Hidden Markov Model

# Part 1 Implementation

To begin implementation, we must discuss the problem at hand, and design the Markov Model that fits the problem. We are tasked with making a model of a robot moving within a block-world. Let us first define how the hidden ‘true’ states of the robots, which represent the location of the robot within the grid. Our prompt indicates the map of the grid, and says that the robot moves to one of its four neighbors chosen uniformly at random. We can illustrate the transition of the states, then:



In this example illustration, the probability of moving from one state to the next is uniformly .25 to each of its 4 neighbors. We also consider the states in which there is an obstacle on the one of its directions. Since its transition leading out of the node must equal 1, our uniform distribution adjusts to .333 per edge, and .5 for nodes with 2 obstacles within its path.

Let us now attempt to model the observation states, x. We know that for every true distance d, the observed measurement is taken at a uniform interval of [0.7d, 1.3d] with one decimal place. Let us take an example if the robot is in the location (2,2) *even though it’s not possible in our grid* and is attempting to measure the tower at the location of 0,0. We can calculate the true distance: . This means that the range of possible noisy measurements are: [0.7 \* 2.828, 1.3 \* 2.828] = [1.5, 3.6], thus our possible observation for this location to the tower, and their respective likelihood are:



Where 0.045 is because there are 22 possible states, thus 1/22 = 0.045. To illustrate this, we can also show the graph as such:



Now, of course, every observation is of 4 towers, not just one. However, since each measurement’s noise function is independent, we can calculate the possibility of each tower individually. To combine all the towers, the probability of that observation, then, is the multiplication of probability of each independent noisy reading.

For example, if we were at the location of (2,2) and our recordings were (2.2, 7.1, 9.9, 7.5), and the probabilities of each readings were: , then the probability of that specific observation for the hidden state is the multiplication of all probabilities: .

# Part 2 Software FamiliarizatioN

# Application