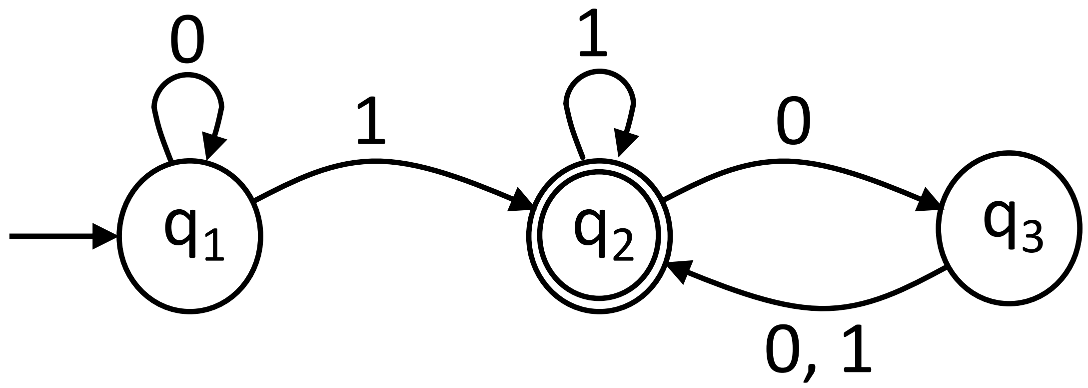
DFA Practice

CSCI 338

Deterministic Finite Automaton (DFA)

DFA: Model of a computer that determines (accept or reject) if a string has a specific format.

Deterministic Finite Automaton (DFA)



DFA: Model of a computer that determines (accept or reject) if a string has a specific format.

DFAs consist of:

1. Finite set of states, Q.
2. Finite alphabet, Σ.
3. Transition function, $\delta: Q \times \Sigma \rightarrow Q$.
4. Start state, $q_0 \in Q$.
5. Set of accept states, $F \subseteq Q$.

DFA Practice

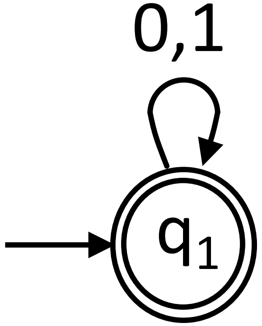
The language of a DFA M is the set of <u>all</u> strings M accepts.

DFA Practice

> The language of a DFA M is the set of <u>all</u> strings M accepts.

What is the language?:

1.

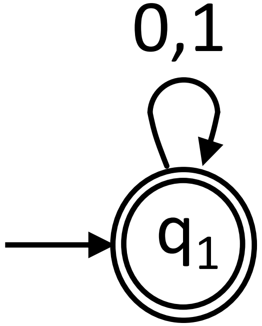


DFA Practice

The language of a DFA M is the set of <u>all</u> strings M accepts.

What is the language?:

1. $\{\omega : \omega$ consists of 0's and 1's$\}$



DFA Language Rules:

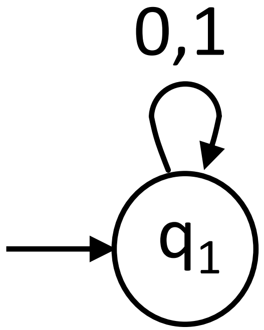
1. If the DFA accepts it, it is in the language.
2. If it is in the language, the DFA must accept it.

DFA Practice

The language of a DFA M is the set of all strings M accepts.

What is the language?:

1.

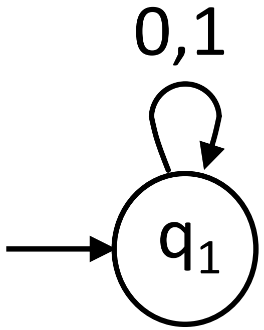


DFA Practice

The language of a DFA M is the set of <u>all</u> strings M accepts.

What is the language?:

1. $\emptyset$

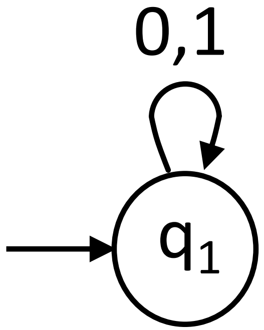


DFA Practice

The language of a DFA M is the set of <u>all</u> strings M accepts.

What is the language?:

1. $\emptyset = \{\omega : \omega$ contains no 0's and contains at least one $0\}$

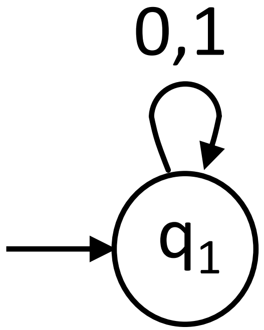


DFA Practice

The language of a DFA M is the set of <u>all</u> strings M accepts.

What is the language?:

1. $\emptyset = \{\omega\colon \omega$ contains no 0's and contains at least one $0\}$



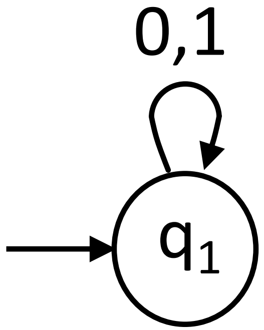
Can it still process $\omega = 11010$?

DFA Practice

The language of a DFA M is the set of <u>all</u> strings M accepts.

What is the language?:

1. $\emptyset = \{\omega : \omega$ contains no 0's and contains at least one $0\}$



Can it still process $\omega = 11010$?

Yes – DFA's can process every string with the appropriate alphabet.

Prove that the following language is regular:

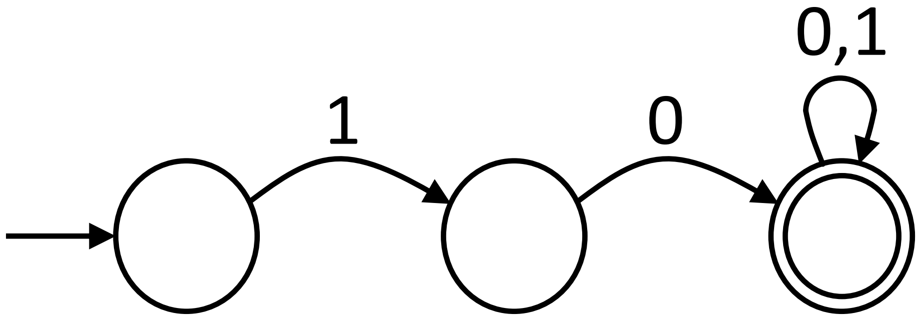
$$\{\omega : \omega \text{ begins with sequence } 10\}.$$

Proof:

Prove that the following language is regular:

$\{\omega : \omega \text{ begins with sequence } 10\}$.

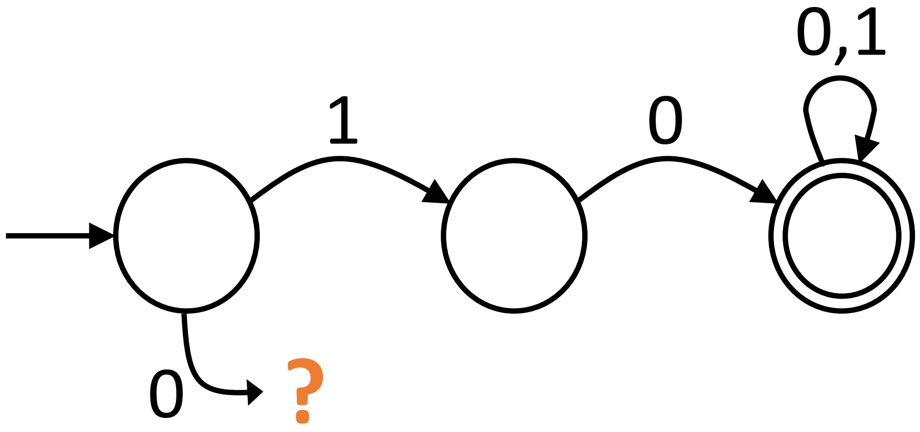
Proof:



Prove that the following language is regular:

$\{\omega: \omega \text{ begins with sequence } 10\}.$

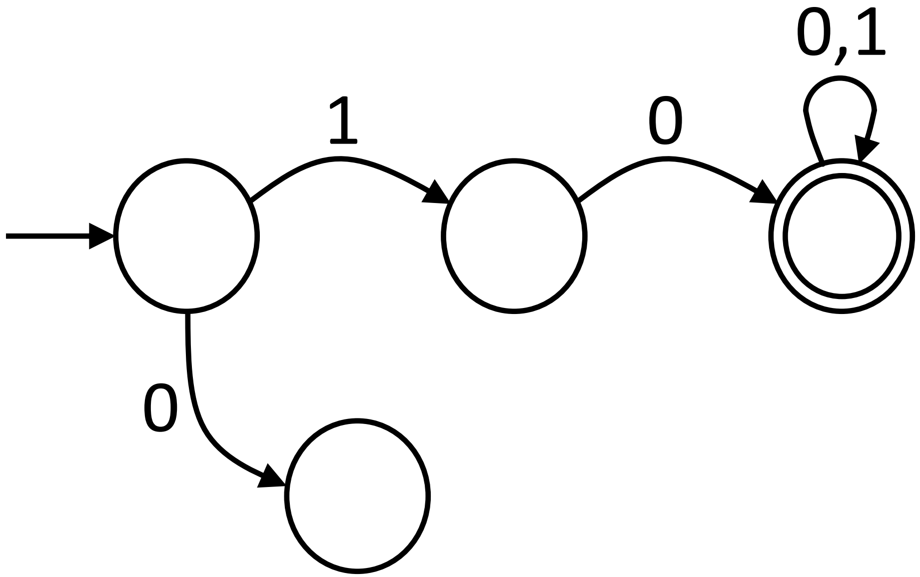
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ begins with sequence } 10\}$.

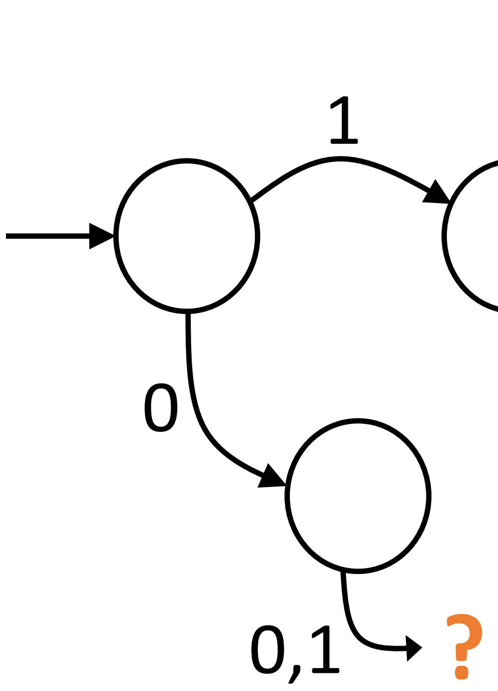
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ begins with sequence } 10\}$.

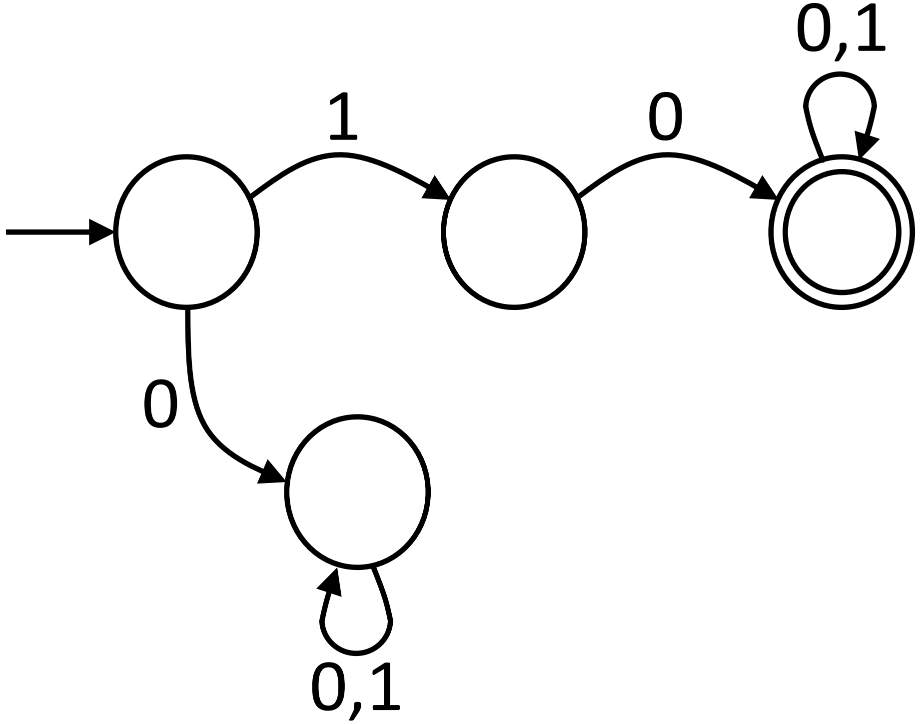
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ begins with sequence } 10\}$.

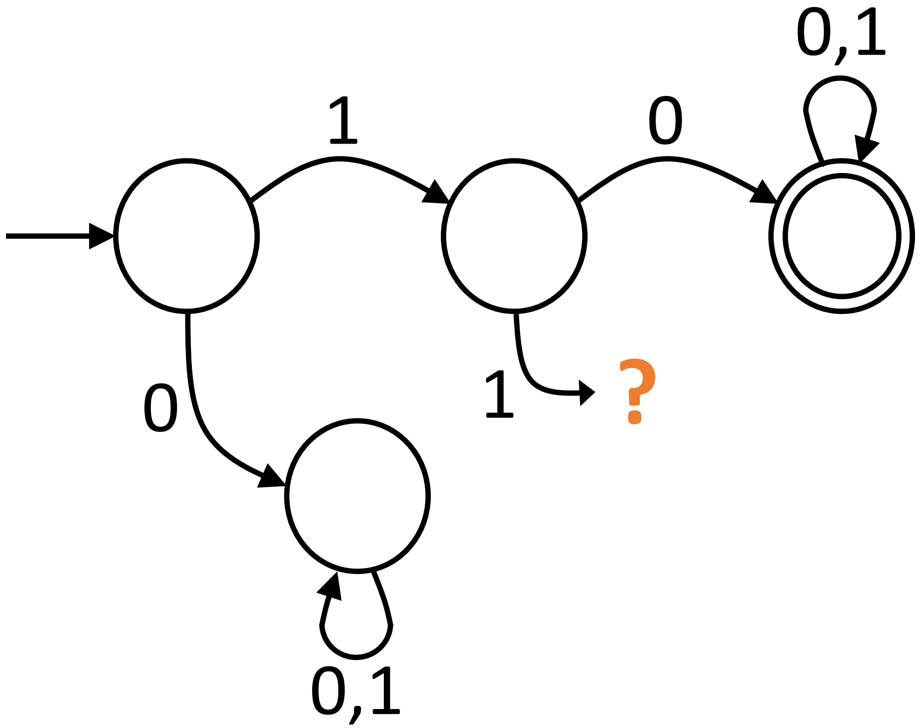
Proof:



Prove that the following language is regular:

$\{\omega \colon \omega$ begins with sequence $10\}$.

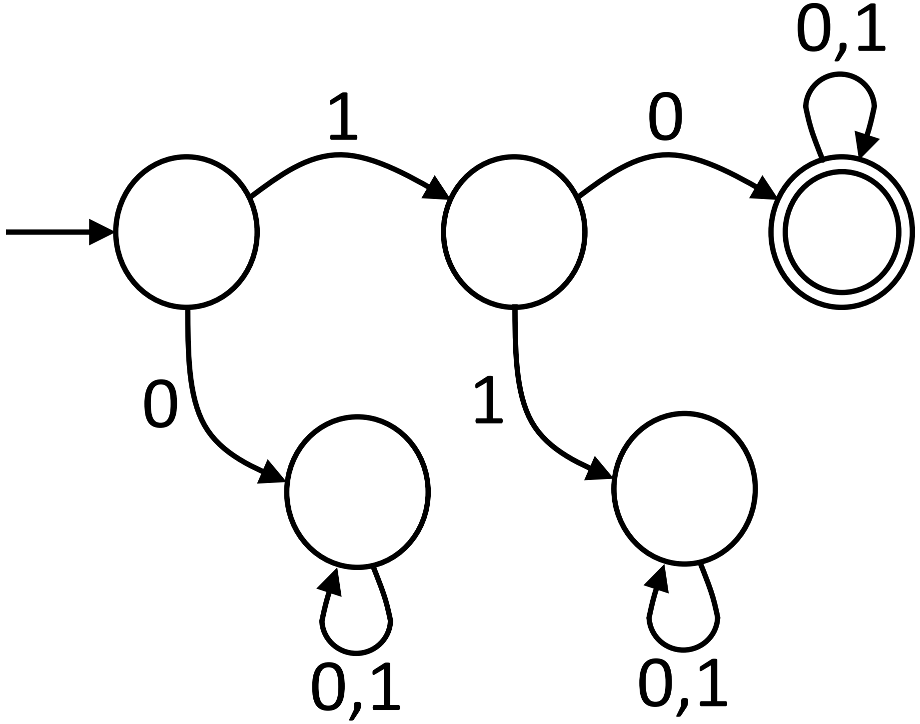
Proof:



Prove that the following language is regular:

$\{\omega: \omega \text{ begins with sequence } 10\}$.

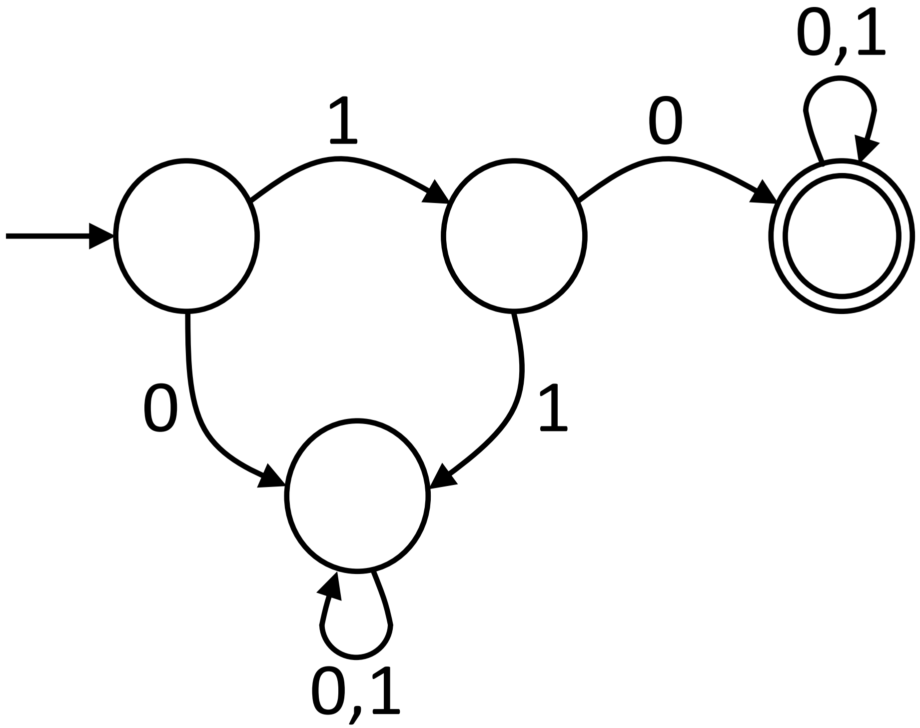
Proof:



Prove that the following language is regular:

$\{\omega \colon \omega \text{ begins with sequence } 10\}$.

Proof:



Prove that the following language is regular:

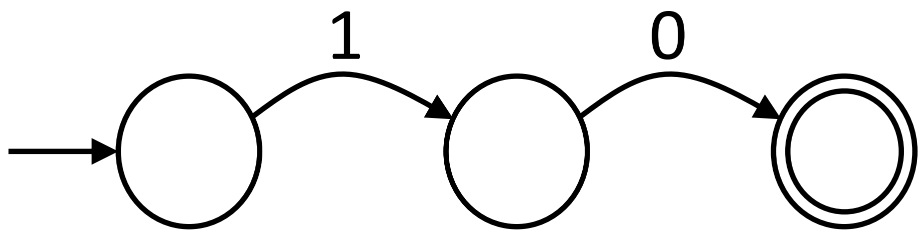
$\{\omega\colon \omega$ ends with sequence $10\}$.

Proof:

Prove that the following language is regular:

$\{\omega : \omega$ ends with sequence $10\}$.

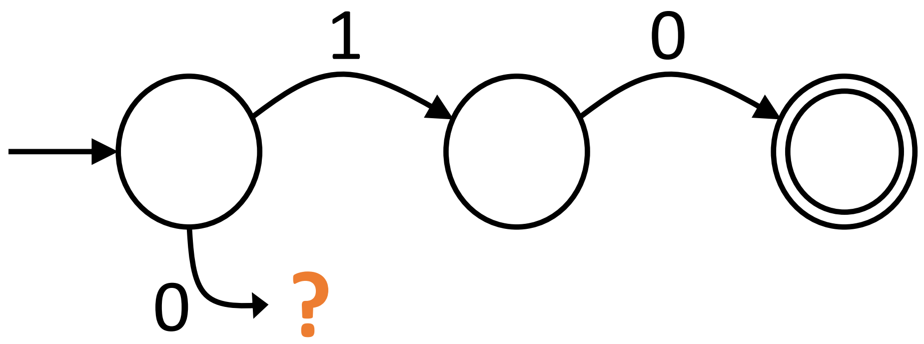
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ ends with sequence } 10\}$.

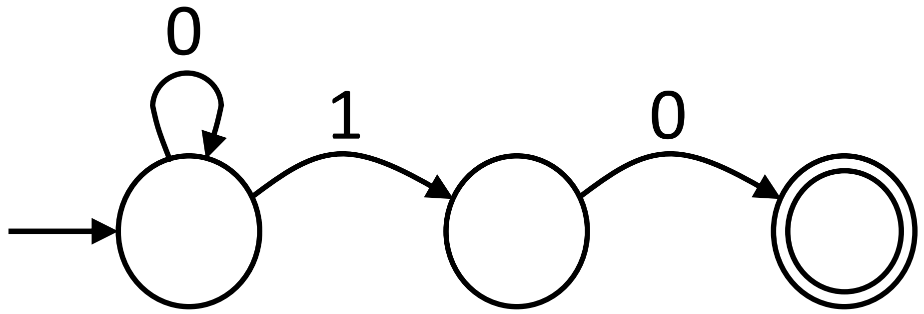
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ ends with sequence } 10\}$.

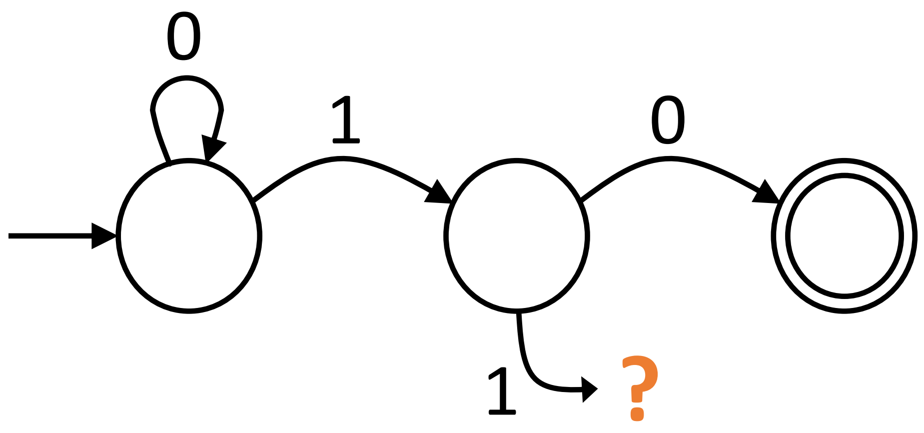
Proof:



Prove that the following language is regular:

$\{\omega: \omega \text{ ends with sequence } 10\}$.

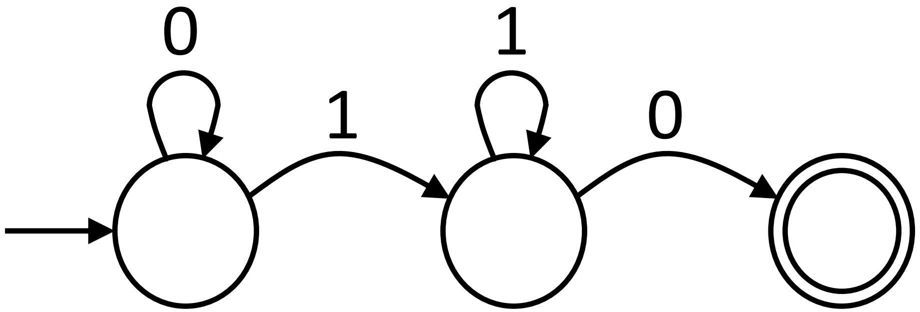
Proof:



Prove that the following language is regular:

$\{\omega : \omega$ ends with sequence $10\}$.

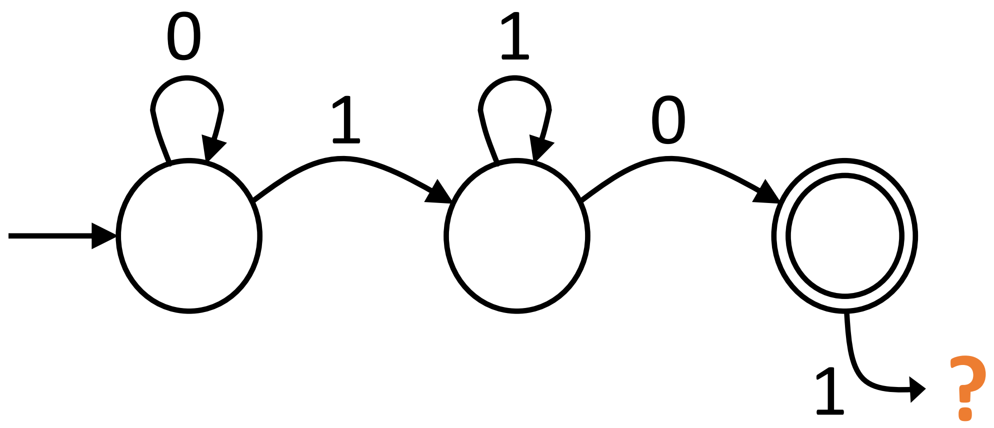
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ ends with sequence } 10\}$.

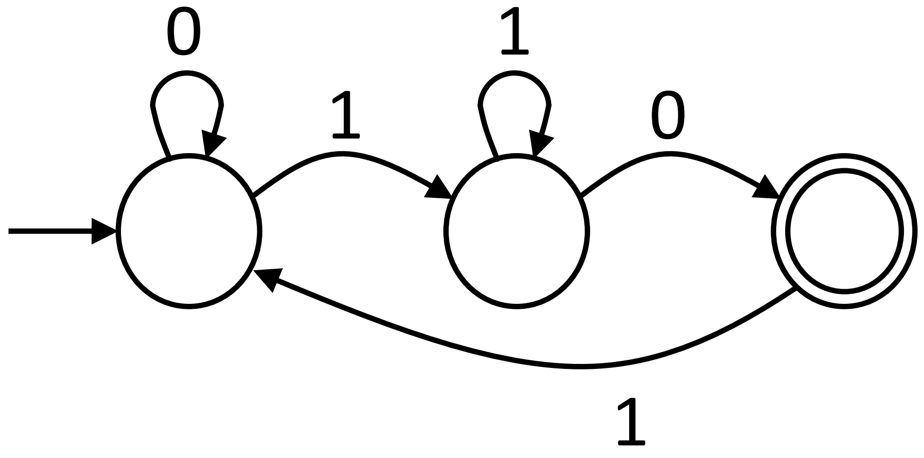
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ ends with sequence } 10\}$.

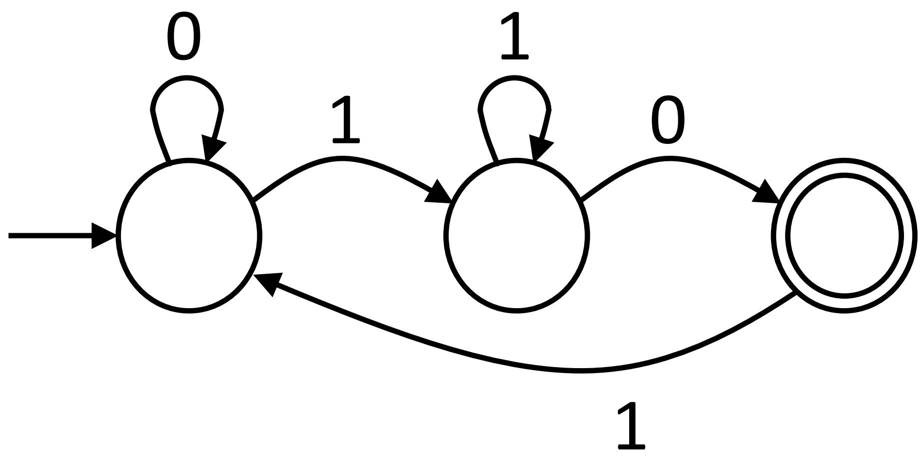
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ ends with sequence } 10\}$.

Proof:

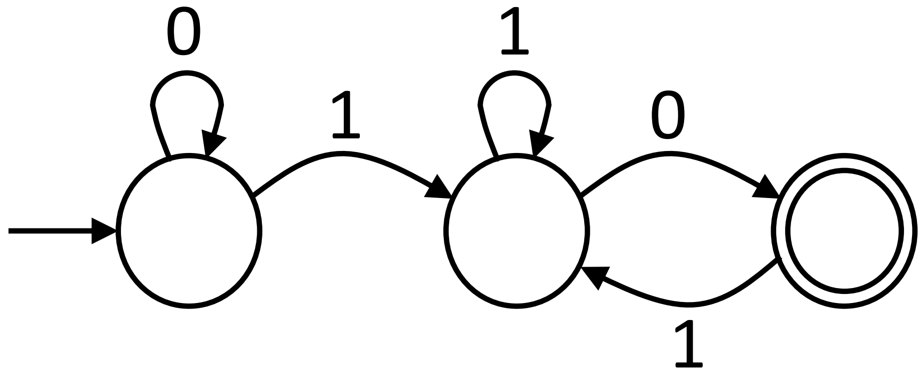


What about 1010?

Prove that the following language is regular:

$\{\omega: \omega \text{ ends with sequence } 10\}$.

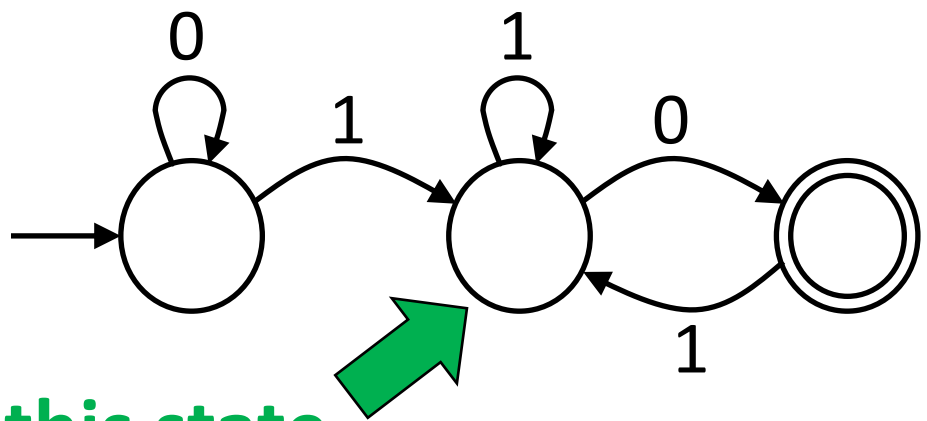
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ ends with sequence } 10\}$.

Proof:

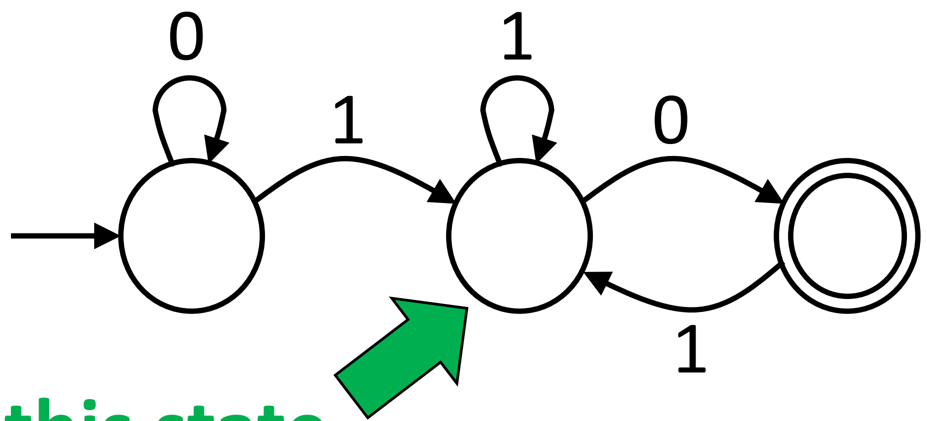


If you had to name this state, what would you name it?

Prove that the following language is regular:

$\{\omega : \omega$ ends with sequence $10\}$.

Proof:



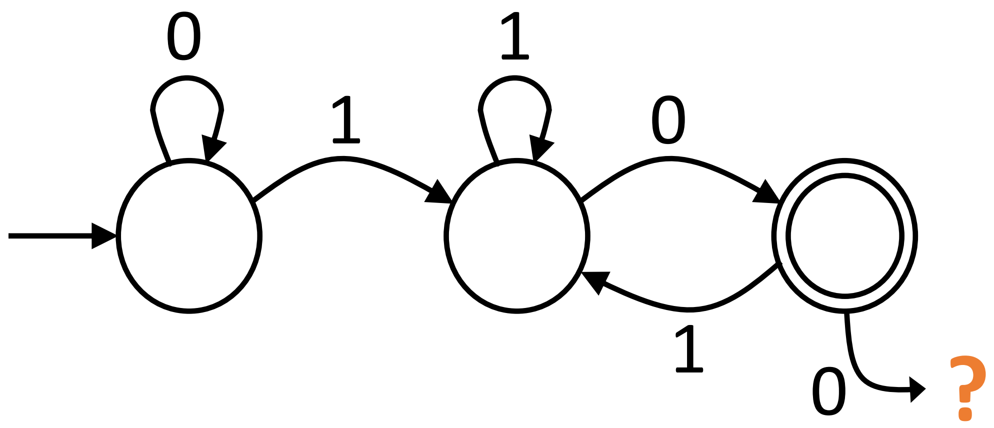
If you had to name this state, what would you name it?

"We just processed a 1 state"

Prove that the following language is regular:

$\{\omega: \omega \text{ ends with sequence } 10\}$.

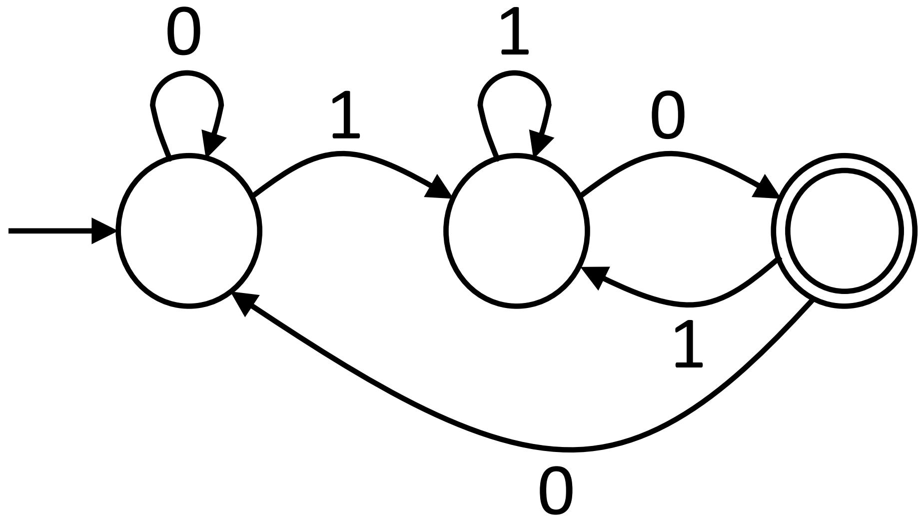
Proof:



Prove that the following language is regular:

$\{\omega\colon \omega \text{ ends with sequence } 10\}$.

Proof:



Prove that the following language is regular:

$\{\omega\colon \omega$ starts and ends with a $0\}$.

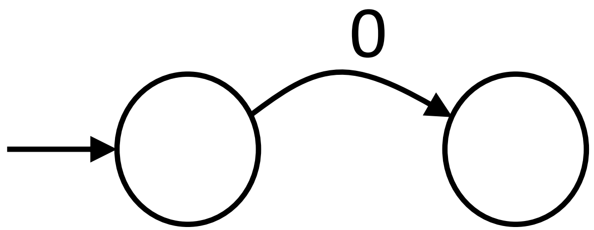
Proof:

?

Prove that the following language is regular:

$\{\omega: \omega \text{ starts and ends with a } 0\}$.

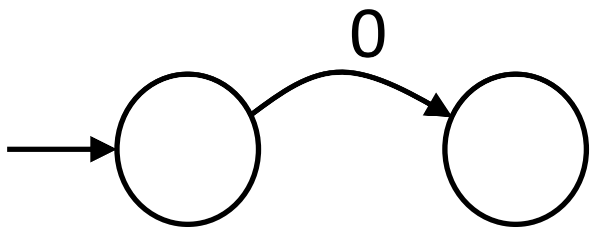
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ starts and ends with a } 0\}$.

Proof:

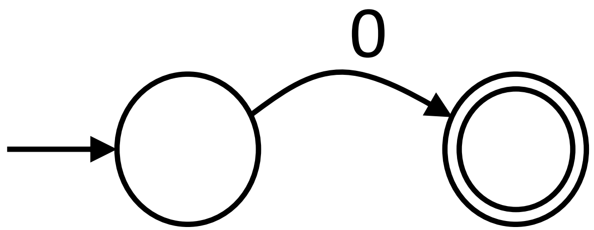


The string $\omega = 0$ starts and ends with a 0 and must be accepted!

Prove that the following language is regular:

$\{\omega : \omega$ starts and ends with a $0\}$.

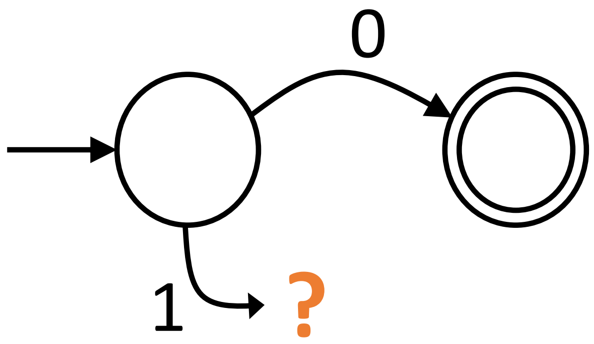
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ starts and ends with a } 0\}$.

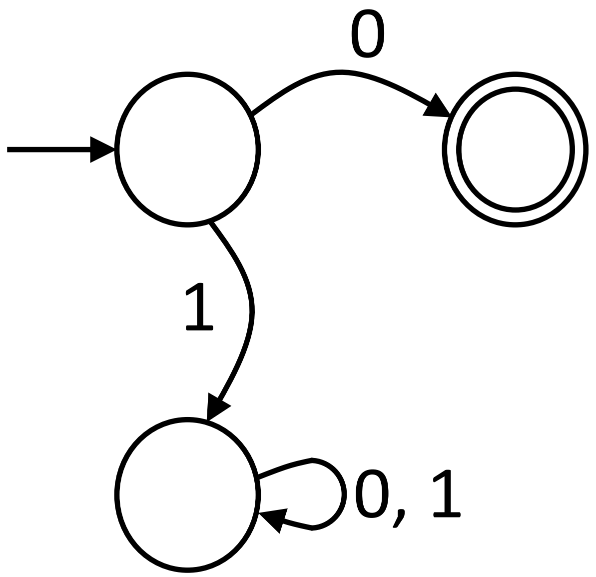
Proof:



Prove that the following language is regular:

$\{\omega\colon \omega$ starts and ends with a $0\}$.

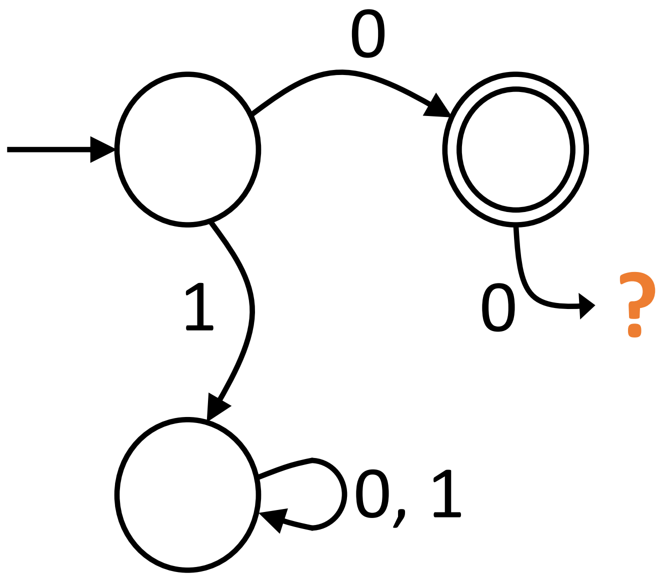
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ starts and ends with a } 0\}$.

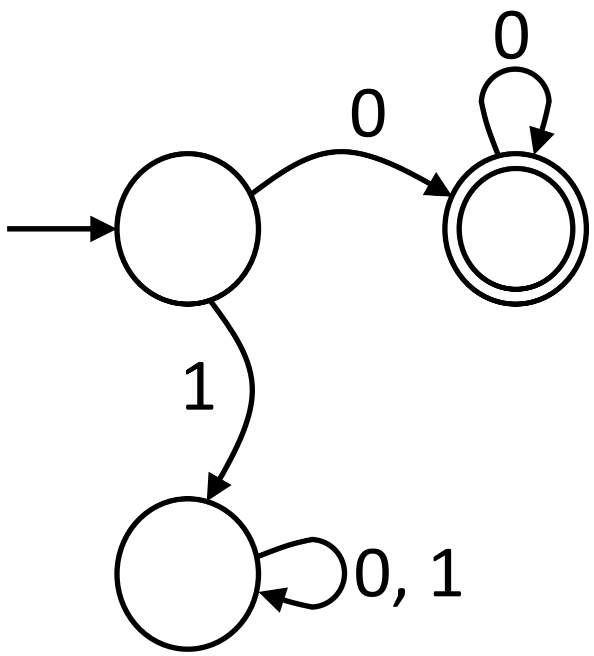
Proof:



Prove that the following language is regular:

$\{\omega: \omega$ starts and ends with a $0\}$.

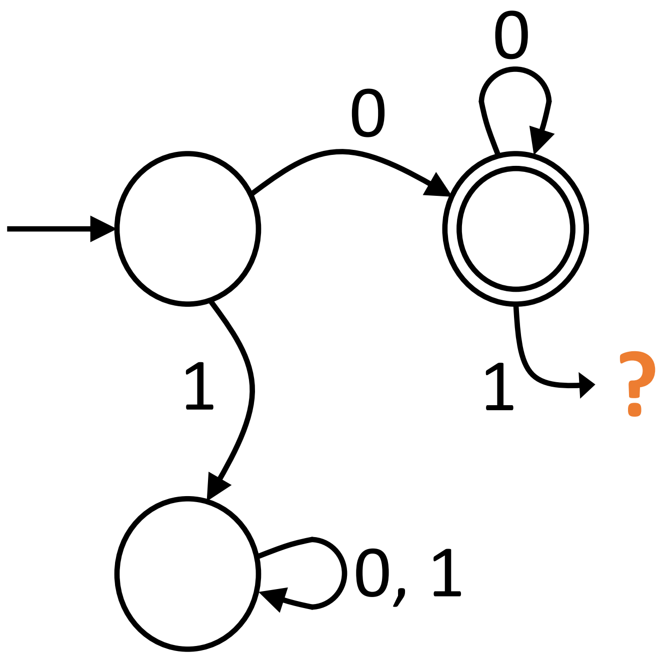
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ starts and ends with a } 0\}$.

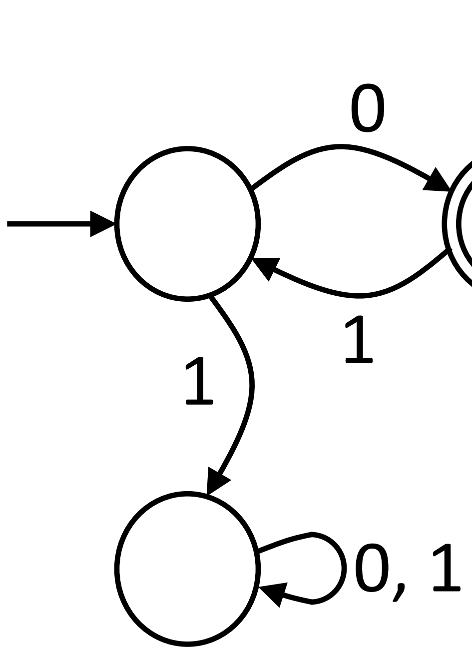
Proof:



Prove that the following language is regular:

$\{\omega \colon \omega \text{ starts and ends with a } 0\}$.

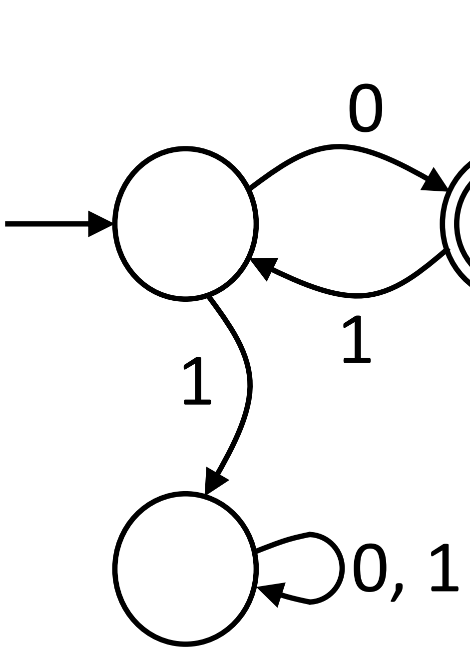
Proof:



Prove that the following language is regular:

$\{\omega : \omega$ starts and ends with a $0\}$.

Proof:

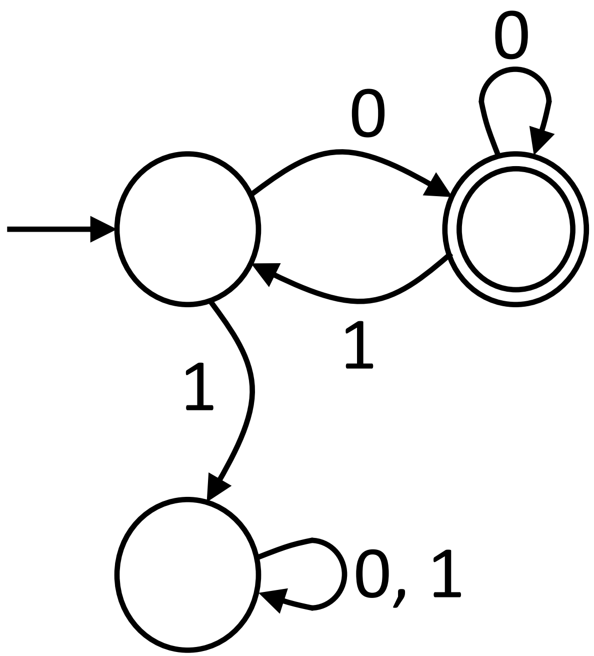


$\omega = 0110$. Accept or Reject?

Prove that the following language is regular:

$\{\omega: \omega$ starts and ends with a $0\}$.

Proof:



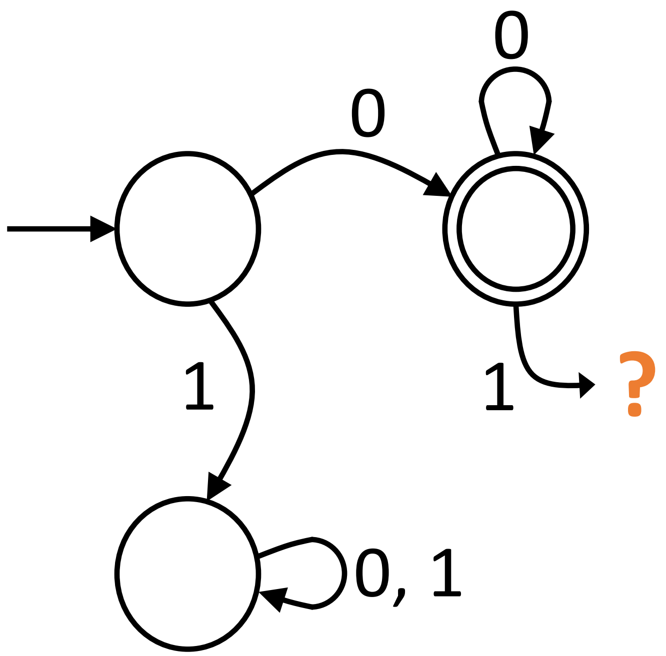
$\omega = 0110$. Accept or Reject?

It rejects but <u>should</u> accept!

Prove that the following language is regular:

$\{\omega : \omega$ starts and ends with a $0\}$.

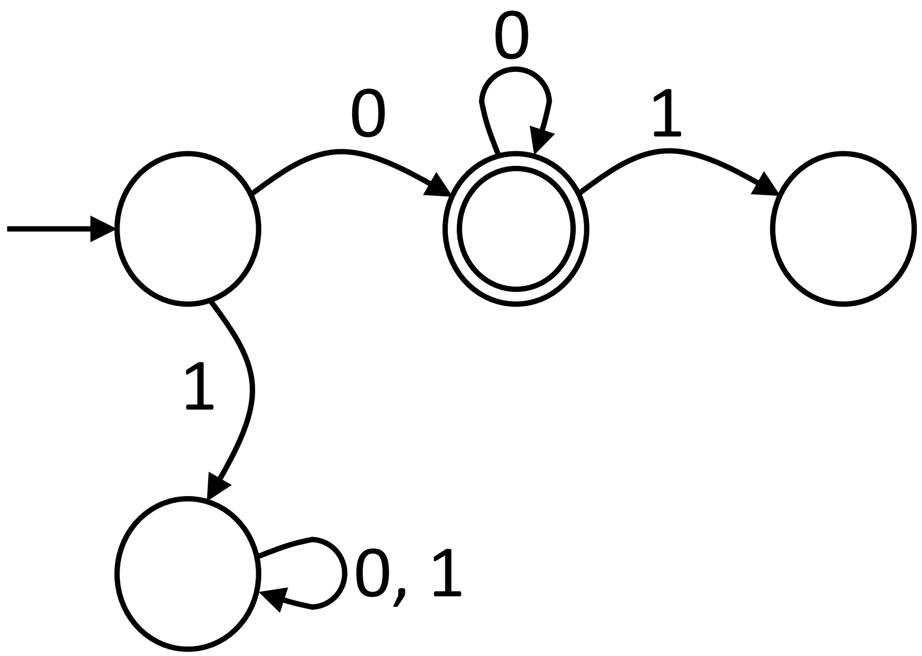
Proof:



Prove that the following language is regular:

$\{\omega\colon \omega$ starts and ends with a $0\}$.

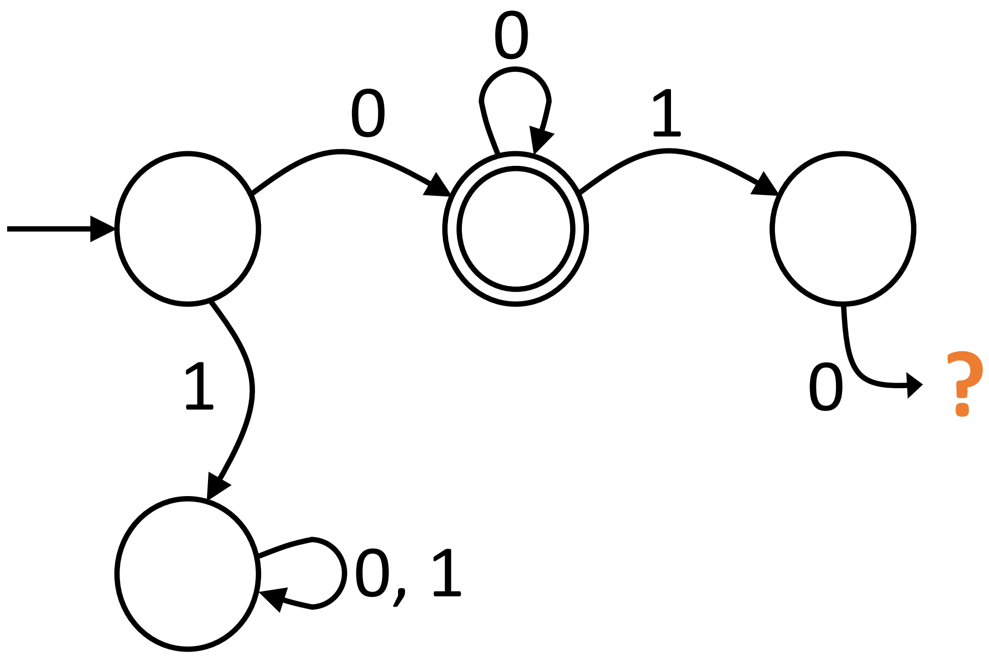
Proof:



Prove that the following language is regular:

$\{\omega\colon \omega$ starts and ends with a $0\}$.

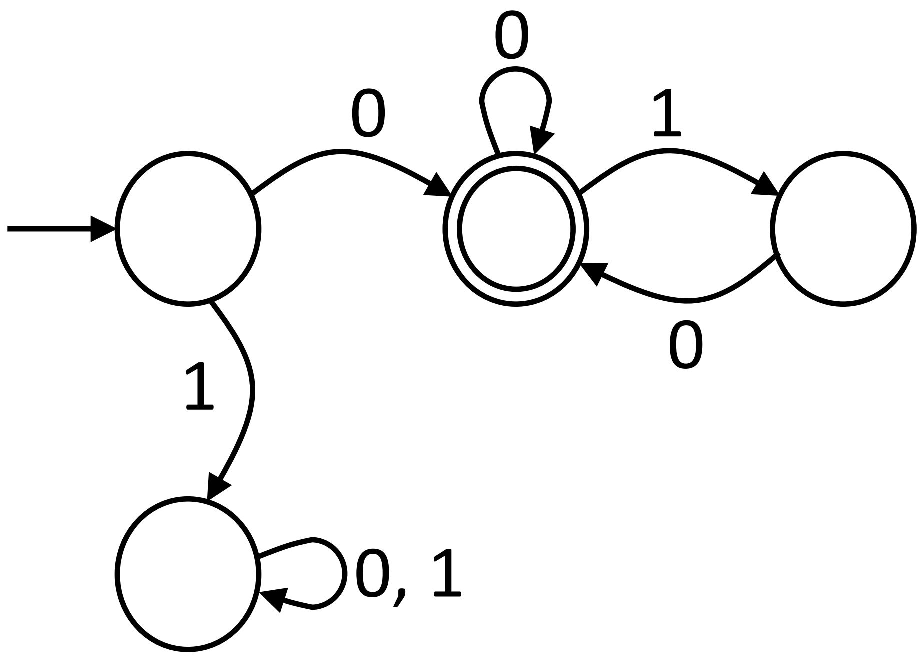
Proof:



Prove that the following language is regular:

$\{\omega : \omega$ starts and ends with a $0\}$.

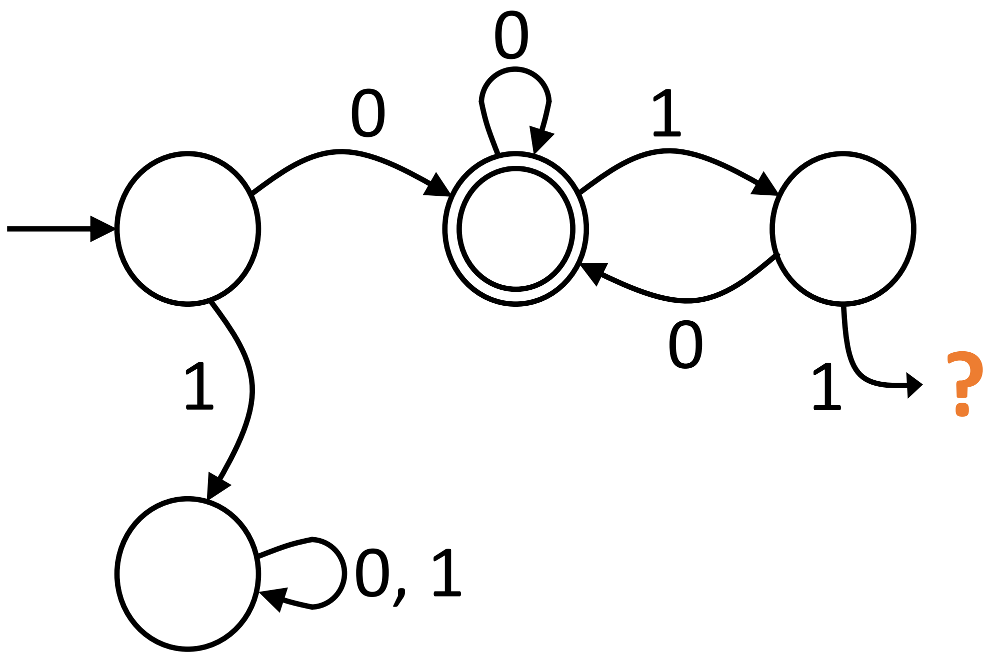
Proof:



Prove that the following language is regular:

$\{\omega : \omega$ starts and ends with a $0\}$.

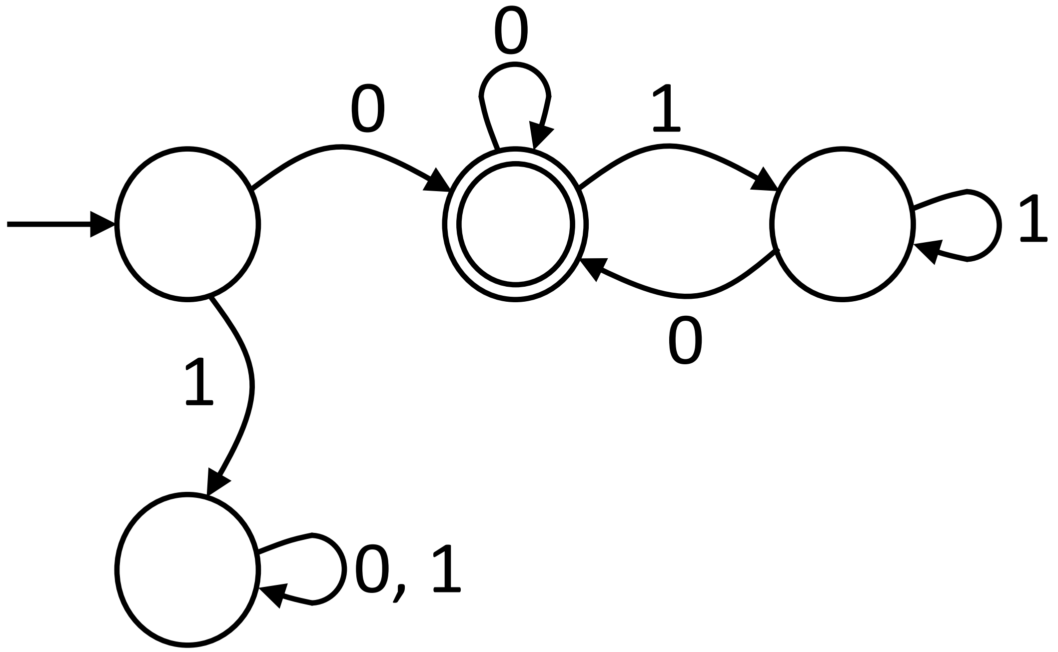
Proof:



Prove that the following language is regular:

$\{\omega\colon \omega \text{ starts and ends with a } 0\}$.

Proof:



Prove that the following language is regular:

$\{\omega : \omega$ starts and ends with the same symbol$\}$.

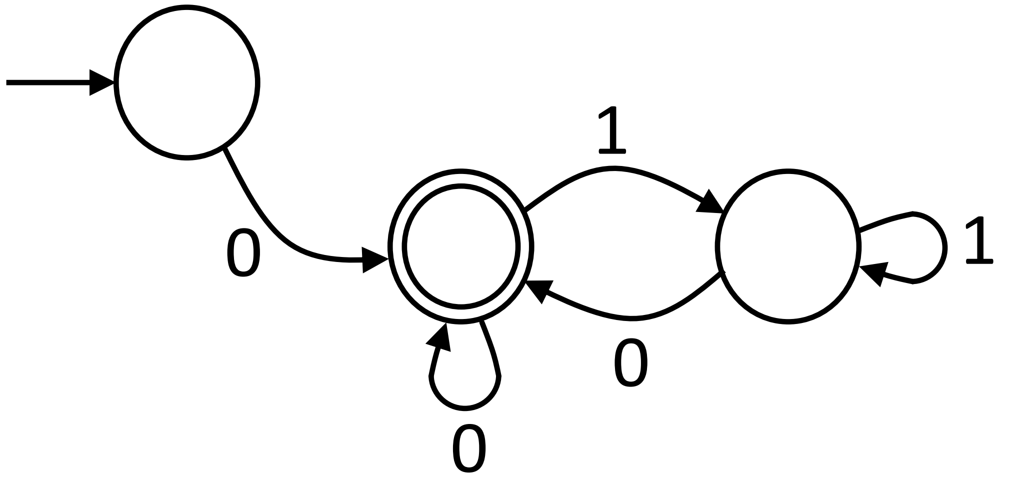
Proof:

?

Prove that the following language is regular:

$\{\omega: \omega \text{ starts and ends with the same symbol}\}$.

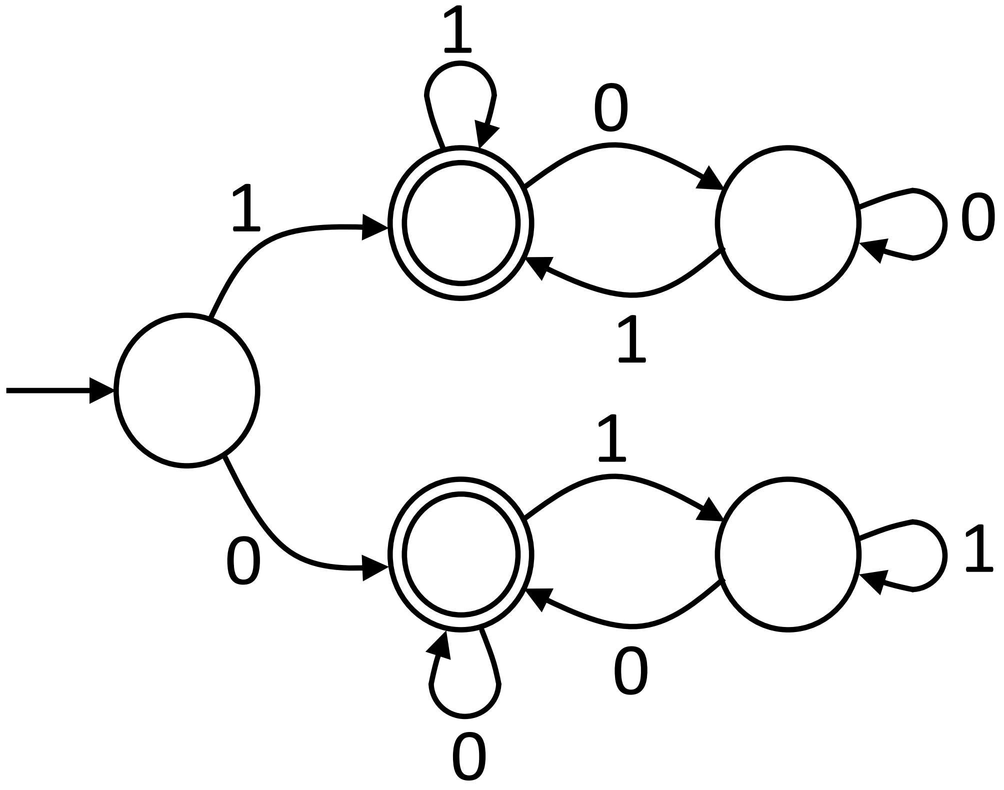
Proof:



Prove that the following language is regular:

$\{\omega: \omega$ starts and ends with the same symbol$\}$.

Proof:



Prove that the following language is regular:

$\{\omega$: every odd symbol is a $1\}$.

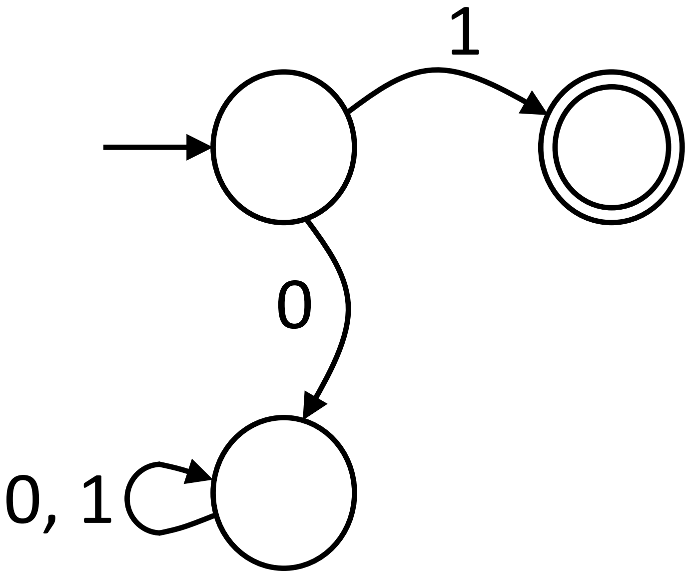
Proof:

?

Prove that the following language is regular:

$\{\omega$: every odd symbol is a $1\}$.

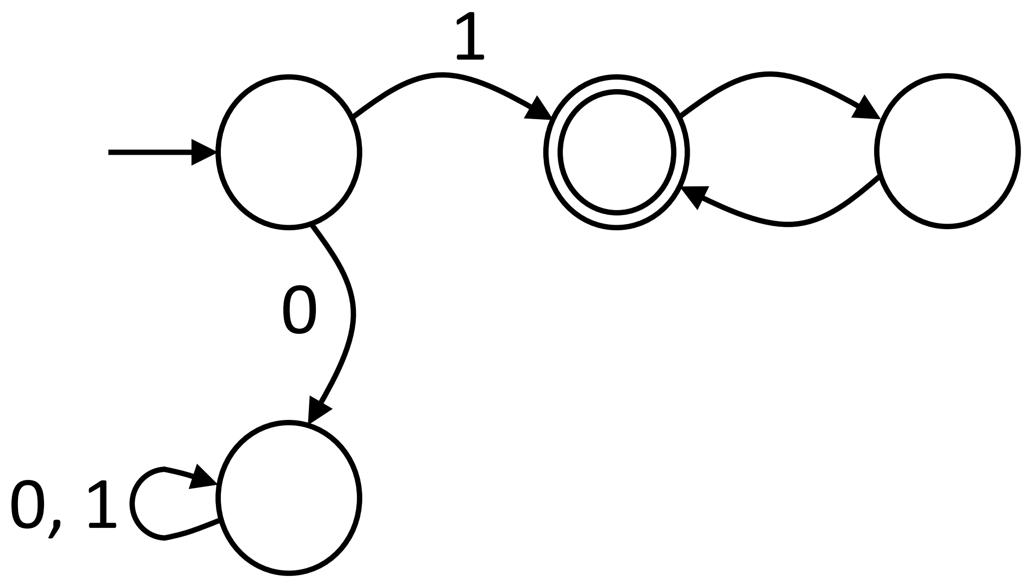
Proof:



Prove that the following language is regular:

$\{\omega$: every odd symbol is a $1\}$.

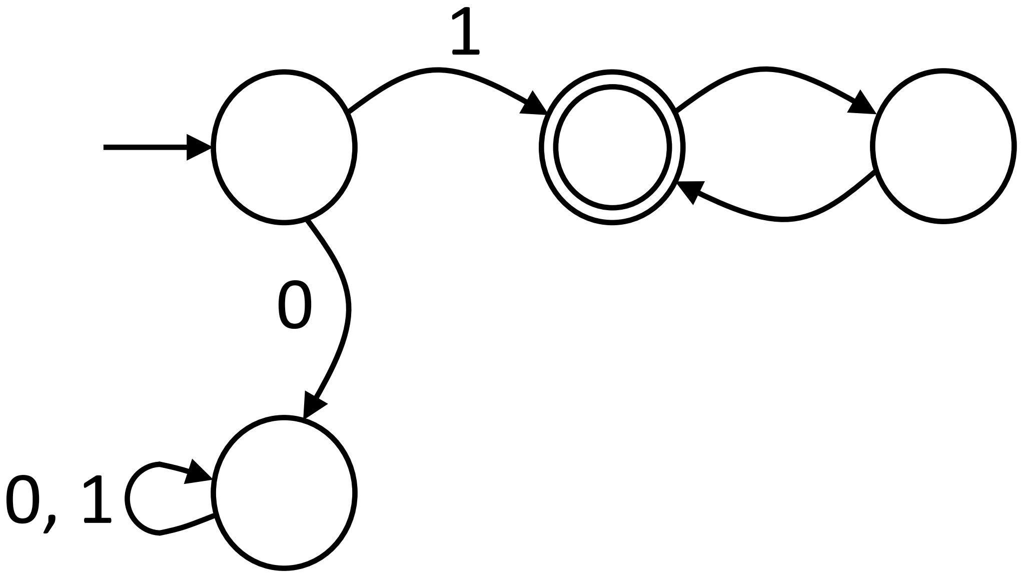
Proof:



Prove that the following language is regular:

$\{\omega$: every odd symbol is a $1\}$.

Proof:

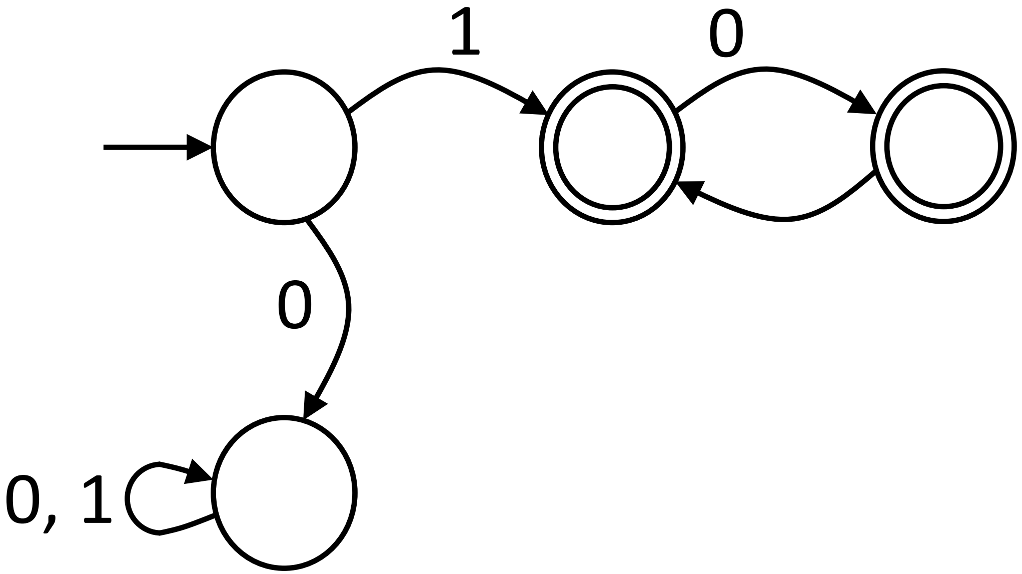


$\omega = 10?$

Prove that the following language is regular:

$\{\omega\text{: every odd symbol is a } 1\}$.

Proof:

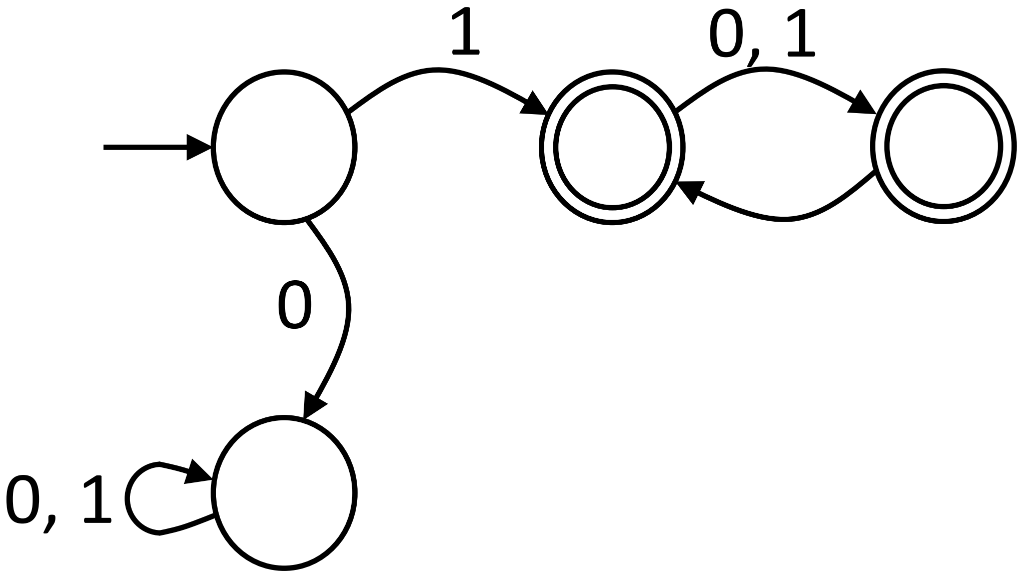


$\omega = 10?$

Prove that the following language is regular:

$\{\omega$: every odd symbol is a $1\}$.

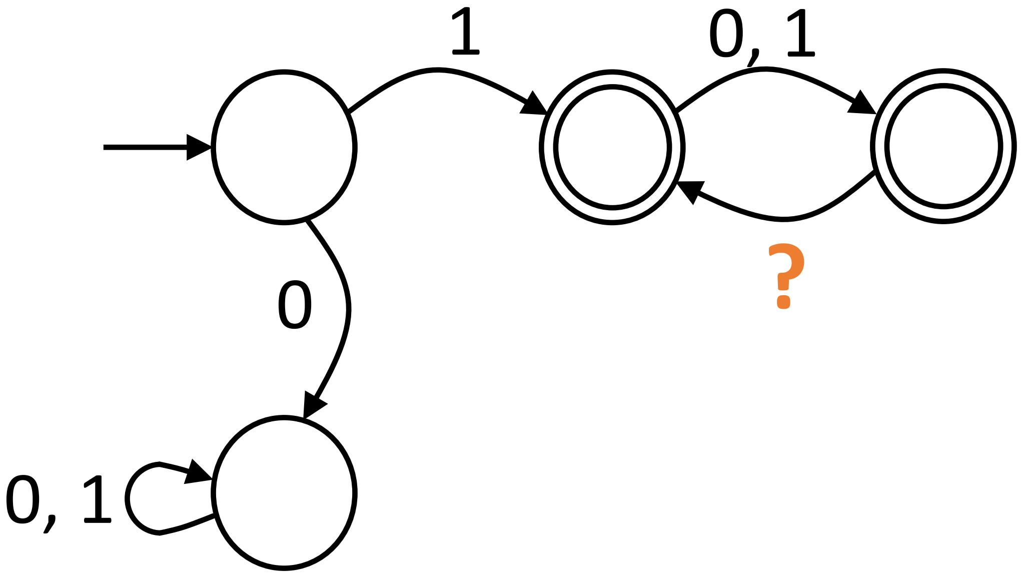
Proof:



Prove that the following language is regular:

$\{\omega$: every odd symbol is a 1$\}$.

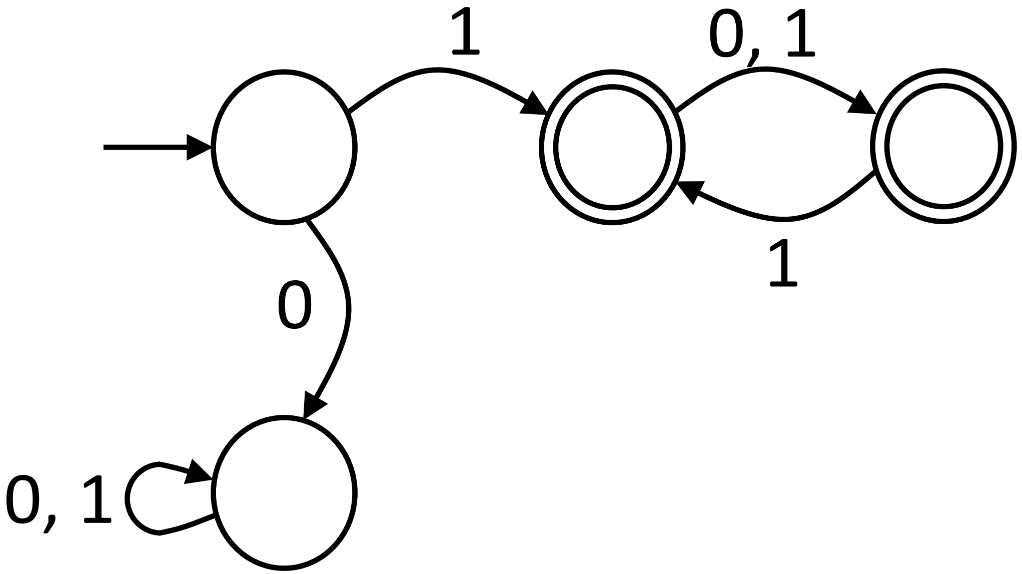
Proof:



Prove that the following language is regular:

$\{\omega$: every odd symbol is a $1\}$.

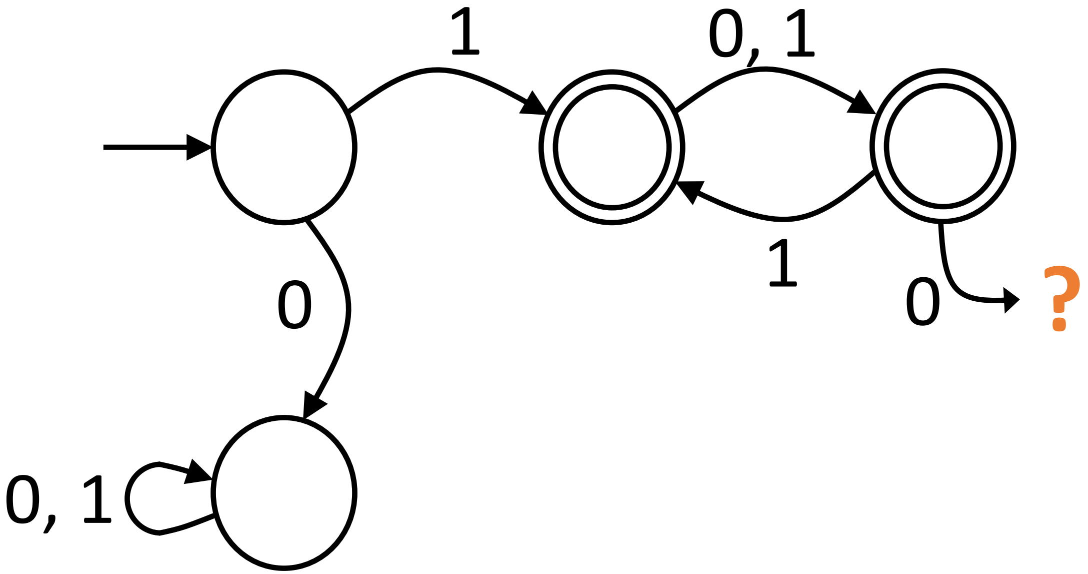
Proof:



Prove that the following language is regular:

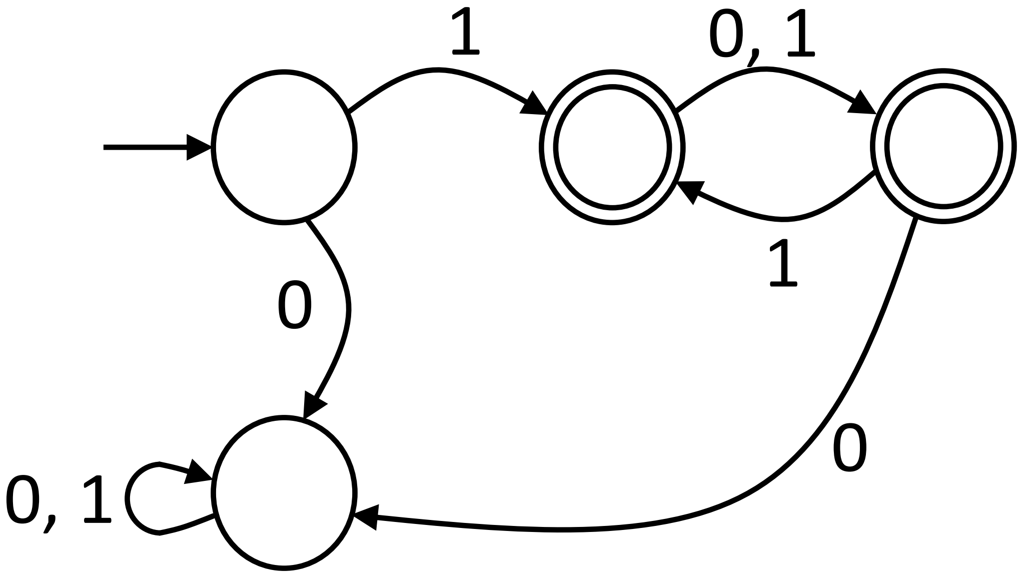
$\{\omega$: every odd symbol is a 1$\}$.

Proof:



Prove that the following language is regular:
$\{\omega$: every odd symbol is a $1\}$.

Proof:



Prove that the following language is regular:

$\{\omega : \omega$ consists of some number of 0s followed by the same number of 1s$\}$. E.g. 000111

Proof:

?

Prove that the following language is regular:

$\{11\}$.

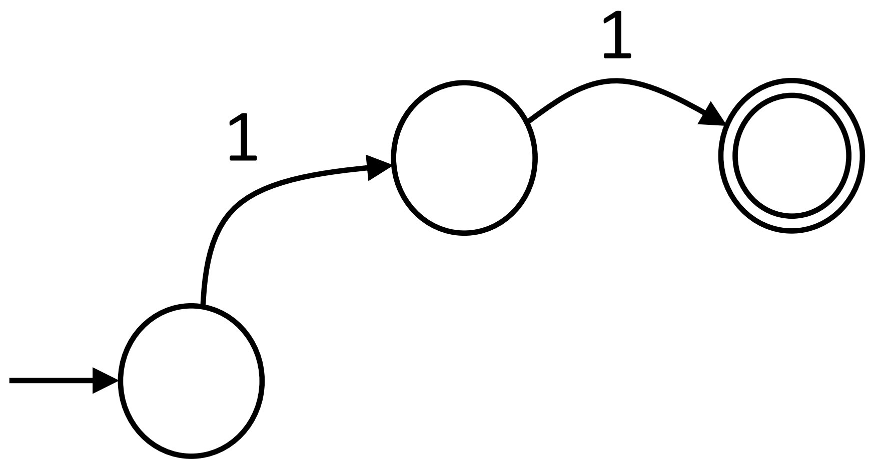
Proof:

?

Prove that the following language is regular:

$$\{11\}.$$

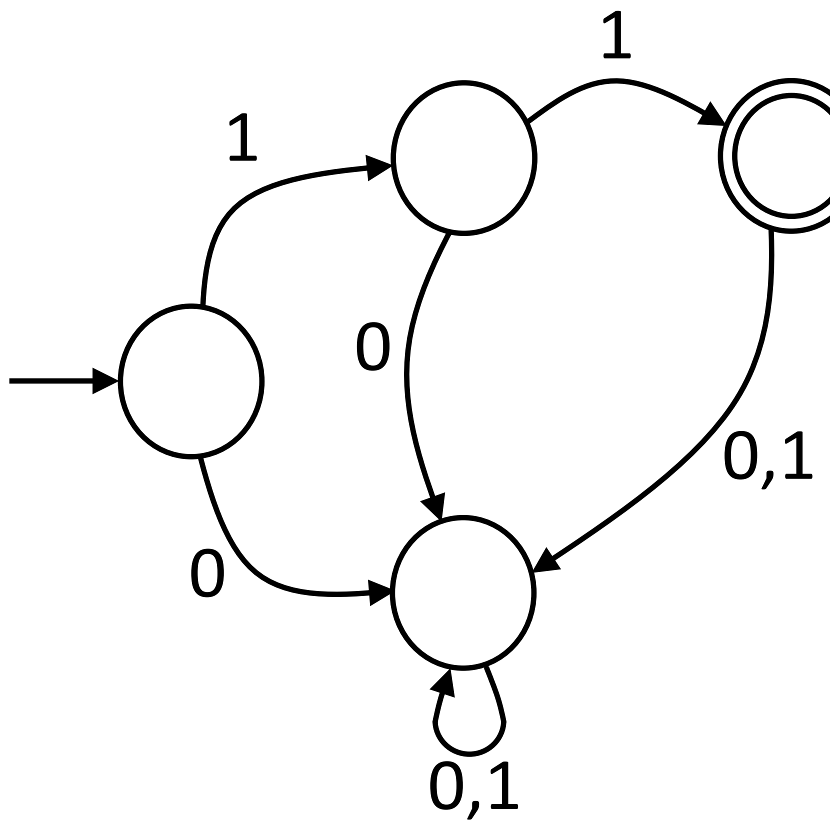
Proof:



Prove that the following language is regular:

$$\{11\}.$$

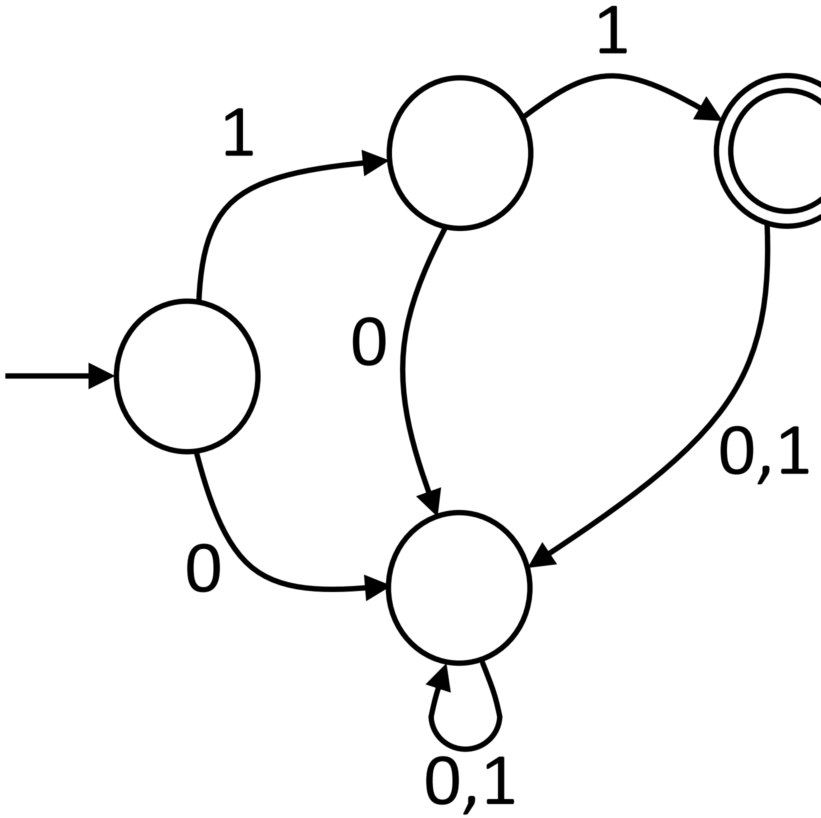
Proof:



Prove that the following language is regular:

$\{\omega : \omega \text{ could be anything except } 11\}.$

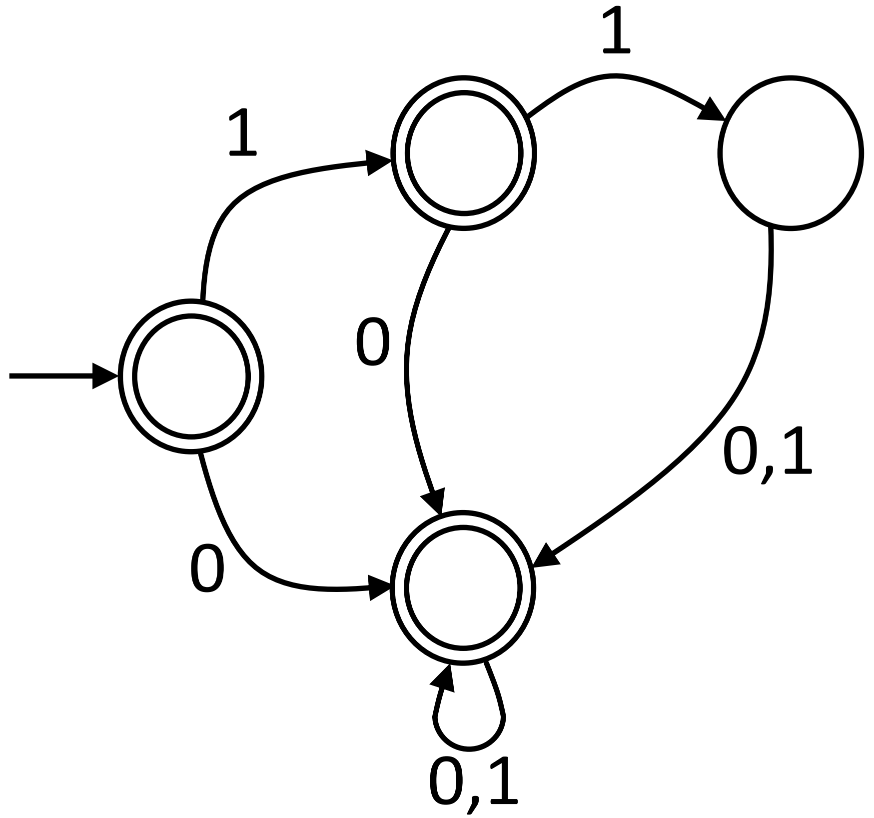
Proof:



Prove that the following language is regular:

$\{\omega\colon \omega \text{ could be anything except } 11\}$.

Proof:



Complements of Regular Languages

Claim: If A is a regular language, then the following is also regular:

$$\bar{A} = \{\omega \colon \omega \notin A\}$$

Proof: ?

Complements of Regular Languages

Claim: If A is a regular language, then the following is also regular:

$$\bar{A} = \{\omega : \omega \notin A\}$$

Proof: A is a regular language $\Rightarrow \exists$ DFA for it.

Complements of Regular Languages

Claim: If A is a regular language, then the following is also regular:

$$\bar{A} = \{\omega \colon \omega \notin A\}$$

Proof: A is a regular language $\Rightarrow$ $\exists$ DFA for it.

Given DFA_A for A, build a $\text{DFA}_{\bar{A}}$ for $\bar{A}$:

?

Complements of Regular Languages

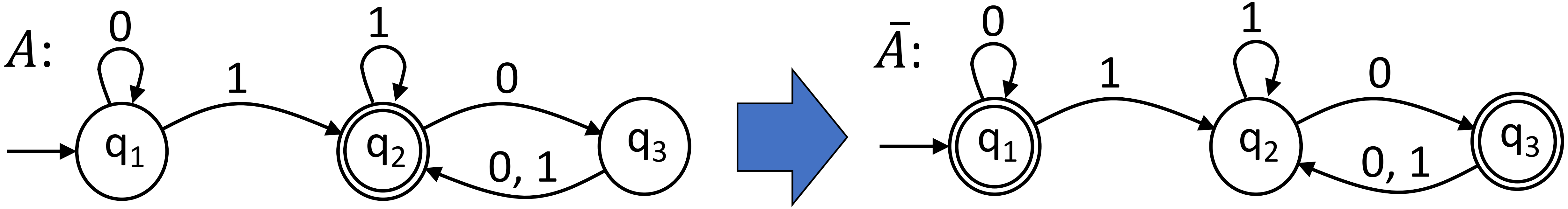
Claim: If A is a regular language, then the following is also regular:

$$\bar{A} = \{\omega : \omega \notin A\}$$

Proof: A is a regular language $\Rightarrow \exists$ DFA for it.

Given DFA_A for A, build a $\text{DFA}_{\bar{A}}$ for $\bar{A}$:

Turn accept states into non-accept states and turn non-accept states into accept states.



Complements of Regular Languages

Claim: If A is a regular language, then the following is also regular:

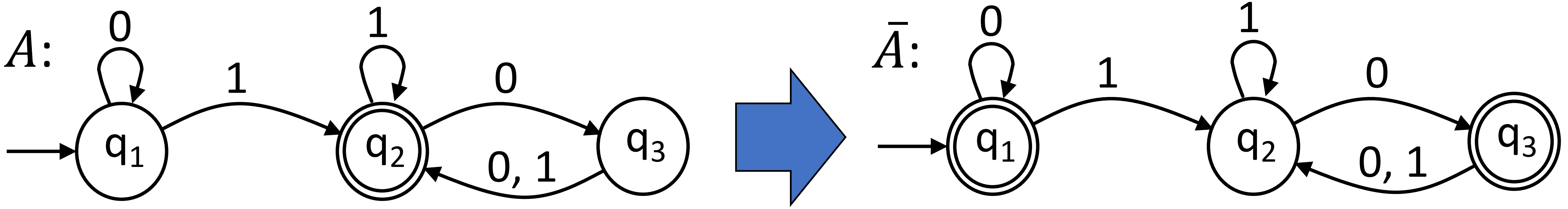
$$\bar{A} = \{\omega : \omega \notin A\}$$

Proof: A is a regular language ⇒ ∃ DFA for it.

Given DFA_A for A, build a $\text{DFA}_{\bar{A}}$ for $\bar{A}$:

Turn accept states into non-accept states and turn non-accept states into accept states.

Need to argue that this DFA defines $\bar{A}$...



Complements of Regular Languages

Claim: If A is a regular language, then the following is also regular:

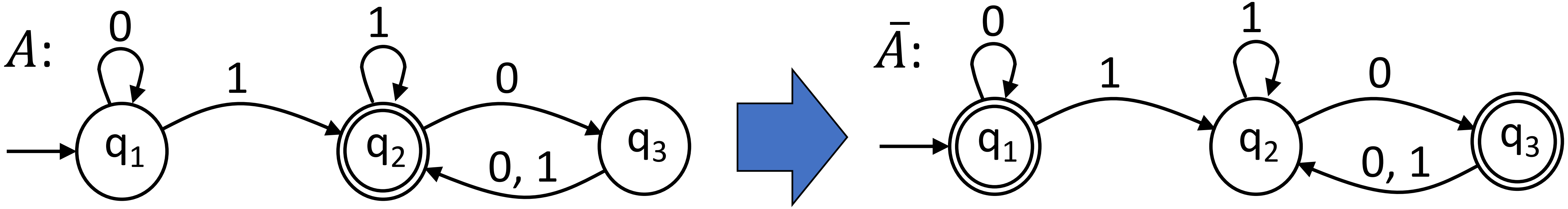
$$\bar{A} = \{\omega \colon \omega \notin A\}$$

Proof: A is a regular language $\Rightarrow \exists$ DFA for it.

Given DFA_A for A, build a $\text{DFA}_{\bar{A}}$ for $\bar{A}$:

Turn accept states into non-accept states and turn non-accept states into accept states.

If $\omega \in A$, then processing it ended on an accept state, which is a non-accept state for $\text{DFA}_{\bar{A}}$, thus $\omega \notin \bar{A}$. (similar if $\omega \notin A$)



ε is called the empty string. It is the string that contains no characters.

Prove that the following language is regular:

$\{\varepsilon\}$.

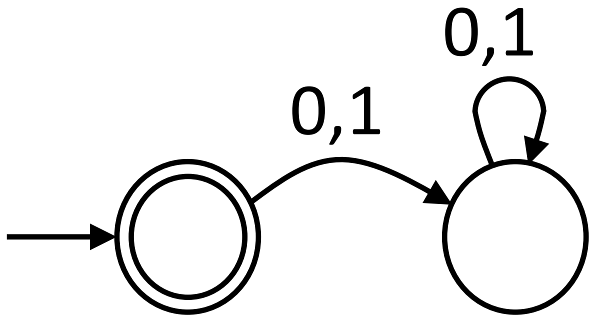
ε is called the empty string. It is the string that contains no characters.

Proof:

Prove that the following language is regular:

$\{\varepsilon\}$.

Proof:



Prove that the following language is regular:

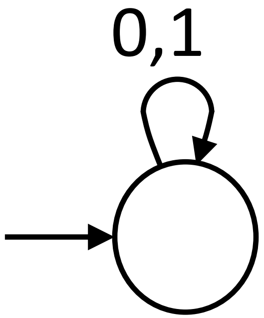
$\emptyset$.

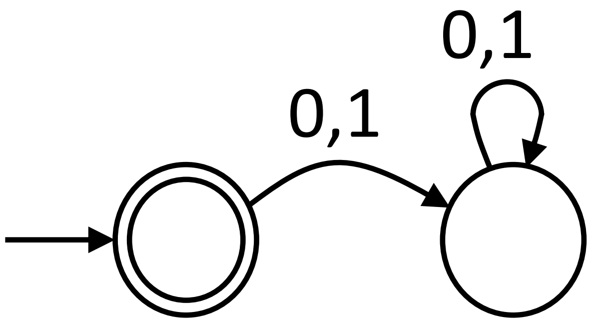
Proof:

Prove that the following language is regular:

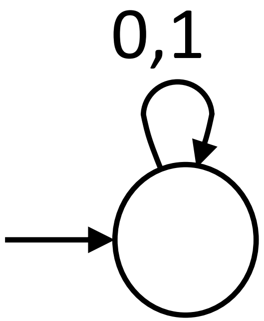
$\emptyset$.

Proof:





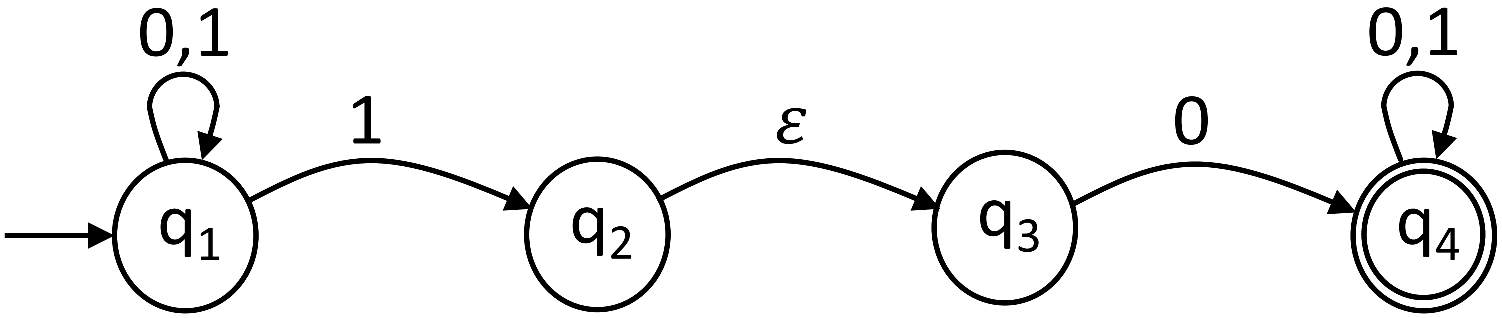
$L = \{\varepsilon\}$



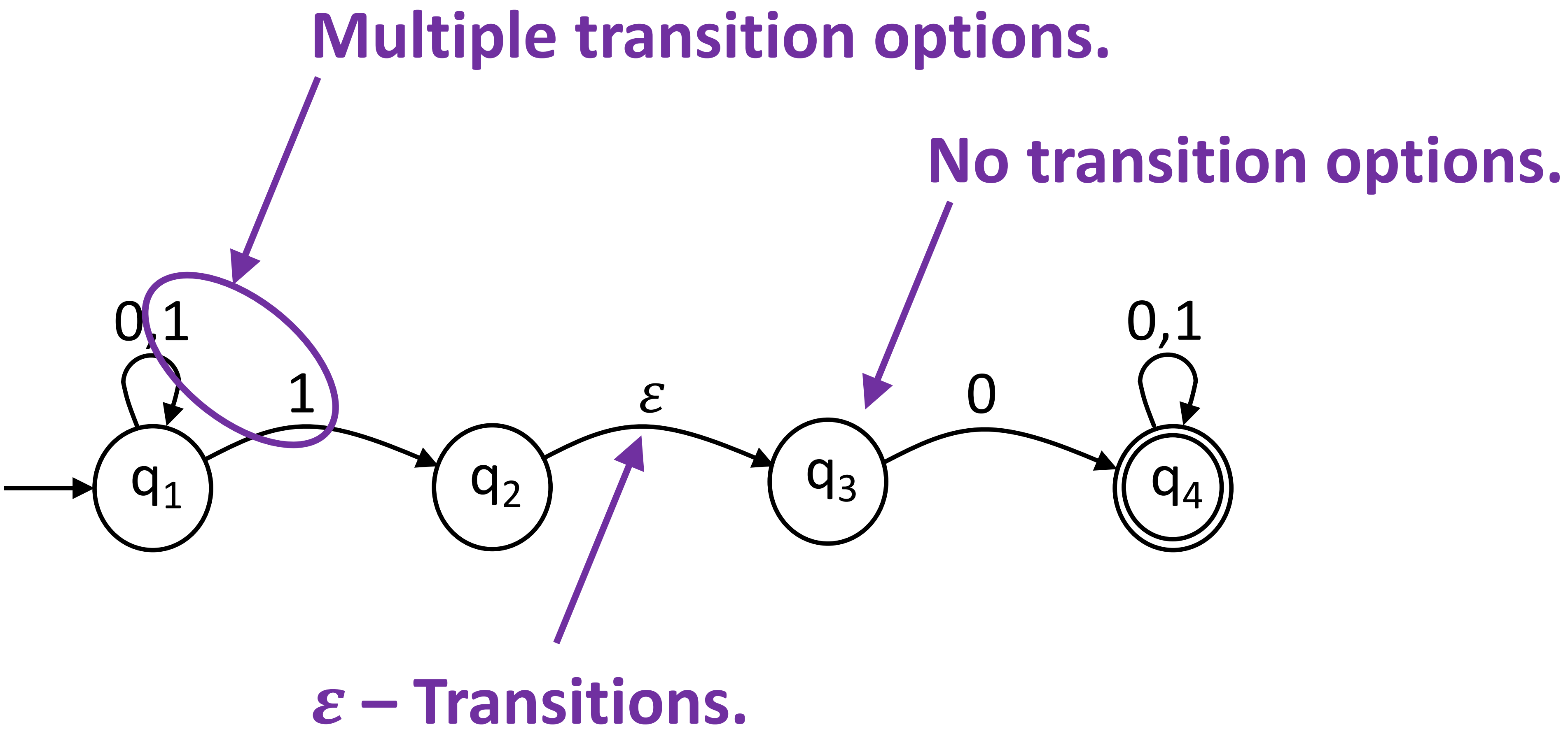
$L = \emptyset$

Empty string vs. Empty set

NFA Teaser



NFA Teaser



Multiple transition options.
No transition options.
0,1
1
ε
0
0,1
q1
q2
q3
q4
ε – Transitions.

Prove that the following language is regular:

$$\{\omega: |\omega| \leq 3\}.$$

$|\omega| =$ length of ω. I.e. number of characters in ω.

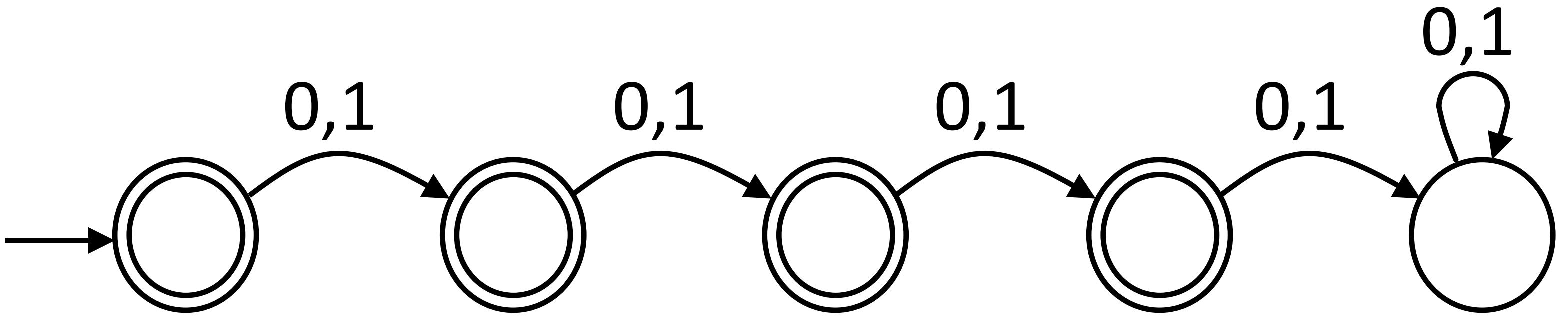
Proof:

Prove that the following language is regular:

$$\{\omega : |\omega| \leq 3\}.$$

$|\omega| =$ length of ω. I.e. number of characters in ω.

Proof:



Prove that the following language is regular:

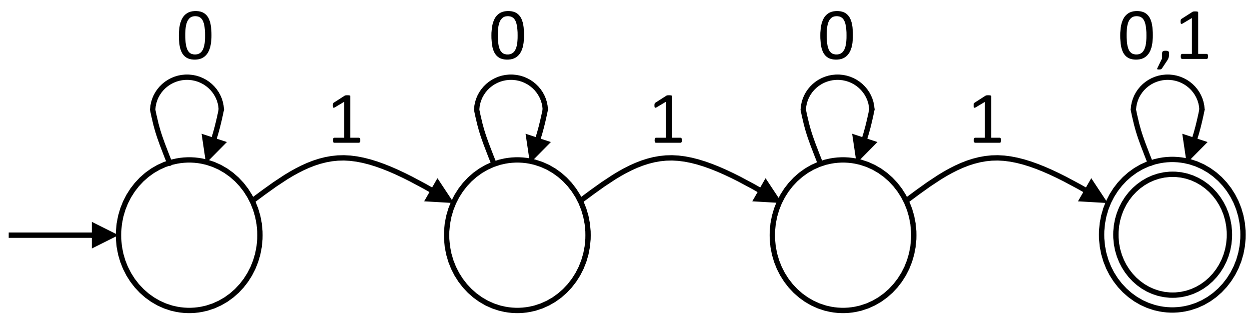
$\{\omega: \omega$ contains at least 3 1s$\}$.

Proof:

Prove that the following language is regular:

$\{\omega: \omega \text{ contains at least 3 1s}\}$.

Proof:



Prove that the following language is regular:

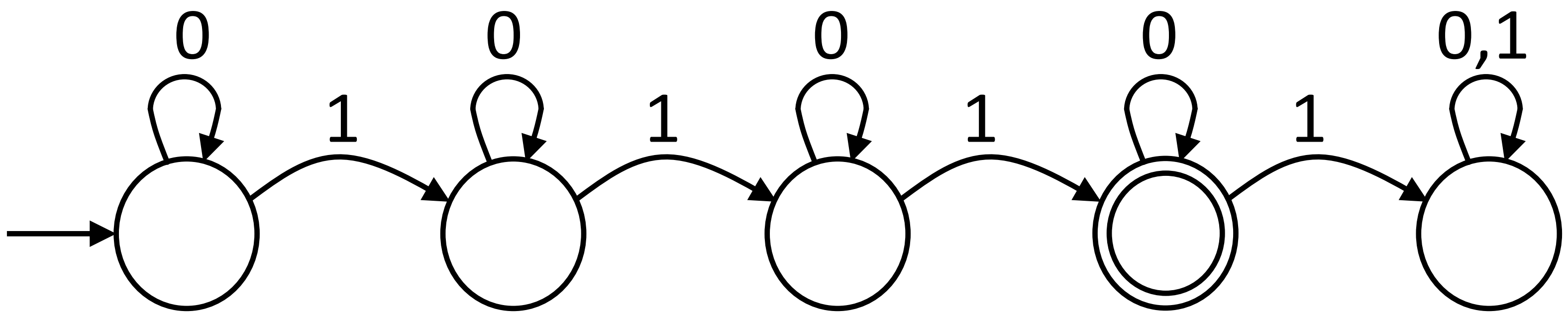
$\{\omega \colon \omega \text{ contains exactly } 3\ 1\text{s}\}$.

Proof:

Prove that the following language is regular:

$\{\omega : \omega \text{ contains exactly } 3\ 1\text{s}\}$.

Proof:



Prove that the following language is regular:

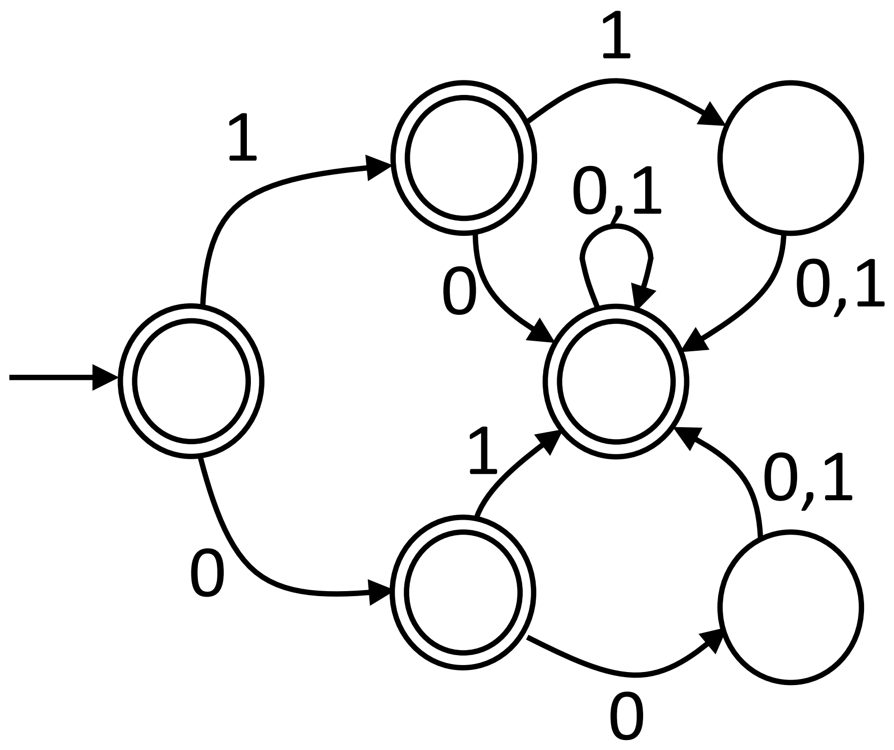
$\{\omega : \omega$ could be anything except 11 or $00\}$.

Proof:

Prove that the following language is regular:

$\{\omega \colon \omega$ could be anything except 11 or $00\}$.

Proof:



Prove that the following language is regular:

$\{\omega \colon \omega$ contains the same number of 0s and $1s\}$.

Proof: