

Discussion 6: ALU & FSM

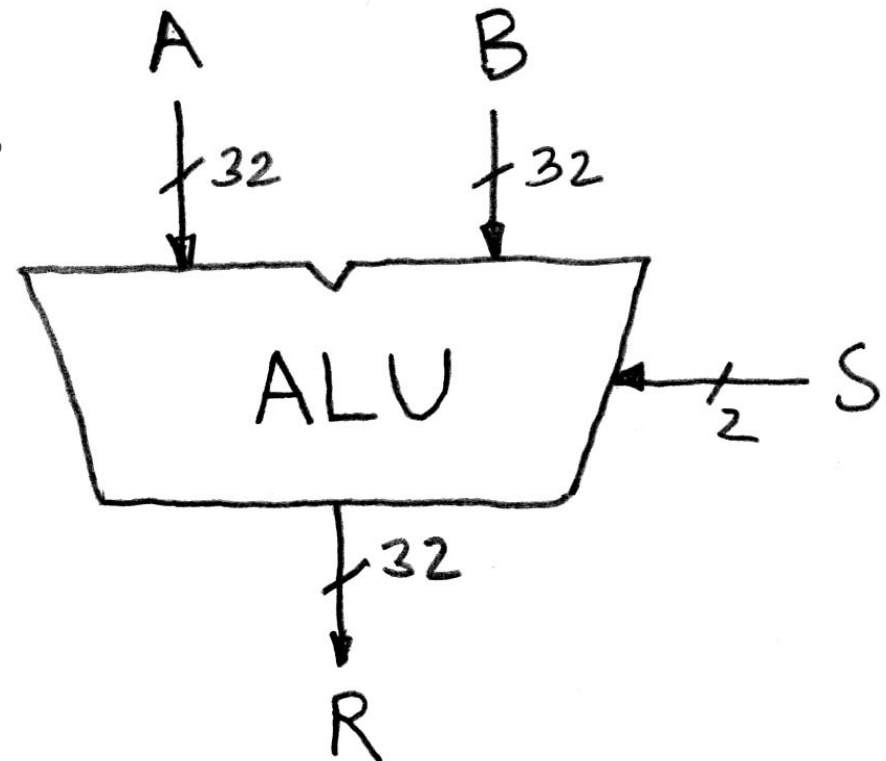
ZHONGYI CAI

Recall

- Synchronous Digital Systems consist of two basic types of circuits:
 - Combinational Logic (CL) circuits
 - Output is A function of the inputs only, not the history of its execution
 - E.g., **ALU**(add,mul,sll...)
 - Sequential Logic (SL) circuits
 - Circuits that “remember” or store information
 - E.g., memories and registers

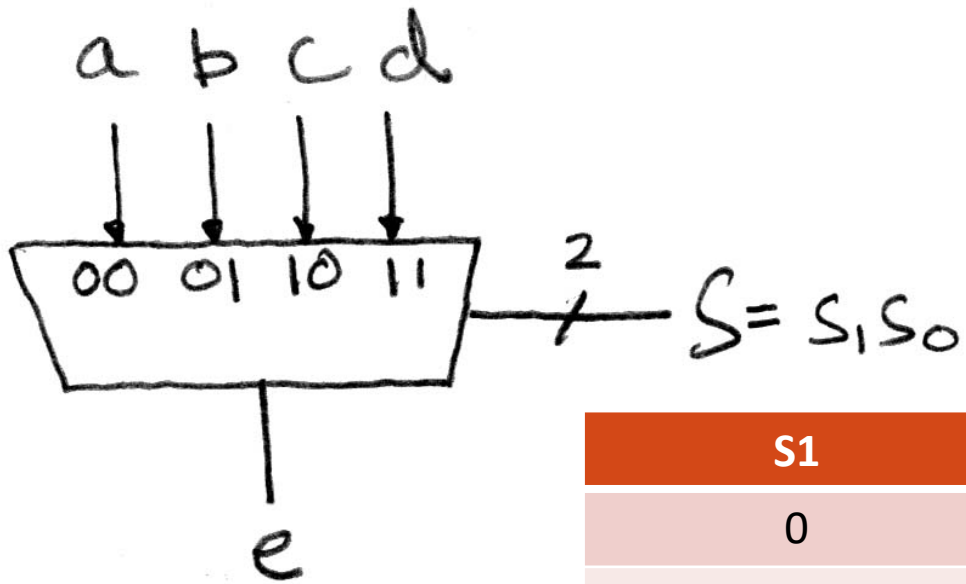
ALU

- Arithmetic operation and Logical operation
- Simplest example: 32bit, 2 function
- Activate needed operation and dim others
- S, control



multiplexer

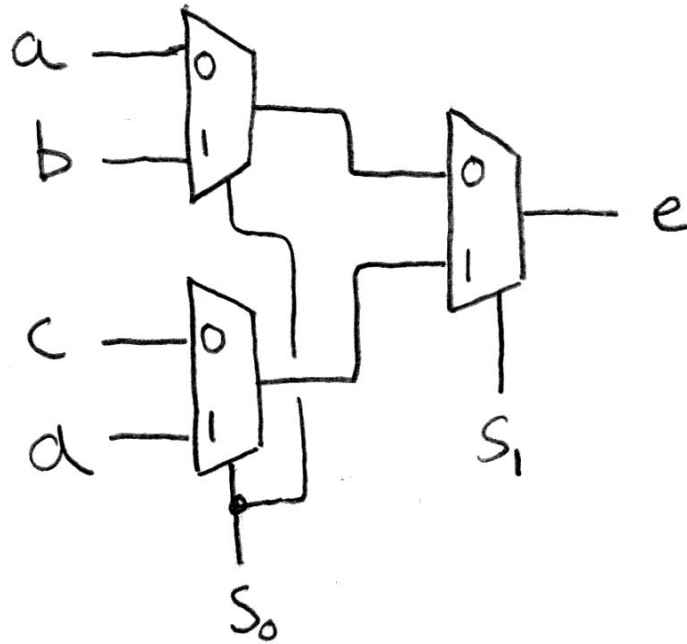
For 4-multiplexer, S is a two bit string



S_1	S_0	S	e
0	0	00(0)	a
0	1	01(1)	b
1	0	10(2)	c
1	1	11(3)	d

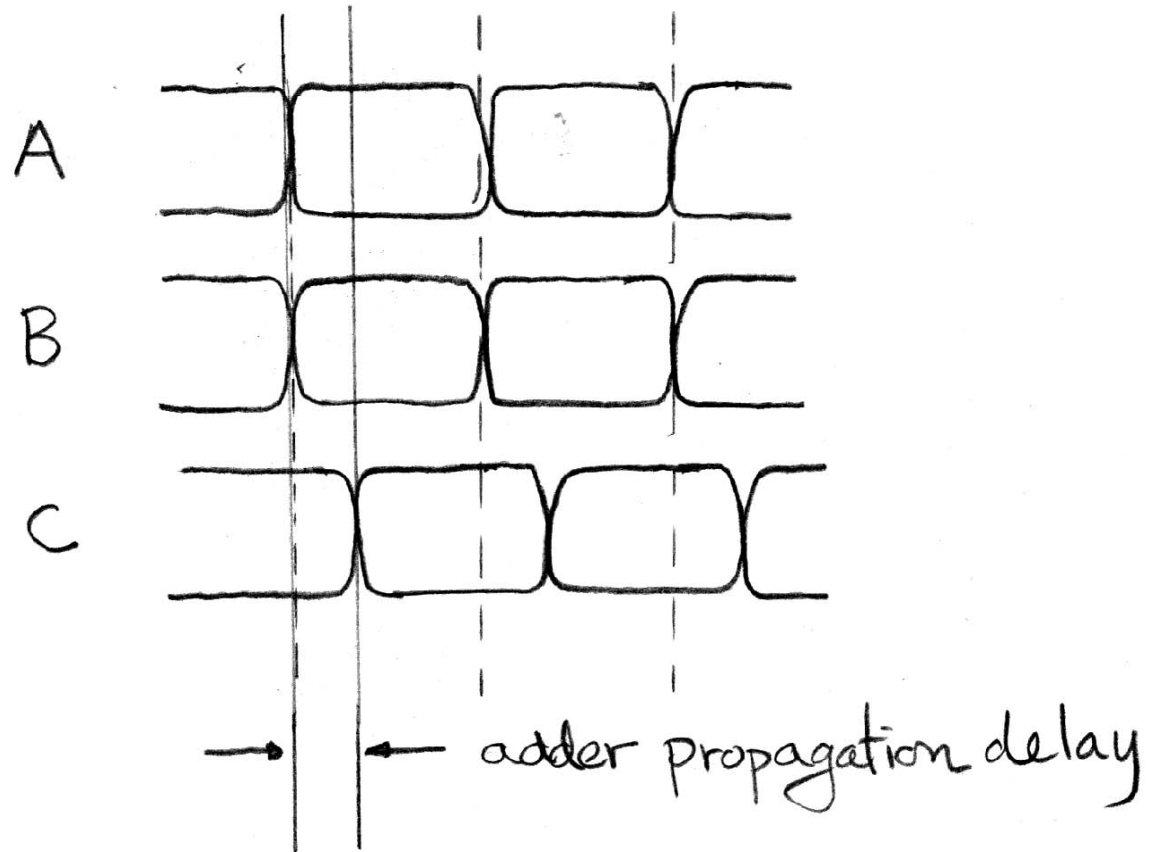
multiplexer

For 4-multiplexer, S is a two bit string



$$e = \overline{s_1}\overline{s_0}a + \overline{s_1}s_0b + s_1\overline{s_0}c + s_1s_0d$$

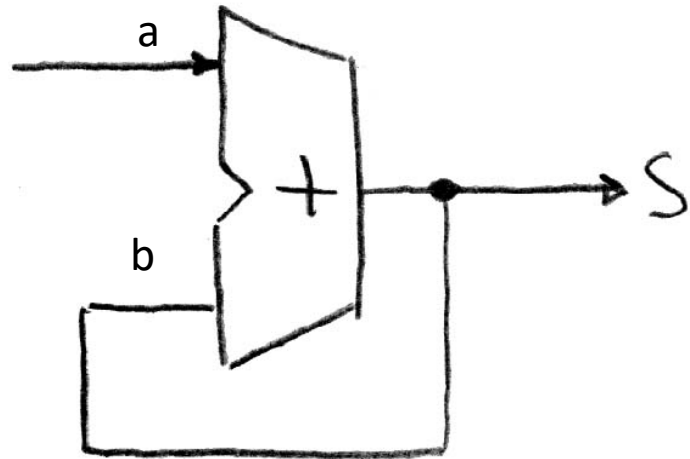
CL delay



Sequential Logic

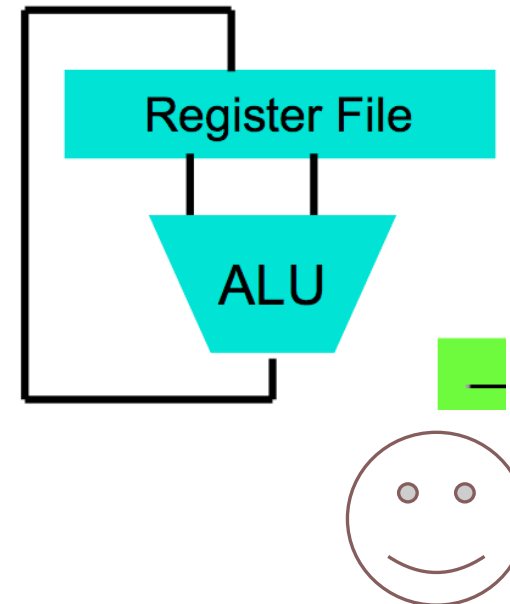
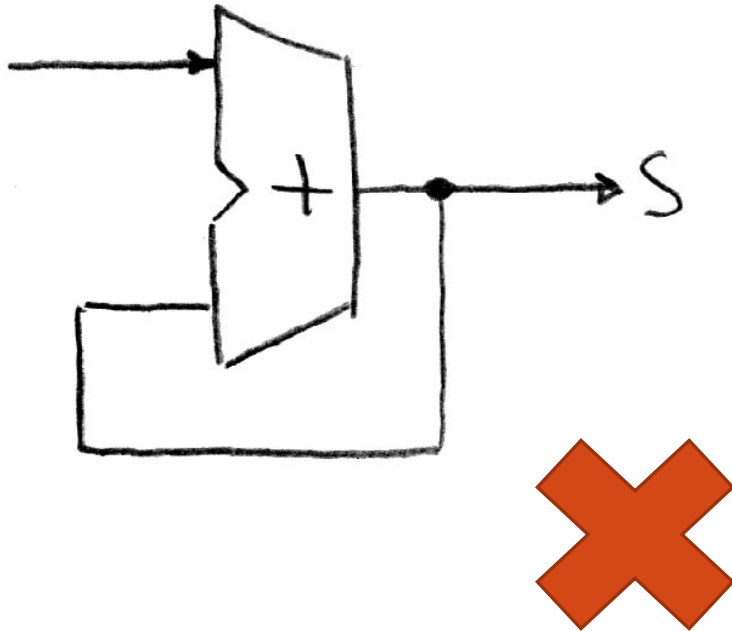
Accumulation operation

$1+2+3+4\dots$

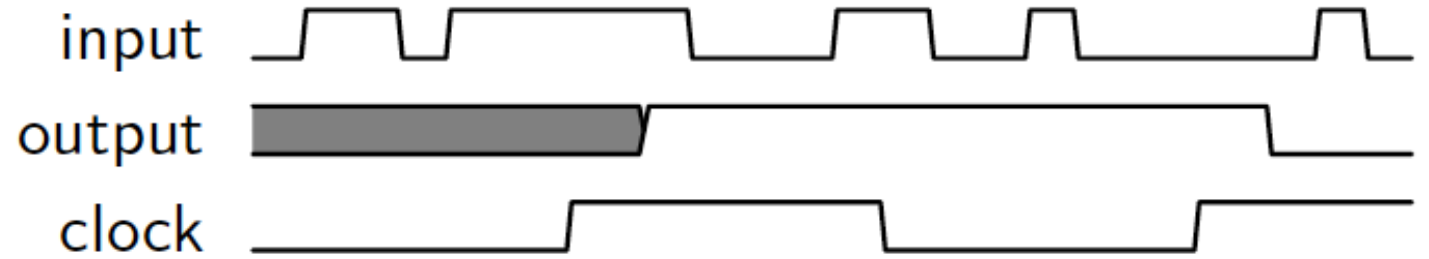
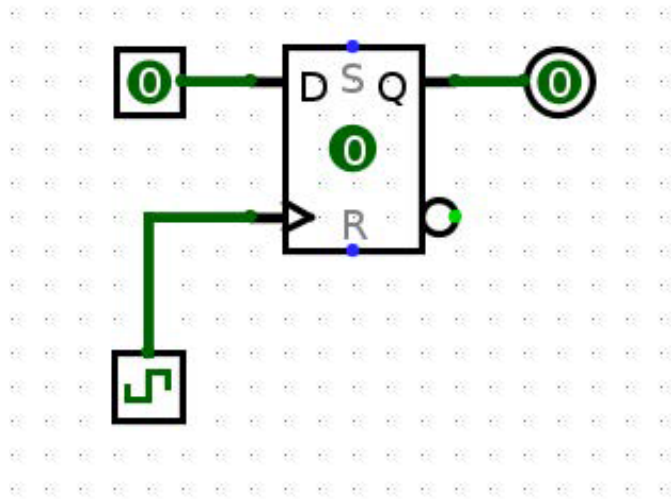


Sequential Logic

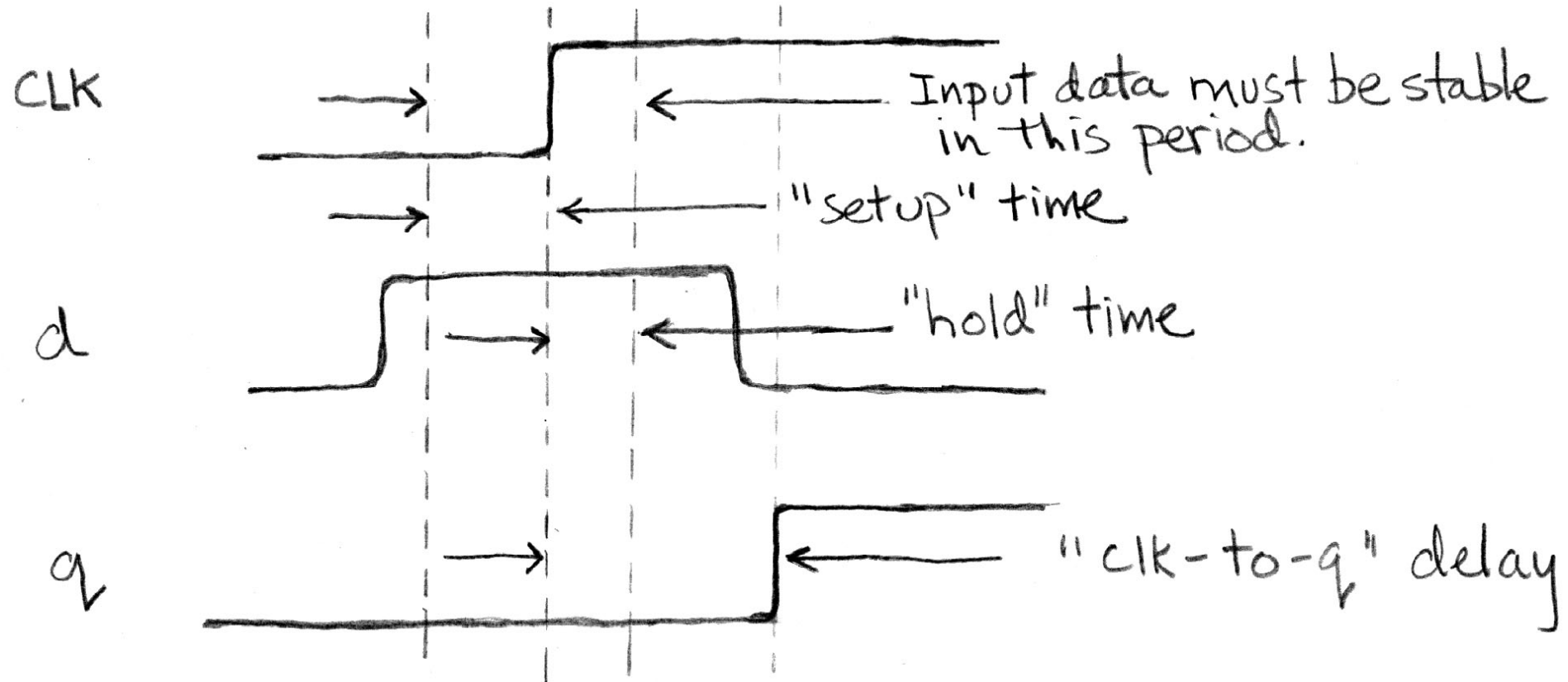
Operation like accumulation needs to store information



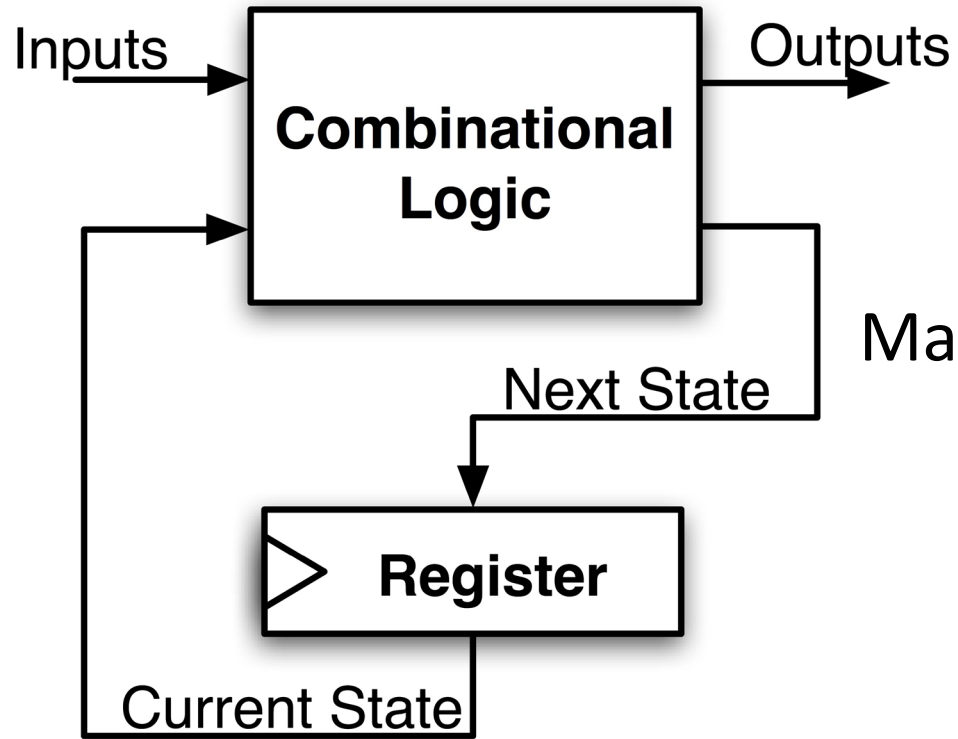
Sequential Logic



Sequential Logic



Max Delay



$$\text{Max Delay} = \text{CLK-to-Q Delay} + \text{CL Delay} + \text{Setup Time}$$

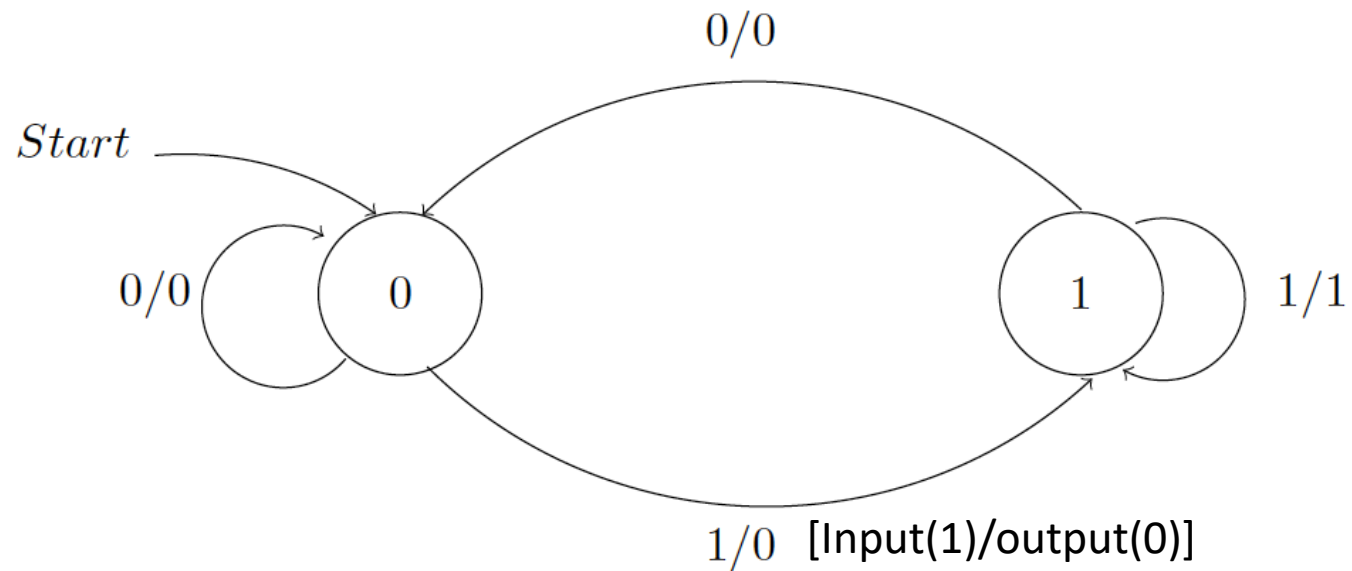
FSM

- A convenient way to conceptualize computation over time
- Start at a state, given an input, follow some edge to another
- Input/output

Example

Input : bit string : "011001001110"

What is the output?



Example

Output: 001000000110

