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Lab2

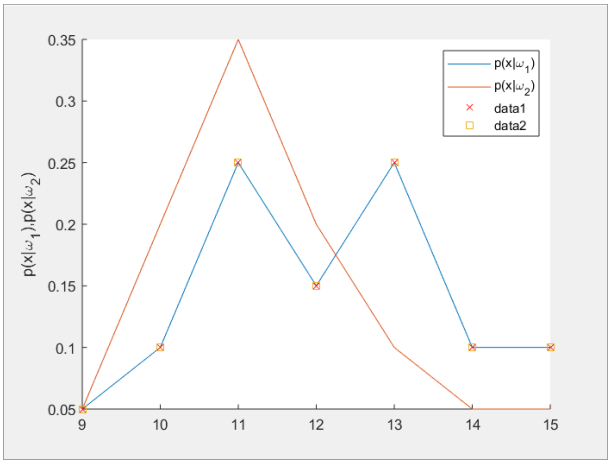
Part I Bayesian Classification

Lab Exercise CH2-1:

The results are shown below. The codes are provided in CH2_1.m, CH2_2.m and CH2_3.m respectively.

➢2-1.1 Using MATLAB to redo p(x|ω1) and p(x|ω2) in Example 1.

The $\mathrm{p}(\mathrm{x}|\omega_i)$ are calculated by diving the total number of fish ω_j.



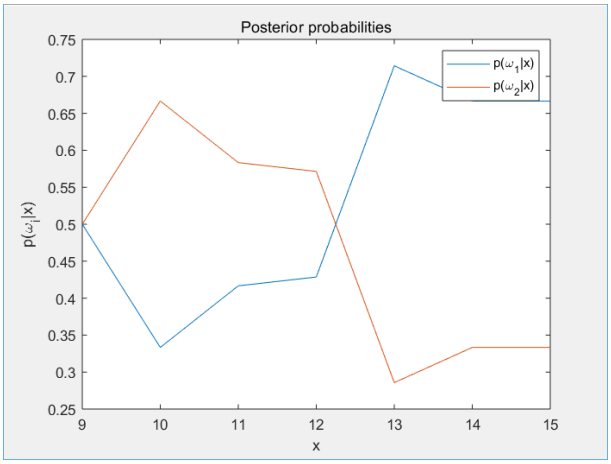
➢2-1.2 Find P(ω1|x) and P(ω2|x) for all x and draw the figure as left using MATLAB.

We use

$$P(\omega_j|x) = \frac{p(x|\omega_j)P(\omega_j)}{p(x)}$$

Where

$$p(x) = \sum_{j=1}^{2} p(x|\omega_j)P(\omega_j)$$

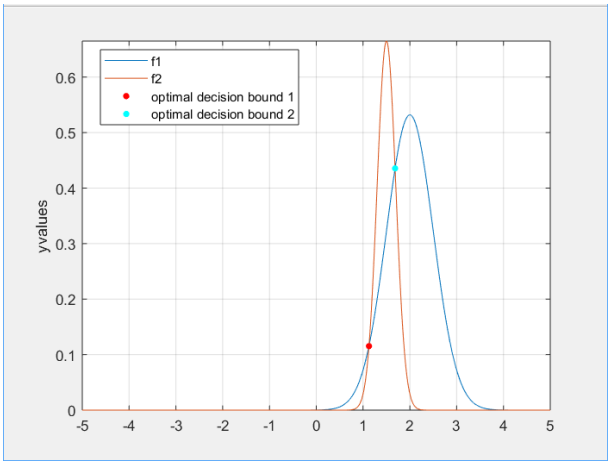


Lab Exercise CH2-2

Two exclusive categories ω1, ω2: P(ω1) = 2/3, P(ω2) = 1/3, P(x| ω1) => N(2, 0.5) (normal distribution), P(x| ω2) => N(1.5, 0.2). Select the optimal decision using MATLAB.T

The discriminant functions are:

$$g_i(x) = \mathrm{p}(\mathrm{x}|\omega_i)P(\omega_i)$$



It is easy to see that

$$\text{Optimal decision} = \begin{cases} Decide\ \omega_1 & if\ x < 1.126 \\ Decide\ \omega_2 & if\ 1.126 \le x < 1.683 \\ Decide\ \omega_1 & if\ 1.683 \le x \end{cases}$$

Lab Exercise CH2-3

Feature space Ω = {ω1, ω2}, P(ω1) = 2/3, P(ω2) = 1/3, P(x| ω1) => N(2, 0.5),

P(x| ω2) => N(1.5, 0.2). $\lambda = \begin{bmatrix} 1 & 4 \\ 3 & 2 \end{bmatrix}$.

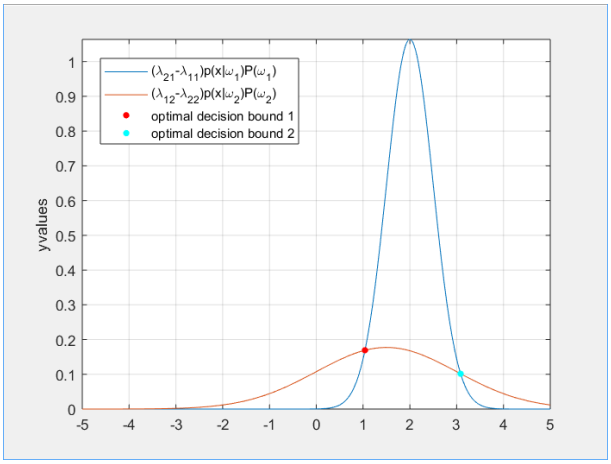
Select the optimal decision using MATLAB.

The discriminant functions are

$$g_1 = (\lambda_{21} - \lambda_{11})\ \mathrm{p}(\mathrm{x}|\omega_1)P(\omega_1)$$
$$g_2 = (\lambda_{12} - \lambda_{22})\ \mathrm{p}(\mathrm{x}|\omega_2)P(\omega_2)$$

It is easy to see that

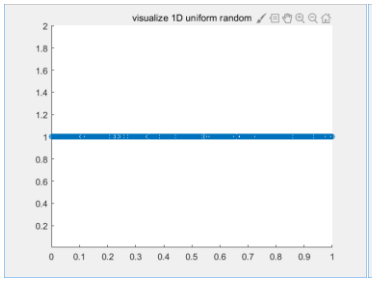
$$\text{Optimal decision} = \begin{cases} Decide\ \omega_1 & if\ x < 1.041 \\ Decide\ \omega_2 & if\ 1.041 \le x < 3.084 \\ Decide\ \omega_1 & if\ 3.084 \le x \end{cases}$$

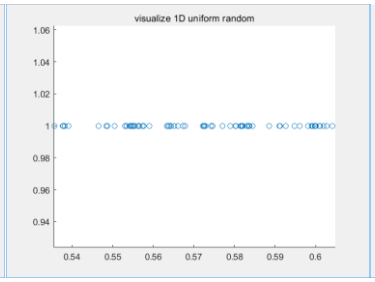


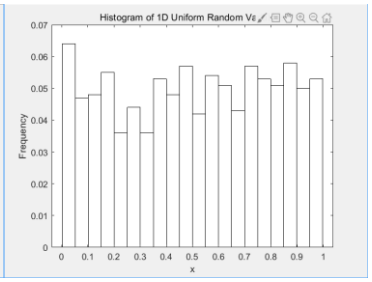
Part II Random number generation

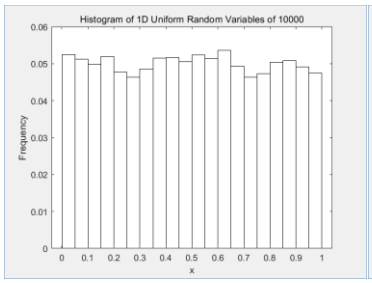
(a) Generate three streams (1D, 2D and 3D) of random numbers with 1,000 samples, you may use the Matlab command rand.
(b) Visualize the generated samples, you may use a scatter plot.
(c) Compute the histogram of the three streams, then normalize them to become a probability density function (pdf).
(d) Visualize the pdf's of the three streams. Are the samples uniformly distributed? Do the pdf's represent a standard uniform distributions? Comment.

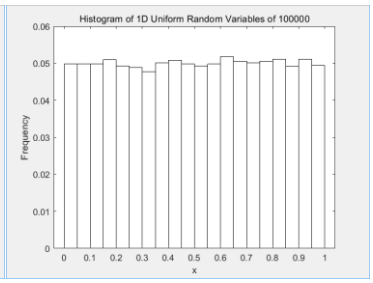
The generated samples are visualized below.
For 1D stream, it was hard to discover the law because the density of points is too large, but we can recognize them by magnifying the figure. From the histogram we find that the samples are not very uniform. This was caused by small size of samples. As we can see, the larger the size of samples, the more uniform the distribution. The same comment also works for 2D and 3D streams. For 3D stream, we can just visualize the pdf in two dimensions.
The codes are provided in 1D.m, 2D.m, 3D.m respectively.

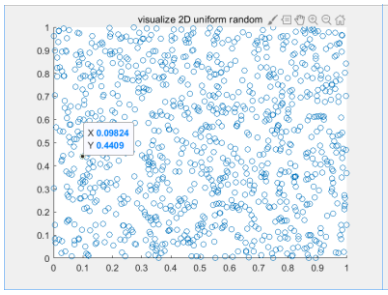


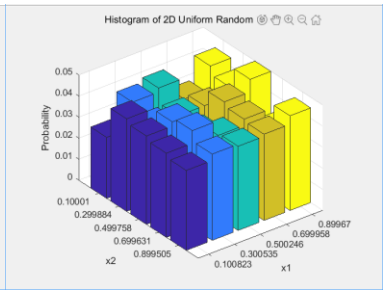


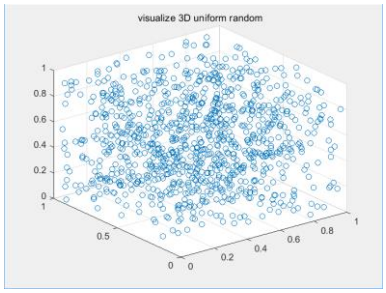


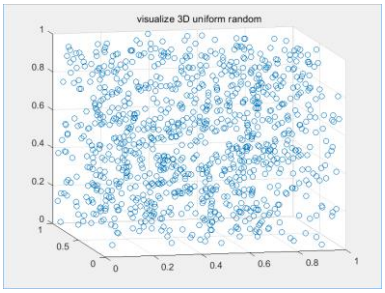




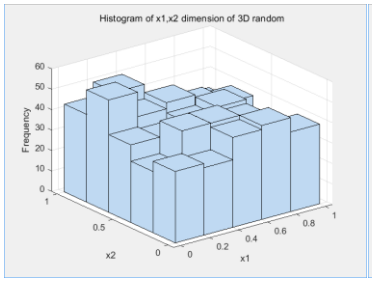


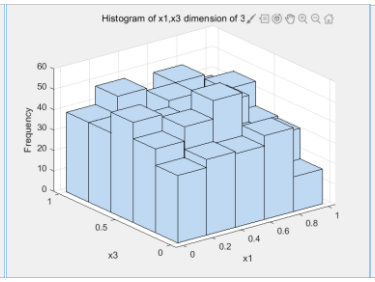


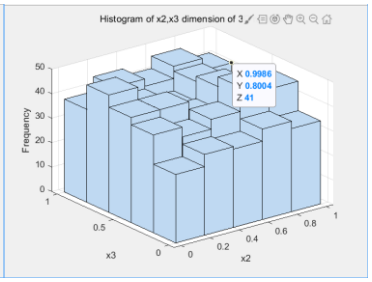


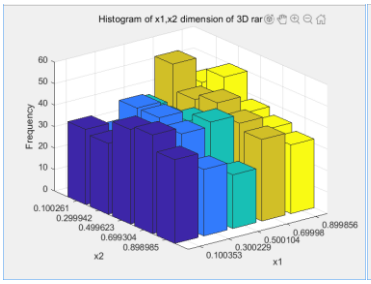


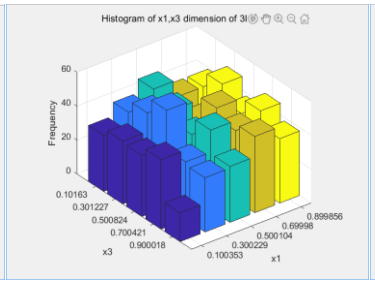
Choose a different view

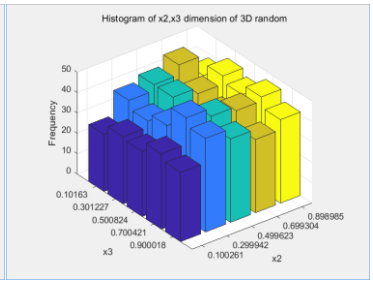







Histogram of x1,x2 dimension of 3D rar
Frequency
0
10
20
30
40
50
60
0.100261
0.299942
0.499623
0.699304
0.898985
x2
0.100353
0.300229
0.500104
0.69998
0.899856
x1


Histogram of x1,x3 dimension of 3I
Frequency
0
20
40
60
0.10163
0.301227
0.500824
0.700421
0.900018
x3
0.100353
0.300229
0.500104
0.69998
0.899856
x1


Histogram of x2,x3 dimension of 3D random
Frequency
0
10
20
30
40
50
0.10163
0.301227
0.500824
0.700421
0.900018
x3
0.100261
0.299942
0.499623
0.699304
0.898985
x2