

CSE 847 (Spring 2016): Machine Learning— Homework 4

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Due on Tuesday, April 5th, before class.

1 Logistic Regression: Experiment

In this part you will implement logistic regression. You are to write a MATLAB function called `logistic_train.m` that takes an input data set, a set of binary training labels, and an optional argument that specifies the convergence criterion, and returns a set of logistic weights. Specifically the function should have the following form:

```
function [weights] = logistic_train(data, labels, epsilon, maxiter)
%
% code to train a logistic regression classifier
%
% INPUTS:
%   data      = n * (d+1) matrix with n samples and d features, where
%               column d+1 is all ones (corresponding to the intercept term)
%   labels    = n * 1 vector of class labels (taking values 0 or 1)
%   epsilon   = optional argument specifying the convergence
%               criterion - if the change in the absolute difference in
%               predictions, from one iteration to the next, averaged across
%               input features, is less than epsilon, then halt
%               (if unspecified, use a default value of 1e-5)
%   maxiter   = optional argument that specifies the maximum number of
%               iterations to execute (useful when debugging in case your
%               code is not converging correctly!)
%               (if unspecified can be set to 1000)
%
% OUTPUT:
%   weights   = (d+1) * 1 vector of weights where the weights correspond to
%               the columns of "data"
%
```

The classifier should be trained using the **Newton-Raphson (IRLS) iterative procedure** described in class and in the text, using the **log-likelihood objective function**. You can initialize all the weights at 0. You will test the algorithm on the Spam Email data set¹. There are 57 features and 2 class labels. Please read the README before you use this data. All features have been converted from counts into binary features (by splitting above and below the mean count).

Create a separate test data set consisting of all rows in the file from row 2001 to 4601 inclusive (and corresponding labels). You now have 2 data sets, a training data set with 2000 rows (the first 2000 rows of the original file) and a test data set with 2601 rows. Train your logistic regression classifier on the **first n rows** of the training data, **n = 200; 500; 800; 1000; 1500; 2000** and report the accuracy on the test data as a function of n.

2 Sparse Logistic Regression: Experiment

In this part, you will perform experiments using **sparse logistic regression** (**ℓ_1 -regularized logistic regression**). Use only the first 50 rows as training, and the same 2601 rows as testing. Sparse

¹http://github.com/jiayuzhou/CSE847-2016Spring/tree/master/homework/spam_email

logistic regression is then applied to train a linear model on the training set and prediction is then performed on the test set. You may use the implementation in SLEP², where the sparse logistic regression is the function `LogisticR`³. An example of using the sparse logistic regression is as follows:

```
function [w, c] = logistic_l1_train(data, labels, par)
% OUTPUT w is equivalent to the first d dimension of weights in logistic_train
%         c is the bias term, equivalent to the last dimension in weights in logistic_train.

% Specify the options (use without modification).
opts.rFlag = 1; % range of par within [0, 1].
opts.tol = 1e-6; % optimization precision
opts.tFlag = 4; % termination options.
opts.maxIter = 5000; % maximum iterations.

[w, c] = LogisticR(data, labels, par, opts);
```

The input `par` is the ℓ_1 regularization parameter, which scales from 0 to 1. Try different values of regularization parameter and **report both the accuracy and the number of features selected** (number of non-zero entries in `w`). A suggested list of parameters is [0.01, 0.02, 0.05, 0.1, 0.2], but other choices of parameters are also encouraged.

For both experiments in this homework, submit a brief report. In addition to the report, submit the MATLAB code (do add some comments in your code for others to understand your code) to a public repository under your Github account (the same account of your project) and include the link in the report.

²<https://github.com/jiayuzhou/SLEP/>

³Located at <https://github.com/jiayuzhou/SLEP/tree/master/SLEP/functions/L1/L1R>