4. Transform the grammar with productions $S \to baAB$,

$A \to bAB \mid \lambda$,

$B \to BAa \mid A \mid \lambda$

into Chomsky normal form.

Remove λ:

$S \to ba \mid baA \mid baB \mid baAB$
$A \to b \mid bA \mid bB \mid bAB$
$B \to a \mid Ba \mid Aa \mid BAa$
$\mid b \mid bA \mid bB \mid bAB$

$\Rightarrow$

$S \to V_bV_a \mid V_bA \mid V_bB \mid V_bV_1$
$V_b \to V_bV_a$, $V_1 \to AB$
$V_a \to a$, $V_b \to b$

$A \to b \mid V_bA \mid V_bB \mid V_bV_1$
$B \to a \mid BV_a \mid AV_a \mid V_2V_a$
$\mid b \mid V_bA \mid V_bB \mid V_bV_1$
$V_2 \to BA$

5. Convert the grammar $S \to AB \mid aB$,

$A \to abb \mid \lambda$,

$B \to bbA$

into Chomsky normal form.

Remove λ:
$S \to B \mid AB \mid aB$
$A \to abb$
$B \to bb \mid bbA$

$\Rightarrow$

Remove unit production
$S \to bb \mid bbA \mid AB \mid aB$
$A \to abb$
$B \to bb \mid bbA$

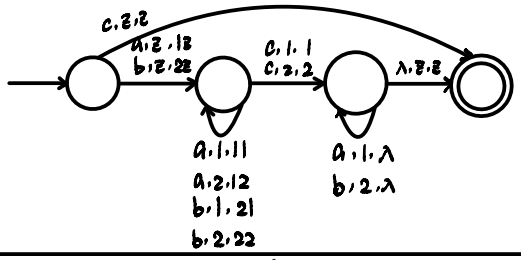
$\Rightarrow$

$S \to V_bV_b \mid V_{bb}A \mid AB \mid V_aB$
$A \to V_aV_{bb}$
$B \to V_bV_b \mid V_{bb}A$
$V_a \to a$, $V_b \to b$, $V_{bb} \to V_bV_b$

6. Construct npda's that accept the following languages on $\Sigma = \{a, b, c\}$:

(a) $L = \{a^n b^{3n} : n \geq 0\}$.

(b) $L = \{wcw^R : w \in \{a, b\}^*\}$.

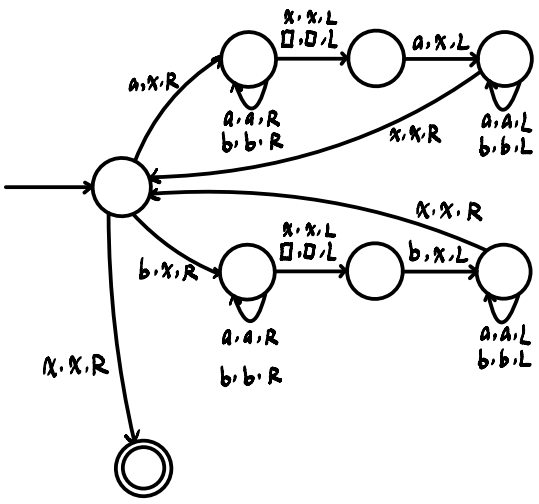


6. Show that the language $L = \{a^{n^2} : n \geq 0\}$ is not context free.

Pick $w = a^{m^2} = uvxyz \in L$, Assume that L is context free.
$|vxy| \leq m$, $|vy| \geq 1$, Let $v = a^{k_1}$, $y = a^{k_2}$
$w = uv^ixy^iz$, pick $i=2$, then $w = a^{m^2+k_1+k_2}$
$k_1 + k_2 \leq m \longrightarrow m^2 + k_1 + k_2 \leq m^2 + m < m^2 + 2m + 1 = (m+1)^2$
$\longrightarrow m^2 + k_1 + k_2$ 不是完全平方數 $\longrightarrow w \notin L \longrightarrow L$ is not context free.

9. Design a Turing machine that accepts the language

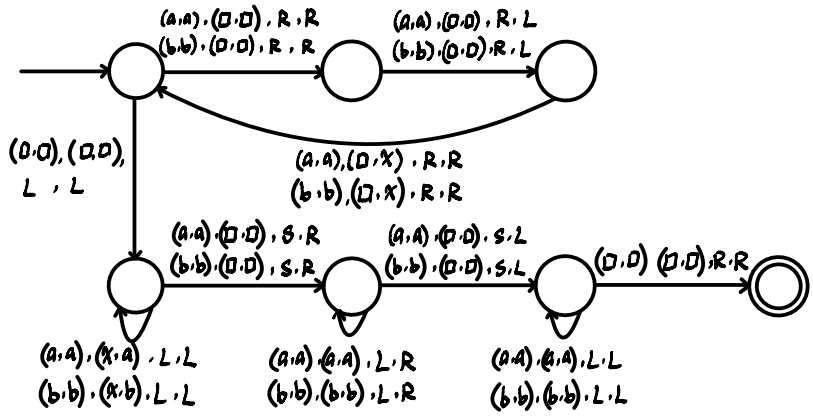
$L = \{ww : w \in \{a, b\}^+\}$.



1. Give a formal definition of a two-tape Turing machine; then write programs that accept the languages below. Assume that $\Sigma = \{a, b, c\}$ and that the input is initially all on tape 1.

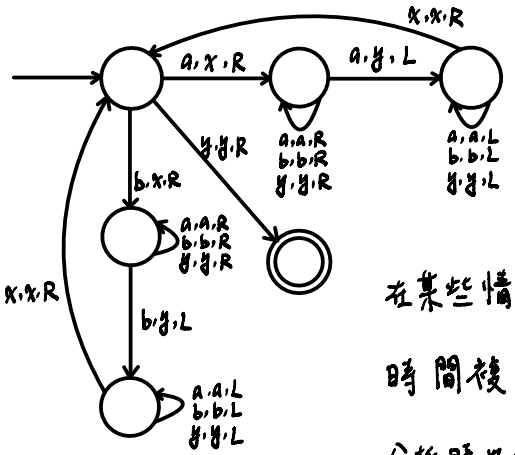
(a) $L = \{a^n b^n c^n\}$, $n \geq 1$.
(b) $L = \{a^n b^n c^m, m > n\}$.
(c) $L = \{ww : w \in \{a, b\}\}$.
(d) $L = \{ww^Rw : w \in \{a, b\}\}$.

S = Stay



2. Write programs for nondeterministic Turing machines that accept the languages below. In each case, explain if and how the nondeterminism simplifies the task.

(a) $L = \{ww : w \in \{a, b\}^+\}$.



在某些情況下，模擬的時間複雜度較低，理論分析時也較容易理解。