CYK Parsing

Exercise

Consider the CFG $G= (N,T,P,S)$ with $N = \{S,A,B,T\}$, $T = \{a,c\}$ and P containing the following productions:

$S \rightarrow AT \mid AB$

$$T \rightarrow SB$$

$$A \rightarrow a$$

$$B \rightarrow AC \mid a \mid c$$

$$C \rightarrow c$$

Assume that this CFG was obtained via transformation into CNF where A, C and T were added as new non-terminals (A and C as preterminals and T as a new binarization non-terminal.)

1. What is the original CFG?

2. Consider the following chart, obtained from parsing *aacac* with the CNF-grammar:

l						
5	$T \rightarrow S_{1,4}B_{5,1}$ $S \rightarrow A_{1,1}T_{2,4}$					
4	$T \rightarrow S_{1,3}B_{4,1}$ $S \rightarrow A_{1,1}T_{2,3}$	$T \rightarrow S_{2,2}B_{4,2}$				
3	$S \rightarrow A_{1,1}B_{2,2}$ $T \rightarrow S_{1,2}B_{3,1}$	$T \rightarrow S_{2,2}B_{4,1}$				
2	$S \rightarrow A_{1,1}B_{2,1}$	$S \rightarrow A_{2,1}B_{3,1}$ $B \rightarrow A_{2,1}C_{3,1}$		$S \rightarrow A_{4,1}B_{5,1}$ $B \rightarrow A_{4,1}C_{5,1}$		
1	$A \rightarrow a$ $B \rightarrow a$	$A \rightarrow a$ $B \rightarrow a$	$C \rightarrow c$ $B \rightarrow c$	$A \rightarrow a$ $B \rightarrow a$	$C \rightarrow c$ $B \rightarrow c$	
	1	2	3	4	5	i

   Give the different steps of de-binarization (slide 21), showing how the chart changes from one step to the next.

3. Give the parse tree in the original (non-CNF) grammar and show which chart entries contribute to this tree.

Solution

1. Original CFG:

   $G = (N, T, P, S)$ with $N = \{S, B\}$, $T = \{a,c\}$ und $P= \{S \rightarrow aB \mid aSB,\ B \rightarrow ac \mid a \mid c\}$

2.

l						
5	$T \rightarrow S_{1,4}B_{5,1}$					

5	S → A$_{1,1}$T$_{2,4}$					
4	T → S$_{1,3}$B$_{4,1}$ S → A$_{1,1}$T$_{2,3}$	T → S$_{2,2}$B$_{4,2}$				
3	S → A$_{1,1}$B$_{2,2}$ T → S$_{1,2}$B$_{3,1}$	T → S$_{2,2}$B$_{4,1}$				
2	S → A$_{1,1}$B$_{2,1}$	S → A$_{2,1}$B$_{3,1}$ B → A$_{2,1}$C$_{3,1}$		S → A$_{4,1}$B$_{5,1}$ B → A$_{4,1}$C$_{5,1}$		
1	A → a B → a	A → a B → a	C → c B → c	A → a B → a	C → c B → c	
	1	2	3	4	5	i

l						
5	T → S$_{1,4}$B$_{5,1}$ S → aT$_{2,4}$					
4	T → S$_{1,3}$B$_{4,1}$ S → aT$_{2,3}$	T → S$_{2,2}$B$_{4,2}$				
3	S → aB$_{2,2}$ T → S$_{1,2}$B$_{3,1}$	T → S$_{2,2}$B$_{4,1}$				
2	S → aB$_{2,1}$	S → aB$_{3,1}$ B → ac		S → aB$_{5,1}$ B → ac		
1	a, B → a	a, B → a	c, B → c	a, B → a	c, B → c	
	1	2	3	4	5	i

l						
5	T → S$_{1,4}$B$_{5,1}$ S → aS$_{2,2}$B$_{4,2}$					
4	T → S$_{1,3}$B$_{4,1}$ S → aS$_{2,2}$B$_{4,1}$	T → S$_{2,2}$B$_{4,2}$				
3	S → aB$_{2,2}$ T → S$_{1,2}$B$_{3,1}$	T → S$_{2,2}$B$_{4,1}$				
2	S → aB$_{2,1}$	S → aB$_{3,1}$ B → ac		S → aB$_{5,1}$ B → ac		
1	a, B → a	a, B → a	c, B → c	a, B → a	c, B → c	
	1	2	3	4	5	i

l						
5	S → aS$_{2,2}$B$_{4,2}$					
4	S → aS$_{2,2}$B$_{4,1}$					
3	S → aB$_{2,2}$					
2	S → aB$_{2,1}$	S → aB$_{3,1}$ B → ac		S → aB$_{5,1}$ B → ac		
1	a, B → a	a, B → a	c, B → c	a, B → a	c, B → c	

	1	2	3	4	5	i

3.

[1,5] S

[1,5] a

[2,2] S

[4,2] B

[2,2] a

[3,1] B

[4,2] a

[4,2] c

[3,1] c