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Machine Learning for Computer Vision

14. April 2018
Topic: **Probabilistic Reasoning**

Exercise 1: Follow the robot

Assume you get your hands on a robot that has various sensors.

a) The robot has a very cheap camera on board, so it's not very accurate at reading colors. After color calibration you know that the camera color model looks as follows:

z \ x	**R**	**G**	**B**
R	0.8	0.1	0.1
G	0.1	0.6	0.2
B	0.1	0.3	0.7

For instance, the probability that the robot reads blue while the true color is green is $p(Z = B|X = G) = 0.3$.
Assume the robot is located in a white room with 5 boxes: 2 red, 2 green and a blue one. The robot moves towards a box and the camera reads green. How likely is it that the box is actually green?

b) The robot also has a proximity sensor and it uses it to measure its distance from a door. The sensor's accuracy can be modeled using a continuous random variable with a Normal distribution with $\sigma_1 = 0.3$ m. Express the sensor model $p(z_t|x_t)$ in the full form (not the shorthand notation).

c) Now the robot moves into a hallway. Initially it knows it is located at the door (x=0). The robot can execute *move* commands but the result of the action is not always perfect. Assume that the robot moves with constant speed v. The motion can also be modeled with a Gaussian with $\sigma_2 = 0.1$ m. Write the motion model $p(x_t|x_{t-1}, u_t)$.

d) **Programming: Bayes Filter**

You let the robot run with a speed of 1 m/s. The robot only runs forward and it updates its belief every second. Assume you get the following sensor measurements in the first 3 seconds: $\{z_1 = 1.2, z_2 = 1.6, z_3 = 2.5\}$. Further assume that the hallway is only 5 meters long. Where does the robot believe it is located with respect to the door after 3 seconds? How certain is it about its location? Try out different standard deviations for the sensor and the motion model. How does the robot's belief change?

Exercise 2: An overview of ML methods

Try to find (for example by internet search or from the book (C.M. Bishop)) at least 5 examples for learning techniques that have not been discussed in class. Describe these techniques briefly and classify them with respect to the categories presented in the lecture.