

Homework 5

ECE/CS 4720-7720 Machine Learning and Pattern Recognition

Question 1 (Practice).

This question is to demonstrate that: 1) when the selected model is poor, the maximum-likelihood classifier does not produce satisfactory results; and 2) proper transformation of the data can compensate for poor models. The dataset¹ used for this question is divided into training² and test³ data, with each one consisting of 3 classes in a 2D-feature space.

a) Assuming Gaussian distribution for all three class conditional densities, and with unknown means and covariances, compute the **maximum likelihood estimates** for each class using the training data.

b) Ignore the priors, i.e. assume 1/3 for all three classes, and redo parts a) and b) of Homework 2, Question 1, and use those same Matlab functions in part c) below. Use the means and variances from part a) above.

c) Classify the test data and compute the test error using confusion matrix⁴.

d) **Bayesian estimates.** The data has a simpler description when seen in polar coordinates. Use *cart2pol()* to transform all the data points to polar coordinates. Use *scatter()* to plot the transformed points. What you should find is that the transformed data looks Gaussian on the radius r and uniform on the angle θ . So, ignore the angle θ and classify the test data only on r as follows.

The problem is now 1-D and again, if you inspect the data, Gaussian distribution is a more suitable pdf to describe all three classes. Assume then that each class has $p(r|\omega_i) = N(\mu_i, \sigma^2)$ with μ_i unknown and variance $\sigma^2 = 0.25$ for all three classes. Let the only prior knowledge about μ_i be $p(\mu_i) = N(\mu_0 = 0, \sigma_0^2 = 100)$ and compute the Bayes estimates for μ_i and the posterior distribution $p(\mu_i|D_i)$ of all three classes. Next compute $p(r|\omega_i, D_i) = \int p(r|\mu_i) p(\mu_i|D_i) d\mu_i$ and use this density estimate to classify the test data and compute the test error using confusion matrix.

Do not forget to comment on the results from each step above.

¹http://vigir.missouri.edu/~gdesouza/ece7720/test_train_data_class3.mat

²access the training data by `TrainPts = Data.train`

³access the test data by `TestPts = Data.test`

⁴http://vigir.missouri.edu/~gdesouza/ece7720/Lecture_Notes/Lecture10.pdf