

## Assignment # 3 - Solution

Present the **CKY** recognition matrix for each of the following strings (one per page on 4 pages) assuming the Chomsky Normal Form grammar,  $G = (\{S,A,B,C,D,E\}, \{a,b\}, S, P)$ , specified by the rules **P**. Note: not all strings are in the language.

**S**  $\rightarrow$  **AB** | **BA**

**A**  $\rightarrow$  **CD** | **a**

**B**  $\rightarrow$  **CE** | **b**

**C**  $\rightarrow$  **a** | **b**

**D**  $\rightarrow$  **AC**

**E**  $\rightarrow$  **BC**

The abbreviated and complete tables for test case 1 (string "abbab"):

	a	b	b	a	b
1	A, C	B, C	B, C	A, C	B, C
2	S, D	E	S, E	S, D	
3	B	B	A		
4	S, S, E	S, E			
5	B				

  

	a	b	b	a	b
1	A → a C → a	B → b C → b	B → b C → b	A → a C → a	B → b C → b
2	S → AB D → AC	E → BC	S → BA E → BC	S → AB D → AC	
3	B → CE	B → CE	A → CD		
4	S → AB S → BA E → BC	S → BA E → BC			
5	B → CE				

The string "abbab" is NOT part of the language, because it cannot be derived from S.

However, it can be derived from B with no ambiguity:

$B \rightarrow CE \rightarrow aE \rightarrow aBC \rightarrow aCEC \rightarrow abEC \rightarrow abBCC \rightarrow abbCC \rightarrow abbaC \rightarrow abbab$

The abbreviated and complete tables for test case 2 (string "baba"):

	b	a	b	a
1	B, C	A, C	B, C	A, C
2	S, E	S, D	S, E	
3	A	B		
4	D			

	b	a	b	a
1	B → b C → b	A → a C → a	B → b C → b	A → a C → a
2	S → BA E → BC	S → AB D → AC	S → BA E → BC	
3	A → CD	B → CE		
4	D → AC			

The string "baba" is NOT part of the language, because it cannot be derived from S.

However, it can be derived from D with no ambiguity:

$D \rightarrow AC \rightarrow CDC \rightarrow bDC \rightarrow bACC \rightarrow baCC \rightarrow babC \rightarrow baba$

The abbreviated and complete tables for test case 3 (string "bbaabb"):

	b	b	a	a	b	b
1	B, C	B, C	A, C	A, C	B, C	B, C
2	E	S, E	D	S, D	E	
3	B	A	A	B		
4	S, E	S, S, D	S, D			
5	A	A				
6	S, S, D					

	b	b	a	a	b	b
1	B → b C → b	B → b C → b	A → a C → a	A → a C → a	B → b C → b	B → b C → b
2	E → BC	S → BA E → BC	D → AC	S → AB D → AC	E → BC	
3	B → CE	A → CD	A → CD	B → CE		
4	S → BA E → BC	S → AB S → BA D → AC	S → AB D → AC			
5	A → CD	A → CD				
6	S → AB S → BA D → AC					

The string "bbaabb" is part of the language, because it can be derived from S (ambiguity of 2 different derivations).

First (leftmost) derivation:  $S \rightarrow AB \rightarrow CDB \rightarrow bDB \rightarrow bACB \rightarrow bCDCB \rightarrow bbDCB \rightarrow bbACCB \rightarrow bbaCCB \rightarrow bbaaCB \rightarrow bbaabB \rightarrow \mathbf{bbaabb}$

Second (leftmost) derivation:  $S \rightarrow BA \rightarrow bA \rightarrow bCD \rightarrow bbD \rightarrow bbAC \rightarrow bbCDC \rightarrow bbaDC \rightarrow bbaACC \rightarrow bbaaCC \rightarrow bbaabC \rightarrow \mathbf{bbaabb}$

The abbreviated and complete tables for test case 4 (string “abba”):

	a	b	b	a
1	A, C	B, C	B, C	A, C
2	S, D	E	S, E	
3	B	B		
4	S, S, E			

	a	b	b	a
1	A → a C → a	B → b C → b	B → b C → b	A → a C → a
2	S → AB D → AC	E → BC	S → BA E → BC	
3	B → CE	B → CE		
4	S → AB S → BA E → BC			

The string "abba" is part of the language, because it can be derived from S (ambiguity of 2 different derivations).

First (leftmost) derivation:  $S \rightarrow AB \rightarrow aB \rightarrow aCE \rightarrow abE \rightarrow abBC \rightarrow abbC \rightarrow \mathbf{abba}$

Second (leftmost) derivation:  $S \rightarrow BA \rightarrow CEA \rightarrow aEA \rightarrow aBCA \rightarrow abCA \rightarrow abbA \rightarrow \mathbf{abba}$