Advanced AI Techniques

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WS 2006/2007

Exercise Sheet 10

Due: Tuesday, 23. January 2007

Exercise 10.1

A robot uses a range sensor that can measure distamces up to $3m$. For simplicity, assume that actual ranges are distributed uniformly in this interval. When a sensor failure occurs, the sensor returns a measurement below $1m$, regardless of the actual range. The prior probability for a sensor failure is $p = 0.01$.
Suppose the robot queries the sensor N times and every single time the measurement is below $1m$. What is the posterior probability of a sensor failure for $N = 1, 2, \ldots, 10$?

Exercise 10.2

Consider the following every-day stituation: You help your grandma to buy some groceries. Unfortunatly, her car is rather old and the speed indicator is not working any more. Since you cannot afford another speeding ticket, you have to reason about your speed using just the public speed indicators on the side of the streets (see the picture below).

Of course, the acceleration is not perfect for such an old car. For each possible action, $a = -10$ (slowing down 10km/h), $a = +10$ (accelerating 10 km/h), $a = 0$ (maintaining the current speed), the transition probabilities for the speed v of your car are given in the following table:

	$v_{i+1} = v_i - 10$	$v_{i+1} = v_i$	$v_{i+1} = v_i + 10$
$a_i = -10$	0.6	0.4	0
$a_i = 0$	0	1	0
$a_i = +10$	0	0.2	0.8

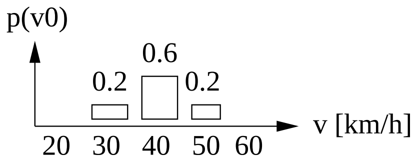
The public speed indicators that provides you with speed measurements m_i have the following measurement accuracy:

	$m_i < v_i - 10$	$m_i = v_i - 10$	$m_i = v_i$	$m_i = v_i + 10$	$m_i > v_i + 10$
probability	0	0.1	0.7	0.2	0

On the ride to the supermarket, you perform the following actions and obtain the following measurements. Each measurement m_i is obtained after the according action a_i has had its effect on the speed.

time i:	1	2	3
action a_i:	$+10$	0	-10
measurement m_i:	60	50	40

You belief, that your initial speed v_0 is distributed as follows:



Please use the Bayesian Filtering technique to calculate your belief about the car speed after each time step i. Is it likely that you have exceeded the speed limit of 50 km/h at some point?