CS M51A, Winter 2021, Assignment 6 (Total Mark: 100 points, 10%)

Due: Wed Feb 17th, 10:00 AM Pacific Time
Student Name:
Student ID:
Note: You must complete the assignments entirely on your own, without discussing with others.

1. (6 Points) Determine whether the sequential systems described by the following tables corresponds to Moore or Mealy machines.

	Input	
PS	$x = 0$	$x = 1$
A	$A, 0$	$B, 1$
B	$C, 1$	$C, 0$
C	$A, 0$	$B, 1$
	NS, Output	

Mealy

	Input	
PS	$x = 0$	$x = 1$
A	$B, 0$	$C, 0$
B	$B, 1$	$C, 0$
C	$A, 1$	$B, 1$
	NS, Output	

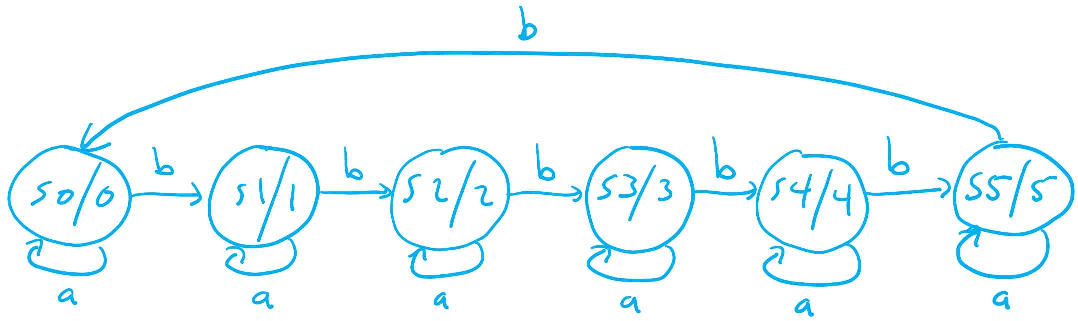
Mealy

	Input	
PS	$x = 0$	$x = 1$
A	$A, 0$	$B, 0$
B	$A, 1$	$C, 1$
C	$A, 1$	$D, 1$
D	$A, 0$	$A, 0$
	NS, Output	

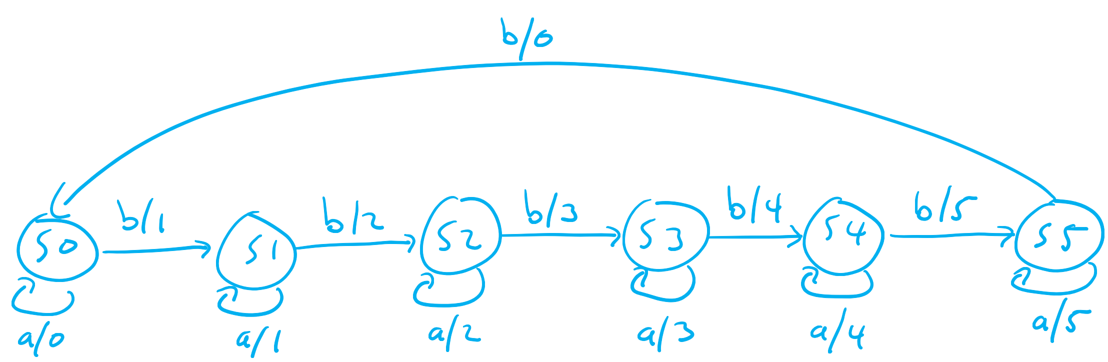
Moore

2. Consider a sequential system that takes in an input $x(t) \in \{a, b\}$, and produces an output $z(t) \in \{0, 1, 2, 3, 4, 5\}$. Draw a finite state machine that outputs the number of b's seen so far in $x(0, t)$. Note that on every 6^{th} b, the count should reset back to 0.

(a) (6 Points) Draw the state diagram as a Moore Machine



(b) (6 Points) Draw the state diagram as a Mealy Machine

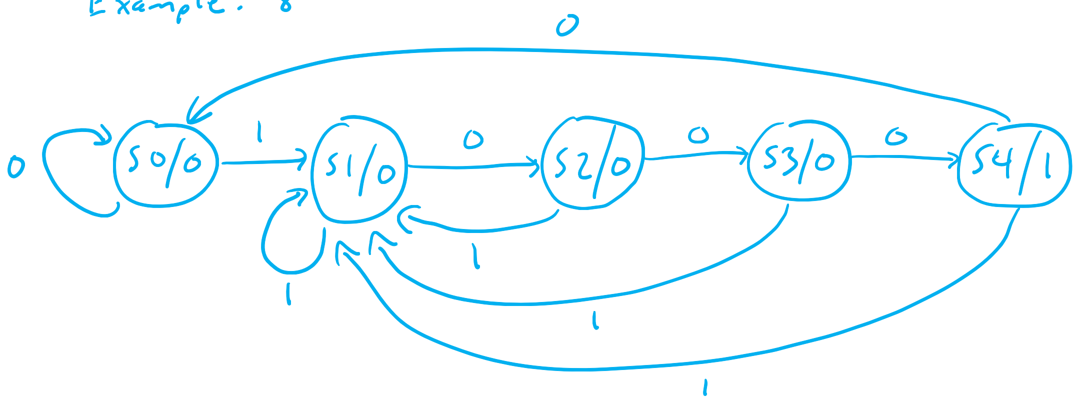


3. (10 Points) Draw the state diagram for a pattern detector (overlapping is allowed) that recognizes the pattern: "$x_3x_2x_1x_0$", where the pattern is the last digit of your student ID presented in 4-bit unsigned binary.

   For example, if your student ID is 32451798, the last digit is 8, and the pattern is 1000. In this example, the output is defined as:

   z(t)=1 if x(t-3,t)=1000
   z(t)=0 otherwise

   Example: 8



4. Consider the following state table:

PS	Input $x=a$	$x=b$	$x=c$	$x=d$
A	$G,1$	$E,0$	$G,1$	$C,0$
B	$D,0$	$G,0$	$E,0$	$F,1$
C	$E,1$	$G,0$	$F,1$	$A,0$
D	$E,1$	$G,0$	$F,1$	$C,0$
E	$C,0$	$G,0$	$E,0$	$F,1$
F	$C,1$	$B,1$	$A,0$	$B,1$
G	$C,0$	$E,0$	$G,0$	$F,1$
H	$G,1$	$E,0$	$F,1$	$A,0$
	NS,z			

   (a) (8 Points) Answer True or False for the questions:

   - State A and B are 2-equivalent. False
   - State C and D are 1-equivalent. True
   - State G and H are 1-distinguishable. True
   - State E and F are 1-equivalent. False

(b) (14 Points) Simplify this table by reducing the state set as much as possible

$P_1 = (ACDH)(BEG)(F)$

input	A	C	D	H	B	E	G	F
	1				2			3
a	2	2	2	2	1	1	1	1
b	2	2	2	2	2	2	2	2
c	2	3	3	3	2	2	2	1
d	1	1	1	1	3	3	3	1

New partition

$P_2 = (A)(CDH)(BEG)(F)$

input	A	C	D	H	B	E	G	F
	1	2			3			4
a	3	3	3	3	2	2	2	2
b	3	3	3	3	3	3	3	3
c	3	4	4	4	3	3	3	1
d	2	1	2	1	4	4	4	3

New partition

$P_3 = (A)(CH)(D)(BEG)(F)$

input	A	C	H	D	B	E	G	F
	1	2		3	4			5
a	4	4	4	4	3	2	2	2
b	4	4	4	4	4	4	4	4
c	4	5	5	5	4	4	4	1
d	2	1	1	2	5	5	5	4

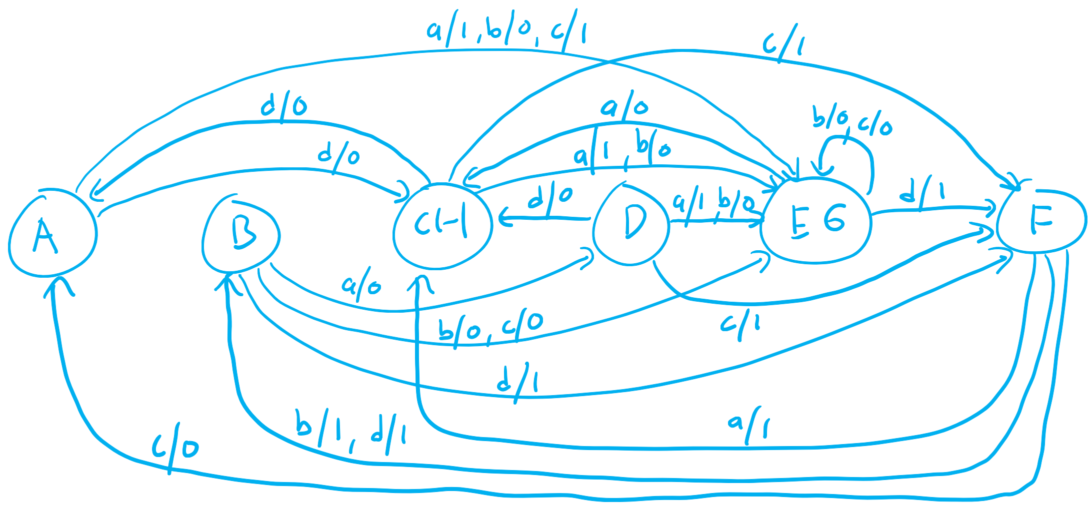
$P_4 = (A)(CH)(D)(EG)(B)(F)$

input	A	C	H	D	E	G	B	F
	1	2		3	4		5	6
a	4	4	4	4	2	2	3	2
b	4	4	4	4	4	4	4	5
c	4	6	6	6	4	4	4	1
d	2	1	1	2	6	6	6	5

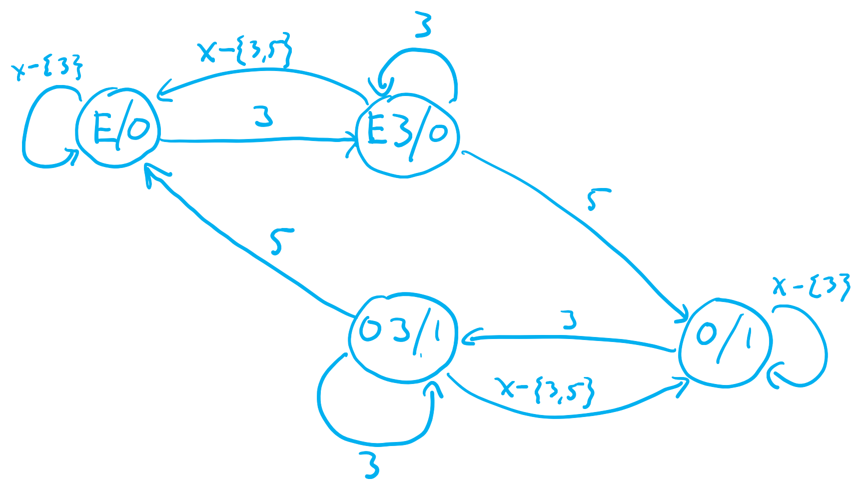
No new partitions

PS	x=a	x=b	x=c	x=d
A	EG,1	EG,0	EG,1	CH,0
B	D,0	EG,0	EG,0	F,1
CH	EG,1	EG,0	F,1	A,0
D	EG,1	EG,0	F,1	CH,0
EG	CH,0	EG,0	EG,0	F,1
F	CH,1	B,1	A,0	B,1

(c) (10 Points) Draw the state diagram for the simplified state table.



5. (10 Points) Consider a sequential system that has a input $x(t) \in \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$ and one bit as output $y(t) \in \{0, 1\}$. The output is one if the number of times the pattern 35 has occurred in x(0, t) is odd. Otherwise, the output is zero. Show the state diagram of the system.



6. (10 Points) Consider the following next-state table and corresponding output table below. The inputs are C and D; the outputs are R and M. NS presents the next state, and $S = (S_1, S_0)$ presents current state. Draw the state diagram of the system using binary coding specification. Note that the X's are don't cares.

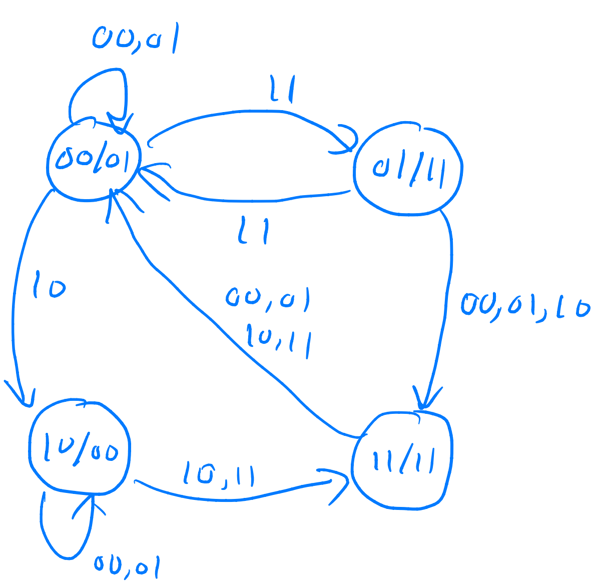
S_1	S_0	C	D	NS_1	NS_0
0	0	0	X	0	0
0	0	1	0	1	0
0	0	1	1	0	1
0	1	0	0	1	1
0	1	0	1	1	1
0	1	X	0	1	1
0	1	1	1	0	0
1	0	0	X	1	0
1	0	1	X	1	1
1	1	X	X	0	0

S_1	S_0	R	M
0	0	0	1
0	1	1	1
1	0	0	0
1	1	1	1

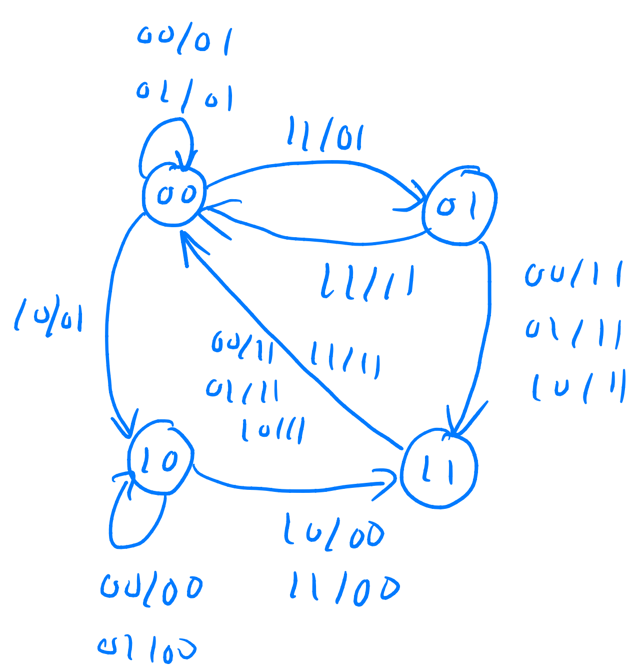
(CD)(Input)

(state) $(S_1 S_0)$	00	01	10	11
00	00, 01	00, 01	10, 01	01, 01
01	11, 11	11, 11	11, 11	00, 11
10	10, 00	10, 00	11, 00	11, 00
11	00, 11	00, 11	00, 11	00, 11

NS, (RM)



OR



7. Simplify the following state tables by reducing the state set as much as possible.

(a) (10 Points)

PS	Input $x=0$	$x=1$
a	$f, 0$	$b, 0$
b	$d, 0$	$c, 0$
c	$f, 0$	$e, 0$
d	$g, 1$	$a, 0$
e	$d, 0$	$c, 0$
f	$f, 1$	$b, 1$
g	$g, 0$	$h, 1$
h	$g, 1$	$a, 0$
	NS,z	

$P_1 = (a.b.c.e)(d.h)(f)(g)$

P_1	1 (a.b.c.e)				2 (d.h)		3 (f)	4 (g)
$x=0$	3	2	3	2	4	4		
$x=1$	1	1	1	1	1	1		

$\Rightarrow$

P_2	1 (a.c)		2 (b.e)		3 (d.h)		4 (f)	5 (g)
$x=0$	4	4	3	3	5	5		
$x=1$	2	2	1	1	1	1		

$P_2 = (a.c)(b.e)(d.h)(f)(g)$

$P_3 = \underbrace{(a.c)}_{S_0}\ \underbrace{(b.e)}_{S_1}\ \underbrace{(d.h)}_{S_2}\ \underbrace{(f)}_{S_3}\ \underbrace{(g)}_{S_4} = P_2$

Input

$\Rightarrow$

PS	$x=0$	$x=1$
S_0	$S_3, 0$	$S_1, 0$
S_1	$S_2, 0$	$S_0, 0$
S_2	$S_4, 1$	$S_0, 0$
S_3	$S_3, 1$	$S_1, 1$
S_4	$S_4, 0$	$S_2, 1$
	NS, output	

(b) (10 Points)

	Input			
PS	$x=a$	$x=b$	$x=c$	$x=d$
A	$E,1$	$C,0$	$B,1$	$E,1$
B	$C,0$	$F,1$	$E,1$	$B,0$
C	$B,1$	$A,0$	$D,1$	$F,1$
D	$G,0$	$F,1$	$E,1$	$B,0$
E	$C,0$	$F,1$	$D,1$	$E,0$
F	$C,1$	$F,1$	$D,0$	$H,0$
G	$D,1$	$A,0$	$B,1$	$F,1$
H	$B,1$	$C,0$	$E,1$	$F,1$
	NS,z			

$P_0 = (A,C,G,H)(B.D.E)(F)$

P_1	1 (A.C.G.H)	2 (B.D.E)	3 (F)
x=a	2 2 2 2	1 1 1	
x=b	1 1 1 1	3 3 3	
x=c	2 2 2 2	2 2 2	
x=d	2 3 3 3	2 2 2	

$P_2 = (A)(C.G.H)(B.D.E)(F)$

$\rightarrow$

P_2	1 (A)	2 (C.G.H)	3 (B.D.E)	4 (F)
x=a		3 3 3	2 2 2	
x=b		1 1 2	4 4 4	
x=c		3 3 3	3 3 3	
x=d		4 4 4	3 3 3	

$P_3 = (A)(C.G)(H)(B.D.E)(F)$

P_3	1 (A)	2 (C.G)	3 (H)	4 (B.D.E)	5 (F)
x=a		4 4		2 2 2	
x=b		1 1		5 5 5	
x=c		4 4		4 4 4	
x=d		5 5		4 4 4	

$\Rightarrow$

	Input			
PS	x=a	x=b	x=c	x=d
S_0	$S_3,1$	$S_1,0$	$S_3,1$	$S_3,1$
S_1	$S_3,1$	$S_0,0$	$S_3,1$	$S_4,1$
S_2	$S_3,1$	$S_1,0$	$S_3,1$	$S_4,1$
S_3	$S_1,0$	$S_4,1$	$S_3,1$	$S_3,0$
S_4	$S_1,1$	$S_4,1$	$S_3,0$	$S_2,0$
	NS, output			

$P_4 = \underbrace{(A)}_{S_0}\underbrace{(C.G)}_{S_1}\underbrace{(H)}_{S_2}\underbrace{(B.D.E)}_{S_3}\underbrace{(F)}_{S_4} = P_3$