FSM Word Problems
FSM Example

• Traffic light controller
  – Traffic sensors: $T_A$, $T_B$ (TRUE when there’s traffic)
  – Lights: $L_A$, $L_B$
  – If $L_A = \text{GREEN}$, then $L_A$ remains GREEN as long as A has cars (i.e. $T_A = 1$)
  – If $L_B = \text{GREEN}$, then $L_B$ remains GREEN as long as B has cars (i.e. $T_B = 1$)
  – Light colors change
    (GREEN, RED) $\rightarrow$ (YELLOW, RED) $\rightarrow$ (RED, GREEN)
FSM Blackbox

- Inputs: CLK, $T_A$, $T_B$
- Outputs: $L_A$, $L_B$
FSM State Transition Diagram

- **S0**: $L_A$: green, $L_B$: red
- **S1**: $L_A$: yellow, $L_B$: red
- **S2**: $L_A$: red, $L_B$: green
- **S3**: $L_A$: red, $L_B$: yellow

- **Transitions**: $T_A$, $T_B$, Reset
Modified FSM Example

• If $L_A$ is GREEN: Case
  – No cars on either A or B: change light after 16 cycles
  – Cars waiting on both A and B: change light after 16 cycles
  – Cars waiting only on A: $L_A$ stays GREEN
  – Cars waiting only on B: change light
  – Light colors change (GREEN, RED) $\rightarrow$ (YELLOW, RED) $\rightarrow$ (RED, GREEN)

• If $L_B$ is GREEN: Case ...
FSM Blackbox

- FSM Inputs: CLK, T_A, T_B, C_R (to reset counter)
- FSM Outputs: L_A, L_B, C_T (TRUE if count is 15, all 1’s)
- Datapath: 4-bit counter
String Recognition

• Simple case: recognize 1101
String Recognition

• General rules:
  1. Create string matching tree
  2. State output = 1 if a “pattern” is contained along the path
  3. Add failure edges: find longest “suffix” of string seen so far and transition to the corresponding “prefix” state
String Recognition

• Example: 1101, 1011, 101
  1. Create string matching tree
  2. State output = 1 if a “pattern” is contained along the path
  3. Add failure edges: find longest “suffix” of string seen so far and transition to the corresponding “prefix” state
String Recognition

• Example: 1111, 1011, 101

1. Create string matching tree
2. State output = 1 if a “pattern” is contained along the path
3. Add failure edges: find longest “suffix” of string seen so far and transition to the corresponding “prefix” state
String Recognition using Shift Registers

• Example: 1111, 1011, 101
  1. Use N bit shift register if longest pattern has N bits
  2. Create an AND gate for pattern
  3. OR together AND gates
  4. Caveat: result is invalid for the first N cycles