CS226 Statistical Techniques in Robotics, Spring 2004
Please email your answers to rahul@cs.stanford.edu.

Written Assignment #2

1 Question 1: Forgetful Occupancy Grid Maps

In class, we learned about the probabilistic occupancy grid technique that maintains the posterior in its log-odds form. This approach was based on the belief that each cell in the world is either occupied or free, and it stays this way forever.

In many environments, occupancy may change over time, and algorithms that can adapt to such changes are superior to ones that cannot. Here you are asked to derive such an algorithm.

Specifically, let us assume that between any two consecutive time steps, the occupancy of a grid cell $\mathbf{m}_i$ stays the same with probability $\pi = 0.99$, but with probability $1 - \pi = 0.01$ it is randomly reset to a new occupancy value, drawn from the prior distribution $p(\mathbf{m}_i)$.

- State the correct Bayes filter, for a log-odds representation of the posterior. (If you cannot state the correct Bayes filter, give a good approximation).

- Derive your Bayes filter mathematically. You can base your derivation on any equation in the book, but please tell us which ones you are using in your derivation. (If you cannot derive your algorithm, argue that it does the appropriate thing).

2 Question 2: ML Estimation of Sensor Returns

Let's again consider the occupancy grid map approach in the book (this question has nothing to do with Question 1). For simplicity, let's consider a world that contains only a single grid cell.

In this question, we are not interested in the posterior probability of a cell being occupied. Rather, we would like to determine the probability of measuring occupancy when pointing a sensor at the grid cell. What would be the maximum likelihood estimator for this probability? Derive the correctness of your answer from first principles.