A pushdown automaton (PDA) consists of seven-tuple:

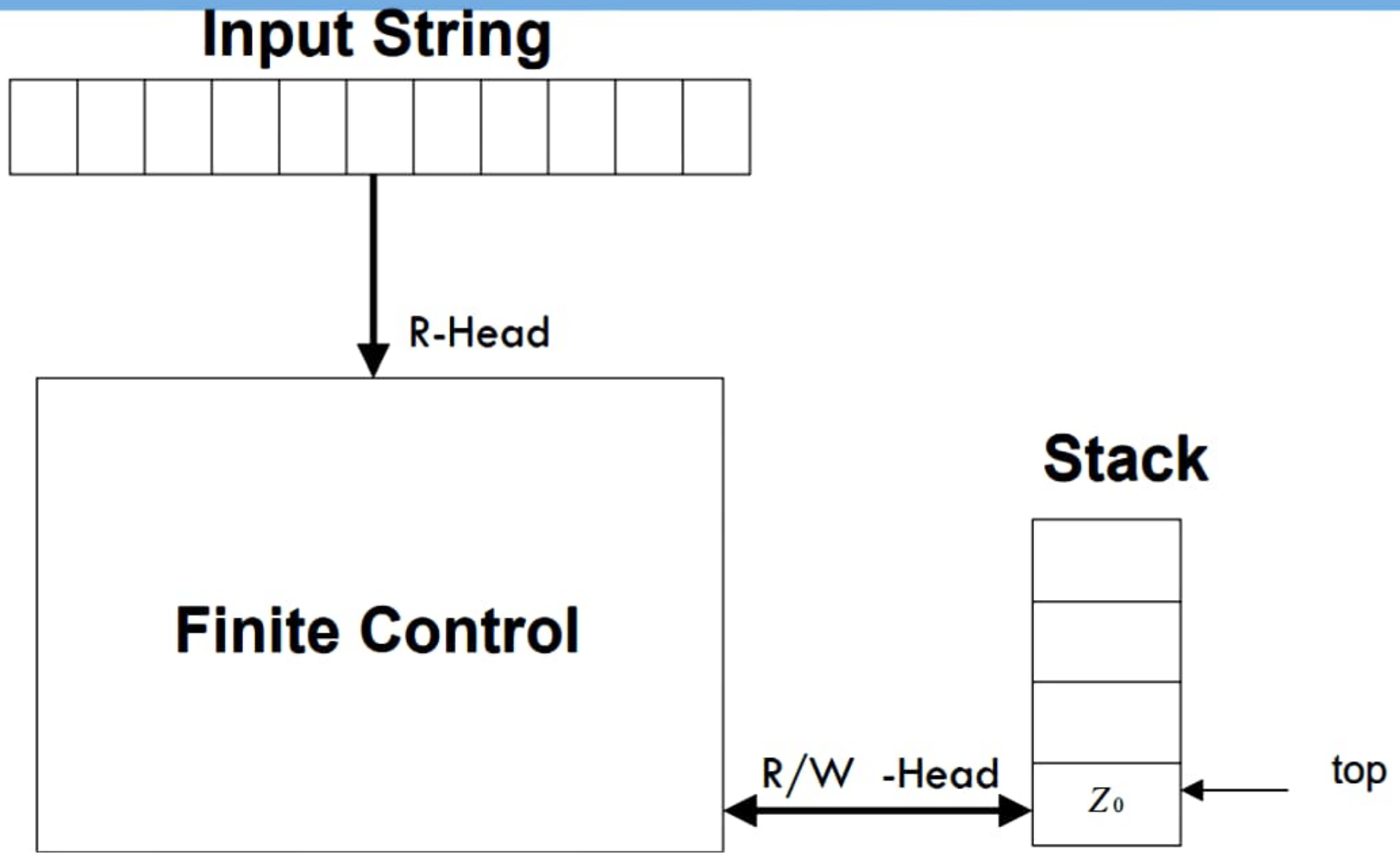
$$M = (Q, \Sigma, \Gamma, \delta, q_0, z_0, F)$$

- Q A finite set of states
- Σ A finite input alphabet
- Γ A finite stack alphabet
- q_0 The initial/starting state, q_0 is in Q
- z_0 A starting stack symbol,
- F A set of final/accepting states, which is a subset of
- δ A transition function, where

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

$\delta: Q \times (\Sigma \cup \{\varepsilon\}) \times \Gamma \rightarrow 2^{Q \times \Gamma^*}$ **(case of NPDA)**

Model of PDA

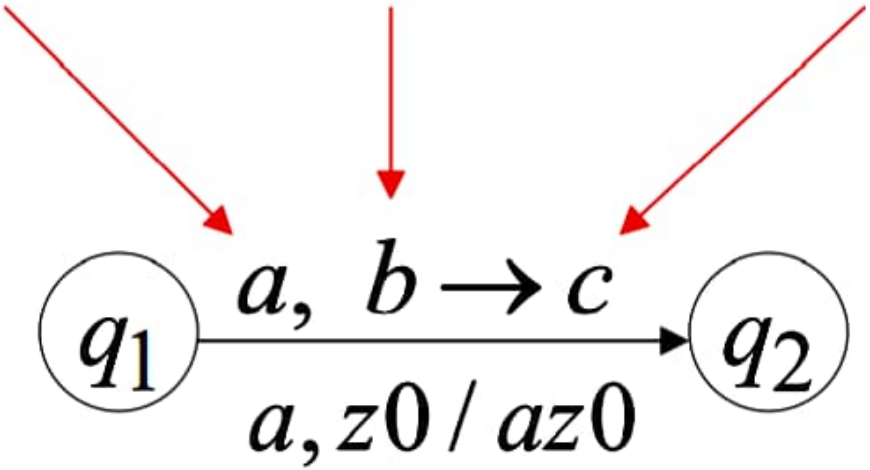


The States

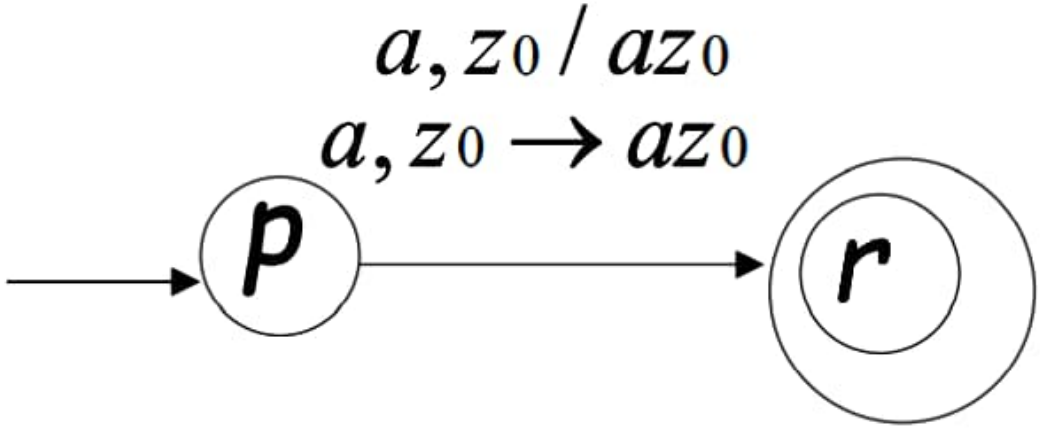
Input symbol

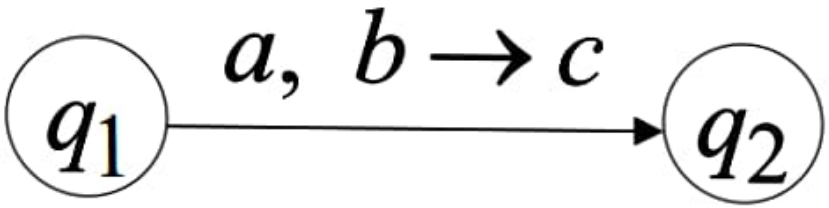
Pop symbol

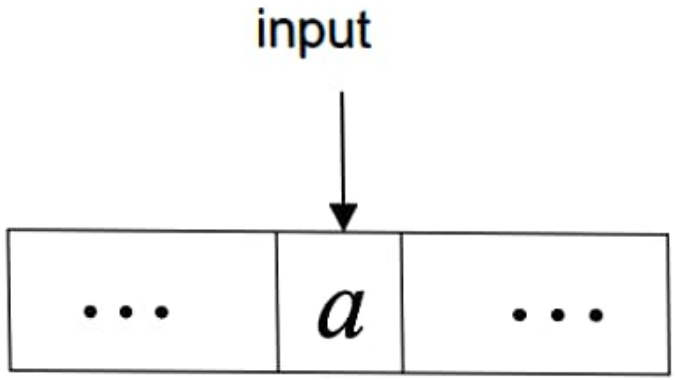
Push symbol



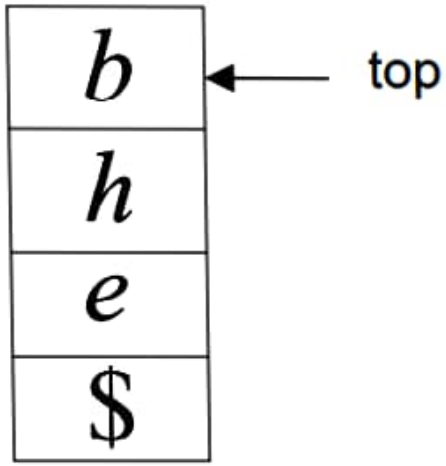
State Representation & Execution

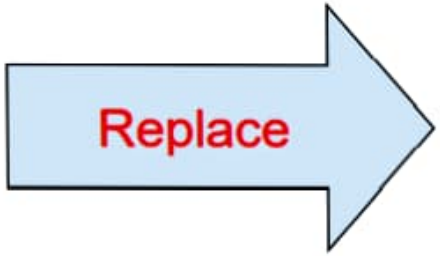


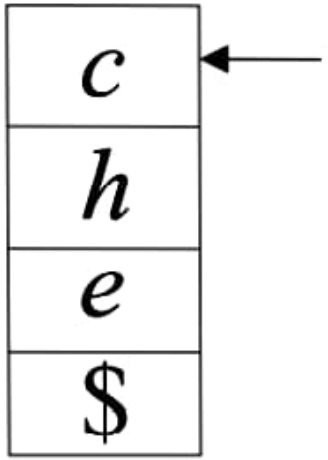


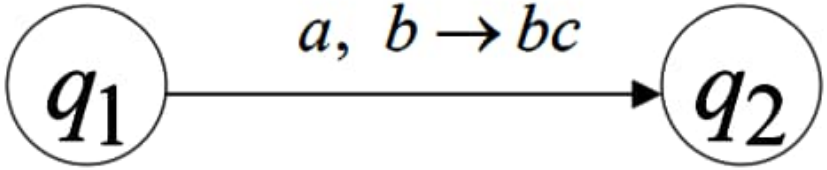


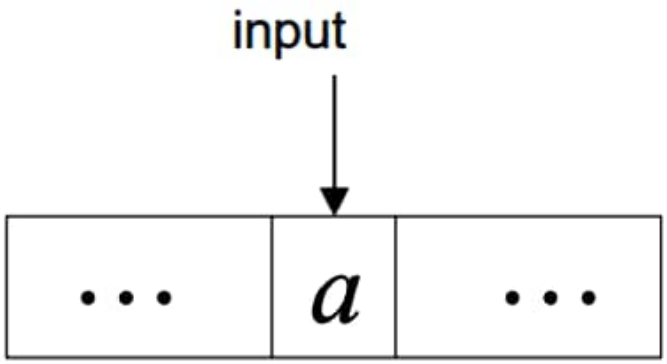
stack

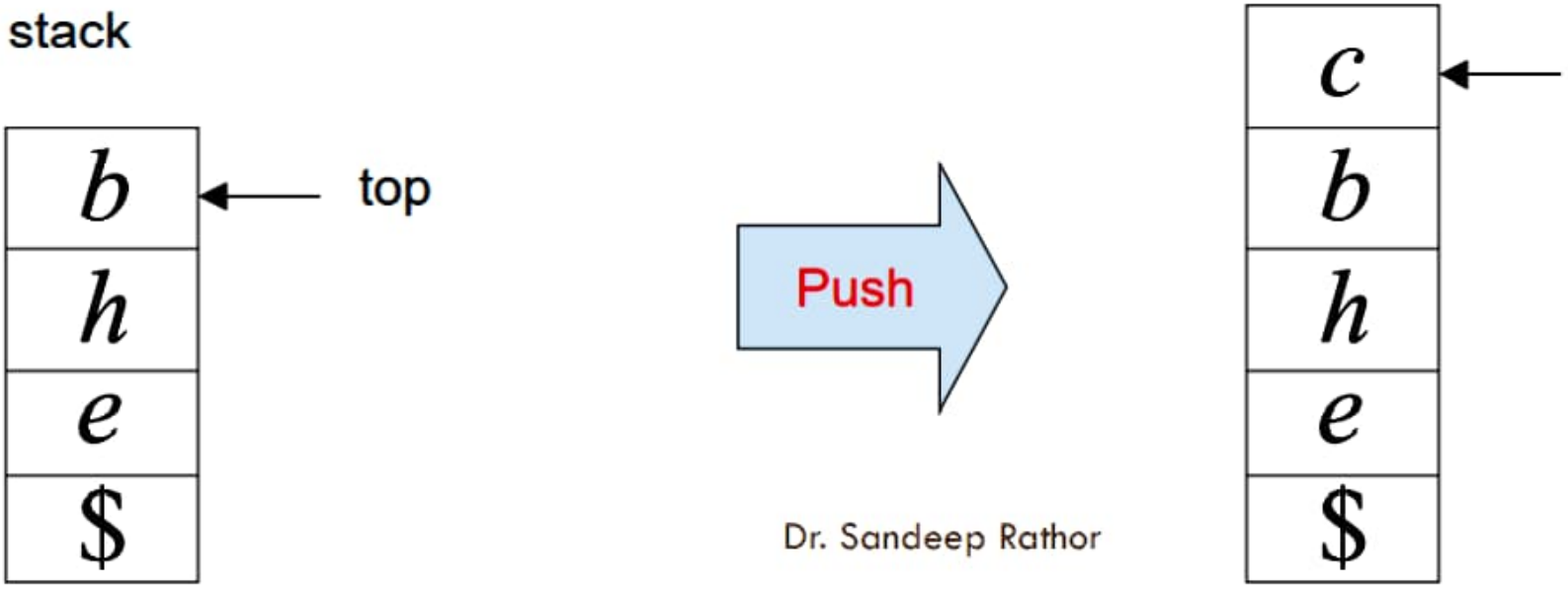


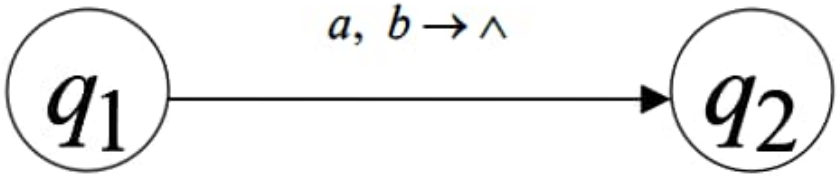


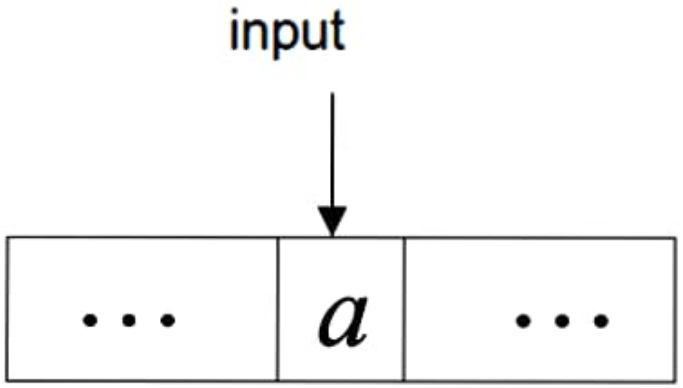



$a,\ b \rightarrow bc$
q_1
q_2

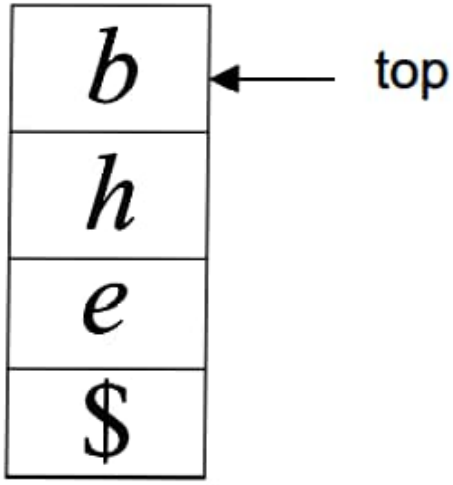

input
...
a
...

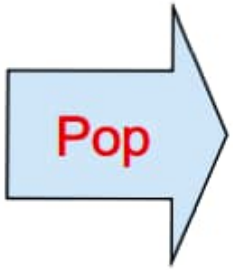

stack
b
top
h
e
$
Push
c
b
h
e
$

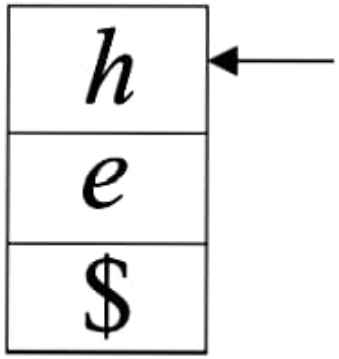




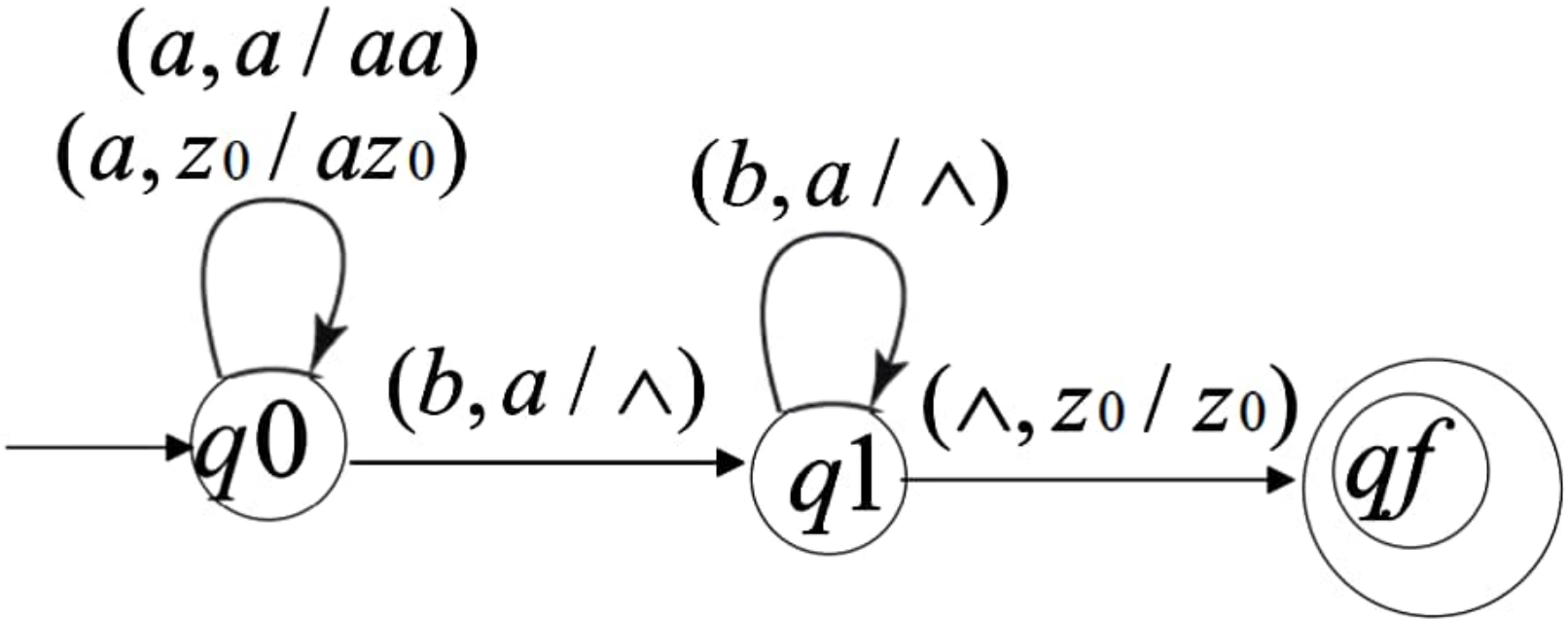
stack







PDA for L={$a^n b^n$: $n \geq 1$}



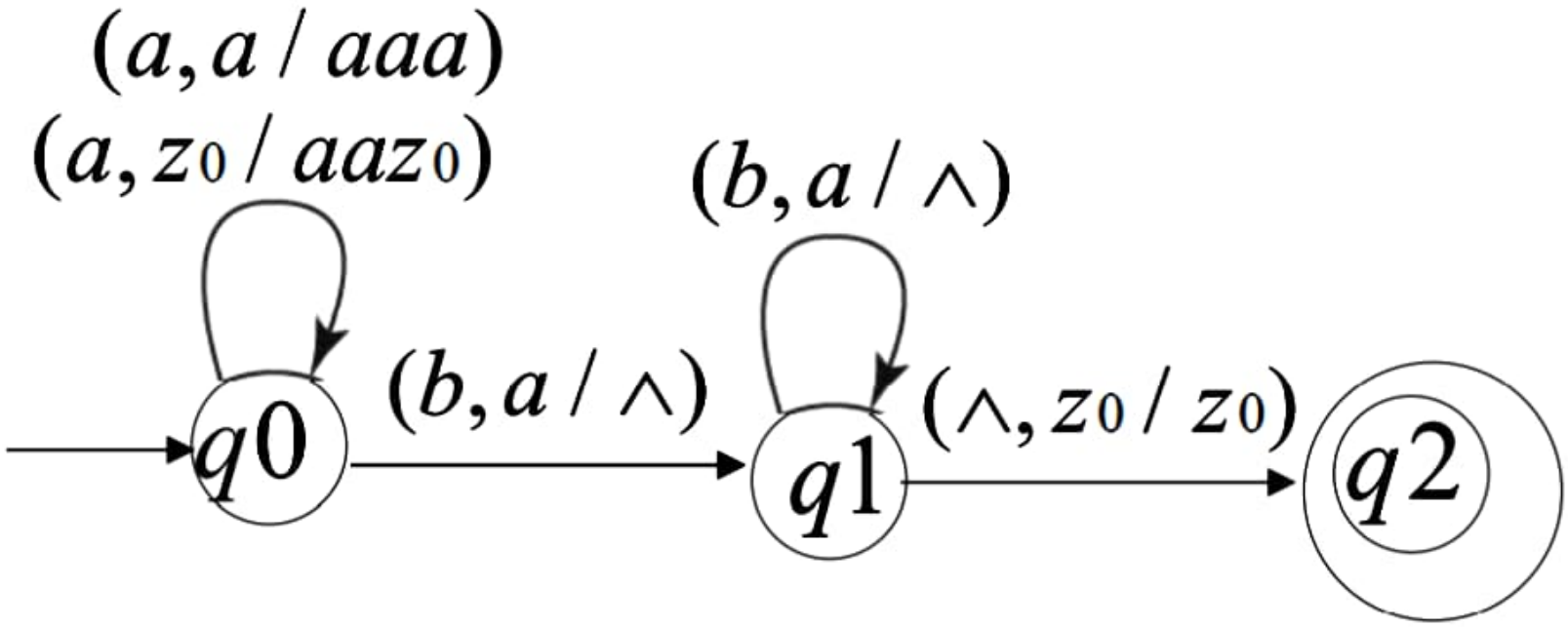
$\delta(q_0, a, Z_0) = (q_0, aZ_0)$
$\delta(q_0, a, a) = (q_0, aa)$
$\delta(q_0, b, a) = (q_1, \varepsilon)$
$\delta(q_1, b, a) = (q_1, \varepsilon)$

$\delta(q_1, \varepsilon, Z_0) = (q_f, Z_0)$ // By Final State

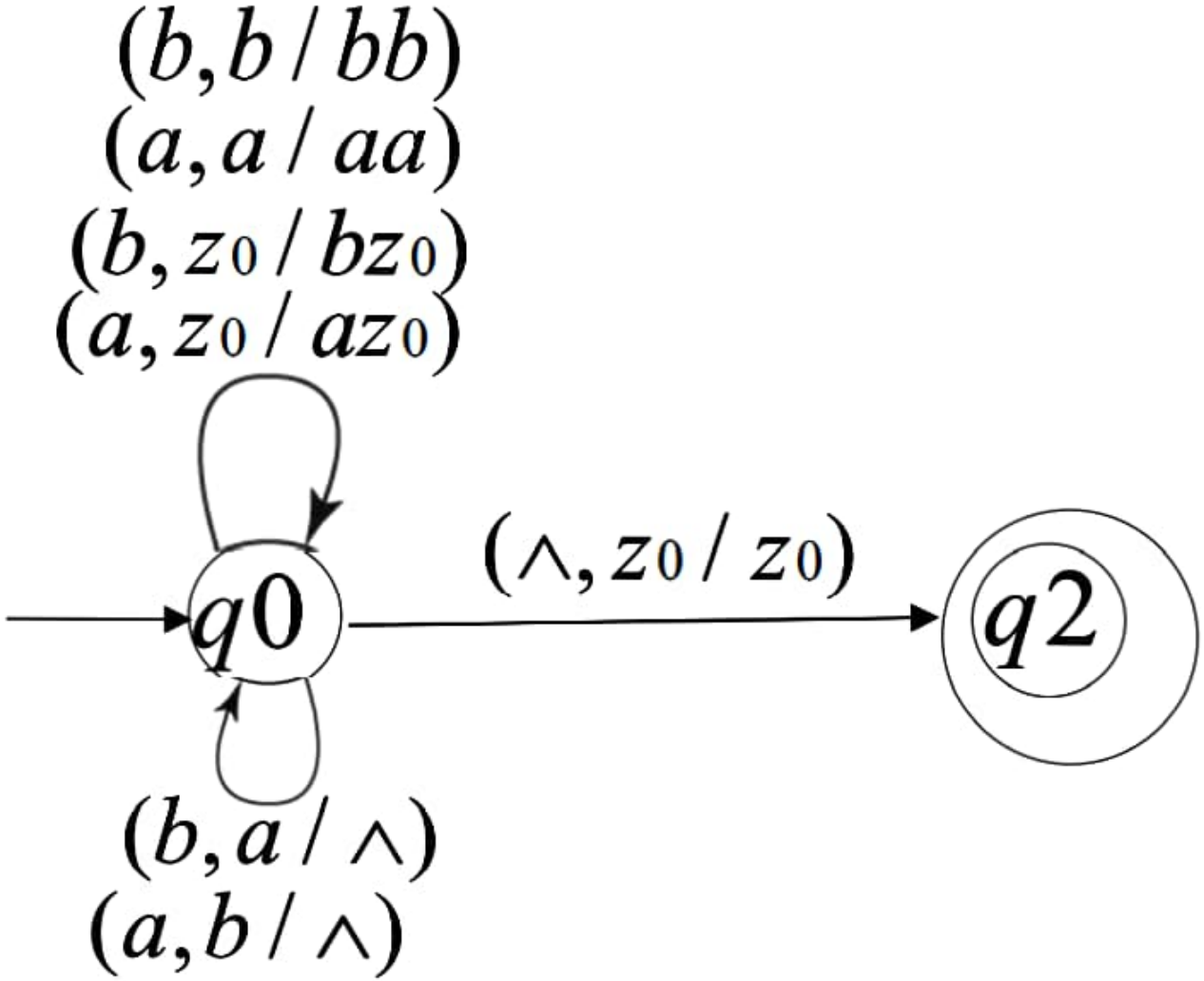
OR

$\delta(q_1, \varepsilon, Z_0) = (q_1, \varepsilon)$// by empty stack

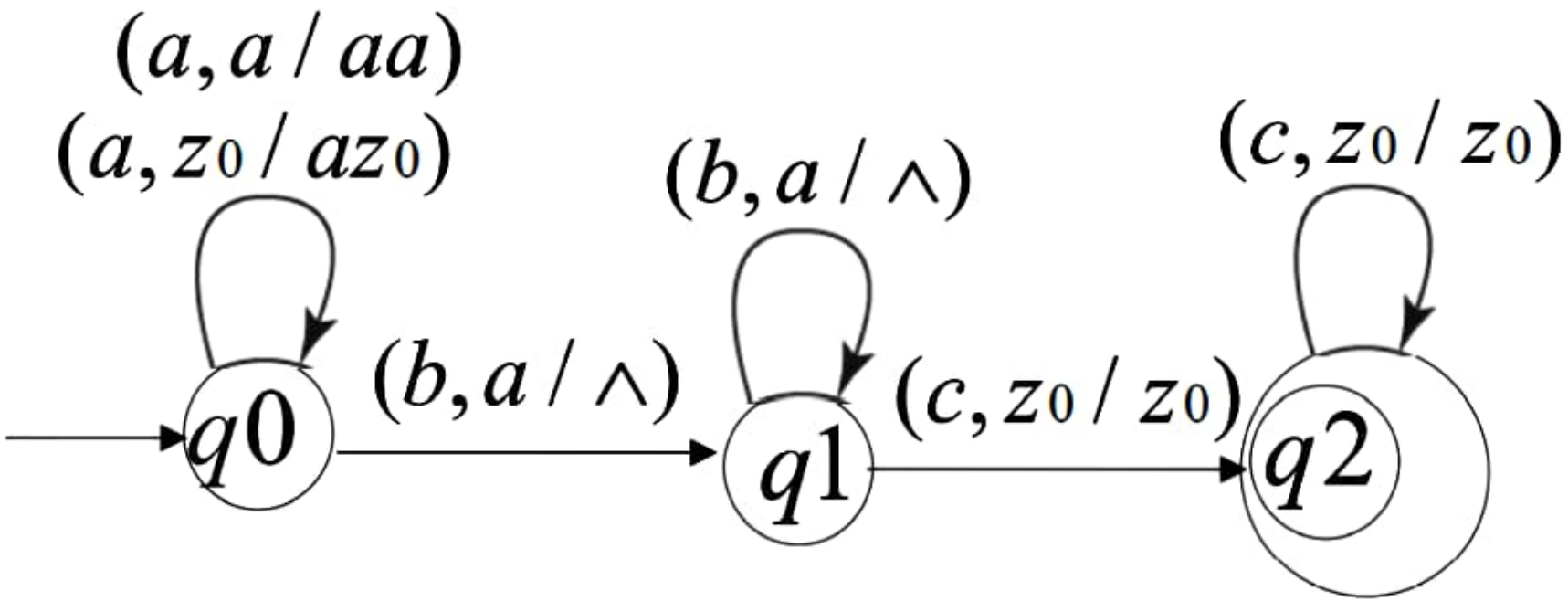
PDA for L={$a^n b^{2n}$: $n \geq 1$}



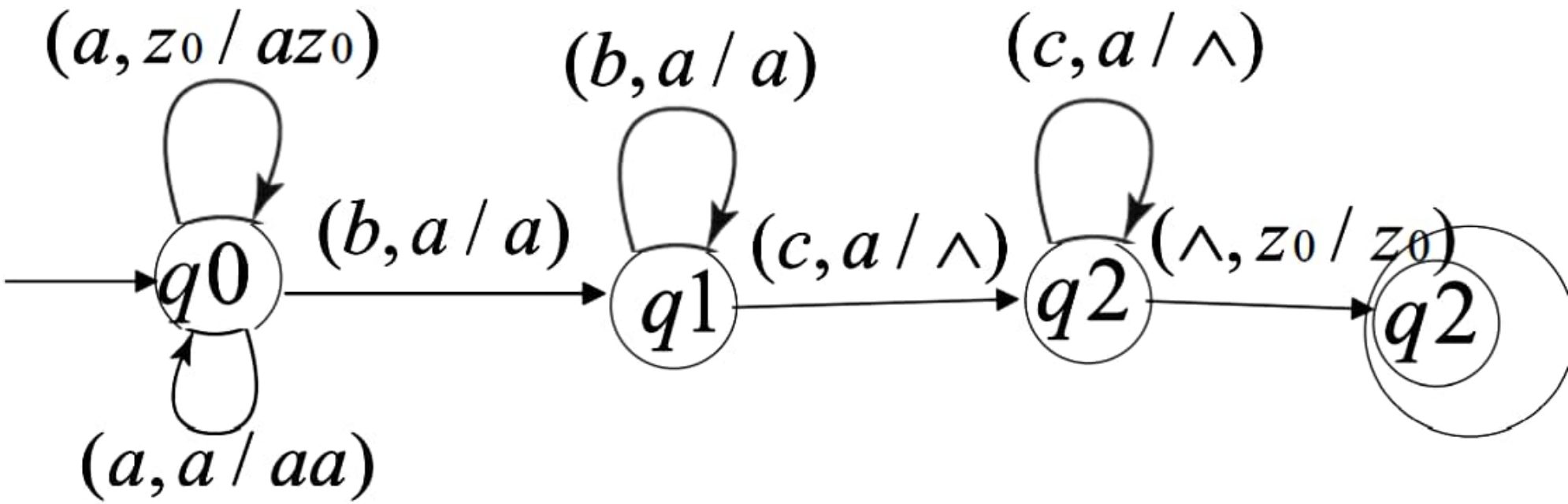
PDA for L={w / $n_a(w) = n_b(w)$}



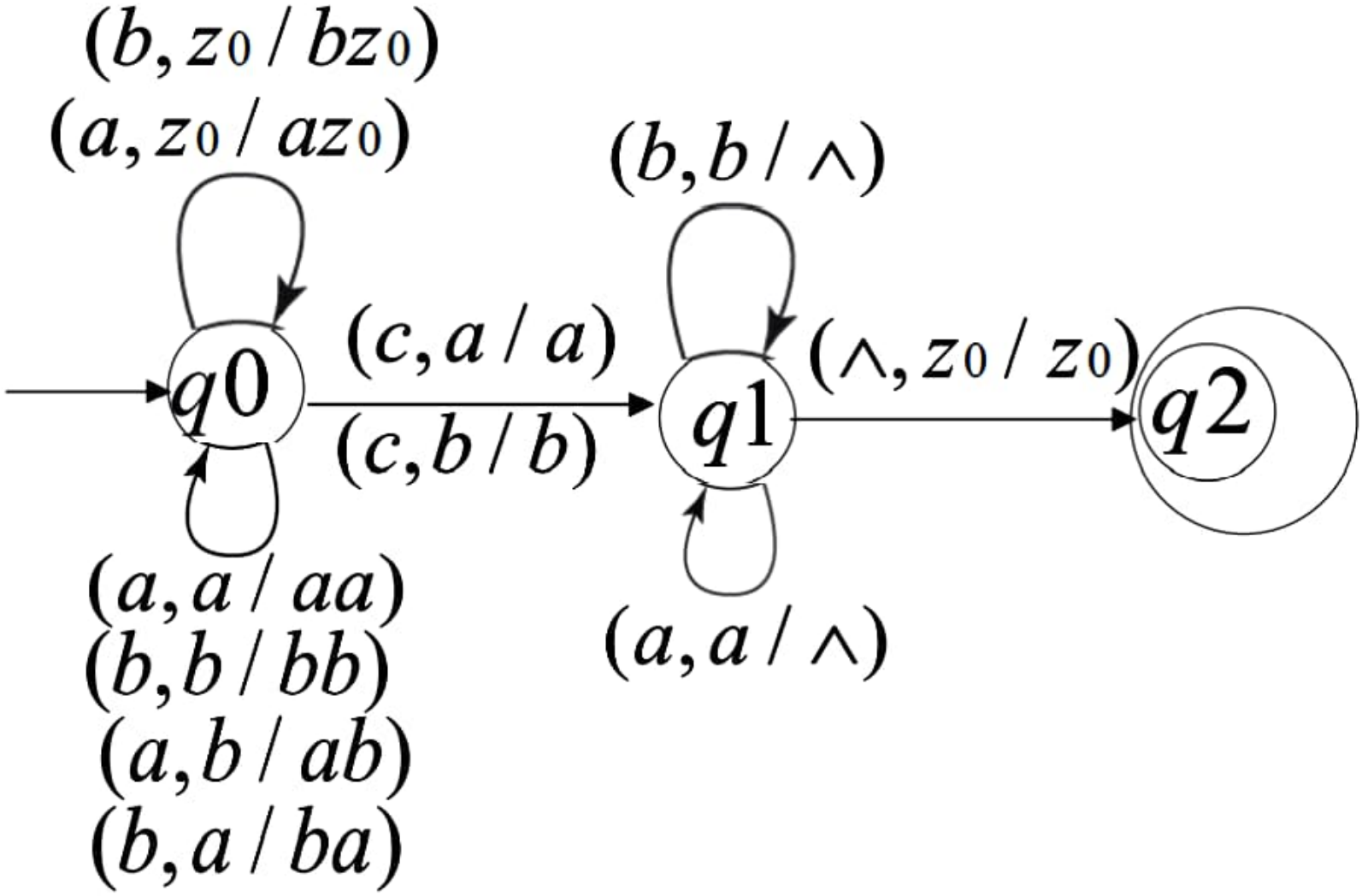
PDA for L={$a^n b^n c^m : n,m \geq 1$}



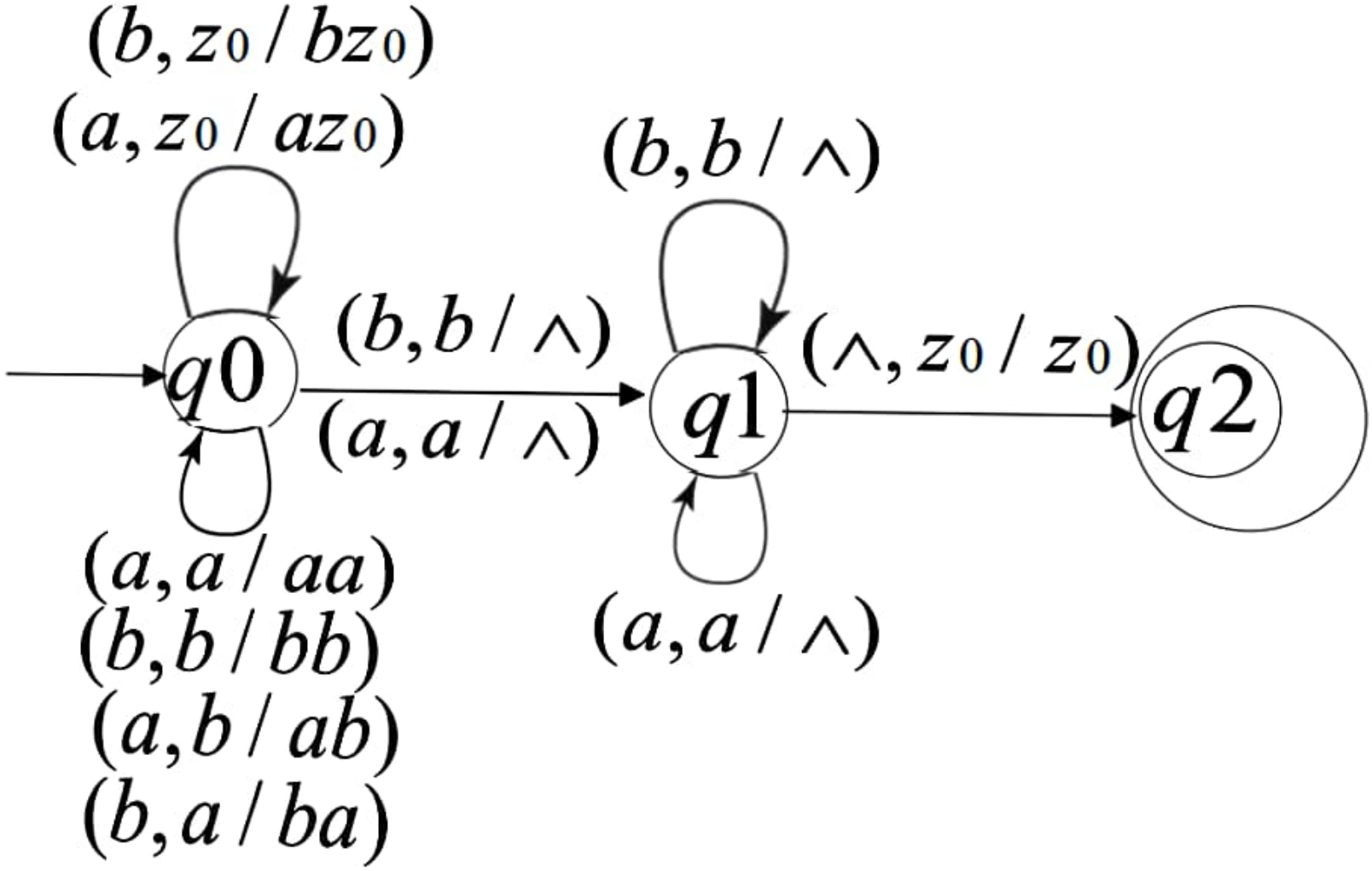
PDA for L={ $a^n b^m c^n : n,m \geq 1$ }



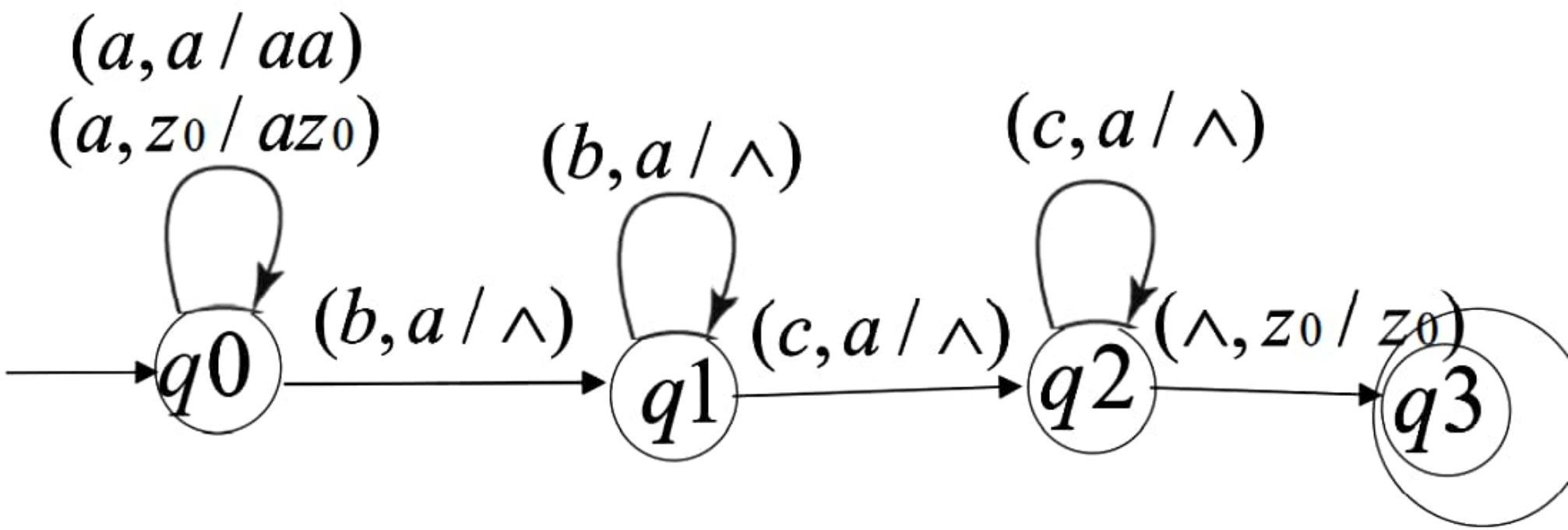
PDA for L={wcw^R : wϵ(a,b)$^+$}



PDA for L={ww^R :wϵ(a,b)$^+$}



PDA for $L=\{a^{m+n}b^{m}c^{n} : n,m \geq 1\}$



PDA for L={$a^{2n}b^n$: $n \geq 1$}