Ministry of Higher Education and Scientific Research
University of Larbi Ben M'Hidi, Oum El Bouaghi
Faculty of Exact Sciences and Natural and Life Sciences
Department of Mathematics and Computer Science

Computer Structure 2

Presented by: **Dr. NASRI/A**
nasri.ahlem1988@gmail.com
nasri.ahlem@univ-oeb.dz

2023-2024

Target audience	**1st year mathematics student + 1st year Common core Mathematics and computer science students .**
Prerequisite	**Students must have basic computer skills.**
Assessment method	**Assessment method: Exam (60%), Continuous assessment (40%)**

Chapter 2: Sequential logic

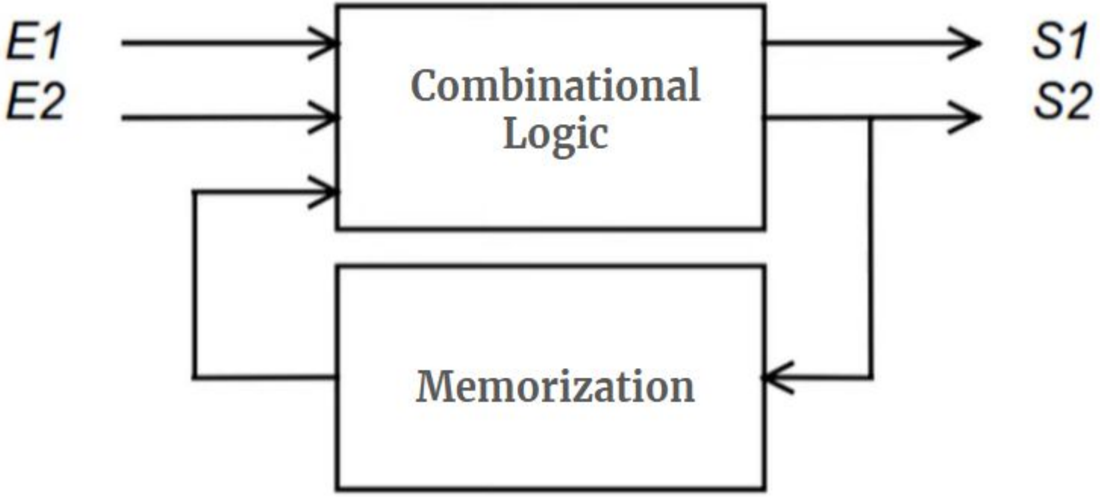
1. Introductory example
2. Definition
3. Latch, Register and Memorization circuit
4. Synthesis of a sequential circuit (finite automata)
5. Creation of automata

Chapter 2: Sequential logic

Finite automata

If the study of combinatorial circuits is based on **Boolean algebra**, that of sequential circuits is based on **the theory of finite automata.**

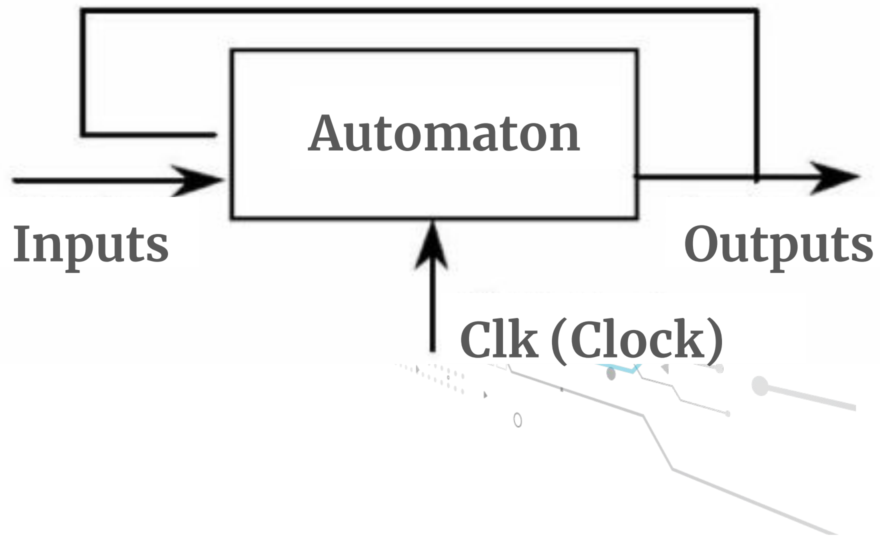
Application examples: the control of an elevator, a traffic light at a road intersection and the PCI bus of your PC are all automats.



- A finite state automaton, also known as a finite state machine (FSM), is **a mathematical model** used **to describe the behavior of machines (systems)** with a finite number of states.
- It consists of a set of states, a set of transitions between these states, and a set of inputs that trigger these transitions.
- A synchronous finite state automaton (SFSA) is a type of finite state automaton where state transitions occur at specific, synchronized points in time, **usually in response to a clock signal,** common to all automat latches.
- In an SFSM, all state transitions happen simultaneously at each clock tick, making the behavior of the machine deterministic and predictable.

Formally a finite automaton is characterized by:

- ➔ An inputs vector
- ➔ An outputs vector
- ➔ A state sequence defining its behavior (Q)
- ➔ a starting state allowing it to begin its operation from a fixed point.



The proper functioning of a automaton is conditional on compliance with the following points:

- ➔ The automaton is a graph whose nodes are called state and the links called transitions.
- ➔ The state does not represent a component of the system but the entire system in a given state, ex: the car and its wheel.
- ➔ Transition represents a condition or event that moves the system from one state to another
- ➔ The automaton operates in such a way that the system receives various events; these events trigger the appropriate transitions, causing the system to move from one state to another for each event without interruption.
- ➔ the system cannot be in 2 or more states at a given time, whatever the running time, only one state is active at a time on the entire automaton.

➔ The behavior of an automaton is determined if one knows either **its transfer functions, its transition tables**, or **its state diagram**.

A. Transfer functions:

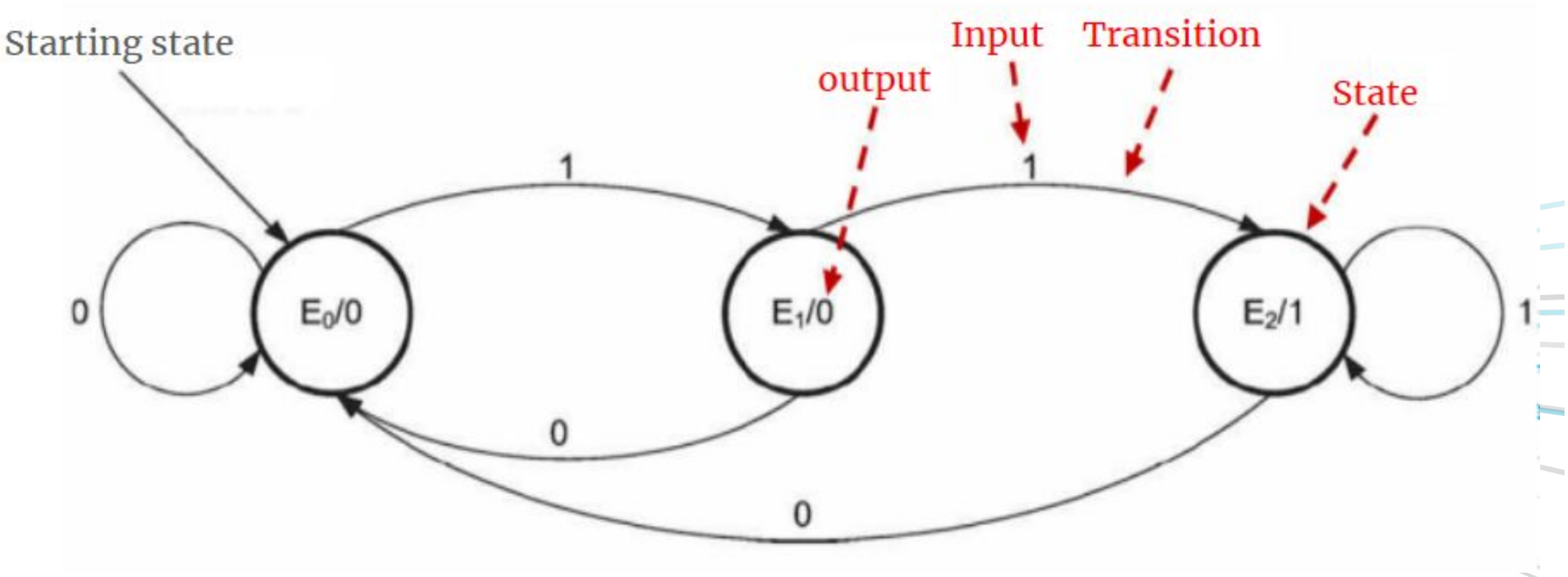
- Its response S at time t+1 as a function of the input E at time t and its state Q at time t:
  S(t+1)= f[E(t)+Q(t)]
- Its state Q at time t+1 as a function of its state Q at time t and its input E at time t:
  Q(t+1)= g[Q(t)+E(t)]

B. Transition tables or Transition states:

which provides the values of functions f, g, ... based on the inputs, the state at time t, the future state (Q(t+1) : Q+), and the inputs and outputs of the latches.

C. State diagram or Transition diagram:

Where states are represented by circles and transitions between these states by arrows going from the initial state to the final state.



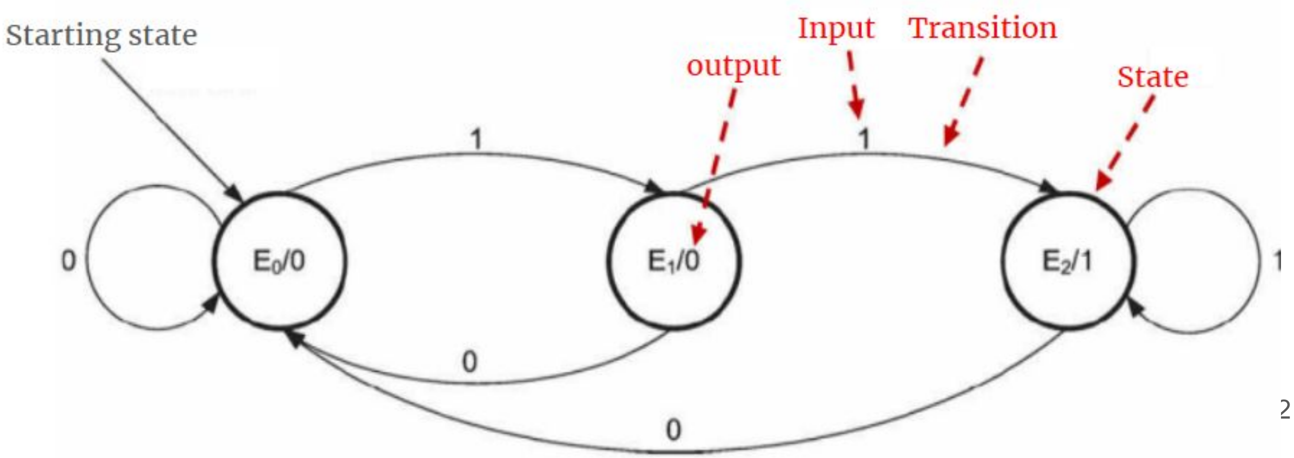
This machine is capable of detecting a sequence of two consecutive 1 in the input

➔Three states noted: E_0, E_1, E_2

➔A starting state: E_0

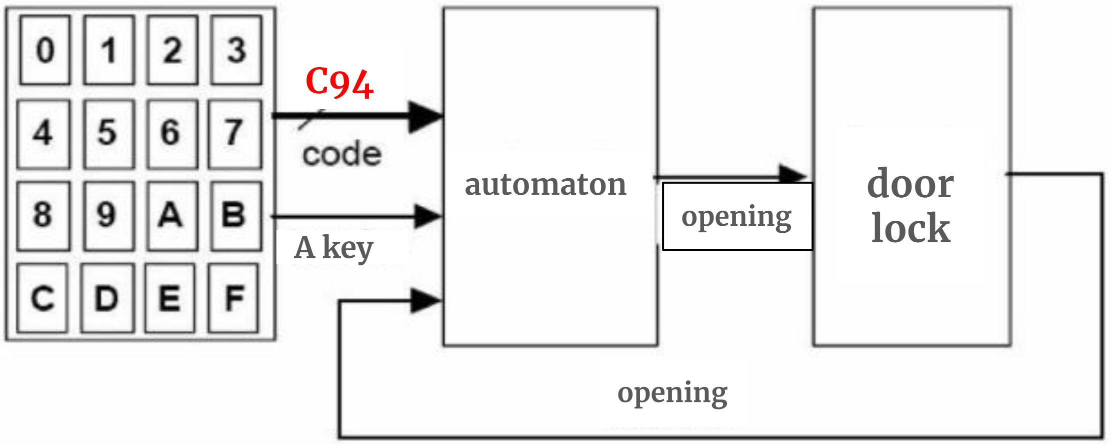
➔An entry in the value is noted on the arcs

➔An output in the value is associated with each state, respectively: 0,0,1



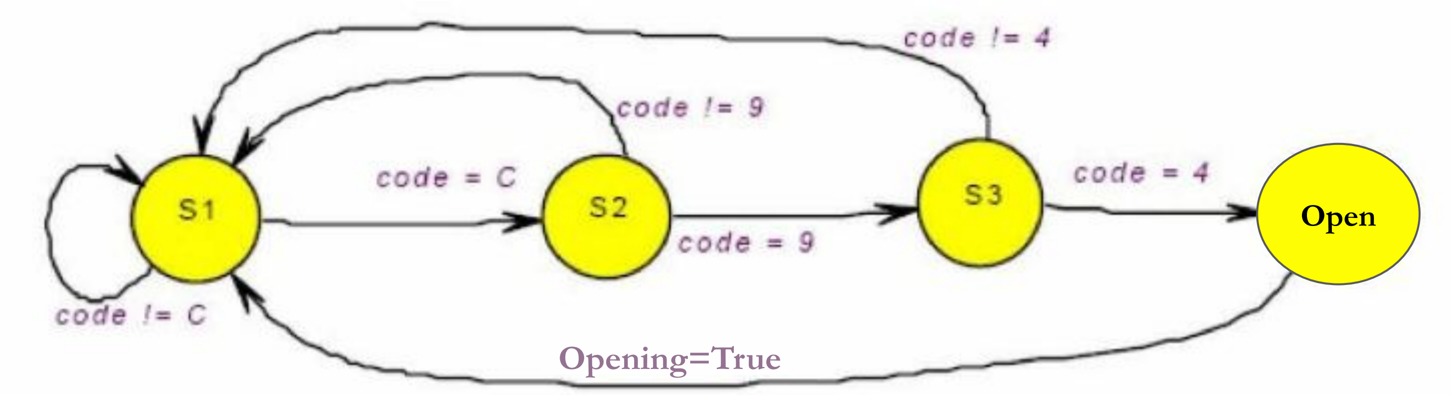
Example: A digital code

A digital code or a keypad used for entering a code or password, often to access a secure area or to operate a device. It's commonly seen in buildings for entry systems, safes, or electronic locks where a numerical code needs to be inputted for authentication or access.
It is made up of 16 keys which constitutes the organ of the automaton whose single output controls the opening of the door.



Solution:

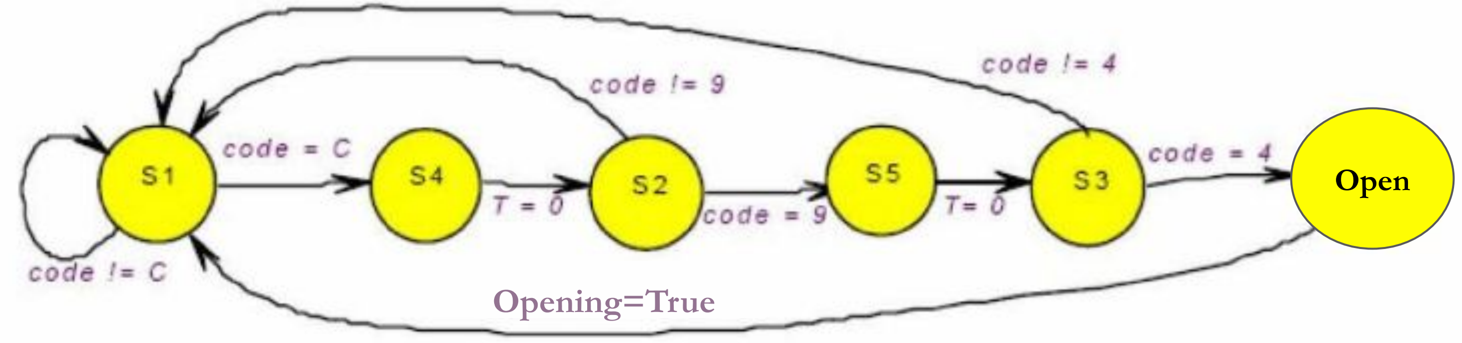
Assuming that the opening of the door is obtained by providing the code **C94.**



Solution:

It is clear that the automaton must have a way to distinguish between keystrokes on different keys; therefore, it must wait between two keystrokes for the user to release the keyboard.

Assuming that the absence of a keystroke causes T=0



The graphic representation of finite state machines can be achieved in two ways:

- Outputs can be indicated on **the arcs** or **inside the states**.

This distinction is not purely graphic, and the two machines represented in both cases are different.

This distinction is not purely graphic and the two machines represented in both cases are deferential.

This difference lies in the fact that in the first case the output depends **only on the state**, while in the second case it depends on both **the state** and **the input**.

Moore's automaton:

Moore's automaton refers to a finite state machine where the outputs are solely determined by the current state of the machine.

Mealy's automaton:

A Mealy automaton is a type of finite state machine where the outputs depend on both the current state of the machine and the inputs (Mealy machines produce outputs based on a combination of the current state and the input signal).

Exemples: A three intensity-light

Moore’s automaton	Mealy’s automaton