Autómatas y Lenguajes formales
Ejercicio Semanal 6

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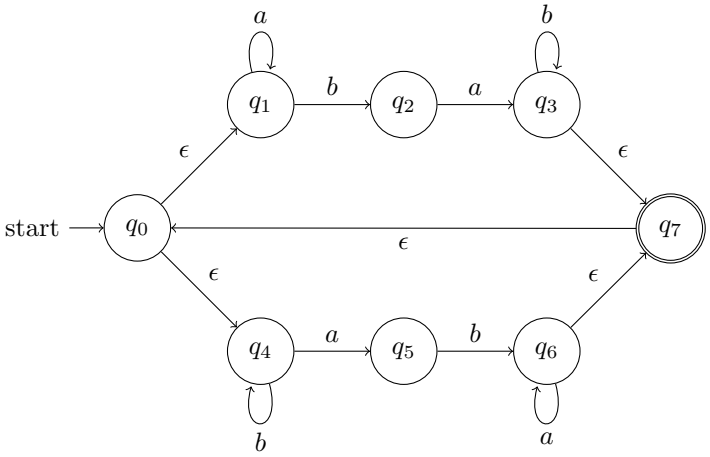
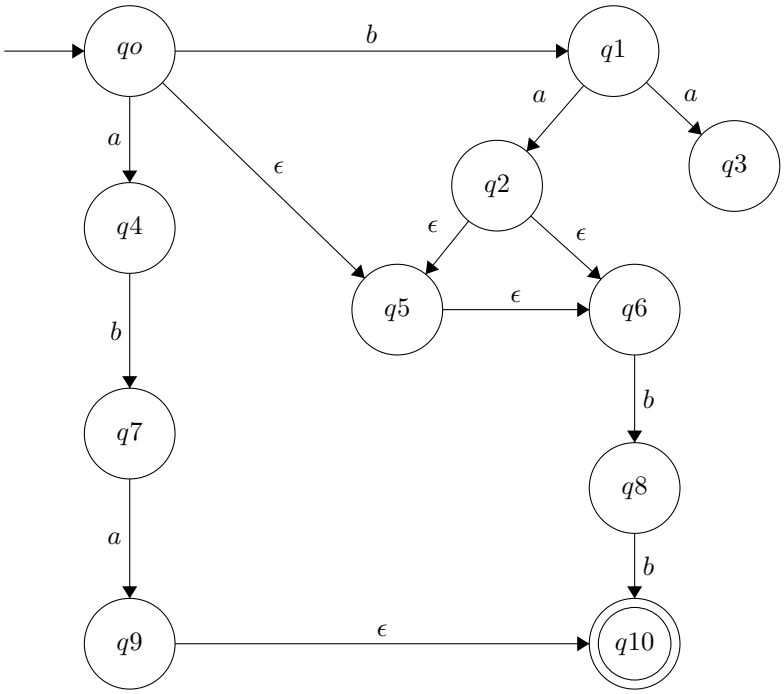
1. Para cada ANF_ϵ, resuelve los siguientes incisos.
   (a) Calcula la ϵ-cerradura de cada estado.
   (b) Elimina las ϵ-transiciones obteniendo un AFN, mostrando el proceso de cálculo de las nuevas transiciones.

1. Autómata 1



2. Autómata 2



(a) Calcula la ϵ-cerradura de cada estado

$$\begin{aligned} Cl_\epsilon(q_0) &= \{q_0, q_5, q_6\} & Cl_\epsilon(q_1) &= \{q_1\} \\ Cl_\epsilon(q_2) &= \{q_2, q_5, q_6\} & Cl_\epsilon(q_3) &= \{q_3\} \\ Cl_\epsilon(q_4) &= \{q_4\} & Cl_\epsilon(q_5) &= \{q_5, q_6\} \\ Cl_\epsilon(q_6) &= \{q_6\} & Cl_\epsilon(q_7) &= \{q_7\} \\ Cl_\epsilon(q_8) &= \{q_8\} & Cl_\epsilon(q_9) &= \{q_9, q_{10}\} \\ Cl_\epsilon(q_{10}) &= \{q_{10}\} \end{aligned}$$

(b) Elimina las ϵ-transiciones obteniendo un AFN, mostrando el proceso de cálculo de las nuevas transiciones.
Sea $M_\epsilon = \langle Q_\epsilon, \Sigma_\epsilon, \delta_\epsilon, q_{0\epsilon}, F_\epsilon \rangle$ el atómata de la figura.
El nuevo automata sería $M = \langle Q, \Sigma, \delta, q_0, F \rangle$ dado por

$$Q = Q_\epsilon,\ \Sigma = \Sigma_\epsilon,\ q_0 = q_{0\epsilon},\ F = F_\epsilon$$

Pues $F_\epsilon \cap Cl_\epsilon(q_0) = \varnothing$.
En cuento a la δ, esta se construye de la siguiente manera

$$\begin{aligned} \delta(q_0, a) &= \delta^*_\epsilon(q_0, a) \\ &= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_0, \epsilon)} \delta_\epsilon(p, a)) \\ &= Cl_\epsilon(\delta_\epsilon(q_0, a) \cup \delta_\epsilon(q_5, a) \cup \delta_\epsilon(q_6, a)) \\ &= Cl_\epsilon(\{q_4\} \cup \varnothing \cup \varnothing) \\ &= \{q_4\} \end{aligned}$$

$$\begin{aligned} \delta(q_0, b) &= \delta^*_\epsilon(q_0, b) \\ &= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_0, \epsilon)} \delta_\epsilon(p, b)) \\ &= Cl_\epsilon(\delta_\epsilon(q_0, b) \cup \delta_\epsilon(q_5, b) \cup \delta_\epsilon(q_6, b)) \\ &= Cl_\epsilon(\{q_1\} \cup \varnothing \cup \{q_8\}) \\ &= \{q_1, q_8\} \end{aligned}$$

$$\begin{aligned} \delta(q_1, a) &= \delta^*_\epsilon(q_1, a) \\ &= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_1, \epsilon)} \delta_\epsilon(p, a)) \\ &= Cl_\epsilon(\delta_\epsilon(q_1, a)) \\ &= Cl_\epsilon(\{q_2, q_3\}) \\ &= \{q_2, q_3, q_5, q_6\} \end{aligned}$$

$$\begin{aligned} \delta(q_1, b) &= \delta^*_\epsilon(q_1, b) \\ &= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_1, \epsilon)} \delta_\epsilon(p, b)) \\ &= Cl_\epsilon(\delta_\epsilon(q_1, b)) \\ &= Cl_\epsilon(\varnothing) \\ &= \varnothing \end{aligned}$$

$$\begin{aligned}
\delta(q_2, a) &= \delta^*_\epsilon(q_2, a) \\
&= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_2, \epsilon)} \delta_\epsilon(p, a)) \\
&= Cl_\epsilon(\delta_\epsilon(q_2, a) \cup \delta_\epsilon(q_5, a) \cup \delta_\epsilon(q_6, a)) \\
&= Cl_\epsilon(\varnothing \cup \varnothing \cup \varnothing) \\
&= \varnothing
\end{aligned}$$

$$\begin{aligned}
\delta(q_2, b) &= \delta^*_\epsilon(q_2, b) \\
&= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_2, \epsilon)} \delta_\epsilon(p, b)) \\
&= Cl_\epsilon(\delta_\epsilon(q_2, b) \cup \delta_\epsilon(q_5, b) \cup \delta_\epsilon(q_6, b)) \\
&= Cl_\epsilon(\varnothing \cup \varnothing \cup \{q_8\}) \\
&= \{q_8\}
\end{aligned}$$

$$\begin{aligned}
\delta(q_3, a) &= \delta^*_\epsilon(q_3, a) \\
&= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_3, \epsilon)} \delta_\epsilon(p, a)) \\
&= Cl_\epsilon(\delta_\epsilon(q_3, a)) \\
&= Cl_\epsilon(\varnothing) \\
&= \varnothing
\end{aligned}$$

$$\begin{aligned}
\delta(q_3, b) &= \delta^*_\epsilon(q_3, b) \\
&= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_3, \epsilon)} \delta_\epsilon(p, b)) \\
&= Cl_\epsilon(\delta_\epsilon(q_3, b)) \\
&= Cl_\epsilon(\varnothing) \\
&= \varnothing
\end{aligned}$$

$$\begin{aligned}
\delta(q_4, a) &= \delta^*_\epsilon(q_4, a) \\
&= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_4, \epsilon)} \delta_\epsilon(p, a)) \\
&= Cl_\epsilon(\delta_\epsilon(q_4, a) \cup \delta_\epsilon(q_5, a) \cup \delta_\epsilon(q_6, a)) \\
&= Cl_\epsilon(\{q_4\} \cup \varnothing \cup \varnothing) \\
&= \{q_4\}
\end{aligned}$$

$$\begin{aligned}
\delta(q_4, b) &= \delta^*_\epsilon(q_4, b) \\
&= Cl_\epsilon(\bigcup_{p \in \delta_\epsilon(q_4, \epsilon)} \delta_\epsilon(p, b)) \\
&= Cl_\epsilon(\delta_\epsilon(q_4, b) \cup \delta_\epsilon(q_5, b) \cup \delta_\epsilon(q_6, b)) \\
&= Cl_\epsilon(\{q_1\} \cup \varnothing \cup \{q_8\}) \\
&= \{q_1, q_8\}
\end{aligned}$$