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LING 185A HW #0607
Section 1B

1. Stack depth and different embedding structures

(1) Left-branching structures
a. John's dog barked

	Type of Step	Rule used	Configuration
0	—	—	($\overline{S}$, John's dog barked)
1	SHIFT	NP → John	(NP $\overline{S}$, 's dog barked)
2	LC-PREDICT	NP → NP POSS N	($\overline{POSS}\ \overline{N}\ NP\ \overline{S}$, 's dog barked)
3	MATCH	POSS → 's	($\overline{N}\ NP\ \overline{S}$, dog barked)
4	MATCH	N → dog	($NP\ \overline{S}$, barked)
5	LC-CONNECT	S → NP VP	($\overline{VP}$, barked)
6	SHIFT	V → barked	($V\ \overline{VP}$, ϵ)
7	LC-CONNECT	VP → V	(ϵ,ϵ)

The largest number of nonterminal symbols on the stack in this parsing is 4.

c. John's brother's wife's dog barked

	Type of Step	Rule used	Configuration
0	—	—	($\overline{S}$, John's brother's wife's dog barked)
1	SHIFT	NP → John	(NP $\overline{S}$, 's brother's wife's dog barked)
2	LC-PREDICT	NP → NP POSS N	($\overline{POSS}\ \overline{N}\ NP\ \overline{S}$, 's brother's wife's dog barked)
3	MATCH	POSS → 's	($\overline{N}\ NP\ \overline{S}$, brother's wife's dog barked)

4	MATCH	N → brother	($NP\ \overline{S}$, ‘s wife’s dog barked)
5	LC-PREDICT	NP → NP POSS N	($\overline{POSS}\ \overline{N}\ NP\ \overline{S}$, ‘s wife’s dog barked)
6	MATCH	POSS → ‘s	($\overline{N}\ NP\ \overline{S}$, wife’s dog barked)
7	MATCH	N → wife	($NP\ \overline{S}$, ‘s dog barked)
8	LC-PREDICT	NP → NP POSS N	($\overline{POSS}\ \overline{N}\ NP\ \overline{S}$, ‘s dog barked)
9	MATCH	POSS → ‘s	($\overline{N}\ NP\ \overline{S}$, dog barked)
10	MATCG	N → dog	($NP\ \overline{S}$, barked)
11	LC-CONNECT	S → NP VP	($\overline{VP}$, barked)
12	SHIFT	V → barked	($V\ \overline{VP}$, ϵ)
13	LC-CONNECT	VP → V	(ϵ,ϵ)

The largest number of nonterminal symbols on the stack in this parsing is 4. Thus, for left-branching structures, left-corner parsing has a normal load.

(2) Right-branching structures
a. Mary chased the cat

	Type of Step	Rule used	Configuration
0	—	—	($\overline{S}$, Mary chased the cat)
1	SHIFT	NP → Mary	(NP $\overline{S}$, chased the cat)
2	LC-CONNECT	S → NP VP	($\overline{VP}$, chased the cat)
3	SHIFT	V → chased	($V\ \overline{VP}$, the cat)
4	LC-CONNECT	VP → V NP	($\overline{NP}$, the cat)
5	SHIFT	D → the	($D\ \overline{NP}$, cat)

6	LC-CONNECT	NP → D N	($\overline{N}$, cat)
7	MATCH	N → cat	(ϵ,ϵ)

The largest number of nonterminal symbols on the stack in this parsing is 2.

c. Mary chased the cat that bit the rat that ate the cheese

	Type of Step	Rule used	Configuration
0	—	—	($\overline{S}$, Mary chased the cat that bit the rat that ate the cheese)
1	SHIFT	NP → Mary	(NP $\overline{S}$, chased the cat that bit the rat that ate the cheese)
2	LC-CONNECT	S → NP VP	($\overline{VP}$, chased the cat that bit the rat that ate the cheese)
3	SHIFT	V → chased	(V $\overline{VP}$, the cat that bit the rat that ate the cheese)
4	LC-CONNECT	VP → V NP	($\overline{NP}$, the cat that bit the rat that ate the cheese)
5	SHIFT	D → the	(D $\overline{NP}$, cat that bit the rat that ate the cheese)
6	LC-CONNECT	NP → D N SRC	($\overline{N}$ $\overline{SRC}$, cat that bit the rat that ate the cheese)
7	MATCH	N → cat	($\overline{SRC}$, that bit the rat that ate the cheese)
8	SHIFT	THAT → that	($THAT$ $\overline{SRC}$, bit the rat that ate the cheese)
9	LC-CONNECT	SRC → THAT VP	($\overline{VP}$, bit the rat that ate the cheese)
10	SHIFT	V → bit	(V $\overline{VP}$, the rat that ate the cheese)
11	LC-CONNECT	VP → V NP	($\overline{NP}$, the rat that ate the cheese)
12	SHIFT	D → the	(D $\overline{NP}$, rat that ate the cheese)
13	LC-CONNECT	NP → D N SRC	($\overline{N}$ $\overline{SRC}$, rat that ate the cheese)
14	MATCH	N → rat	($\overline{SRC}$, that ate the cheese)

15	SHIFT	THAT → that	($THAT\ \overline{SRC}$, ate the cheese)
16	LC-CONNECT	SRC → THAT VP	($\overline{VP}$, ate the cheese)
17	SHIFT	V → ate	($V\ \overline{VP}$, the cheese)
18	LC-CONNECT	VP → V NP	($\overline{NP}$, the cheese)
19	SHIFT	D → the	($D\ \overline{NP}$, cheese)
20	LC-CONNECT	NP → D N	($\overline{N}$, cheese)
21	MATCH	N → cheese	(ϵ,ϵ)

The largest number of nonterminal symbols on the stack in this parsing is 2. Thus, for right-branching structures, left-corner parsing has a normal load.

(3) Center-embedding structures
a. the rat fled

	Type of Step	Rule used	Configuration
0	—	—	($\overline{S}$, the rat fled)
1	SHIFT	D → the	(D $\overline{S}$, rat fled)
2	LC-PREDICT	NP → D N	($\overline{N}\ NP\ \overline{S}$, rat fled)
3	MATCH	N → rat	($NP\ \overline{S}$, fled)
4	LC-CONNECT	S → NP VP	($\overline{VP}$, fled)
5	SHIFT	V → fled	($V\ \overline{VP}$, ϵ)
6	LC-CONNECT	VP → V	(ϵ,ϵ)

The largest number of nonterminal symbols on the stack in this parsing is 3.

c. the rat the cat the dog bit chased fled

	Type of Step	Rule used	Configuration
0	—	—	($\overline{S}$, the rat the cat the dog bit chased fled)
1	SHIFT	D $\rightarrow$ the	(D $\overline{S}$, rat the cat the dog bit chased fled)
2	LC-PREDICT	NP $\rightarrow$ D N ORC	($\overline{N}\ \overline{ORC}\ NP\ \overline{S}$, rat the cat the dog bit chased fled)
3	MATCH	N $\rightarrow$ rat	($\overline{ORC}\ NP\ \overline{S}$, the cat the dog bit chased fled)
4	SHIFT	D $\rightarrow$ the	(D $\overline{ORC}\ NP\ \overline{S}$, cat the dog bit chased fled)
5	LC-PREDICT	NP $\rightarrow$ D N ORC	($\overline{N}\ \overline{ORC}\ NP\ \overline{ORC}\ NP\ \overline{S}$, cat the dog bit chased fled)
6	MATCH	N $\rightarrow$ cat	($\overline{ORC}\ NP\ \overline{ORC}\ NP\ \overline{S}$, the dog bit chased fled)
7	SHIFT	D $\rightarrow$ the	(D $\overline{ORC}\ NP\ \overline{ORC}\ NP\ \overline{S}$, dog bit chased fled)
8	LC-PREDICT	NP $\rightarrow$ D N	($\overline{N}$ NP $\overline{ORC}\ NP\ \overline{ORC}\ NP\ \overline{S}$, dog bit chased fled)
9	MATCH	N $\rightarrow$ dog	(NP $\overline{ORC}\ NP\ \overline{ORC}\ NP\ \overline{S}$, bit chased fled)
10	LC-CONNECT	ORC $\rightarrow$ NP V	($\overline{V}\ NP\ \overline{ORC}\ NP\ \overline{S}$, bit chased fled)
11	MATCH	V $\rightarrow$ bit	($NP\ \overline{ORC}\ NP\ \overline{S}$, chased fled)
12	LC-CONNECT	ORC $\rightarrow$ NP V	($\overline{V}\ NP\ \overline{S}$, chased fled)
13	MATCH	V $\rightarrow$ chased	($NP\ \overline{S}$, fled)
14	LC-CONNECT	S $\rightarrow$ NP VP	($\overline{VP}$, fled)
15	SHIFT	V $\rightarrow$ fled	($V\ \overline{VP}$, ϵ)
16	LC-CONNECT	VP $\rightarrow$ V	(ϵ,ϵ)

The largest number of nonterminal symbols on the stack in this parsing is 7. Thus, for center-embedding structures, left-corner parsing has a higher load.

2. More on stack depth

Firstly, I want to apply the bottom-up parsing to (6d) using Hypothesis #1.

(6d). * John said slowly John said loudly Mary said quietly John ate

	Type of Step	Rule used	Configuration
0	—	—	(ϵ, John said slowly John said loudly Mary said quietly John ate)
1	SHIFT	NP → John	(NP, said slowly John said loudly Mary said quietly John ate)
2	SHIFT	SAID → said	(NP SAID, slowly John said loudly Mary said quietly John ate)
3	SHIFT	ADV → slowly	(NP SAID ADV, John said loudly Mary said quietly John ate)
4	SHIFT	NP → John	(NP SAID ADV NP, said loudly Mary said quietly John ate)
5	SHIFT	SAID → said	(NP SAID ADV NP SAID, loudly Mary said quietly John ate)
6	SHIFT	ADV → loudly	(NP SAID ADV NP SAID ADV, Mary said quietly John ate)
7	SHIFT	NP → Mary	(NP SAID ADV NP SAID ADV NP, said quietly John ate)
8	SHIFT	SAID → said	(NP SAID ADV NP SAID ADV NP SAID, quietly John ate)
9	SHIFT	ADV → quietly	(NP SAID ADV NP SAID ADV NP SAID ADV, John ate)
10	SHIFT	NP → John	(NP SAID ADV NP SAID ADV NP SAID ADV NP, ate)
11	SHIFT	V → ate	(NP SAID ADV NP SAID ADV NP SAID ADV NP V, ϵ)
12	REDUCE	VP → V	(NP SAID ADV NP SAID ADV NP SAID ADV NP VP, ϵ)

13	REDUCE	S $\rightarrow$ NP VP	(NP SAID ADV NP SAID ADV NP SAID ADV S, ϵ)
14	REDUCE	VP $\rightarrow$ SAID ADV S	(NP SAID ADV NP SAID ADV NP VP, ϵ)
15	REDUCE	S $\rightarrow$ NP VP	(NP SAID ADV NP SAID ADV S, ϵ)
16	REDUCE	VP $\rightarrow$ SAID ADV S	(NP SAID ADV NP VP, ϵ)
17	REDUCE	S $\rightarrow$ NP VP	(NP SAID ADV S, ϵ)
18	REDUCE	VP $\rightarrow$ SAID ADV S	(NP VP, ϵ)
19	REDUCE	S $\rightarrow$ NP VP	(S, ϵ)

From above, we can see that the highest number of nonterminal symbol on the stack is 11 since only when we shift to the very end can we start to reduce the stack.

Using hypothesis #2, we have:

	Type of Step	Rule used	Configuration
0	—	—	(ϵ, John said slowly John said loudly Mary said quietly John ate)
1	SHIFT	NP $\rightarrow$ John	(NP, said slowly John said loudly Mary said quietly John ate)
2	SHIFT	SAID $\rightarrow$ said	(NP SAID, slowly John said loudly Mary said quietly John ate)
3	SHIFT	ADV $\rightarrow$ slowly	(NP SAID ADV, John said loudly Mary said quietly John ate)
4	REDUCE	X $\rightarrow$ SAID ADV	(NP X, John said loudly Mary said quietly John ate)
5	SHIFT	NP $\rightarrow$ John	(NP X NP, said loudly Mary said quietly John ate)
6	SHIFT	SAID $\rightarrow$ said	(NP X NP SAID, loudly Mary said quietly John ate)
7	SHIFT	ADV $\rightarrow$ loudly	(NP X NP SAID ADV, Mary said quietly John ate)
8	REDUCE	X $\rightarrow$ SAID ADV	(NP X NP X, Mary said quietly John ate)
9	SHIFT	NP $\rightarrow$ Mary	(NP X NP X NP, said quietly John ate)

10	SHIFT	SAID $\rightarrow$ said	(NP X NP X NP SAID, quietly John ate)
11	SHIFT	ADV $\rightarrow$ quietly	(NP X NP X NP SAID ADV, John ate)
12	REDUCE	X $\rightarrow$ SAID ADV	(NP X NP X NP X, John ate)
13	SHIFT	NP $\rightarrow$ John	(NP X NP X NP X NP, ate)
14	SHIFT	V $\rightarrow$ ate	(NP X NP X NP X NP V, ϵ)
15	REDUCE	VP $\rightarrow$ V	(NP X NP X NP X NP VP, ϵ)
16	REDUCE	S $\rightarrow$ NP VP	(NP X NP X NP X S, ϵ)
17	REDUCE	VP $\rightarrow$ X S	(NP X NP X NP VP, ϵ)
18	REDUCE	S $\rightarrow$ NP VP	(NP X NP X S, ϵ)
19	REDUCE	VP $\rightarrow$ X S	(NP X NP VP, ϵ)
20	REDUCE	S $\rightarrow$ NP VP	(NP X S, ϵ)
21	REDUCE	VP $\rightarrow$ X S	(NP VP, ϵ)
22	REDUCE	S $\rightarrow$ NP VP	(S, ϵ)

From above, we can see that the highest number of nonterminal symbol on the stack is 8, which is less than what we have in hypothesis #1. Also, we know that there is a memory limitation on the stack. Hence, choosing from hypothesis #1 and #2, hypothesis #2 would be the correct assumption since it uses less memory space in the stack.

3. Stack depth and different embedding structures

A. FSA Parsing for the string 'aaaacbbbb'

	Type of Step	Rule used	Configuration
0	—	—	(0A, aaaacbbbb)
1	CONSUME	$0\mathrm{A} \xrightarrow{a} 1A$	$(1\mathrm{A}$, aaacbbbb)

2	CONSUME	$1\mathrm{A} \xrightarrow{a} 2A$	(2A, aacbbbb)
3	CONSUME	$2\mathrm{A} \xrightarrow{a} 3A$	(3A, acbbbb)
4	CONSUME	$3\mathrm{A} \xrightarrow{a} 4A$	(4A, cbbbb)
5	CONSUME	$4\mathrm{A} \xrightarrow{c} 4B$	(4B, bbbb)
6	CONSUME	$4\mathrm{B} \xrightarrow{b} 3B$	(3B, bbb)
7	CONSUME	$3\mathrm{B} \xrightarrow{b} 2B$	(2B, bb)
8	CONSUME	$2\mathrm{B} \xrightarrow{b} 1B$	(1B, b)
9	CONSUME	$1\mathrm{B} \xrightarrow{b} 0B$	(0B, ϵ)

B. top-down parsing for the string ‘aaaacbbbb’

	Type of Step	Rule used	Configuration
0	—	—	(S, aaaacbbbb)
1	PREDICT	S → A S B	(A S B, aaaacbbbb)
2	MATCH	A → a	(S B, aaacbbbb)
3	PREDICT	S → A S B	(A S B B, aaacbbbb)
4	MATCH	A → a	(S B B, aacbbbb)
5	PREDICT	S → A S B	(A S B B B, aaacbbbb)
6	MATCH	A → a	(S B B, acbbbb)
7	PREDICT	S → A S B	(A S B B B B, acbbbb)
8	MATCH	A → a	(S B B B B, cbbbb)
9	PREDICT	S → C	(C B B B B, cbbbb)
10	MATCH	C → c	(B B B B, bbbb)
11	MATCH	B → b	(B B B, bbb)

12	MATCH	$B \to b$	(B B, bb)
13	MATCH	$B \to b$	(B, b)
14	MATCH	$B \to b$	(ϵ, ϵ)

C. bottom-up parsing for the string ‘aaaacbbbb’

	Type of Step	Rule used	Configuration
0	—	—	(ϵ, aaaacbbbb)
1	SHIFT	$A \to a$	(A, aaacbbbb)
2	SHIFT	$A \to a$	(A A, aacbbbb)
3	SHIFT	$A \to a$	(A A A, acbbbb)
4	SHIFT	$A \to a$	(A A A A, cbbbb)
5	SHIFT	$C \to c$	(A A A A C, bbbb)
6	MATCH	$S \to C$	(A A A A S, bbbb)
7	SHFIT	$B \to b$	(A A A A S B, bbb)
8	REDUCE	$S \to A\ S\ B$	(A A A S, bbb)
9	SHFIT	$B \to b$	(A A A S B, bb)
10	REDUCE	$S \to A\ S\ B$	(A A S, bb)
11	SHFIT	$B \to b$	(A A S B, b)
12	REDUCE	$S \to A\ S\ B$	(A S, b)
13	SHFIT	$B \to b$	(A S B, ϵ)
14	REDUCE	$S \to A\ S\ B$	(S, ϵ)

D. left-corner parsing for the string ‘aaaacbbbb’

	Type of Step	Rule used	Configuration
0	—	—	($\overline{S}$, aaaacbbbb)
1	SHIFT	A $\rightarrow$ a	($A\ \overline{S}$, aaacbbbb)
2	LC-CONNECT	S $\rightarrow$ A S B	($\overline{S}\ \overline{B}$, aaacbbbb)
3	SHIFT	A $\rightarrow$ a	(A $\overline{S}\ \overline{B}$, aacbbbb)
4	LC-CONNECT	S $\rightarrow$ A S B	($\overline{S}\ \overline{B}\ \overline{B}$, aacbbbb)
5	SHIFT	A $\rightarrow$ a	(A $\overline{S}\ \overline{B}\ \overline{B}$, acbbbb)
6	LC-CONNECT	S $\rightarrow$ A S B	($\overline{S}\ \overline{B}\ \overline{B}\ \overline{B}$, acbbbb)
7	SHIFT	A $\rightarrow$ a	(A $\overline{S}\ \overline{B}\ \overline{B}\ \overline{B}$, cbbbb)
8	LC-CONNECT	S $\rightarrow$ A S B	($\overline{S}\ \overline{B}\ \overline{B}\ \overline{B}\ \overline{B}$, cbbbb)
9	SHIFT	C $\rightarrow$ c	(C $\overline{S}\ \overline{B}\ \overline{B}\ \overline{B}\ \overline{B}$, bbbb)
10	LC-CONNECT	S $\rightarrow$ C	($\overline{B}\ \overline{B}\ \overline{B}\ \overline{B}$, bbbb)
11	MATCH	B $\rightarrow$ b	($\overline{B}\ \overline{B}\ \overline{B}$, bbb)
12	MATCH	B $\rightarrow$ b	($\overline{B}\ \overline{B}$, bb)
13	MATCH	B $\rightarrow$ b	($\overline{B}$, b)
14	MATCH	B $\rightarrow$ b	(ϵ, ϵ)