Theory of Computation
CS F351

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Lecture - 18

Review

$Q \times \Sigma \rightarrow Q$

1. Deterministic FA is defined as a quintuple (Q, ∑, δ, s, F).
   - δ is a transition function from Q x ∑ to Q.
2. NDFA is defined as a quintuple (Q, ∑, δ, s, F).
   - δ is a transition relation and is a finite subset of (Q x (∑ U { ϵ }) x Q)
3. CFG is defined as four tuples (V, ∑, R, S).
   - V is a finite set of non-terminals. and terminals
   - ∑ is a finite set of terminals.
   - R is the set of production rules and is a finite subset of $\boxed{V \times V^*}$. In other words, its elements are of the form $\alpha \rightarrow \beta$, where $\alpha \in \cancel{V}$, and $\beta \in \cancel{V^*}$. $(V \cup \Sigma)^*$ $(V-\Sigma) \times V^*$ $(V-\Sigma)$
   - S is the start symbol (or non-terminal), and S $\in$ V.

4. PDA is defined as a six tuple (Q, ∑, **τ**, **Δ**, s, F).
   - **Δ** is defined as a transition relation and is a finite subset of (Q x (∑ U {ϵ}) x **τ***) x (Q x **τ***)

     pushed on the stack.

     popped out of stack
   - What is the acceptance criteria of a string by a given PDA?

Review

1. Every Finite Automata can be viewed as a PDA that never operates on its stack: True/False.

Given a DFA $M = (Q, \Sigma, \delta, s, F)$, construct a correspond

PDA $M_1 = (Q', \Sigma', \Gamma, \Delta, s', F')$

$M_1 = (Q, \Sigma, \phi, \Delta, s, F)$

$\Delta \Rightarrow ?$ for every $(p, u, q) \in \delta$,
include $(p, u, \epsilon)(q, \epsilon)$ in Δ.

Review

1. For every ambiguous grammar, there always exists a corresponding unambiguous grammar. True/False.

$L = \{ a^i b^j c^k \mid i = j \text{ OR } j = k \}$

→ Inherently Ambiguous.

$S \rightarrow S_1 \mid S_2$

$S_1 \rightarrow S_1 c \mid A$

$A \rightarrow aAb \mid \epsilon$

$S_2 \rightarrow aS_2 \mid B$

$B \rightarrow bBc \mid \epsilon$

Review

There always exists an unambiguous grammar for each regular language. True / False.

Review

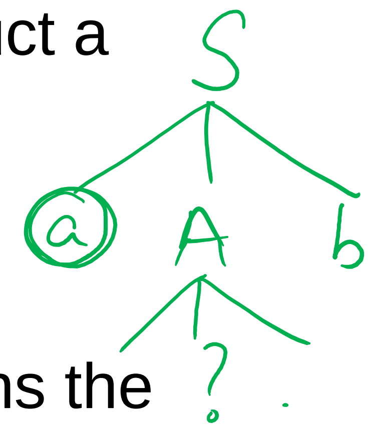
What is a leftmost derivation and rightmost derivation?

Review

Theorem: Each CFG is accepted by some PDA.

1) Let G = (V, ∑, R, S) be a CFG. Construct a corresponding PDA M such that L(G) = L(M).

2) Let M = (Q, ∑, **τ**, **Δ**, s, F) be a PDA, Construct a corresponding G such that L(M) = L(G)



<u>**Proof of (1)**</u>

M = (Q, ∑, **τ**, **Δ**, s, F)

= ({p, q}, ∑, V U ∑ , **Δ** , $\cancel{S}$ p, {q}), where **Δ** contains the following transitions:

- ((p, ϵ, ϵ), (q, S))
- ((q, ϵ, A), (q, α)), for each rule $A \rightarrow \alpha$ in R
- ((q, a, a), (q, ϵ)), for each terminal $a \in \cancel{R}$ Σ.

Left Most Derivation of String.

Review

$\mathcal{L}(M) = \mathcal{L}(M_1) - \mathcal{L}(M_2)$

innovate achieve lead

You know that Regular Languages are closed under intersection operation. Is there a direct proof for intersection. In other words, given 2 DFA's M1 and M2, how to directly construct a DFA for M, where L(M) = L(M1) ∩ L(M2).

$M_1 = (Q_1, \Sigma, \delta_1, q_1, F_1)$ $\quad M_2 = (Q_2, \Sigma, \delta_2, q_2, F_2)$

$M = (Q, \Sigma, \delta, s, F)$, $L(M) = L(M_1) \cap L(M_2)$

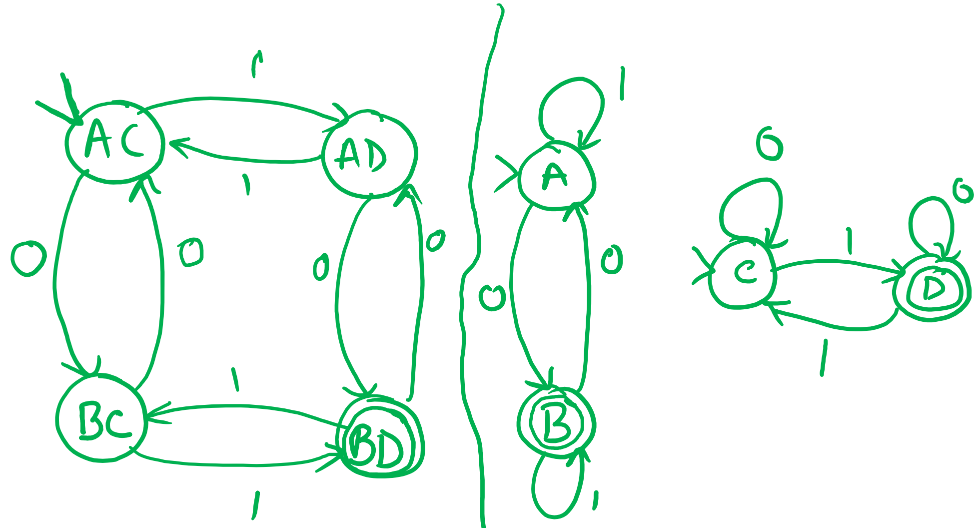
$Q = Q_1 \times Q_2$

$\delta \Rightarrow \delta((p_1, p_2), a) = (\delta(p_1, a), \delta(p_2, a))$

$s = (q_1, q_2)$

$F = F_1 \times F_2$

$= F_1 \times F_2'$?



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Q1) Given a DFA M,

(a) is $L(M) = \phi$?

(b) is $L(M)$ finite ?

(c) Given two DFA's M_1, M_2,

is $L(M_1) \subseteq L(M_2)$.