Computation Structures 2014 yuzhy

S6 ☐ making state machines

☐ asynchronous circuits & metastability

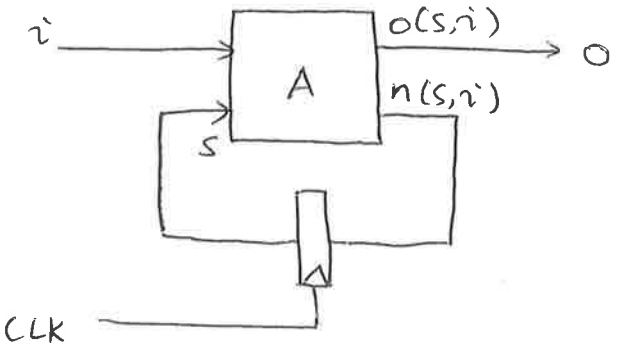
• Statemachines

announce quiz. share lecture notes

tsetup
thold.

- S_0 — start state
- $n(S,i)$ — next state
- $o(S,i)$ — output

- next state will be the state in the next round



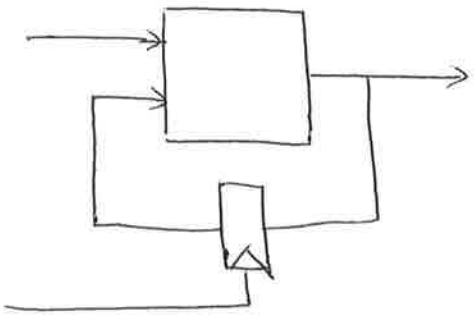
- if A implements $o(S,i)$ and $n(S,i)$, then statemachine works (under the condition that dynamic discipline satisfied)

- e.g. count the number of times a non-zero occurs
  for simplicity, just 1-bit count (can extend) —
  1 if odd, 0 if even.

  $X = [0, 1, 0, 2, 3, \cdots]$ (for simplicity, 2-bit)
  $y = [0, 1, 1, 0, 1, \cdots]$

  $S_0 = 0 \quad n(S,i) = \begin{cases} S & \text{if } i \neq 0 \\ \overline{S} & \text{if } i = 0 \end{cases} \qquad o(S,i) = n(S,i)$

X_1	X_0	S_t	S_{t+1}	O_t
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	0
1	0	0	1	1
1	0	1	0	0
1	1	0	1	1
1	1	1	0	0



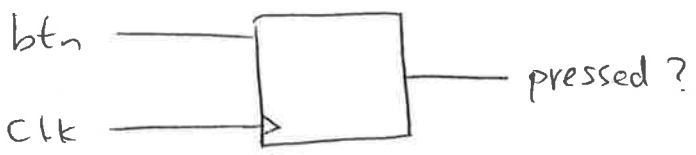
$$S_{t+1} = \bar{X}_1 \bar{X}_0 S_t + \bar{X}_1 X_0 \bar{S}_t + X_1 \bar{X}_0 \bar{S}_t + X_1 X_0 \bar{S}_t$$

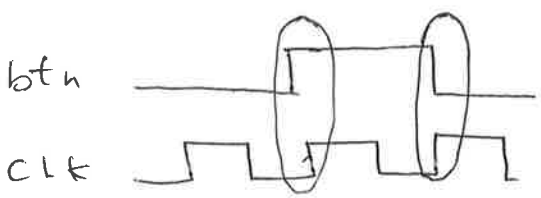
- accummulator ⟶ use one adder

Asynchronous circuits & meta-stability

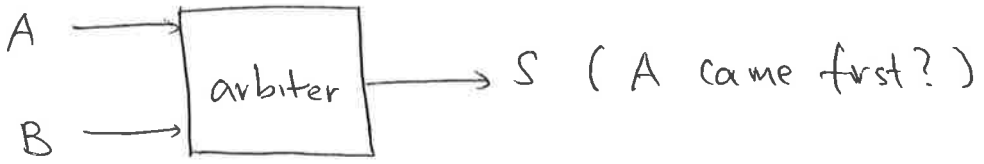
- there are cases when setup and hold time cannot be satisfied.

when there are two clocks in a circuits
when there is external signal





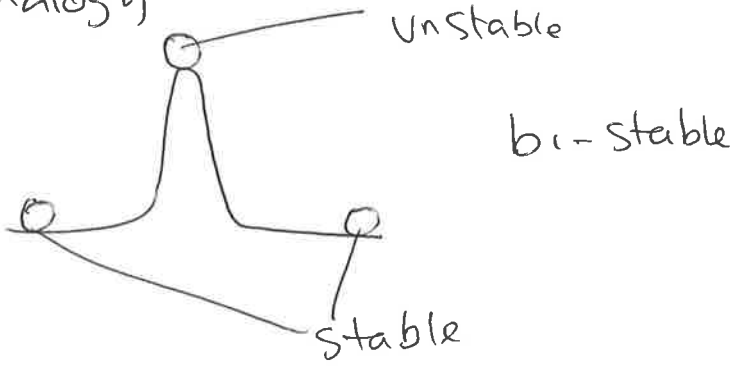
This problem can be reduced to the following problem



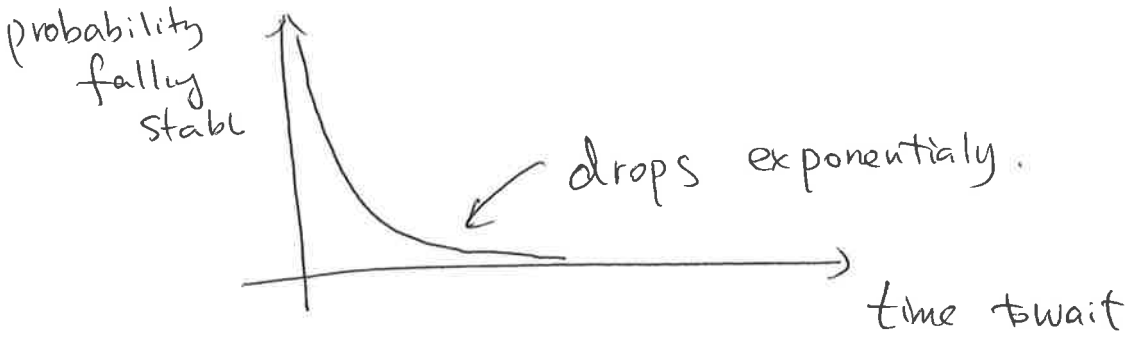
it turns out that { a correct answer is impossible
an incorrect answer is impossible

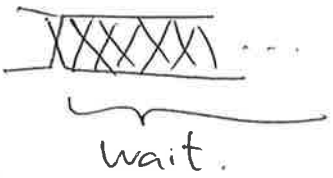
because the output can stay  invalid for infinitely long.

- Analogy

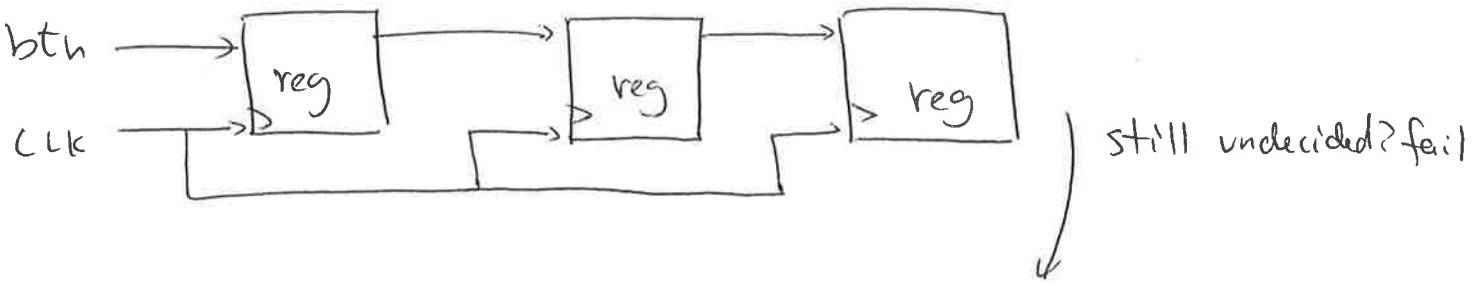


time(unstable) is commonly very small but there is no guarantee of a bound.
(the sharper, the less likely long staying unstable)



so the longer to wait, the less likely 

one common solution



wait 100 ns ⟶ 10^{30} years a failure

Take home message: all circuits can fail, but very unlikly