

Machine Learning for Computer Vision
Winter term 2018

22. Oktober 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:

| $z \backslash x$ | 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.