Parsing

Homework 3 (Top-Down Parsing), due 11 May 2020

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Question 1 (Top-Down parsing) *Consider the CFG G with $N = \{S, X\}, T = \{a\}$, start symbol S and productions*

$$S \to aSa \mid X, X \to aX \mid a$$

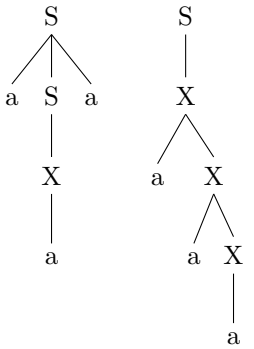
and the input $w = aaa$.

1. *Give all parse trees for this input.*
2. *Is G ambiguous?*
3. *Give all pairs of prediction stack, remaining input and analysis stack that arise in a top-down parsing for this input. (The productions are assumed to be numbered in the order above, i.e., $S \to aSa$ is the 1st S-production etc.) List them in a table with a unique number for each pair and indicate from which other pair a new pair was obtained.*

id	*stack*	*rem. input*	*analysis stack*	*obtained from*
1.	S	aaa	–	*axiom*
2.	aSa	aaa	S_1	*from 1.*
3.	X	aaa	S_2	*from 1.*
4.	…	…		

4. *Give the resulting leftmost derivations.*
5. *Assuming we have a filter such that we do not generate pairs where the stack is longer than the remaining input. Which of the triples from the table in 3. would not be generated in this case?*
6. *Now assume that we pursue a depth-first strategy, which of the triples in the table in 3. would then remain? Which is the leftmost derivation one encounters first?*

Solution:

1. 

2. yes (see 1.)

3.

id	stack	rem. input	analysis stack	obtained from

1.	S	aaa	–	axiom
2.	aSa	aaa	S_1	from 1.
3.	X	aaa	S_2	from 1.
4.	Sa	aa	S_1a	from 2.
5.	aX	aaa	S_2X_1	from 3.
6.	a	aaa	S_2X_2	from 3.
7.	Xa	aa	S_1aS_2	from 4.
8.	aSaa	aa	S_1aS_1	from 4.
9.	X	aa	S_2X_1a	from 5.
10.	–	aa	S_2X_2a	from 6.
11.	aa	aa	$S_1aS_2X_2$	from 7.
12.	Saa	aa	S_1aS_1a	from 8.
13.	aX	aa	$S_2X_1aX_1$	from 9.
14.	a	aa	$S_2X_1aX_2$	from 9.
15.	a	a	$S_1aS_2X_2a$	from 11.
16.	aSaaa	aa	$S_1aS_1aS_1$	from 12.
17.	Xaa	aa	S_1aS_1a	from 12.
18.	X	a	$S_2X_1aX_1a$	from 13.
19.	–	a	$S_2X_1aX_2a$	from 14.
20.	–	–	$S_1aS_2X_2aa$	from 15.
21.	Saaa	a	$S_1aS_1aS_1a$	from 16.
22.	aXaa	aa	$S_1aS_1aX_1$	from 17.
23.	aaa	aa	$S_1aS_1aX_2$	from 17.
24.	aX	a	$S_2X_1aX_1aX_1$	from 18.
25.	a	a	$S_2X_1aX_1aX_2$	from 18.
26.	aSaaaa	a	$S_1aS_1aS_1aS_1$	from 21.
27.	Xaaa	a	$S_1aS_1aS_1aS_2$	from 21.
28.	Xaa	a	$S_1aS_1aX_1a$	from 22.
29.	aa	a	$S_1aS_1aX_2a$	from 23.
30.	X	–	$S_2X_1aX_1aX_1a$	from 24.
31.	–	–	$S_2X_1aX_1aX_2a$	from 25.
32.	Saaaa	a	$S_1aS_1aS_1aS_1a$	from 26.
33.	aXaaa	a	$S_1aS_1aS_1aS_2X_1$	from 27.
34.	aaaa	a	$S_1aS_1aS_1aS_2X_2$	from 27.
35.	aXaa	a	$S_1aS_1aX_1aX_1$	from 28.
36.	aaa	a	$S_1aS_1aX_1aX_2$	from 28.
37.	a	–	$S_1aS_1aX_2aa$	from 29.
38.	aX	–	$S_2X_1aX_1aX_1aX_1$	from 30.
39.	a	–	$S_2X_1aX_1aX_1aX_2$	from 30.
40.	aSaaaaa	a	$S_1aS_1aS_1aS_1aS_1$	from 32.
41.	Xaaaa	a	$S_1aS_1aS_1aS_1aS_2$	from 32.
42.	Xaaa	–	$S_1aS_1aS_1aS_2X_1a$	from 33.
43.	aaa	–	$S_1aS_1aS_1aS_2X_2a$	from 34.
44.	Xaa	–	$S_1aS_1aX_1aX_1a$	from 35.
45.	aa	–	$S_1aS_1aX_1aX_2a$	from 36.
46.	Saaaaa	–	$S_1aS_1aS_1aS_1aS_1a$	from 40.
47.	aXaaaa	a	$S_1aS_1aS_1aS_1aS_2X_1$	from 41.
48.	aaaaa	a	$S_1aS_1aS_1aS_1aS_2X_2$	from 41.
49.	aXaaa	–	$S_1aS_1aS_1aS_2X_1aX_1$	from 42.
50.	aaaa	–	$S_1aS_1aS_1aS_2X_1aX_2$	from 42.
51.	aXaa	–	$S_1aS_1aX_1aX_1aX_1$	from 44.
52.	aaa	–	$S_1aS_1aX_1aX_1aX_2$	from 44.

... und noch ein paar mehr ...

4. $S_1S_2X_2$, $S_2X_1X_1X_2$
5. Remaining items: 1–7, 9–11, 13–15, 18–20, 25, 31
6. Remaining items: 1., 2., 4., 7., 11., 15., 20., leftmost derivation is $S_1S_2X_2$