CS 520 Final: Question 1 - Localization

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a) You are somewhere in the above maze, with no prior knowledge. What is the probability you are at G?

For the given maze, there are 695 white cells which robot can be drooped in. We have 1/695 probability to drop the robot at any of these white cells. So the probability the robot starts at position G is also 1/695.

b) Argue that there is a finite sequence of moves that without knowing where you start, and without any feedback on your moves will result in you ending at location G with complete probability/certainty. Hint: What if you knew you started either at the top left or bottom right corner, but didn't know which?

We see that there is not a closed area in the given maze. The every point can be reached from G, so there every point can reach the G no matter where the robot start at. Therefore, there must be a finite move sequence of moves can make the me arrive the G without knowing where I start.

c) How could you find such a sequence? How could a computer find such a sequence?

Even we get any feedback on our moves if move into a wall, we still can move to reach the wall. When reached the wall, we still can make a move to the direction of wall, but our position do not change. The sequence I find is that we can apply a sequence of moves to make sure we can get out of the inner box first, then move out from the middle box. After that we can try move to right bottom corner, and then move to the G with a direct move sequence.

Computer can find such a sequence by implement the move from above.

d) Write an algorithm to find the shortest sequence of moves you can to reach G independent of where you begin and without feedback. Describe your algorithm in detail, including any design choices you made. What is the sequence of moves?

For the given maze, I find out there is a move sequence can help reach the position G. I want move the robot to the bottom right corner no matter where it start at. To do this, I need to move the robot out of the inner box, then middle box of each pattern(There are

obvious 9 nested boxes in the maze).
1) I move right 3 times(make sure it reach the wall), then move down 3 times, move left 1 time and move down 2 times. This step make sure move the robot out of inner box.
2) After that, I move down 6 times, move right 6 times, move up 6 times, move left 3 times and move up 2 times. This step make sure robot out of middle box.
Now, I need to move the robot to the bottom right corner
4) Move down 35 times, move right 35 times, move down 35 times.
5) Move left 10 times, move down 35 times, move right 35 times.
6) Move up 10 times, move right 35 times, move down 35 times.
Finally, the robot is certainly at bottom right corner. Then we can use a fixed and direct a move sequence to move the robot to the G. When robot reached the G, we can backtrack every step that the position of robot is truly changed, then we will get the shortest move sequence.

e) Suppose that after each move, you receive an observation / feedback of the form Yt = the number of blocked cells surrounding your location. Let Y0 be the number of blocked cells surrounding your starting location. Again, you get no feedback if the move was successful or not, simply the number of blocked cells surrounding your current location.

e.1) You initially observe that you are surrounded by 5 blocked cells. You attempt to move LEFT. You are surrounded by 5 blocked cells. You attempt to move LEFT. You are surrounded by 5 blocked cells. Indicate, for each cell, the final probability of you being in that cell.

The probabilities of I being one of following cells is $\frac{1}{69}$. (1, 7), (1, 19), (1, 31), (2, 1), (3, 6), (3, 7), (3, 8), (3, 18), (3, 19), (3, 20), (3, 30), (3, 31), (3, 32), (9, 6), (9, 7), (9, 8), (9, 18), (9, 19), (9, 20), (9, 30), (9, 31), (9, 32), (10, 1), (13, 7), (13, 19), (13, 31), (14, 1), (15, 6), (15, 7), (15, 8), (15, 18), (15, 19), (15, 20), (15, 30), (15, 31), (15, 32), (21, 6), (21, 7), (21, 8), (21, 18), (21, 19), (21, 20), (21, 30), (21, 31), (21, 32), (22, 1), (25, 7), (25, 19), (25, 31), (26, 1), (27, 6), (27, 7), (27, 8), (27, 18), (27, 19), (27, 20), (27, 30), (27, 31), (27, 32), (33, 6), (33, 7), (33, 8), (33, 18), (33, 19), (33, 20), (33, 30), (33, 31), (33, 32), (34, 1). The probabilities of I being one of remain cells are 0.

e.2) Write an algorithm to take a sequence of observationsY0,Y1,...,Yn and a sequence of actionsA0,A1,...,An1 and returns the cell you are most likely to be in.

The algorithm is like that I take an observation first. Then go back to the maze extract all cells that satisfy that observation. I randomly choose a direction to move and record that move. I take an observation again. I apply the move on each cells I extracted, and check again to see which cell can satisfy my second observation. I eliminate the cells that does not satisfy the observation. I keep doing this until there is only one cell left. Finally, that cell is that I most likely to be in.