Project 6

Jesse Adams, Dominic Orsi, Ben Puryear

November 2nd, 2023

1   Let $L = \{a^n b^m c^{2n+m} | n, m \geq 0\}$. Construct a context-free grammar, G, that generates L.

Our context free grammar, G, that generates L, starts with string S:

$$S \Rightarrow AB$$
$$A \Rightarrow aABCC | aACC | \lambda$$
$$B \Rightarrow bBC | \lambda$$
$$C \Rightarrow cC\lambda$$

2

2.1 State the rules for Chomsky Normal Form (CNF).

A CFG is in CNF if every rule is of the form:

$A \Rightarrow BC$

$A \Rightarrow a$

$S \Rightarrow \lambda$

Where:

$a \in \Sigma$

$A, B, C \in V$

S is the start variable

2.2 Convert the following grammar to CNF.

$$S \Rightarrow aA|ABA$$
$$A \Rightarrow AA|a$$
$$B \Rightarrow AbA|bb$$

2.2.1 Guarantee Start Variable is only on LHS.

No action needed

2.2.2 Eliminate all rules of $A \Rightarrow \lambda$ where $A \neq S$.

No action needed

2.2.3 Eliminate all unit rules.

No action needed

2.2.4 Fix remaining rules.

Let $U_1 \Rightarrow a$ and $U_2 \Rightarrow b$

$$S \Rightarrow U_1 A|ABA$$
$$A \Rightarrow AA|a$$
$$B \Rightarrow AU_2 A|bb$$
$$U_1 \Rightarrow a$$
$$U_2 \Rightarrow b$$

Let $B_1 \Rightarrow BA$ and $B_2 \Rightarrow U_2 A$

$$S \Rightarrow U_1 A | AB_1$$
$$A \Rightarrow AA | a$$
$$B \Rightarrow AB_2 | U_2 U_2$$
$$B_1 \Rightarrow BA$$
$$B_2 \Rightarrow U_2 A$$
$$U_1 \Rightarrow a$$
$$U_2 \Rightarrow b$$

This grammar is now in Chomsky Normal Form.

3 Using Example 2.14, show that the machine, M1 in Figure 2.15 recognizes 0011.

Input String	Stack Content	Rule	Description
ϵ	$	$\epsilon, \epsilon \Rightarrow \$$	Input ϵ, pop ϵ from stack, push $.
0	0$	$0, \epsilon \Rightarrow 0$	Input 0, pop ϵ from stack, push 0.
0	00$	$0, \epsilon \Rightarrow 0$	Input 0, pop ϵ from stack, push 0.
1	0$	$1, 0 \Rightarrow \epsilon$	Input 1, pop 0 from stack, push ϵ.
1	$	$1, 0 \Rightarrow \epsilon$	Input 1, pop 0 from stack, push ϵ.
ϵ		$\epsilon, \$ \Rightarrow \epsilon$	Input 1, pop $ from stack, push ϵ.