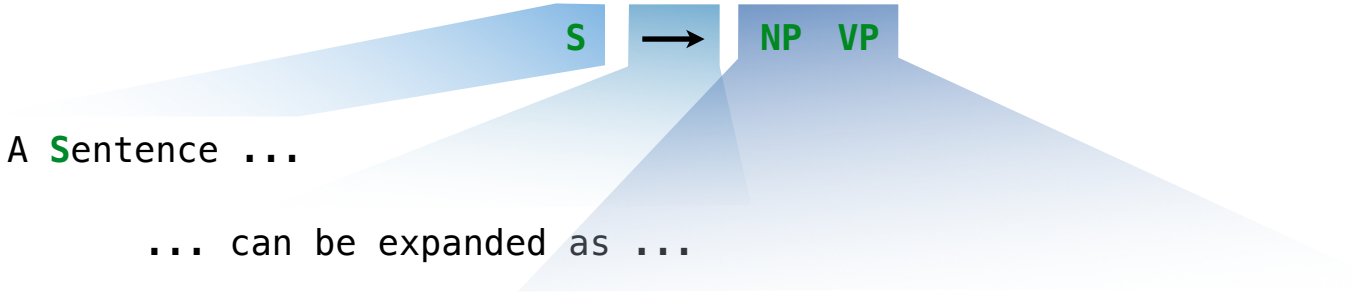

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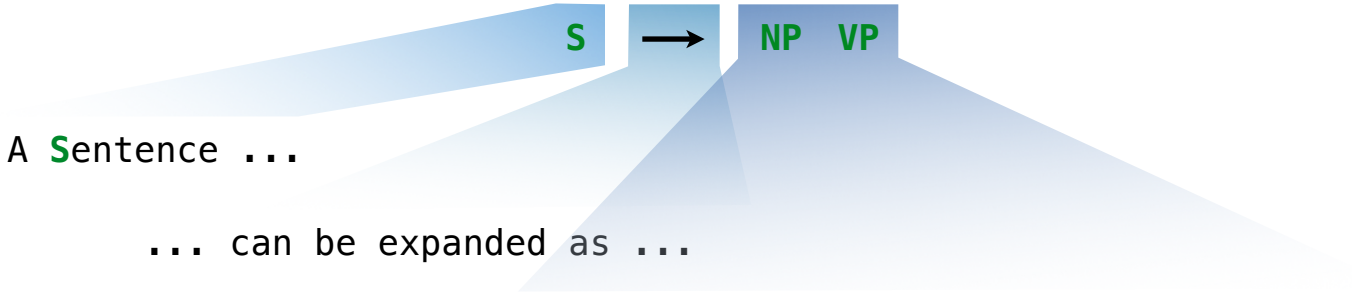

Grammar

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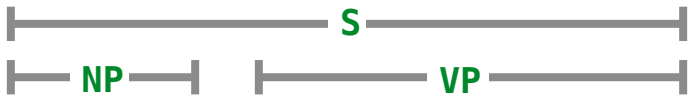

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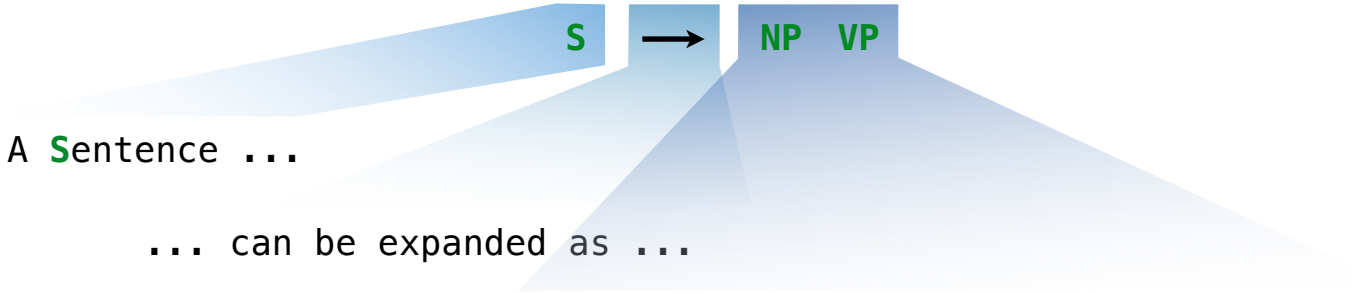
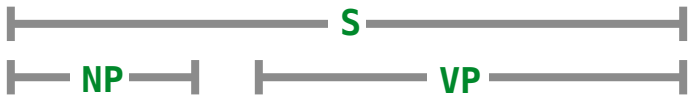


Grammar

S → NP VP

NP → N



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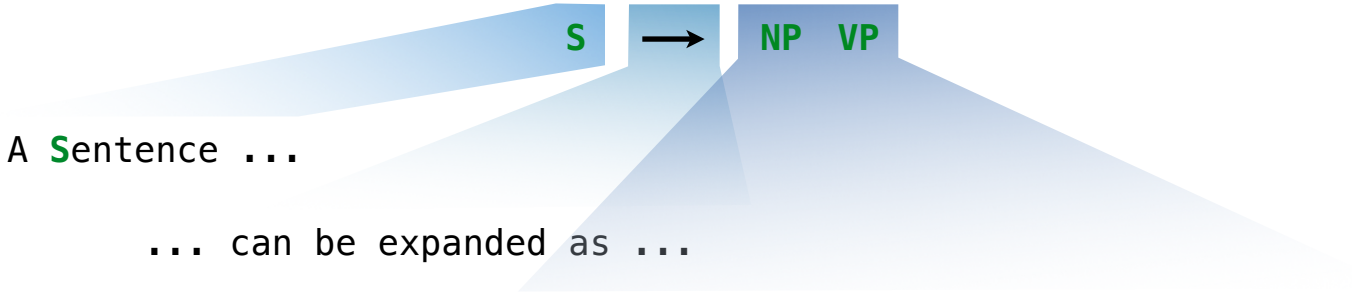

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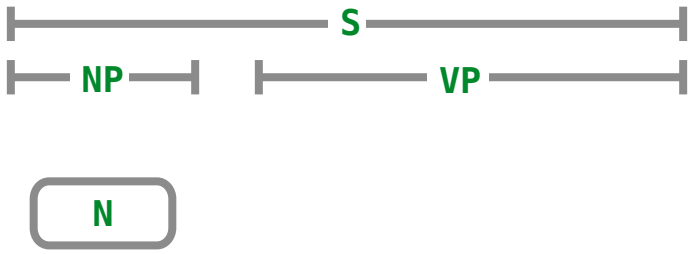

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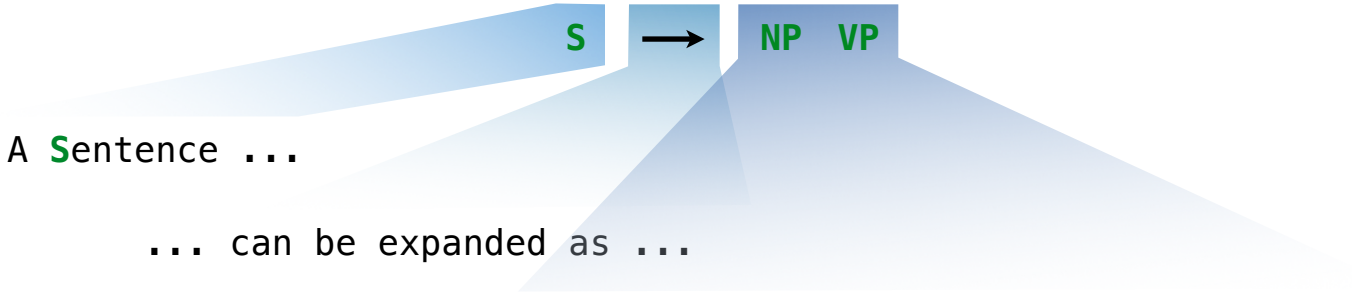
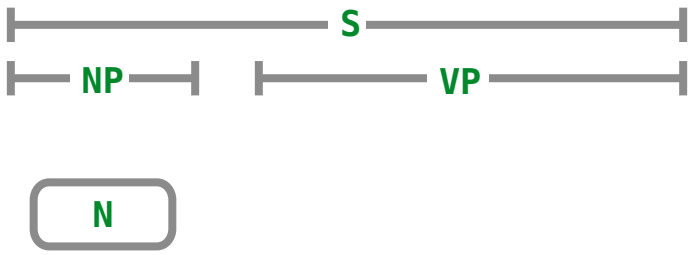


Grammar

S → NP VP

NP → N

N → buffalo



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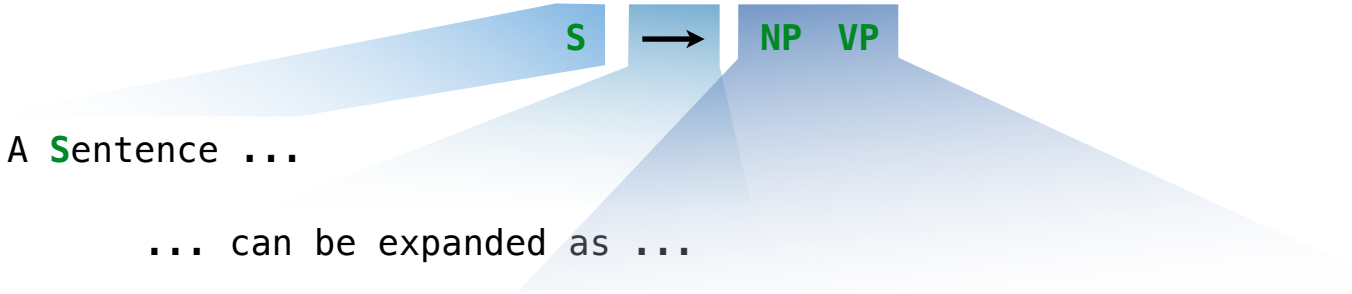

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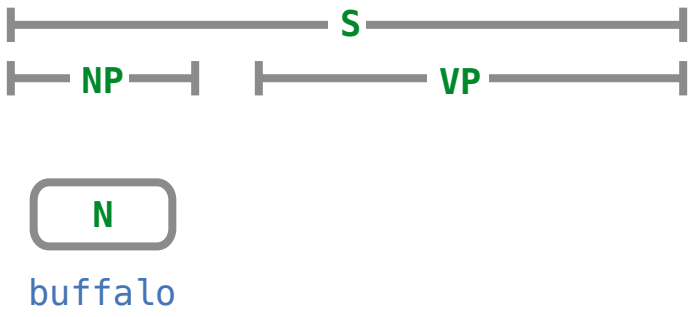

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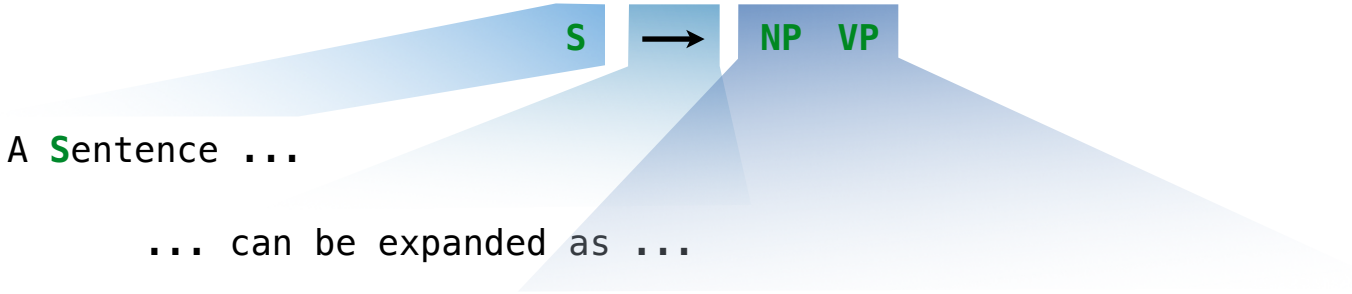

Grammar

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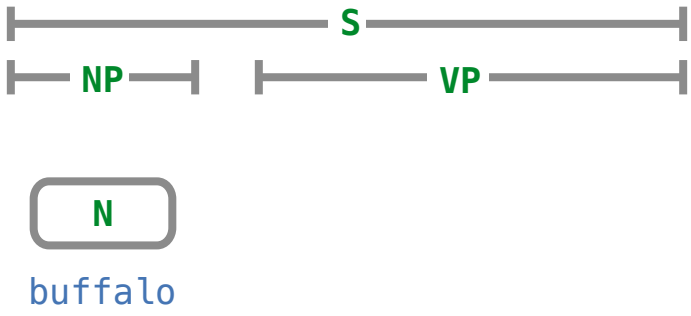

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A grammar rule describes how a tag can be expanded as a sequence of tags or words

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A Sentence ...

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Grammar

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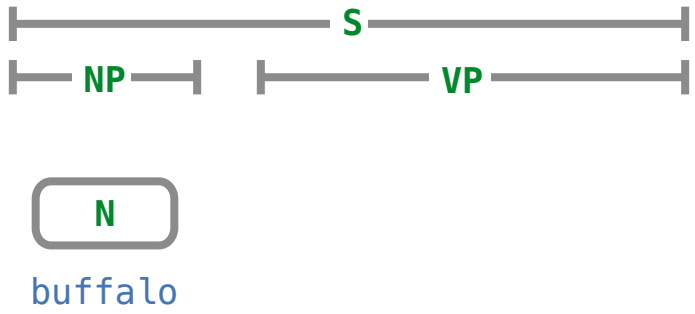
VP → V NP



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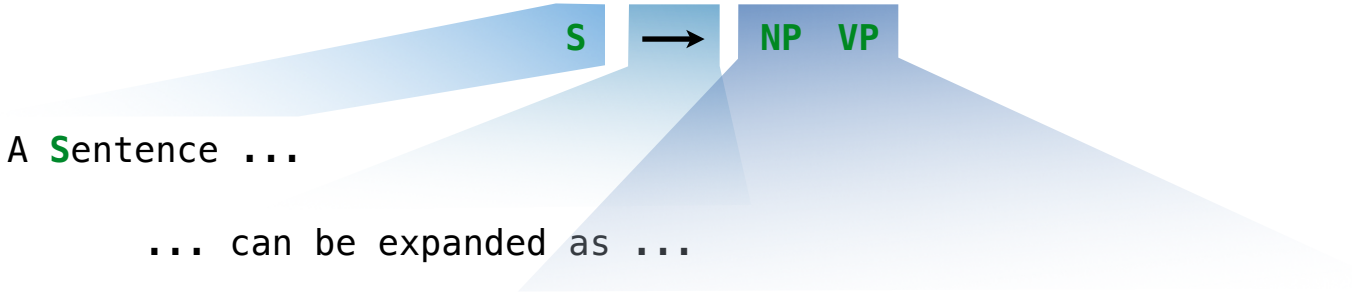

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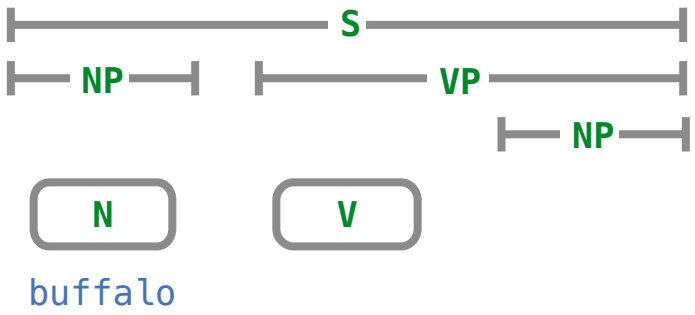

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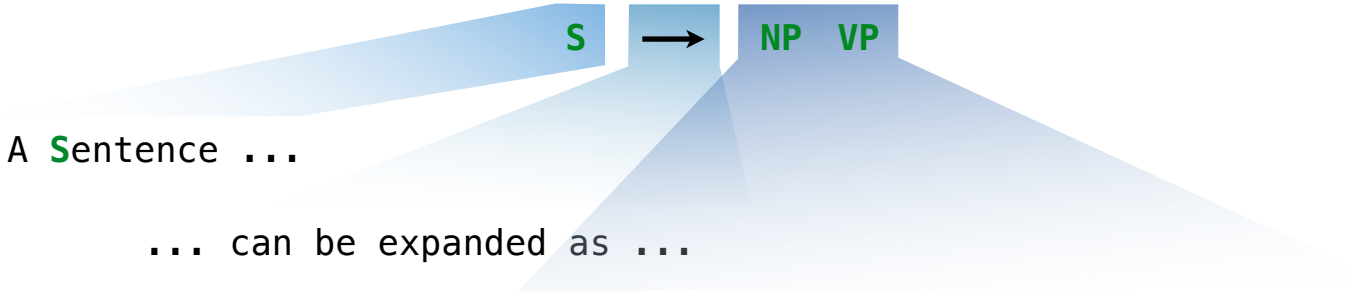

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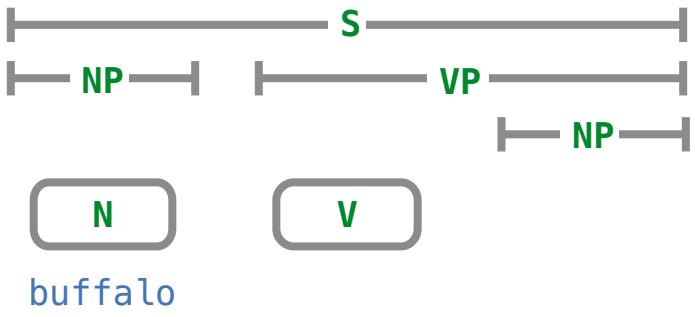

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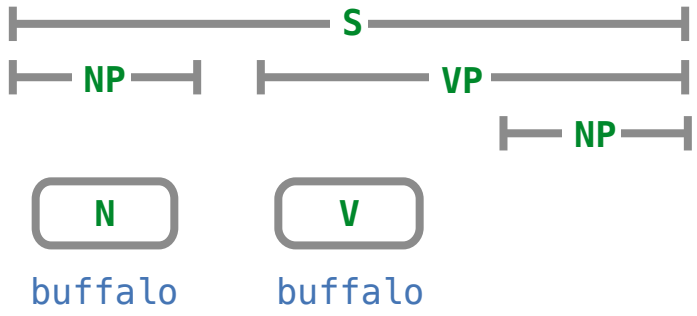

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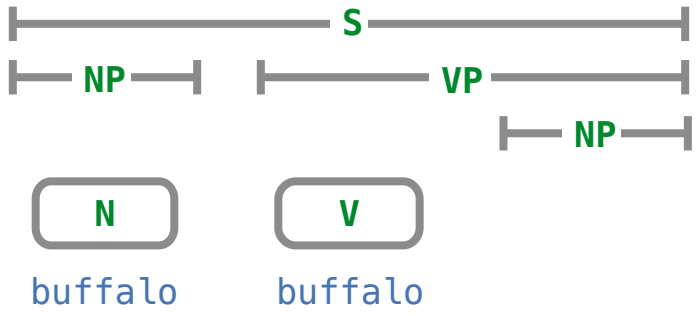

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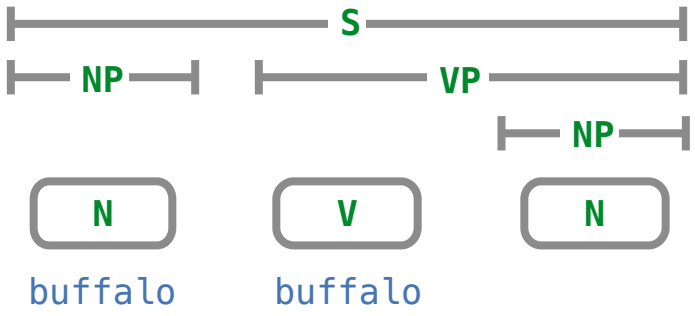

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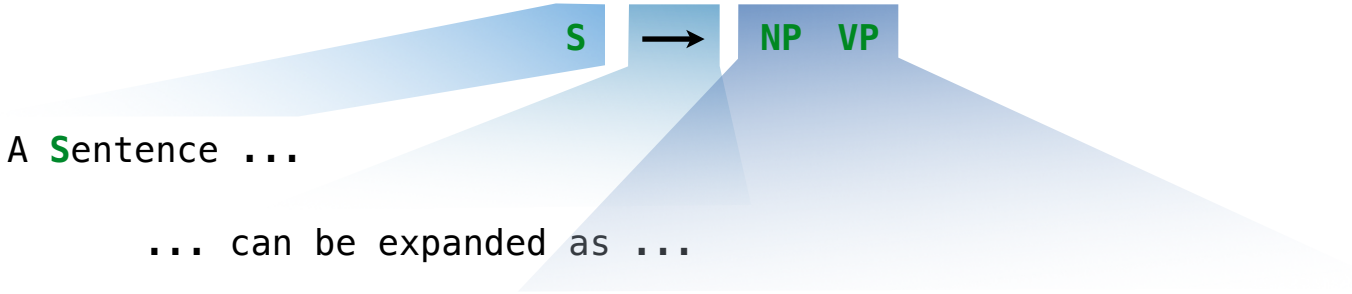

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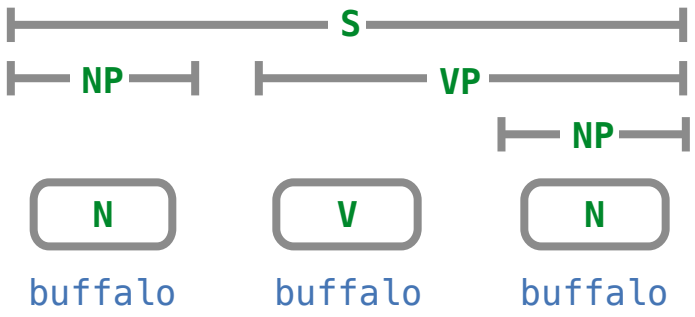

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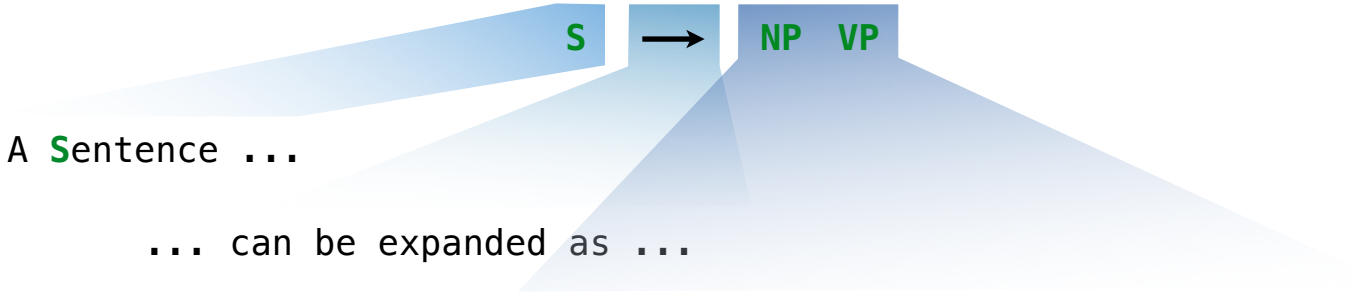

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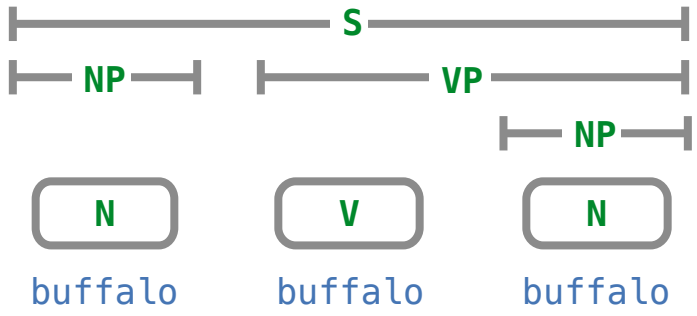

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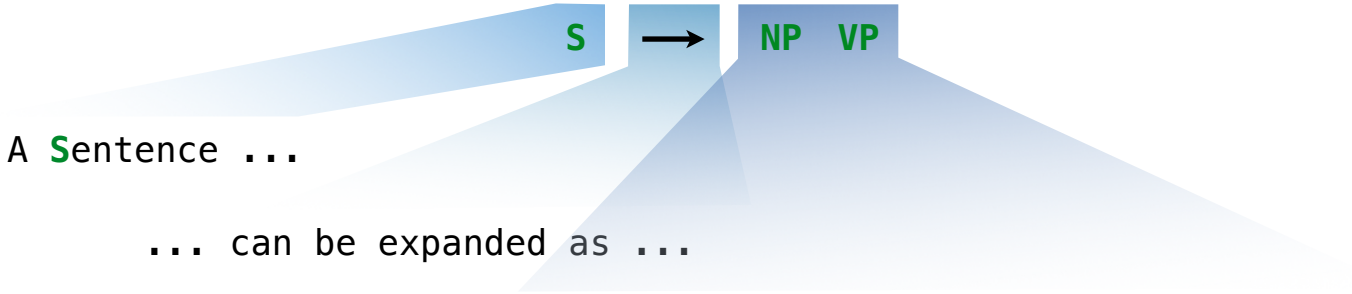

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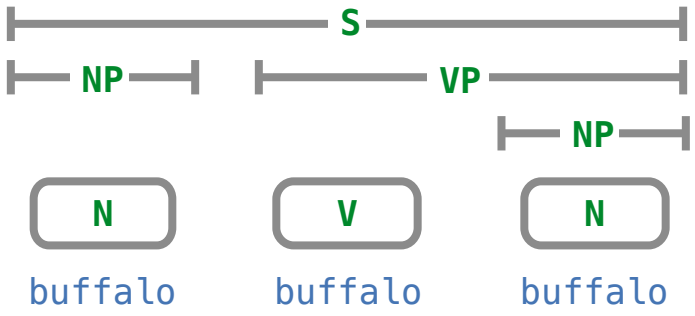

(Demo)

Parsing

Exhaustive Parsing

Expand all tags recursively, but constrain words to match input

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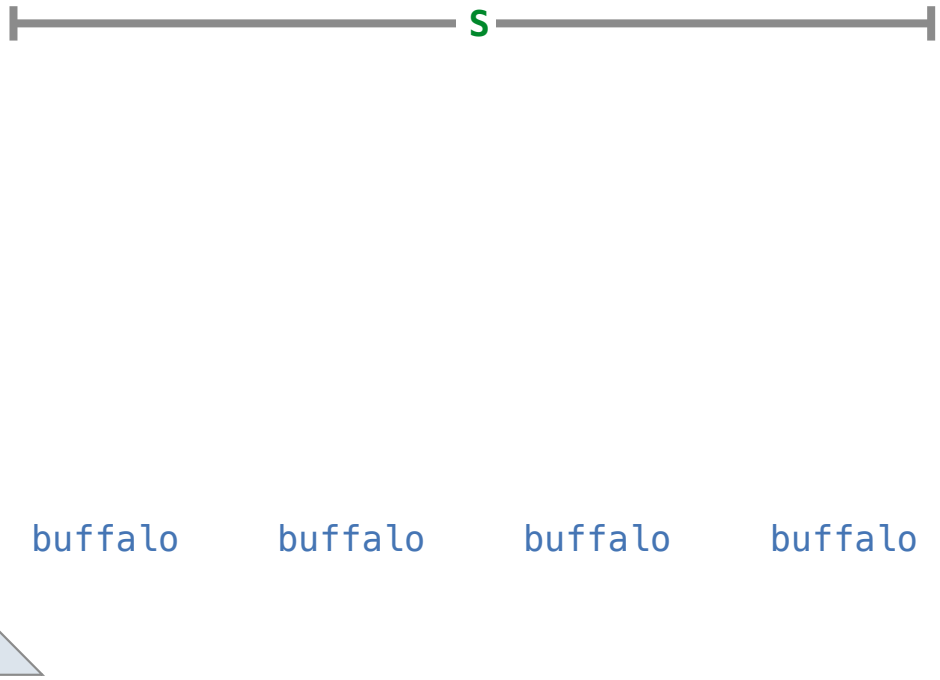

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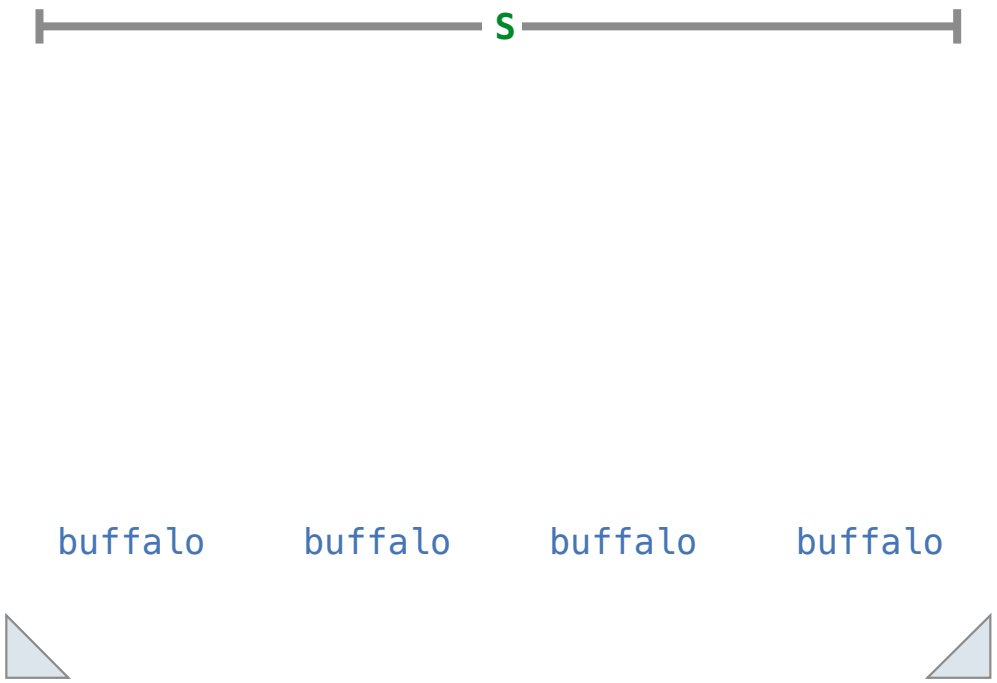

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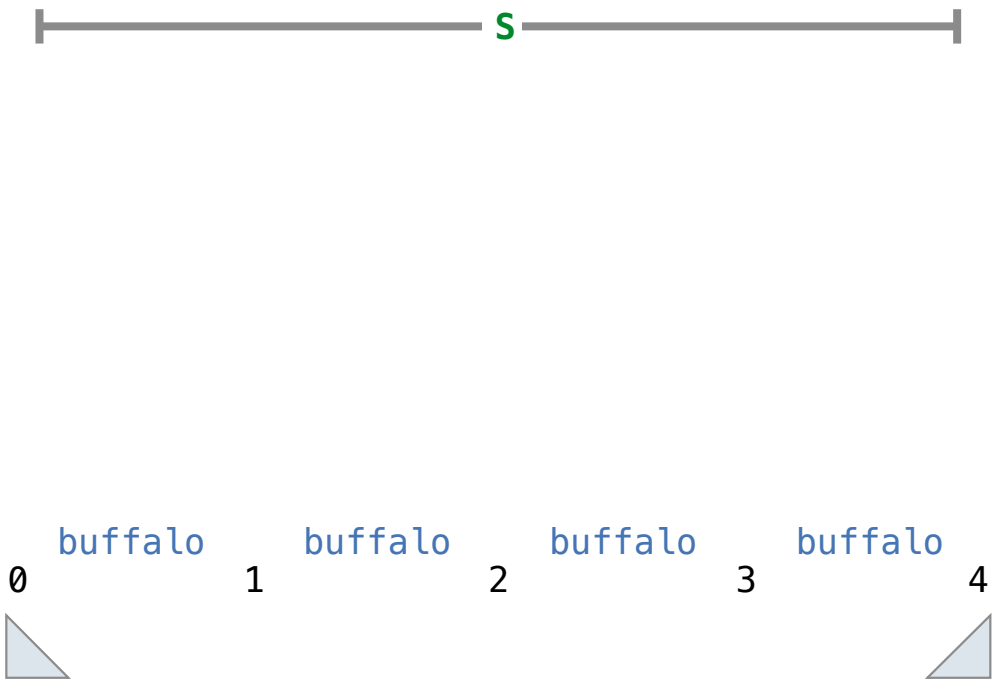

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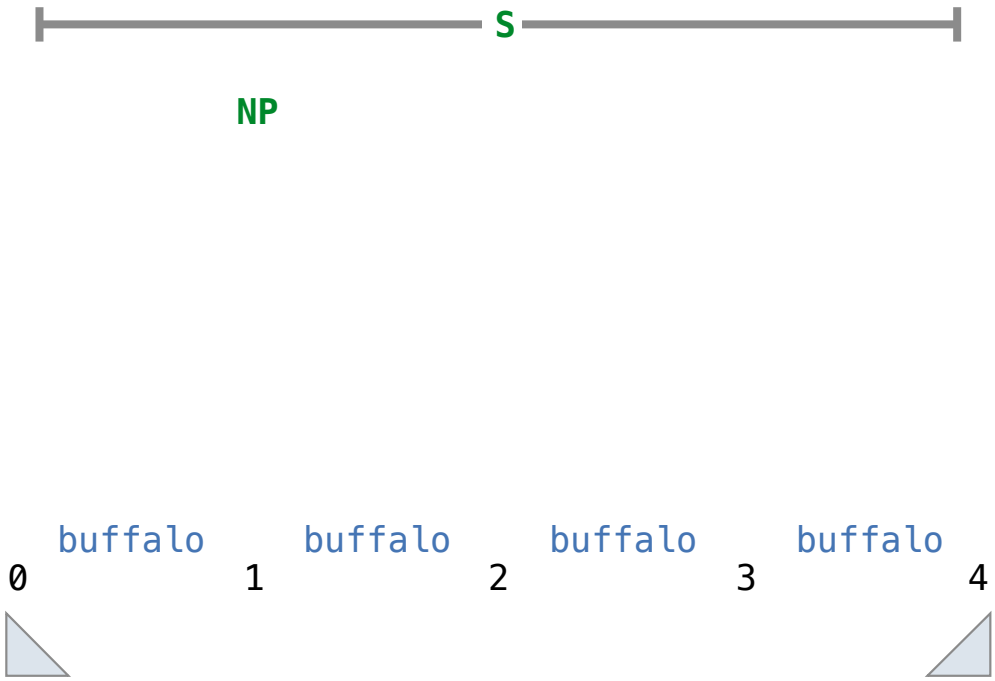

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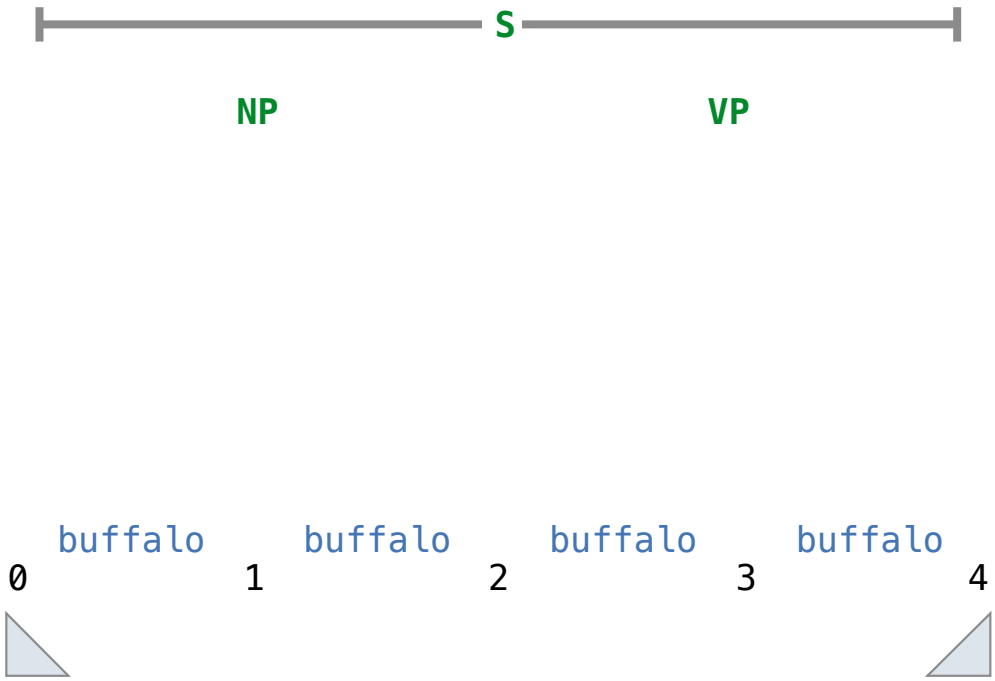

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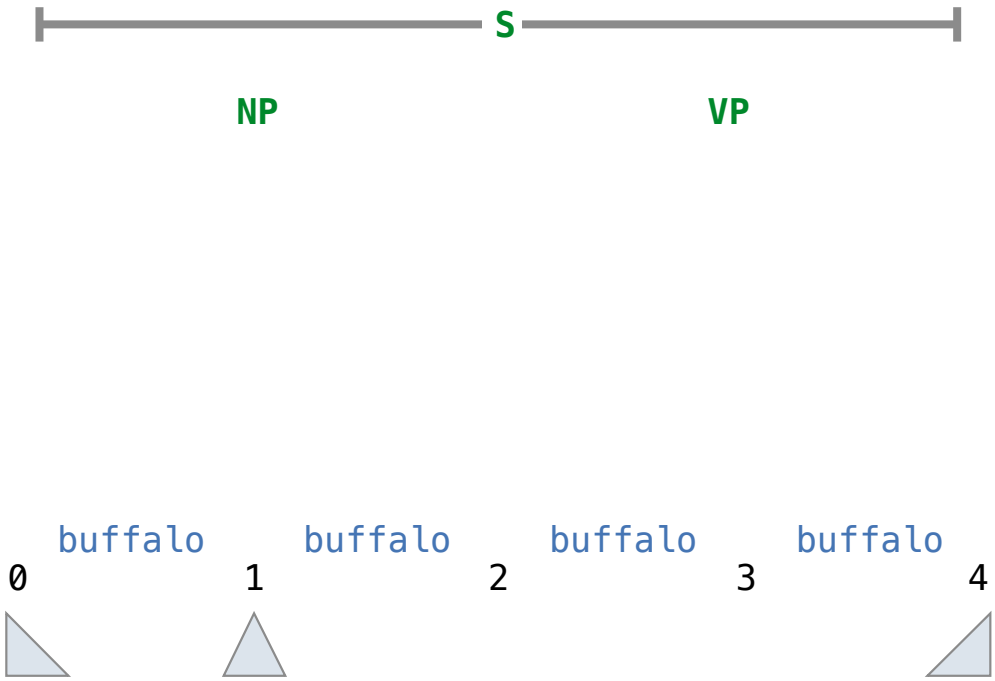

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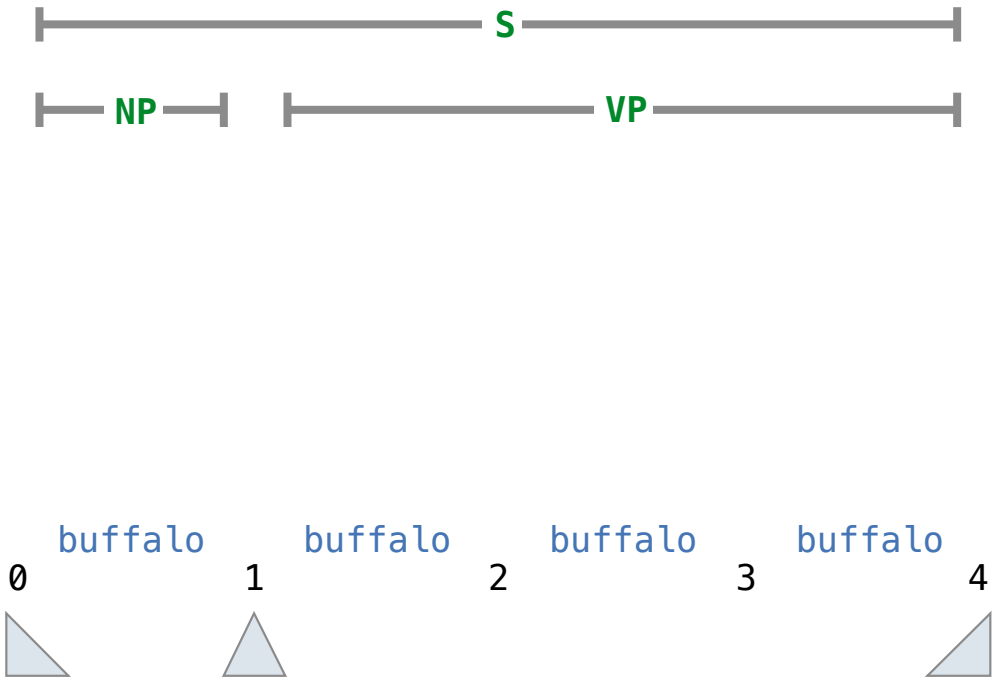

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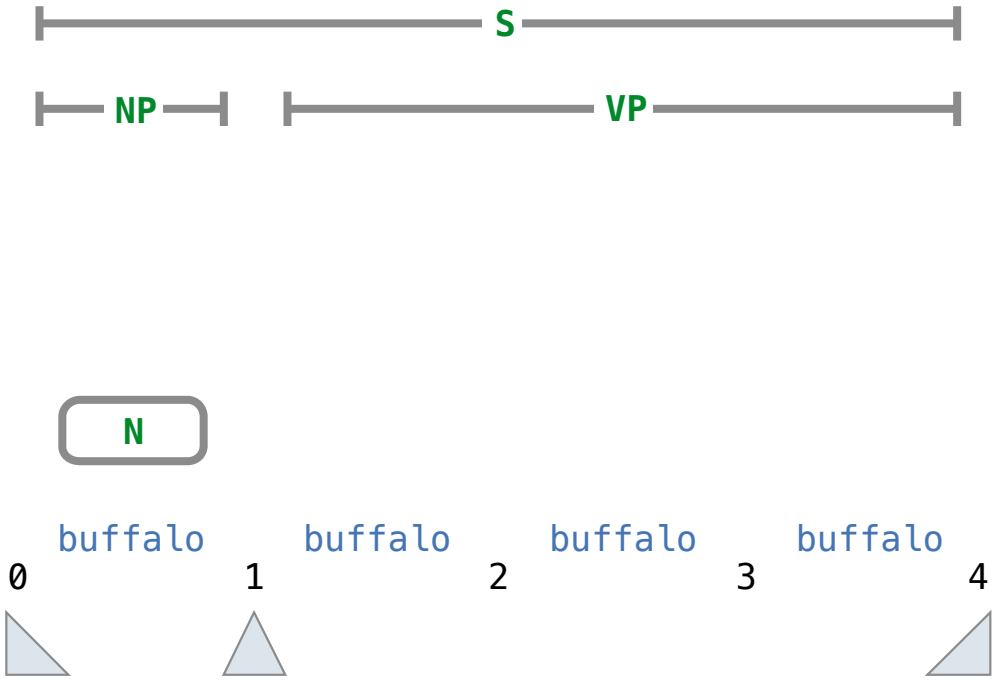

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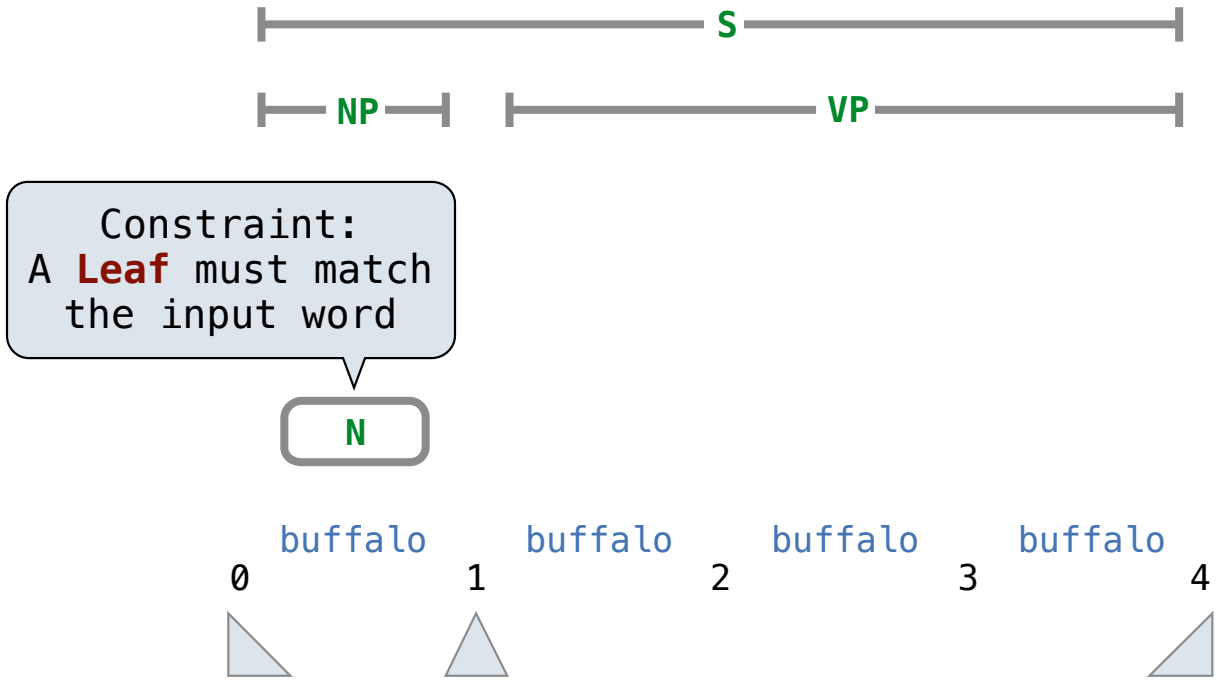

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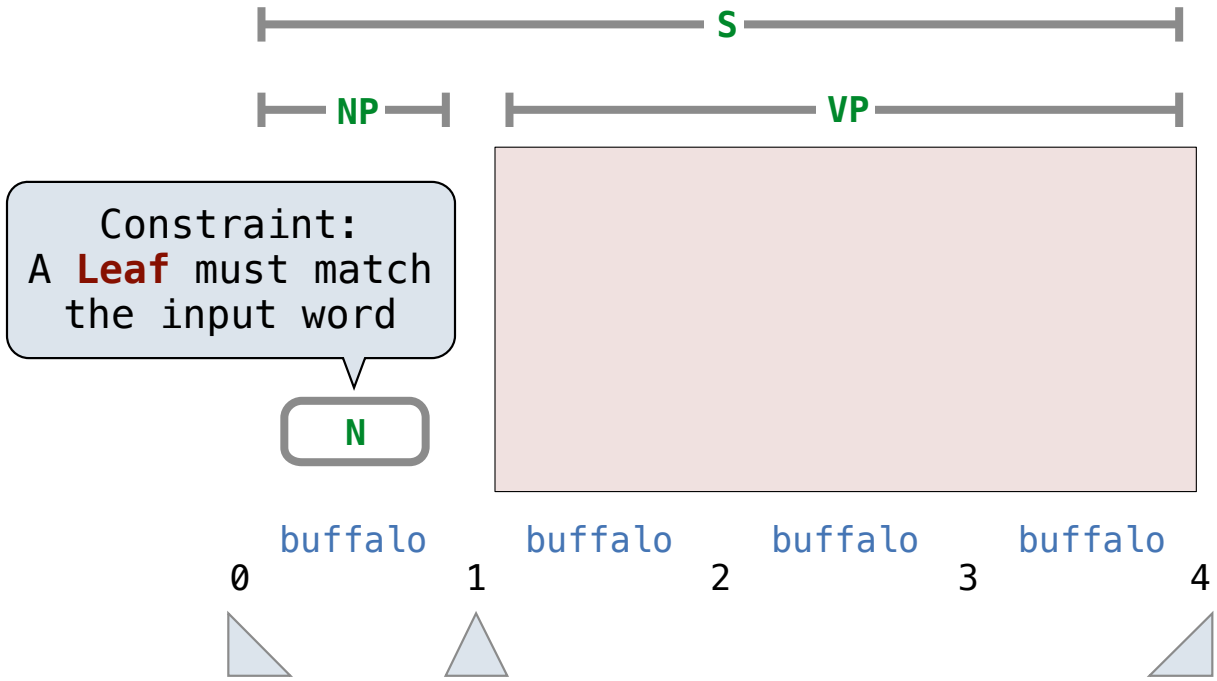

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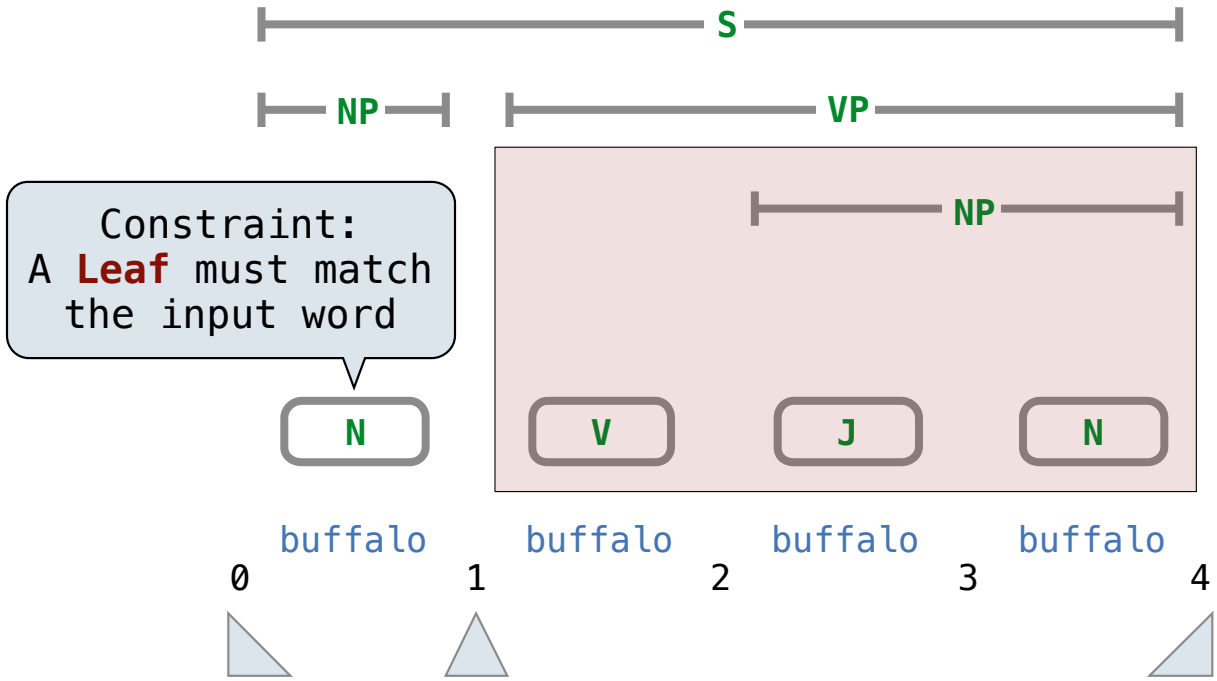

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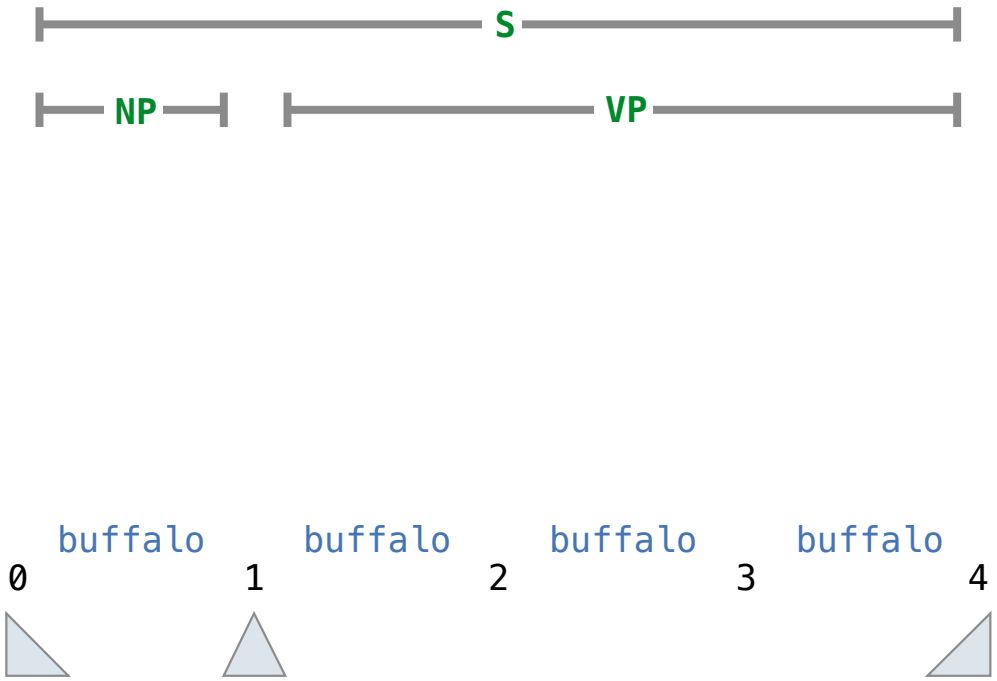

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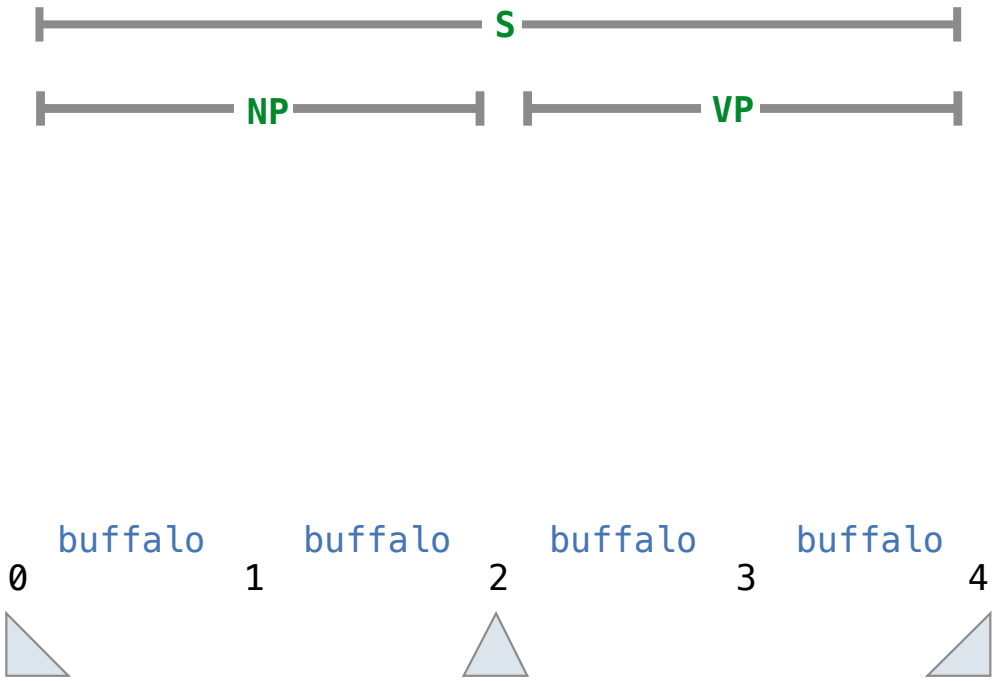

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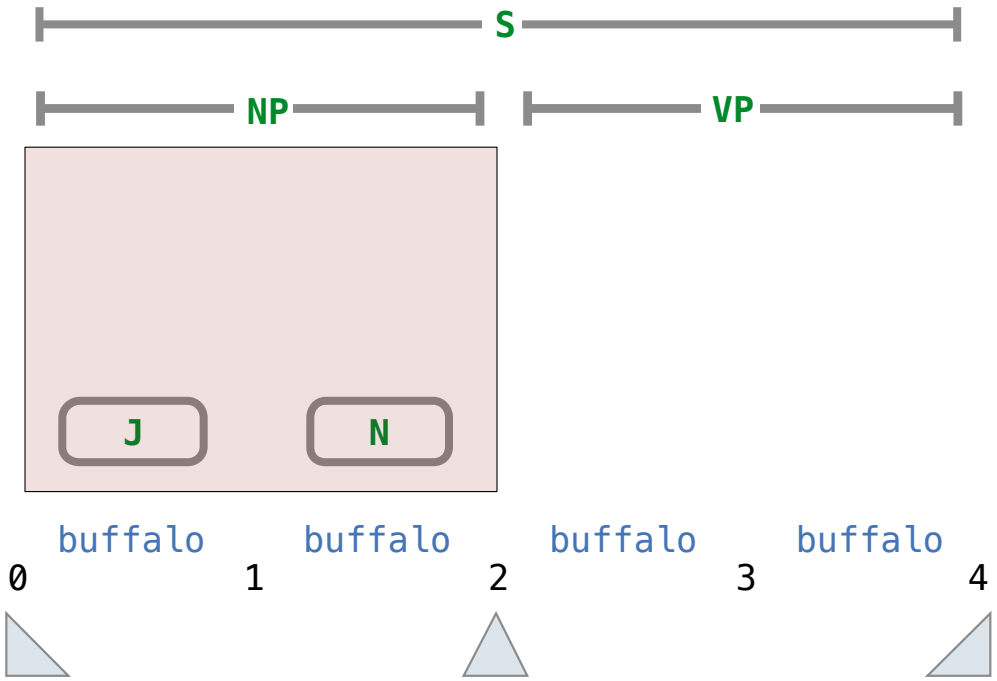

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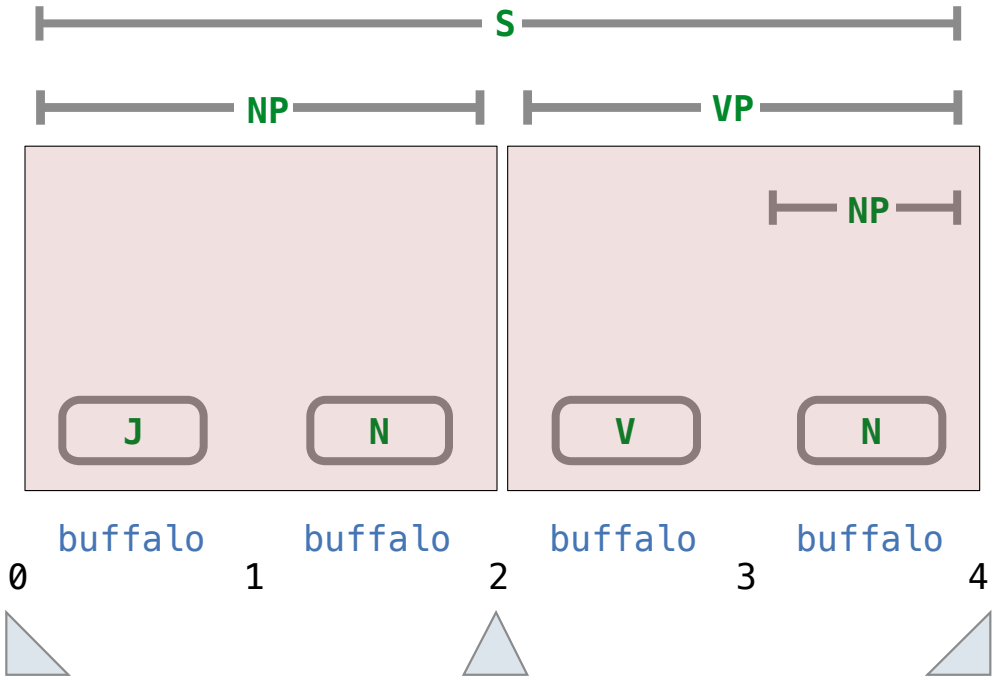

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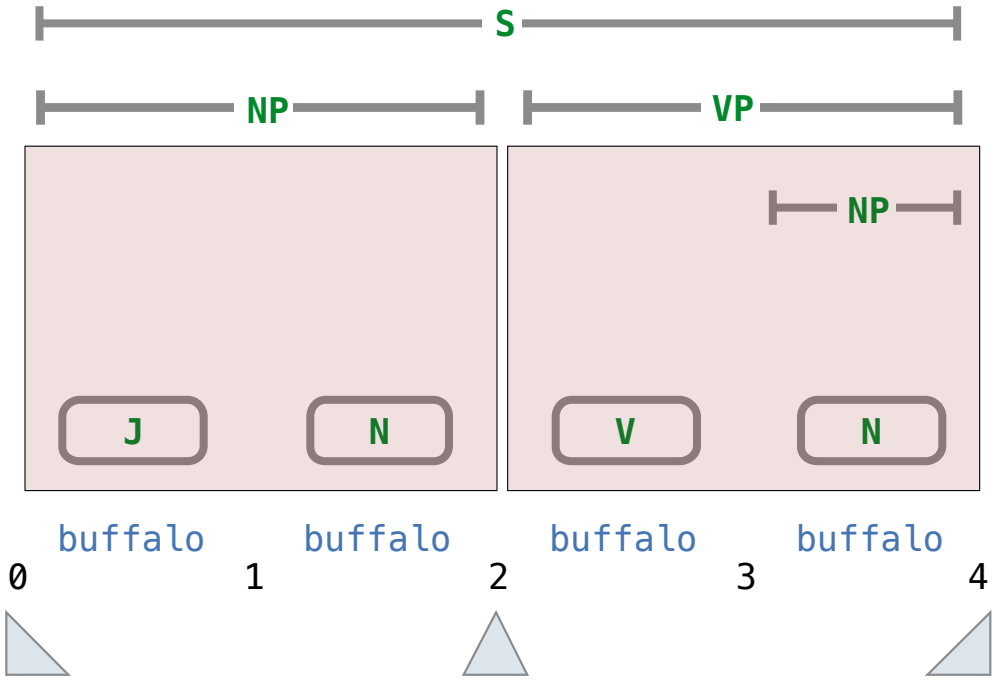

(Demo)

Learning

(Demo)

Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common

Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common

teacher strikes idle kids

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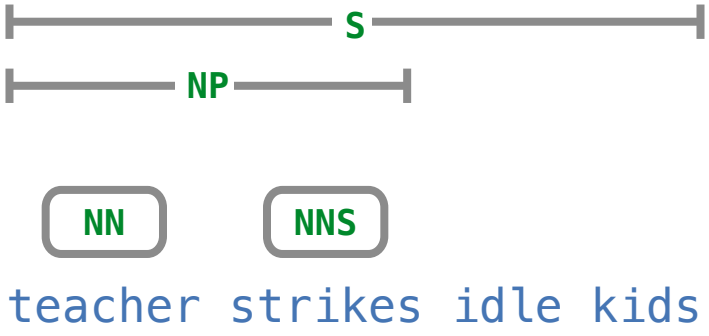

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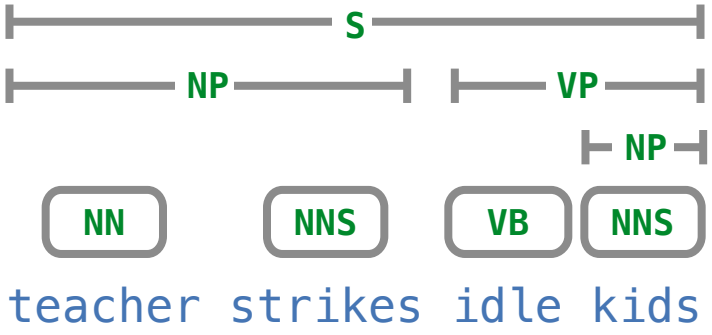

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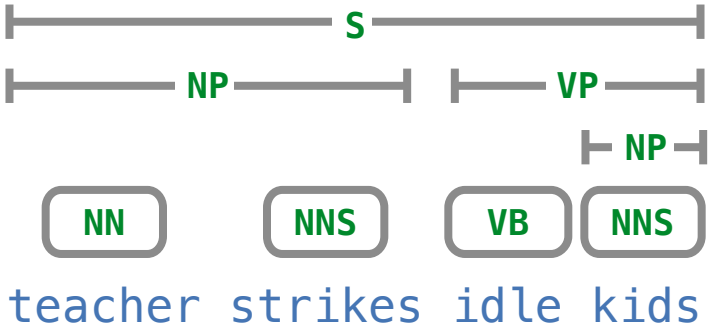

S	⟶	NP VP	NN	⟶	teacher
NP	⟶	NN NNS	NNS	⟶	strikes
VP	⟶	VB NP	VB	⟶	idle
NP	⟶	NNS	NNS	⟶	kids

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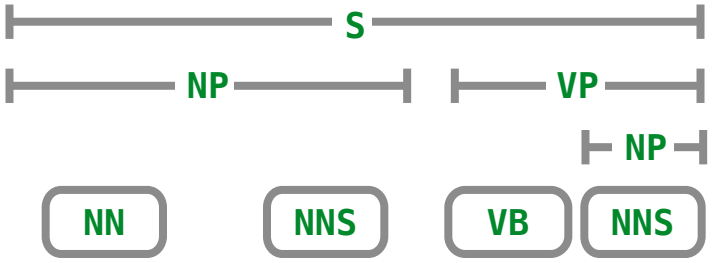

Rule frequency per 100,000 tags

S → NP VP		NN →	teacher
NP → NN NNS		NNS →	strikes
VP → VB NP		VB →	idle
NP → NNS		NNS →	kids

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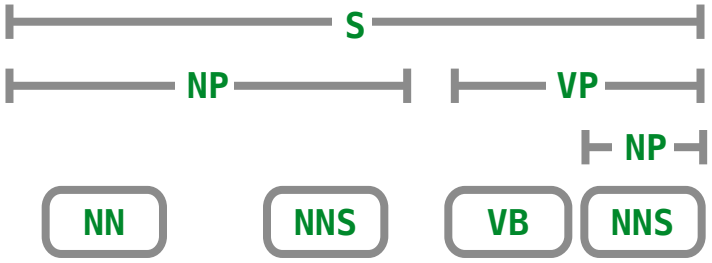
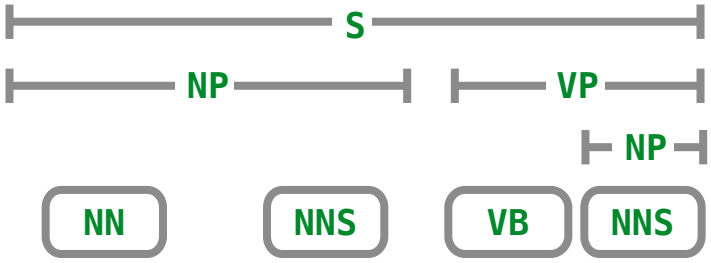


Rule frequency per 100,000 tags

S → NP VP	25372	NN →	teacher
NP → NN NNS		NNS →	strikes
VP → VB NP		VB →	idle
NP → NNS		NNS →	kids

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
NP ⟶ NN NNS	1335	NNS ⟶	strikes
VP ⟶ VB NP		VB ⟶	idle
NP ⟶ NNS		NNS ⟶	kids

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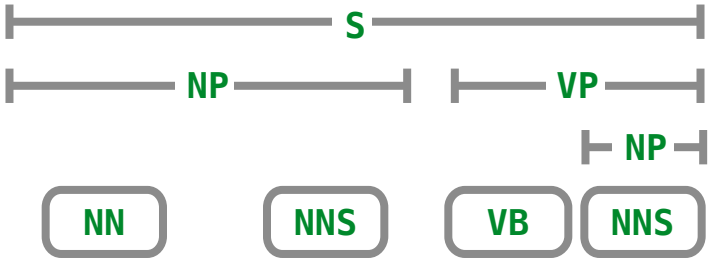

Rule frequency per 100,000 tags

S → NP VP	25372	NN →	teacher
NP → NN NNS	1335	NNS →	strikes
VP → VB NP	6679	VB →	idle
NP → NNS		NNS →	kids

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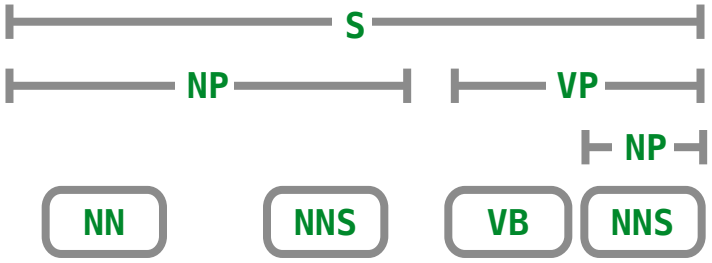
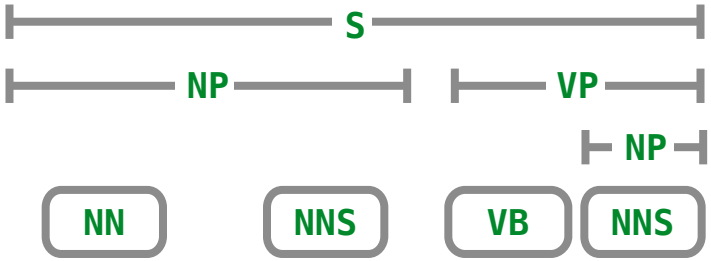


Rule frequency per 100,000 tags

S → NP VP	25372	NN →	teacher
NP → NN NNS	1335	NNS →	strikes
VP → VB NP	6679	VB →	idle
NP → NNS	4282	NNS →	kids

Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common

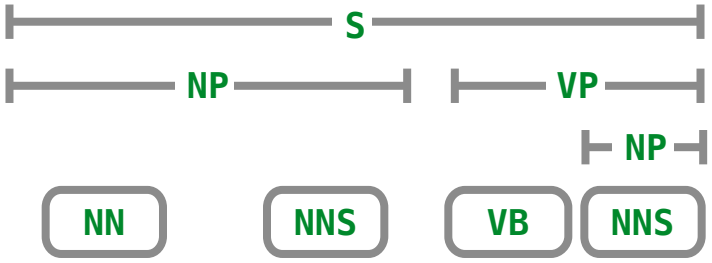


Rule frequency per 100,000 tags

S ⟶ NP VP	25372	NN ⟶	teacher	5
NP ⟶ NN NNS	1335	NNS ⟶	strikes	
VP ⟶ VB NP	6679	VB ⟶	idle	
NP ⟶ NNS	4282	NNS ⟶	kids	

Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common

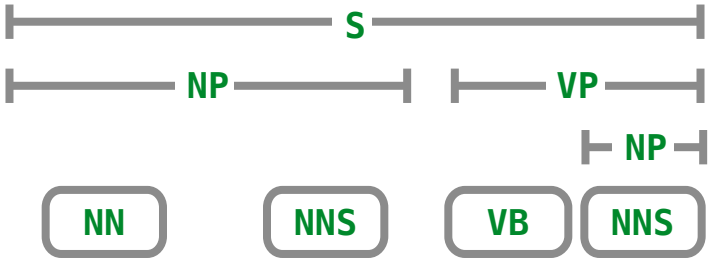


Rule frequency per 100,000 tags

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

Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common

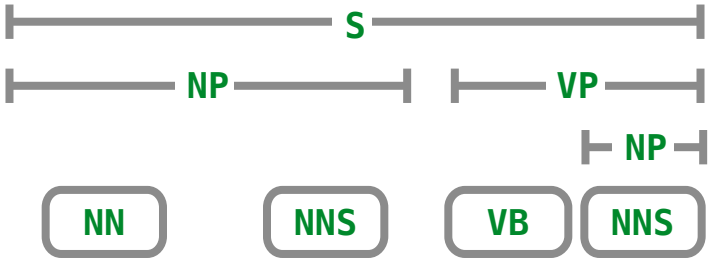


Rule frequency per 100,000 tags

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	

Scoring a Tree Using Relative Frequencies

Not all syntactic structures are equally common

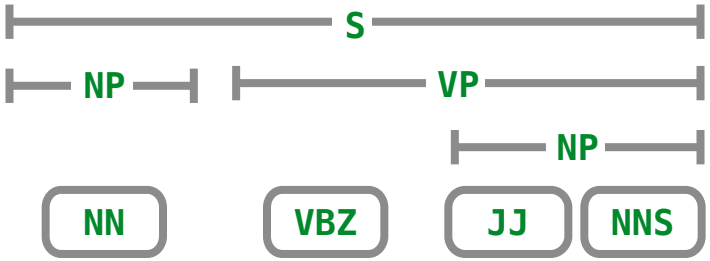


Rule frequency per 100,000 tags

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

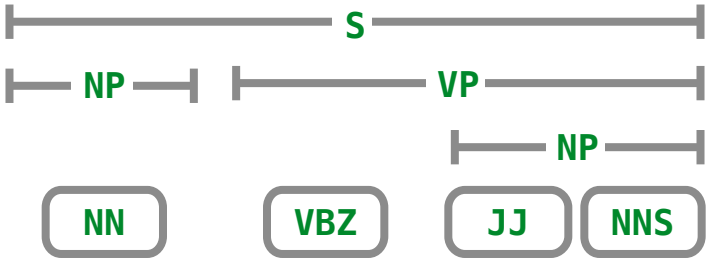


Rule frequency per 100,000 tags

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	

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)