MATH 574M: Homework 6 Solution


**Answer:** please see the paper.

2. (a) Show that an adaptive LASSO problem can be transformed into an equivalent LASSO problem.
   (b) Explain how you can use LARS package to fit the adaptive LASSO.

**Answer:** Re-scale the design matrix by absorbing the weights into each column. Express the weighted LASSO as a standard LASSO problem. Then apply the LARS package (with the normalize=F option) to tune the $\lambda$ and obtain the solution. The regression coefficients should be scaled back.

Check the lecture note for math details.

3. Download the prostate cancer data set from the website http://statweb.stanford.edu/~tibs/ElemStatLearn/. The data set contains eight predictors (columns 1-8), $X \in \mathbb{R}^8$. The outcome variable $Y$ is given by column 9. The last column (column 10) is the train/test indicator, indicating 67 “training” data observations and 30 “testing” observations. Let $n = 67$ and $\tilde{n} = 30$. Denote the training set by $\{(x_i, y_i), i = 1, \cdots, n\}$ and the test set by $\{ (\tilde{x}_i, \tilde{y}_i), i = 1, \cdots, \tilde{n}\}$.

**Analysis:** Consider the linear regression of $Y$ on $X$. Use the training set to fit a regression model, $\hat{f}(x) = \hat{\beta}_0 + \hat{\beta}^T x$. For any fitted model $\hat{f}(x)$, calculate its “training error” by $TrainErr = \frac{1}{n} \sum_{i=1}^{n} |y_i - \hat{f}(x_i)|^2$, and its “test error” by $TestErr = \frac{1}{\tilde{n}} \sum_{i=1}^{\tilde{n}} |\tilde{y}_i - \hat{f}(\tilde{x}_i)|^2$. Fit the adaptive LASSO regression for the prostate cancer data set.

   (a) Select the parameter with 5-fold CV, using the minimum CV rule. Report the best tuning parameter, the selected model, the estimated regression coefficients, and the TestErr.
   (b) Select the parameter with 5-fold CV, using the one-standard rule. Report the best tuning parameter, the selected model, the estimated regression coefficients, and the TestErr.
   (c) Compare the adaptive LASSO with the LASSO and forward selection, in terms of their variable selection results and prediction accuracy.

**Answer:** Please check the code. The results are subject to variations due to the random seed used in the function cv.lars().

4. Classify 2’s and 3’s for zip code using the linear SVM, Gaussian kernel SVM, and polynomial kernel SVM. Fit the training data using a sequence of tuning parameters and find the one which gives the best error on the test set. You may consider using the R package e1071.

**Answer:** please see the code.

5. Classify “1”, “2” and “3” for the zip code using the classification tree in R. Report both the training error and test error. You may consider using the R package tree.

**Answer:** please see the code. The results are subject to variations due to the random seed used in the function tree().