



Mobile Robots
Summer Semester 2013
Assignment 7

due date: 18.06.2013, presentation: 25.06.2013
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Exercise 1 Occupancy Grid Mapping (9 Points)

- (a) We derived the following update rule for occupancy grid mapping with inverse sensor models:

$$\frac{p(m_i|z_{1,\dots,t})}{1 - p(m_i|z_{1,\dots,t})} = \frac{p(m_i|z_t)}{1 - p(m_i|z_t)} \cdot \frac{p(m_i|z_{1,\dots,t-1})}{1 - p(m_i|z_{1,\dots,t-1})} \cdot \frac{1 - p(m_i)}{p(m_i)}$$

Solve this equation for $p(m_i|z_{1,\dots,t})$. (2 Points)

- (b) Count the minimum number of additions and the number of multiplications or divisions required for updating a cell based on a new sensor measurement. Keep in mind that some values do not change and can be precomputed. (2 Points)
- (c) Do the same as above for the update rule using odds and log-odds representations. (1 Points)
- (d) Your robot received the following 5 full measurements of a very small map:

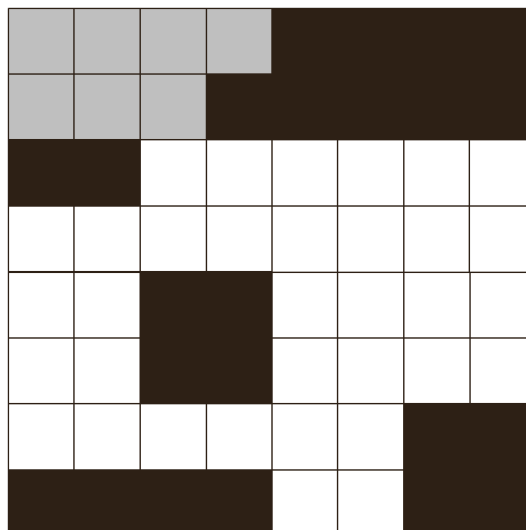


Given $p(m_i) = 0.5$, $p(m_i|z = occ) = 0.8$ and $p(m_i|z = free) = 0.2$, compute the posterior probabilities $p(m_i|z_{1,\dots,5})$ and both their odds and log-odds representations.

(4 Points)

Exercise 2 Quadtrees (6 Points)

You are given the following occupancy grid map:



- (a) Construct and draw a corresponding quadtree representation with the same resolution. (2 Points)
- (b) For the quadtree constructed in (a), find examples of grid cells which require as many and as few operations as possible to have their values changed. (2 Points)
- (c) You want to store an occupancy grid map consisting of 256×256 grid cells as a quadtree. What is the maximum depth of the resulting quadtree? Of how many nodes could this quadtree consist in the worst case? (2 Points)

Exercise 3 Topological Maps (5 Points)

Manually apply Thrun's algorithm for extracting topological maps to the following map.



- (a) Draw the Generalized Voronoi Diagram (GVD) of this map. (2 Points)
- (b) Find all critical points and critical lines and draw them in another color. (2 Points)
- (c) Sketch the graph of the resulting topological map. (1 Points)