Deep Learning –HW2

About the Assignment

The main aim of the assignment is to make you familiar with the calculating PDF and classification using Bayesian Classifier, which is also called as Bayes Rule.

$$p(\underline{x}|\omega_i) = \frac{1}{(2\pi)^{\frac{1}{2}}|\Sigma_i|^{\frac{1}{2}}} \exp\left(-\frac{1}{2}(\underline{x}-\underline{\mu}_i)^{\mathrm{T}}\Sigma_i^{-1}(\underline{x}-\underline{\mu}_i)\right) \quad (Eq.1)$$

$\underline{\mu}_i = E[\underline{x}]$: $\ell \times 1$ vector in $\omega_i = mean\ of\ \ samples\ \ for\ \ classs\ \omega_i$

$\Sigma_i = E\left[(\underline{x}-\underline{\mu}_i)(\underline{x}-\underline{\mu}_i)^{\mathrm{T}}\right]$: $\ell \times \ell$ matrix in ω_i

Σ_i covariance matrix

$|\Sigma_i|$: *is* determinant of covariance matrix

Σ_i^{-1} : is inverse of covariance matrix

In this experiment, assume that class probabilities are equal, $p(\omega_0) = p(\omega_1) =, \ldots, = p(\omega_3)$

Therefore, we will use **Maholanabis distance in place of Bayes Classifier**.

For this experiment, we will make simulations on Caltech Tiny dataset. The dataset is provided as train and test.

Step-1: Explanation

Assume that you are given 3 classes named as $\omega_1, \omega_2, \omega_3$, where each class contain n samples. According to the Bayes Rule, we have to calculate the distances of the given test sample in order to check whether belongs or not to a specific class. For this purpose, we will use the Eq. 2.

Prior to test stage, you have to found below variables for each class.

$\underline{\mu}_i$ mean of samples in class ω_i

Σ_i covariance matrix

It is advised to store these variables in a python list, called models.

In total, you will obtain 3 mean vector and 3 covariance matrix.

In case of test stage, you need to execute the following equation to compute distances. This is known as Mahalanobis distance.

$$p(w_i|\underline{x}) = \left((\underline{x} - \underline{\mu}_i)^T \Sigma_i^{-1} (\underline{x} - \underline{\mu}_i)\right) \quad \text{(Eq.2)}$$

Step-2: Training Stage

First of all, read images from data/train folder and resize to 64x64 format. Next, convert all images into vector format as 4096x1. Assume that each class contains n images. In total, you will obtain a matrix with size of 4096xn.

For each class, you need to calculate, a covariance matrix and a mean vector.

For each class, the size of covariance matrix will be 4096x4096

For each class, the size of mean vector will be 4096x1

Save these covariance matrices and vectors in a list.

Step-3: Test Stage

Read test images from data/test folder and convert to 64x64 format. Next, convert image to 4096x1 vector format. Then, compute the distance between a test vector and all classes by using the equation 2.

The distances must be stored in an array. Then, the minimum distance would indicate the predicted class label of processed test sample.

Submit the Assignment

Ex: No_Name_Surname_HW#.zip

Hint

See course lecture on Mahalanobis distance .