CS5011 : Introduction to Machine Learning

Programming Assignment #2

- The goal of this assignment is to experiment with some of the concepts taught in the class till now.
- This is an individual assignment. Collaborations and discussions with others are strictly prohibited.
- You may use Matlab, Python for your implementation. If you are using any other languages, please contact us before you proceed. For the **pmtk** question, you need to use matlab
- You have to turn in the well documented code along with a detailed report of the results of the experiment electronically in Moodle. Typeset your report in LaTeX.
- Your report should contain detailed answer for all of the questions asked below.
- Submission deadline: 18th October, 2015.

Backpropagation

1. Implement the original backpropagation algorithm, which you learnt in class. Use DS2(image data) from the previous assignment for training your network. Report per-class precision, recall and F-measure on the test data. Also plot your training error vs epochs while training your network, and submit these plots.
2. Now consider the following alternate error function, with regularized terms

$$R(\theta) = \frac{1}{2}\sum_{i=1}^{N}\sum_{k=1}^{k=K}\left(y_{ik} - f_k(x_i)\right)^2 + \gamma(\sum_{k}\sum_{m}\beta_{km}^2 + \sum_{m}\sum_{l}\alpha_{ml}^2)$$

   where N is the number of training instances, K is the number of output features, $f_k(x)$ is the predicted output vector, y is the original output vector, α and β are the weights and γ is a regularization parameter. Derive the gradient descent update rule for this function R. Now train your neural network with this new error function. Report per-class precision, recall and f-measure on the same test data. What will happen when you vary the value of γ? Vary the value of γ from 10^{-2} to 10^2 in multiples of 10 and repeat the experiment and report the results. Can you figure out the effect of γ in the results? Look at the weights learnt using the new error function. What do you infer from them? Also submit training error vs epochs plots

QDA & RDA

1. We have discussed about Linear Discriminant Analysis(LDA) in the class. We will see how different variants of this technique works. For this experiment, you have to use Iris Dataset (`http://archive.ics.uci.edu/ml/datasets/Iris`). Use only petal width and petal length features and perform LDA. Visualize the boundaries learnt. Also read about Quadratic Discriminant Analysis (QDA) and Regularized Discriminant Analysis (RDA) from the text book. Do QDA and RDA on the same data set and visualize the boundaries. You have to submit all the three plots. Please refer to section of 4.3 of Elements of Statistical Learning.

Logistic Regression

1. Use DS2 and perform Logistic Regression on it. Report per-class precision, recall and f-measure on the same test data you used to test the neural network. Now perform L1-regularized Logistic Regression on the same dataset and report similar performance results. Use l1 logreg code provided by Boyd's Group `http://www.stanford.edu/~boyd/l1_logreg/`.

Using External Libraries

1. You can use PMTK (https://github.com/probml/pmtk3) for LDA, RDA and QDA. For L1-regularized Logistic Regression use the code provided by Stephen Boyd's group. Link is provided in the question. You should NOT use any other external libraries or toolkit.

Submission Instructions

Submit a single tarball file containing the following files in the specified directory structure. Use the following naming convention: 'cs5011_pa2_rollno.tar.gz'

code

Source Code

report.pdf