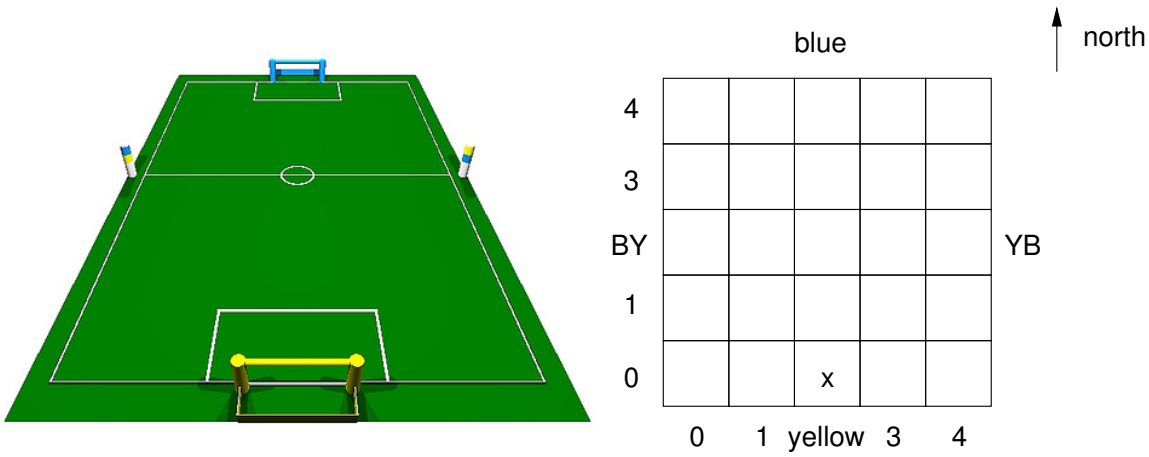
CISC 3415 Fall 2011, Homework 4

For this homework we will walk through the calculations of one of the probabilistic localization algorithms we covered in class. All the questions are set in the context of a robot that is playing soccer on the field in Figure 1(a) (rather like the RoboCup soccer field I showed you in the last class).



(a) The soccer field

(b) A map of the field

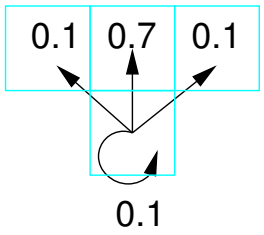
Figure 1: Two views of the environment.

For the purposes of localization, we will use a map as in Figure 1(b). We know that the robot starts in the square with coordinates $(2, 0)$ (marked by an x in Figure 1(b)).

1. As mentioned above, the robot starts in $(2, 0)$, and it is facing north, that is facing the blue goal. For simplicity we will assume that the robot never changes direction — however it moves, it is always facing north.

   This initial information means that the robot has a probability of 1 of being in square $(2, 0)$ and zero probability of being in any other square.

   The robot then tries to move one square forward. The motion model that describes its movement is the following:



   meaning that if it tries to move one square north from square (x, y) it has a probability of 0.7 of being in square $(x, y+1)$, a probability of 0.1 of being in square $(x+1, y+1)$, a probability of 0.1 of being in square $(x-1, y+1)$, and a probability of 0.1 of being in square (x, y).

   After the robot moves, what does it know about its position?

   Hint: this knowledge will be in the form of a probability distribution — the robot will has some probability of being in a number of different squares.

(25 points)

2. The robot then tries to move one more square forward. After this second movement, what does the robot know about its position?

   (25 points)

3. The robot then uses its camera to obtain some information about its environment. In particular, the robot observes the YB beacon at a distance of 2 squares.

   The sensor model for the beacon detection algorithm is described by the following probability distribution:

	1	2	3
$P(d_t\|2)$	0.2	0.6	0.2

   meaning that the probability of the robot really being 1 (or 3) squares away from the beacon is 0.2, and the probability of it being 2 squares away is 0.6.

   What does the robot know about its position after it updates with the observation of the YB beacon?

   Hint: again what the robot knows will be in the form of a probability distribution.

   Hint: a distance of one square in terms of the sensor model is one in any direction, not including including diagonal movement. Thus $(4, 2)$ is one square from the YB beacon, while $(3, 2)$ is 2 squares away and $(3, 1)$ is 3 squares away.

   (25 points)

4. Given your answers to the previous questions, comment on how effectively you think the robot is able to determine where it is. How might localization for the robot be improved?

   (25 points)