CENG 280
Formal Languages and Abstract Machines
Spring 2021-2022
Homework 2

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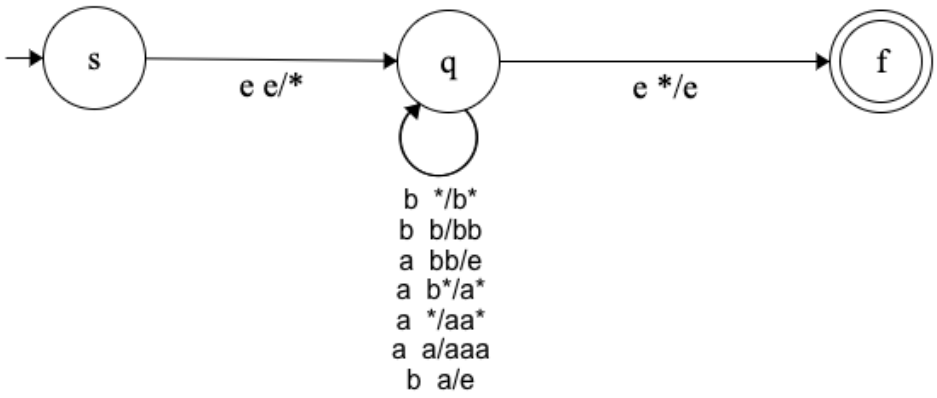
1. (a) $S \rightarrow aSbSb|bSaSb|bSbSa|SS|\epsilon$

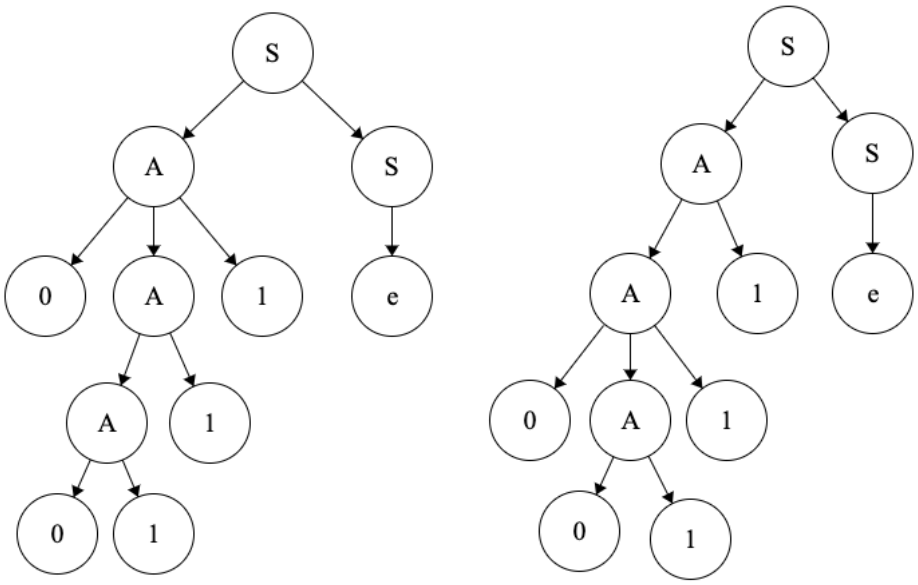
   (b) $S \rightarrow aSb|aSbb|\epsilon$

   (c) $M = (K, \sum, \Gamma, \Delta, s, F)$
   $K = \{s, q, f\}$
   $\sum = \{a, b\}$
   $\Gamma = \{*, a, b\}$
   $F = \{f\}$
   $\Delta = \{((s, \epsilon, \epsilon), (q, *)), ((q, b, *), (q, b*)), ((q, b, b), (q, bb)), ((q, a, bb), (q, \epsilon)), ((q, a, b*), (q, a*)),$
   $((q, a, *), (q, aa*)), ((q, a, a), (q, aaa)), ((q, b, a), (q, \epsilon)), ((q, \epsilon, *), (f, \epsilon))\}$



   (d) $S \rightarrow A|B$
   $A \rightarrow aAbAb|bAaAb|bAbAa|AA|\epsilon$
   $B \rightarrow aBb|aBbb|\epsilon$

2. (a) To be ambiguous, G_1 has to have more than one parse tree for some string. If we take 00111 string as example string, we get two different parse trees for its two derivations. Thus G_1 is ambiguous.
$S \to AS \to 0A1S \to 0A11S \to 00111S \to 00111$
$S \to AS \to A1S \to 0A11S \to 00111S \to 00111$



(b) $R' = \{S \to AS|e, A \to 0A1|B, B \to B1|01\}$

(c) $S \to AS \to 0A1S \to 0B1S \to 0B11S \to 00111S \to 00111$