Assignment 7

1A:

Top-down

Center embedded

$_0$The $_1$ actor $_2$ the $_3$ boy $_4$ met $_5$ won $_6$

	Step Type	Rule	Configuration
0	--	--	(S, 0)
1	PREDICT	S → NP VP	(NP VP, 0)
2	PREDICT	NP → D N ORC	(D N ORC VP, 0)
3	MATCH	D → the	(N ORC VP, 1)
4	MATCH	N → actor	(ORC VP, 2)
5	PREDICT	ORC → NP V	(NP V VP, 2)
6	PREDICT	NP → D N	(D N V VP, 2)
7	MATCH	D → the	(N V VP, 3)
8	MATCH	N → boy	(V VP, 4)
9	MATCH	V → met	(VP, 5)
10	PREDICT	VP → V	(V, 5)
11	MATCH	V → won	(ϵ, 6)

$_0$The $_1$ actor $_2$ the $_3$ boy $_4$ the $_5$ baby $_6$ saw $_7$ met $_8$ won $_9$

	Step Type	Rule	Configuration
0	--	--	(S, 0)
1	PREDICT	S → NP VP	(NP VP, 0)
2	PREDICT	NP → D N ORC	(D N ORC VP, 0)
3	MATCH	D → the	(N ORC VP, 1)
4	MATCH	N → actor	(ORC VP, 2)
5	PREDICT	ORC → NP V	(NP V VP, 2)
6	PREDICT	NP → D N ORC	(D N ORC V VP, 2)
7	MATCH	D → the	(N ORC V VP, 3)
8	MATCH	N → boy	(ORC V VP, 4)
9	PREDICT	ORC → NP V	(NP V V VP, 4)
10	PREDICT	NP → D N	(D N V V VP, 4)
11	MATCH	D → the	(N V V VP, 5)
12	MATCH	N → baby	(V V VP, 6)
13	MATCH	V → saw	(V VP, 7)
14	MATCH	V → met	(VP, 8)

15	PREDICT	VP → V	(V, 8)
16	MATCH	V → won	(ϵ, 9)

Max stack size: 4 → 5; increase

Left Corner

Left embedded

$_0$Mary $_1$ ’s $_2$ baby $_3$ won $_4$

	Step Type	Rule	Configuration
0	--	--	($\overline{S}$, 0)
1	SHIFT	NP → Mary	(NP $\overline{S}$, 1)
2	LC PREDICT	NP → NP POSS N	($\overline{P}\overline{O}\overline{S}\overline{S}$ $\overline{N}$ NP $\overline{S}$, 1)
3	MATCH	POSS → ‘s	($\overline{N}$ NP $\overline{S}$, 2)
4	MATCH	N → baby	(NP $\overline{S}$, 3)
5	LC CONNECT	S → NP VP	($\overline{V}\overline{P}$, 3)
6	SHIFT	V → won	(V $\overline{V}\overline{P}$, 4)
7	CONNECT	VP → V	(ϵ, 4)

$_0$Mary$_1$’s $_2$ boss $_3$ ’s $_4$ baby $_5$ won $_6$

	Step Type	Rule	Configuration
0	--	--	($\overline{S}$, 0)
1	SHIFT	NP → Mary	(NP $\overline{S}$, 1)
2	LC PREDICT	NP → NP POSS N	($\overline{P}\overline{O}\overline{S}\overline{S}$ $\overline{N}$ NP $\overline{S}$, 1)
3	MATCH	POSS → ‘s	($\overline{N}$ NP $\overline{S}$, 2)
4	MATCH	N → boss	(NP $\overline{S}$, 3)
5	LC PREDICT	NP → NP POSS N	($\overline{P}\overline{O}\overline{S}\overline{S}$ $\overline{N}$ NP $\overline{S}$, 3)
6	MATCH	POSS → ‘s	($\overline{N}$ NP $\overline{S}$, 4)
7	MATCH	N → baby	(NP $\overline{S}$, 5)
8	LC CONNECT	S → NP VP	($\overline{V}\overline{P}$, 5)
9	SHIFT	V → won	(V $\overline{V}\overline{P}$, 6)
10	LC CONNECT	VP → V	(ϵ, 6)

Max stack size: 4 → 4; no increase

Right embedded

$_0$John $_1$ met $_2$ the $_3$ boy $_4$ that $_5$ saw $_6$ the $_7$ actor $_8$

	Step Type	Rule	Configuration
0	---	---	($\overline{S}$, 0)

1	SHIFT	NP → John	(NP $\overline{S}$, 1)
2	LC CONNECT	S → NP VP	($\overline{V}\overline{P}$, 1)
3	SHIFT	V → met	(V $\overline{V}\overline{P}$, 2)
4	LC CONNECT	VP → V NP	($\overline{N}\overline{P}$, 2)
5	SHIFT	D → the	(D $\overline{N}\overline{P}$, 3)
6	LC CONNECT	NP → D N SRC	($\overline{N}$ $\overline{S}\overline{R}\overline{C}$, 3)
7	MATCH	N → boy	($\overline{S}\overline{R}\overline{C}$, 4)
8	SHIFT	THAT → that	(THAT $\overline{S}\overline{R}\overline{C}$, 5)
9	LC CONNECT	SRC → THAT VP	($\overline{V}\overline{P}$, 5)
10	SHIFT	V → saw	(V $\overline{V}\overline{P}$, 6)
11	LC CONNECT	VP → V NP	($\overline{N}\overline{P}$, 6)
12	SHIFT	D → the	(D $\overline{N}\overline{P}$, 7)
13	LC CONNECT	NP → D N	($\overline{N}$, 7)
14	MATCH	N → actor	(ϵ, 8)

$_0$John $_1$ met $_2$ the $_3$ boy $_4$ that $_5$ saw $_6$ the $_7$ actor $_8$ that $_9$ won $_{10}$ the $_{11}$ award $_{12}$

	Step Type	Rule	Configuration
0	---	---	($\overline{S}$, 0)
13	LC CONNECT	NP → D N SRC	($\overline{N}$ $\overline{S}\overline{R}\overline{C}$, 7)
14	MATCH	N → actor	($\overline{S}\overline{R}\overline{C}$, 8)
15	SHIFT	THAT → that	(THAT $\overline{S}\overline{R}\overline{C}$, 9)
16	LC CONNECT	SRC → THAT VP	($\overline{V}\overline{P}$, 9)
17	SHIFT	V → won	(V $\overline{V}\overline{P}$, 10)
18	LC CONNECT	VP → V NP	($\overline{N}\overline{P}$, 10)
19	SHIFT	D → the	(D $\overline{N}\overline{P}$, 11)
20	LC CONNECT	NP → D N	($\overline{N}$, 11)
21	MATCH	N → award	(ϵ, 12)

Max stack size: 2 → 2; no increase

Center embedded

$_0$the $_1$ actor $_2$ the $_3$ boy $_4$ met $_5$ won $_6$

	Step Type	Rule	Configuration
0	--	--	($\overline{S}$, 0)
1	SHIFT	D → the	(D $\overline{S}$, 1)
2	LC PREDICT	NP → D N ORC	($\overline{N}$ $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 1)
3	MATCH	N → actor	($\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 2)
4	SHIFT	D → the	(D $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 3)
5	*LC PREDICT	NP → D N	($\overline{N}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 3)

6	MATCH	N → boy	(NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 4)
7	LC CONNECT	ORC → NP V	($\bar{V}$ NP $\bar{S}$, 4)
8	MATCH	V → met	(NP $\bar{S}$, 5)
9	LC CONNECT	S → NP VP	($\bar{V}\bar{P}$, 5)
10	SHIFT	V → won	(V $\bar{V}\bar{P}$, 6)
11	CONNECT	VP → V	(ϵ, 6)

$_0$the $_1$ actor $_2$ the $_3$ boy $_4$ the $_5$ baby $_6$ saw $_7$ met $_8$ won $_9$

	Step Type	Rule	Configuration
0	SAME STEPS UNTIL (NOT INCLUDING)*LC PREDICT		
1	SHIFT	D → the	(D $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 3)
2	LC PREDICT	NP → D N ORC	($\bar{N}$ $\bar{O}\bar{R}\bar{C}$ NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 3)
3	MATCH	N → boy	($\bar{O}\bar{R}\bar{C}$ NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 4)
4	SHIFT	D → the	(D $\bar{O}\bar{R}\bar{C}$ NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 5)
5	LC PREDICT	NP → D N	($\bar{N}$ NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 5)
6	MATCH	N → baby	(NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 6)
7	LC CONNECT	ORC → NP V	($\bar{V}$ NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 6)
8	MATCH	V → saw	(NP $\bar{O}\bar{R}\bar{C}$ NP $\bar{S}$, 7)
9	LC CONNECT	ORC → NP V	($\bar{V}$ NP $\bar{S}$, 6)
10	MATCH	V → saw	(NP $\bar{S}$, 7)
11	LC CONNECT	S → NP VP	($\bar{V}\bar{P}$, 8)
12	SHIFT	V → won	(V $\bar{V}\bar{P}$, 9)
13	CONNECT	VP → V	(ϵ, 9)

Max stack size: 5 → 7; increase

1B

Based on the parsing below, arc-standard left-corner is not the best parser for right embedded and center embedded structures, since it requires a nonterminal and all its constituents to be parsed before the stack can begin to reduce. It is the worst for right embedded sentences and best for left embedded.

1b: $_0$Mary$_1$'s $_2$ baby $_3$ won $_4$

	Step Type	Rule	Configuration
0	---	---	($\bar{S}$, 0)
1	SHIFT	NP → Mary	(NP $\bar{S}$, 1)
2	LC PREDICT	NP → NP POSS N	($\bar{P}\bar{O}\bar{S}\bar{S}$ $\bar{N}$ NP $\bar{S}$, 1)
3	MATCH	POSS → 's	($\bar{N}$ NP $\bar{S}$, 2)
4	MATCH	N → baby	(NP $\bar{S}$, 3)
5	LC PREDICT	S → NP VP	($\bar{V}\bar{P}$ S $\bar{S}$, 3)
6	SHIFT	V → won	(V $\bar{V}\bar{P}$ S $\bar{S}$, 4)

7	PREDICT	VP → V	(VP $\overline{V}\overline{P}$ S $\overline{S}$, 4)
8	CANCEL		(S $\overline{S}$, 4)
9	CANCEL		(ϵ, 4)

1c: $_0$ Mary$_1$ ’s $_2$ boss $_3$ ’s $_4$ baby $_5$ won $_6$

	Step Type	Rule	Configuration
0	---	---	($\overline{S}$, 0)
1	SHIFT	NP → Mary	(NP $\overline{S}$, 1)
2	LC PREDICT	NP → NP POSS N	($\overline{P}\overline{OSS}$ $\overline{N}$ NP $\overline{S}$, 1)
3	MATCH	POSS → ‘s	($\overline{N}$ NP $\overline{S}$, 2)
4	MATCH	N → boss	(NP $\overline{S}$, 3)
5	LC PREDICT	NP → NP POSS N	($\overline{P}\overline{OSS}$ $\overline{N}$ NP $\overline{S}$, 3)
6	MATCH	POSS → ‘s	($\overline{N}$ NP $\overline{S}$, 4)
7	MATCH	N → baby	(NP $\overline{S}$, 5)
8	LC PREDICT	S → NP VP	($\overline{V}\overline{P}$ S $\overline{S}$, 5)
9	SHIFT	V → won	(V $\overline{V}\overline{P}$ S $\overline{S}$, 6)
10	PREDICT	VP → V	(VP $\overline{V}\overline{P}$ S $\overline{S}$, 6)
11	CANCEL		(S $\overline{S}$, 6)
12	CANCEL		(ϵ, 6)

2b: $_0$ John $_1$ met $_2$ the $_3$ boy $_4$ that $_5$ saw $_6$ the $_7$ actor $_8$

	Step Type	Rule	Configuration
0	---	---	($\overline{S}$, 0)
1	SHIFT	NP → John	(NP $\overline{S}$, 1)
2	LC PREDICT	S → NP VP	($\overline{V}\overline{P}$ S $\overline{S}$, 1)
3	SHIFT	V → met	(V $\overline{V}\overline{P}$ S $\overline{S}$, 2)
4	LC PREDICT	VP → V NP	($\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 2)
5	SHIFT	D → the	(D $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 3)
6	LC PREDICT	NP → D N SRC	($\overline{N}$ $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 3)
7	MATCH	N → boy	($\overline{N}$ $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 4)
8	SHIFT	THAT → that	(THAT $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 5)
9	LC PREDICT	SRC → THAT VP	($\overline{V}\overline{P}$ SRC $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 5)
10	SHIFT	V → saw	(V $\overline{V}\overline{P}$ SRC $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 6)
11	LC PREDICT	VP → V NP	($\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ SRC $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 6)
12	SHIFT	D → the	(D $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ SRC $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 7)
13	LC PREDICT	NP → D N	($\overline{N}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ SRC $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 7)
14	MATCH	N → actor	(NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ SRC $\overline{S}\overline{R}\overline{C}$ NP $\overline{N}\overline{P}$ VP $\overline{V}\overline{P}$ S $\overline{S}$, 8)

20	CANCEL		(ϵ, 8)

2c: $_0$John $_1$ met $_2$ the $_3$ boy $_4$ that $_5$ saw $_6$ the $_7$ actor $_8$ that $_9$ won $_{10}$ the $_{11}$ award $_{12}$

	Step Type	Rule	Configuration
0	---	---	($\overline{S}$, 0)
13	LC PREDICT	NP → D N SRC	($\overline{N}$ $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 7)
14	MATCH	N → actor	($\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 8)
15	SHIFT	THAT → that	(THAT $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 9)
16	LC PREDICT	SRC → THAT VP	($\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 9)
17	SHIFT	V → won	(V $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 10)
18	LC PREDICT	VP → V NP	($\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 10)
19	SHIFT	D → the	(D $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 11)
20	LC PREDICT	NP → D N	($\overline{N}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 11)
21	MATCH	N → award	(NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ SRC $\overline{SRC}$ NP $\overline{NP}$ VP $\overline{VP}$ S $\overline{S}$, 12)
30	CANCEL		(ϵ, 12)

3b: $_0$the $_1$ actor $_2$ the $_3$ boy $_4$ met $_5$ won $_6$

	Step Type	Rule	Configuration
0	---	---	($\overline{S}$, 0)
1	SHIFT	D → the	(D $\overline{S}$, 1)
2	LC PREDICT	NP → D N ORC	($\overline{N}$ $\overline{ORC}$ NP $\overline{S}$, 1)
3	MATCH	N → actor	($\overline{ORC}$ NP $\overline{S}$, 2)
4	SHIFT	D → the	(D $\overline{ORC}$ NP $\overline{S}$, 3)
5	LC PREDICT	NP → D N	($\overline{N}$ NP $\overline{ORC}$ NP $\overline{S}$, 3)
6	MATCH	N → boy	(NP $\overline{ORC}$ NP $\overline{S}$, 4)
7	LC PREDICT	ORC → NP V	($\overline{V}$ ORC $\overline{ORC}$ NP $\overline{S}$, 4)
8	MATCH	V → met	(ORC $\overline{ORC}$ NP $\overline{S}$, 5)
9	CANCEL		(NP $\overline{S}$, 5)
10	LC PREDICT	S → NP VP	($\overline{VP}$ S $\overline{S}$, 5)
11	SHIFT	V → won	(V $\overline{VP}$ S $\overline{S}$, 6)
12	LC PREDICT	VP → V	(VP $\overline{VP}$ S $\overline{S}$, 6)

13	CANCEL		(S $\overline{S}$, 6)
14	CANCEL		(ϵ, 6)

3c: $_0$the $_1$actor $_2$the $_3$boy $_4$the $_5$baby $_6$saw $_7$met $_8$won $_9$

	Step Type	Rule	Configuration
0	---	---	($\overline{S}$, 0)
5	LC PREDICT	NP → D N ORC	($\overline{N}$ $\overline{O}\overline{R}\overline{C}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 3)
6	MATCH	N → boy	($\overline{O}\overline{R}\overline{C}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 4)
7	SHIFT	D → the	(D $\overline{O}\overline{R}\overline{C}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 5)
8	LC PREDICT	NP → D N	($\overline{N}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 5)
9	MATCH	N → baby	(NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 6)
10	LC PREDICT	ORC → NP V	($\overline{V}$ ORC $\overline{O}\overline{R}\overline{C}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 6)
11	MATCH	V → saw	(ORC $\overline{O}\overline{R}\overline{C}$ NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 7)
12	CANCEL		(NP $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 7)
13	LC PREDICT	ORC → NP V	($\overline{V}$ ORC $\overline{O}\overline{R}\overline{C}$ NP $\overline{S}$, 7)
14	MATCH	V → met	(NP $\overline{S}$, 8)
15	LC PREDICT	S → NP VP	($\overline{V}\overline{P}$ S $\overline{S}$, 8)
16	SHIFT	V → won	(V $\overline{V}\overline{P}$ S $\overline{S}$, 9)
17	LC PREDICT	VP → V	(VP $\overline{V}\overline{P}$ S $\overline{S}$, 9)
19	CANCEL		(ϵ, 9)

2

First, we can parse 5b, since the rules that are different in the hypotheses does not appear here. Since it is also ungrammatical, it implies that there is some max load that the Martians cannot parse beyond. The max load here turns out to be 8, so Martians must not be able to parse loads that are 8 or above. To confirm this, we can parse 6d with both hypotheses and find that their max loads are both greater than 7. Finally, we can parse 6c in order to see if either hypothesis exceeds this max load even though this sentence is grammatical. It turns out that parsing 6c with hypothesis 1 gives a max load of 8, while hypothesis 2's max load is 5. This shows that hypothesis 2 is the correct hypothesis.

5b: $_0$John $_1$met $_2$the $_3$boy $_4$that $_5$saw $_6$the $_7$actor $_8$

	Step Type	Rule	Configuration
0	---	---	(ϵ, 0)
1	SHIFT	NP → John	(NP, 1)
2	SHIFT	V → met	(NP V, 2)
3	SHIFT	D → the	(NP V D, 3)
4	SHIFT	N → boy	(NP V D N, 4)
5	SHIFT	THAT → that	(NP V D N THAT, 5)

6	SHIFT	V → saw	(NP V D N THAT V, 6)
7	SHIFT	D → the	(NP V D N THAT V D, 7)
8	SHIFT	N → actor	(NP V D N THAT V D N, 8)
9	REDUCE	NP → D N	(NP V D N THAT V NP, 8)
10	SHIFT	VP → V NP	(NP V D N THAT VP, 8)
11	SHIFT	SRC → THAT VP	(NP V D N SRC, 8)
12	REDUCE	NP → D N SRC	(NP V NP, 8)
14	SHIFT	S → NP VP	(S, 8)

Sentence 6d

Hypothesis 1

$_0$ John $_1$ said $_2$ slowly $_3$ John $_4$ said $_5$ loudly $_6$ Mary $_7$ said $_8$ quietly $_9$ John $_{10}$ won $_{11}$

	Step Type	Rule	Configuration
0	---	---	(ϵ, 0)
1	SHIFT	NP → John	(NP, 1)
2	SHIFT	SAID → said	(NP SAID, 2)
3	SHIFT	ADV → slowly	(NP SAID ADV, 3)
4	SHIFT	NP → John	(NP SAID ADV NP, 4)
5	SHIFT	SAID → said	(NP SAID ADV NP SAID, 5)
6	SHIFT	ADV → loudly	(NP SAID ADV NP SAID ADV, 6)
7	SHIFT	NP → Mary	(NP SAID ADV NP SAID ADV NP, 7)
8	SHIFT	SAID → said	(NP SAID ADV NP SAID ADV NP SAID, 8)
9	SHIFT	ADV → quietly	(NP SAID ADV NP SAID ADV NP SAID ADV, 9)
10	SHIFT	NP → John	(NP SAID ADV NP SAID ADV NP SAID ADV NP, 10)
11	SHIFT	V → won	(NP SAID ADV NP SAID ADV NP SAID ADV NP V, 11)
12	REDUCE	VP → V	(NP SAID ADV NP SAID ADV NP SAID ADV NP VP, 11)
13	REDUCE	S → NP VP	(NP SAID ADV NP SAID ADV NP SAID ADV S, 11)
		REDUCTION STEPS	
	REDUCE	S → NP VP	(S, 11)

Hypothesis 2

$_0$ John $_1$ said $_2$ slowly $_3$ John $_4$ said $_5$ loudly $_6$ Mary $_7$ said $_8$ quietly $_9$ John $_{10}$ won $_{11}$

	Step Type	Rule	Configuration
0	---	---	(ϵ, 0)
1	SHIFT	NP → John	(NP, 1)

2	SHIFT	SAID → said	(NP SAID, 2)
3	SHIFT	ADV → slowly	(NP SAID ADV, 3)
4	REDUCE	X → SAID ADV	(NP X, 3)
5	SHIFT	NP → John	(NP X NP, 4)
6	SHIFT	SAID → said	(NP X NP SAID, 5)
7	SHIFT	ADV → loudly	(NP X NP SAID ADV, 6)
8	REDUCE	X → SAID ADV	(NP X NP X, 6)
9	SHIFT	NP → Mary	(NP X NP X NP, 7)
10	SHIFT	SAID → said	(NP X NP X NP SAID, 8)
11	SHIFT	ADV → quietly	(NP X NP X NP SAID ADV, 9)
12	REDUCE	X → SAID ADV	(NP X NP X NP X, 9)
13	SHIFT	NP → John	(NP X NP X NP X NP, 10)
14	SHIFT	V → won	(NP X NP X NP X NP V, 11)
15	REDUCE	VP → V	(NP X NP X NP X NP VP, 11)
16	REDUCE	S → NP VP	(NP X NP X NP X S, 11)
17	REDUCE	VP → X S	(NP X NP X NP VP, 11)
22	REDUCE	S → NP VP	(S, 11)

Sentence 6c

Hypothesis 1

$_0$John $_1$said $_2$slowly $_3$Mary $_4$said $_5$quietly $_6$John $_7$won $_8$

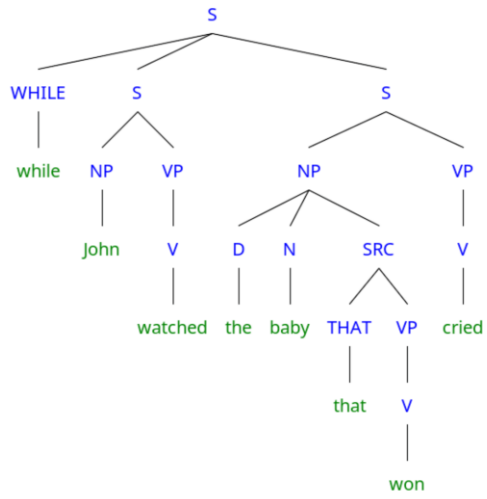
	Step Type	Rule	Configuration
0	---	---	(ϵ, 0)
1	SHIFT	NP → John	(NP, 1)
2	SHIFT	SAID → said	(NP SAID, 2)
3	SHIFT	ADV → slowly	(NP SAID ADV, 3)
4	SHIFT	NP → Mary	(NP SAID ADV NP, 4)
5	SHIFT	SAID → said	(NP SAID ADV NP SAID, 5)
6	SHIFT	ADV → quietly	(NP SAID ADV NP SAID ADV, 6)
7	SHIFT	NP → John	(NP SAID ADV NP SAID ADV NP, 7)
8	SHIFT	V → won	(NP SAID ADV NP SAID ADV NP VP, 8)
		REDUCTION STEPS	
	REDUCE	S → NP VP	(S, 8)

Hypothesis 2

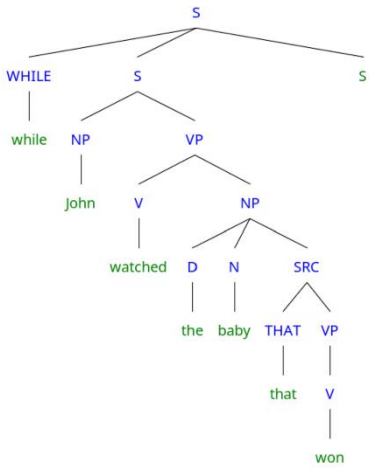
$_0$John $_1$said $_2$slowly $_3$Mary $_4$said $_5$quietly $_6$John $_7$won $_8$

	Step Type	Rule	Configuration
0	---	---	(ϵ, 0)
1	SHIFT	NP → John	(NP, 1)
2	SHIFT	SAID → said	(NP SAID, 2)
3	SHIFT	ADV → slowly	(NP SAID ADV, 3)
4	REDUCE	X → SAID ADV	(NP X, 3)
5	SHIFT	NP → Mary	(NP X NP, 4)
6	SHIFT	SAID → said	(NP X NP SAID, 5)
7	SHIFT	ADV → quietly	(NP X NP SAID ADV, 6)
8	REDUCE	X → SAID ADV	(NP X NP X, 6)
9	SHIFT	NP → John	(NP X NP X DP, 7)
10	SHIFT	V → won	(NP X NP X DP V, 8)
11	REDUCE	VP → NP V	(NP X NP X VP, 8)
		REDUCTION STEPS	
	REDUCE	S → NP VP	(S, 8)

3A



Correct Tree



Partial Tree

3B: Bottom Up Parse

$_0$ While $_1$ John $_2$ watched $_3$ the $_4$ baby $_5$ that $_6$ won $_7$ cried $_8$

Correct Parse

	Step Type	Rule	Configuration
0	---	---	(ϵ , 0)

1	SHIFT	WHILE → while	(WHILE, 1)
2	SHIFT	NP → John	(WHILE NP V, 2)
3	SHIFT	V → watched	(WHILE NP V, 3)
4	REDUCE	VP → V	(WHILE NP VP, 3)
5	REDUCE	S → NP VP	(WHILE S, 3)
6	SHIFT	D → the	(WHILE S D, 4)
7	SHIFT	N → baby	(WHILE S D N, 5)
8	SHIFT	THAT → that	(WHILE S D N THAT, 6)
9	SHIFT	V → won	(WHILE S D N THAT V, 7)
10	REDUCE	SRC → THAT VP	(WHILE S D N SRC, 7)
11	REDUCE	NP → D N SRC	(WHILE S NP, 7)
12	SHIFT	V → cried	(WHILE S NP V, 8)
13	REDUCE	VP → V	(WHILE S NP VP, 8)
14	SHIFT	S → NP VP	(WHILE S S, 8)
15	REDUCE	S → WHILE S S	(S, 8)

Incorrect parse (partial)

	STEP TYPE	RULE	CONFIGURATION
0	---	---	(ϵ , 0)
4	SHIFT	D → the	(WHILE, 1)
5	SHIFT	N → baby	(WHILE NP V, 2)
6	SHIFT	THAT → that	(WHILE NP V, 3)
7	SHIFT	V → won	(WHILE NP VP, 3)

3C: Top Down Parse

Correct Parse

	STEP TYPE	RULE	CONFIGURATION
0	---	---	(S, 0)
1	PREDICT	S → WHILE S S	(WHILE S S, 0)
2	MATCH	WHILE → while	(S S, 1)
3	PREDICT	S → NP VP	(NP VP S, 1)
4	MATCH	NP → John	(VP S, 2)
5	PREDICT	VP → V	(V S, 2)
6	MATCH	V → watched	(S, 3)
7	PREDICT	S → NP VP	(NP VP, 3)
8	PREDICT	NP → D N SRC	(D N SRC NP, 3)

9	MATCH	D → the	(N SRC VP, 4)
10	MATCH	N → baby	(SRC VP, 5)
11	PREDICT	SRC → THAT VP	(THAT VP VP, 6)
12	MATCH	THAT → that	(VP VP, 6)
13	PREDICT	VP → V	(V VP, 6)
14	MATCH	V → won	(VP, 7)
15	PREDICT	VP → V	(V, 7)
16	MATCH	V → cried	(ϵ, 8)

Incorrect parse (partial)

	STEP TYPE	RULE	CONFIGURATION
0	---	---	(S, 0)
5	PREDICT	VP → V NP	(V NP S, 2)
6	MATCH	V → watched	(NP S, 3)
7	PREDICT	NP → D N SRC	(D N SRC, 3)

3D: The bottom-up and top-down parser begin parsing incorrectly at different points in the sentence, and the eye moves back to the place that incorrect parsing begins. Therefore, we would only need to determine where the backtracking goes back to in order to determine whether humans parse bottom-up or top-down. In this example, I have determined that bottom-up parsers take a "wrong turn" at position 3, whereas top-down does so at position 2. Therefore, if the human eye goes back to position 3 to backtrack, then humans parse bottom-up, and vice versa.

4A

	TRANSITION	CONFIGURATION
0	---	(0A, aaacbbb)
1	(0A, a, 1A)	(1A, aacbbb)
2	(1A, a, 2A)	(2A, acbbb)
3	(2A, a, 3A)	(3A, cbbb)
4	(3A, c, 3B)	(3B, bbb)
5	(3B, b, 2B)	(2B, bb)
6	(2B, b, 1B)	(1B, b)
7	(1B, b, 0B)	(0B, ϵ)

4B

	STEP TYPE	RULE	CONFIGURATION
0	---	---	(S , aaacbbb)
1	PREDICT	S → A S B	(A S B, aaacbbb)

2	MATCH	A → a	(S B, aacbbb)
3	PREDICT	S → A S B	(A S B B, aacbbb)
4	MATCH	A → a	(S B S B, acbbb)
5	PREDICT	S → A S B	(A S B B B, acbbb)
6	MATCH	A → a	(S B B B, cbbb)
7	MATCH	S → c	(B B B, bbb)
8	MATCH	B → b	(B B, bb)
9	MATCH	B → b	(B, b)
10	MATCH	B → b	(ϵ, ϵ)

4C

	STEP TYPE	RULE	CONFIGURATION
0	---	---	(ϵ, aaacbbb)
1	SHIFT	A → a	(A, aacbbb)
2	REDUCE	A → a	(ϵ, aacbbb)
3	SHIFT	A → a	(A, acbbb)
4	REDUCE	A → a	(ϵ, acbbb)
5	SHIFT	A → a	(A, cbbb)
6	SHIFT	S → c	(A S, bbb)
7	SHIFT	B → b	(A S B , bb)
8	REDUCE	S → A S B	(S, bb)
9	SHIFT	B → b	(S B, b)
10	REDUCE	B → b	(S, b)
11	SHIFT	B → b	(S B, ϵ)
12	REDUCE	B → b	(S, ϵ)

4D

	STEP TYPE	RULE	CONFIGURATION
0	---	---	($\overline{S}$, aaacbbb)
1	SHIFT	A → a	(A $\overline{S}$, aacbbb)
2	LC CONNECT	S → A S B	($\overline{S}$ $\overline{B}$, aacbbb)
3	SHIFT	A → a	(A, acbbb)
4	LC CONNECT	S → A S B	($\overline{S}$ $\overline{B}$ $\overline{B}$, acbbb)
5	SHIFT	A → a	(A $\overline{S}$ $\overline{B}$ $\overline{B}$, cbbb)
6	LC CONNECT	S → A S B	($\overline{S}$ $\overline{B}$ $\overline{B}$ $\overline{B}$, cbbb)
7	MATCH	S → c	($\overline{B}$ $\overline{B}$ $\overline{B}$, bbb)
8	MATCH	B → b	($\overline{B}$ $\overline{B}$, bb)
9	MATCH	B → b	($\overline{B}$, b)
10	MATCH	B → b	(ϵ, ϵ)