

**Team Members:**

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Homework - 5Problem 1.

1. The Context-free Grammar for language  $L$  consisting all strings over  $\{a, b\}$  that have twice as many  $a$ 's as  $b$ 's is

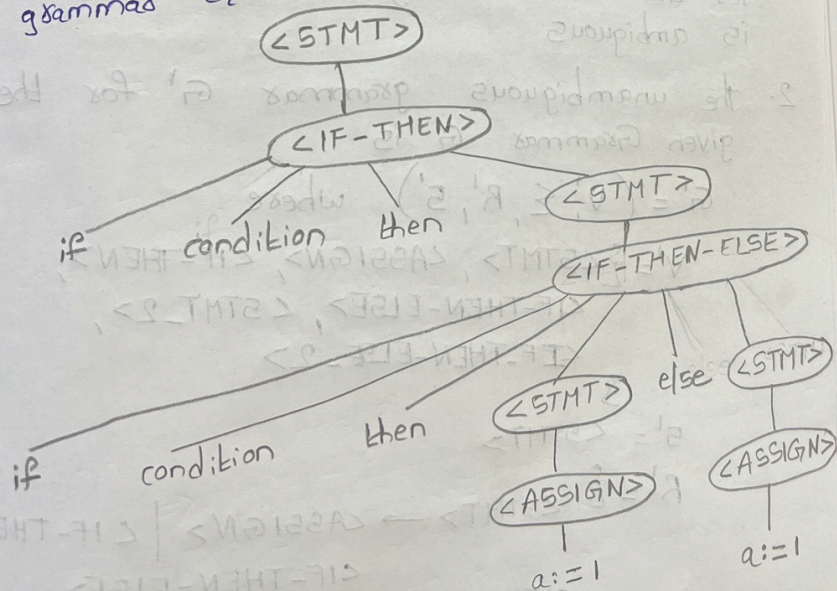
$G = (\{S\}, \{a, b\}, R, S)$  where

$$R = \{S \rightarrow \epsilon \mid SS \mid aaSb \mid bSaa \mid aSbSa\}$$

Problem 2.

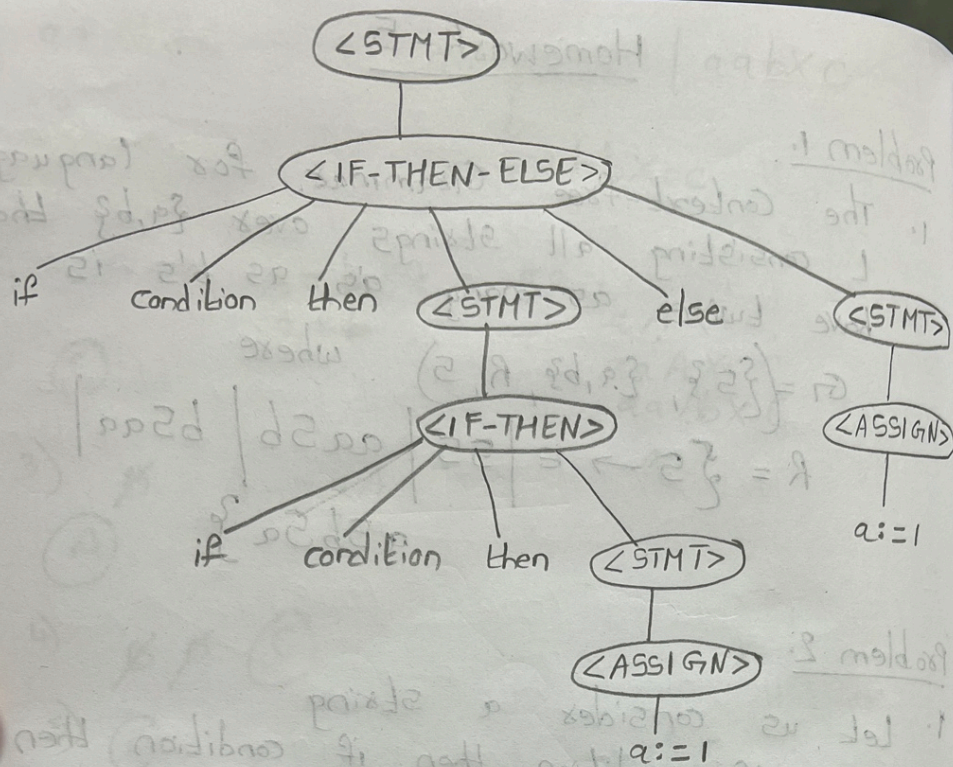
1. Let us consider a string  $w$ :  
 $w$ : if condition then if condition then  
 $a := 1$  else  $a := 1$

The parse trees for deriving  $w$  using grammar  $G$  are



Parse Tree - 1





### Parse Tree-2

Since, there are 2 different parse trees for the same string  $w$ , the grammar  $G$  is ambiguous

2. the unambiguous grammar  $G'$  for the given Grammar  $G$  is

$G' = (V', \Sigma, R', S')$  where

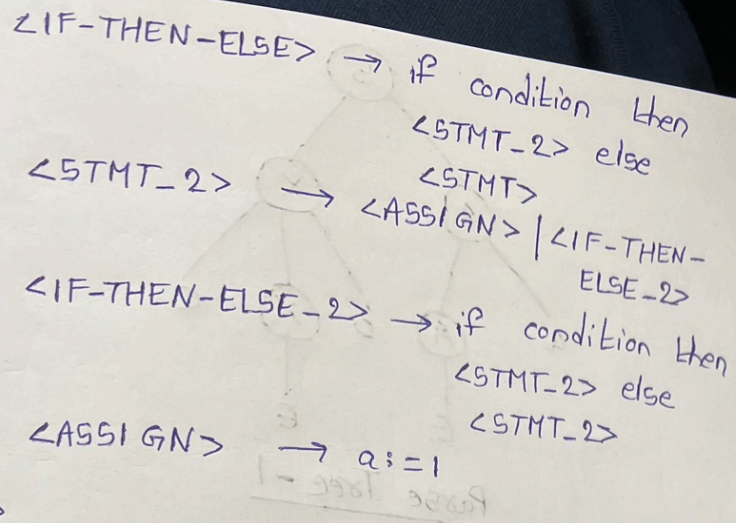
$V' = \{ \langle \text{STMT} \rangle, \langle \text{ASSIGN} \rangle, \langle \text{IF-THEN} \rangle, \langle \text{IF-THEN-ELSE} \rangle, \langle \text{STMT}_2 \rangle, \langle \text{IF-THEN-ELSE}_2 \rangle \}$

$S' = \langle \text{STMT} \rangle$

$R' = \{ \langle \text{STMT} \rangle \rightarrow \langle \text{ASSIGN} \rangle \mid \langle \text{IF-THEN} \rangle \mid \langle \text{IF-THEN-ELSE} \rangle$

$\langle \text{IF-THEN} \rangle \rightarrow \text{if condition then } \langle \text{STMT} \rangle$





### Problem 3.

the context-free Grammar for language

$A = \{a^i b^j c^k \mid i=j \text{ or } j=k \text{ where } i, j, k \geq 0\}$  is

$G = (\{S, A, C, X, Y\}, \{a, b, c\}, R, S)$  where

$R = \{$

$S \rightarrow AX \mid YC$

$A \rightarrow aA \mid \epsilon$

$C \rightarrow cC \mid \epsilon$

$X \rightarrow bXc \mid \epsilon$

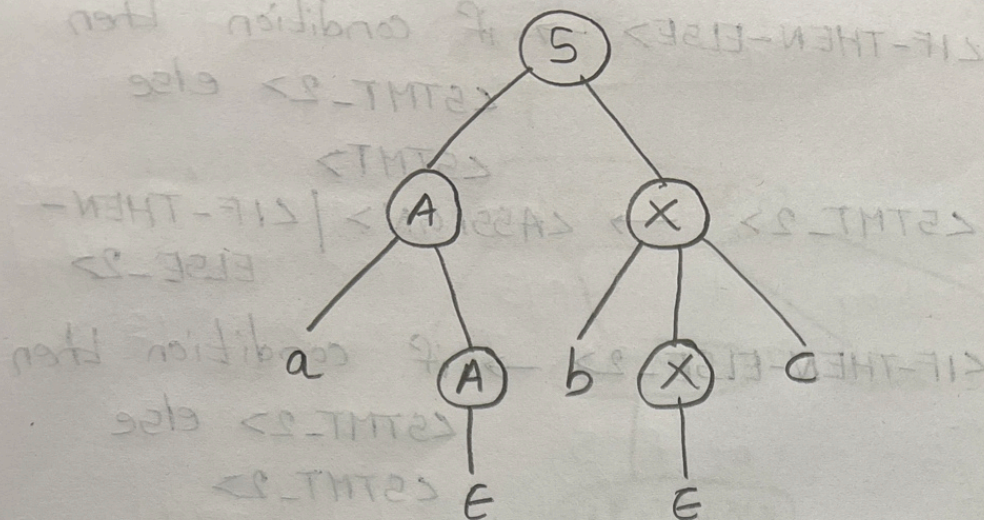
$Y \rightarrow aYb \mid \epsilon$

$\}$

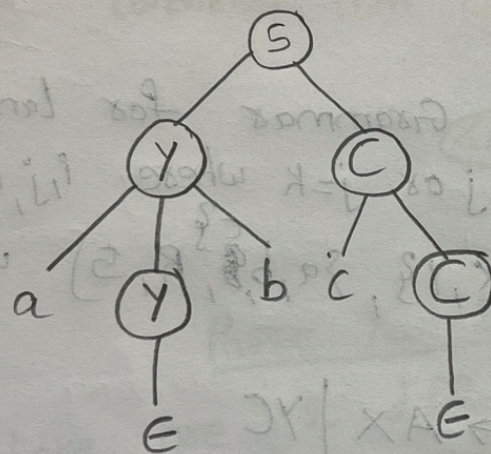
The above grammar is ambiguous when string  $w$  has equal number of  $a$ 's,  $b$ 's &  $c$ 's

Let us consider string  $w = abc$   
The parse trees for deriving  $w$  using  $G$  are





Parse Tree - 1



Since, there are 2 different parse trees for the same string  $w$ , the grammar  $G$  is ambiguous