Assignment-2: CSE643: AI-SecB Deadline: 28-11-2025 Full Marks: 30 18-11-2025

1. **[State estimation]** In this exercise we will apply Bayes rule to Gaussians. Suppose we have a mobile root that walks on a long straight road. The robot's location x will simply be the position along this road. Now suppose that initially, the robot is believed to be at location $x_{init} = 1,000m$, but we happen to know that this estimate is uncertain. Based on this uncertainty, we model our initial belief by a Gaussian with variance $\sigma^2_{min} = 900m^2$.

   To find out more about our location, we query a GPS receiver. The GPS tells us our location is $z_{gps} = 1,100m$. The GPS receiver is known to have an error variance of $\sigma^2_{init} = 100m^2$.

   (a) Write the pdfs of the prior $p(x)$ and the measurement $p(z \mid x)$. 5

   (b) Using Bayes rule, what is the posterior $p(x \mid z)$? 5

   (c) How likely was the measurement $x_{gps} = 1,100m$ given our prior, and knowledge of the error probability of our GPS receiver ? 5

2. **[Robotic exploration]** Consider a robot that operates in the triangular environment with three types of landmarks as shown in Figure 1:

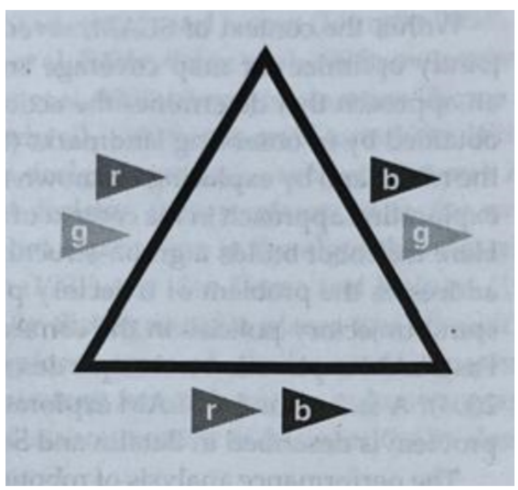

Figure 1: Triangular environment. Each location has two differently colored landmarks.

   Each location has two different landmarks, each with a different color. Let us assume that in every round the robot can only inquire about the presence of one landmark type: either the one labeled "r", the one labeled "g", or the one labeled "b". Suppose the robot first fires the detector for "b" landmarks and moves clockwise to the next arc.

   What would be the optimal landmark detector to use next ? How would the answer change if the robot does not move to the next arc? 10+5