**Solution 4.1.** The idea is that each state in $Q'$ not only stores the state in $Q$ but also tracks the current letter position (1st, 2nd, 3rd). Specifically, we extend each state $q \in Q$ to $\{(q,0),(q,1),(q,2)\}$, representing every first, second, and third letter respectively. For the first and second characters, we only update the number in the tuple. For example, $(q_0,0)$ becomes $(q_0,1)$ after receiving the first character. When the third letter is received (the number in the tuple is 2), the number resets to 0, and $q_0$ transitions according to the original transition function in $\delta$. For example:

$$(q_0,2) \xrightarrow{a} (q_1,0)$$

The final states are set to $\{(q_f,0),(q_f,1),(q_f,2)\}$for all $q_f \in F$.

**Solution 4.2.** For DFA B, we have DFA B $= (Q', \Sigma, q_0', \delta', F')$:

- $Q' = Q \times \{0,1,2\}$
- $q_0' = (q_0, 0)$
- $\delta' = \delta'((q,n),l) = \begin{cases} (q,n+1) & n = 0,1 \\ (\delta(q,l),0) & n = 2 \end{cases}, q \in Q, l \in \Sigma$
- $F' = (q,n), q \in F, n \in \{0,1,2\}$