Robotics Assignment 2

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BN: 2 Sec: 3

6.1:-

Given

$P(m=oc \mid z=d) = 0.8$

$P(m=oc \mid z>d) = 0.2$

$P(m_{ij}) = 0.2$

$\because P(m=occ \mid z=d) = 0.8$

$\because l(x) = \text{logs odd}$

$= \ln\left(\frac{P(x)}{1-P(x)}\right)$

$\therefore l(m=occ \mid z=d) = \ln\left(\frac{0.8}{1-0.8}\right) = \boxed{1.386}$ (1)

$\therefore l(m=occ \mid z>d) = \ln\left(\frac{0.2}{0.8}\right) = \boxed{-1.386}$ (2)

$\therefore l(m_{ij}) = \ln\left(\frac{0.2}{0.8}\right) = \boxed{-1.386}$ (3)

a) Formulate the update rule of the map cell with these concrete numbers using the logs-odd ratio

$\because l(x) = \text{inverse\_sensor\_model}(m_i, z_t, x_t) + \underbrace{l_{t-1,i}}_{\text{recursive}} - \underbrace{l_0}_{\text{Prior}}$

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$\therefore$ if $z = d$

$l(x) = \text{inverse\_sensor\_model}(m_i, z_t, x_t)$
$(+\cancel{1.386} + \cancel{1.386}) = 2 l_0$

$\therefore l(x) = \text{inverse\_sensor\_model}(m_i, x_t, z_t) + 2.\cancel{7}36$

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$\therefore$ if $z > d$

$\therefore l(x) = \text{inverse\_sensor\_model}(m_i, z_t, x_t)$
$\cancel{-1.386} + \cancel{1.386}$

$\therefore l(x) = \text{inverse\_sensor\_model}(m_i, z_t, x_t)$

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b) What is the log-odds ratio after measuring 100 times if 60 measurements return the value d & 40 return a value $> d$? also compute the resulting occupancy probability.

Due to the recursive term in the

equation, we can compute it as:

$$l(x) = 60 \times 2.736 - \cancel{40(0)} - l_0$$

$$\therefore l(x) = 164.16 + 1.368 = \boxed{165.528}$$

(6)

$\therefore$ the resulting occupancy $= P(165.528)$

$$P(165.528) = 1 - \frac{1}{1+\exp(165.528)} = \boxed{1}$$

(7)

c) What's the reflection probability of the cell?

$$Bel(m^{[xy]}) = \frac{hits(x,y)}{hits(x,y)+misses(x,y)} = \frac{60}{100} = 0.6$$

d) What are the benefits of the reflection map representation & where are the problems?

Benfits:

1. Simple way of considering the map as a grid of cells

2. Another way of representing the occupations

3. It stores in each cell the probability that a beam is reflected by a cell, So it shows the material of the object to some level, whether it is transperent or not.

4. It determines how often a cell reflects a beam.

Problems:-

1. Reflection probability could be very small even when the cell is occupied
(Transparent Materials Problem)

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6.2

C_0	C_1	C_2	C_3

Given

@ C_0 we have 4 readings
z_0, z_1, z_2, z_3
resulting 4 beliefs
$b_0 = 0.25$ $b_2 = 0.5$
$b_1 = 1/3$ $b_3 = 1$

Now given these three measurements
$z_{t0} = 0$ $z_{t2} = 3$ $z_{t3} = 1$
Compute $\underline{z_{t1}}$

Analysis:
Since we have $z(t_0) - z(t_3)$, this implies that we have emitted 4 rays

Since $z(t_0) = 0$, this means that the first ray cause a hit @ $\underline{C_0}$

Since $z(t_2) = 3$, this means that

the ray caused a hit @ C_3 & misses all of C_0, C_1 & C_2

since $z(t_3 = 1)$ so this means we have a hit at C_1 & miss @ C_0

Now since $b_i = \frac{hits(x,y)_i}{hits(x,y) + misses(x,y)}$

$\therefore b_0 = 0.25$ & $\because$ all rays passed by C_0

$\boxed{0.25 = 1/4} = (1+x)/4$

$\therefore x = 0$

$\therefore z_{t_0} = 0$ $\boxed{\therefore z_{t_1} \text{ must be } > 0}$ ①

$\because b_1 = 1/3$ $\therefore$ this indicates we have 3 rays passed by C_1

$\therefore b_2 = 0.5 = 1/2 \rightarrow$ 2 rays

$b_3 = 1 = 1/1 \rightarrow$ 1 ray

∴ this indicates that Z_{t1} must be greater Z_{t3} & less than Z_{t2}

∵ $Z_{t3} = 1$ $Z_{t2} = 3$

∴ $1 \leq Z_{t1} < 3$ & Z is integer

∴ $Z_{t1} = 2$ RJ Find

7.2 In bearing only SLAM, where only inexpensive sensors are used such as single camera, direct distance to the landmarks would not be provided, since it can only measure bearings of the landmarks. And this causes initialization of landmarks to be harder.

Most the approaches used Gaussian PDFs, but there is more efficient method using EKF to fuse the data obtained by

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the laser beam to obtain Range & Bearing EKF SLAM instead of Bearing only.

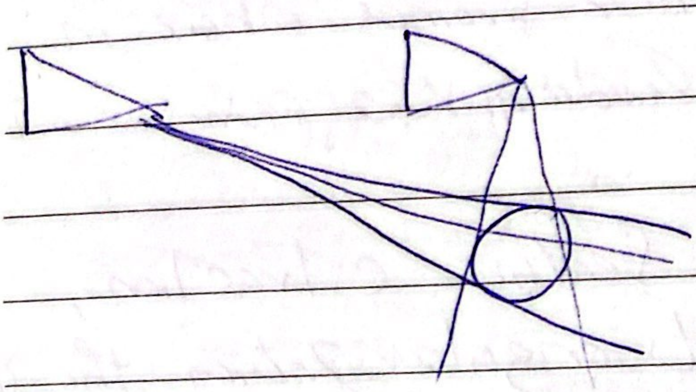
Naive way for landmark initialization is done by taking two frames where in both a specific landmark appears.

And then using feature extraction, matching and triangularization, the 3D location of the point could be obtained

the Problem with this is when both frames are taken from same angle, only difference in distance to the land mark, in such case, applying triangularization is quite hard

After applying triangularization, the uncertainity are considered, and the result is gaussian, where the mean is the nominal solution and the covariance is obtained by transforming the robot & measuring uncertainties via Jacobians of the observations.

Unhappy
Bad scenario for Triangularization



happy
Good scenario for Triangularizatio

Solution:

So there are two methods for the un-delayed landmark representation

1. First method is an offline method called the multi-map algorithm that uses Geometric Ray, say the laser beam has two readings, r_{min} & r_{max} then we fill the distances between these two with gaussians, using different ranges for each gaussian & keeping the linearization constraint

then we have a logarithmic number of terms which are relatively small number that can be easily handled with EKF.

these terms initializes different maps each with different mean & covariance for the gaussian of the landmark.

then as the robot moves & obtains more frames, & measuring likelihood of landmarks the maps with more unlikely landmark locations are preened till only one map is remained with the right landmark member & that remained member is also Gaussian.

2 the second algorithm is called FIS (federated Information sharing) which is online Algorithm & real-Time