Istanbul Technical University- Spring 2017
BLG527E Machine Learning
Homework 1

Purpose: Better understanding of PR/ML basics.

Total worth: 6% of your grade.

Handed out: Thursday, Sept 21, 2017.

Due: Wednesday, Oct 4, 2017 22.00. (through ninova!)

Instructor: Zehra Cataltepe (cataltepe@itu.edu.tr),

Assistants:

Hakan Gündüz (hakangunduz@itu.edu.tr)

Policy: Collaboration in the form of discussions is acceptable, but you should write your own answer/code by yourself. Cheating is highly discouraged for it could mean a zero or negative grade from the homework. If a question is not clear, please let us know (via email, during office hour or in class).

Submission Instructions: Please submit through the class ninova site.
Please zip and upload all your files using filename studentID_HW1.zip. You must provide all functions you wrote with your zipped file. Functions you do not submit may cause you lose a portion of your grade. You must also include a .doc or pdf file with answers to the questions and how to call your R functions for each question so that we can run and check the results. Also make sure you add the x, y labels and title to the plots.

QUESTIONS:

Q1) [2 points][Central Limit Theorem]
Consider a univariate random variable x distributed according to N(0,1) (i.e. unit normal)
Q1a) Using R,
Repeat for i=1...500
Xi = draw N=10 samples of from the distribution,
compute the mean (mi = mean(Xi))
Plot the histogram of these means for 500 different experiments. Make sure you add the x, y labels, title and x-y tick values on the plot.

Q1b) Repeat Q1a) for N=100 instances in each sample.

Q1c) What are the differences and similarities between the plots you see in 1a) and 1b)? Why?

Q2) [4 points] [Bayesian Decision Theory]

Assume a discriminant function of the form: $g_i(x) = \ln(p(x|C_i))+\ln(P(C_i))$

Assume that there are two classes and inputs are distributed according to Gaussians.

Likelihood for classes 1 and 2 are given as: $p(x|C1) = N(0,1)$, $p(x|C2) = N(1,2)$

Q2a) Derive the discriminant functions g1(x) and g2(c) for classes C1 and C2. Assume P(C1)=P(C2)=0.5

Q2b) Generate two random datasets from p(x|C1) and p(x|C2), plot the histograms and p(x|C1) and p(x|C2) on the same graph. Plot P(C1|x) and P(C2|x) on another graph.

Q2c) Plot the discriminant functions and identify the decision regions R1 and R2 for classes C1 and C2.

Q2d) Assume that P(C2) = 0.8, plot the discriminant functions and identify the decision regions R1 and R2 for classes C1 and C2.