

61A Lecture 37

Friday, December 2

What is Computer Science?

Systems

Artificial Intelligence

Graphics

Security

Networking

Programming Languages

...

Computer Vision

Planning

Robotics

Natural Language Processing

...



Machine Translation

Target language corpus gives examples of well-formed sentences

I will get to it later

See you later

He will do it

Parallel corpus gives translation examples

I will do it gladly

Yo lo haré de muy buen grado

You will see later

Después lo veras

Machine translation system:

Source language

Yo lo haré después

NOVEL SENTENCE

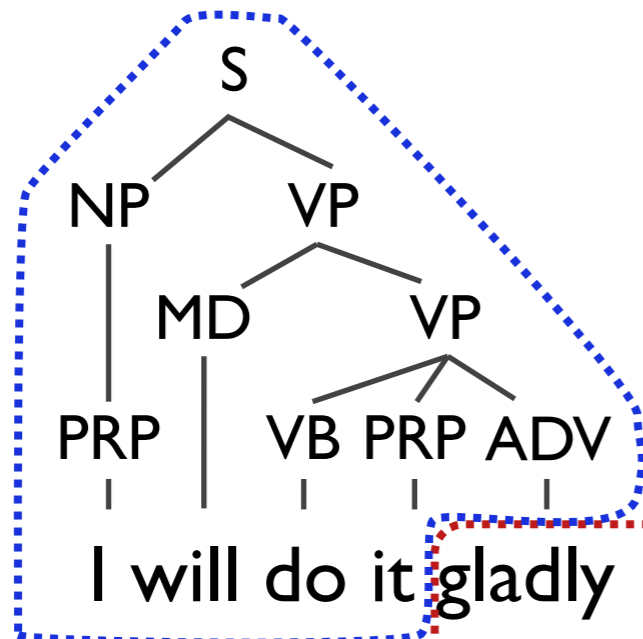
Model of translation

Target language

I will do it later

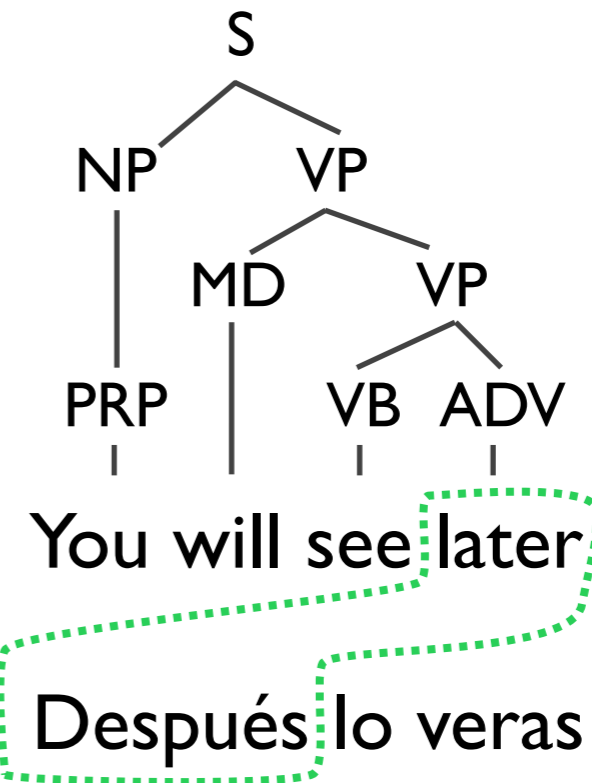
The Syntactic Structure of Natural Language

Parallel corpus gives translation examples



I will do it gladly

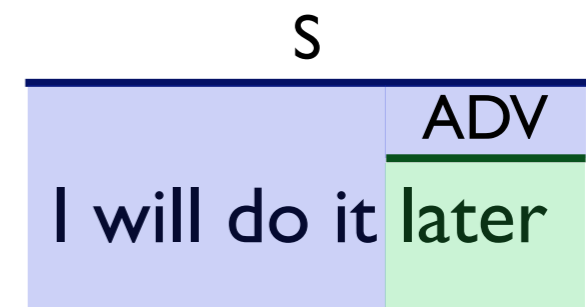
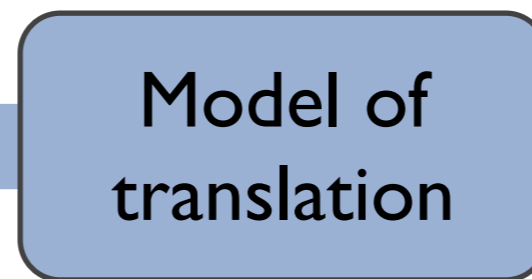
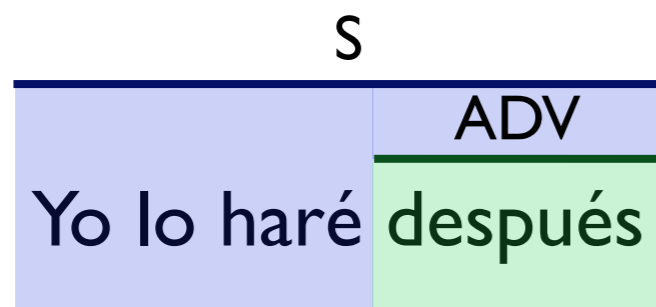
Yo lo haré de muy buen grado



You will see later

Después lo veras

Machine translation system:



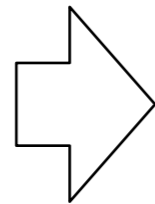
A Translation System in 20 Minutes

Context-free grammars as a model of language generation

Large-scale linguistic annotations

Tree transformations

English



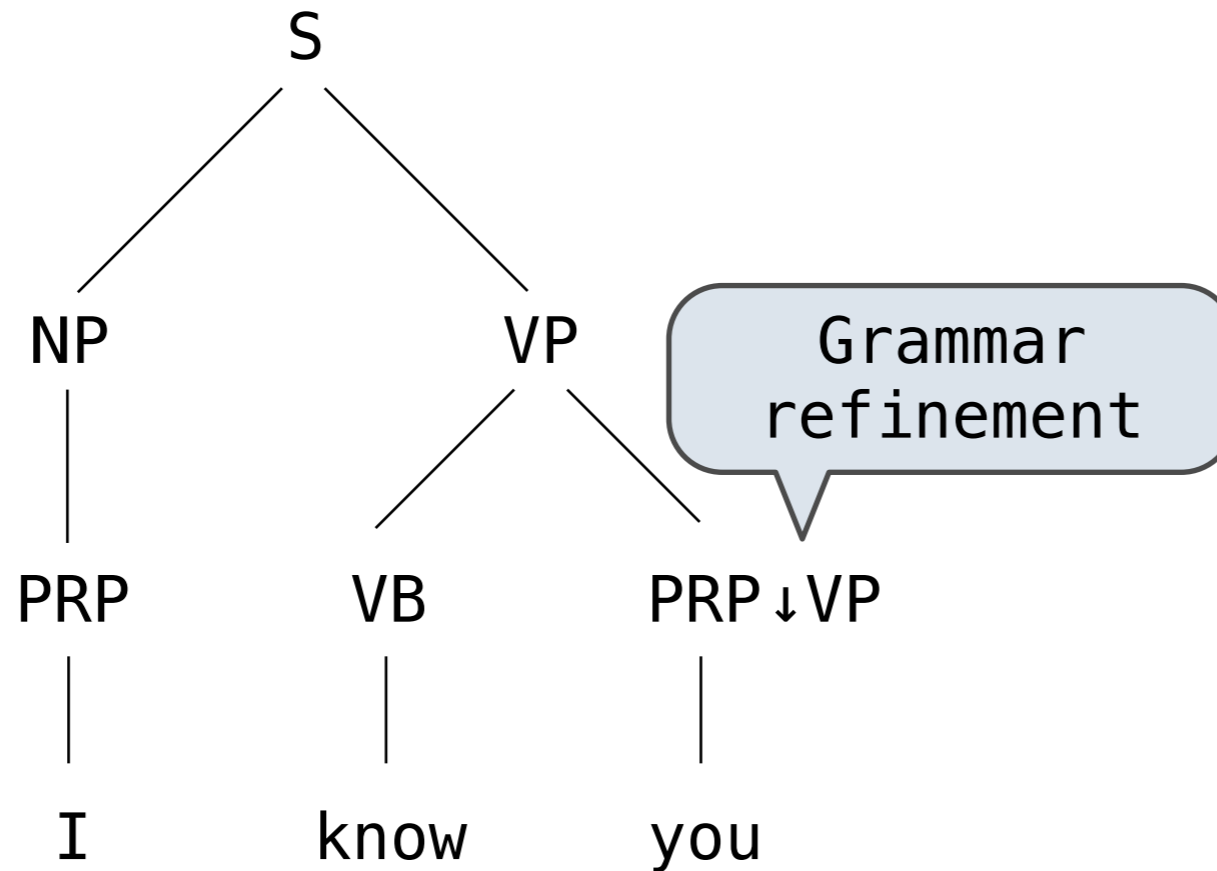
Yoda-speak

Help you, I can!
Yes! Mm!

When 900 years old you reach,
look as good, you will not. Hm.



A Context-Free Grammar Describes Generation



"Grammar"

$S \rightarrow NP VP$

$NP \rightarrow PRP \downarrow NP$

$VP \rightarrow VB$

$VP \rightarrow VB PRP \downarrow VP$

"Lexicon"

$PRP \rightarrow I$

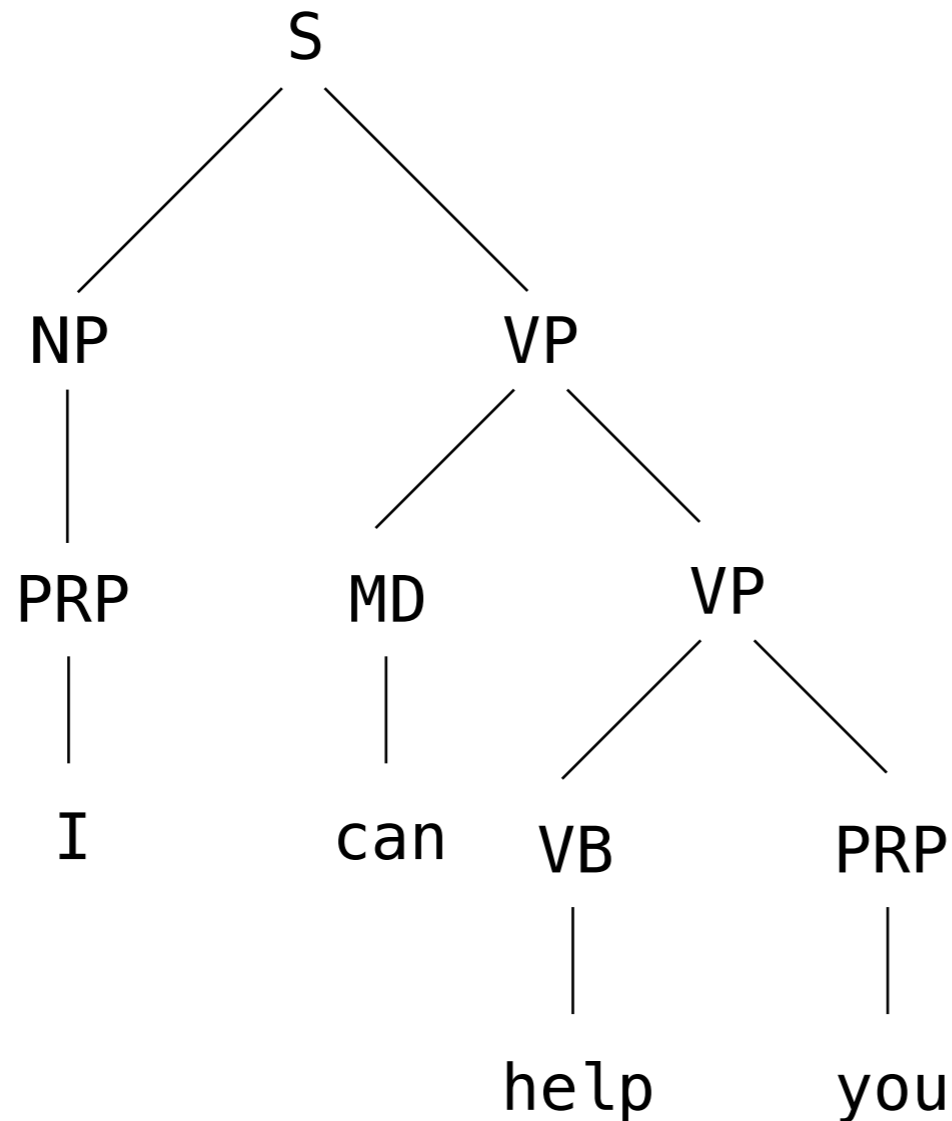
$PRP \rightarrow you$

$VB \rightarrow know$

$VB \rightarrow help$

$PRP \downarrow VP \rightarrow me$

A Context-Free Grammar Describes Generation



"Grammar"

S → NP VP

NP → PRP

VP → VB

VP → VB PRP

VP → MD VP

"Lexicon"

PRP → I

PRP → you

VB → know

VB → help

MD → can

A grammar can be *learned* from data (demo)

Left-Corner Parsing Builds Trees For Sentences

```
parse_next(S, 1)
```

```
complete(S, (PRP i), 1)
```

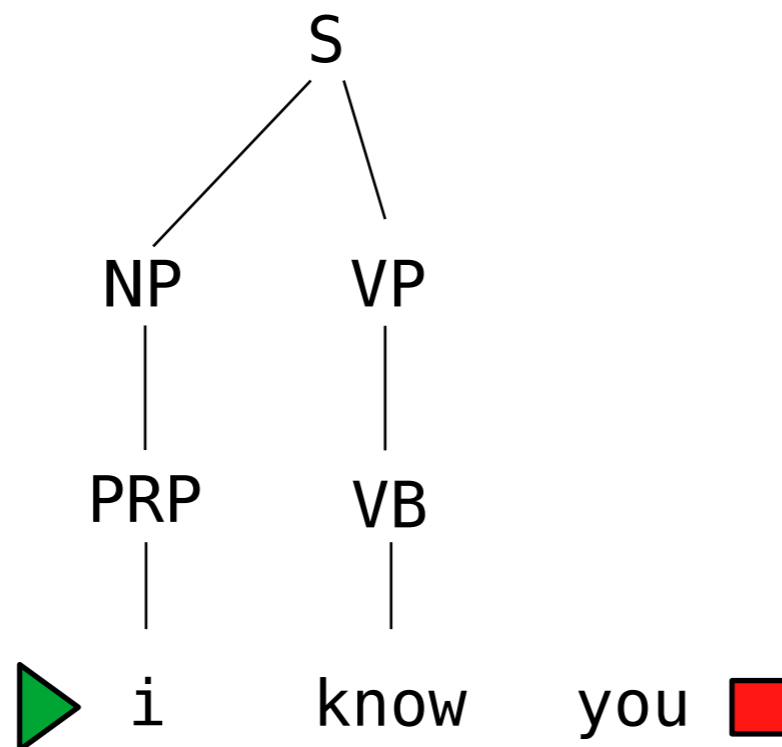
```
complete(S, (NP (PRP i)), 1)
```

```
parse_next(VP, 2)
```

```
complete(VP, (VB know), 2)
```

```
complete(VP, (VP (VB know)), 2)
```

```
complete(S, (S ...), 1)
```



"Grammar"

S → NP VP

NP → PRP

VP → VB

VP → VB PRP

Left corners

"Lexicon"

PRP → I

PRP → you

VB → know

VB → help

Left-Corner Parsing Builds Trees For Sentences

parse_next(S, 1)

complete(S, (PRP i), 1)

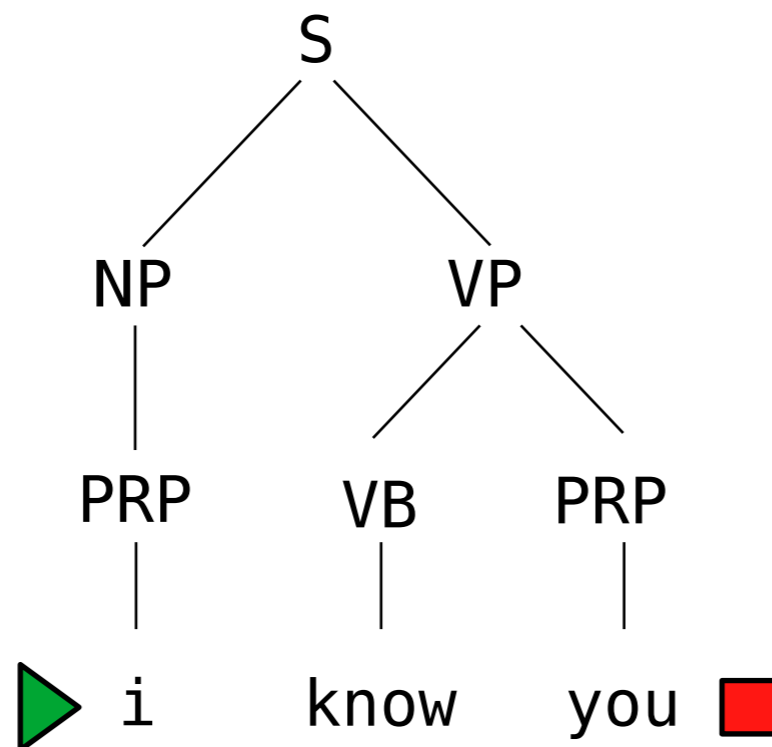
complete(S, (NP (PRP i)), 1)

parse_next(VP, 2)

complete(VP, (VB know), 2)

complete(VP, (VP (VB know) (PRP you)), 2)

complete(S, (S ...), 1)



"Grammar"

S → NP VP

NP → PRP

VP → VB

VP → VB PRP

Left corners

"Lexicon"

PRP → I

PRP → you

VB → know

VB → help