5. **For this problem you will implement several agent types in a variant of the "vacuum world" described in our text/lecture.**

Consider a 3x3 grid for the vacuum world environment. The agent can go up, down, left right, suck or do nothing. Randomize the starting location of the robot, the number of rooms with dirt piles (let's say in separate cases: 1, 3 and 5 piles initially, respectively), as well as the locations of the dirt piles. Report results for the following types of agents:

(i) **A simple reflex agent (in this case define a "rule table" based on the location/dirt present – just as in the book); in this case you can just make up a rule for where the robot moves next, according to its current location. Please note that the "where to move next" rule is only based on the current percept and should be fixed by the rule table (which is to say we don't actively "learn" a movement strategy).**

(ii) **A randomized agent (movement and suck/no suck are randomized). Describe explicitly how you randomize the agent.**

(iii) **Apply murphy's law with the same environment for a reflex agent. Murphy's law: 25% of the time the suck action fails to clean the floor if it is dirty and deposits dirt onto the floor if the floor is clean; suppose also that the "dirt sensor" give the wrong answer 10% of the time.**

(iv) **Apply murphy's law conditions (as in iii) for a randomized agent.**

For each agent, the performance measure I used was based on the number of actions taken, including moves and sucking (or failing to suck and dumping). A lower number of moves indicates a better performance.

My simple reflex agent for part (i) did fairly well. I initially had a hard time figuring out a rule that would guarantee the agent would touch each square at least once. This was because the starting position of the agent is randomized. In order to get around this, I made it so the agent went clockwise around the edge, but when the agent was on square (0,1), directly to the left of the center, it would have a 50% change to go right into the center and a 50% change to go up to the corner. This ultimately slowed down the run time because it would occasionally move back and forth between the side and the center, but this allowed for the guarantee that it would reach every square eventually. It had an average of 6.3, 12.5, and 16.7 moves for 1, 3, and 5 piles respectively.

The randomized agent for part (ii) performed far worse than the agent in (i) which was to be expected. I randomized it by selecting a random integer between 0 and 4, inclusive, and it attempted to take an action specified by the integer (0-3 for the directions, and 4 for suck). If it couldn't go in a direction, it would choose another integer but not register an action. Since the sucking/not-sucking was supposed to be randomized as well, if it chose 4, it would suck regardless of its position and register an action. It had an average of 47.1, 87.4, and 109.8 moves for the 1, 3, and 5 pile environments respectively.

The agent in part (iii) that had to deal with Murphy's law was fun to watch. There is not much more to explain about this one except that I verified that it was working correctly through displaying the grid. It had an average of 8.8, 17.6, and 23.7 moves for the 1, 3, and 5 pile environments respectively.

The agent in part (iv) that was random as well as prone to error was obviously worse than the simply random agent. I set the maximum number of actions at 500 to make sure it wouldn't run infinitely. I was surprised

that it completed the task at all. It had an average of 190.2, 278.1, and 305.6 moves for the 1, 3, and 5 pile environments respectively.

Admittedly, I jumped the gun on filling this table out before reading that the suggested number of runs was about 100. I was playing around with the run count and was still seeing large variations at 100 runs. So, after **100,000** runs of each agent in each number of starting piles, here are the average performance scores in average actions per run.

Agent Type/Initial dirt piles	1 pile (avg moves taken)	3 piles (avg moves taken)	5 piles (avg moves taken)
(i)	6.328	12.485	16.693
(ii)	47.104	87.440	109.789
(iii)	8.756	17.643	23.699
(iv)	190.238	278.097	305.577