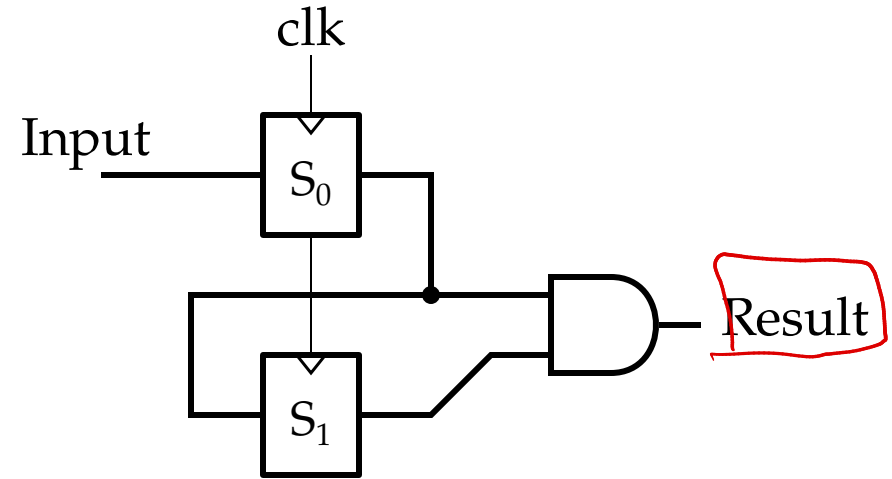
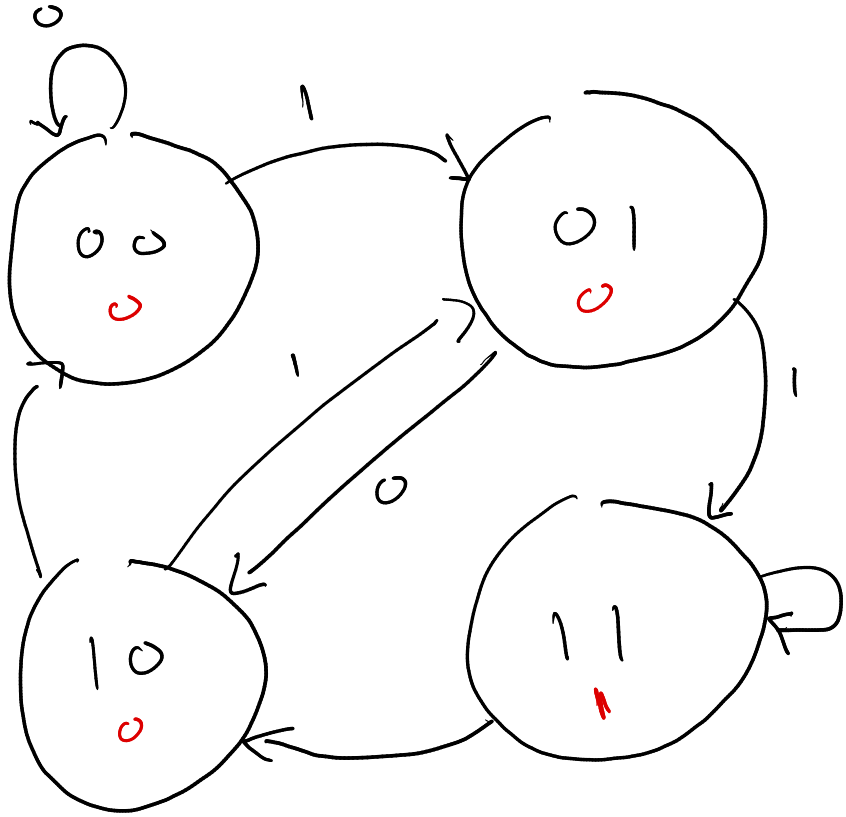


# Warmup

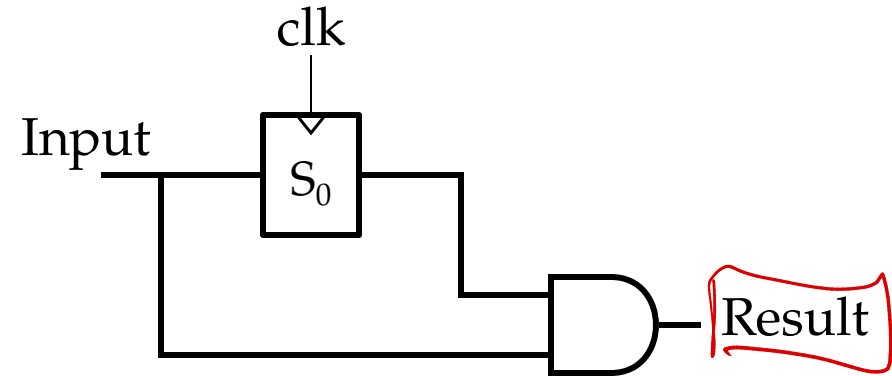
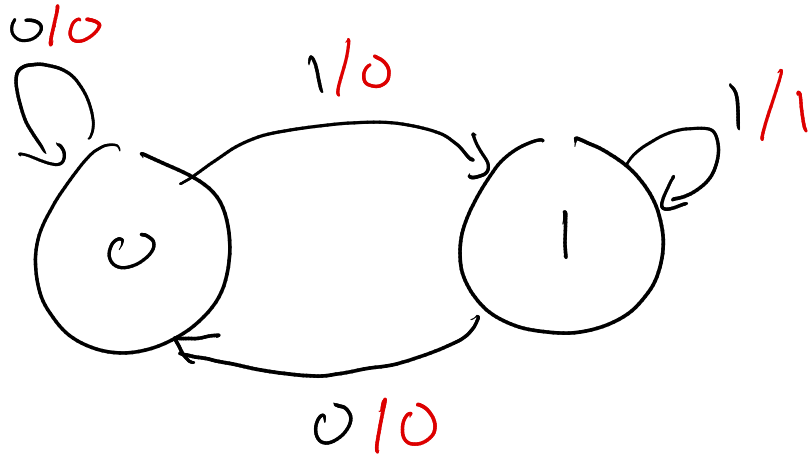
Draw a state diagram for the circuit below:

If it helps, assume that both FFs are 0, and work from there



# Warmup

What about this circuit?



# ES 4: State machines, part 2

Steven Bell

24 October 2024

# Logistics

- Exam 2 will be on Nov 14 (Thursday before break)
- Final project in teams of exactly 4 (survey due next Thursday)

Lab 7 will have multiple options, you may want to distribute them between members of your team.

VGA display driver

NES gamepad

Using RAM

Storing graphics in ROM

Wii Nunchuck (I2C)

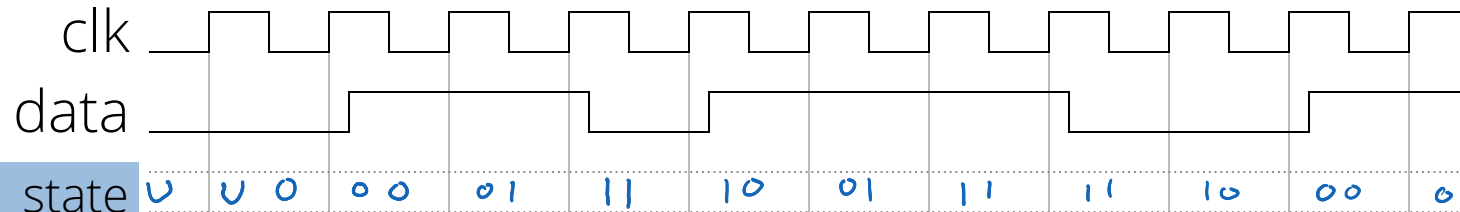
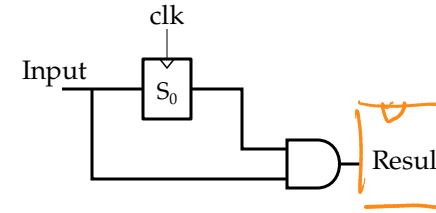
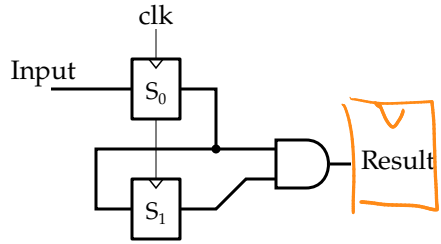
SD card

# Moore

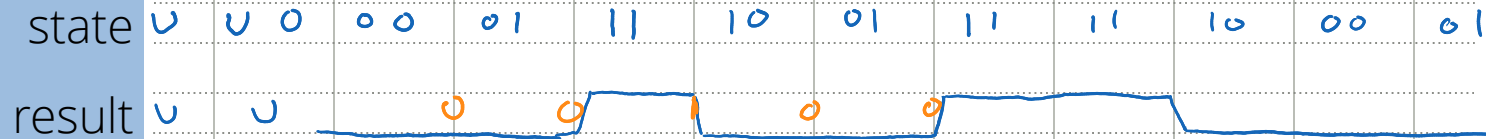
vs.

# Mealy

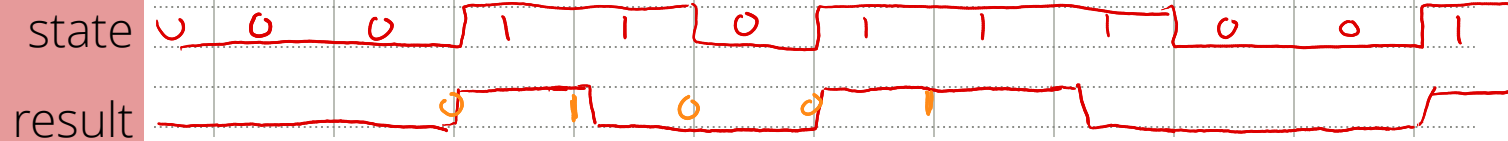
(See also Harris example 3.7)



Moore

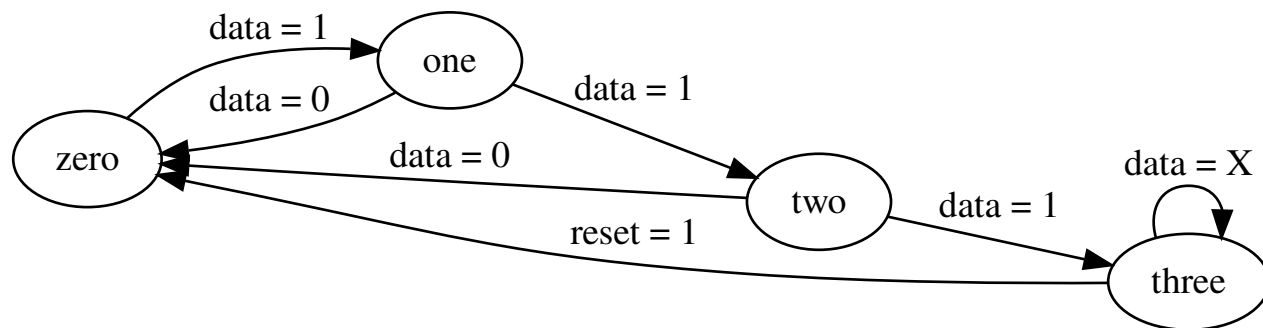
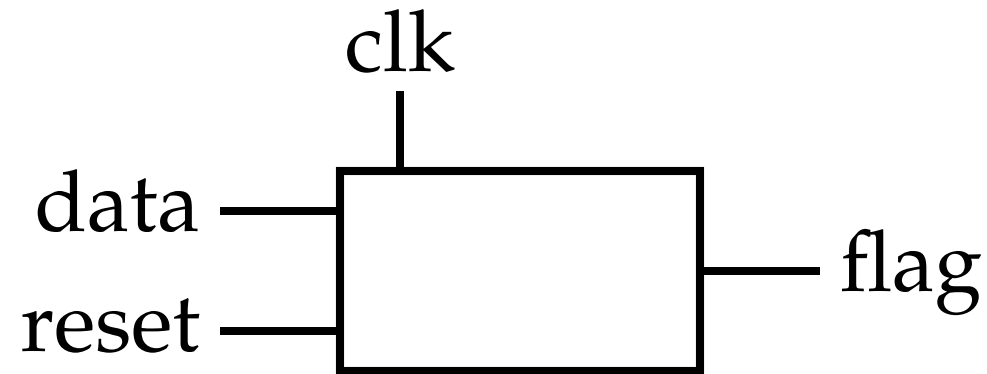


Mealy



# FSMs in VHDL

Design a circuit which sets a flag high when the "data" input has been high for 3 clock cycles. The flag should stay high until the reset signal is asserted (i.e., = 1)



# FSM code: entity

```
library IEEE;  
use IEEE.std_logic_1164.all;  
use IEEE.numeric_std.all;
```

```
entity flag3 is  
    port(  
        clk : in std_logic;  
        data : in std_logic;  
        reset : in std_logic;  
        flag : out std_logic  
    );  
end;
```

# FSM code: architecture

```
architecture synth of flag3 is
    type State is (START, ONE, TWO, THREE);
    signal s : State := START;
begin

end;
```



# FSM code: state logic (inside architecture)

```
process(clk) begin
  if rising_edge(clk) then
    if reset = '1' then
      s <= START;
    elsif s = START then
      if data = '1' then
        s <= ONE;
      else
        s <= START;
      end if;
    elsif s = ONE then
      if data = '1' then
        s <= TWO;
      else
        s <= START;
      end if;
    elsif s = TWO then
      if data = '1' then
        s <= THREE;
      else
        s <= START;
      end if;
    else
      s <= THREE;
    end if;
  end if;
end process;
```

# FSM code: output logic

No flip-flop required, so this goes outside the process

```
flag <= '1' when s = THREE else '0';
```