Parsing Practice

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1 Parsing

Consider the following CFG.

S → NP VP
NP → NP Poss N
NP → D N
VP → V (NP) (PP)
PP → P NP

N → boy, girl
NP → Mary, paella, Spain
V → met, ate
D → the
P → on, in

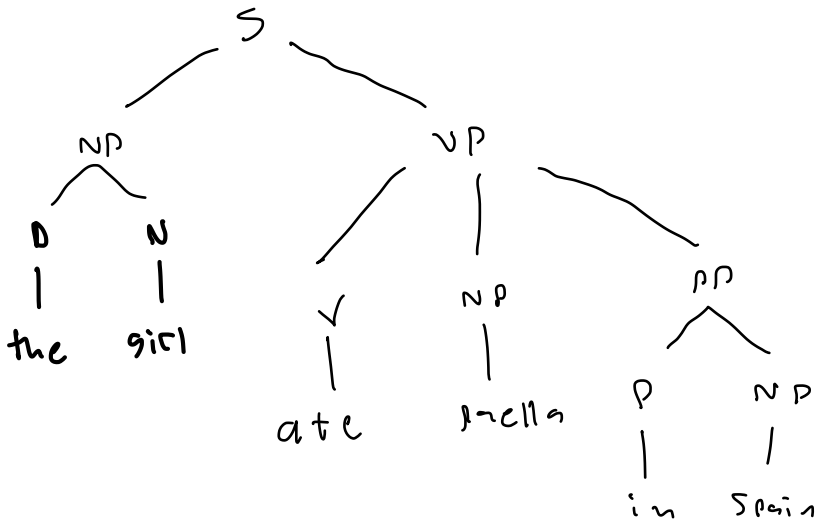
Complete the following parsing tables with the steps for the bottom-up, top-down, and left-corner parse of "the girl ate paella in Spain." See the lecture handout for examples.

2 Bottom-up parsing

Bottom-up parsing schema

- Starting configuration: $(\epsilon, x_1 \dots x_n)$
  where $x_1 \dots x_n$ is the input
- SHIFT step: $(\Phi, x_i x_{i+1} \dots x_n) \Rrightarrow (\Phi A, x_{i+1} \dots x_n)$
  where there is a rule $A \to x_i$ in the grammar
- REDUCE step: $(\Phi B_1 \dots B_m, x_i \dots x_n) \Rrightarrow (\Phi A, x_i \dots x_n)$
  where there is a rule $A \to B_1 \dots B_m$ in the grammar
- Goal configuration: (A, ϵ)
  where A is one of the grammar's start symbols

	Type of transition	Rule used	Configuration
0	-	-	(ϵ, the girl ate paella in Spain)
1	shift	D → the	(D, girl ate paella in Spain)
2	shift	N → girl	(D N, ate paella in Spain)
3	Reduce	NP → D N	(NP, ate paella in Spain)
4	shift	V → ate	(NP V, paella in Spain)
5	shift	NP → paella	(NP V NP, in Spain)
6	shift	P → in	(NP V NP P, Spain)
7	shift	NP → Spain	(NP V NP P NP, eps)
8	reduce	PP → P NP	(NP V NP PP, eps)
9	reduce	VP → V NP PP	(NP VP, eps)
10	reduce	S → NP VP	(S, ϵ)

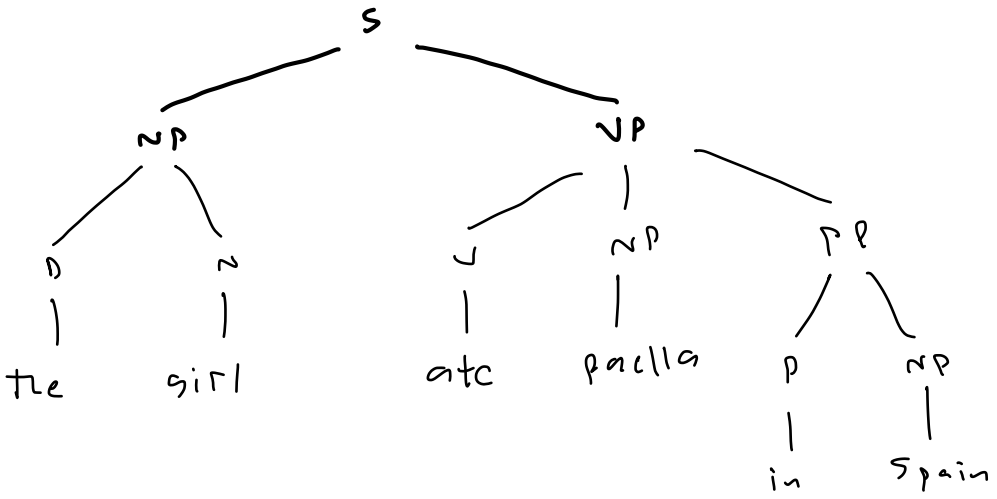


3 Top-down parsing

Top-down parsing schema

- Starting configuration: $(A, x_1 \dots x_n)$
  where A is one of the grammar's start symbols and $x_1 \dots x_n$ is the input
- PREDICT step: $(A\Phi, x_i \dots x_n) \Rrightarrow (B_1 \dots B_m \Phi, x_i \dots x_n)$
  where there is a rule $A \to B_1 \dots B_m$ in the grammar
- MATCH step: $(A\Phi, x_i x_{i+1} \dots x_n) \Rrightarrow (\Phi, x_{i+1} \dots x_n)$
  where there is a rule $A \to x_i$ in the grammar
- Goal configuration: (ϵ, ϵ)

	Type of transition	Rule used	Configuration
0	-	-	(S, the girl ate paella in Spain)
1	predict	S → NP VP	(NP VP, the girl ate paella in Spain)
2	predict	NP → D N	(D N VP, the girl ate paella in Spain)
3	match	D → the	(N VP, girl ate paella in Spain)
4	match	N → girl	(VP, ate paella in Spain)
5	predict	VP → V NP PP	(V NP PP, ate paella in Spain)
6	match	V → ate	(NP PP, paella in Spain)
7	match	NP → paella	(PP, in Spain)
8	predict	PP → P NP	(P NP, in Spain)
9	match	P → in	(NP, Spain)
10	match	NP → Spain	(ϵ, ϵ)



4 Left-corner parsing

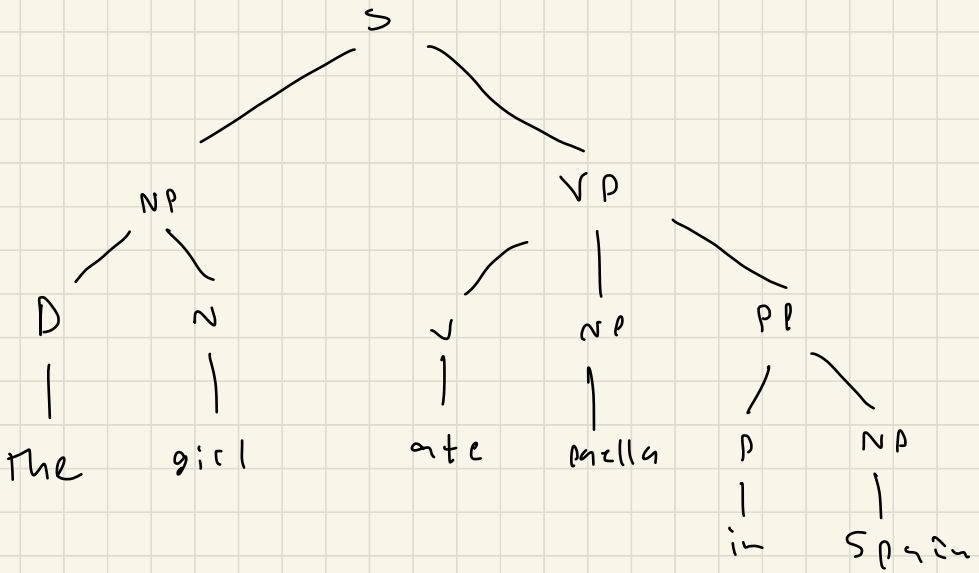
Left-corner parsing schema

- Starting configuration: $(\overline{A}, x_1 \dots x_n)$
  where A is one of the grammar's start symbols and $x_1 \dots x_n$ is the input
- SHIFT step: $(\Phi, x_i x_{i+1} \dots x_n) \Rrightarrow (A\Phi, x_{i+1} \dots x_n)$
  where there is a rule $A \to x_i$ in the grammar
- MATCH step: $(\overline{A}\Phi, x_i x_{i+1} \dots x_n) \Rrightarrow (\Phi, x_{i+1} \dots x_n)$
  where there is a rule $A \to x_i$ in the grammar
- LC-PREDICT step: $(B_1\Phi, x_i \dots x_n) \Rrightarrow (\overline{B_2} \dots \overline{B_m} A\Phi, x_i \dots x_n)$
  where there is a rule $A \to B_1 \dots B_m$ in the grammar
- LC-CONNECT step: $(B_1\overline{A}\Phi, x_i \dots x_n) \Rrightarrow (\overline{B_2} \dots \overline{B_m}\Phi, x_i \dots x_n)$
  where there is a rule $A \to B_1 \dots B_m$ in the grammar
- Goal configuration: (ϵ, ϵ)

The way I like to think about it: X means you have parsed/found an X. $\overline{\text{X}}$ means you want/are looking for an X. Thus:

- SHIFT creates an X; you've found an X in the beginning of the string
- MATCH removes an $\overline{\text{X}}$; you were looking for an X and you found it in the beginning of the string
- LC-PREDICT, using a rule A → B C…D, removes a B from the stack, and adds $\overline{\text{C}}$…$\overline{\text{D}}$ A to the stack. That is, you already found a B before, and if you can find a C, …, D, etc. you'll know you've found an A.
- LC-CONNECT works in a similar way, given a rule A → B C…D. You have a B and you're looking for an $\overline{\text{A}}$. You can get the A you're looking for by using your B, as long as you find additional C…D. So now all you are looking for is that C …D.

	Type of transition	Rule used	Configuration
0	-	-	($\overline{\text{S}}$, the girl ate paella in Spain)
1	shift	D → the	(D $\overline{\text{S}}$, girl ate paella in Spain)
2	LC-predict	NP → D N	($\overline{\text{N}}$ NP $\overline{\text{S}}$, girl ate paella in Spain)
3	match	N → girl	(NP $\overline{\text{S}}$, ate paella in Spain)
4	LC-connect	S → NP VP	($\overline{\text{VP}}$, ate paella in Spain)
5	shift	V → ate	(V $\overline{\text{VP}}$, paella in Spain)
6	LC-connect	VP → V NP PP	($\overline{\text{NP}}$ $\overline{\text{PP}}$, paella in Spain)
7	match	NP → paella	($\overline{\text{PP}}$, in Spain)
8	shift	P → in	(P, $\overline{\text{PP}}$, Spain)
9	LC-connect	PP → P NP	($\overline{\text{NP}}$, Spain)
10	match	NP → Spain	(ϵ, ϵ)


S
NP
VP
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PP
The
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P
NP
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Spain