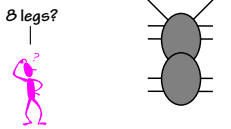
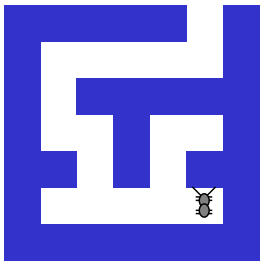
Lets build an *Ant*



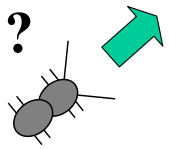
- SENSORS: antennae L and R, each 1 if in contact with something.
- ACTUATORS: Forward Step F, ten-degree turns TL and TR (left, right).

GOAL: Make our ant smart enough to get out of a maze like:

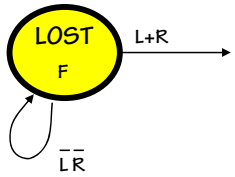


STRATEGY: "Right antenna to the wall"

Lost in space

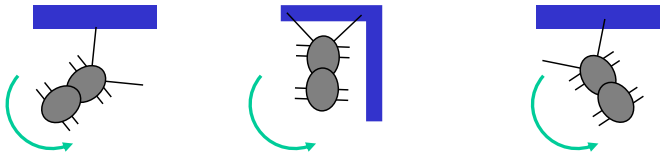


Action: Go forward until we hit something.

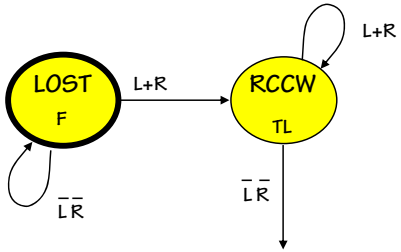


"lost" is the initial state

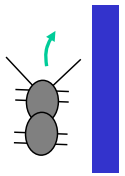
Bonk!



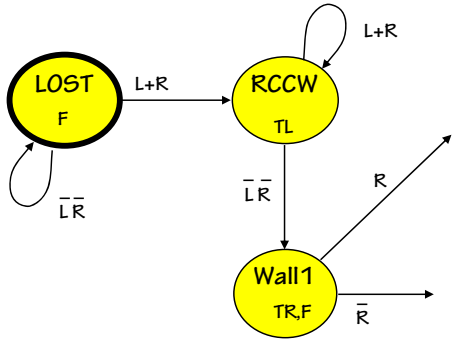
Action: Turn left (CCW) until we don't touch anymore



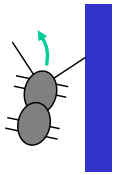
A little to the right…



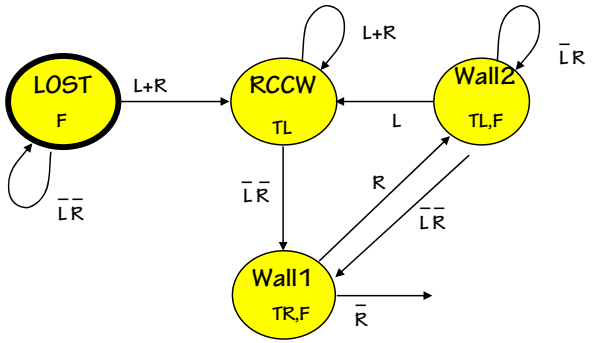
Action: Step and turn right a little, look for wall



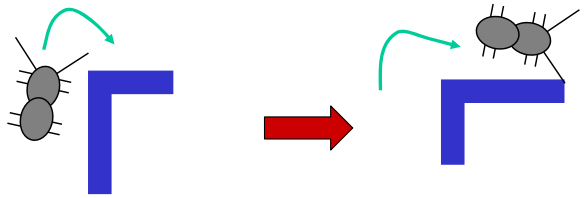
Then a little to the left



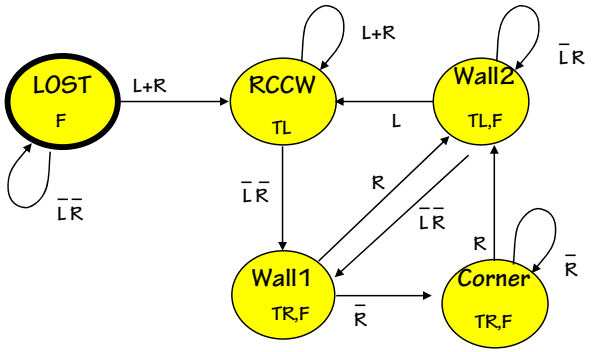
Action: Step and turn left a little, till not touching (again)



Dealing with corners



Action: Step and turn right until we hit perpendicular wall



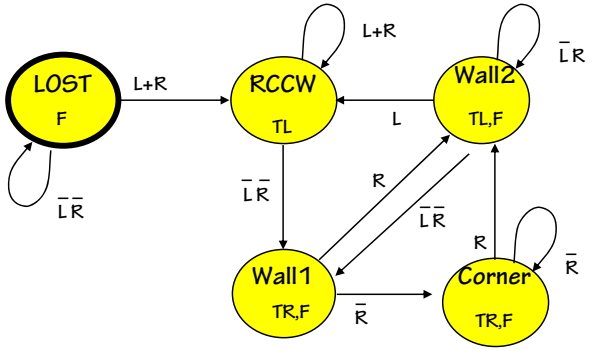
Equivalent State Reduction

Observation: $S_i \equiv S_j$ if

1. States have identical outputs; AND
2. Every input → equivalent states.

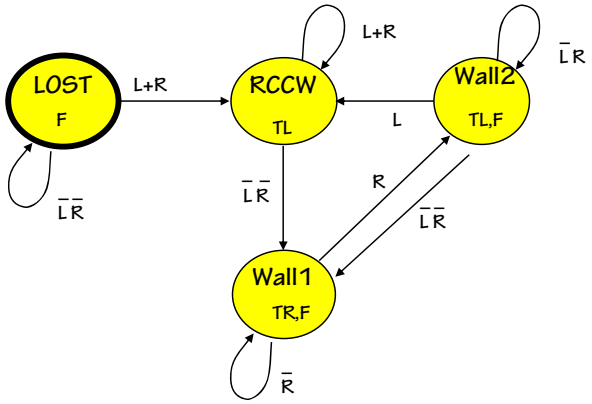
Reduction Strategy:

Find pairs of equivalent states, MERGE them.



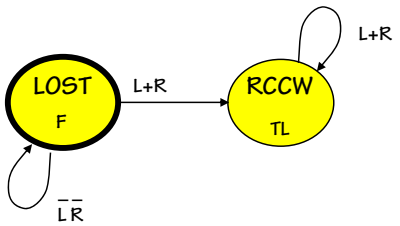
An Evolutionary Step

Merge equivalent states Wall1 and Corner into a single new, combined state.



Behaves exactly as previous (5-state) FSM, but requires half the ROM in its implementation!

Building the Transition Table



S	L	R	S'	TR	TL	F
00	0	0	00	0	0	1
00	1	-	01	0	0	1
00	0	1	01	0	0	1
01	1	-	01	0	1	0
01	0	1	01	0	1	0

Implementation Details

	S	L	R	S'	TR	TL	F
LOST	00	0	0	00	0	0	1
	00	1	-	01	0	0	1
	00	0	1	01	0	0	1
RCCW	01	1	-	01	0	1	0
	01	0	1	01	0	1	0
	01	0	0	10	0	1	0
WALL1	10	-	0	10	1	0	1
	10	-	1	11	1	0	1
	11	1	-	01	0	1	1
WALL2	11	0	0	10	0	1	1
	11	0	1	11	0	1	1

Complete Transition table

S1′

LR \ S_1S_0	00	01	11	10
00	0	1	1	1
01	0	0	1	1
11	0	0	0	1
10	0	0	0	1

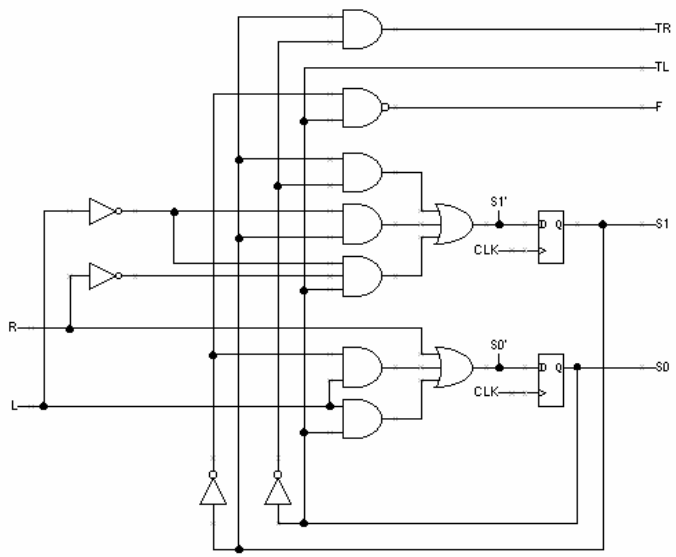
$$S_1' = S_1\overline{S_0} + \overline{L}S_1 + \overline{L}\,\overline{R}S_0$$

S0′

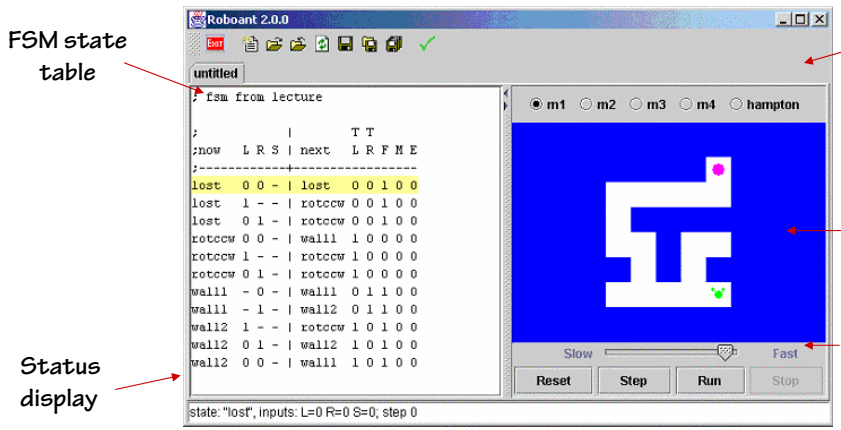
LR \ S_1S_0	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	1	1	1	1
10	1	1	1	0

$$S_0' = R + L\overline{S_1} + LS_0$$

Ant Schematic



Roboant®



Featuring the new Mark-II ant: can add (M), erase (E), and sense (S) marks along its path.