CSE 180 – Introduction to Robotics
Homework N. 4 – Spring 2019

Important Information

1. This homework is due on May 9th, 2019 at 4:15pm. The deadline is strict and will be enforced by CatCourses. **No exceptions.**
2. Your solution must be submitted in electronic form through CatCourses. Paper submissions will not be accepted. **No exceptions.**
3. If you write your solution by hand, write clearly. Unreadable documents will not be graded.
4. The method you follow to determine the solution is more important than the final results. Clearly illustrate and explain the intermediate steps. If you just write the final result you will get not credit.
5. **THIS HOMEWORK MUST BE SOLVED INDIVIDUALLY. NO EXCEPTIONS**.

1 Integrating multiple sensor readings

A robot is moving in an environment where there are two doors. One door is blue, the other is red. The robot is equipped with a sensor that can return R, B, or N to indicate, respectively, that the robot is facing the red door, the blue door, or no door. The sensor model is given below, and let Z_t be the sensor reading returned at time t (so, $Z_t \in \{R, B, N\}$). The state of the robot is $X \in \{X_B, X_R, X_N\}$. $X = X_B$ means the robot is facing the blue door, $X = X_R$ means the robot is facing the red door, and $X = X_N$ means the robot is not facing any door. The robot queries the sensor three times and no motion happens between the readings. Assume the prior is $\Pr[X = X_N] = \Pr[X = X_R] = \Pr[X = X_B] = \frac{1}{3}$.

1. If the sensor returns (in sequence) R, R, B what is the posterior after the three sensor readings have been integrated?

	$X = X_R$	$X = X_B$	$X = X_N$
$Z = R$	0.8	0.2	0.2
$Z = B$	0.05	0.6	0.1
$Z = N$	0.15	0.2	0.7

Table 1: Sensor model. Values in the table give the conditional probabilities for the sensor readings. For example $\Pr[Z = R|X = X_R] = 0.8$, $\Pr[Z = N|X = X_B] = 0.2$, and so on.

2 Unidimensional Kalman Filter

Consider a scenario similar to example 6.8 in the lecture notes with a robot moving along a rail with the following transition and sensor models:

$$x_t = x_{t-1} + 2u_t$$

$$z_t = 2x_t$$

Assume $x_0 \sim \mathcal{N}(0, 1)$, $R \sim \mathcal{N}(0, 1)$ and $Q \sim \mathcal{N}(0, 0.2)$. Let $u_t = 2$ and $z_t = 5$. Compute one full iteration of the Kalman Filter, i.e., prediction and update, and draw the diagram as in Figure 6.12 in the lecture notes.