

ELL 409/791 Minor II Time: 50 mts Marks: 100

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This minor is equivalent to 4 quizzes.

Q. 1. Run LIBSVM to solve the binary classification problem with samples $(-1, -1)$, $(-1, 1)$, $(1, -1)$, $(1, 1)$, and $(4, 4)$ with class labels $-1, 1, 1, -1, -1$, respectively.

(a) Use a RBF kernel. Do not use default values of hyperparameters. Choose appropriate values of hyperparameters. Write out the command line statement for running LIBSVM, and copy any input files you made onto your answer sheet.

(b) Copy the model file. On separate lines, list the sample feature values, class label, and λ_i .

(c) Determine the value of b .

(d) Write out the statements and steps used to find the class of a test sample at the locations $(0.5, 0.5)$, $(-2, -2)$, $(2, 3)$.

(40)

Q. 2. In a kernel SVM, the samples x^i are transformed to an image space using a map (ϕ) , and the hyperplane in the image space is given by $w^T \phi(x) + b = 0$.

(a) Derive the margin for the classifier image (ϕ) space.

(b) Compute the margin for the hyperplane found in Q.1.

(30)

Q. 3. Consider the following SVM classifier formulation.

$$\text{Min } 0.5(\|w\|^2 + Ab^2) + C \sum_{i=1}^M q_i^2 \quad (1)$$

subject to the constraints

$$y_i(w^T x^i + b) + q_i = 1, i = 1, 2, \dots, M \quad (2)$$

$$q_i \text{ unconstrained in sign} \quad (3)$$

where the symbols have their usual connotation.

(a) Write the Lagrangian and the KKT conditions.

(b) Determine the dual formulation.

(30)