RG → CFG

FA → PDA

Context free languages

- **Generator** → Context Free Grammar (CFG) (Type 2)
  - $V \rightarrow (V \cup T)^*$
- **Acceptor** → Push Down Automata (PDA)

Push Down Automata

$Q, \Sigma, \delta, q_0, z_0, F, \Gamma$

- Q → finite set of states
- Σ → input alphabet
- δ → transition fn
- q_0 → Initial state
- z_0 → Bottom of stack
- F → final states
- Γ → Stack Alphabet

(Stack)

Power

DFA = NFA

DPDA < NPDA

PDA

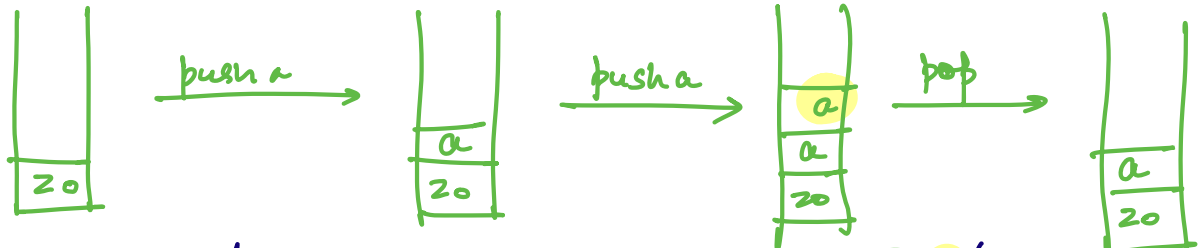
- Deterministic (DPDA)
- Non Deterministic (NPDA)

$Q \times (\Sigma \cup \varepsilon) \times \Gamma \rightarrow Q \times \Gamma^*$

$Q \times (\Sigma \cup \varepsilon) \times \Gamma \rightarrow 2^{(Q \times \Gamma^*)}$

eg: $a^n b^n \mid n \geq 1$

aabb ε



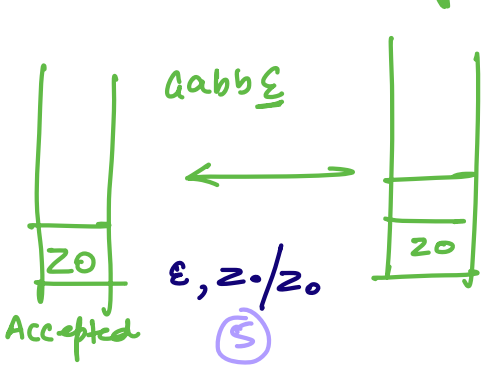
① $a, z_0 / a z_0$

② $a, a / aa$

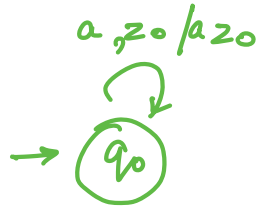
③ $b, a / \varepsilon$

aabbε

④ $b, a / \varepsilon$ pop



(1)



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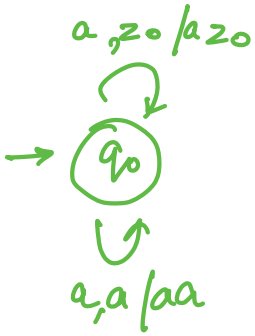

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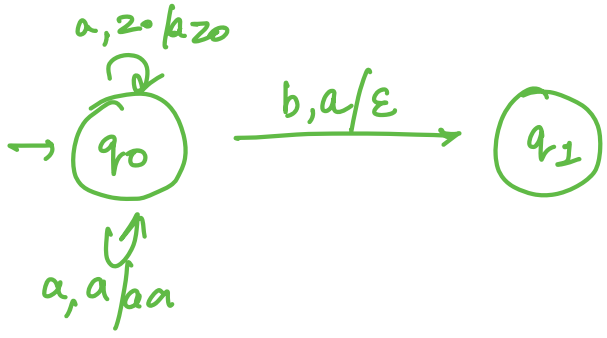

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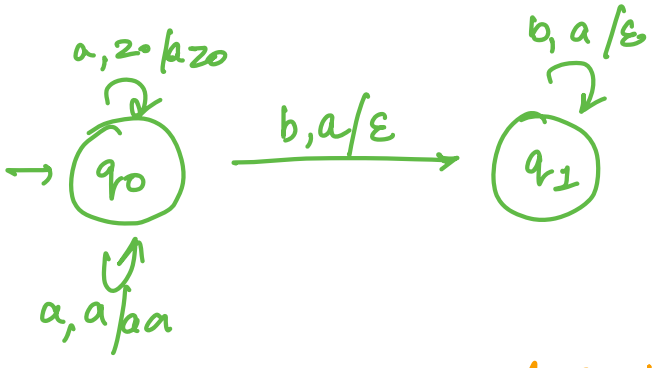

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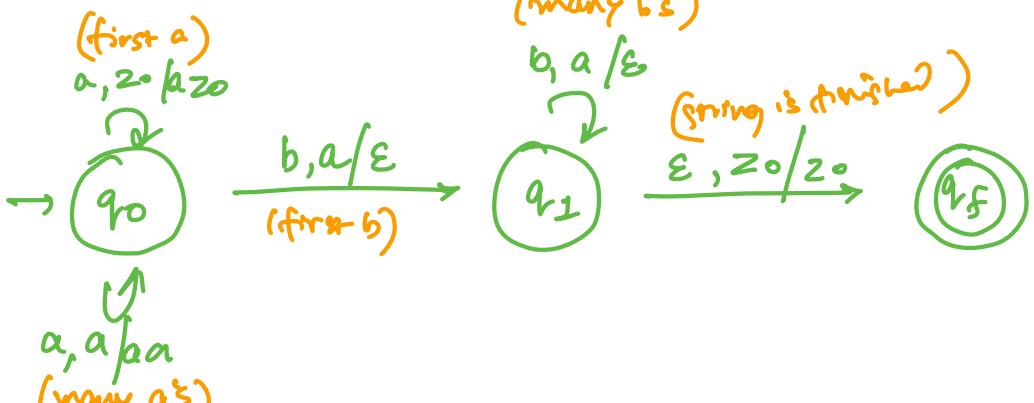


Acceptance by final State.

$\delta : Q \times (\Sigma \cup \varepsilon) \times \Gamma \rightarrow Q \times \Gamma^*$

$\delta(q_0, a, z_0) \rightarrow (q_0, a z_0)$

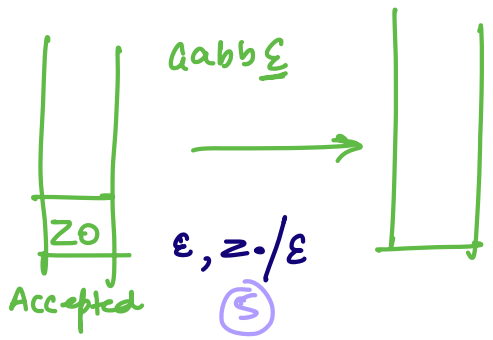
$\delta(q_0, a, a) \rightarrow (q_0, aa)$

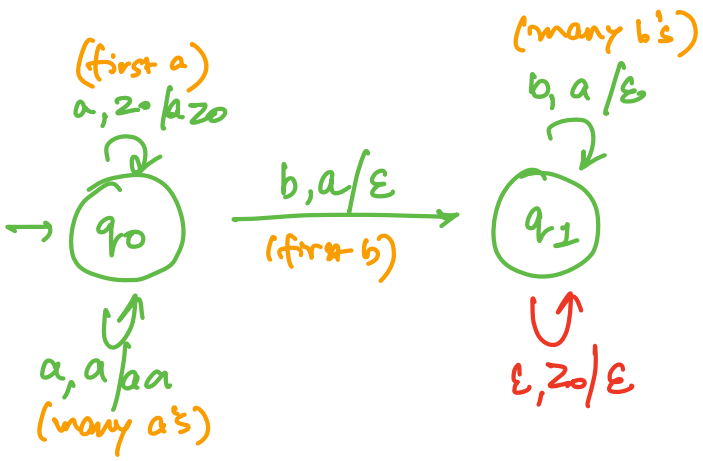
$\delta(q_0, b, a) \rightarrow (q_1, \varepsilon)$

$\delta(q_1, b, a) \rightarrow (q_1, \varepsilon)$

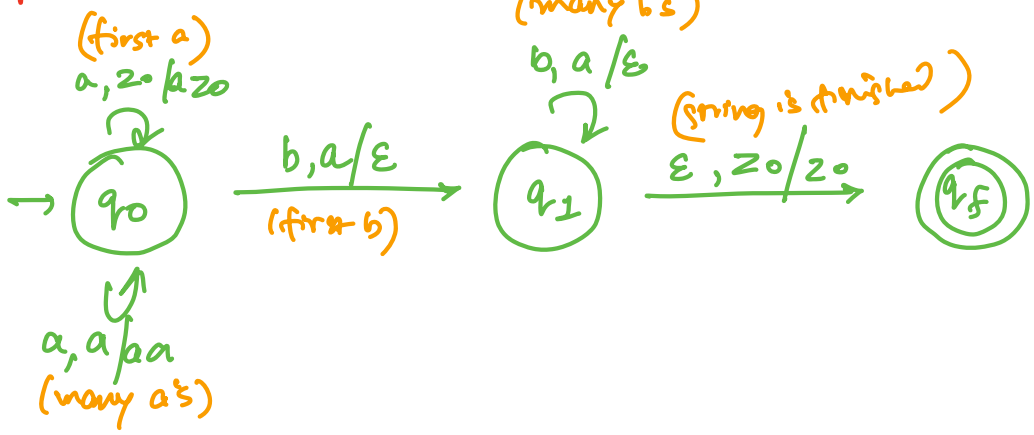
$\delta(q_1, \varepsilon, z_0) \rightarrow (q_f, z_0)$ | Acceptance by final state

Acceptance by empty stack





Strings which dont belong to language



Fully:

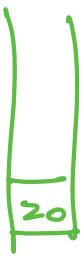
- state, input transition
- 1 state q0.

Partially

- 1 state q0

Non

bab



$(q_0 b, z_0)$?

Not accepted
Dead state

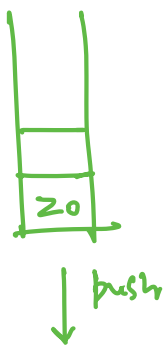
Q: $w \mid n_a(w) = n_b(w)$

Logic:

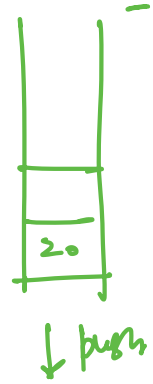
first alphabet → push

a, a b, b	push
a, b b, a	pop

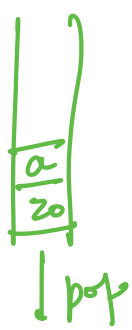
abba



bbaa

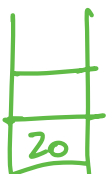


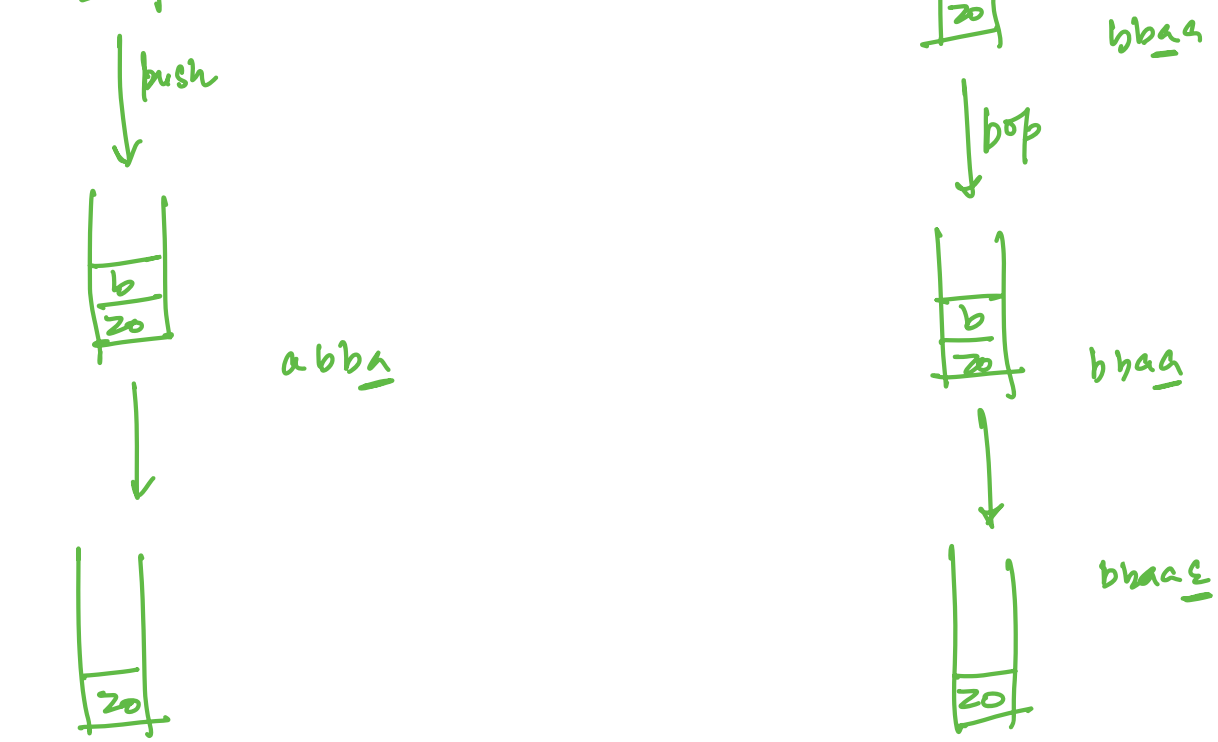
abba

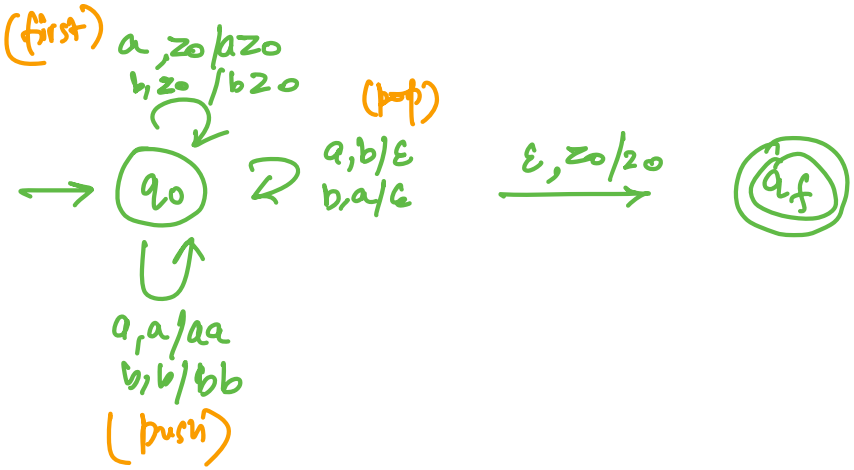


bbaa

abba

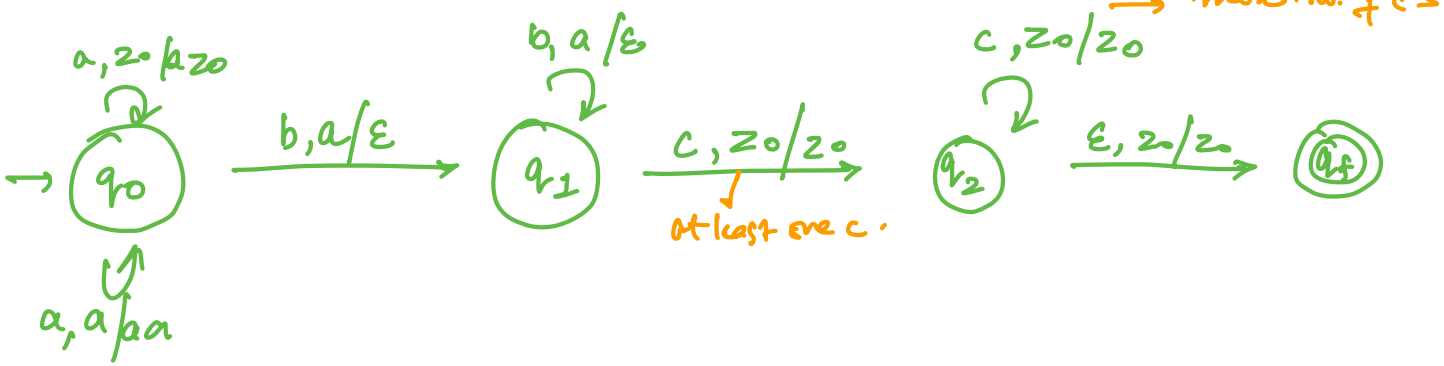






Eg: $a^n b^n c^m \mid n, m \geq 1$

a: push a
b: pop a
c: ignore

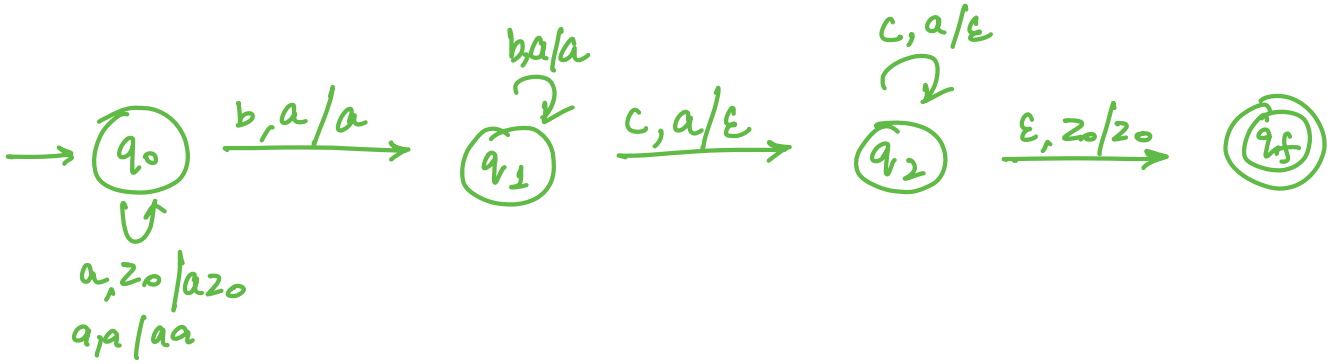


Eg: $a^n b^m c^n \mid n, m \geq 1$

a: push a
b: ignore

≥ 0

c: pop a

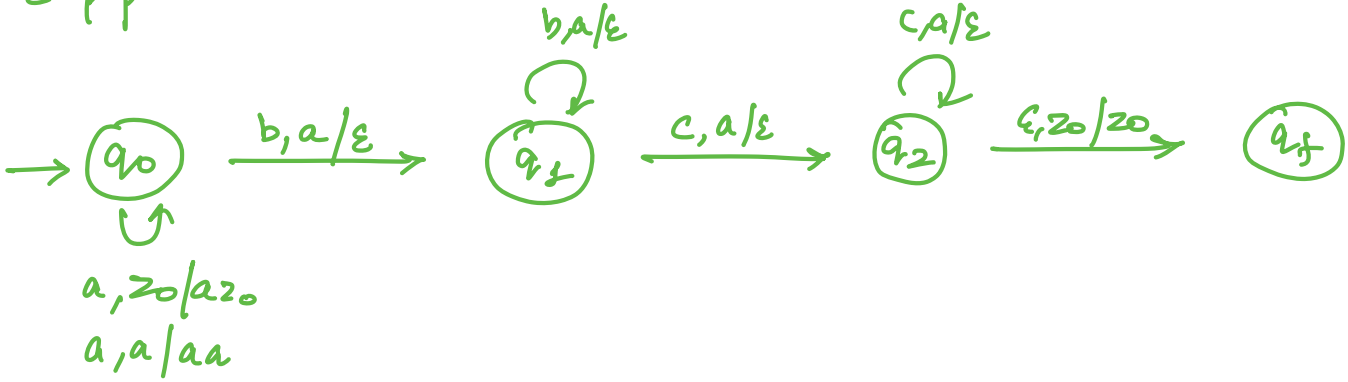


Eg: $a^{m+n} b^m c^n \mid n,m \geq 1$

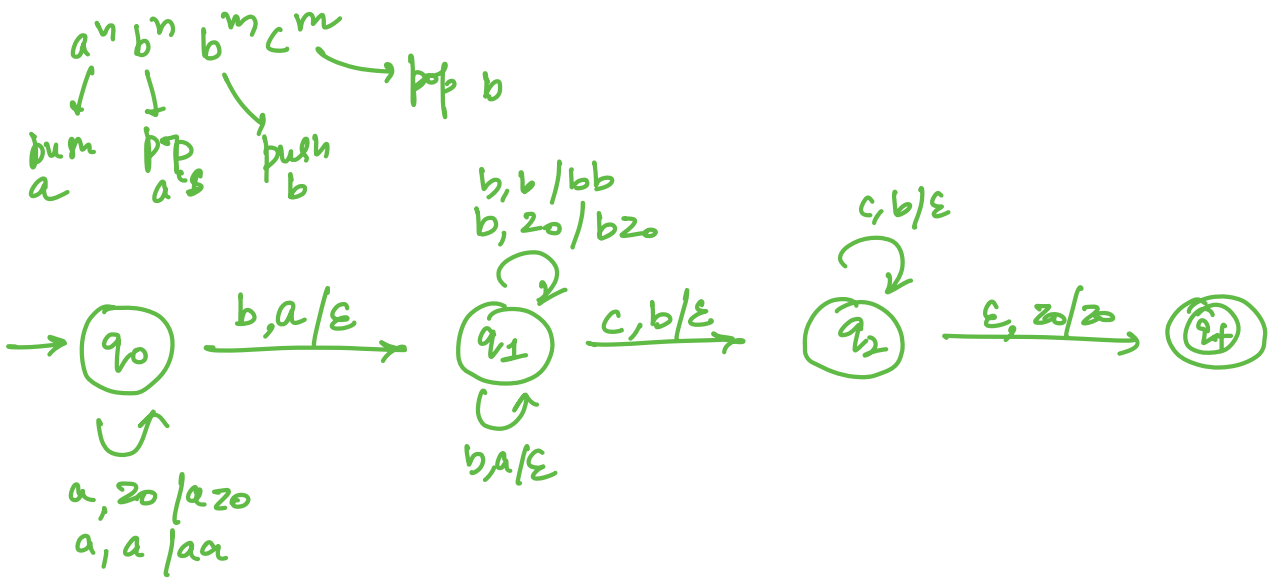
$a^m . a^n b^m c^n$

$a^n a^m b^m c^n$ ✔

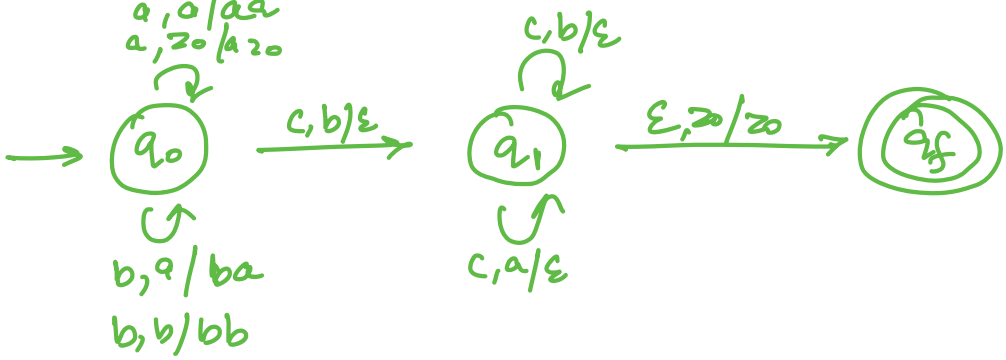
a: push
b: pop a
c: pop a



Eg: $a^n b^{n+m} c^m \mid n,m \geq 1$



Eg: $a^n b^m c^{n+m} \mid n, m \geq 1$

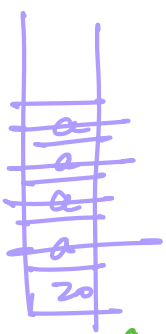


Eg: $a^n b^m c^n d^m \mid n, m \geq 1$

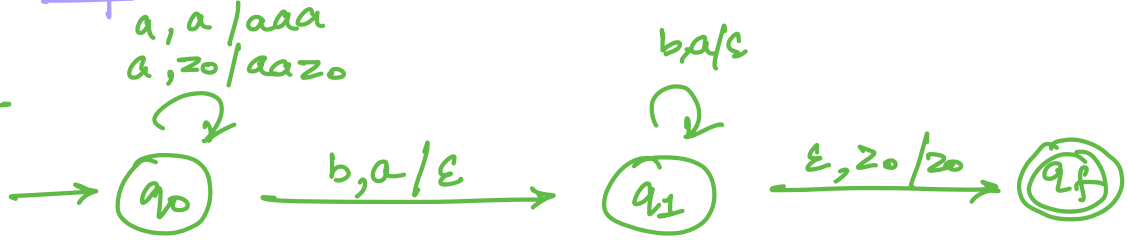
PDA not possible using single stack.

Eg: $a^n b^{2n} \mid n \geq 1$

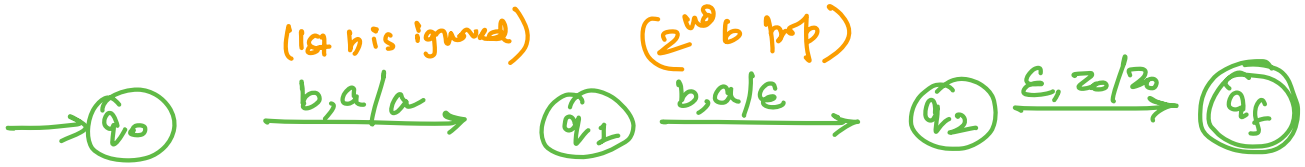
aa bbbb



Way 1:

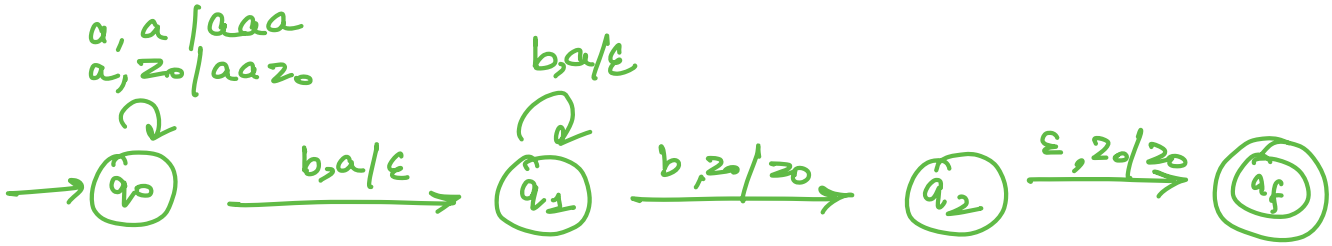


Way 2:

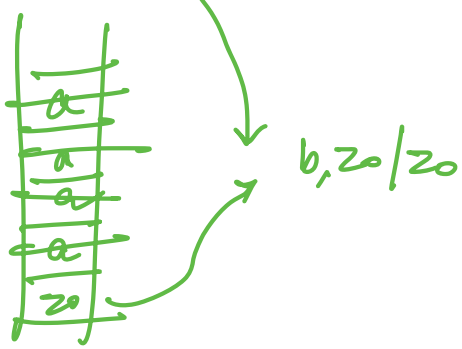


Eg: $a^n b^{2n+1} \mid n \geq 1$

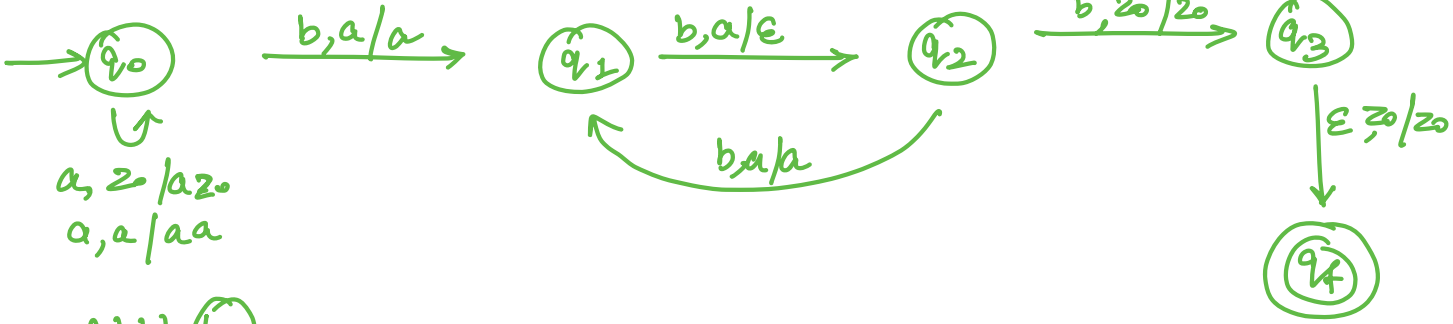
Way 1:



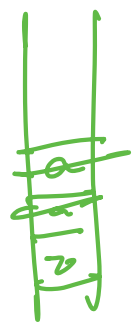
aa bbbbb b



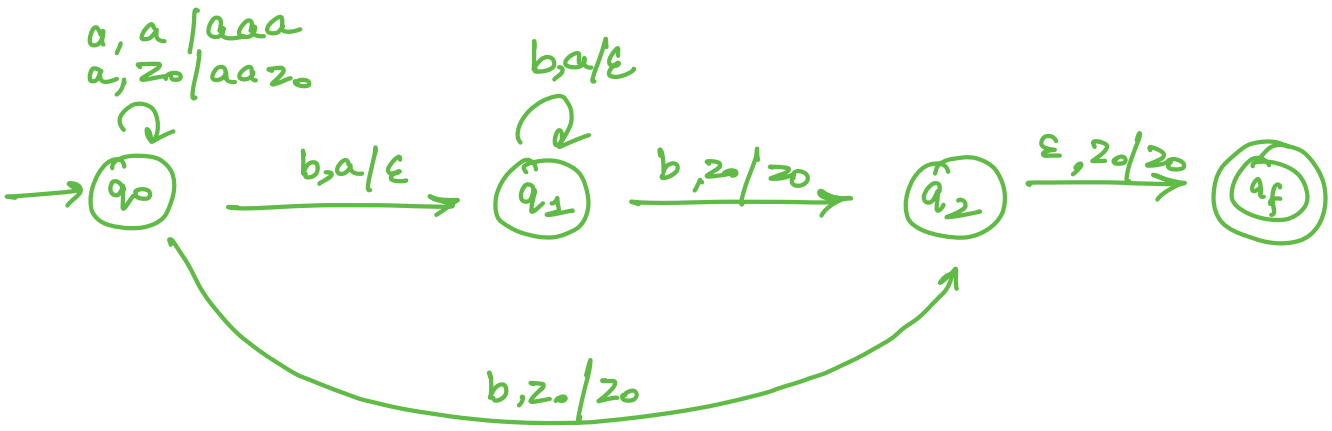
Way 2: aa bbbbb b



aa bbbbb b



Eg: $a^n b^{2n+1} \mid n \geq 0$


a, a / aaa
a, z0 / aa z0
b, a / ε
b, a / ε
b, z0 / z0
ε, z0 / z0
q0
q1
q2
qf
b, z0 / z0