Theoretical Computer Science

Lab Session 3

February 11, 2021

Innopolis University

Agenda

- Exercises on Finite State Automaton (FSA)

Exercises

Exercises (first part)

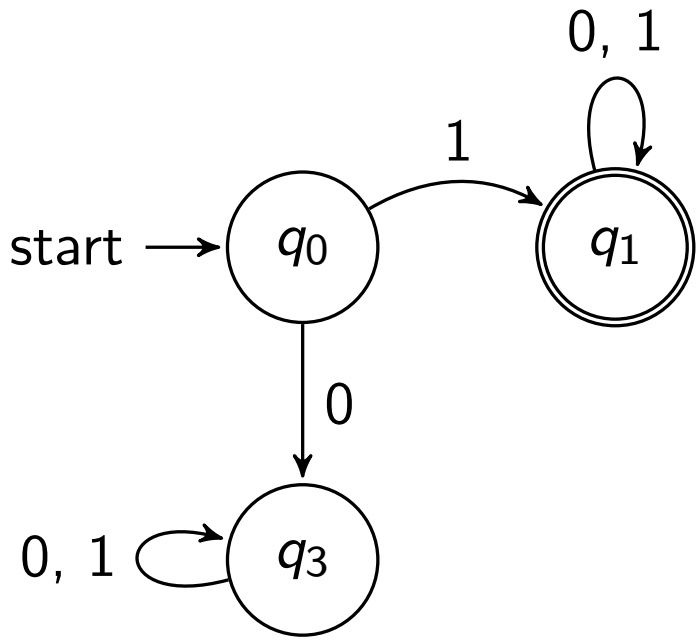
Build complete FSAs that recognize the following languages:
Let Σ be the alphabet $\Sigma = \{0, 1\}$

- $L_0 = \{x \in \Sigma^* \mid x \text{ starts with } 1\}$;
- $L_1 = \{x \in \Sigma^* \mid x \text{ does not begin with } 1\}$;
- $L_2 = \{x \in \Sigma^* \mid \text{any } 0 \text{ in } x \text{ is followed by at least a } 1\}$.
  Strings example: 010111, 1111, 01110111011.
- $L_3 = \{x \in \Sigma^* \mid x \text{ ends with } 00\}$;
- $L_4 = \{x \in \Sigma^* \mid x \text{ contains exactly 3 zeros}\}$;

Solution (0)

Let Σ be the alphabet $\Sigma = \{0, 1\}$

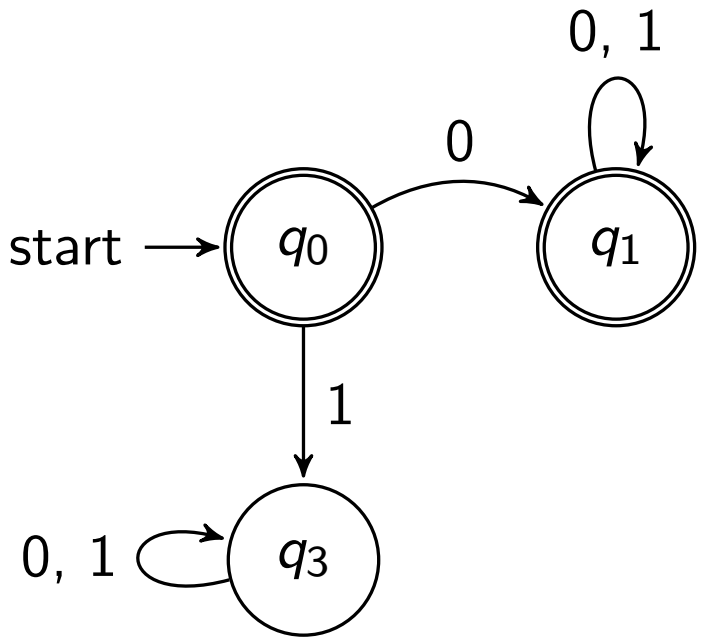
- $L_0 = \{x \in \Sigma^* \mid x \text{ starts with } 1\}$;



Solution (1)

Let Σ be the alphabet $\Sigma = \{0, 1\}$

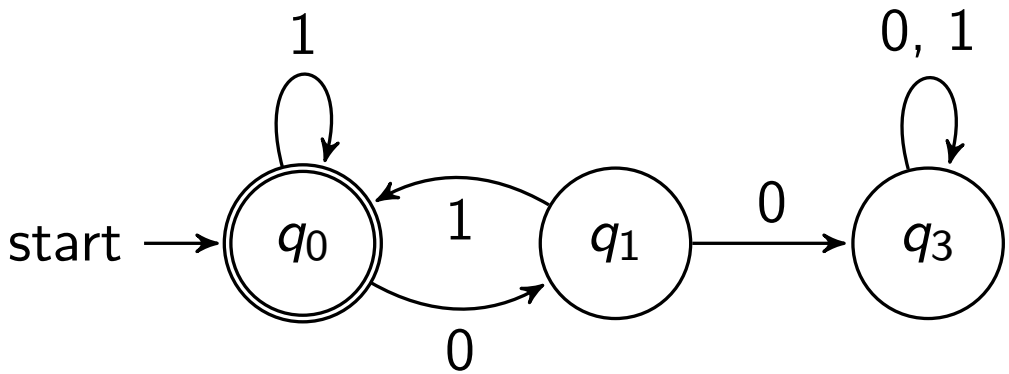
- $L_1 = \{x \in \Sigma^* \mid x \text{ does not begin with } 1\}$;



Solution (2)

Let Σ be the alphabet $\Sigma = \{0, 1\}$

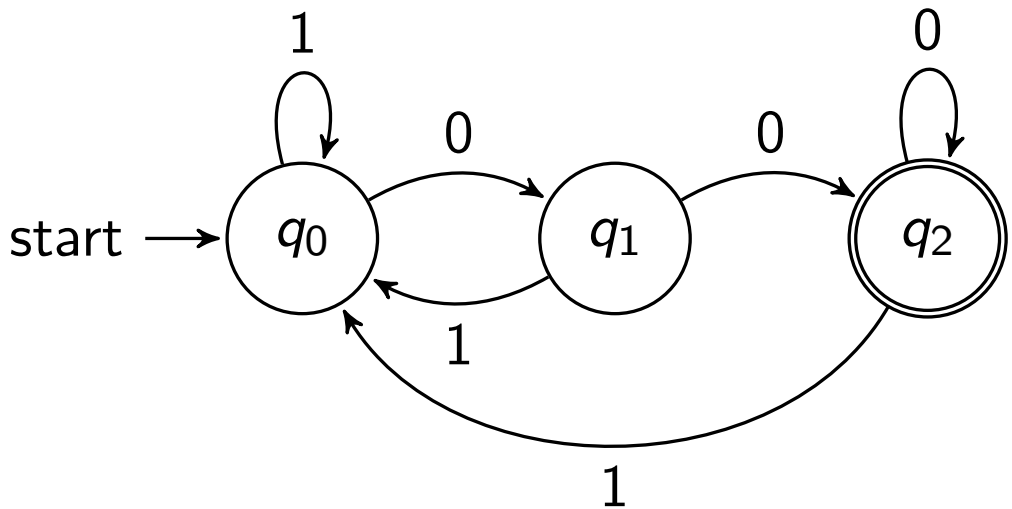
- $L_2 = \{x \in \Sigma^* \mid$ any 0 in x is followed by at least a $1\}$.
  Strings example: 010111, 1111, 01110111011.



Solution (3)

Let Σ be the alphabet $\Sigma = \{0, 1\}$

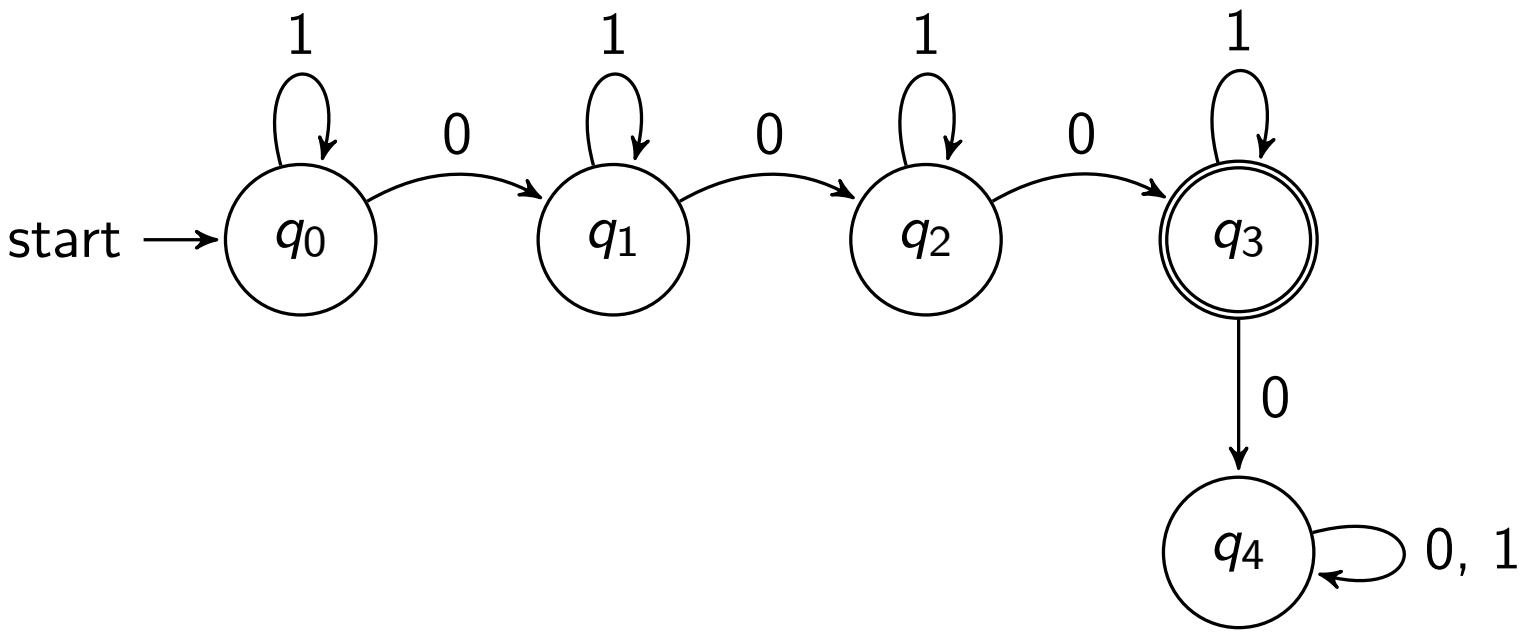
- $L_3 = \{x \in \Sigma^* \mid x \text{ ends with } 00\}$;



Solution (4)

Let Σ be the alphabet $\Sigma = \{0, 1\}$

- $L_4 = \{x \in \Sigma^* \mid x \text{ contains exactly 3 zeros}\}$;



Exercises (second part)

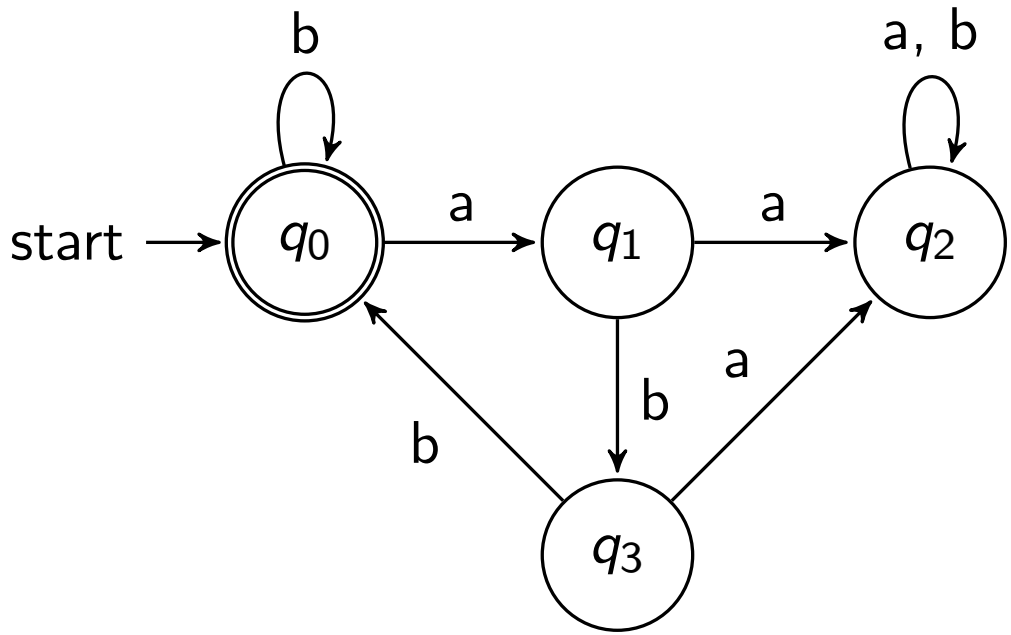
Build complete FSAs that recognize the following languages:
Let Σ be the alphabet $\Sigma = \{a, b\}$

- $L_5 = \{x \in \Sigma^* \mid$ every a in x (if there are any) is followed immediately by $bb\}$.
- $L_6 = \{x \in \Sigma^* \mid$ x ends with b and does not contain the substring $aa\}$.
- $L_7 = \{x \in \Sigma^* \mid \ x$ contains the substring $abbaab\}$;
- $L_8 = \{x \in \Sigma^* \mid$ x has an even number of a's and an even number of b's$\}$;

Solution (5)

Let Σ be the alphabet $\Sigma = \{a, b\}$

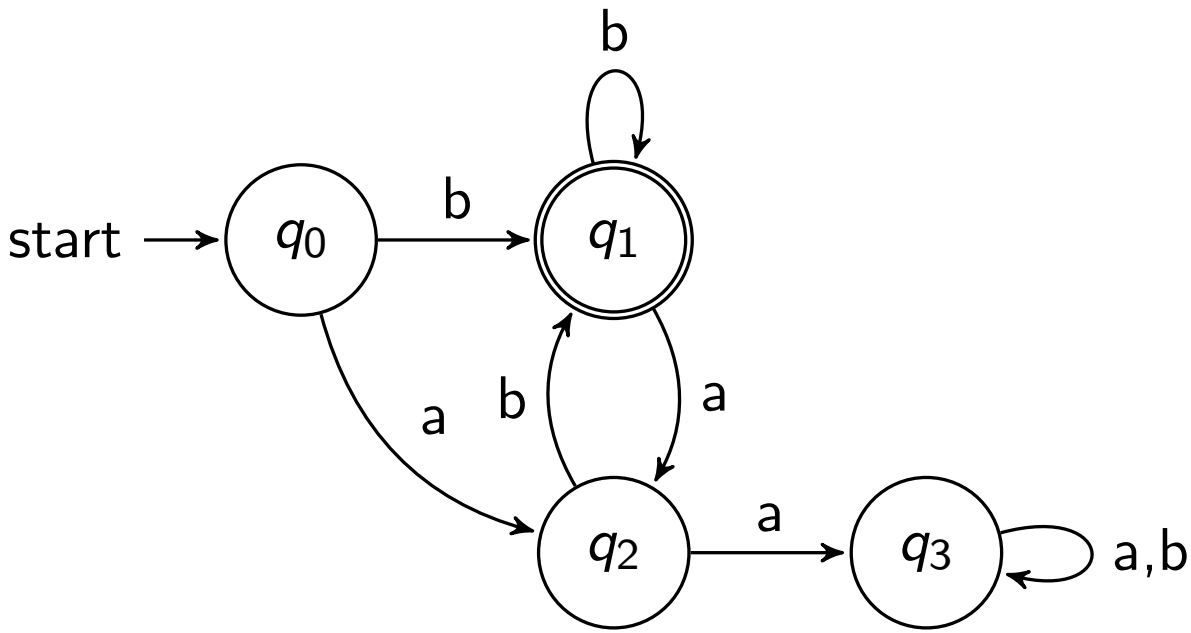
- $L_5 = \{x \in \Sigma^* \mid$
  every a in x (if there are any) is followed immediately by $bb\}$.



Solution (6)

Let Σ be the alphabet $\Sigma = \{a, b\}$

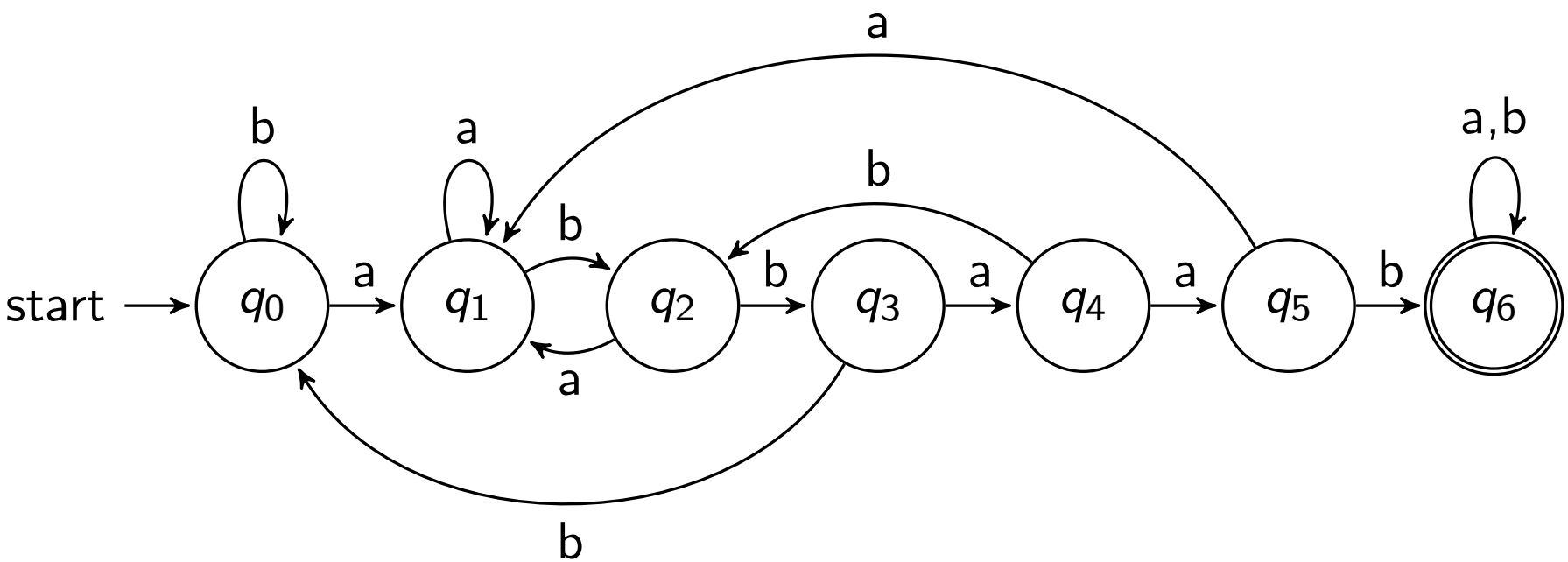
- $L_6 = \{x \in \Sigma^* \mid$
  x ends with b and does not contain the substring $aa\}$.



Solution (7)

Let Σ be the alphabet $\Sigma = \{a, b\}$

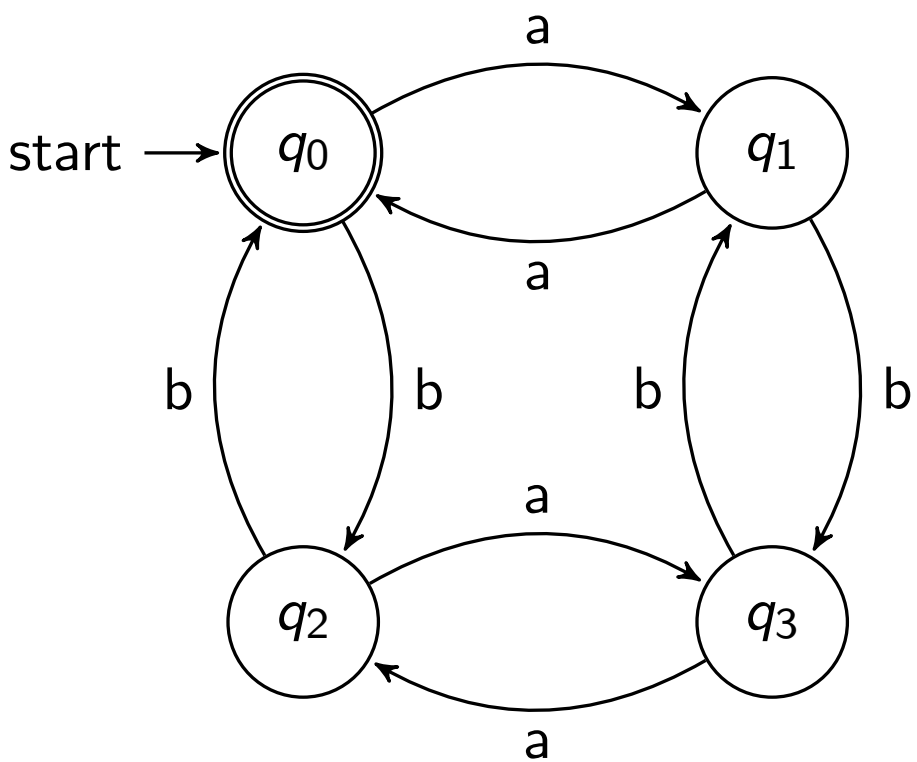
- $L_7 = \{x \in \Sigma^* \mid x \text{ contains the substring } abbaab\}$;



Solution (8)

Let Σ be the alphabet $\Sigma = \{a, b\}$

- $L_8 = \{x \in \Sigma^* \mid$
  x has an even number of a's and an even number of b's$\}$;



Exercises - Part 3

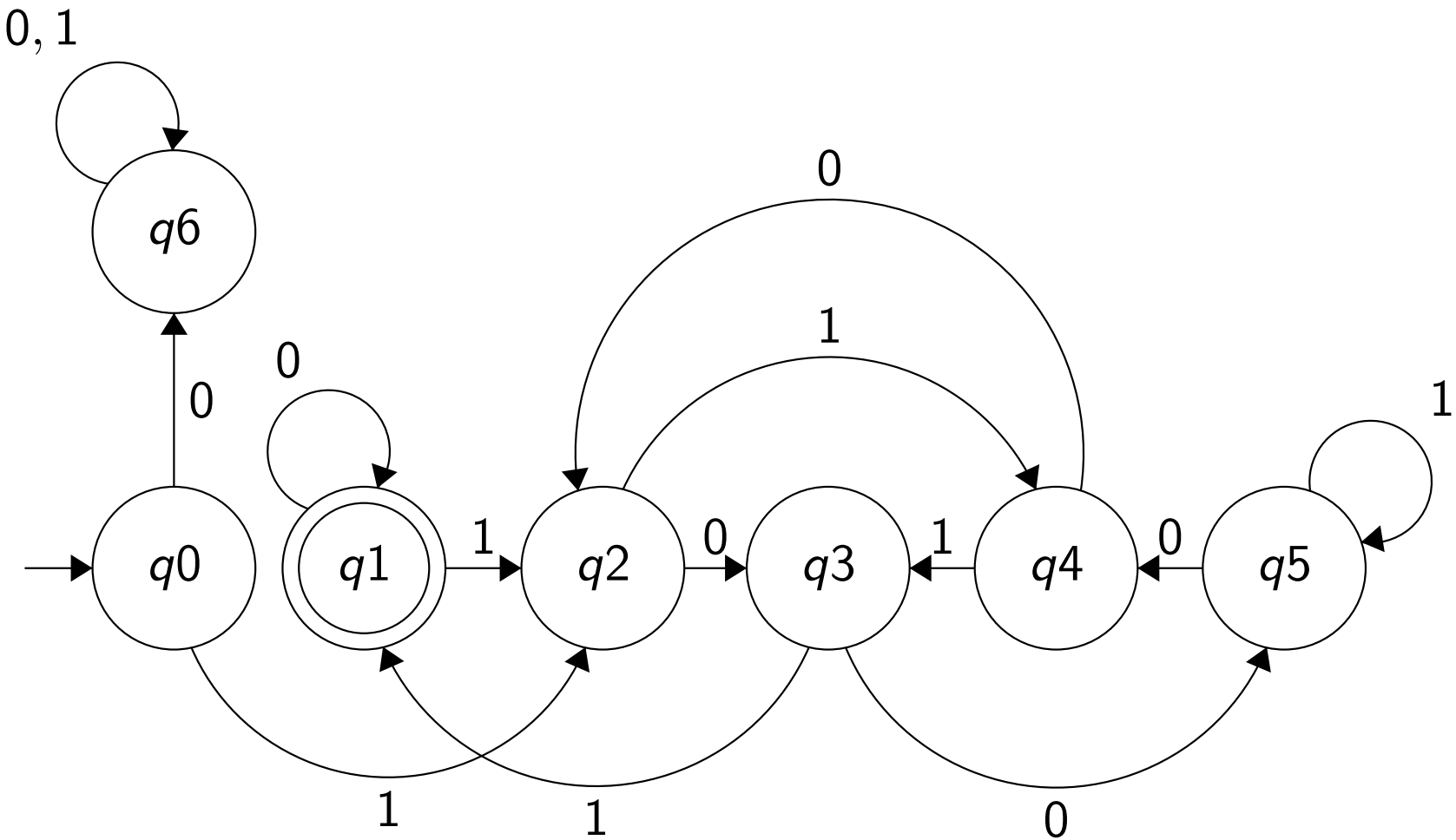
Build complete FSAs accepting the following languages over the alphabet $\Sigma = \{0, 1\}$

- $L_a = \{x \in \Sigma^* \mid$ x is a binary representation of an integer divisible by 5 and it begins with $1\}$;
- $L_b = \{x \in \Sigma^* \mid |x| \geq 2 \wedge$ final two symbols are the same$\}$;

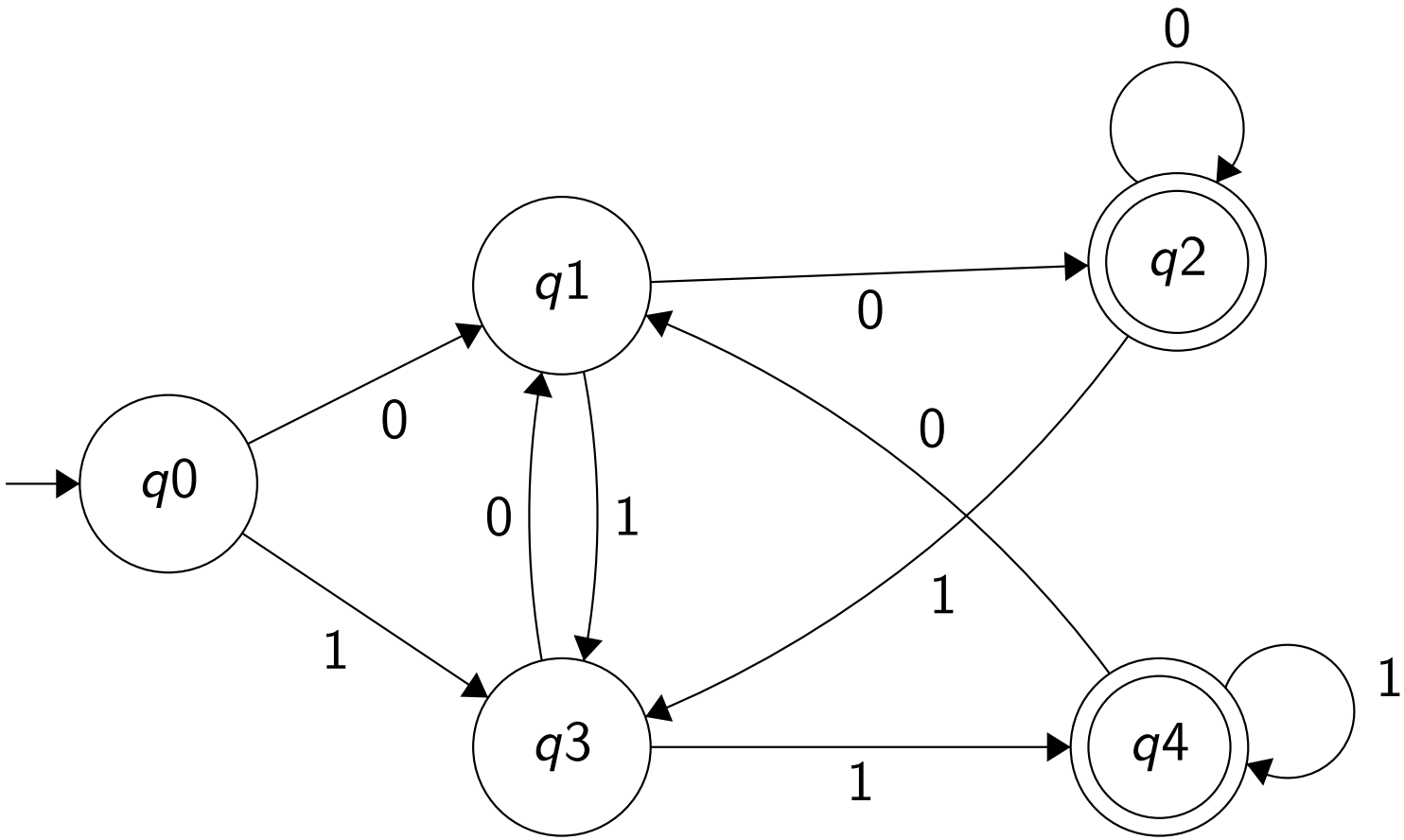
Build a complete FSA accepting the following language over the alphabet $\Sigma = \{a, b, c\}$

- $L_c = \{x \in \Sigma^* \mid$ the substring abc in x occurs an odd number of times$\}$.

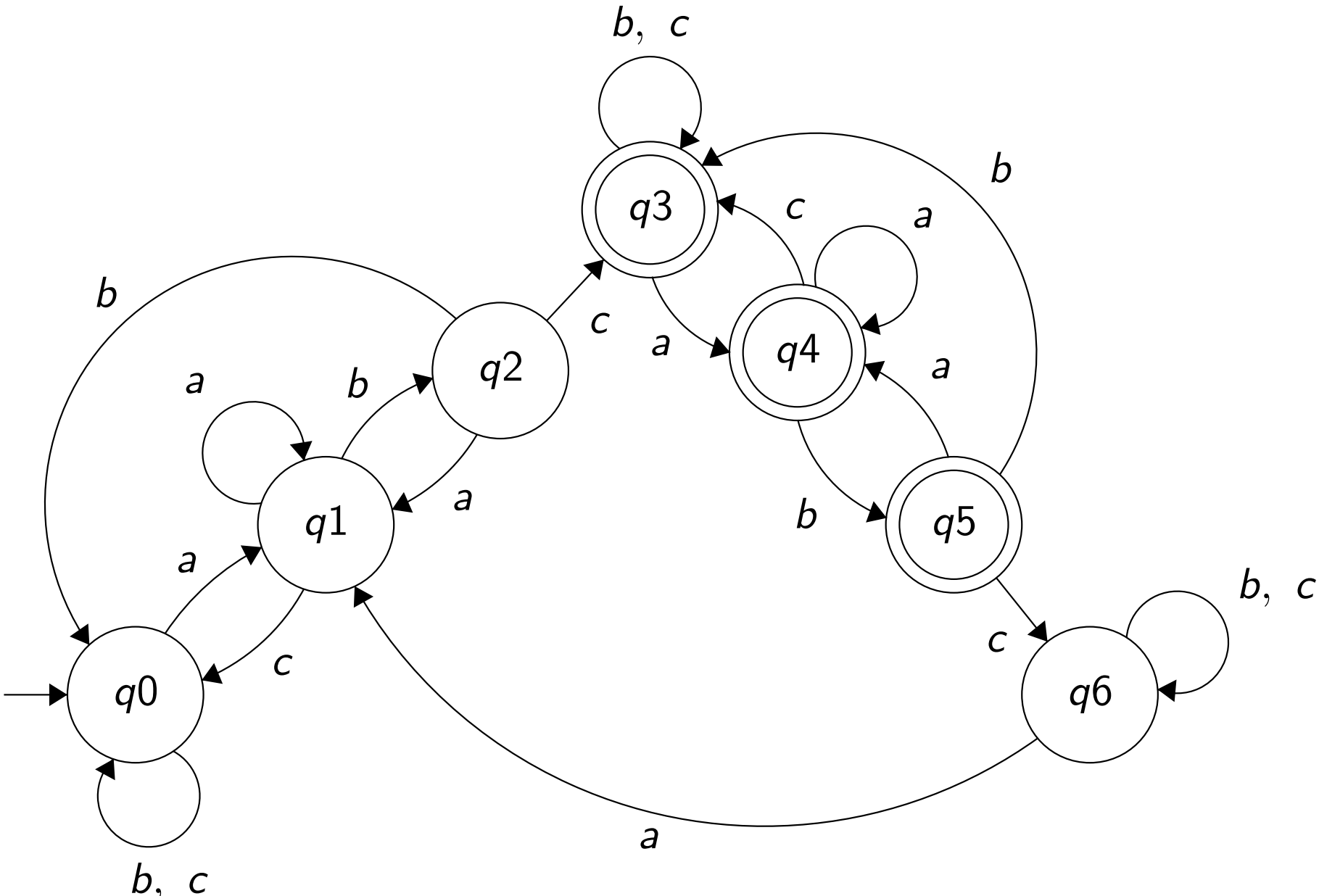
Solution - Part 3 L_a - starts with 1 and divisible by 5



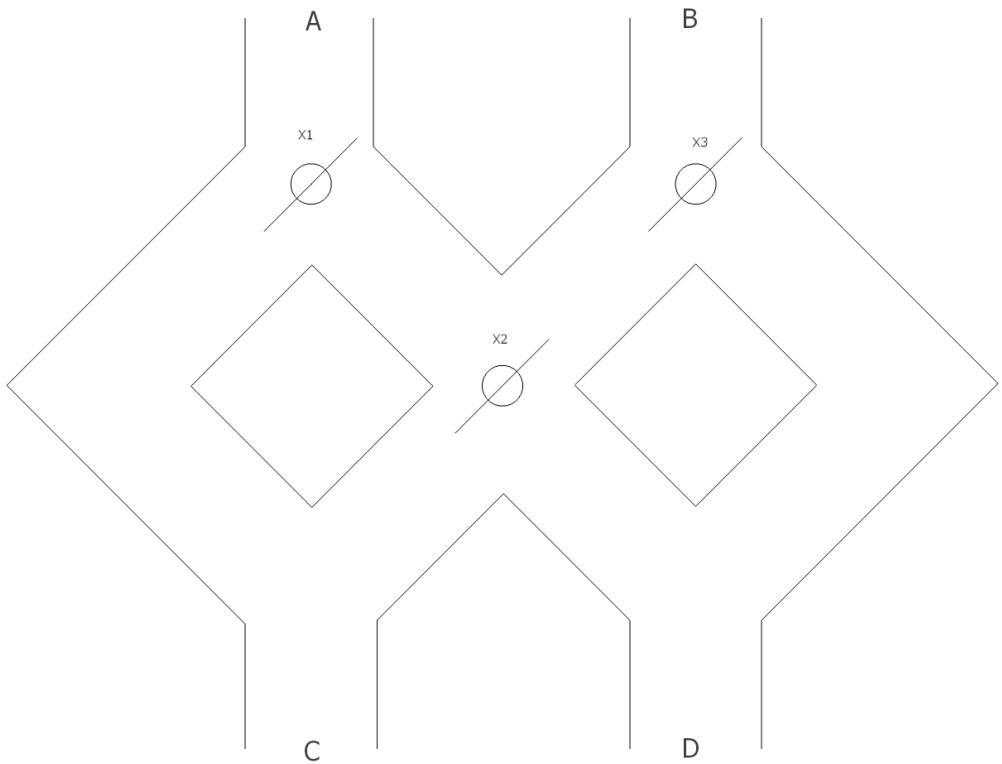
Solution - Part 3 $L_b - |x| \geq 2$, final two symbols are same



Solution - Part 3 L_c - abc occurs odd number of times

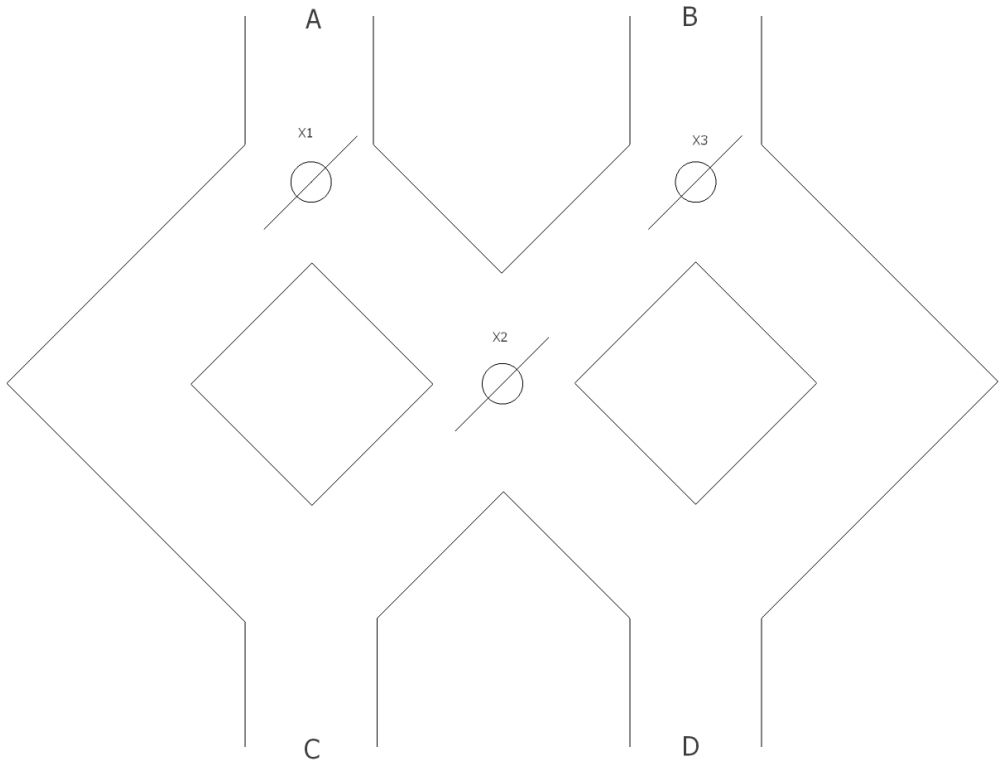


Exercises - Part 4



The figure is a marble toy. A marble is dropped at A or B. Levers $x1$, $x2$, and $x3$ cause the marble to fall either to the left of to the right. Whenever a marble encounters a lever, it causes the lever to reverse after the marble passes, so the next marble will take the opposite branch.

Exercises - Part 4



Model this toy by a complete FSA. Let the inputs A and B represent the input into which the marble is dropped. Let acceptance correspond to the marble exiting at D; nonacceptance represents a marble exiting at C.