University of Tehran

School of Electrical and Computer Engineering

Digital Image Processing

Instructor: Hamid Soltanian-Zadeh

Assignment 10

Chapter 12 – Digital Image Fundamentals

Due Date: 16th of Khordad 1401

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Problem 1

In this problem, we want to classify two different classes using different methods:

a. Implement the minimum distance classifier discussed in Section 12.2.1 for two classes. Calculate and plot the decision boundary for the two category two-dimensional data described in the following. Establish the classifier recognition performance by determining the percent of patterns that are classified correctly.
   - Class number 1:
     - X1: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.4).
     - X2: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.4).
   - Class number 2:
     - X1: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.2).
     - X2: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.2).

b. Implement the Bayes classifier discussed in Section 12.2.2. Calculate and plot the decision boundary for the two category two-dimensional data part a. Assuming Gaussian distributions for both of the classes and equal prior probabilities, $P(\omega_1) = P(\omega_2) = 0.5$. Establish the classifier recognition performance by determining the percent of patterns that are classified correctly.

Run your code 10 times to generate different data and calculate the average of the results for each method and report and compare the results of two different classifiers.

Note: You **cannot use** MATLAB built-in functions.

Problem 2:

Repeat problem 1 for the two-category two-dimensional data described in the following:

- Class number 1:
  - X1: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.7).
  - X2: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.4).
- Class number 2:
  - X1: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.3).
  - X2: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.3).
  -

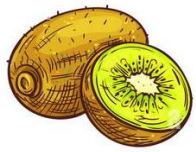
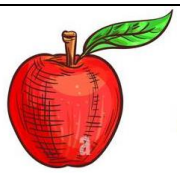
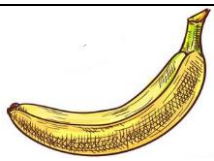
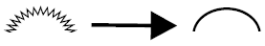
Run your code 10 times to generate different data and calculate the average of the results for each method and report and compare the results of two different classifiers.

Note: You **cannot use** MATLAB built-in functions.

Problem 3:

In this problem, we want to implement the perceptron neural network to classify three classes of fruits by assuming three features described in Table 1. Train a perceptron neural network for this classification and detect the unknown fruits described at the end of the table. Use the training and learning rule that has been mentioned in the textbook. Present your results and explain enough about your implementation.

Table 1

Fruit	Color	Circularity	Texture
	-0.5	0.4	0.1
	1	0.85	1
	0	0	1
Fruit 1	-0.3	0.5	0.2
Fruit 2	0.15	0.1	0.9
	-1 0 1 	0 1 	0 1 

Note: You **cannot use** MATLAB built-in functions.

Problem 4:

a. Train a multilayer feedforward neural network by the back-propagation algorithm using the two-category two-dimensional data described in the following:

- Class number 1:
  - X1: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.3).
  - X2: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.3).

  - X1: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.3).
  - X2: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.3).

  - X1: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.3).
  - X2: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.3).

- Class number 2:
  - X1: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.2).
  - X2: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.2).

First classify two classes using a single layer neural network. Now use two layers (one hidden layer) and three layers neural networks, respectively. Run your code 10 times to generate different data and train every network and finally calculate the average of the

results for each network. compare the results and explain the difference of neural network with one, two, and three layers. (layer two and three should have 5 or 10 neurons)

Establish the classifier recognition performance by determining the percent of patterns that are classified correctly. Plot the decision boundaries.

b. Repeat part a. using the data described in the following:
   - Class number 1:
     - X1: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.3).
     - X2: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.3).

     - X1: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.3).
     - X2: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.3).

   - Class number 2:
     - X1: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.2).
     - X2: Generate 50 random numbers with Normal distribution (Mean = 0, SD = 0.2).

     - X1: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.2).
     - X2: Generate 50 random numbers with Normal distribution (Mean = 1, SD = 0.2).

   Compare the results.

Note: You can use the MATLAB built-in functions.

Descriptive Assignments

Please solve the following questions of the 12th Chapter of the textbook: 6, 15, 17, and 22.

Notes:

1. Put written codes for each problem in one m-file, and for each section, intercept them by %%.
2. Analytical problems can be solved on papers, and there is no need to type the answers. The only thing that matters is the quality of your pictures. Scanning your answer sheets is recommended. If you are using your smartphones, you may use apps such as CamScanner or Google Drive Application.
3. Simulation problems need report as well as source code and results. This report must be prepared as a standard scientific report.
4. Your report is particularly important in the correction process. Please mention all the notes and assumptions you made for solving problems in your report.
5. You have to prepare your final report, including the analytical problems answer sheets and your simulation report in a single pdf file.
6. Finalized report and your source codes must be uploaded to the course page as a ".zip" or ".rar" file with the file name format as: Fullname_StudentNumber_HW#.rar.
7. Plagiarisms will be strictly penalized.
8. You may ask your questions from the corresponding TA of each assignment.

Good Luck!