

18-1 /  $0^n 1^n 0^n \notin \text{CFL}$   $\in \text{ALL}$

DFA  $\Rightarrow$  NFA  $\Rightarrow$  PDA  $\Rightarrow$

$\delta: Q \times M(\Sigma) \rightarrow P(Q)$

$\delta: Q \times M(\Sigma) \times M(\Gamma) \rightarrow P(Q \times M(\Gamma))$

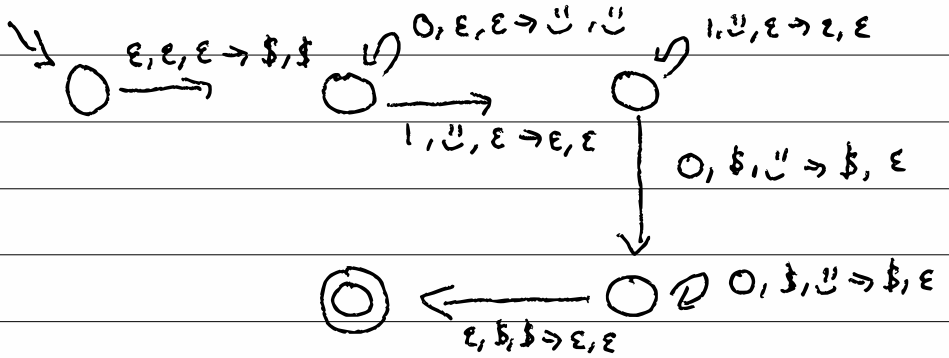
NFA = 0-PDA

PDA = 1-PDA

2-PDA

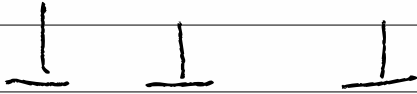
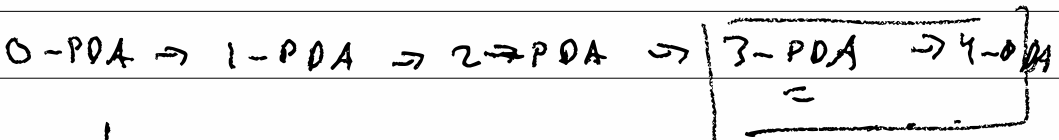
2-PDA solve  $0^n 1^n 0^n$

18-2



what about  $0^n 1^n 0^n 1^n$ ?

... 3-PDA

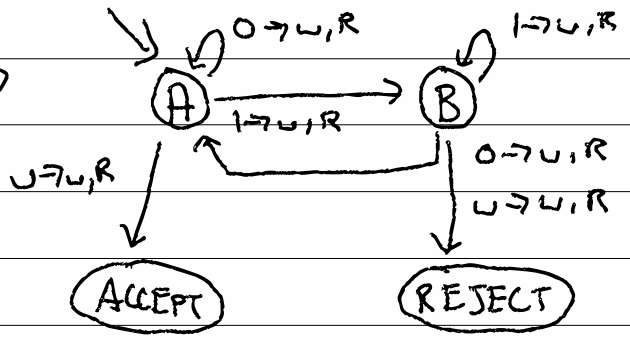
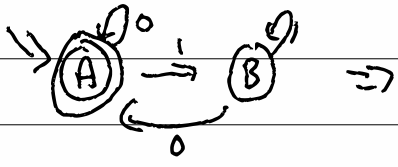


# 18-3/ Turing Machine

Alan Turing 1912

$a \rightarrow b$ , direction (L, R)  
TM

DFA



$\epsilon[A]0110 \rightarrow \epsilon u[A]110 \rightarrow uu[B]10 \rightarrow uu[B]0$   
 $\downarrow$   
 $\checkmark \leftarrow \text{ACCEPT} \leftarrow uuuu[A]\epsilon$

18-4 Turing machine

- read a char
- replace it
- move left or right
- infinite tape
- explicit accept & reject

DFA:  $[q_i]$  input

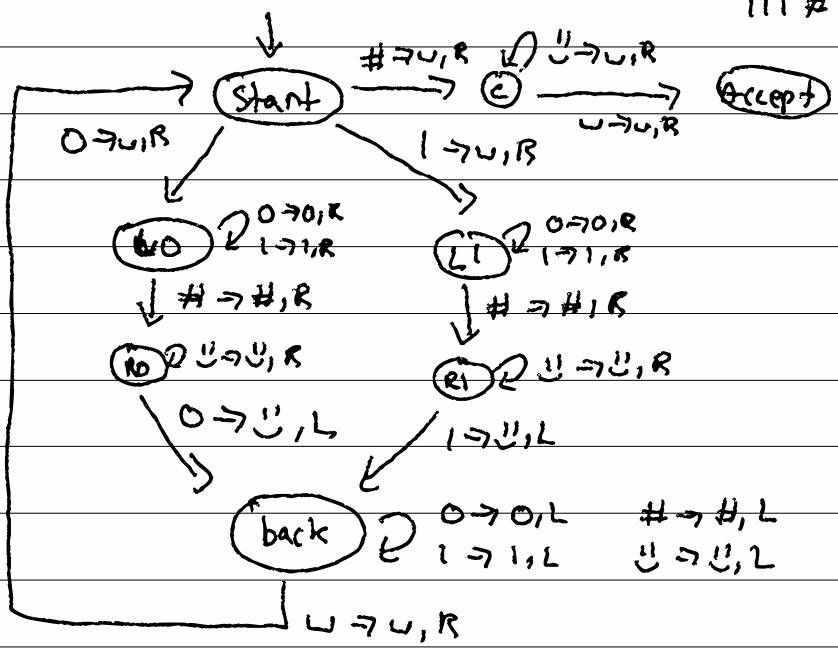
PDA: stack  $[q_i]$  input

T M: tape to the left  $[q_i]$  tape to the right

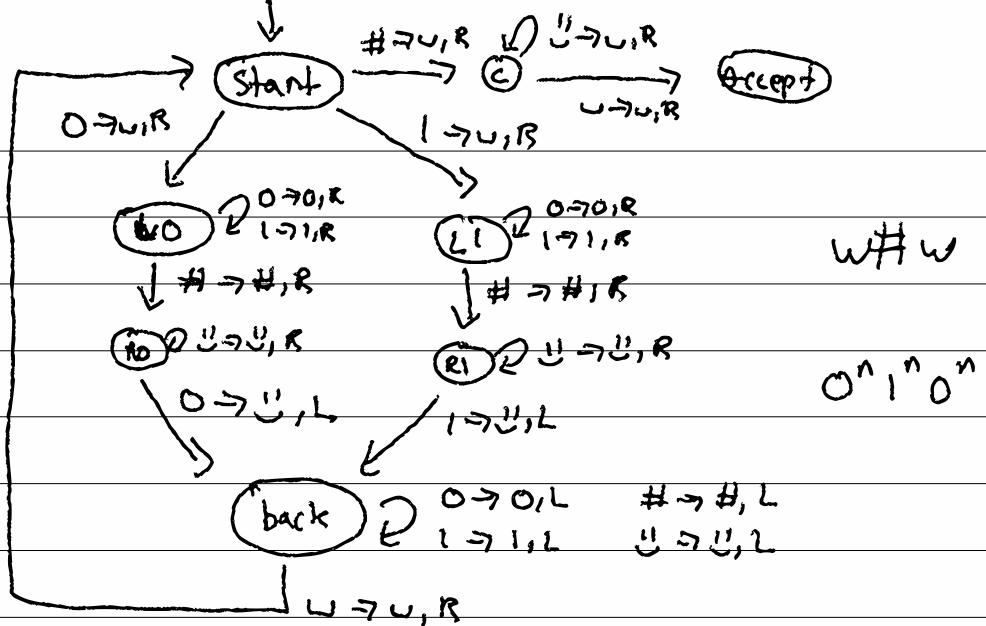
18-5)  $0^n 1^n 0^n$

$\{ w\#w \mid w \in \{0,1\}^* \}$

01#01  
111#111



18-6



$w [S] 01\#01 \rightarrow uu [LO] 1\#01 \rightarrow uu [LO] \#01 \rightarrow$   
 $uu \# [RO] 01 \rightarrow uu [B] \# \cup 1 \rightarrow uu [B] \# \cup 1 \rightarrow$   
 $w [B] u \# \cup 1 \rightarrow uu [S] \# \cup 1 \rightarrow uu [LI] \# \cup 1 \rightarrow$   
 $uu \# [RI] \cup 1 \rightarrow uu \# \cup [RI] 1 \rightarrow uu \# [B] \cup \cup \rightarrow$   
 $uu \# [B] \# \cup \cup \rightarrow uu [B] u \# \cup \cup \rightarrow uu [S] \# \cup \cup \rightarrow \cup [C] \cup \cup \rightarrow$   
 $\cup [C] \cup \rightarrow \cup [C] u \rightarrow \text{accept} \checkmark$

157 /  $0^n 1^n 0^n$

