Iowa State University
Department of Computer Science
Machine Learning (Com S 573)
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Problem Set 4

1. (**25 pts.**) Prove the modularity property of kernel functions (see lecture notes for statement of this property).

2. (**25 pts.**) Consider the problem of solving for the lagrange multipliers α_1 and α_2 that define the weight vector corresponding the maximum margin separating hyperplane and the bias term b in the special case where there are only 2 linearly separable training samples $(\mathbf{X}_1, y_1)$ and $(\mathbf{X}_2, y_2)$. Precisely formulate the corresponding optimization problem. Does this optimization problem have a closed-form solution? Comment on the possibility of using the results of your analysis for solving the general SVM optimization problem where the training set contains more than 2 training examples.

3. **25 pts.**) Show that the VC-dimension of convex d-gons (polygons with d sides in 2-dimensional plane is $2d + 1$.

4. **25 pts.**) For any two hypothesis classes H_1 and H_2 with VC-dimensions d_1 and d_2 respectively, show that the VC-dimension $H_1 \cup H_2$ is less than or equal to $d_1 + d_2 + 1$.

5. **25 pts.**) How would you generalize the p-spectrum kernel for sequences to work with 2-dimensional images? Design a suitable kernel for classifying documents that consist of both text and images. (Hint: use modularity property of kernels).