Homework 6
Chapter 9

Due date: Thursday, Dec. 6, 2018

1) Exercises: #1
   - In this problem first use the Adaboost version in the book.
   - Then, repeat the problem using the original Adaboost proposed by its inventors.

2) An additional problem
   In this problem you are asked to write down a perceptron learning algorithm to determine the weights that a master classifier in an Adaboost algorithm. Suppose that the original training set has m examples denoted by $x_1, x_2, \ldots, x_m$. Suppose that class labels are either 0 or 1. Let x_j be the j-th example and $c(x_j)$ denote the class of that example. Suppose that the Adaboost algorithm induces n baseline classifiers. Let $h_i(x_j)$, for $1 \le i \le n$ and $1 \le j \le m$, denote the class that the i-th baseline classifier determines for example x_j. Let w_i denote the weight associated with the i-th baseline classifier. Let η be the perceptron learning rate. Write down a perceptron learning algorithm using the notations above.

3) Computer Assignment
   - Implement both the Adaboost algorithm in the textbook and the original Adaboost algorithm by its inventors. Also implement perceptron learning.
   - Use the training set in ILMS. This training set contains 90 examples with 2 classes. Each example is described by 4 continuous attributes.
   - In both versions of the Adaboost algorithm, randomly create 9 training subsets. From each training subset, induce a 1-NN classifier. For each training subset, randomly select (with replacement) 10 examples. Induce a 1-NN that you have learned in Chapter 3.
   - In the original version of Adaboost, the weights that the master classifier uses on each individual classifier are given by

   $$\alpha_t = \frac{1}{2} \ln \left(\frac{1 - \epsilon_t}{\epsilon} \right).$$

   - If $\beta_t = 0$ in the t-th round, use the same probability distribution to choose examples.
   - For the Adaboost version given in the textbook, use perceptron learning algorithm to determine the weights.
   - Find the classification accuracy of the master classifiers of the two versions using the testing set (which contains 15 examples) on ILMS. Keep only the first 10 examples.
   - Also use your perceptron learning program to induce a linear classifier using 90 examples. Find the classification accuracy of this linear classifier. How does it compare with the accuracy of the two Adaboost algorithms? Use 0.2 as the initial weights and the learning rate.

Exercises

1. Suppose the probabilities of the training examples to be used by *Adaboost* are those listed in Table 9.6. From these, a training subset, T_i, has been created, and from T_i, classifier C_i was induced. Suppose that C_i then misclassifies examples $\mathbf{x_2}$ and $\mathbf{x_9}$. Show how the probabilities of all training examples are re-calculated, and then normalize the probabilities.

Table 9.6 The probabilities of ten training examples

$p(\mathbf{x_1})$	$p(\mathbf{x_2})$	$p(\mathbf{x_3})$	$p(\mathbf{x_4})$	$p(\mathbf{x_5})$	$p(\mathbf{x_6})$	$p(\mathbf{x_7})$	$p(\mathbf{x_8})$	$p(\mathbf{x_9})$	$p(\mathbf{x_{10}})$
0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.17	0.17	0.17