01205517 Final Exam

You have 2 hours to complete Question 1 to 4 in the examination room and you have until Monday Sep. 6th, 2019 to complete Question 5.

Part I: In this part, you will need to show all steps of your computation on the GOOGLE Document and submitted online by the deadline.

1. (10 points) Let Z be an $M \times N$ binary images, and Y_{ij} be the number of 1s in a block of size $K \times K$ centered (i, j) where K is a positive odd number. Fig. 1 displays an example of Z and Y_{ij} with $K = 3$. From experience, we know that Y_{ij} can be modeled as a mixture of two-binomial distribution, i.e.,

$$\Pr(Y_{ij} = l) = \pi \binom{n}{l} p^l (1-p)^{n-l} + (1-\pi) q^l (1-q)^{n-l}$$

where $0 < \pi, p, q < 1$ and $n = K^2$. Derive the estimates of π^t, p^t and q^t at the t-th iteration of the EM-algorithm. (Please check the idea of EM algorithm in the Image Segmentation Method Lecture).

1	1	0	0	0	1
1	1	0	0	1	1
0	0	0	0	1	1
0	0	1	1	0	0
0	0	1	1	0	0
0	0	1	1	0	0

Example of Z

4	4	2	1	3	3
4	4	2	2	5	5
2	3	3	4	5	4
0	2	4	5	4	2
0	3	6	6	3	0
0	2	4	4	2	0

Example of Y

Figure 1: Example of Z and Y

2. (10 points) In many practical situations, the geometry of a remote sensing may be enhanced in different ways (smoothing and edge detection) before adding back together. Let $t_1(x, y)$ and $t_2(x, y)$ be the templates for two dissimilar image operations. Furthermore, let $\varphi(x, y)$ be the original image, and $\rho_1(x, y) = T_1(\varphi(x, y)) = t_1(x, y) * \varphi(x, y)$ and $\rho_2(x, y) = T_2(\varphi(x, y)) = t_2(x, y) * \varphi(x, y)$ be the enhanced images from Templates $t_1(x, y)$ and $t_2(x, y)$, respectively. Show that $\rho_s(x, y) = \alpha\rho_1(x, y) + \beta\rho_2(x, y)$where $\rho_s(x, y)$is the output image obtained by applying template $\alpha t_1(x, y) + \beta t_2(x, y)$. This result demonstrates that we can add all templates together first before applying to the image which can reduce the computational time.

3. (10 points) Find the decision surface (line) of a two-bands image where the Maximum Likelihood classifier of the multivariate normal model is used if $\mathbf{m}_1 = [1 \quad 1]^T$

and $\mathbf{m_2} = [1 \quad -1]^T$ and $\Sigma_1 = \begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$ and $\Sigma_2 = \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}$. Also draw a decision surface.

Part II: Computer program

4. (10 points) Classify a remote sensing image in a file "FinalQ4Image.jpg" using the training samples in the following list "agriculture_samples.csv, barren_samples.csv, Range_samples.csv, urban_samples.csv, water_samples.csv" for Classes of Agriculture Barren, Range, Urban and water respective. Each file contains 10,000 locations in row and column for the underlying class. You will use the first 8,000 and another 2,000 samples from each class for train and test, respectively. You must submit
    a. Classified Map where urban, agriculture, Range, water, and barren use the color codes [0,255,255], [255,255,0], [255,0,255] [0,0,255], and [255,255,255] in the RGB color space, respectively. You can use any algorithm. [5 points for 80% or more, 4 points for 70%-80%, 3 points for 60%-70%, and 0 point for 0%-60% in term of overall accuracy.]
    b. Produce the confusion matrix of test samples
    c. Find Overall, Users' and Producers' accuracies.
    d. Find Kappa Coefficient.
    e. Submit the results in a GOOGLE Document and land cover map as a separate file.

5. (10 points) Use the image from Pavia University Dataset from Prof. Paolo Gamba where "PaviaU.mat" and "PaviaU_gt.mat" are image and ground truth files in the MAT file format (MATLAB MAT FILE).
    a. Find the first 3-band Minimum Noise Fraction Transformation of the Pavia University image where the first, second and third bands are put into red, green and blue color.
    b. Perform a land cover mapping on PaviaU Image using PaviaU_GT as a train and test samples. The portion of train and test samples are 10/90.
    c. Report on the overall accuracies and Kappa coefficient. Please note that your score is judged by the accuracy of your land cover map
    d. Submit the results in GOOGLE Document and land cover map as a separate file.