

10.009 The Digital World

Term 3. 2016

Problem Set 9 - Part I (for Week 9)

Last update: January 5, 2016

Due dates:

- **Problems: Cohort sessions:** Following week: Monday 11:59pm.
- **Problems: Homework:** Same as for the cohort session problems.
- **Problems: Exercises:** These are practice problems and will not be graded. You are encouraged to solve these to enhance your programming skills. Being able to solve these problems will likely help you prepare for the midterm examination.

Objectives:

1. Create state machines from given state diagrams of time step tables.
2. Use SM class to run state machine.
3. Draw state diagrams.

Note: Solve the programming problems listed below using the IDLE or Canopy editor. Make sure you save your programs in files with suitably chosen names and in an newly created directory. In each problem find out a way to test the correctness of your program. After writing each program, test it, debug it if the program is incorrect, correct it, and repeat this process until you have a fully working program. Show your working program to one of the cohort instructors.

Note: This handout only contains the questions for Problem Set 9 - Part I. Questions for Problem Set 9 - Part II can be found in Tutor.

Problems: Cohort sessions

1. *State Machine: Coke:* In this problem you will implement in Python the behavior of a simplified coke dispensing machine. The behavior of such a machine is captured in the state diagram shown in Figure 1. The machine consists of two states labeled 0 and 1. Note that the state diagram does not show what the machine would do if an unexpected coin is inserted. Assume that any unexpected coin is returned to the user without a change in the machines state.

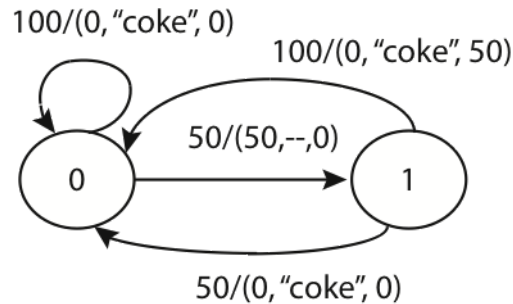


Figure 1: State diagram for a simple coke dispenser machine.

Each directed arc in the state diagram is labeled as x/y where x denotes the input received and y the output generated. For example, the arc that connects state 0 to state 1 and labeled $50/(50, --, 0)$ means that when the dispenser receives 50¢ (50 before the /) in state 0 it moves to state 1 and generates an output of $(50, --, 0)$. This triple of values in the output indicates that the dispenser display shows 50 which is the amount entered by the user, no coke has been dispensed yet as indicated by $--$, and no change has been returned to the user as indicated by the last entry which is a 0.

The machine accepts only 50¢ and dollar (100¢) coins. It has a display that shows how many cents have been entered.

- State 0: When a 50¢ coin is deposited the dispenser moves to state 1. At this time the display shows 50 but nothing is dispensed and no change is returned. If a dollar coin is deposited the machine continues to display 0, dispenses coke, and does not return any money (well, why should it!).
- State 1: When a 50¢ coin is deposited the dispenser moves to state 0. At this time the display shows 0, coke is dispensed and no change is returned. If a dollar coin is deposited the machine continues to display 0, dispenses coke, and returns 50¢.

Python program: We wish to write a Python program that simulates the behavior of the coke dispenser as described above. We will write a class named CM that contains

environment variables (attributes) and functions as described below.

- CM class is a subclass of sm.SM class, which is part of libdw.
- CM class has a class attribute called **startState** which is the starting state of the machine. This attribute should be initialized to 0.
- CM class has a method named getNextValues(self, state, inp) that takes in the current state and the input, and returns the next state and output as a tuple.

Sample interaction:

```
>>>
>>> c=CM()
>>> c.start()
>>> c.step(50)
(50, '--', 0)
>>> c.step(50)
(0, 'coke', 0)
>>> c.step(100)
(0, 'coke', 0)
>>> c.step(10)
(0, '--', 10)
>>> c.step(50)
(50, '--', 0)
>>> c.step(100)
(0, 'coke', 50)
>>> c.step(10)
(0, '--', 10)
```

Submission to Tutor: Please submit your entire class with the startState and the getNextValues defined.

2. Checkoff: Show your state diagram to an instructor to get a checkoff point

- (a) Draw a state diagram that does the following things:
 - i. Moves the robot forward until its front sensor detects a wall.
 - ii. Once the front sensor detects a wall, wait for 15 sec.
 - iii. After 15 sec, the robot turns 180 deg.
 - iv. After the robot turns 180 deg, the robot moves forward and repeats Step 1.

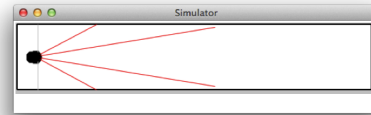


Figure 2: Robot should move forward, detect wall, wait, turn around, and move again.

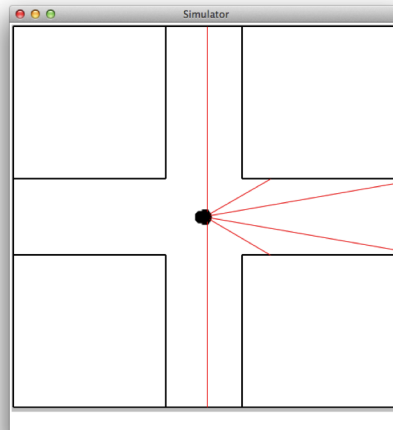


Figure 3: Robot should move forward, detect wall, wait, turn around, and move again. When it is at the junction, the robot should always turn to its right.

(b) Draw a state diagram that does the following things:

- i. Moves the robot forward until its front sensor detects a wall.
- ii. Once the front sensor detects a wall, wait for 15 sec.
- iii. After 15 sec, the robot turns 180 deg.
- iv. After the robot turns 180 deg, the robot moves forward until it senses a junction.
- v. When it senses a junction, the robot turns right and enter the alley on its right.
- vi. When it is inside the alley, the robot moves forward and repeats Step 1.

Access Tutor for the rest of the Problem Set 9.