Middle East Technical University Department of Computer Engineering

CENG 280

Formal Languages and Abstract Machines

Spring 2022-2023

Homework 5

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Answer for Q1

a. G_1 is union of $G_2 = \{0^n 1^n, n \geq 0\}$ and $G_3 = \{1^n 0^n, n \geq 0\}$.

b.
Since for every string there is only one distinct derivation, grammar is not ambigious. The order of rules applied can change, but that doesn't mean it's a distinct derivation. We can say there is only one distinct leftmost or rightmost derviation.

Answer for Q2

a. If we can find more than one distinct derivation for at least one string, then language is ambiguous. Let's consider string "aabbb" and derive it with leftmost derivation:

$$S \to AB \to aAB \to aaAB \to aaB \to aabB \to aabbB \to aabbbB \to aaabbb$$

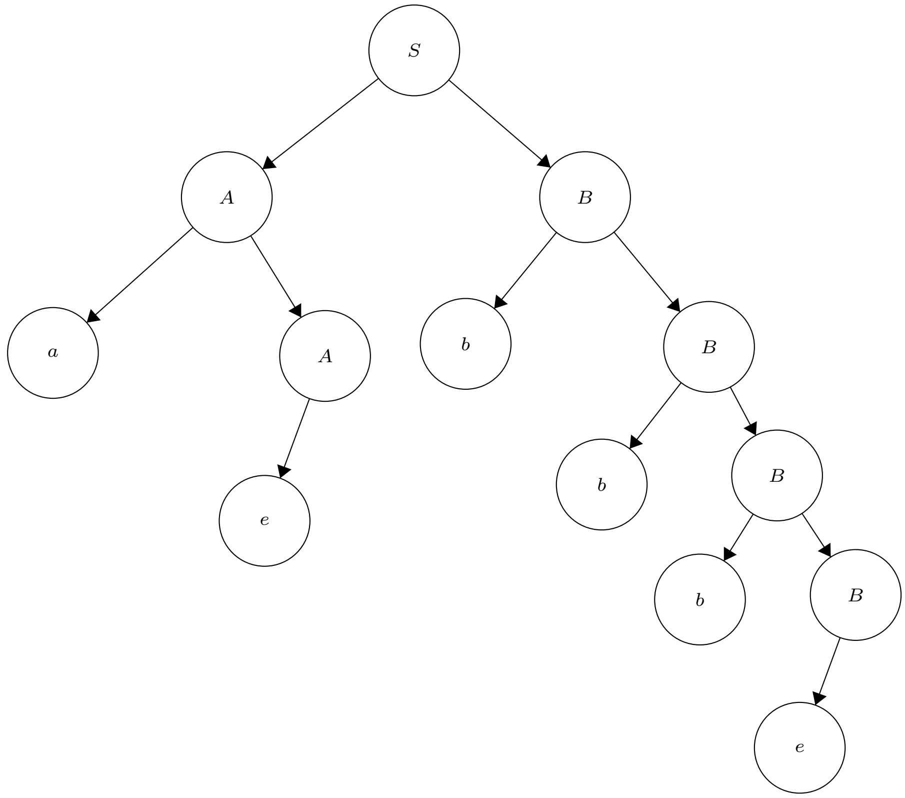
$$S \to AB \to aAB \to aaB \to aabB \to aabbB \to aabbb$$

We constructed "aabbb" with different rule order i.e. there are more than one distinct derivation for this string. Therefore this language is ambiguous.

b. If we take out $A \to a$ and $B \to b$ rules, ambiguity is disappears. Because we can also do that with $A \to aA \to a$ in 2 steps. So the corrected grammar is:
$G_2 = \{V, \sum, R, S\}$ where $V = \{a, b, S, A, B\}, \sum = \{a, b\}$ and R is:
$S \to AB$
$A \to aA|e$
$B \to bB|e$

c.

$$S \rightarrow AB \rightarrow aAB \rightarrow aB \rightarrow abB \rightarrow abbB \rightarrow abbB \rightarrow abbbB \rightarrow abbb$$



Answer for Q3

a. If we can construct a PDA with no compitable transitions, then L is deterministic. We must add \$ to end of the L before construction. Let's try to construct the PDA:
K = { p, q, r, s, t, k, l, m, x }
$\sum = \{a, b, c, d, \$\}$
$\Gamma = \{a, Z\}$
s = p
F = {x, k, m}
$\triangle = \{((p, c, e), (q, Z)), ((p, d, e), (r, Z)), ((q, a, e), (q, a)), ((q, b, a), (s, e)), ((q, b, Z), (t, e)), ((q, \$, a), (k, e)),$
$((s, b, a), (s, e)), ((s, b, Z), (t, e)), ((t, b, e), (t, e)),$
$((t, \$, e), (x, e)), ((s, \$, a), (k, e)), ((k, e, a), (k, e)), ((r, a, e), (r, aa)), ((r, \$, Z), (m, e)),$
$((r, b, a), (l, e)), ((l, b, a), (l, e)), ((v, \$, Z), (m, e))\}$
We manage to construct a PDA with no compatible transitions, so this language is determinstic.

K = { p, q, r, s, t, k, l, m }
$\sum = \{a, b, c, d, \$\}$
$\Gamma = \{a, Z\}$
s = p
F = {t,l,m}
$\triangle = \{((p, e, e), (q, Z)), ((q, a, e), (q, aa)), ((q, c, e), (r, e)), ((q, d, e), (s, e)),$
$((r, b, aa), (r, e)), ((r, \$, aa), (t, e)), ((t, e, aa), (t, e)), ((r, b, Z), (k, e)),$
$((k, b, e), (k, e)), ((k, \$, e), (l, e)), ((s, b, a), (s, e)), ((s, \$, a), (s, e)), ((s, \$, Z), (m, e))\}$
Since we have no compatible transitions, this PDA is deterministic. Therefore CFL is deterministic.

b.