Robotics
Problem Sheet 9

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Notes

The homework serves as preparation for the exams. It is strongly recommended that you solve them before the given deadline - but you do not need to hand them in. Feel free to work on the problems as a group - this is even recommended.

1 Problem

Given a quadtree with maximum depth 3, which is used to represent an area of 8×8 meters (or more precisely $[0.0, 8.0[\times[0.0, 8.0[$. Draw the quadtree after each sensor reading for the following sequence of sensor readings that indicate occupancy in the related locations:

1. (0.2, 7.1)
2. (2.5, 2.3)
3. (3.7, 2.7)
4. (3.0, 3.9)
5. (4.2, 5.9)
6. (2.1, 3.5)
7. (6.8, 1.0)
8. (3.2, 3.4)

2 Problem

Consider a 1-dimensional world where a mobile robot r has a 1-dimensional range sensor that returns the distance d_o to the nearest obstacle. An evidence grid $g(x)$ with log odds is to be used for representing uncertainty in a map of the environment. Concretely, a base two logarithm (log_2) is used for the log odds.

The robot is supposed to generate a 1D map over 10 cm with a 1 cm resolution, i.e., $g(x)$ holds the occupancy estimate of the area $[xcm, x + 1cm[$. For the sake of convenience, we assume discrete motions and discrete sensor readings.

Given the robot pose x_r and a sensor reading d_o, the conditional probability $P(s = d_o|o@x)$, respectively $P(s = d_o|\neg o@x)$ - or short $P(o@x)$ and $P(\neg o@x)$ - of getting sensor value d_o when there is an obstacle at x ("$o@x$"), respectively free space at coordinate x ("$\neg o@x$") is given as:

- $P(o@x) = 0.9 \Leftrightarrow x = x_r + d_o$
- $P(o@x) = 0.3 \Leftrightarrow x = x_r + d_o \pm 1cm$
- $P(\neg o@x) = 0.8 \Leftrightarrow \forall x : x_r \leq x < x_r + d_o - 1cm$

No information about the environment is given for the initial state of the map, i.e., $\forall x : P(o@x) = P(\neg o@x)$ as long as there are no sensor readings yet.

- What is the initial map $g()_0$ at time $t = 0$, i.e., the value of all cells $g(x)_0$?
- Suppose the robot starts at coordinate (0) and gets a sensor reading of $d_o = 6$ at $t = 1$. What does the map $g()_1$ look like after this sensor reading is integrated in it?
- At $t = 2$, the robot is moving and it gets to coordinate (3). There, the sensor value is $d_o = 4$. What does the map $g()_2$ look like after this sensor reading is used to update the map?
- At $t = 3$, the robot is still at coordinate (3). The sensor value is now $d_o = 3$. What does the map $g()_3$ look like?
- At $t = 4$, the robot is again still at coordinate (3). The sensor value is again $d_o = 3$. What does the map $g()_4$ look like?