4

ออโตมาตาจำกัด

FINITE AUTOMATA

FINITE AUTOMATA

ประเด็นที่ควรสนใจ

คำถาม

How to know which word is in the given language ?

How to know if any given word is in the given language ?

FINITE AUTOMATA

ออโตมาตำกัด นิยาม

A finite automaton or finite state machine (abbreviated FA) is a 5-tuple $(Q, \Sigma, q_0, \delta, A)$ where

- Q means a finite set of states.
- Σ is a finite input alphabet.
- $q_0 \in Q$ named Initial state.
- $A \subseteq Q$, A is the set of all accepted states.
- δ is a function from $Q \times \Sigma$ to Q, called transition function.

FINITE AUTOMATA

ออโตมาตำกัดตัวอย่าง

Suppose that $\Sigma = \{ 0, 1 \}$, and $Q = \{ q_0, q_1, q_2 \}$.
The transition function δ is defined as follow;

$\delta(q_0,0) = q_0$
$\delta(q_0,1) = q_1$
$\delta(q_1,0) = q_2$
$\delta(q_2,0) = q_0$
$\delta(q_2,1) = q_1$

The initial state is q_0.
The accepted or final state is q_2.

Example:
Consider this string 01001.
Start at the initial state q_0,
$\delta(q_0,0)$ gives state q_0.
$\delta(q_0,1)$ gives state q_1.
$\delta(q_1,0)$ gives state q_2.
$\delta(q_2,0)$ gives state q_0.
$\delta(q_0,1)$ gives state q_1.
It ends at the state q_1 which is not the accepted state.
We say that it **rejects** the input, otherwise we say it accepts.

FINITE AUTOMATA

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$\delta(q_1,1) = q_1$

The initial state is q_0.
The accepted state is q_1.

Example:
Consider this string 0101.
Start: $\delta(q_0,0) \rightarrow q_0$.
$\delta(q_0,1) \rightarrow q_1$.
$\delta(q_1,0) \rightarrow q_0$.
$\delta(q_0,1) \rightarrow q_1$.
Then it **accepts** 0101.
Consider 0110.
Start: $\delta(q_0,0) \rightarrow q_0$.
$\delta(q_0,1) \rightarrow q_1$.
$\delta(q_1,1) \rightarrow q_1$.
$\delta(q_1,0) \rightarrow q_0$.
Then it **rejects** 0110.

FINITE AUTOMATA

ออโตมาตำกัดตัวอย่าง

Suppose that $\Sigma = \{ 0, 1 \}$, and $Q = \{ q_0, q_1 \}$.
The transition function δ is defined as follow;

$\delta(q_0,0) = q_0$
$\delta(q_0,1) = q_1$
$\delta(q_1,0) = q_0$
$\delta(q_1,1) = q_1$

The initial state is q_0.
The accepted state is q_1.

TABLE:

State/input	0	1
q_0	q_0	q_1
q_1	q_0	q_1

REPRESENTATION BY TABLE

FINITE AUTOMATA

ออโตมาตำกัดตัวอย่าง

Suppose that $\Sigma = \{ 0, 1 \}$, and $Q = \{ q_0, q_1 \}$.
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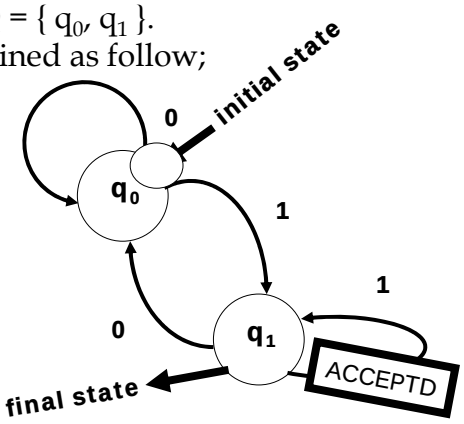
The initial state is q_0.
The accepted state is q_1.

Input string is 0101



REPRESENTATION BY DIAGRAM

FINITE AUTOMATA

ออโตมาตำกัด นิยาม

accepted word ≠ rejected word

The set of all strings that leave the finite state machine in the final state is called the language defined by the finite state machine or the language associated with this machine.

language-recognizer

FINITE AUTOMATA

ออโตมาตาจำกัด นิยาม

ACCEPTANCE BY FA

accepted word ≠ rejected word

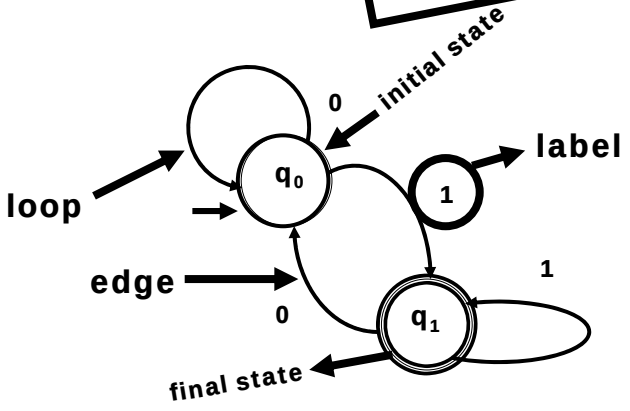
The set of all strings that leave the finite state machine in the final state is called the language defined by the finite state machine or the language associated with this machine.

language-recognizer

$$L(M) = \{ x \in \sum^* \mid x \text{ is accepted by } M \}$$

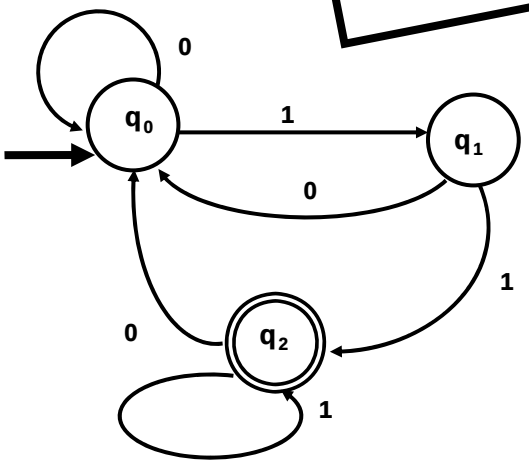
FINITE AUTOMATA

ออโตมาตาจำกัด นิยาม



FINITE AUTOMATA

ออโตมาตาจำกัด ทดลอง



GIVEN

~~111001010~~

110110111

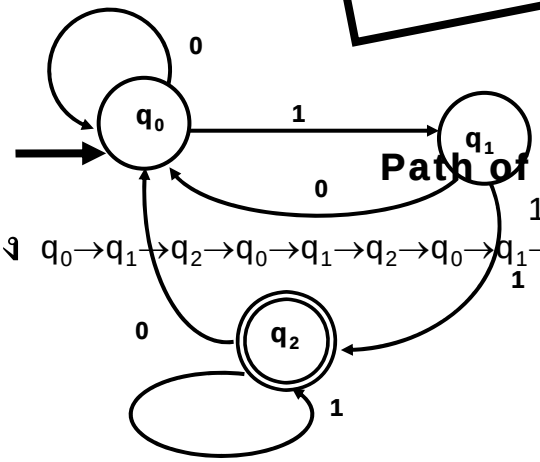
000000111

~~011011100~~

~~010010101~~

FINITE AUTOMATA

ออโตมาตาจำกัด นิยาม

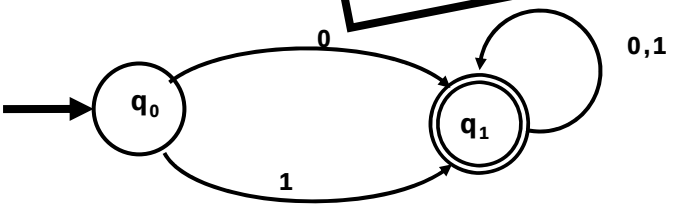


Path of the string 110110111 is

เส้นทาง $q_0 \rightarrow q_1 \rightarrow q_2 \rightarrow q_0 \rightarrow q_1 \rightarrow q_2 \rightarrow q_0 \rightarrow q_1 \rightarrow q_2 \rightarrow q_2$

FINITE AUTOMATA

ออโตมาตำกัดตัวอย่าง



Find the language accepted by this finite machine.

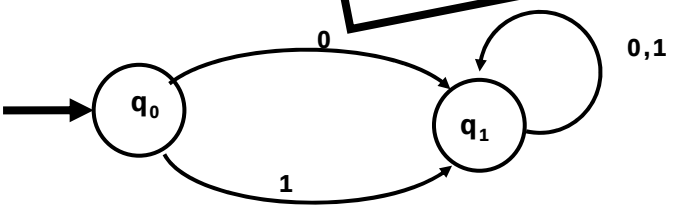
(0+1)(0+1)*

or

$(0+1)^+$

FINITE AUTOMATA

ออโตมาตำกัดตัวอย่าง

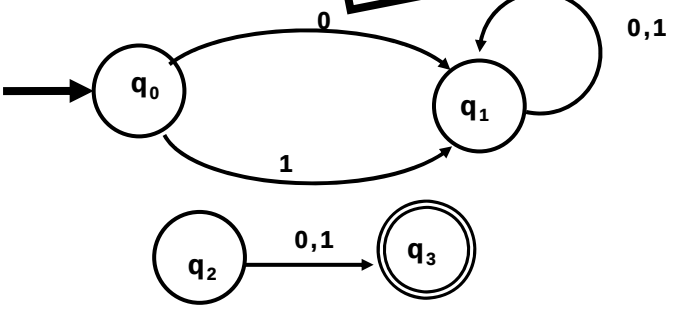


There is no final state.

AUTOMATA WITH NO LANGUAGE

FINITE AUTOMATA

ออโตมาตาจำกัดตัวอย่าง

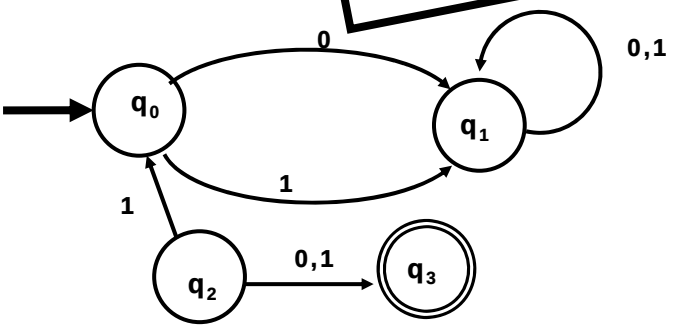


The graph is disconnected.

AUTOMATA WITH NO LANGUAGE

FINITE AUTOMATA

ออโตมาตาจำกัดตัวอย่าง



There is no path from the initial state to the final state.

AUTOMATA WITH NO LANGUAGE

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Studies finite automata for two different angles:

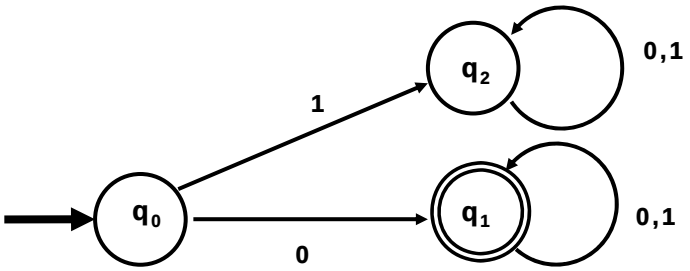
- Given a language, can we build a machine for it ?
- Given a machine, can we deduce its language ?

MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Suppose we want to build a finite machine that accepts all words in the language 0(1+0)*.



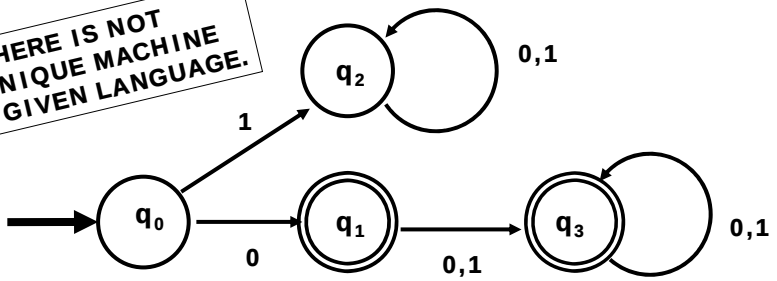
MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Suppose we want to build a finite machine that accepts all words in the language 0(1+0)*.

THERE IS NOT AN UNIQUE MACHINE FOR A GIVEN LANGUAGE.



MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

From example, we can ask a question

Is there always at least one finite automaton that accepts each possible language ?

This is related to the question: Can all languages be recognized by a finite automaton ?

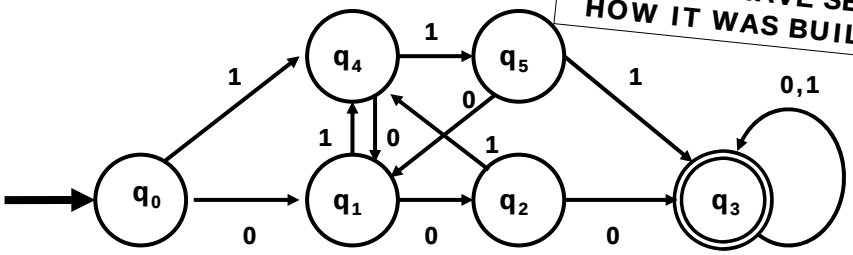
MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Suppose we want to build a finite machine that accepts all words in the language containing a triple characters, (i.e., 000 or 111).

EASY ! WE HAVE SEEN HOW IT WAS BUILT

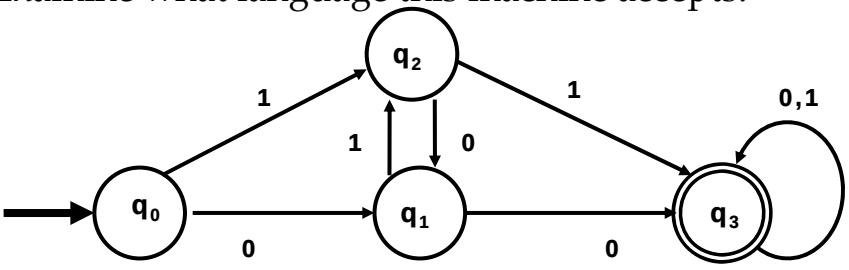


MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Examine what language this machine accepts.



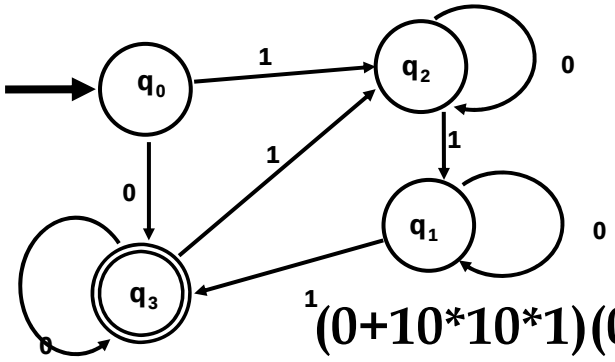
(0+1)*(00+11)(0+1)*

MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Examine what language this machine accepts.



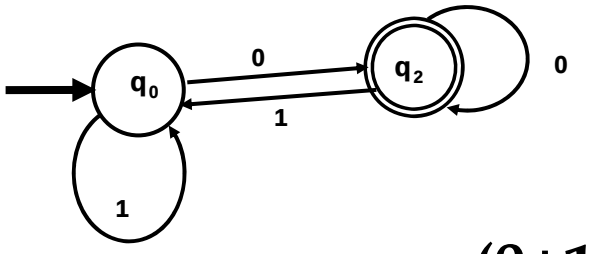
$$(0+10^*10^*1)(0+10^*10^*1)^*$$

MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Examine what language this machine accepts.



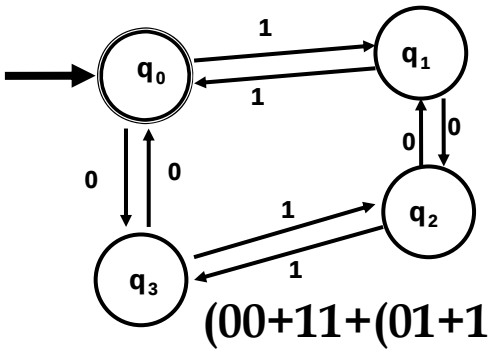
$$(0+1)^*0$$

MACHINES AND THEIR LANGUAGES

FINITE AUTOMATA

ออโตมาตาจำกัด ภาษา

Examine what language this machine accepts.



EVEN-EVEN LANGUAGE

(00+11+(01+10)(00+11)*(01+10))*

MACHINES AND THEIR LANGUAGES