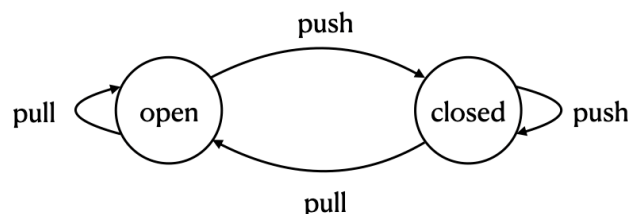


Sequential Circuits (I)

What is a Sequential Circuits

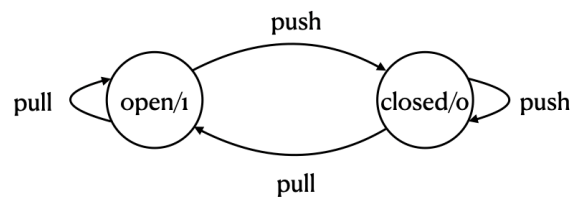
- **Combinational circuits** are often referred to as “**memoryless**” circuits, since their output **depends only on** their **current input** and no history of prior inputs is related.
- The current **output of a sequential circuit depends** not only on the **current input**, but also on the **current state** of the circuit.
- For example, the door has two possible states: open and closed. Two actions on the door: pull and push. Depending on the door's current state, the same action can lead to different results.
 - If a door is currently open and you pull the door, it's still open.
 - If a door is currently closed and you pull the door, it's open.
 - If a door is currently open and you push the door, it's closed.
 - If a door is currently closed and you push the door, it's still closed.
- Although we can use truth table to represent the current state and next state based on the input of a sequential circuit. It's less straightforward to represent the transition between states.
- So, we introduce State Machine to better represent the state transition of sequential circuits.
- A **state machine** is a **graphic way** of representing a time/history dependent process.
- It uses **circles to represent states** and **edges to represent the transition** from a state to another.
- We can draw a state machine for the above example.



- The difference between this example and the sequential circuits is that sequential circuits usually have outputs.
- Therefore, we need to introduce outputs into the state machines.

Moore Machine

- Moore machines let the **output associate with the state**.
- The **input** in Moore machines **decides the next state**.
- The **output** in Moore machines **only depends on the state you transit into**, not on how you got into the state (the input value).
- Suppose there is a LED light on the top of the door to indicate the door is open or not in the dark. If the door is open, the LED is on. Otherwise, it's off. We can update the above state machine to the following Moore machine.



- Example

- Design a **controller for an elevator**.
- The **elevator** can be **at one of the four floors: Ground, First, Second, and Third**.
- There is **a button** that controls the elevator, and it has **two possible values: up and down**.
- The elevator goes **up one floor every time you set the button to “up”**, and **goes down one floor every time you set the button to “down”**.
- There are **two lights in a row** in the elevator that indicate the current floor. **Both lights off (00)** indicates the **ground floor**; **The left light off and right light on (01)** indicates the **first floor**; **The right light off and left light on (10)** indicates the **second floor**; **Both lights on (11)** indicates the **third floor**.
- Each time, the controller checks the current floor and current input before changing floors and lights.
- Draw a **Moore machine diagram** for the specification.

