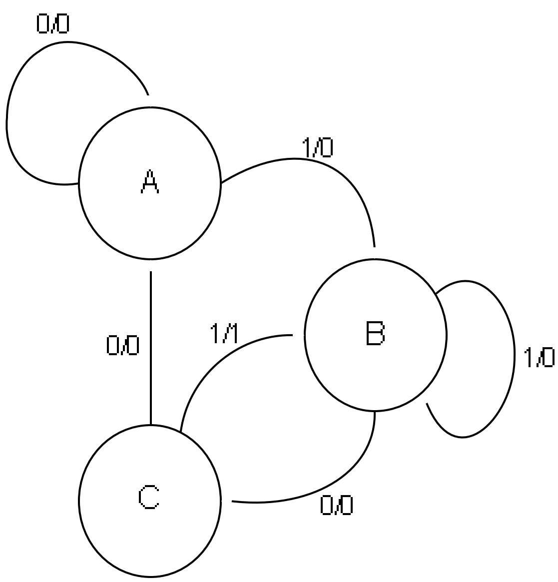
ECE/CS 314 Fall 2003 **Section 6**

State Machines

Problem:
Implement a 3-bit sequence recognizer that produces a high on its output bit when the bit sequence 101 is recognized. Assume that the input is a bit sequence entering from the left one bit at a time:

$b_n\ b_{n-1}\ \ldots\ b_2\ b_1\ b_0$? State Machine ? Output

Mealy Machine: outputs depend on both state and inputs (asynchronous output)



	S1	S0
A	0	0
B	0	1
C	1	0

On each arch, the label x/y means the input is x and the output is y.

Current State		Input	Next State		Output
S1	S0	I	S1'	S0'	Out
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	0	0
0	1	1	0	1	0
1	0	0	0	0	0
1	0	1	0	1	1
1	1	0	X	X	X
1	1	1	X	X	X

Espresso

Espresso is a logic minimization tool; it is installed on the machines in the CSL lab. To demonstrate it, use the truth table from above. Place the table in a text file as follows (Let's call it mealy.raw):

```
.i 3
.o 3
000 000
001 010
010 100
011 010
100 000
101 011
110 ---
111 ---
.e
```

Note that don't-cares are indicated as '-' rather than an 'x'.

You can run espresso on this file by executing:

```
espresso –s mealy.raw > mealy.red
```

The reduced truth table will be saved in mealy.red:

```
.i 3
.o 3
.p 4
-10 100
1-1 001
--1 010
.e
```

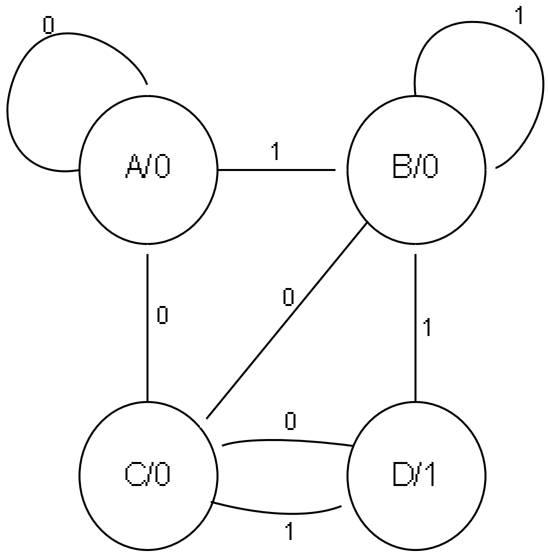
To extract the equations, look at each column on the right (output) side. A '1' indicates that the min-term on the left is included in the reduced equation. For example, the S1' column (1^{st} column on the right side) has '1's at the 1^{st} row (-10), which means that the min-terms is $S0 \cdot \underline{I}$.

The equations for the mealy machine are:

$S1' = S0 \cdot \underline{I}$
$S0' = I$
$Out = S1 \cdot I$

(Note: If an equation has more than one min-term, the result is just the "sum" of them)

Moore Machine: outputs depend only on states



	S1	S0
A	0	0
B	0	1
C	1	0
D	1	1

Note that in a Moore machine, the outputs are attached to the states, rather than the arcs.

Current State		Input	Next State		Output
S1	S0	I	S1’	S0’	Out
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	0	0
0	1	1	0	1	0
1	0	0	0	0	0
1	0	1	1	1	0
1	1	0	1	0	1
1	1	1	0	1	1

Using Espresso, the following reduced equations can be obtained:

$S1' = S1 \cdot \underline{S0} \cdot I + S0 \cdot \underline{I}$
$S0' = I$
$Out = S1 \cdot S0$