CS 520 Final: Question 1 - Localization

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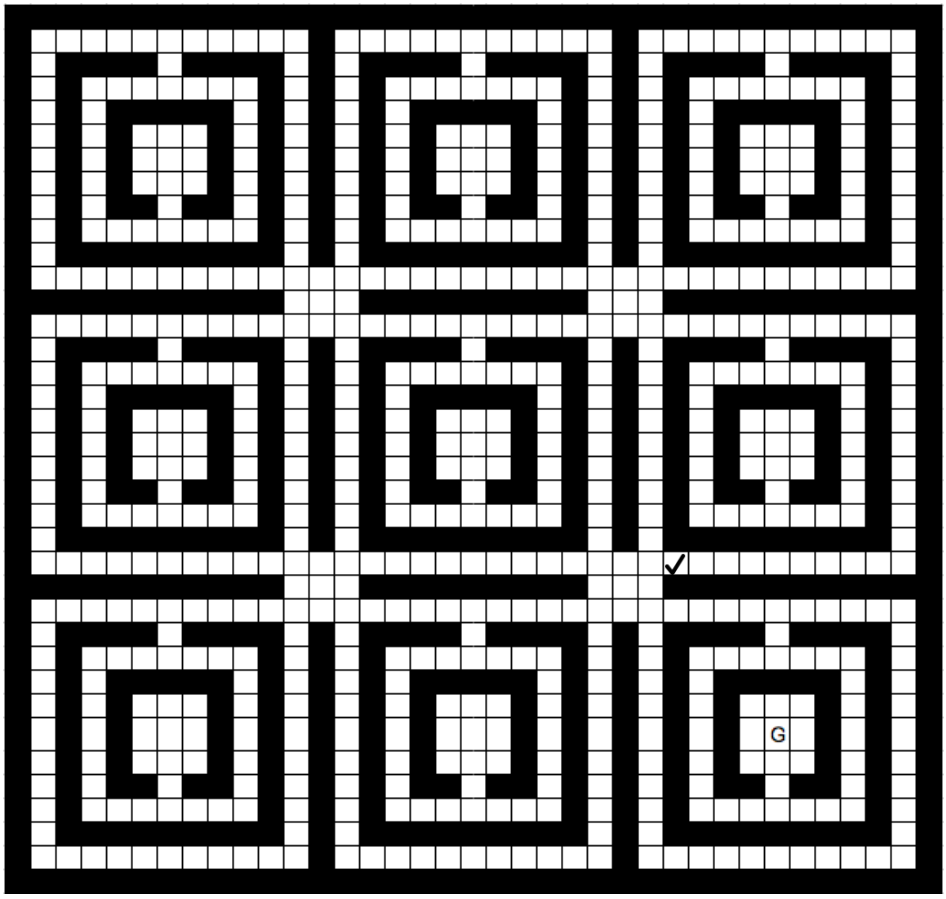
You cannot be graded on what you don't write down. This problem is to be completed individually, without any coordination with others. Complete each question to the best of your ability. If you write code to solve one of the problems, you must submit that code along with your final answers. Explain your process and algorithms. Be explicit. Answers, without evidence of the thought and process that led to them, will not earn credit.



You are a **MazeSolvingBot**, dropped into the above maze. Unfortunately, while your motors are still functional (and you can tell which direction is north), your sensors are completely inoperable - you are effectively completely blind, and can't even tell if you are running into a wall. All you have available to you (as a knowledge base) is the above map. You are free to move between adjacent white cells (up/down/left/right) but black cells are blocked - and you get no feedback whether the move was successful or not.

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

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?*

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

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?

e) Suppose that after each move, you receive an observation / feedback of the form $Y_t =$ **the number of blocked cells surrounding your location**. Let Y_0 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.

e.2) Write an algorithm to take a sequence of observations $\{Y_0, Y_1, \ldots, Y_n\}$ and a sequence of actions $\{A_0, A_1, \ldots, A_{n-1}\}$ and returns the cell you are most likely to be in.

Bonus: G was chosen arbitrarily. In the no-feedback case, if you want to determine where you are as efficiently as possible, what square should you try to get to, and what moves should you take to get there?