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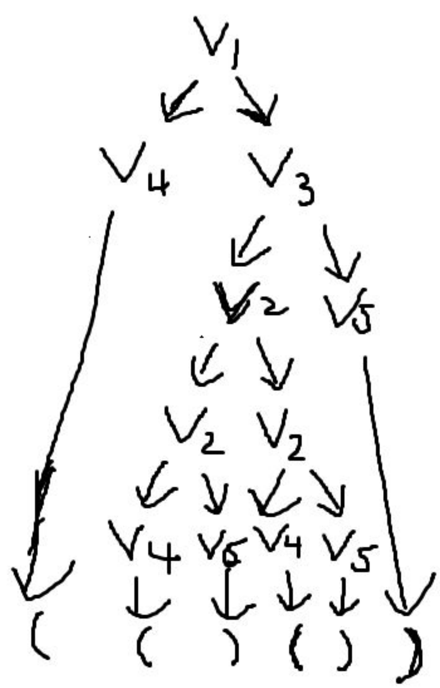
HW 6

1) a) w = “(())(()())”
P[1, 4, 5] = true → ‘)’ , V5
P[1, 5, 3] = false → ‘(‘ , V4
P[5, 2, 1] = false → “())((” , {}
P[9, 2, 3] = false → “())(()())” , {}

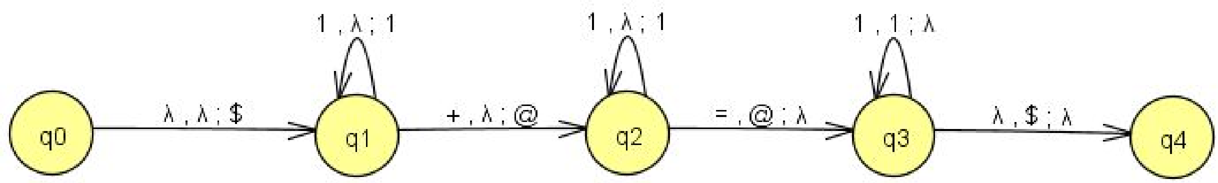
b) Leftmost derivation: V1 → V4V3 → (V3 → (V2V5 → (V2V2V5 → (V4V5V2V5 → ((V5V2V5 → (()V2V5 → (()V4V5V5 → (()(V5V5 → (()()V5 → (()())

Parse Tree:



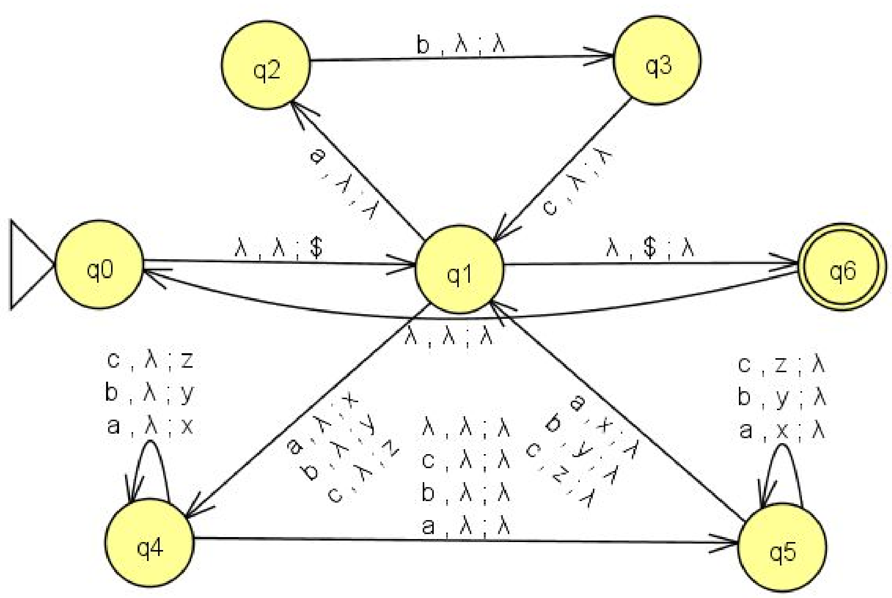
2) a) S → A+A=A
A → AA | 1

b)



3) a) $S \rightarrow SS \mid T \mid abc \mid \varepsilon$
$T \rightarrow aTa \mid bTb \mid cTc \mid U$
$U \rightarrow a \mid b \mid c \mid \varepsilon$

b)



4) a) L(P) accepts strings that are in $L = \{ a^n b^k c^{2(n-k)} \mid n >= k, k >= 0 \}$
For example, P may accept a string with the same number of a's and b's with no c's, or P may accept a string with double the amount of c's as a's with no b's.

b) Suppose A is context-free with pumping length p.

Then, by the context-free pumping lemma every s in A of length >= p has a pumpable decomposition.
Let $s = a^{2p}b^{p}c^{2p}$
Consider any decomposition s = uvxyz with |vxy| <= p, |vy| > 0
The key observation is that if you pump only a's b's or c's, then the ratio of the string will no longer be accepted in the language.
Case 1: v or y includes only a's. Then uvvxyyz = $a^{2(p+k)}b^{p}c^{2p}$ for some k > 0 is not in A, as there are too many a's compared to b's and c's.
Case 2: v or y includes only b's. Then uvvxyyz = $a^{2p}b^{p+k}c^{2p}$ for some k > 0 is not in A, as there are too many b's compared to a's and c's.
Case 3: v or y includes only c's. Then uvvxyyz = $a^{2p}b^{p}c^{2(p+k)}$ for some k > 0 is not in A, as there are too many c's compared to a's and b's.
This contradicts the pumping lemma, so A is context-sensitive.