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CS416: AI and Robotics

Final Project: Hidden Markov Models in VREP

For my final project, I expanded on our original two bubbleRob simulations in VREP to represent the use of the Hidden Markov Model in decision making. As a real-world application, when self-driving vehicles are moving, they will come across obstacles ahead of them with their sensors. In response, they will need a method of determining their next action. The purpose of my project is to simulate a vehicle responding to its sensors detecting obstacles and using the probabilities returned from a Hidden Markov Model algorithm to decide on what the obstacle ahead probably is.

In my simulation, there are several silver bubbleRobs around the simulation one a black path. These bubbleRobs have three visual sensors pointed at the ground. Using the feedback of the black path and the two leftmost and rightmost sensors, these bubbleRobs follow their paths and increase or decrease speeds on sides that detect the path. Because they are on the path, if they come across something in their path it will probably be another bubbleRob, so they are set to stop for a set amount of time before continuing. These bubbleRobs do not involve Hidden Markov Models, but are present to be a moving obstacle to the main bubbleRob.

The main bubbleRob is bubbleRob#0, recognizable as is it is the only bright red bubbleRob. This red bubbleRob always tries to move forward as long as it does not detect something in front of it. When red bubbleRob detects something it first switched to a “stopped” state and begin the decision-making process. I have included a hiddenMarkovModel() method which takes in a two dimensional table, nextState_Observation, representing a table of sensor results and the probabilities of the obstacle being a wall or a vehicle. It also takes a second two-dimensional table, currentState_NextState, representing the probabilities of the obstacle being a wall or a vehicle based on the previous probabilities. There is also a table with two values representing the two initial probabilities that the obstacle has of being. The values I used are included in tables at the end of this paper.

The red bubbleRob is set up so that when it first detects something, its probabilities lean towards the assumption of the object being another bubbleRob. This is because there is a higher threshold, 0.9, for the object to be treated as another vehicle. If the red bubbleRob reaches this threshold though, it will continue forward because, being certain that the object was a moving vehicle, this means it is safe to assume the object will be out of the way.

However, as the red bubbleRob continues to detect an object, the probability that the object is a stationary wall and will not be moving increases. After the probability of the object being a bubbleRob drops below 0.21, the assumption is that it is a wall and the red bubbleRob begins to back-up in a curve. The change in the probabilities of the objects can be seen in the console as they change the longer the object is detected. As a result, the red bubbleRob has a different response for both sorts of objects in the simulation.

This simulation was developed with the intention to depict an issue that exists in the real world. With the fact that self-driving cars are becoming more and more of a reality, I felt it would be important to become better educated in the sort of work involved with this field of work. It is also valuable to see how the ideas behind Hidden Markov Models can be applied to deciding an action based on the probability of what a detected object is rather than simply deciding a future action based on the previous. Overall, this project has helped developed my experience and interest in not only determining probabilities with algorithms for decision making but also in what new ways they could be applied to meet real-world challenges.

Table 1: nextState_Observation information

Obstacle	Sensor	
	Clear	Not Clear
Wall	0	1
bubbleRob	0.5	0.5

Table 2: currentState_nextState

Current Obstacle Guess	Next Obstacle Guess	
	Wall	bubbleRob
Wall	0.8	2
bubbleRob	0.1	0.9

Table 3:intialProbabilities

	Wall	bubbleRob
Initial Probabilities	0.1	0.9