

# Sample Solution - Assignment 4

## CSCI 3136


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- (a) Grammar:
- $S \rightarrow SS$  (1)
  - $S \rightarrow (S)$  (2)
  - $S \rightarrow \epsilon$  (3)

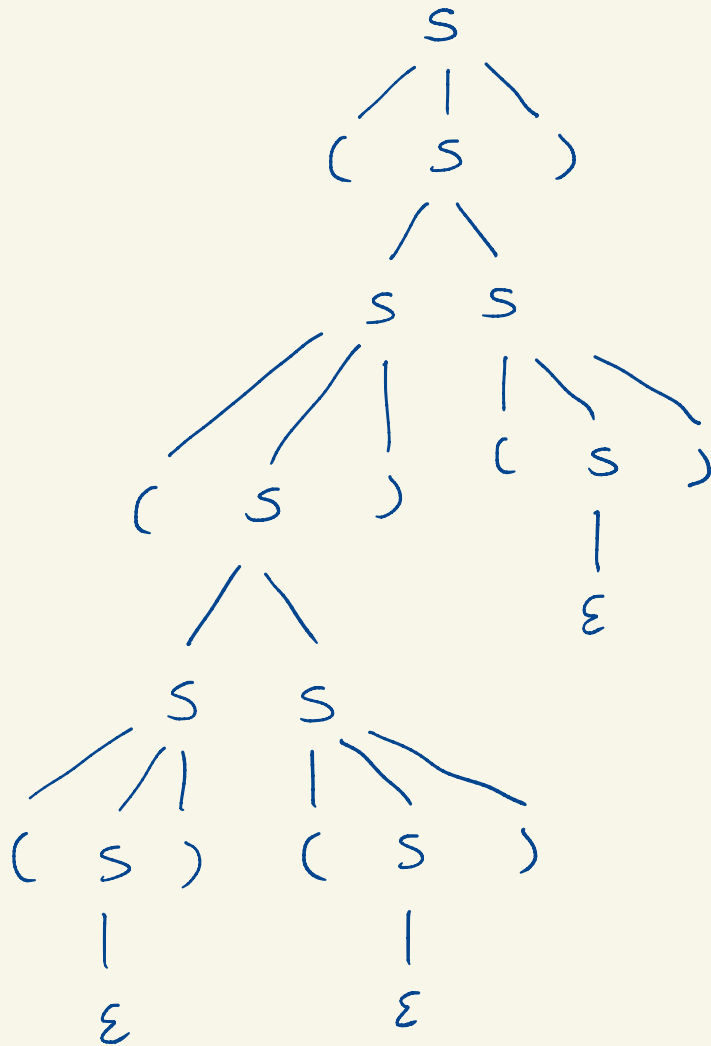
This grammar generates the language of properly nested parenthesis sequences because:

- The empty string is in this language (rule 3).
- A non-empty string is either
  - A properly nested parenthesis sequence between two matching parentheses (rule 2) or
  - The concatenation of two properly nested parenthesis sequences if there is no single "topmost" parenthesis pair (rule 1).

PDA:

start  $\rightarrow$    $(\epsilon, S, SS)$   
 $(\epsilon, S, (S))$   
 $(\epsilon, S, \epsilon)$   
 $("(", "(" , \epsilon)$   
 $(")", ")" , \epsilon)$

Parse tree:



Leftmost derivation:

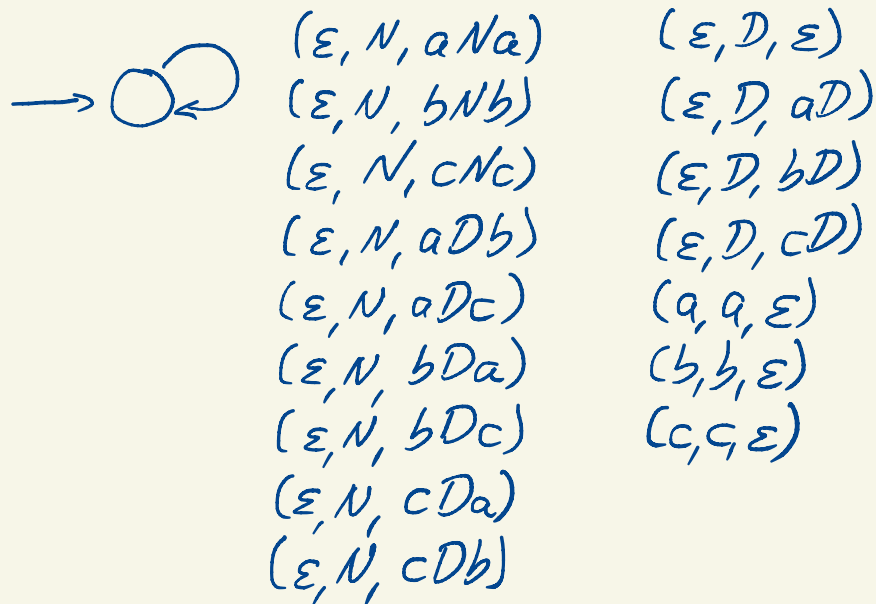
$S \rightarrow (S)$   
 $\rightarrow (SS)$   
 $\rightarrow ((S)S)$   
 $\rightarrow ((SS)S)$   
 $\rightarrow (((S)S)S)$   
 $\rightarrow (((())S)S)$   
 $\rightarrow (((())(S))S)$   
 $\rightarrow (((())())S)$   
 $\rightarrow (((())())(S))$   
 $\rightarrow (((())())())$

(b) Grammar:

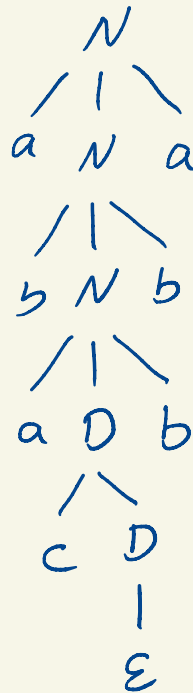
$N \rightarrow aNa$	(1)	$D \rightarrow \epsilon$	(10)
$N \rightarrow bNb$	(2)	$D \rightarrow aD$	(11)
$N \rightarrow cNc$	(3)	$D \rightarrow bD$	(12)
$N \rightarrow aDb$	(4)	$D \rightarrow cD$	(13)
$N \rightarrow aDc$	(5)		
$N \rightarrow bDa$	(6)		
$N \rightarrow bDc$	(7)		
$N \rightarrow cDa$	(8)		
$N \rightarrow cDb$	(9)		

Explanation: A non-palindrome ( $N$ ) is either a non-palindrome enclosed by a pair of matching characters (rules 1-3) or an arbitrary string ( $D$ ) enclosed by a pair of non-matching characters (rules 4-9). An arbitrary string is either empty (rule 10) or a letter  $a, b$  or  $c$  followed by an arbitrary string (11-13).

PDA:



Parse tree:



Rightmost derivation:

$N \rightarrow aNa$   
 $\rightarrow abNba$   
 $\rightarrow abaDbba$   
 $\rightarrow abacDbba$   
 $\rightarrow abacbba$