In The Name of Allah
Pattern Recognition (Autumn 2018)
Instructor: Mahdi Yazdian
Practical Exercise#2: Bayesian Decision Theory

Due Date: 97.08.06

Perform this homework using MALTAB or Python.

Implementation guide

- Implement a function named as 'CreateBayesModel':

```
[model] = CreateBayesModel (method, Likelihoodfcns, priors, costs)
{
        //insert your code
}
```

inputs:

- $method$: it would $'Bayes'\ or\ 'MAP'or\ 'ML'$.
- $Likelihoodfcns$: a vector $(1 \times n)$ of handler functions. The i^{th} element shows the likelihood function of the i^{th} class (n shows #class).
- $priors$: a vector $(1 \times n)$ that consists of the prior of each class.
- $costs$: a matrix $(n \times n)$. The element $< i, k >$ represents the cost of choosing class C_i when class C_k is the true class

output:

- $model$: a structure including all parameters of the specified $method$.

Note: Evidently some inputs are not needed according to the selected $method$.

- Implement a function named as 'ClassifyByBayes':

```
[labels, scores] = ClassifyByBayes(model, samples)
{
        //insert your code
}
```

inputs:

- model: the model used for classification (created by CreateBayesModel)
- samples: a $(d \times m)$ matrix consists of m d-dim samples when m shows #samples and d shows the input dimension, i.e., #features.

outputs:

- labels: a $(1 \times m)$ vector determines the label of each input sample.
- scores: a $(n \times m)$ vector determined the score samples at each class when n shows #class.

1. Describe the input of ‘CreateBayesModel’ when you want to have (a) Bayes (b) MAP and (c) ML decision rule.

2. **Binary classification**
    - Download “tic-tac-toe” dataset from tic-tac-toe.
    - Using your above implementations, classify the dataset using Bayes (with cost matrix $\begin{bmatrix} 0 & 2 \\ 1 & 0 \end{bmatrix}$), MAP and ML.

      Guide: Use the dataset to estimate the prior and likelihood function of each class.

    a) Report the confusion matrix of each method.

    b) For each method, report the accuracy of each class and the averaged accuracy.

    c) Compare and discuss about the results.

3. **Multi-class classification**
    - Download dataset from https://archive.ics.uci.edu/ml/datasets/glass+identification
    - Using your above implementations, classify the dataset using MAP and ML.

      Guide: Use the datasets to estimate the prior and likelihood function of each class.

    a) Report the confusion matrix of each method.

    b) For each method, report the accuracy of each class and the averaged accuracy.

    c) Compare and discuss about the results.

4. **Hints: In previous sections (2&3):**

    a) Check if the covariance matrixes are singular?

    b) If the covariance matrixes are singular, what problem happens?

    c) Offer solutions for resolve problem in section b.

    d) Implement one of your suggested solutions and evaluate the results. **[optional]**

Note:

- Prepare a report in PDF format including the figures, answer to the questions and discussions mentioned in the homework.
- Put your report and your codes within a folder named as “YourNameYourFamily-Practical”+ “Exercise Number”.
  (Note that your code is needed to be self-comment)
- Submit all things in a zipped folder.

Good Luck