

**CSE 260M / ESE 260**  
**Intro. To Digital Logic & Computer Design**

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# **This week**

- **Hw #3 Due Thursday - Don't wait until the last minute!!!**
- **Clarifications / Examples**

# Review (Again)

- Negation Notation
  - $\overline{AB}$  vs.  $\overline{A} \cdot \overline{B}$ 
    - $\overline{A} \cdot \overline{B} = \overline{AB}$
- K-Maps: What, why, and how?

# **K-Maps (Again)**

# Review

- D Flip-Flops
  - Sequence of two D-Latches
    - Transparent at opposite clock cycles
  - Provide precise timing of data acquisition / storage
  - General focus: positive/rising edge triggers

# Sequential & Synchronous Logic

- Sequential circuits
  - Can't be represented with a *simple* table of just inputs and outputs (Possibly a complex table of history of inputs and outputs)
  - Output depends on sequence of inputs and timing
  - *Synchronous* Sequential Circuits
    - Sequential circuits with additional restrictions on form to improve predictability

# ***Synchronous Sequential Circuits***

- *Are synchronized* by a common clock
- Uses registers (D Flip-Flops)
- Mix of registers and combinational logic
- All cycles include *at least one register*
- Goal: Impose predictable behavior!

# Finite State Machines (FSMs)

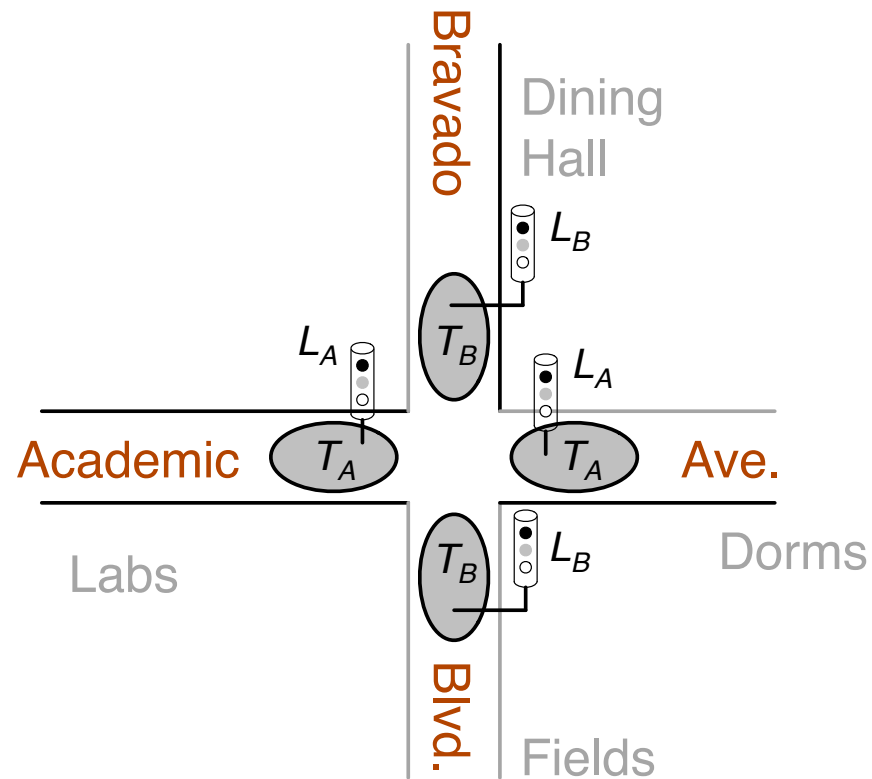
- State: A condition of being
- Finite: Er. Finite
  - Real machine has real-world limitations:  $k \times$  D-latches
  - $k$  D-Latches means  $\leq 2^k$  states (finite)
- (Typically) implemented via *synchronous* sequential logic



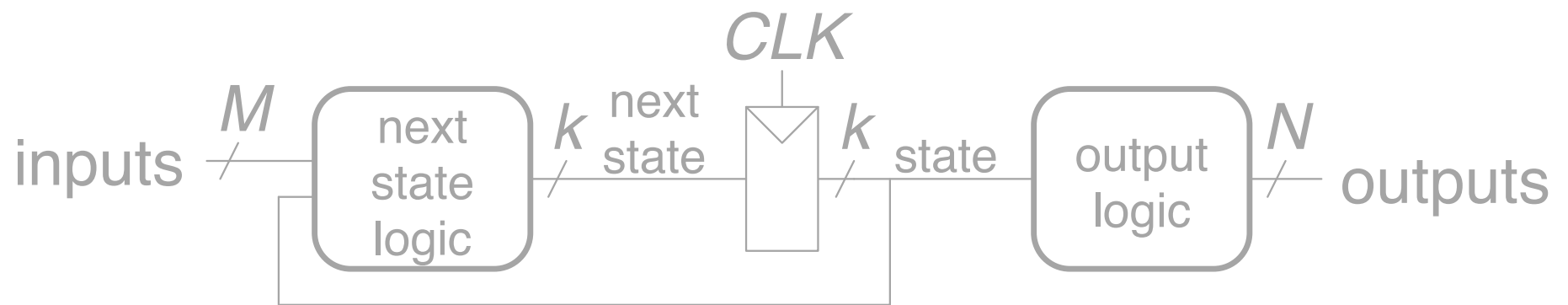
# FSM Applications

- Things with modes or sequences of steps. Examples:
  - Washing Machine (fill, agitate, rinse, spin)
  - Stop lights & Traffic control: Green, Yellow, Red
  - Locks: Locked & unlocked
  - Computer programs: Playing game vs. on menu
  - Elevator controls (state = floor)
  - ...

# Book Example Variation: Stop Light

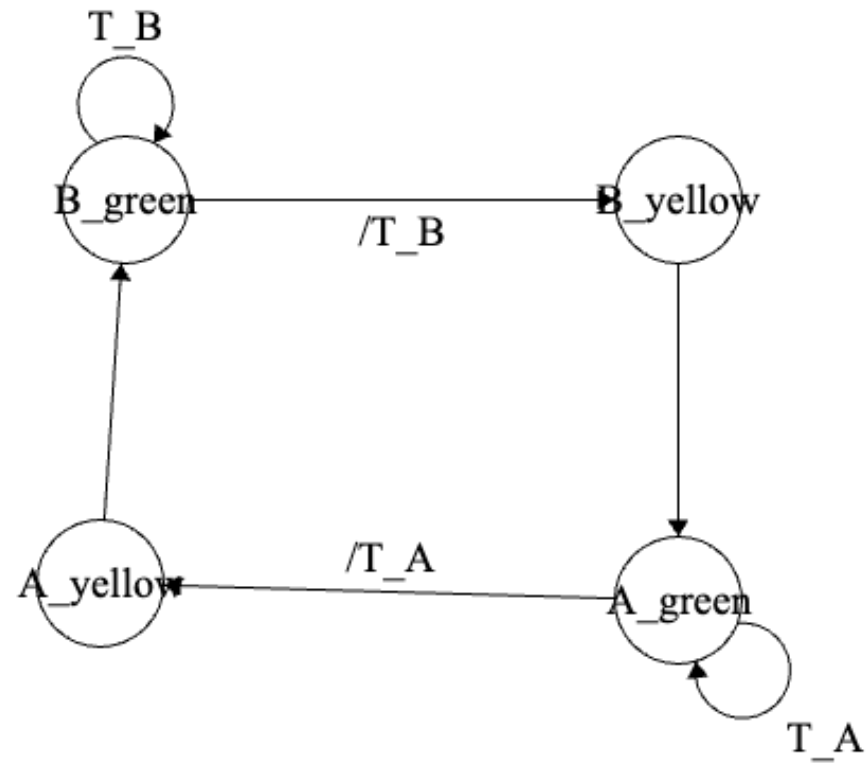


# FSM: Moore Machine Structure

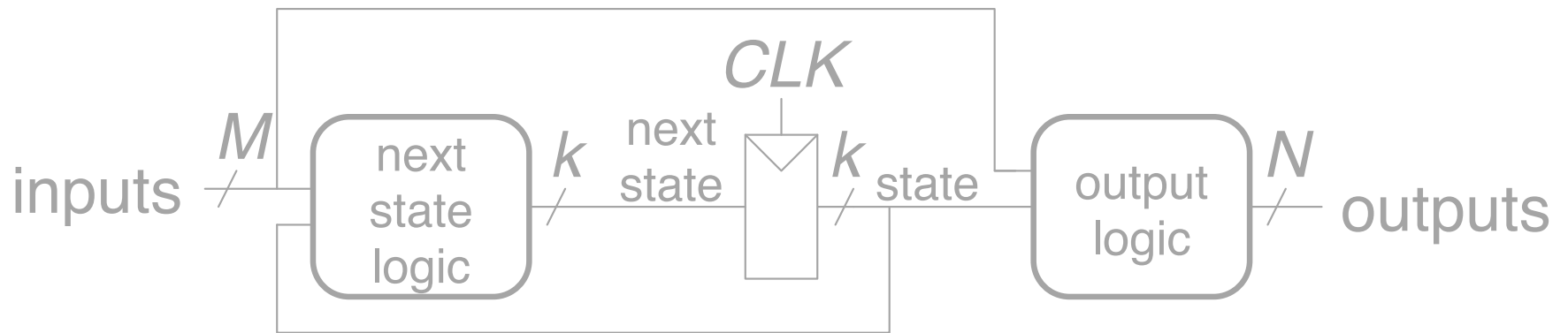


# Background

- Clock is 5s: minimum time in a state
- Need to describe behavior over time
- State diagram forms
  - FSM Designer: <https://wilsonem.github.io/fsm/>
- Example



# FSM: Mealy Machine



# Next Time

- Studio
- Homework 3 due Thursday night!