Regularized support vector machine

(Due on Nov.-01-2019)

Instruction: Each student needs to submit the source code file and a report by Latex. In the report file, you can summarize what you observe or difficulties you have. **You will be evaluated based on correctness of your algorithms, accuracy and efficiency of algorithms, performance on applications, and also the report**. Compress your files into a single .zip file, name it as "MATP6960_Assignment3_YourName", and send it to `optimization.rpi@gmail.com`

1 Problem description

The ℓ_2 regularized support vector machine is formulated as

$$\underset{\mathbf{w}}{\text{minimize}} \ \frac{1}{N}\sum_{i=1}^{N}\max(0, 1 - y_i\mathbf{x}_i^\top\mathbf{w}) + \frac{\mu}{2}\|\mathbf{w}\|^2, \tag{1}$$

where $\{(\mathbf{x}_i, y_i)\}_{i=1}^N$ are given training data with each $y_i \in \{+1, -1\}$. Let $\mathbf{w}^*$ be the solution. Then for a new data point $\mathbf{x}$, it can be classified as $\text{sign}(\mathbf{x}^\top\mathbf{w}^*)$.

2 Requirements

Include every item below in a single report and attach your code. Use the provided testfile to test your code.

1. Give the dual problem of (1) and develop a solver for it using the stochastic dual coordinate ascent method. The input of the solver should include $\mathbf{X}$, $\mathbf{y}$, $\mu > 0$, and other parameters like the stopping tolerance. Here, the i-th row of $\mathbf{X}$ contains i-th data point, and y_i contains the label.

2. Develop a solver for (1) using the stochastic gradient method. The input of the solver should include $\mathbf{X}$, $\mathbf{y}$, $\mu > 0$, and other parameters like the stopping tolerance. In your solver, you can set the mini-batch size as a parameter.

3. Compare the two solvers by using the provided `realsim` data set. Use `(Xtrain, ytrain)` as the training data. Report the primal objective values of the iterate at each epoch (e.g., after each pass of data). Also, use `(Xtest,ytest)` as the testing data and report the prediction accuracy given by the two solvers.