Model Checking - II

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EE 709: Testing & Verification of VLSI Circuits

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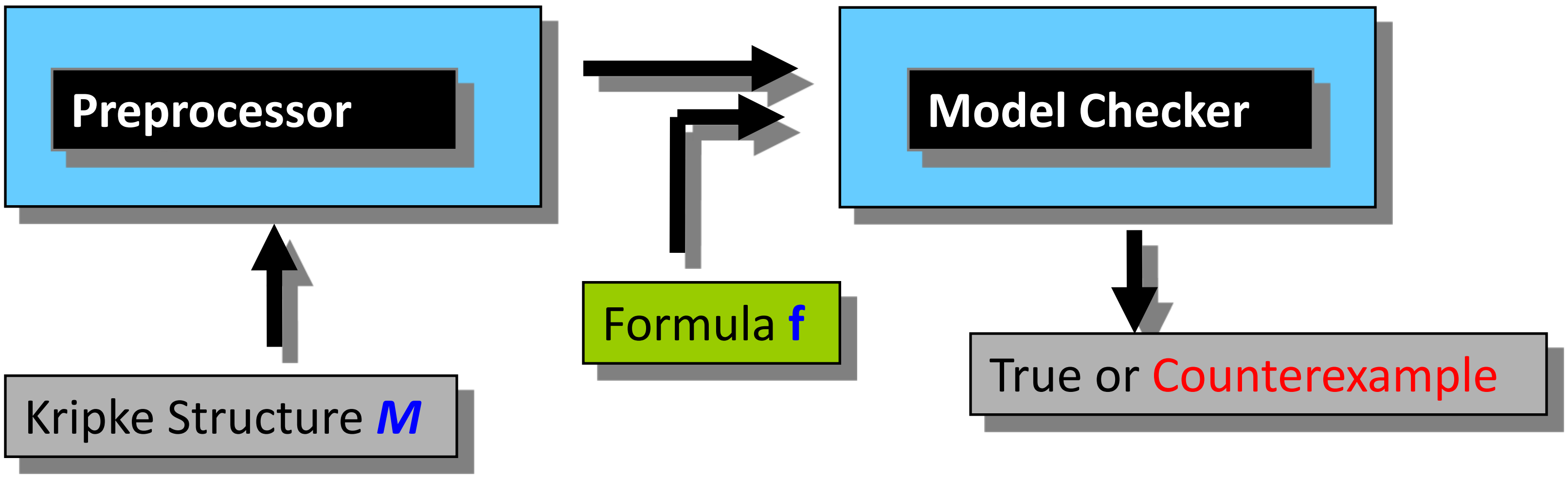
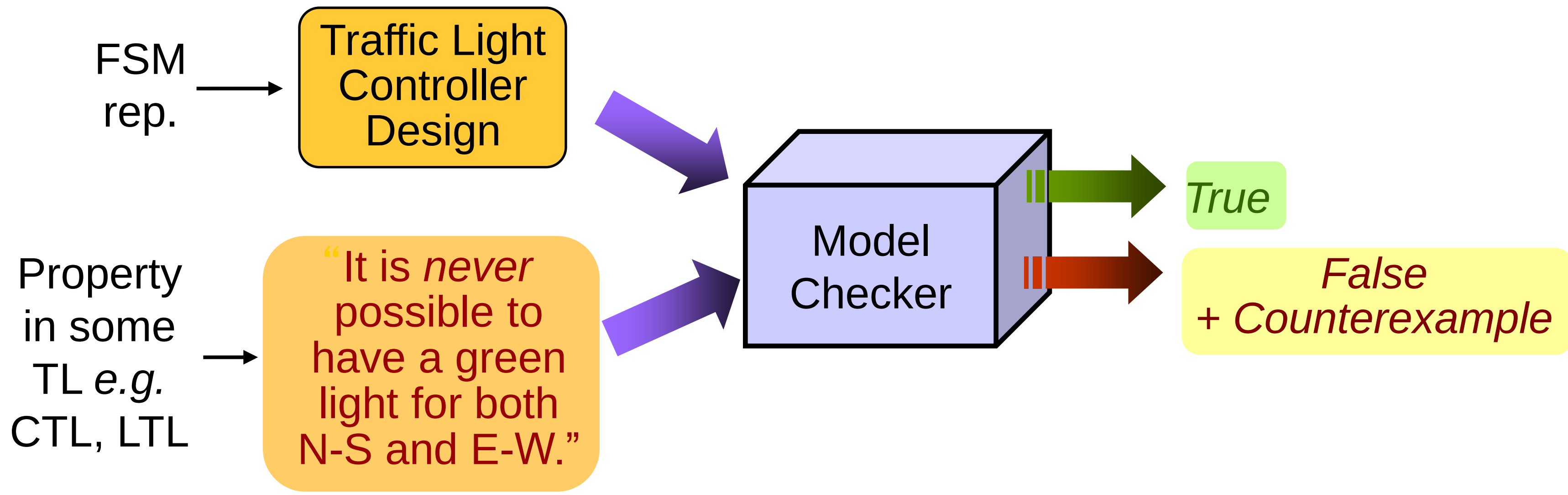
The Model Checking Problem

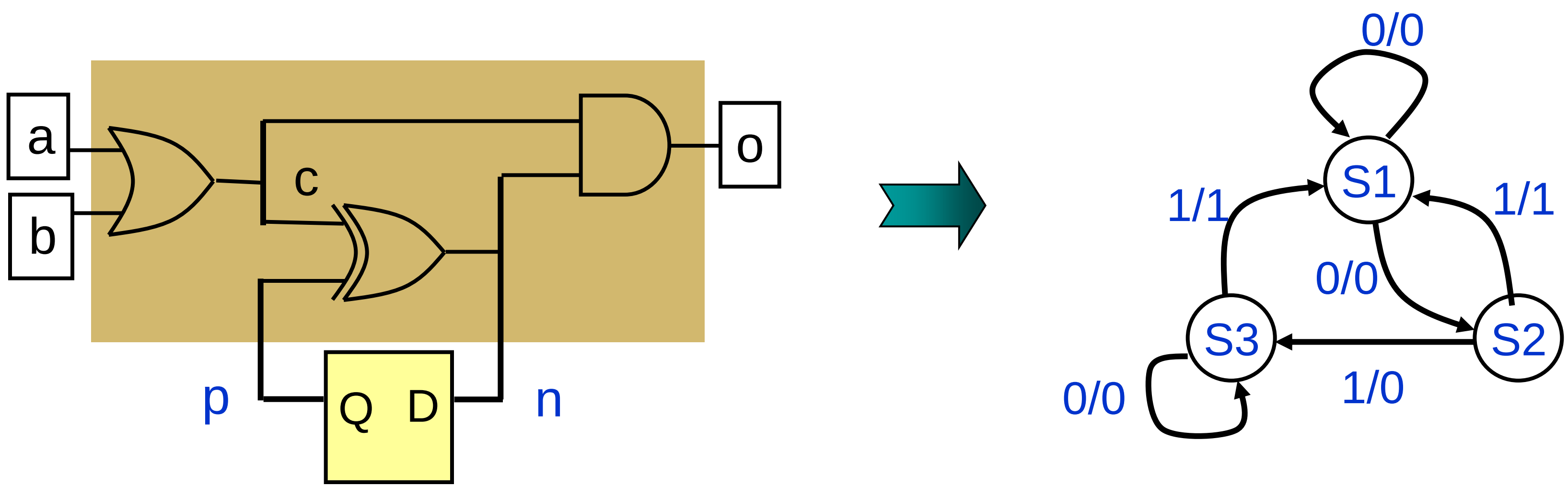
The Model Checking Problem (CE81):

- Let *M* be a Kripke structure (i.e., state-transition graph).
- Let *f* be a formula of temporal logic (i.e., the specification).
- Find all states *s* of *M* such that *M, s* |= f

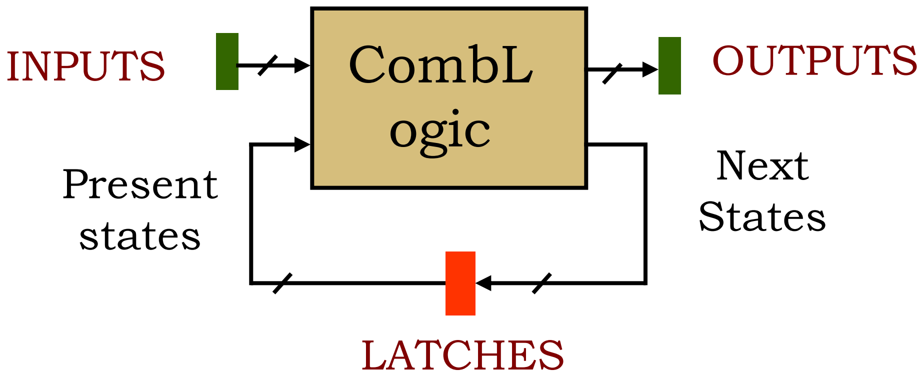


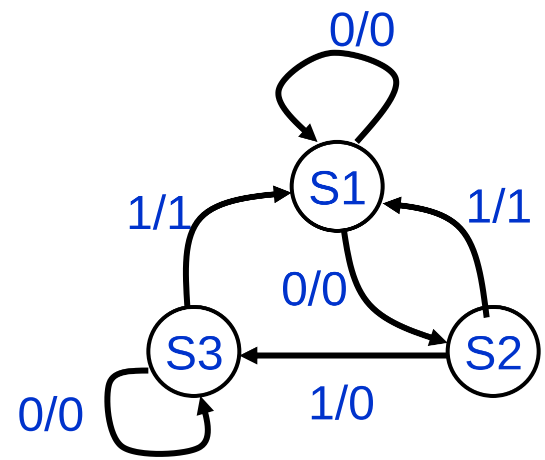
Temporal logic model checking





Finite State Machine (FSM)





State Transition Graph

<u>Mealy FSM: ⟨I, S, δ, S_0, O, λ⟩</u>

- I: input alphabet
- S: finite, non-empty set of states
- $\delta : S \times I \rightarrow S$, next-state function
- $S^0 \subseteq S$: set of initial (reset) states
- O: output alphabet
- $\lambda : S \times I \rightarrow O$, output function

	x = 0	x = 1
S1	S1,0	S2,1
S2	S1,0	S2,0
S3	S3,0	S1,1

State Transition Table

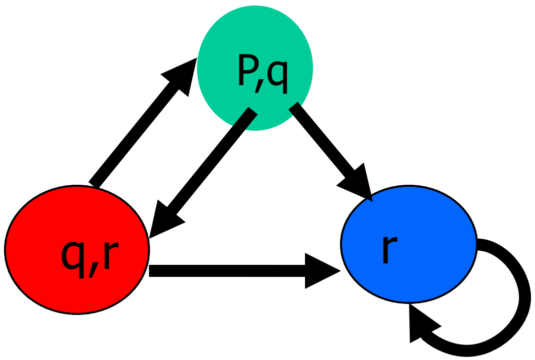
3 Step Process

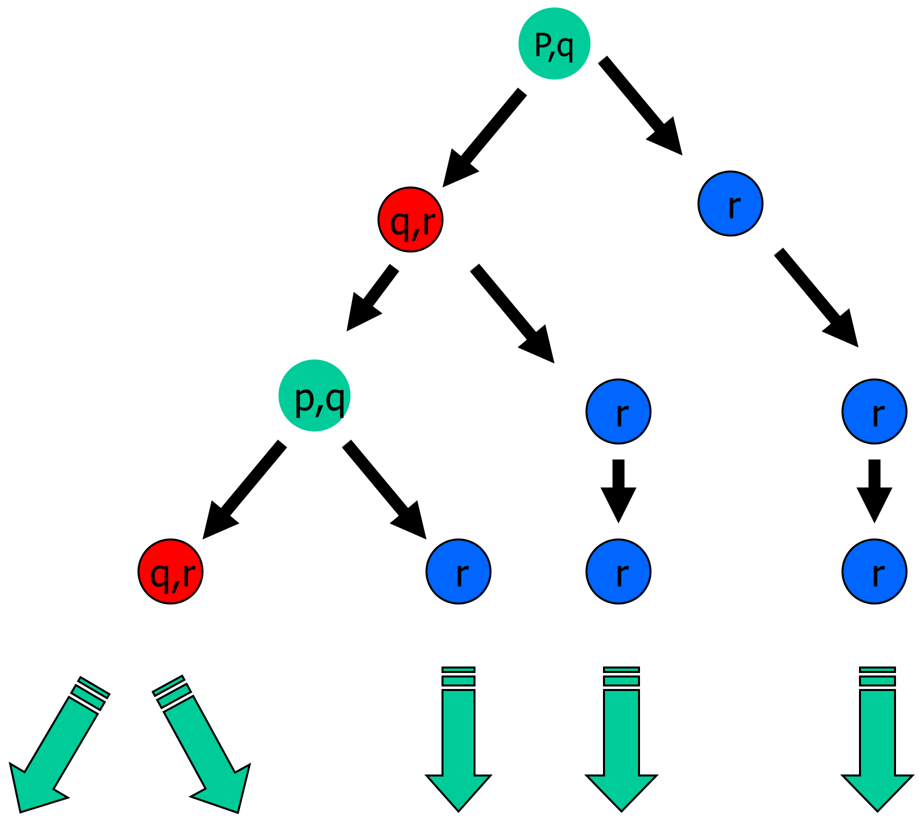
- Formal Specification
  - Precise statement and property
  - Environment constraint
  - Logic: Temporal logic
  - Automata, Labeled transition system
- Models
  - Flexible model generation to specify design
  - Fairness
  - Transition system
- Formal Verification
  - Checking that model satisfy the property

Semantic of Finite State System

- Semantic associated with behaviour
- Branching Time Semantics
  - The tree of states obtained by unwinding the state machine transition graph
  - Possible choices are explicitly represented
- Linear Time Semantics
  - The set of all possible runs of the system
  - The set of infinite paths in SM

Computation Tree Logics





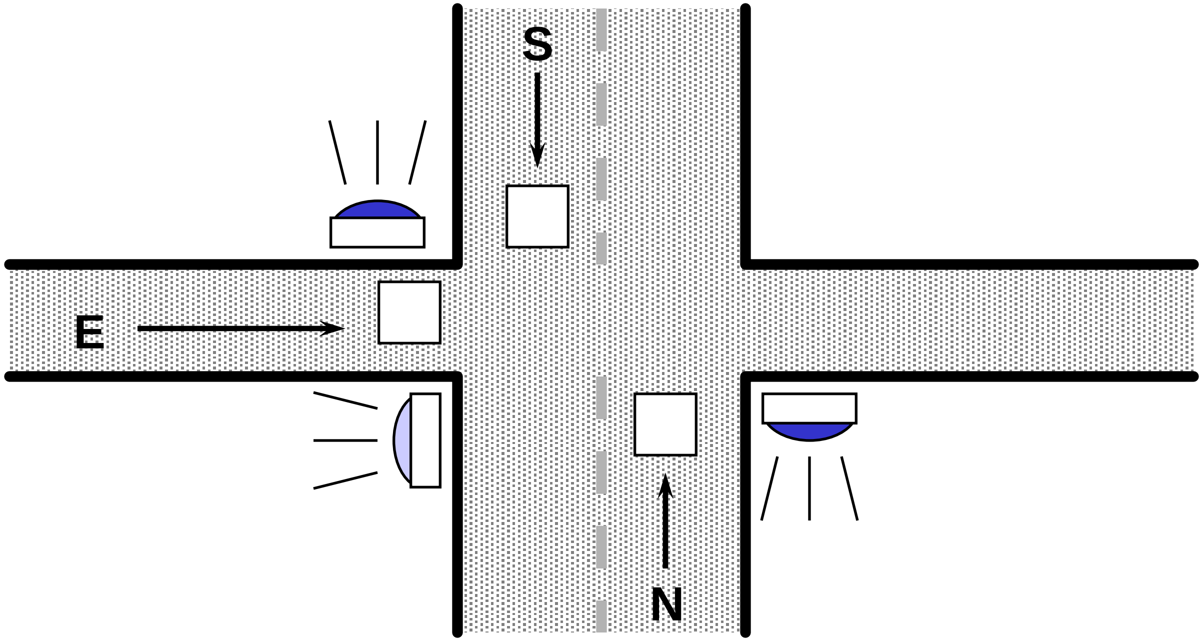
Formal Specification

- Describe unambiguously and precisely the expected behaviour of the design
- In general, a list of properties
- Includes, environmental constraints

Classification of Properties

- Safety Property
  - (un) desirable things always (never) happen
    - A bus arbiter never grants the requests to two masters
    - Message received is message sent
- Liveness (Progress) Property
  - desirable state eventually reached
    - Every bus request is eventually granted
    - A car at a traffic light is eventually allowed to pass
- Fairness Property
  - Desirable state repeatedly reached
    - A request state and a grant state for each client must be visited infinitely often

Example: traffic light controller



- Guarantee no collisions
- Guarantee eventual service

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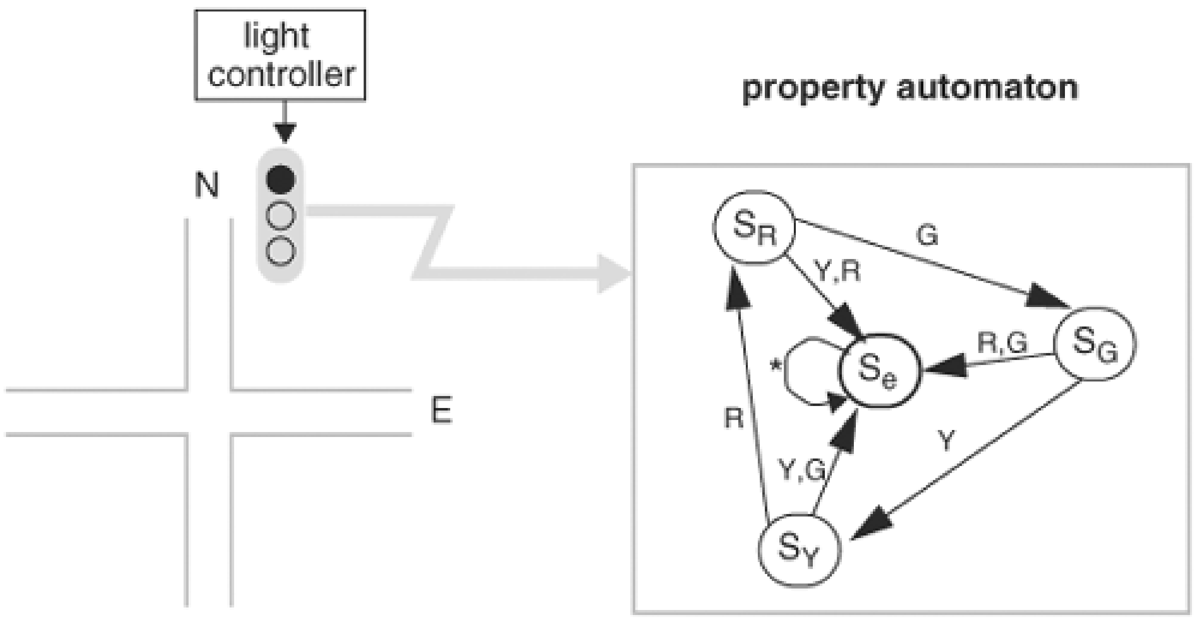
Property Specification

Properties for traffic light controller

- P1 = (s1 ⊕ w1) + (s2 ⊕ w2)
- Sequence R, G, Y, R, G, Y, ……



Thank you