COMP 7745/8745: Machine Learning

Instructor: Deepak Venugopal

Spring 2018: Homework 3

Due Date: April 16, 2018 (Hard copy in class or softcopy in ecourseware)

1. Given the following dataset, which kernel for the support vector machine would you pick and why?(10 points)

X_0	X_1	y
0	0	-1
0	1	1
1	0	1
1	1	1

2. Given a support vector machine trained on m examples, what is an upper bound on its leave-one-out cross validation error given that it has a) m support vectors b) $m/2$ support vectors (10 points)

3. Given the following dataset, we wish to apply Adaboosting using SVMs with linear kernels as our base classifier. Is this a good idea? Explain your answer. (10 points)

X_0	X_1	y
0	0	-1
0	1	-1
1	0	-1
1	1	1

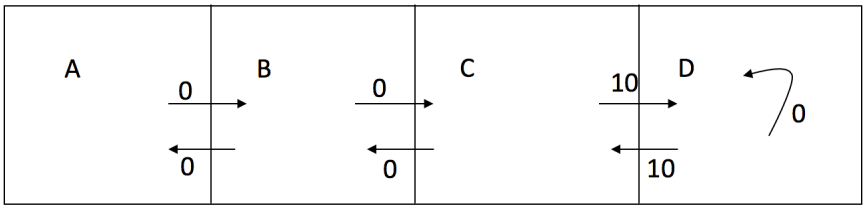
4. An SVM is trained with the following data (20 points)

X_0	X_1	y
0	0	-1
0	1	1
1	2	1

a) Using a Linear kernel, what is the optimization problem that needs to be solved to determine the support vectors.

b) Assume that the Lagrangian coefficients have the values, $\alpha_1 = 4$, $\alpha_2 = 2$, $\alpha_3 = 0$. What are the support vectors. Given a new instance (-1,0), what are the steps that the SVM would take to classify this instance?

c) Suppose we find out that for a given dataset, using a linear kernel, the solver for the optimization problem, returns infinite values for Lagrangian coefficients, what can you say about the dataset? What would be your next logical step?



5. For the above grid world, assuming a discount factor of 0.1, what is the i) optimal policy ii) Approximate Q-values that the Q-learning algorithm will converge to. (15 points)

6. In the ADABoosting algorithm, suppose in iteration t+1, we increase the weights of those data points that are correctly classified in iteration t. Is this a good idea. Explain your reasoning. (15 points)

7. Here, you will experiment with the SVM implementation in Weka for the given dataset and Adaboosting with the wines dataset. For this, download the LIbSVM jar (provided in the zip file). You need to start Weka GUI from commandline with the libsvm.jar in the class path. E.g. java -classpath weka.jar;libsvm.jar weka.gui.GUIChooser. The SVM implementation shows up as SMO under functions, and Adaboosting is under Meta. (20 points)

   Report the 10-fold cross-validation results (average precision,recall and F1) for each of the 3 kernel types (linear (polynomial degree 1), RBF and polynomial degree 2) for the cost factors, 1, 10, 100 and 1000. Briefly explain your observations of the effect of kernel types and cost factors on computation time and accuracy?

   For Adaboosting, you will experiment with using weak and strong base classifiers. For the first-case, choose decision stumps as the base classifier, and for the second case use J48 as the base classifier. Does Adaboosting help boost the performance of both? Specifically, compare the 10-fold cross-validation results (average precision,recall and F1) for the base classifiers (decision stumps and J48), with the Adaboosted versions of these base classifiers.