CO543 - Image Processing
Lab 04
Pattern Recognition

The process of image pattern recognition includes four steps: image acquisition, image preprocessing, image feature extraction and classification

Recognition Based on Decision- Theoritic Methods

Matching

Matching is usually referred to as the class of operations that involve registration of two or more images with one another. Matching can be classified into a number of categories.

Recognition techniques based on matching represent each class by a prototype pattern vector. An unknown pattern is assigned to the class to which it is closest in terms of a predefined metric. The simplest approach is the minimum distance classifier, which as its name implies, computes the Euclidean distance between the unknown and each prototype vector.

Neural Netowrks

Perceptron for two pattern classes

In machine learning, the perceptron is an algorithm for supervised learning of binary classifiers. A binary classifier is a function which can decide whether or not an input, represented by a vector of numbers, belongs to some specific class.

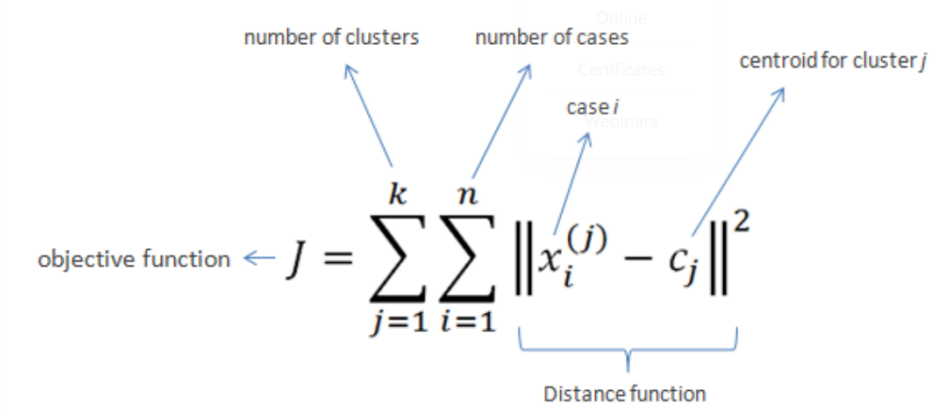
Image Segmentation with K-Means clustering

Image segmentation is the classification of an image into different groups.Image segmentation is an important step in image processing, it is necessary if we want to analyze what's inside the image. Image segmentation is used to separate objects and analyze each object individually to check what it is. K-Means clustering is one of the most popular method used in image segmentation.

K-Means clustering algorithm

K-Means clustering algorithm is an unsupervised algorithm and it is used to segment the interest area from the background. It clusters, or partitions the given data into K-clusters or parts based on the K-centroids.

The algorithm is used when you have unlabeled data(i.e. data without defined categories or groups). The goal is to find certain groups based on some kind of similarity in the data with the number of groups represented by K.



Steps in K-Means algorithm:

1. Choose the number of clusters K.
2. Select at random K points, the centroids(not necessarily from your dataset).
3. Assign each data point to the closest centroid → that forms K clusters.
4. Compute and place the new centroid of each cluster.
5. Reassign each data point to the new closest centroid. If any reassignment . took place, go to step 4, otherwise, the model is ready.

** We encourage you to refer to the 12th chapter of the Digital Image Processing 3rd ed. - R. Gonzalez, R. Woods
** The neural network part of the lab is a self taught exercise and we would encourage you to read papers and refer to the guided tutorials of tensorflow.

Lab Task

1. Using K-means algorithm Identify the different clusters of MNIST Handwritten Digits
   Dataset : https://www.kaggle.com/c/digit-recognizer
   a. Briefly describe the elbow method and the silhouette method
   b. Mention the criteria behind the way you define number of clusters
   c. Visualize each cluster and justify the reasons for misclusted images(eg: 5 is in 8's cluster).
   d. Suggest the ways to reduce the cluster errors.

2. Using Artificial neural network and convolutional neural network Identify the different classes of MNIST Fashion dataset.
   Dataset : https://www.kaggle.com/zalando-research/fashionmnist

a. Initially train a classifier using artificial neural network while treating pixels as different features
b. Train a Convolutional neural network(CNN) for the above data set considering data points as images.
c. Identify the difference between above 2 models
d. Visualize the different layers in the CNN and identify different patterns recognized in each layer of the network.
e. Identify the change of complexity of the patterns recognized by layers with the depth of the network.
f. Discuss having more or less nodes in a single layer and having a deep or a shallow network against the computational complexity.
g. Discuss about the way you defined the optimum neural network architecture for the above problem.

Submission

You need to submit all python files containing the relevant functions named according to the relevant question names or as indicated in the lab sheet, along with the main function to run them and display your outputs. Make sure to include the images you used to run the codes as well.

You need to submit a report (e17XXXresults.pdf) including

- Screenshots for the codes
- all results from your code (your input and output images under each section after performing the required functions).
- Necessary explanations and answers for the questions

under every part of the lab task.

You can submit a single ZIP file as e17XXXlab03.zip including all:

- Python source codes
- Report

Note: XXX indicates your registration number in all cases.