Minesweeper Final AI Report

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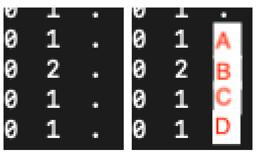
I. Minimal AI

I.A. Briefly describe your Minimal AI algorithm. What did you do that was fun, clever, or creative?

We categorize tiles into two types: solved and unsolved, which means the tile whos neighboring tiles are all uncovered or not, respectively. Once we perceive a clue after uncovering, we check if we can uncover its neighboring tiles and mark it as solved or unsolved tile. We also rescan all the unsolved tiles to see if we can now solve them.

Sometime this algorithm stucks when all the unsolved tiles can no longer be solved. In such situation, we solve it by an interesting algebra method. First we given all unopened tiles variables.



The tile 2 indicates that there are two mines out of tiles A, B, and C. The tile 1 below 2 indicates that there is a mine out of tiles B, C, and D, and so on. So we have those equations:

(1) $A + B + C \quad\quad = 2$

(2) $\quad\quad B + C + D = 1$

(3) $\quad\quad\quad\quad C + D = 1$

By subtracting eq (2) by eq (3), we get $B = 0$, which indicates B is safe to uncover.

By subtracting eq (1) by eq (3), we get $A + B - D = 1$, because we already know $B = 0$ so it becomes $A - D = 1$. Note that $A - D = 1$ equals to $A = 1 \; and \; D = 0$ because all variables are either 0 or 1.

Afterward, we can solve eq (3) and get $C = 1$ using the knowledge of D.

So finally we get $A = 1,\ B = 0,\ C = 1,\ D = 0$, which means both A and C are mines.

We keep solving the equations to get the right moves until all unsolved tiles become solved.

I.B Describe your Minimal AI algorithm's performance:

Board Size	Sample Size	Score	Worlds Complete
5x5	1000	1000	1000
8x8	1000	663	663
16x16	1000	1284	642
16x30	1000	345	115
Total Summary	4000	3292	2420

II. Final AI

II.A. Briefly describe your Final AI algorithm, focusing mainly on the changes since Minimal AI:

We implemented a probability function to predict whether an uncovered block is a mine or not. An opened block provides information of numbers of mines in its neighborhood. Therefore, we utilized the below equation to calculate the probability.

$$P(\textit{unopened block is a mine}) = \frac{\textit{total number of neighboring mines} - \textit{discovered mines}}{\#\ \textit{of unopened neighbor}}$$

We compared all the unopened block and opened the block with lowest chance to be a mine. An unopened block can also have more than one clue from its opened neighbors. If the situation occurred, we assigned the maximum probability to the unopened block. After comparing to all the unopened blocks' probabilities, the program will uncovered the block with lowest chance to be a mine.

Aside from probability function, we also added additional clue to solve the matrix when the remaining unopened tiles are congregated together. In this scenario, we introduced an equation to help us to solve the matrix. We set all the remaining unopened tiles as one and set the equation equals to the number of undiscovered mine left. This additional condition provides us key information when we are in a delima like below:

Eq #	A	B	C	D	E	# of mines
1	0	1	0	0	1	1
2	1	1	0	1	0	1
3	1	1	1	1	1	1

If we had equations of 1 and 2, we would not have enough clues to solve all 5 tiles. However, knowing there's only one mine left in all five tiles, we could obtain that B is the mine with a bit of algebra manipulations.

II.B Describe your Final AI algorithm's performance:

Board Size	Sample Size	Score	Worlds Complete
5x5	1000	1000	1000
8x8	1000	789	789
16x16	1000	1510	755
16x30	1000	513	171
Total Summary	4000	3812	2751

III. In about 1/4 page of text or less, provide suggestions for improving this project (*this section does __NOT__ count as past of your two-page total limit.*)

Originally our team wanted to use proposition to solve the minesweeper project, since it was taught in the class. However, we had difficulty to convert resolution into actual code. We felt it would be really beneficial if the lecture would cover how to implement proposition and resolution in coding format.