

TDA 231 Machine Learning: Homework 3

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Due Date: February 17 , 2012

Goal: Support Vector Machines

General guidelines:

1. All datasets can be downloaded from the course website.
2. All matlab files have to be submitted as a single zip file named *code.zip*.
3. All plots, tables and additional information should be in a single pdf file named *report.pdf*.
4. The report should clearly indicate your name, personal number, email address and group number.

Useful matlab functions:

- *General:* svmtrain, svmclassify, quadprog, feval
 - *Kernel function example (linear kernel):* $K = @(x, y) \text{dot}(x, y)$;
 - All datasets have variables X (data) and Y (labels)
1. (2 points) Use matlab *quadprog* package to implement the function $[alpha] = qp_svm_separable(X, Y)$ which solves (dual) svm formulation for the linear separable case.
 - (a) Run it on the dataset *d1.mat*. Report running time for training. Give the classifier in terms of w, b .
 - (b) Submit your implementation of $[alpha] = qp_svm_separable(X, Y)$.
 - (c) (Not to be submitted) Plot the hyperplanes $w^\top x + b = -1$ and $w^\top x + b = 1$.
 2. (3 points) Implement the function $[alpha] = my_svm(X, Y, K, C)$ which solves the svm (dual) formulation for the non-separable case. Here K and C denote the kernel function and box constraint (for the soft margin) respectively.
 - (a) Submit your implementation of $[alpha] = my_svm(X, Y, K, C)$.
 - (b) Run it on dataset *d2.mat* with the linear kernel. Repeat your experiment with the degree-2 kernel $K(x, z) = (1 + x^\top z)^2$. Use $C = 1$.
 - (c) Construct a classifier

$$f(x) = \text{sign}\left(\sum_i \alpha_i y_i K(x_i, x) + b\right)$$

Report classifier accuracy as well as time taken for the two kernels.

3. (2 points) Redo the above question with the degree-2 kernel on the dataset *d3.mat*. Run *svmtrain* using the SMO method (available in Matlab) on the same datasets. Report a table comparing the running time and accuracy.
4. (3 points) Redo the digits classification problem with polynomial kernel in the above problem, with the variance feature map discussed in the first assignment. Set $C = 1$. Report the classification accuracy.