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FSM Design using ASM Charts

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Algorithmic State Machines

- ASMs have three types of building blocks:
  - State Box
  - Decision Box
  - Conditional Output Box

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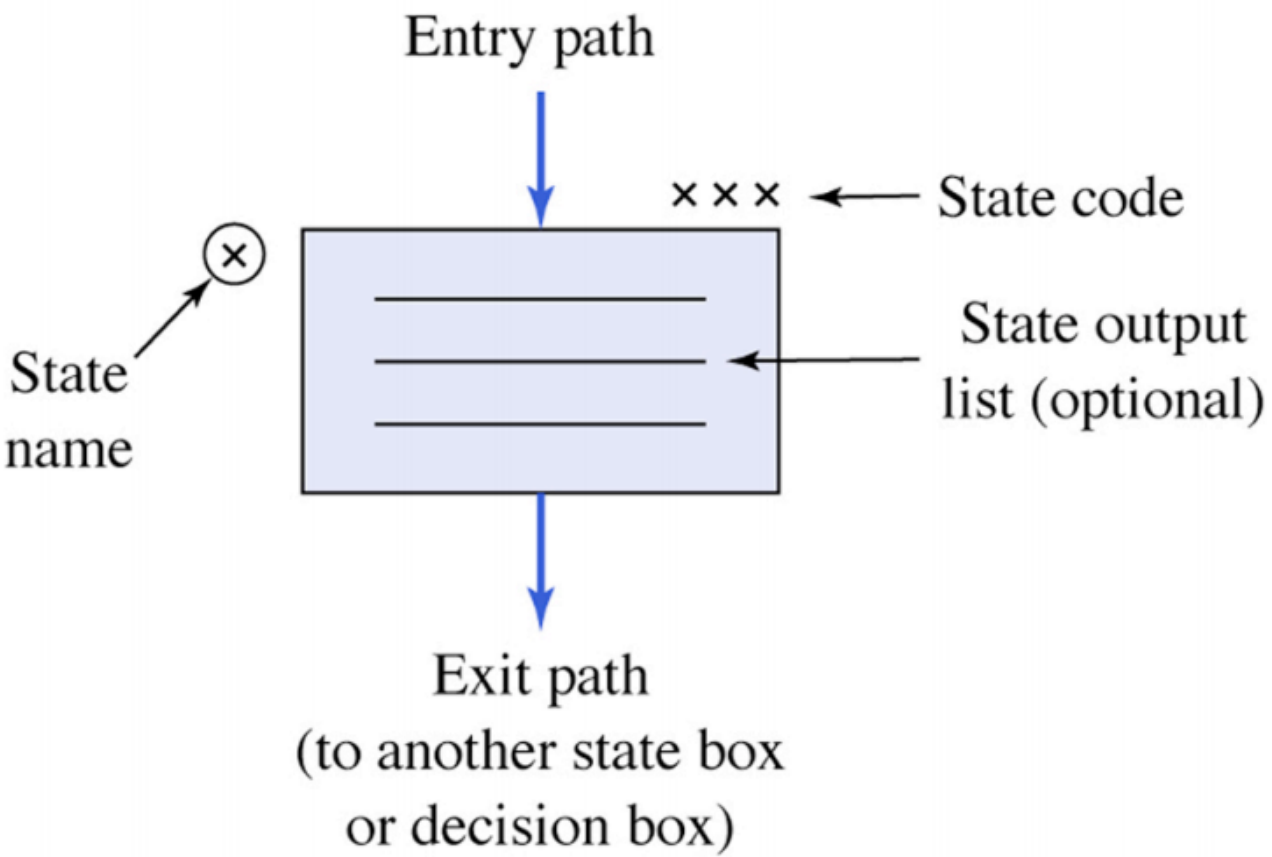
The State Box



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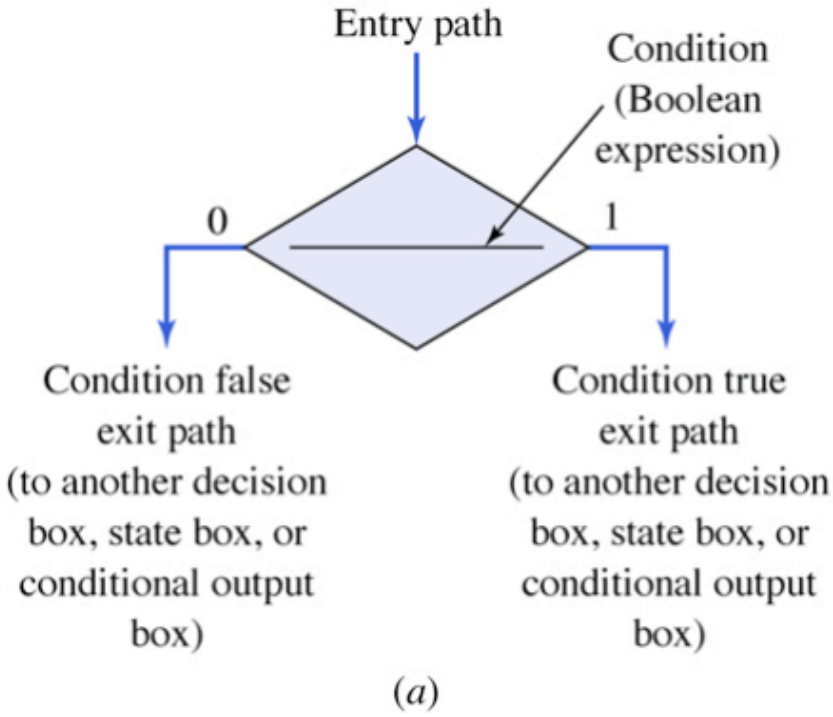
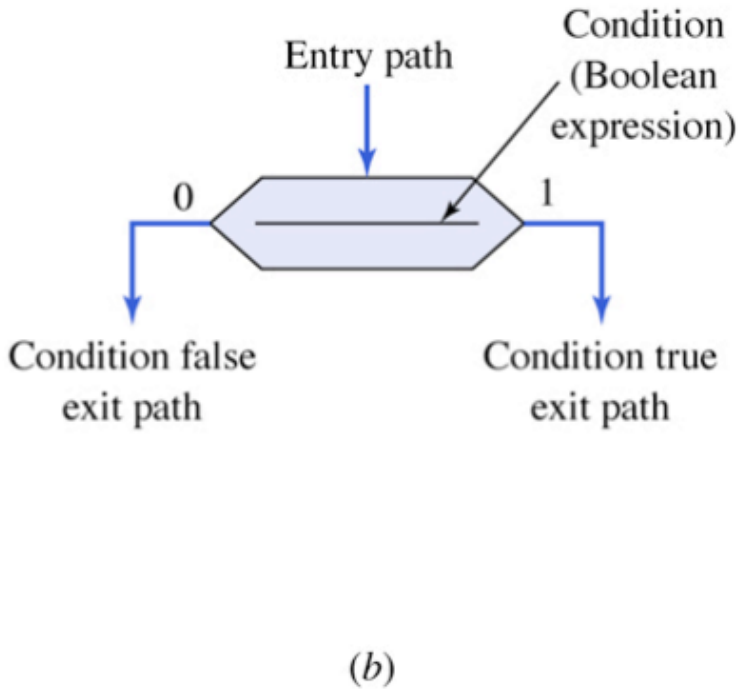
The Decision Box

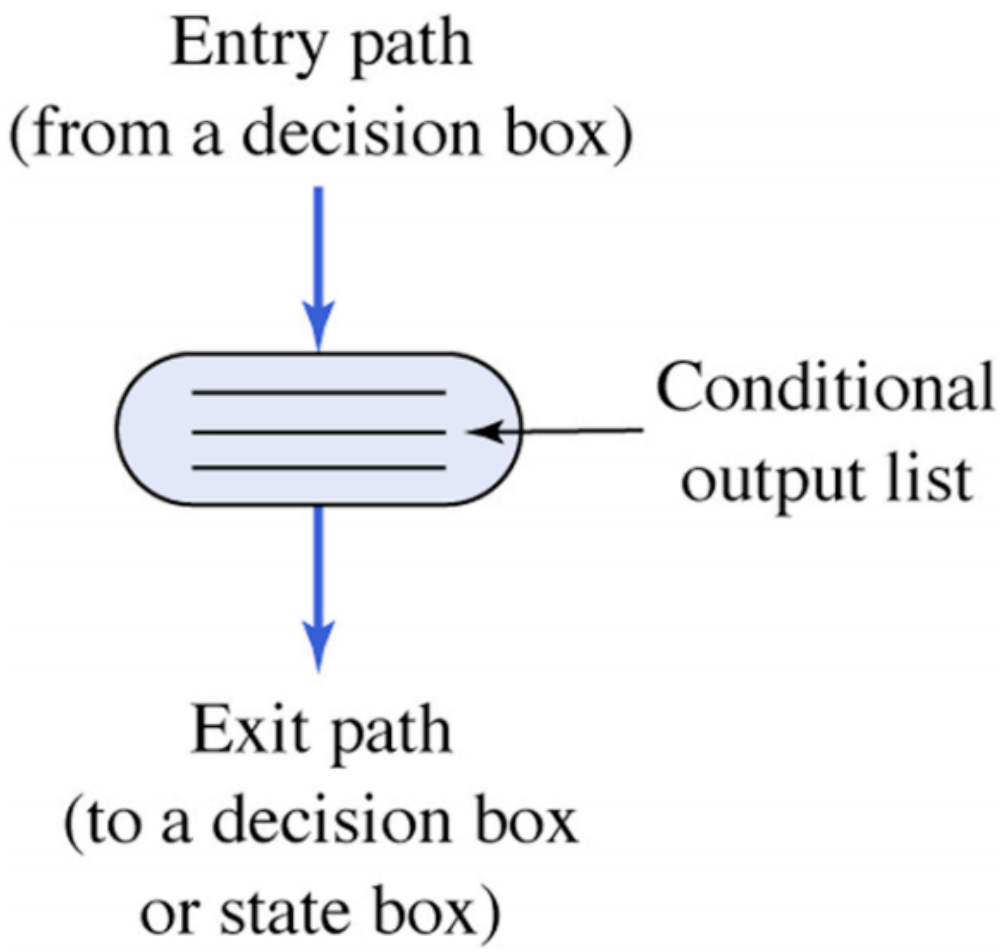


Symbol

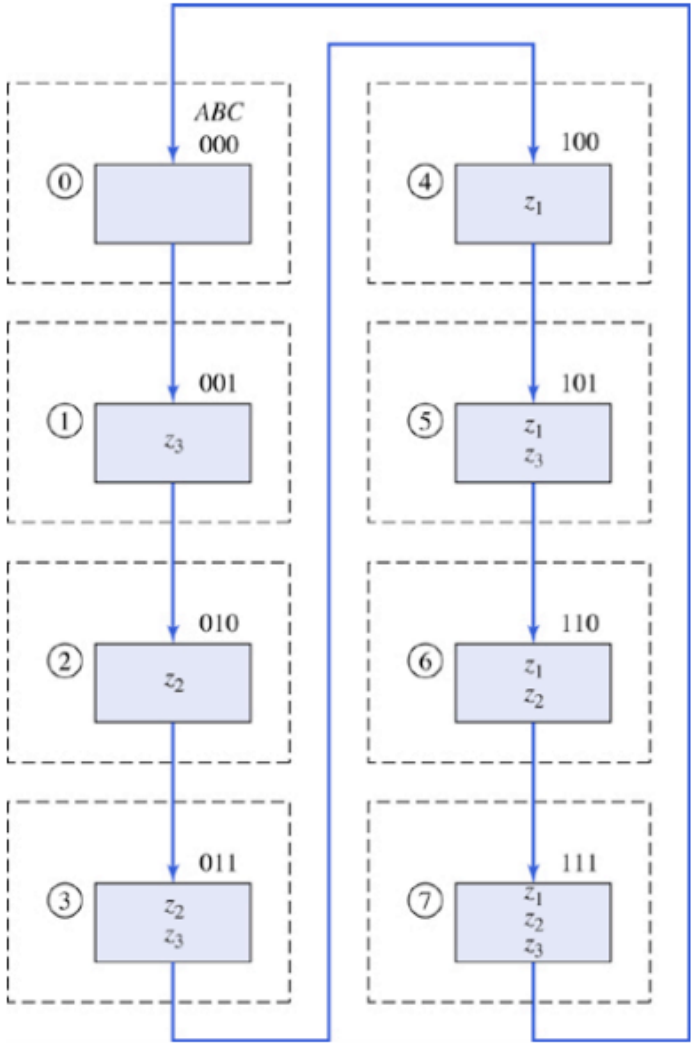


Alternate Symbol

The Conditional Output Box

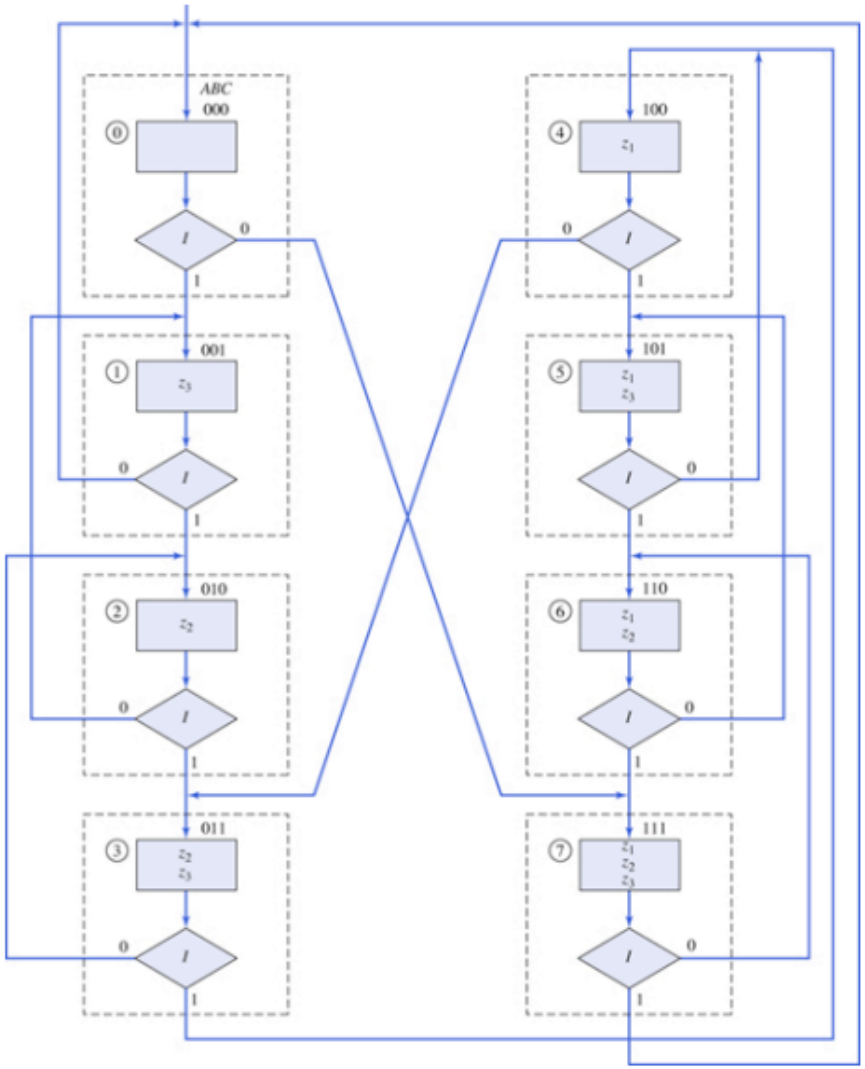


Example:
ASM for a 3-bit binary counter



Example:
ASM for a 3-bit binary up/down counter

Input I controls direction



Example: ASM Chart

State/NextState Sequence:

A → A, B

B → A, C, D

C → C, D

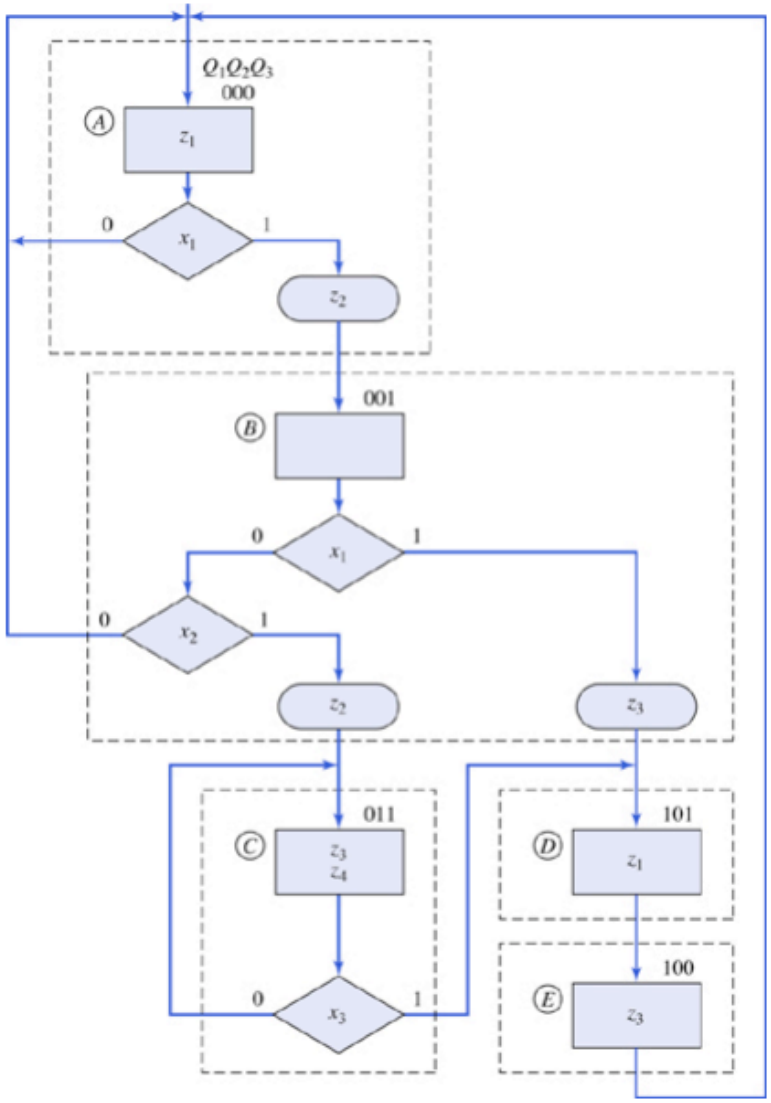
D → E

E → A

3 state bits needed

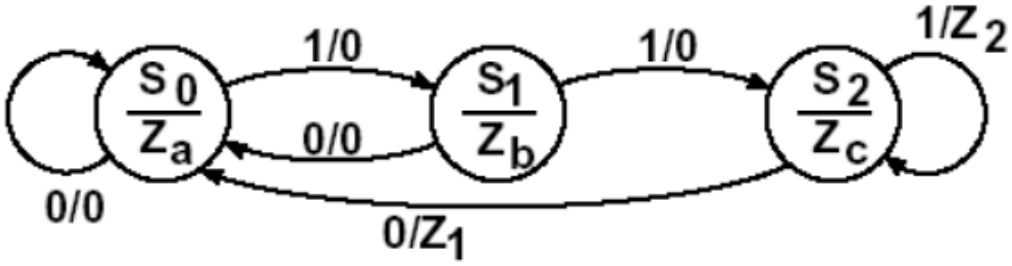
Assign codes to each state

(Possibly arrange adjacent states to be at Hamming distance of 1)

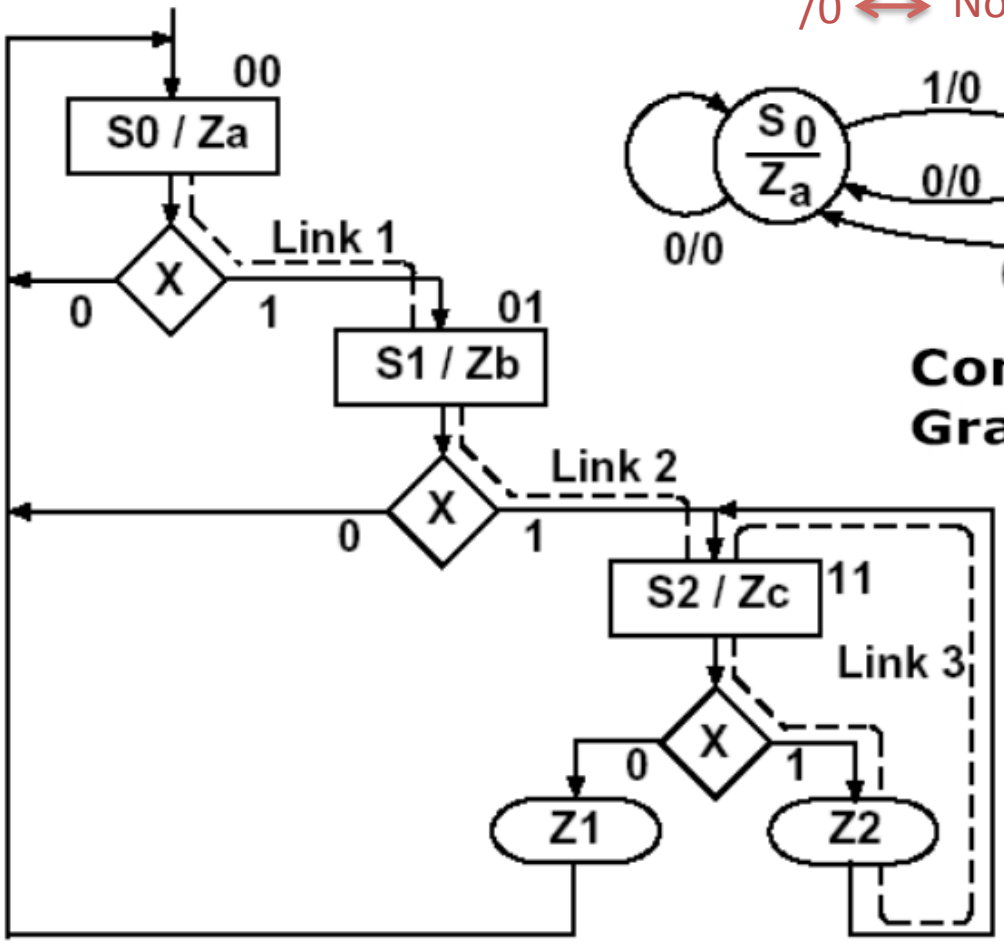


State Diagrams vs. ASM Charts

/0 ⟷ No conditional output

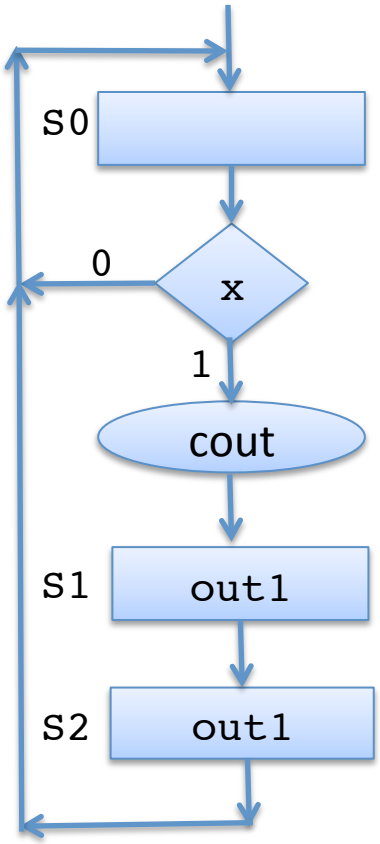


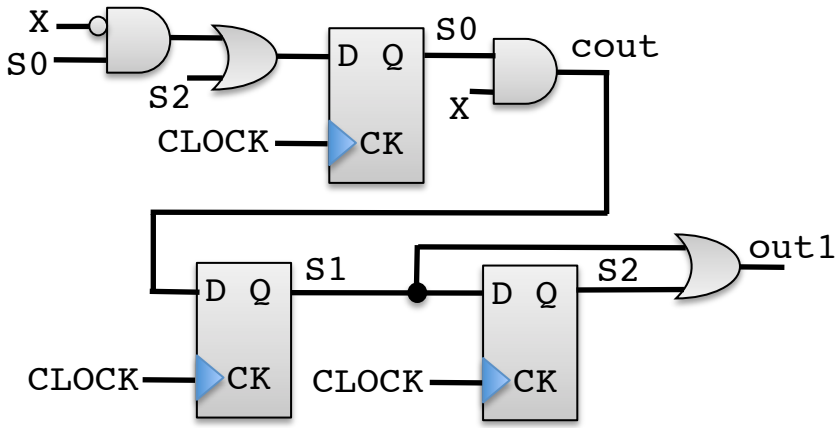
Conversion of a State Graph to an SM Chart



Mapping ASM blocks to Logic Elements

Example:





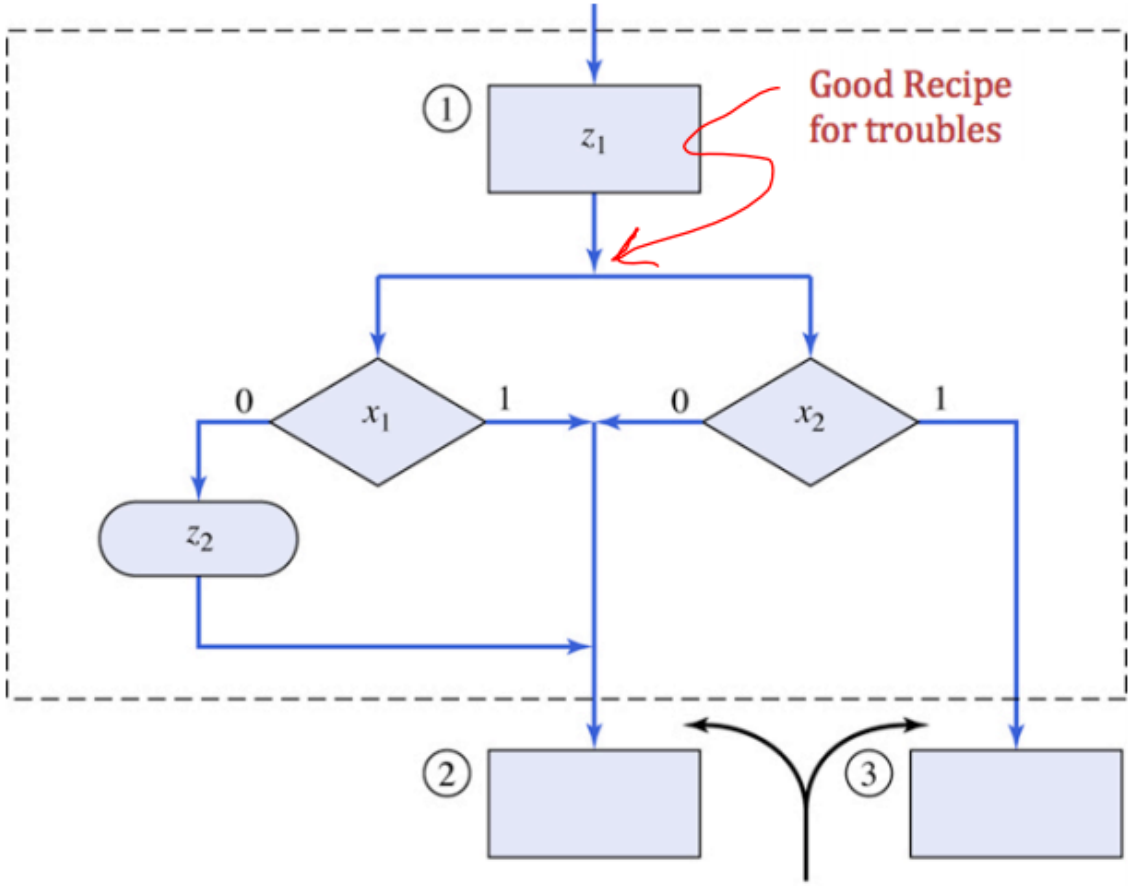
NOTE:
to make the mapping simpler the logic "synthesized" is sub-optimal (min # state FFs = = $\log_2$ state boxes)

State boxes → flip-flops
Decision Boxes → combinational logic gates
Conditional Output Boxes → combinational logic of state bits and inputs
Non Conditional Outputs → combinational logic of state bits

Moore

Mealy

Invalid ASM block having nonunique next states.



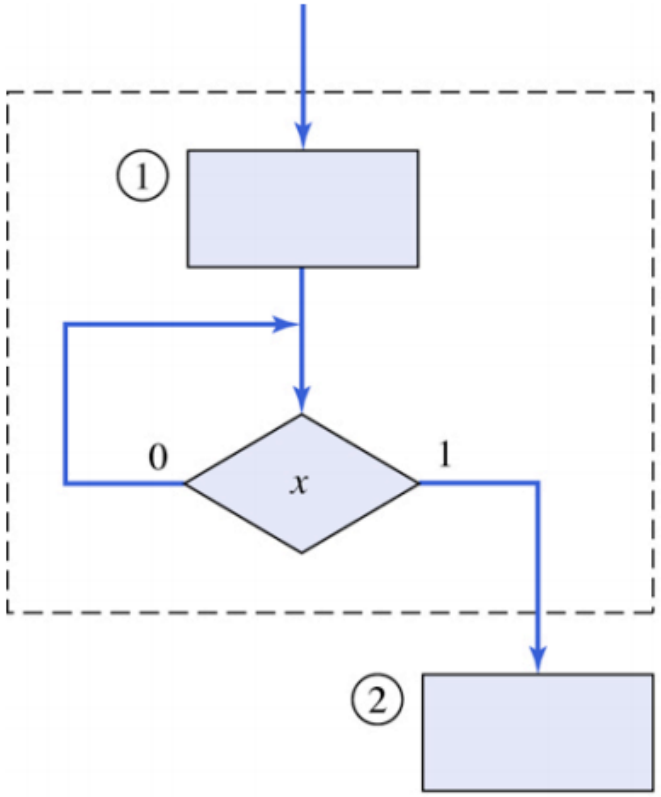
Both exits selected when

both inputs are 1

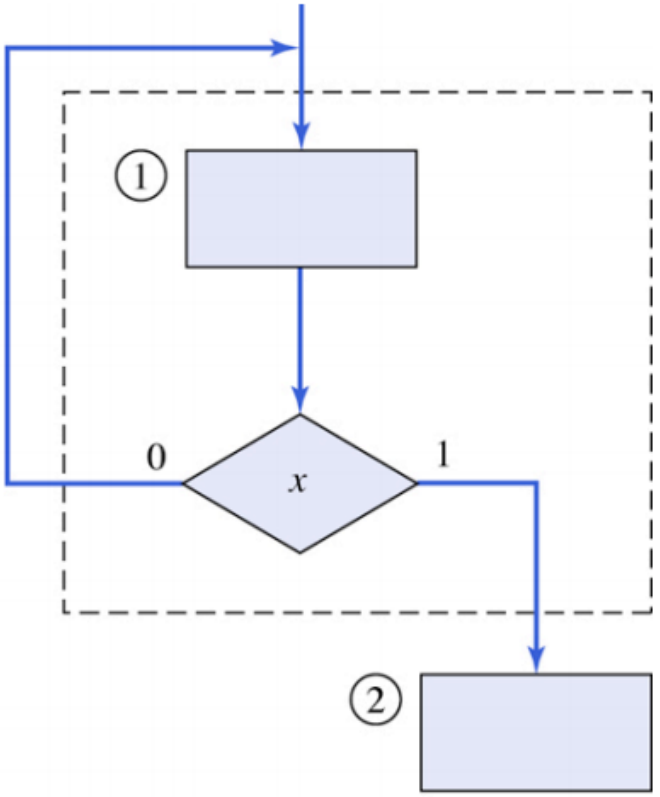
(i.e. when in state 1 if x1*x2=1 the next state is not unique)

Looping.

Any closed loop must contain at least one state box ← RULE



(a) Incorrect.

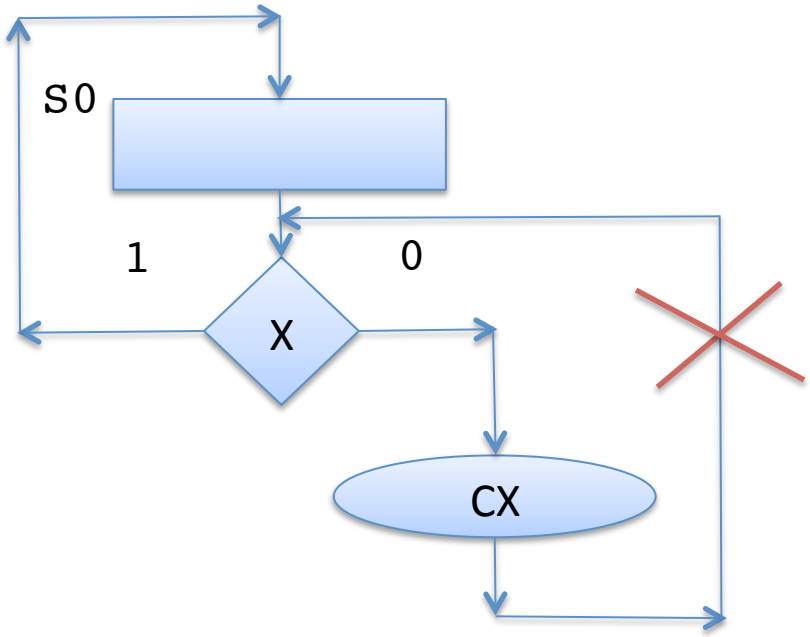


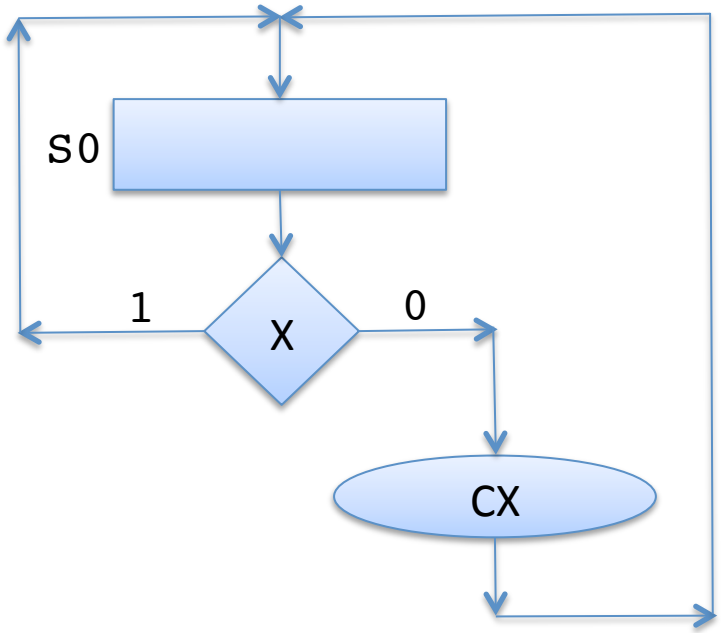
(b) Correct.

It forms a combinational feedback loop

Another Looping example

Any closed loop must contain at least one state box ← RULE





(a) Incorrect.

(b) Correct.

It forms a combinational feedback loop

Linked State Machines

When a machine becomes large and complex is desirable to divide the machine up into several smaller machines that are linked together