TU München
Fakultät für Informatik
PD Dr. Rudolph Triebel
John Chiotellis

Machine Learning for Robotics and Computer Vision
Winter term 2015

Homework Assignment 1

Topic 1: Introduction to Probabilistic Reasoning and Learning
October 26, 2015

Exercise 1:

In class, we had an example of a robot that can measure its distance to a wall in front of it. We modeled this using a continuous random variable with a Normal distribution $\mathcal{N}(x; \mu, \sigma^2)$.

a) Our robot also has a camera that is not color-calibrated correctly so the color mapping is probabilistic and looks like the following table:

Sensed color	Actual color	p(Sensed | Actual)
red	red	0.8
red	green	0.1
red	blue	0.1
green	red	0.1
green	green	0.6
green	blue	0.2
blue	red	0.1
blue	green	0.3
blue	blue	0.7

Assume our robot is located in a room with 5 boxes: 2 red, 2 green and a blue one. The robot moves towards a box and it reads green. How likely is it that the box is actually green?

b) The robot's distance sensor can be modeled using a continuous random variable with a Normal distribution with $\sigma_1 = 0.3$ m. Write the sensor model $p(z|x)$ in the full form (not the shorthand notation).

c) Now the robot moves into another room that is empty. 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 deviation $\sigma_2 = 0.1$ m. Write the motion model $p(x_t|x_{t-1}, u_t)$.

d) We let the robot run in the room with a speed of 1 m/s. The robot only runs forward and it updates its belief every second. Assume we obtain the following sensor measurements: $(z_1 = 1.2, z_2 = 1.6, z_3 = 2.5)$.

   Further assume that the position can only take discrete values from 0 to 5. Where does the robot believe it is located with respect to the door after 3 seconds? How certain is it about its location?

Exercise 2:

Try to find (for example by internet search or from the book) 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 hierarchy from the lecture.

Topic 2: Regression

Exercise 3:

We are testing a tracking program. We evaluate it with the help of a quadrocopter. The quadrocopter sends estimates of its velocity and the tracking program estimates its global position with respect to the quadrocopter's initial position (before flying).

a) The tracker yields these tracked position estimates at a frequency of $1Hz$:

$$\mathcal{T} = \left\{ \begin{pmatrix} 2 \\ 0 \\ 1 \end{pmatrix} \begin{pmatrix} 1.08 \\ 1.68 \\ 2.38 \end{pmatrix} \begin{pmatrix} -0.83 \\ 1.82 \\ 2.49 \end{pmatrix} \begin{pmatrix} -1.97 \\ 0.28 \\ 2.15 \end{pmatrix} \begin{pmatrix} -1.31 \\ -1.51 \\ 2.59 \end{pmatrix} \begin{pmatrix} 0.57 \\ -1.91 \\ 4.32 \end{pmatrix} \right\} \tag{1}$$

Plot these data with your tool of choice (e.g. Matlab).

b) Assuming the quadrocopter flies with constant speed, which speed does it have? What is the residual error of the estimation?

c) Now assume that the quadrocopter flies with constant acceleration. What is the residual error now? Is the error higher or lower? Why?

d) According to our last model, what is the quadrocopter's most likely position in the next second?

Hint for b) and c): Use the Polynomial Regression method introduced on slides 8 - 12 of the lecture.

Exercise 4: Programming

Solve exercise 3 in your preferred programming language.

The next exercise class will take place on **November 20th, 2015**.

For downloads of slides and of homework assignments and for further information on the course see

`http://vision.in.tum.de`
