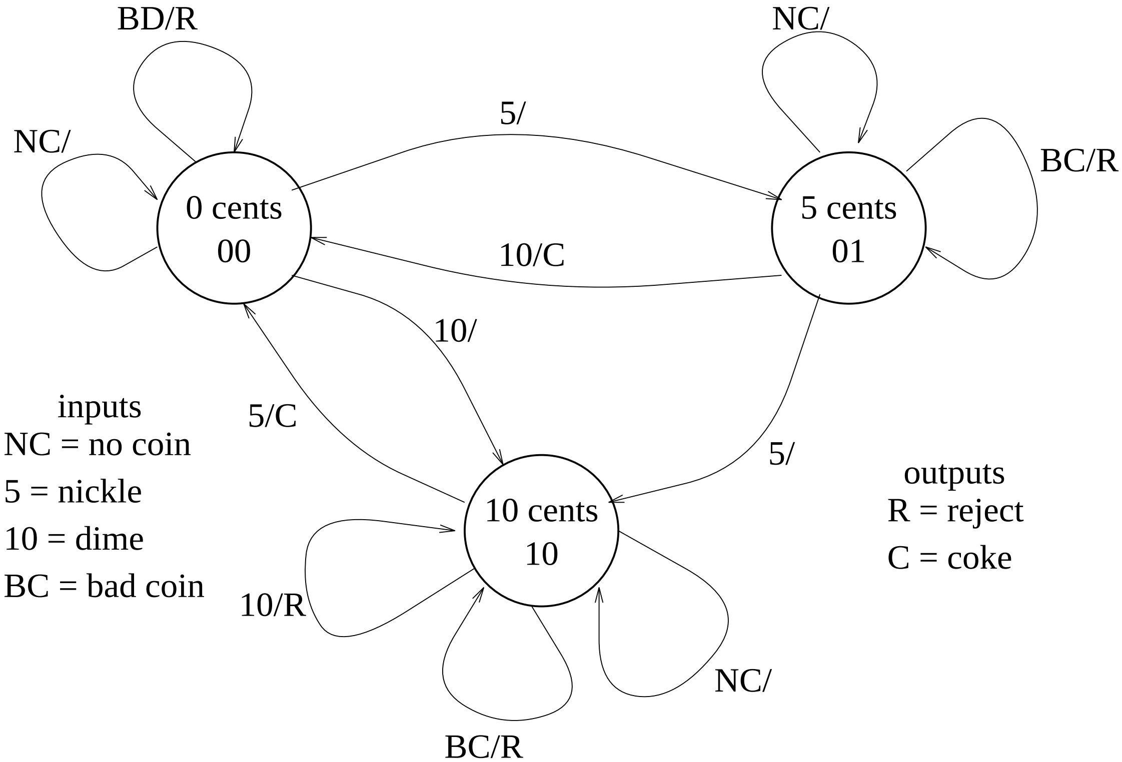
This section examples how to design and implement a simple state machine. First, a state diagram is constructed where edges represent states the machine can be in, and arcs represent transitions between edges. The arc labeling notation is *input/output* where *inputs* are the high inputs which cause the transition, and *outputs* are the high outputs during that transitions. Each state must have outgoing arcs representing each possible input combination.

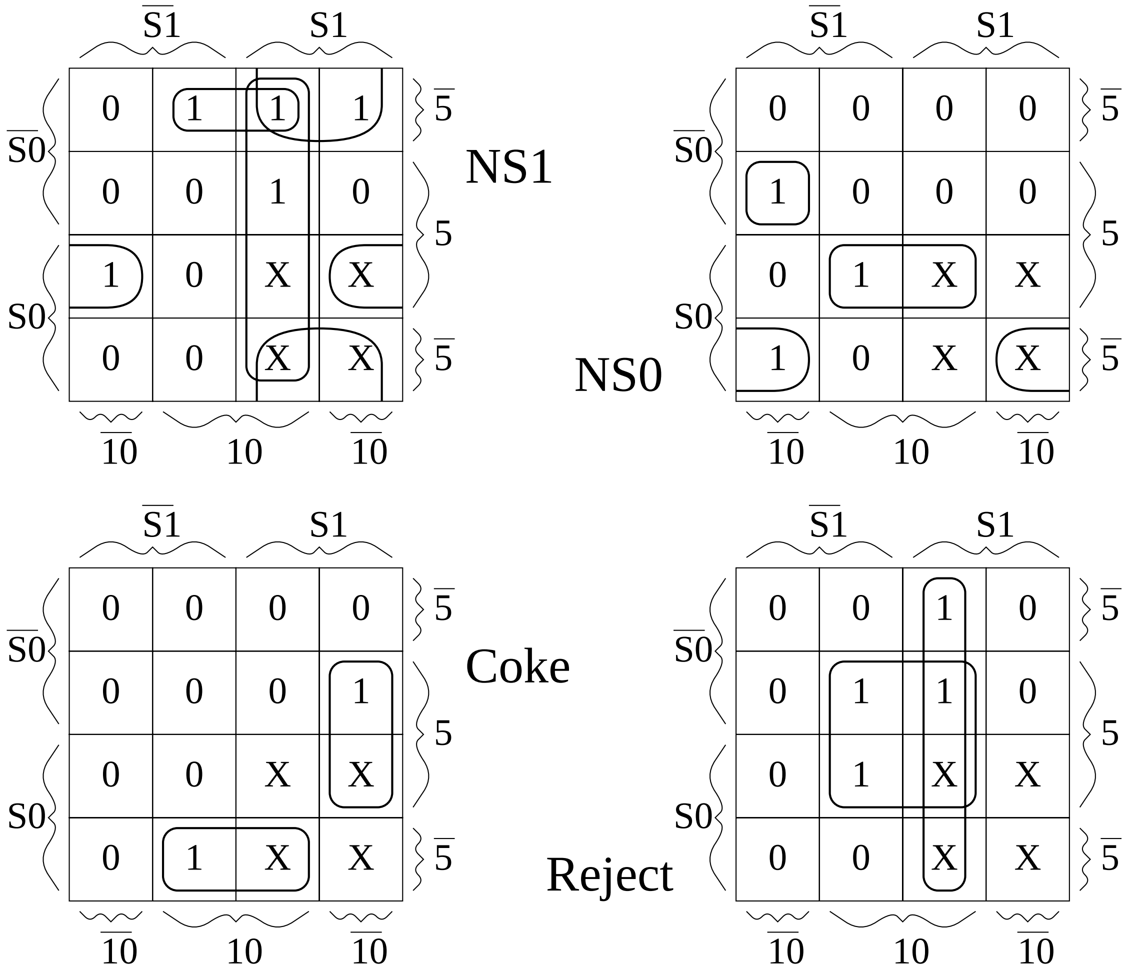
The state diagram for the 15 cent coke described in class is show below. This diagram is optimized in that the 15 cent state has been removed. A coke is dispensed as soon as the last coin is inserted.



The state digram is converted directly into a state table. First, each state is assigned a unique binary state (starting with zero). Then an entry is added to the state table for each arc in the state diagram. S_0 and S_1 represent the current state. NS_0 and NS_1 represent the next state. If there are N states in a state diagram, the will be $log_2(N)$ state variables (state bits). Since the state 11 is not used (and disallowed) the outputs in this state are don't cared.

S_1	S_0	10	5	NS_1	NS_0	Coke	Reject
0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0
0	0	1	0	1	0	0	0
0	0	1	1	0	0	0	1
0	1	0	0	0	1	0	0
0	1	0	1	1	0	0	0
0	1	1	0	0	0	1	0
0	1	1	1	0	1	0	1
1	0	0	0	1	0	0	0
1	0	0	1	0	0	1	0
1	0	1	0	1	0	0	1
1	0	1	1	1	0	0	1
1	1	X	X	X	X	X	X

From this state table, simplified expressions can be generated for each output using a simplification technique like Karnaugh maps.



$$NS_1 = S_1\,10 + S_1\,\overline{5} + \overline{S_0}\,\overline{5}\,10 + S_0\,5\,\overline{10}$$

$$NS_0 = S_0\,5\,10 + S_0\,\overline{5}\,\overline{10} + \overline{S_0}\,\overline{S_1}\,5\,\overline{10}$$

$$Coke = S_1\,5\,\overline{10} + S_0\,\overline{5}\,10$$

$$Reject = 5\,10 + S_1\,10$$

These simplified expressions can be implemented directly using mixed logic. The final schematic combines this logic (included in the combination logic box below) with two register cells to form the state machine.