CSC 445, Spring 2018, Assignment 7

Purpose: Discrete Bayes Filter

Due: 4:30pm, Thursday, May 3, 2018

Program: Discrete Bayes Filter

The goal of this assignment is to implement a discrete Bayes filter. The filter will update a robot's belief based on an uncertain state transition model. The environment is a bounded one dimensional array of cells. The robot has two possible actions at a given time step: move left or move right. However, the motion of the robot is subject to error. When the robot executes a right move, the following may occur:

- There is a 25% chance that the robot does not move.
- There is a 50% chance that the robot moves right one cell.
- There is a 25% chance that the robot moves right two cells.

The same model is used when the robot moves left. Since, the environment is bounded, the motion model changes when the robot approaches a boundary:

- If the robot is located at the last cell and executes a right move, then there is a 100% chance that the robot stays in that cell.
- If the robot is located at the second to the last cell and executes a right move, there is a 25% chance that the robot stays in the same cell and a 75% chance that the robot moves to the last cell.

Again, the same model is used when the robot moves left.

Create a Python script named `assignment7.py` that does the following:

1. Define a function with the signature

   ```
   def discrete_filter(bel, direction):
   ```

   where `bel` is the belief of the robot's cell location from the previous time step and `direction` is direction of travel: 1 for right and -1 for left. The return result is the updated belief.

2. Write code that calls the `discrete_filter` function to update the robot's belief over a number of motion commands. The environment must be twenty cells and the robot is initially positioned on the eleventh cell. Plot the estimated state after the robot performs nine consecutive right moves followed by three consecutive left moves.

   Note: You can check your implementation by ensuring that the belief sums to one (within the precision error of floating point numbers.)

Algorithm

function DISCRETE BAYES FILTER($\{p_{k,t-1}\}, u_t, z_t$)
  for all k **do**
    $\overline{p}_{k,t} = \sum_i p(X_t = x_k \mid u_t, X_{t-1} = x_i) p_{i,t-1}$
    $p_{k,t} = \eta p(z_t \mid X_t = x_k) \overline{p}(k,t)$
  return $\{p_{k,t}\}$

Grading Criteria

This assignment is required for graduate students. An undergraduate who chooses to complete this assignment can replace the lowest graded assignment with the grade from this assignment if it is higher.

Turning in the Assignment

Submit the `assignment7.py` file to the appropriate folder on D2L.