Albert-Ludwigs-Universität Freiburg
Lecture: Introduction to Mobile Robotics
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Sheet 8

Topic: Mapping with Known Poses

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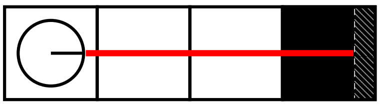
Exercise 1: Counting Model

A robot applies the so-called simple counting approach to build a grid map of a 1D environment consisting of the cells $c_0, \ldots, c_3$. While standing in cell c_0, the robot integrates four measurements $z_{t_0}, \ldots, z_{t_3}$. After integrating these measurements, the resulting belief of the robot with regards to the occupancy of the four cells is $b_0 = 0,\ b_1 = \frac{1}{4},\ b_2 = \frac{2}{3},\ b_3 = 1$. Given that the first three measurements are $z_{t_0} = 1,\ z_{t_1} = 2,\ z_{t_2} = 3$, compute the value of the last measurement z_{t_3}.

Exercise 2: Occupancy Mapping

A robot has to build an occupancy grid map (cells $c_0, \ldots c_n$) of a simple one-dimensional environment using a sequence of measurements from a range sensor.



Assume a very simple sensor model: every grid cell with a distance (based on its coordinate) smaller than the measured distance is assumed to be occupied with $p = 0.3$. Every cell behind the measured distance is occupied with $p = 0.6$. Every cell located more than $20cm$ behind the measured distance should not be updated. Calculate the resulting occupancy grid map using the inverse sensor model (see mapping lecture slide 32) using Python.

Assign the cell coordinates, which span from 0 to 200 (both endpoints included) with increments of 10, to one array `c` and the belief values to another array `m`. Use `matplotlib.pyplot.plot(c,m)` to visualize the belief. The measurements and the prior belief are given in the following table.

Grid resolution	10 cm
Map length (1D only)	2 m
Robot position	c_0
Orientation (of the sensor)	heading to c_n (see figure)
Measurements (in cm)	101, 82, 91, 112, 99, 151, 96, 85, 99, 105
Prior	0.5

Exercise 3: Occupancy Mapping

Prove that in the occupancy grid mapping framework the occupancy value of a grid cell $P(m_j|x_{1:t}; z_{1:t})$ is independent of the order in which the measurements are integrated.