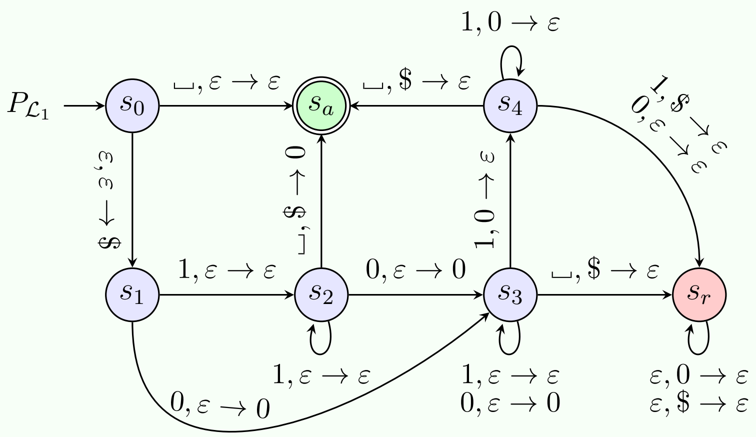
Autômato com Pilha (*PDA – Pushdown Automaton*)

- Sextupla $P = \langle \Sigma, \Gamma, S, s_0, \delta, F \rangle$, onde:

$$
\begin{aligned}
\Sigma &: \text{ alfabeto de entrada,}\\
\Gamma &: \text{ alfabeto da pilha,}\\
S \neq \emptyset &: \text{ conjunto finito de estados,}\\
s_0 \in S &: \text{ estado inicial,}\\
\delta &: S \times (\Sigma \cup \{\varepsilon\}) \times (\Gamma \cup \{\varepsilon\}) \to \mathcal{P}(S \times (\Gamma \cup \{\varepsilon\}))\\
&: \text{ função de transição de estados, e}\\
F \subseteq S &: \text{ conjunto de estados finais (ou de aceitação).}
\end{aligned}
$$

Atenção: Embora as respostas dos exercícios sejam elaboradas com esforço e cuidado, e continuamente revisadas, algumas delas ainda estão incompletas ou podem conter erros que passaram despercebidos. Comentários ou correções específicas são bem-vindos, especialmente se forem relacionados a erros críticos!

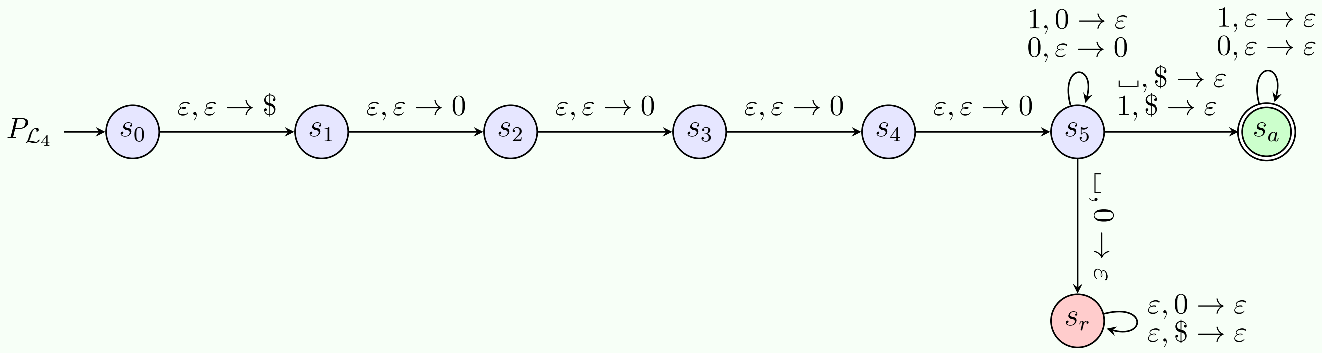
$\mathcal{L}_1 = \{w \in \Sigma^* = \{0,1\}^* \mid w = u1^{|u|_0},\ u \in \Sigma^*\}$



$\mathcal{L}_2 = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m u,\ |u|_0 \leqslant m,\ m \in \mathbb{N}^+,\ u \in \Sigma^*\}$

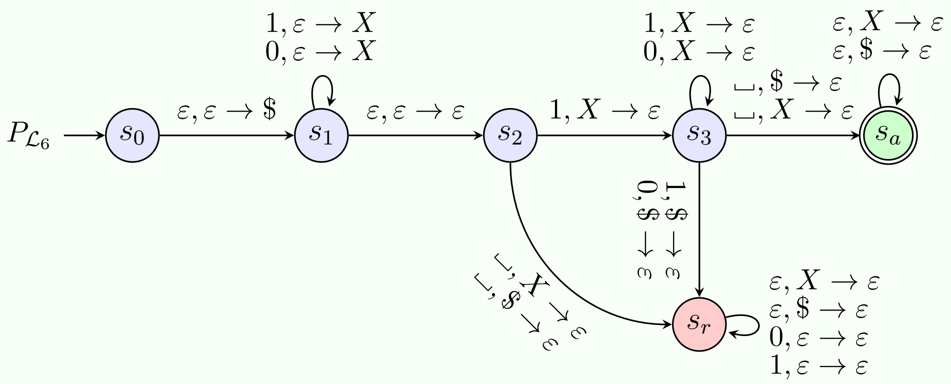
$\mathcal{L}_3 = \{w \in \Sigma^* = \{0,1\}^* \mid w = 1^5 u,\ 2 \cdot |w|_0 = 3 \cdot |w|_1,\ u \in \Sigma^*\}$

$\mathcal{L}_4 = \{w \in \Sigma^* = \{0,1\}^* \mid w = uv,\ |u|_1 \geqslant |u|_0 + 4,\ u, v \in \Sigma^*\}$

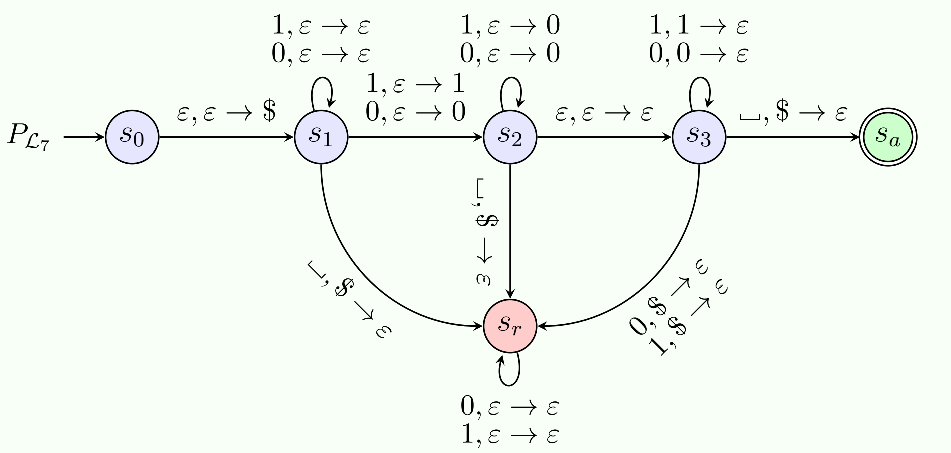


$\mathcal{L}_5 = \{w \in \Sigma^* = \{0,1\}^* \mid w = uv,\ |u| = |v|,\ |v|_1 \geqslant 1,\ u, v \in \Sigma^*\}$

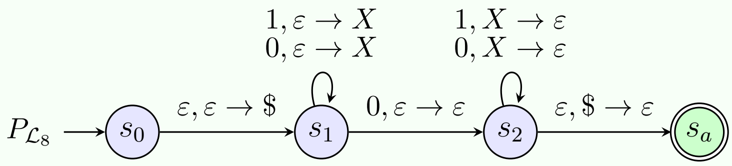
$\mathcal{L}_6 = \{w \in \Sigma^* = \{0,1\}^* \mid w = uv,\ |u| \geqslant |v|,\ v = r1s,\ u, r, s \in \Sigma^*\}$



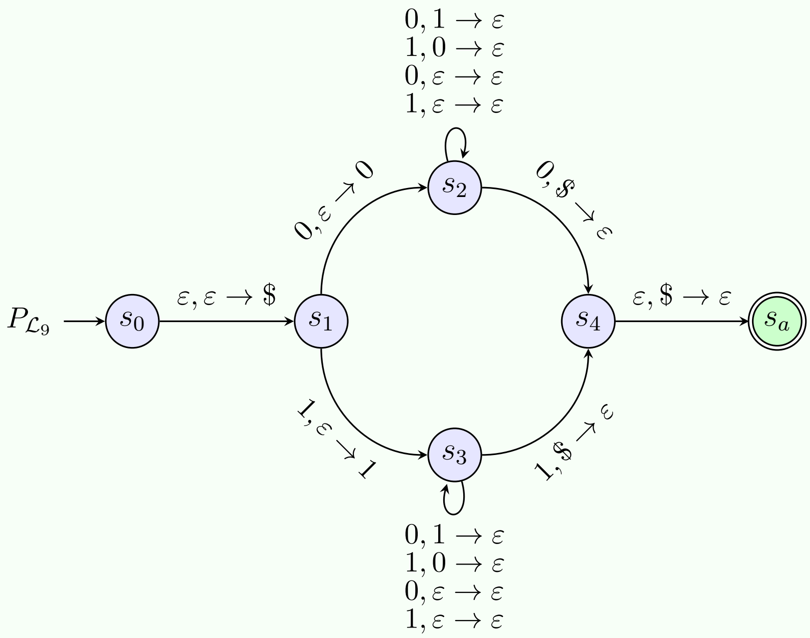
$\mathcal{L}_7 = \{w \in \Sigma^* = \{0,1\}^* \mid w = uv^Rv,\ u \in \Sigma^*,\ v \in \Sigma^+\}$



$\mathcal{L}_8 = \{w \in \Sigma^* = \{0,1\}^* \mid w = u0v,\ |w| = 2 \cdot k + 1,\ |u| = |v|,\ k \in \mathbb{N},\ u, v \in \Sigma^+\}$

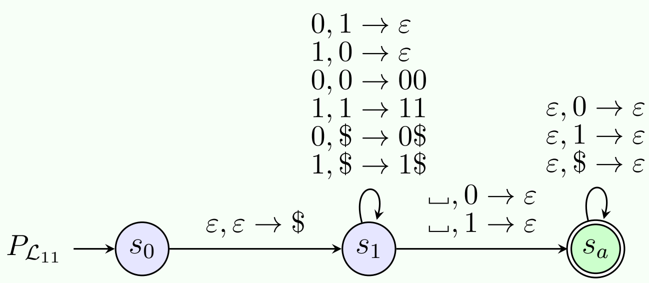


$\mathcal{L}_9 = \{w \in \Sigma^* = \{0,1\}^* \mid w = cuc,\ c \in \Sigma,\ u \in \Sigma^+,\ |w|_0 = |w|_1\}$

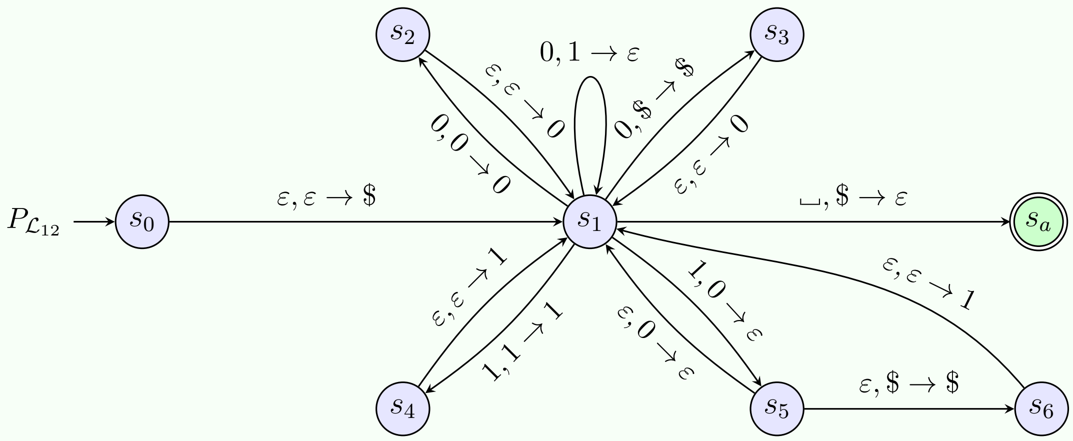


$\mathcal{L}_{10} = \{w \in \Sigma^* = \{0,1\}^* \mid |w| = 3 \cdot |w|_0\}$

$\mathcal{L}_{11} = \{w \in \Sigma^* = \{0,1\}^* \mid |w|_0 \neq |w|_1\}$



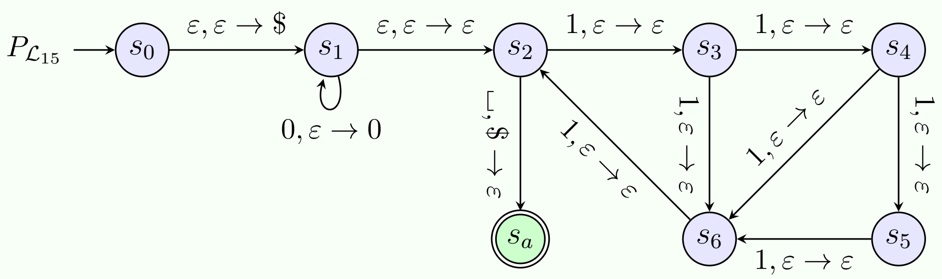
$\mathcal{L}_{12} = \{w \in \Sigma^* = \{0,1\}^* \mid |w|_0 = 2 \cdot |w|_1\}$



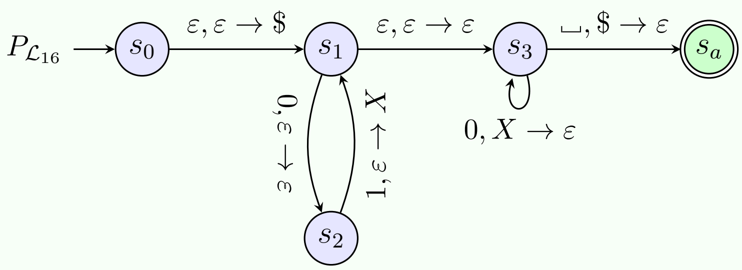
$\mathcal{L}_{13} = \{w \in \Sigma^* = \{0,1\}^* \mid |w|_{101} = |w|_{010}\}$

$\mathcal{L}_{14} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n,\ m \neq n \text{ e } 2 \cdot m \neq n,\ m, n \in \mathbb{N}\}$

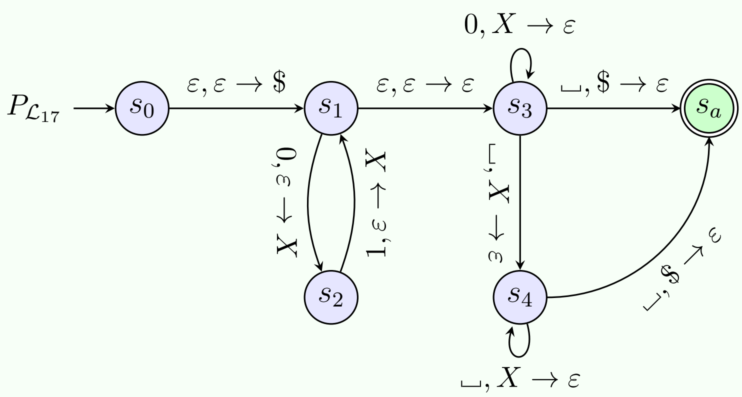
$\mathcal{L}_{15} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n,\ 3 \cdot m \leqslant n \leqslant 5 \cdot m,\ m, n \in \mathbb{N}\}$



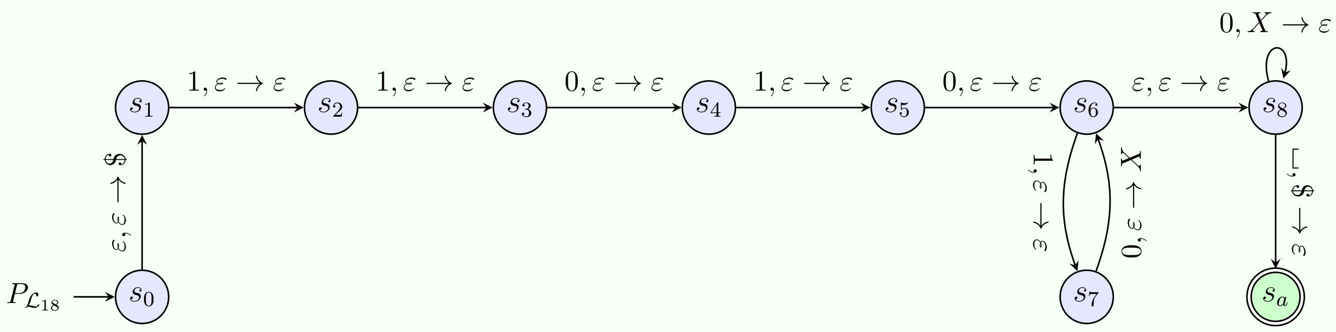
$\mathcal{L}_{16} = \{w \in \Sigma^* = \{0,1\}^* \mid w = (01)^n 0^n,\ n \in \mathbb{N}\}$



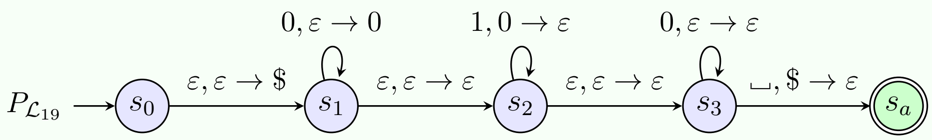
$\mathcal{L}_{17} = \{w \in \Sigma^* = \{0,1\}^* \mid w = (01)^m 0^n,\ n \geqslant 2 \cdot m,\ m, n \in \mathbb{N}\}$



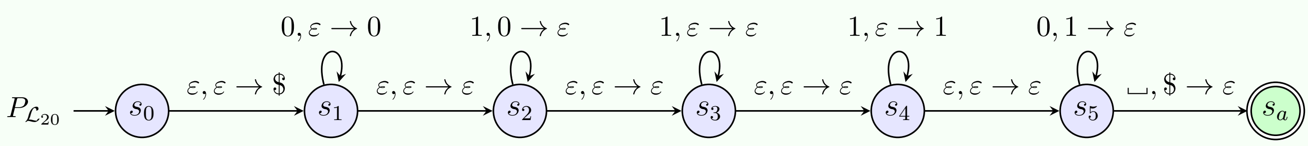
$\mathcal{L}_{18} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 110(10)^n 0^{n-1},\ n \in \mathbb{N}\}$



$\mathcal{L}_{19} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^m 0^n,\ m, n \in \mathbb{N}\}$



$\mathcal{L}_{20} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^q,\ m + q \leqslant n,\ m, n, q \in \mathbb{N}\}$



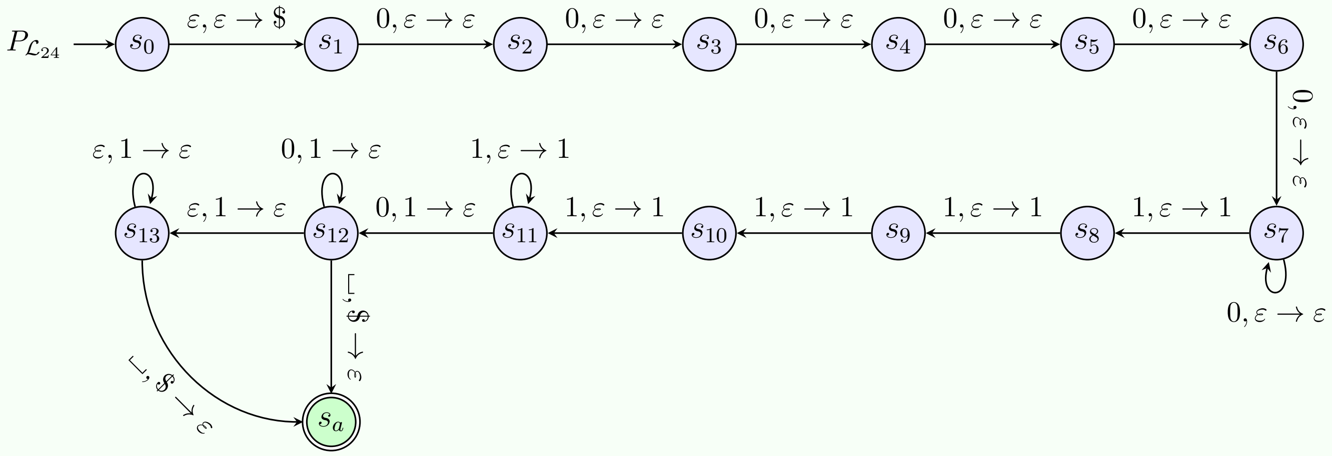
- Se $m + q \leqslant n$, então $m + p + s = n$, para $s \geqslant 0$. Logo, $0^m 1^n 0^p = (0^m 1^m)(1^s)(1^p 0^p)$.

$\mathcal{L}_{21} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^q,\ n \neq m + q,\ m, n, q \in \mathbb{N}\}$

$\mathcal{L}_{22} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^q,\ m \neq q,\ m, n, q \in \mathbb{N}\}$

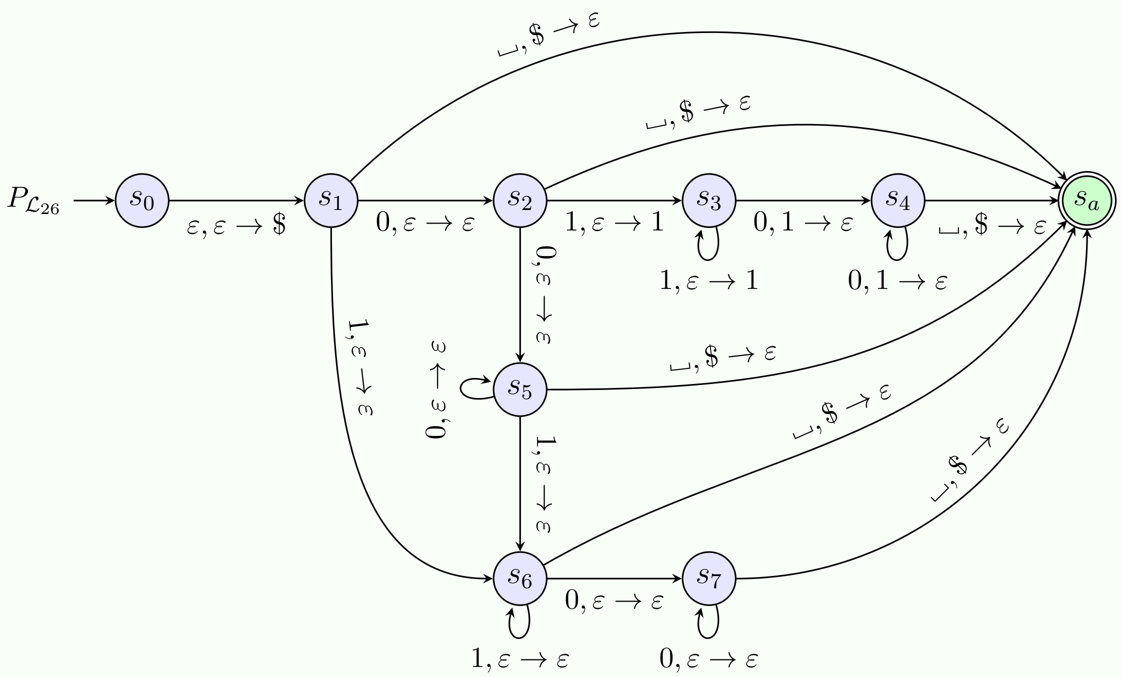
$\mathcal{L}_{23} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^q,\ q = 2 \cdot (m+n),\ m,n,q \in \mathbb{N}\}$

$\mathcal{L}_{24} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^q,\ m > 5,\ n > 3,\ q \leqslant n,\ m,n,q \in \mathbb{N}\}$

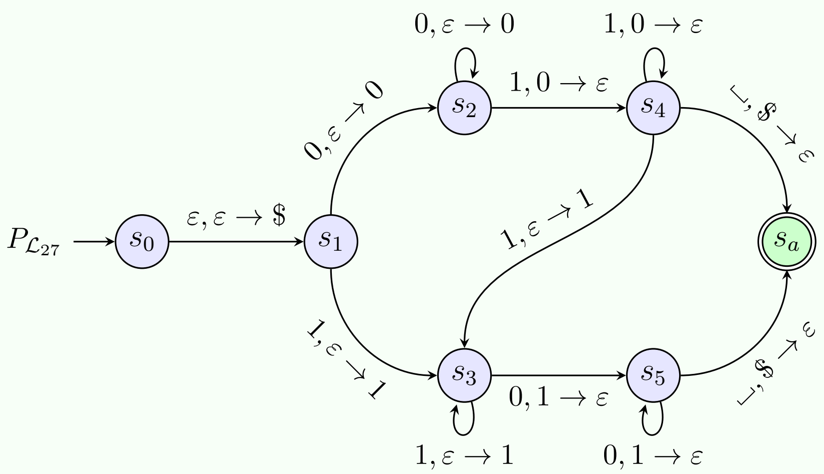


$\mathcal{L}_{25} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^q,\ m \leqslant 2 \cdot n$ **ou** $n \leqslant 3 \cdot q,\ m,n,q \in \mathbb{N}\}$

$\mathcal{L}_{26} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^q,\ m = 1 \Rightarrow n = q,\ m,n,q \in \mathbb{N}\}$

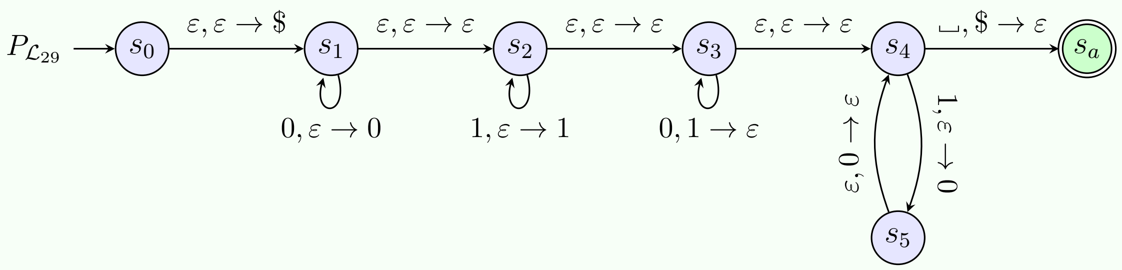


$\mathcal{L}_{27} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^{m+n} 0^n,\ m+n > 0,\ m,n \in \mathbb{N}\}$

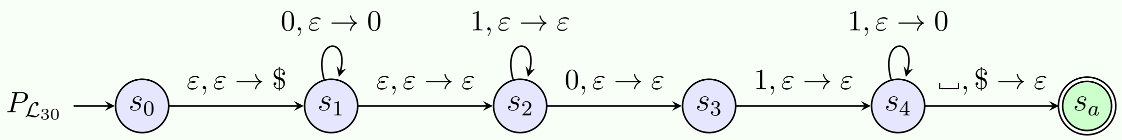


$\mathcal{L}_{28} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^{m-n},\ m > n,\ m,n \in \mathbb{N}\}$

$\mathcal{L}_{29} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0^r 1^s,\ m = 2 \cdot s,\ n = r,\ \ m,n,r,s \in \mathbb{N}\}$



$\mathcal{L}_{30} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m 1^n 0 1^{m+1},\ m,n \in \mathbb{N}\}$

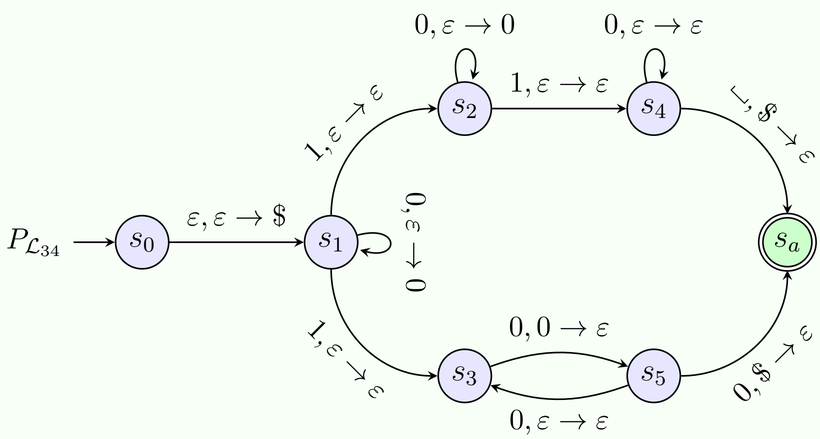


$\mathcal{L}_{31} = \{w \in \Sigma^* = \{0,1\}^* \mid w = (01)^n 0^m (01)^n,\ m < 3,\ m,n \in \mathbb{N}\}$

$\mathcal{L}_{32} = \{w \in \Sigma^* = \{0,1\}^* \mid w = (01)^n (01^{m_n})^n,\ m_n, n \in \mathbb{N}^+\}$

$\mathcal{L}_{33} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 1^m (01)^n (10)^n,\ m \geqslant 4,\ m,n \in \mathbb{N}^+\}$

$\mathcal{L}_{34} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m10^n10^q \text{ ou } w = 0^n10^{2n},\ m,n,q \in \mathbb{N}\}$



$\mathcal{L}_{35} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^n10^{2n} \text{ ou } w = 1^n01^{3n},\ n \in \mathbb{N}\}$

$\mathcal{L}_{36} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m1^n0^q1^r0^s1^t,\ m+q+r+t = n+s,\ m,n,q,r,s,t \in \mathbb{N}\}$

$\mathcal{L}_{37} = \{w \in \Sigma^* = \{0,1\}^* \mid w = 0^m1^n0^q1^r0^s1^t,\ m+q+r = n+s+t,\ m,n,q,r,s,t \in \mathbb{N}\}$