

(2)

The CKY parsing algorithm, is used for parsing - free grammars in chomsky normal form. However, provided. grammar is not in chomsky normal form. CNF requires each production to have exactly two non-terminal symbols or exactly one terminal symbol on its right-hand side.

Given CFG = $\{aSa/bSb/aa/bb/a/b\}$

Transform the given grammar into CNF.

Original rules are as follows:

1. $S \rightarrow aSa$
2. $S \rightarrow bSb$
3. $S \rightarrow aa$
4. $S \rightarrow bb$
5. $S \rightarrow a$
6. $S \rightarrow b$

→ We introduce new non-terminal symbol A and B with rules $A \rightarrow a$ and $B \rightarrow b$.

→ We also introduce new non-terminals CDEF with rules $C \rightarrow AS$, $D \rightarrow SB$, $E \rightarrow BA$, $F \rightarrow AB$. Where we break-down the original rules which had more than 2 symbols.

→ Therefore, new rules in CNF are

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|---|------------------------|
| 1. $S \rightarrow AC$ (replaces $S \rightarrow aSa$) | 10. $D \rightarrow AS$ |
| 2. $S \rightarrow DF$ (replaces $S \rightarrow bSb$) | 11. $E \rightarrow SB$ |
| 3. $S \rightarrow AA$ (replaces $S \rightarrow aa$) | 12. $F \rightarrow AB$ |
| 4. $S \rightarrow BB$ (replaces $S \rightarrow bb$) | |
| 5. $S \rightarrow A$ (replaces $S \rightarrow a$) | |
| 6. $S \rightarrow B$ (replaces $S \rightarrow b$) | |
| 7. $A \rightarrow a$ | |
| 8. $B \rightarrow b$ | |
| 9. $C \rightarrow SD$ | |

Given string is "aabbba", now parse the given string using the CKY algorithm and the transformed grammar.

To build the CKY parsing table for the string "aabbba", we have to fill the main diagonal with the possible productions for each terminal symbol, later occupy the rest of the table for large substrings.

⇒ Resulting table as follows:

	a	a	b	b	a	a.
a	A, S					
a		A, S				
b			B, S			
b				B, S		
a					A, S	
a						A, S

⇒ Now, fill the rest of table with possible combinations from lower diagonals.

	a	a	b	b	a	a.
a	A, S	AA, S				
a		A, S	AB			AA, S
b			B, S	BB, S	BA	
b				B, S	BB	
a					A, S	AA, S
a						A, S

	a	a	b	b	a	a.
a	A, S	AA, S		BA, AB, S		
a						