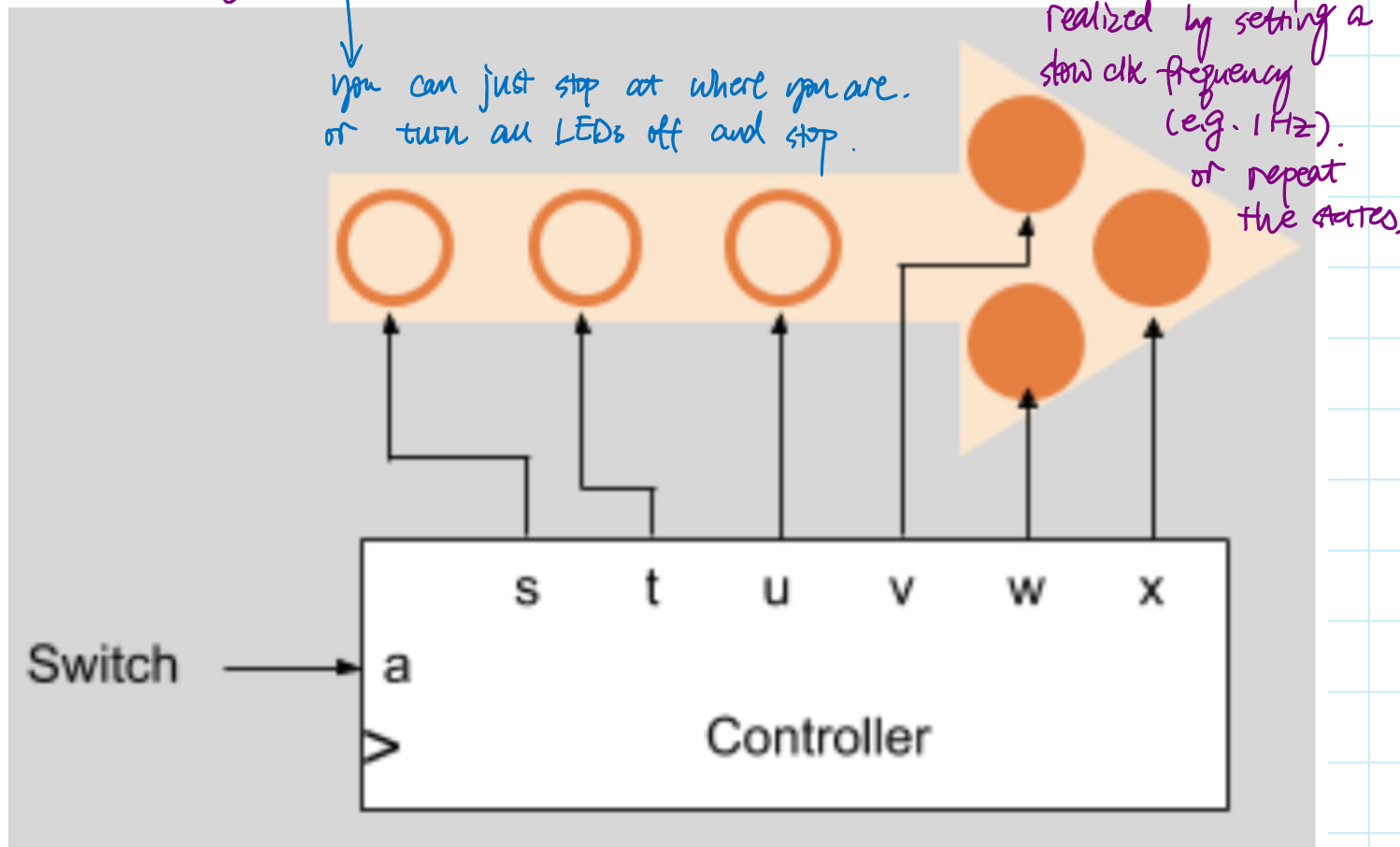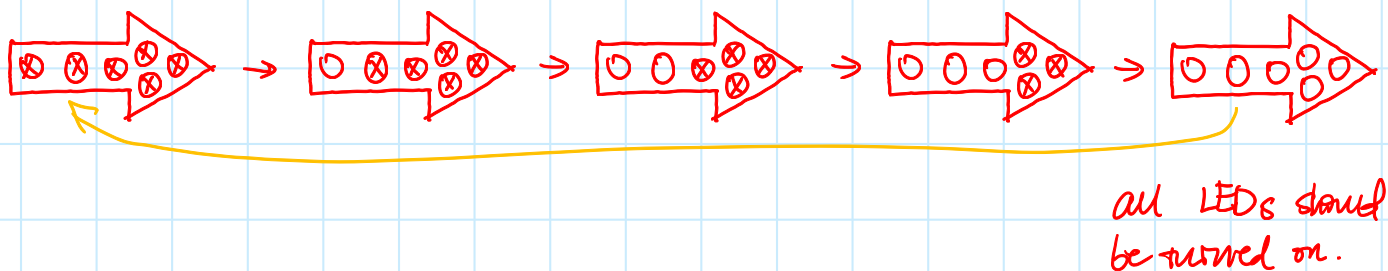A highway construction sign illuminates LEDs to tell drivers to move over, as illustrated below. The behavior can be captured as an FSM to generate the necessary output sequence: LEDs connected to outputs s, t, u will be turned on sequentially, before the 3 LEDs in the triangle area are all turned on at the same time, then all of them will be turned off and repeat. Input a = 1 activates the sequence, or it will stops the illumination, controlled by a switch on the sign. Make sure the LEDs are on for sufficient amount of time (your decision).

you can just stop at where you are. or turn all LEDs off and stop.

realized by setting a slow clk frequency (e.g. 1 Hz). or repeat the series.

s   t   u   v   w   x

Switch ⟶ a

> Controller

(a) capture the FSM behavior in a state diagram. (30 points)

(b) Create the state table with the states encoded. (10 points)

(c) Draw standard architecture of the FSM. (10 points) (Don't have to show details of the combinational circuit)

all LEDs should be turned on.

Method 1.

(a)   Input : a   Output : s, t, u, v, w, x   Clk freq. : 1 Hz.

do not forget this arrow.

a'

a a

init 000
000000

a' a'

S_0 001
100000

S_1 010
110000

a

S_3 111
111111

S_2 110
111000

a

a'
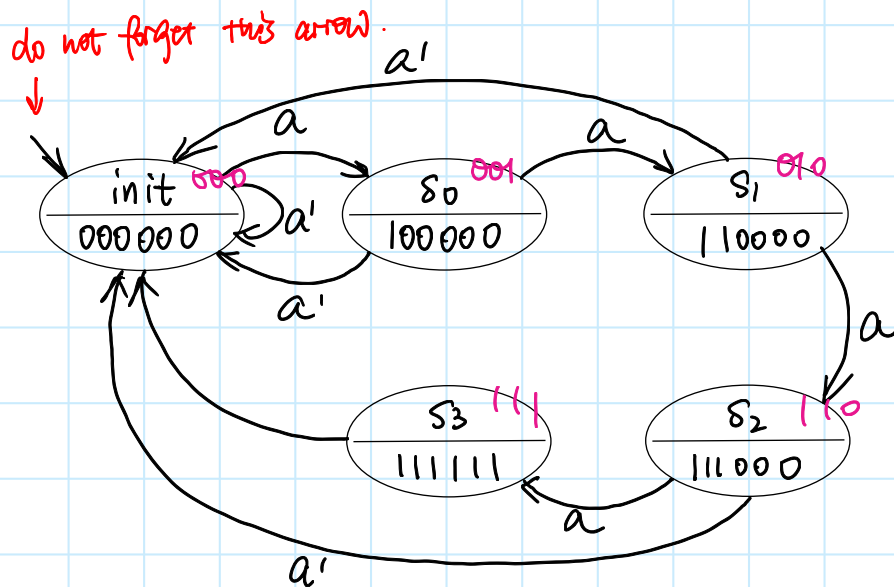
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(b)

S2	S1	S0	a	n2	n1	n0	s	t	u	v	w	x	The output of the
0	0	0	0	0	0	0	0	0	0	0	0	0	present state.
0	0	0	1	0	0	1	0	0	0	0	0	0	
0	0	1	0	0	0	0	1	0	0	0	0	0	
0	0	1	1	0	1	0	1	0	0	0	0	0	
0	1	0	0	0	0	0	1	1	0	0	0	0	
0	1	0	1	0	1	1	1	1	0	0	0	0	
0	1	1	0	0	0	0	1	1	1	0	0	0	
0	1	1	1	1	0	0	1	1	1	0	0	0	
1	0	0	0	0	0	0	1	1	1	1	1	1	
1	0	0	1	0	0	0	1	1	1	1	1	1	
1	0	1	0	x	x	x	x	x	x	x	x	x	
1	0	1	1	x	x	x	x	x	x	x	x	x	
1	1	0	0	x	x	x	x	x	x	x	x	x	
1	1	0	1	x	x	x	x	x	x	x	x	x	
1	1	1	0	x	x	x	x	x	x	x	x	x	
1	1	1	1	x	x	x	x	x	x	x	x	x	

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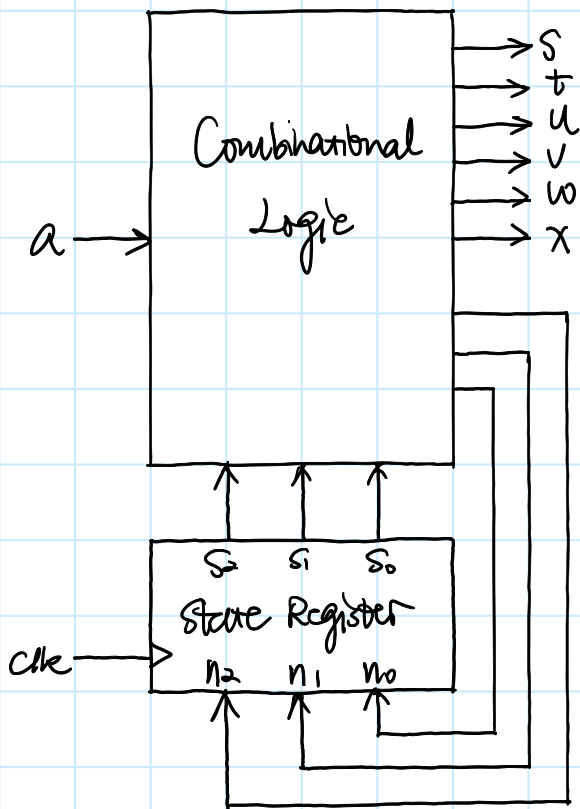
Method 2

(a)   Input: a Output: s, t, u, v, w, x

State machine diagram:

- init (000): $s=0$, $t=0$, $u=0$, $v=0$, $w=0$, $x=0$
- S0 (001): $s=1$, $t=0$, $u=0$, $v=0$, $w=0$, $x=0$
- S1 (010): $s=1$, $t=1$, $u=0$, $v=0$, $w=0$, $x=0$
- S2 (011): $s=1$, $t=1$, $u=1$, $v=0$, $w=0$, $x=0$
- S4 (101): $s=1$, $t=1$, $u=1$, $v=1$, $w=1$, $x=1$
- S3 (100): $s=1$, $t=1$, $u=1$, $v=1$, $w=1$, $x=1$
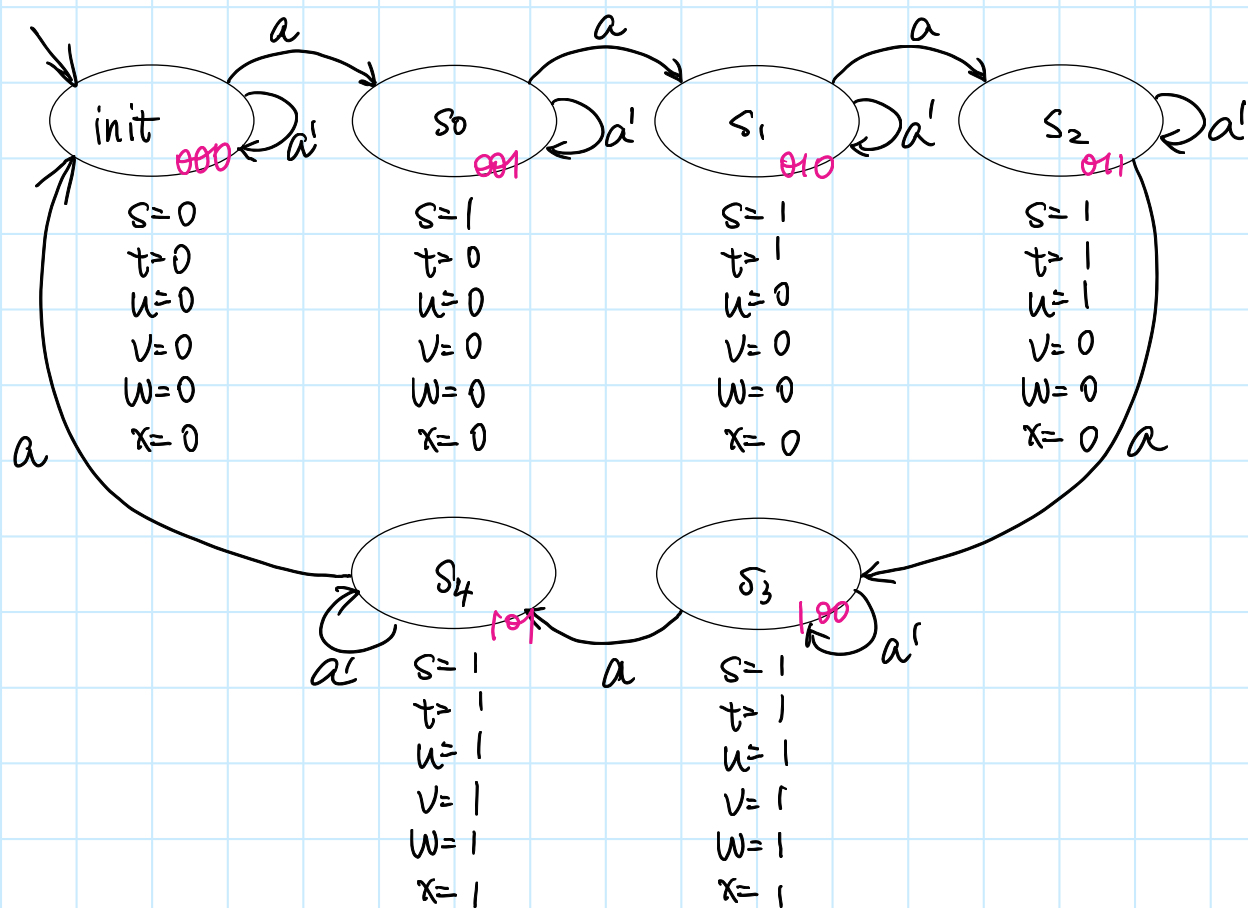
You can just repeat this state or repeat all the states.

(b)

S2	S1	S0	a	n2	n1	n0	s	t	u	v	w	x
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	1	0	0	0	0	0	0
0	0	1	0	0	0	1	1	0	0	0	0	0
0	0	1	1	0	1	0	1	0	0	0	0	0
0	1	0	0	0	1	0	1	1	0	0	0	0
0	1	0	1	0	1	1	1	1	0	0	0	0
0	1	1	0	0	1	1	1	1	1	0	0	0
0	1	1	1	1	0	0	1	1	1	0	0	0
1	0	0	0	1	0	0	1	1	1	1	1	1
1	0	0	1	1	0	1	1	1	1	1	1	1
1	0	1	0	1	0	1	1	1	1	1	1	1
1	0	1	1	0	0	0	1	1	1	1	1	1
1	1	0	0	x	x	x	x	x	x	x	x	x
1	1	0	1	x	x	x	x	x	x	x	x	x
1	1	1	0	x	x	x	x	x	x	x	x	x
1	1	1	1	x	x	x	x	x	x	x	x	x

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CS