Practical Data Science/Analytics (Classification)

Write R Scripts or use R to perform any mathematical operations while solving the following problems.

Problem 1: Support Vector Machine Hard Margin Classifier

Given that the positive class has points (-2,1), (-1,1), (-1,2) and negative class has points (1,-2), (1,-1), (2,-1), what is the maximum margin linear separator? What are the support vectors?

Problem 2: Support Vector Machine Soft Margin Kernel Classifiers

The following figure plots SVM decision boundaries resulting from using different kernels and/or different slack penalties. In the figure, there are two classes of training data, with labels {-1,1}, represented by circles and squares respectively. The SOLID circles and squares represent the support vectors. Label each plot in figure with the letter of the optimization problem below and explain WHY you pick the figure for a given kernel. (Note that there are 6 plots, but only 5 problems, so one plot does not match any of the problems.)

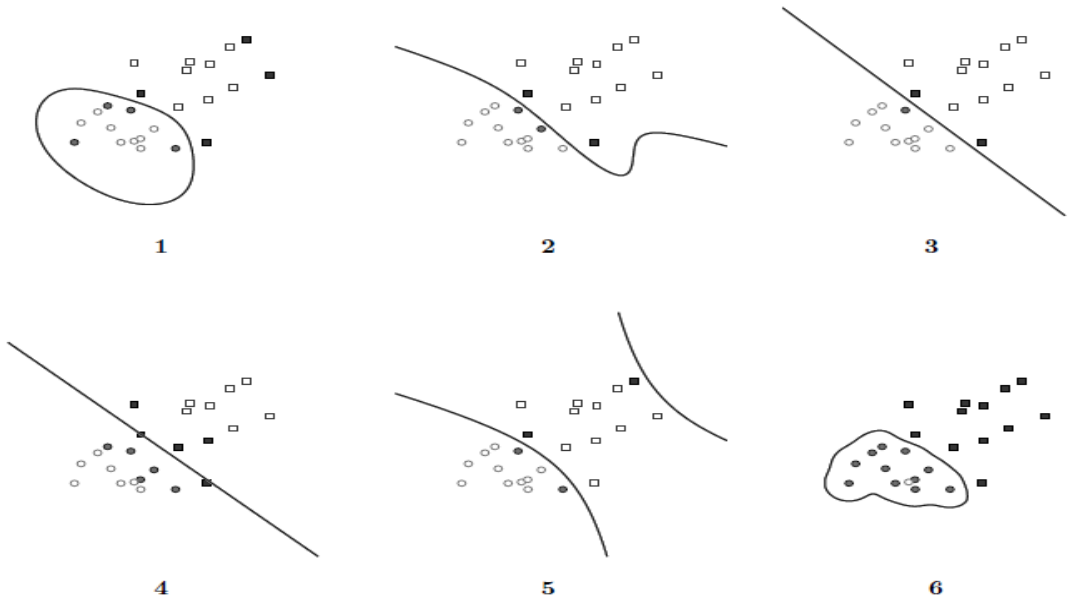
(a) A soft-margin linear SVM with C = 0.1

(b) A soft-margin linear SVM with C = 10

(c) A hard-margin kernel SVM with K(u,v) = u.v + (u.v)2

(d) A hard-margin kernel SVM with K(u,v) = $\exp\left(-\frac{1}{4}\|\mathbf{u}-\mathbf{v}\|^2\right)$

(e) A hard-margin kernel SVM with K(u,v) = $\exp\left(-4\|\mathbf{u}-\mathbf{v}\|^2\right)$



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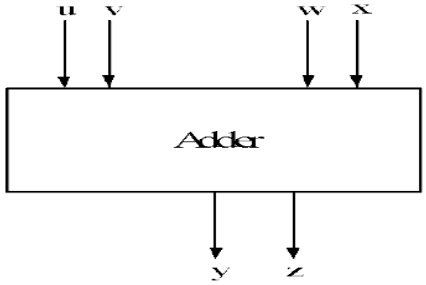
Problem 3: Perceptron Learning

Find the weights and for a Perceptron with inputs x, y, and z, and whose output is z if x = -1 and y = 1, and is -1 otherwise.

Problem 4: Perceptron Learning

For this problem, change the definition of an Perceptron so that both its inputs and output are binary. View uv, wx as two-bit binary (0 or 1) numbers, and yz as the 2 low-order bits of the numerical addition of uv and wx.



(a) Give weights for Perceptron which generates z.
(b) Give weights for Perceptron which generates y.