Albert-Ludwigs-Universität Freiburg
Lecture: Introduction to Mobile Robotics
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Sheet 3

Topic: Locomotion, Bayes Rule

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Exercise 1: Differential Drive Implementation

Write a function in *Octave* that implements the forward kinematics for the differential drive as explained in the lecture.

(a) The function header should look like
`function [x_n y_n theta_n]=diffdrive(x, y, theta, v_l, v_r, t, l)`
where x, y, and θ is the pose of the robot, v_l and v_r are the speed of the left and right wheel, t is the driving time, and l is the distance between the wheels of the robot. The output of the function is the new pose of the robot x_n, y_n, and θ_n.

(b) After reaching position $x = 1.5m$, $y = 2.0m$, and $\theta = \frac{\pi}{2}$ the robot executes the following sequence of steering commands:

(a) $c_1 = (v_l = 0.3m/s, v_r = 0.3m/s, t = 3s)$
(b) $c_2 = (v_l = 0.1m/s, v_r = -0.1m/s, t = 1s)$
(c) $c_3 = (v_l = 0.2m/s, v_r = 0m/s, t = 2s)$

Use the function to compute the position of the robot after the execution of each command in the sequence (the distance l between the wheels of the robot is $0.5m$).

Exercise 2: Bayes Rule

Suppose you are a witness to a nighttime hit-and-run accident involving a taxi in Athens. All taxi cars in Athens are blue or green. You swear under oath that the taxi was blue. Extensive testing shows that, under the dim lighting conditions, discrimination between blue and green is 75% reliable.

(a) Given your statement as a witness and given that 9 out of 10 Athenian taxis are green, what is the probability of the taxi being blue?

(b) Is there a significant change if 7 out of 10 Athenian taxis are green?

(c) Suppose now that there is a second witness who swears that the taxi is green. Unfortunately he is color blind, so he has only a 50% chance of being right. How would this change the estimate from (b)?

Exercise 3: Bayes Filter

A vacuum cleaning robot is equipped with a cleaning unit to clean the floor. Furthermore, the robot has a sensor to detect whether the floor is clean or dirty. Neither the cleaning unit nor the sensor are perfect.

From previous experience you know that the robot succeeds in cleaning a dirty floor with a probability of

$$p(x_{t+1} = \text{clean} \mid x_t = \text{dirty}, u_{t+1} = \text{vacuum-clean}) = 0.7,$$

where x_{t+1} is the state of the floor after having vacuum-cleaned, u_{t+1} is the control command, and x_t is the state of the floor before performing the action.

The probability that the sensor indicates that the floor is clean although it is dirty is given by $p(z = \text{clean} \mid x = \text{dirty}) = 0.3$, and the probability that the sensor correctly detects a clean floor is given by $p(z = \text{clean} \mid x = \text{clean}) = 0.9$.

Unfortunately, you have no knowledge about the current state of the floor. However, after cleaning the floor the sensor of the robot indicates that the floor is clean.

(a) Compute the probability that the floor is still dirty after the robot has vacuum-cleaned it. Use an appropriate prior distribution and justify your choice.

(b) Which prior gives you a lower bound for that probability?