PUSH DOWN AUTOMATA (PDA)

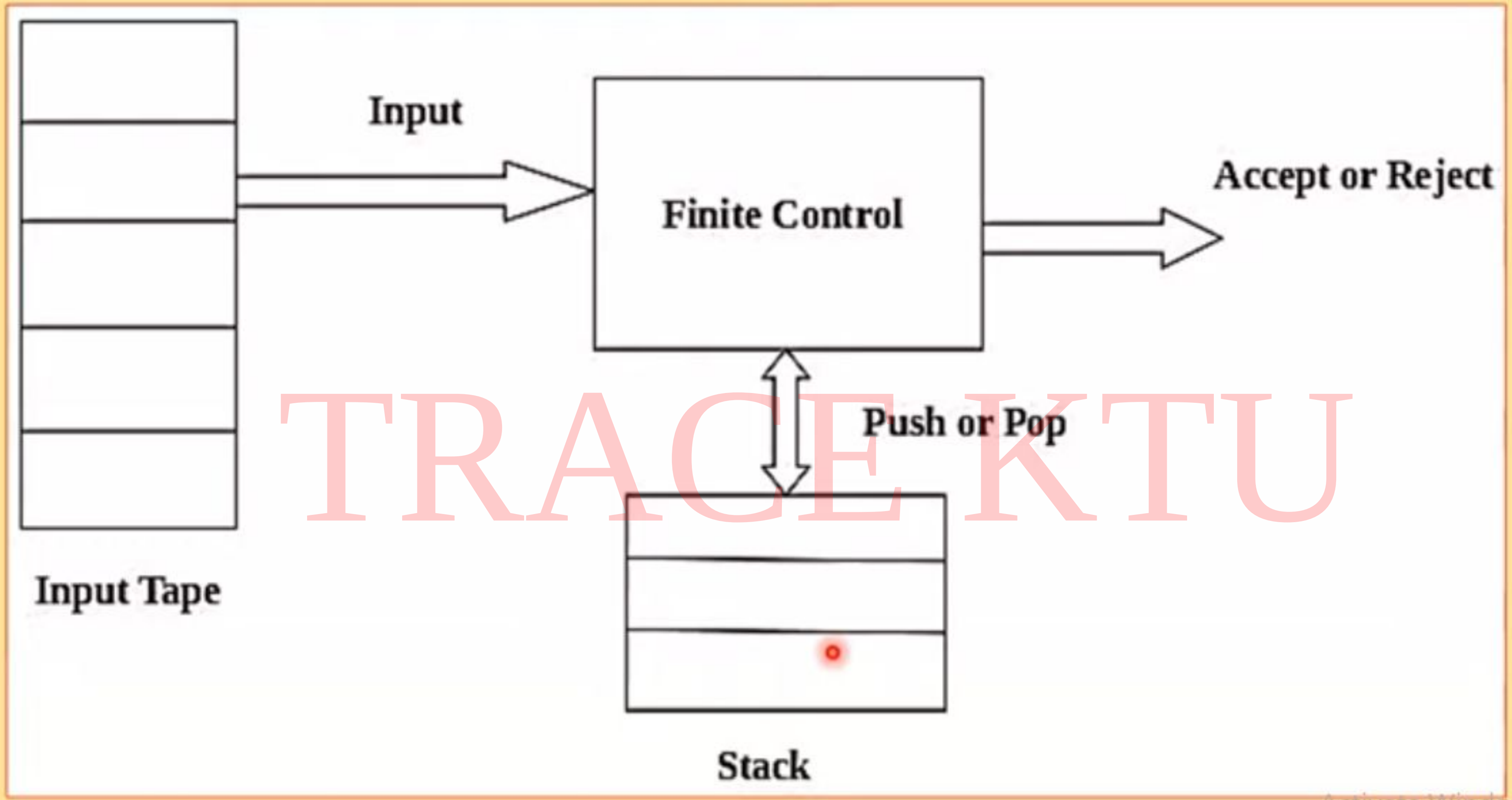
- Pushdown automata is a way to implement a CFG in the same way we design Finite Automata (FA) for a regular grammar.
- A FA can remember a finite amount of information, but a PDA can remember an infinite amount of information.

Pushdown automata = "Finite State Machine + stack memory"

- The addition of stack is used to provide a last-in-first-out memory management capability to Pushdown automata.
- Pushdown automata can store an unbounded amount of information on the stack.

- PDA is more powerful than FSM (Finite State Machine)
- A PDA can push an element onto the top of the stack and pop off an element from the top of the stack.
- To read an element into the stack, the top elements must be popped off and are lost.
- A PDA is more powerful than FA.
- Any language which can be acceptable by FA can also be acceptable by PDA.
- PDA also accepts a class of language which even cannot be accepted by FA. Thus PDA is much more superior to FA.

Fig: Push Down Automata (PDA)



❖PDA Components

➢**Input tape:** The input tape is divided in many cells or symbols. The input head is read-only and may only move from left to right, one symbol at a time.

➢**Finite control:** The finite control has some pointer which points the current symbol which is to be read.

➢**Stack:** The stack is a structure in which we can push and remove the items from one end only.

- It has an infinite size.
- In PDA, the stack is used to store the items temporarily.

❖ Formal definition of PDA

The PDA can be defined as a collection of 7 components:

Q : the finite set of states

∑ : the input set

Γ : a stack symbol which can be pushed and popped from the stack

q_0 : the initial state

Z_0 : a start symbol which is in Γ.

F : a set of final states

δ : mapping function which is used for moving from current state to next state.

Transition function δ takes as argument a triple

$\delta(q,a,x)$ where

- q is a state in Q
- a is either an input symbol in Σ or a can be ε
- x is stack symbol , that is a member of Γ

The output of δ is finite set of pairs (p, γ)

p – new state

γ – string of stack symbols that replaces x at the top of the stack

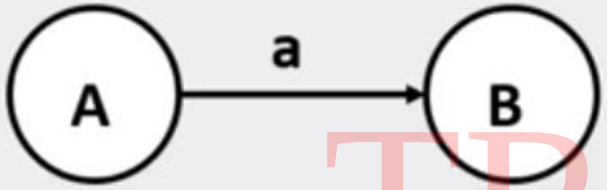
If $\gamma = \varepsilon$ then the stack is popped

If $\gamma = x$ then the stack is unchanged

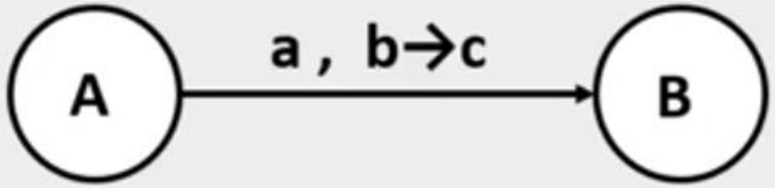
If $\gamma = yz$ then x is replaced by z and y is pushed on to the stack

GRAPHICAL NOTATION OF PDA

Finite Automata (Finite State Machine)



Push Down Automata (PDA)



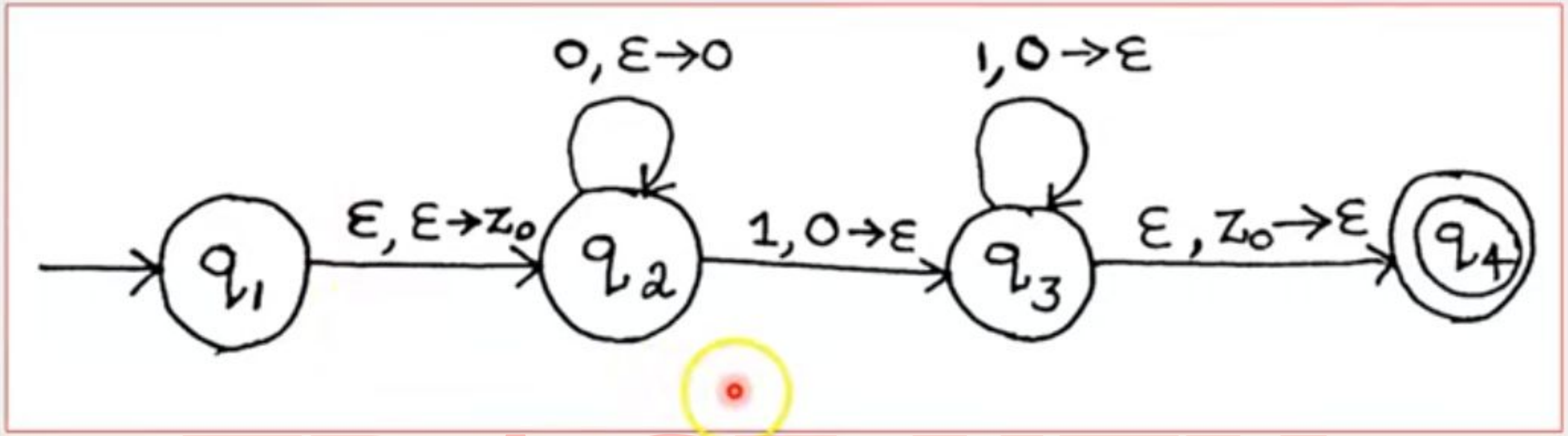
PDA

a – Input symbol (This can also be ε)

b – Symbol on top of stack. This symbol is popped (ε means the stack is neither read nor popped)

c – This symbol is pushed on to the stack (ε means nothing is pushed)

Eg: Construct a PDA that accepts $L = \{0^n 1^n \mid n \geq 0\}$



Suppose our input string is 0011

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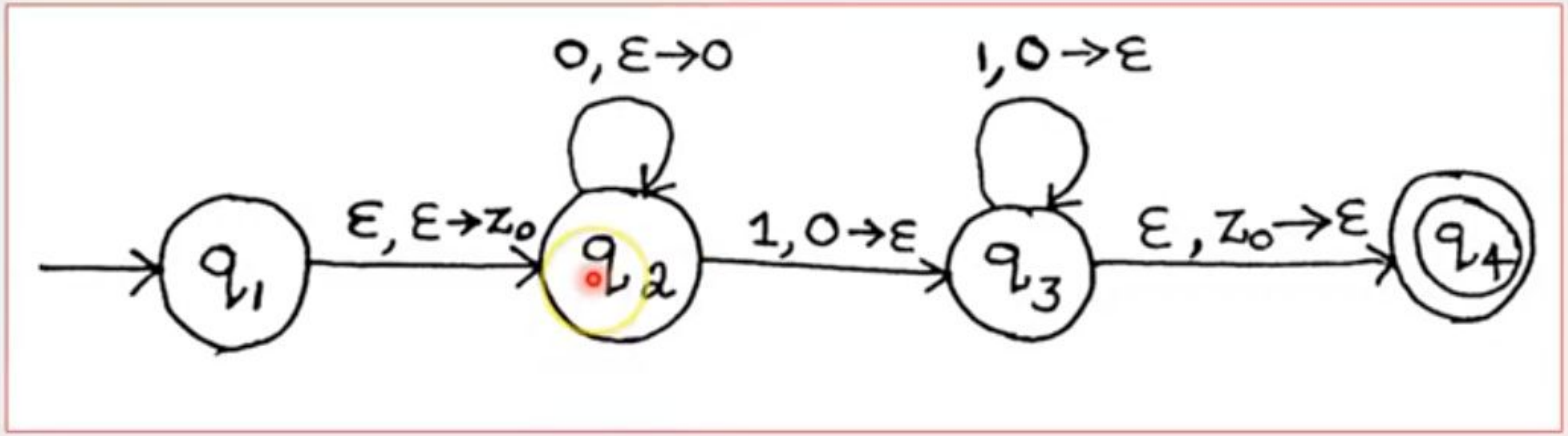

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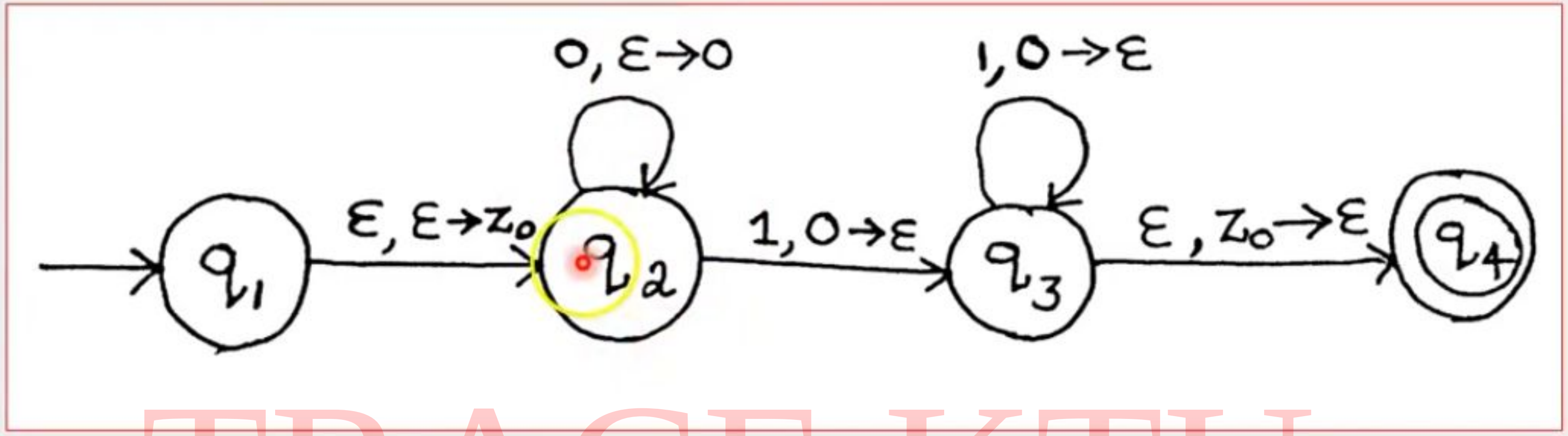
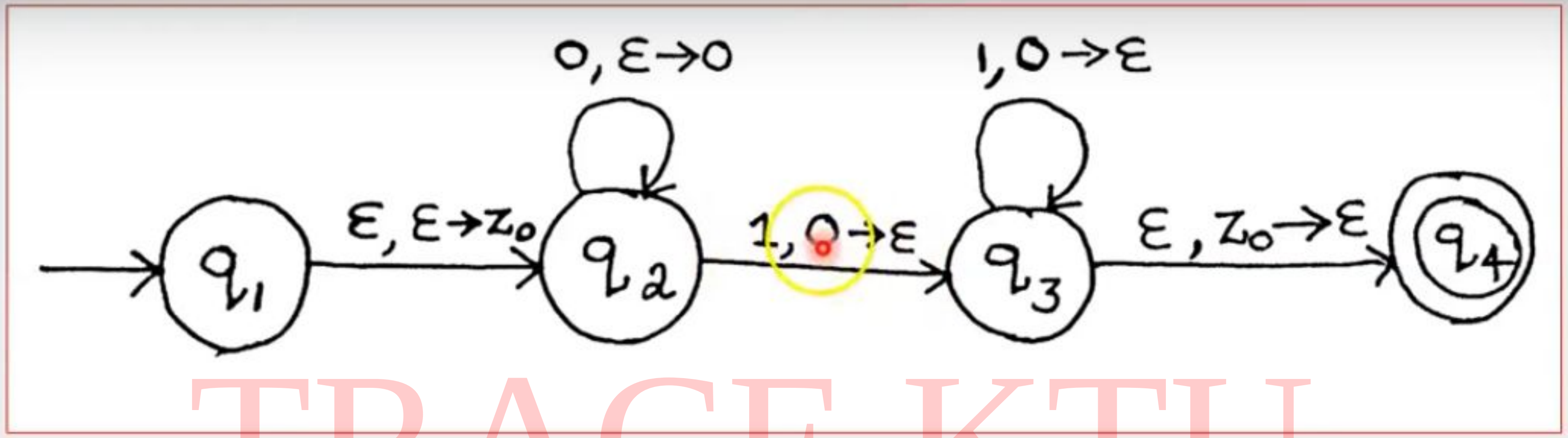


Suppose our input string is 0011

0
Z_0



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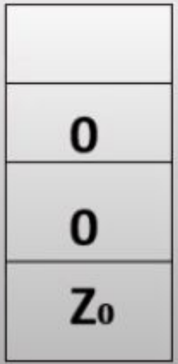

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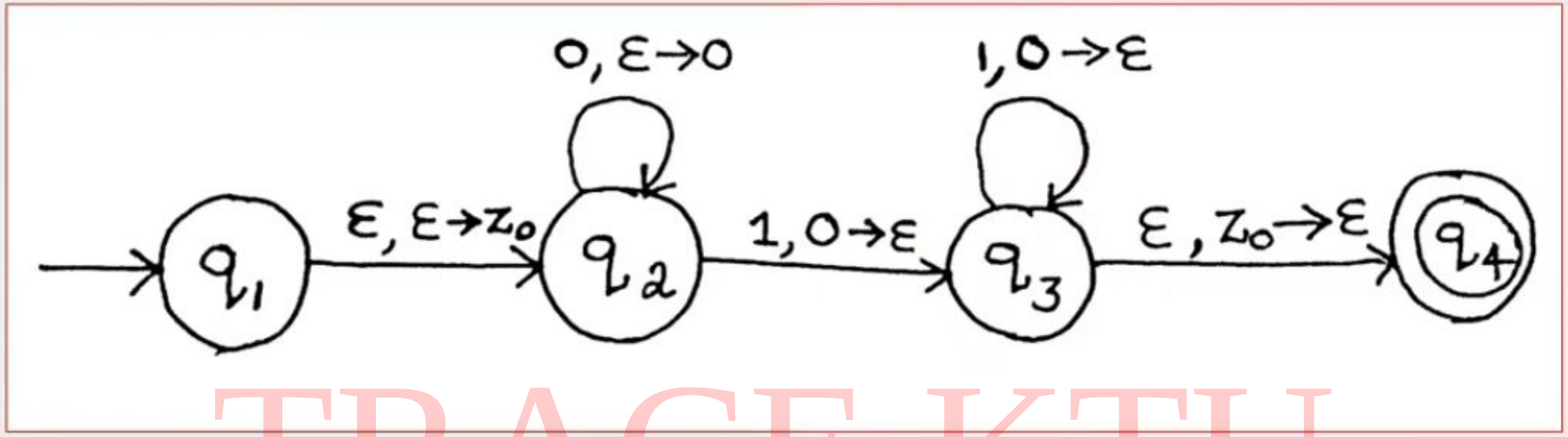

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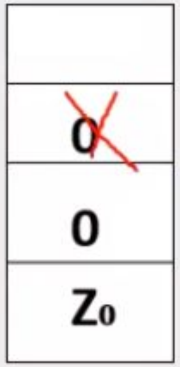

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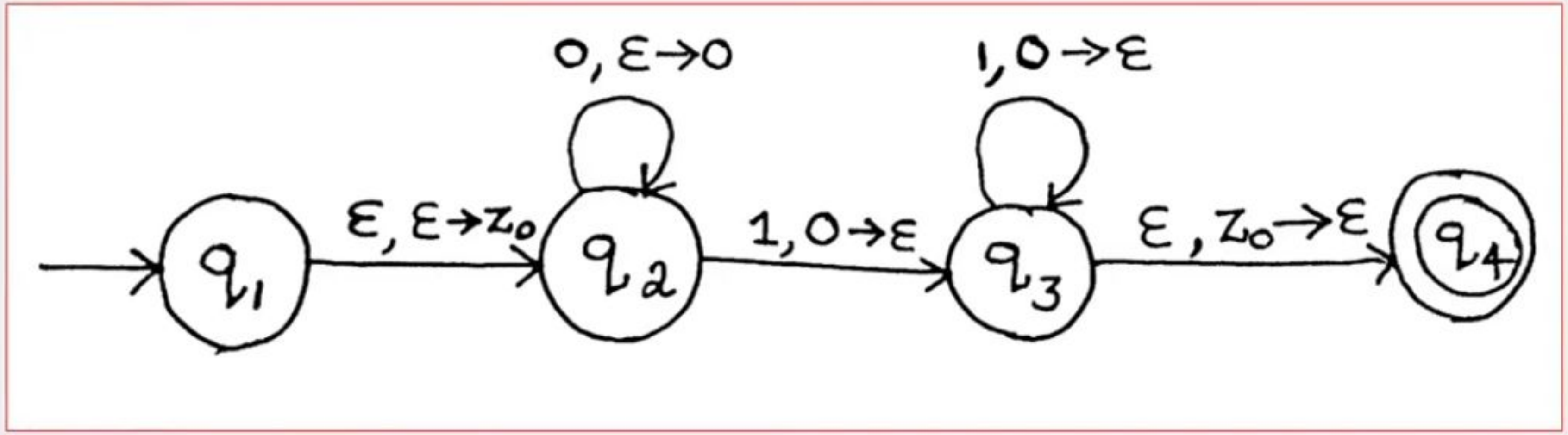

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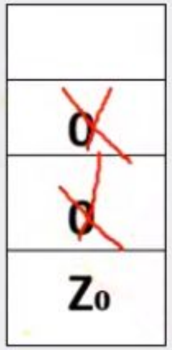

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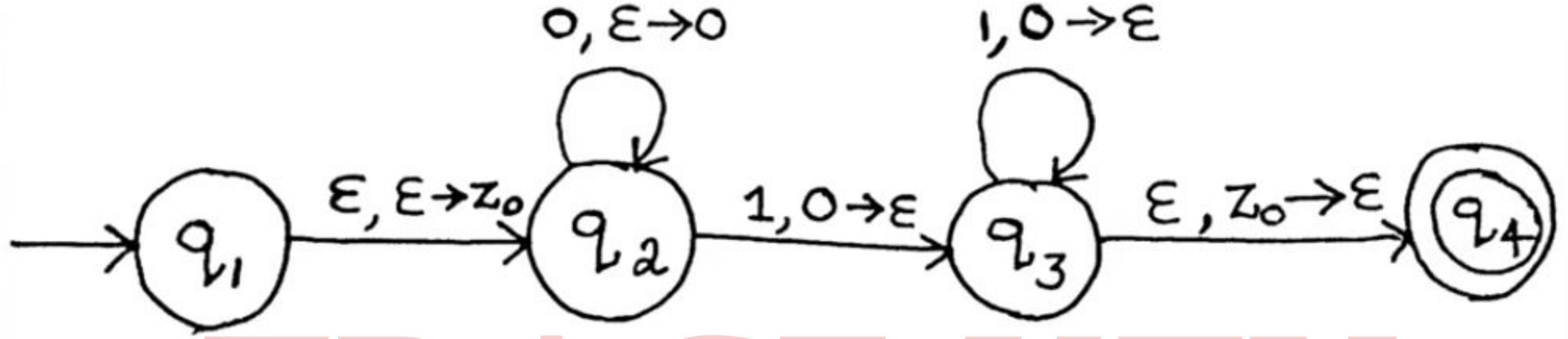

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