

Course: DD2427 - Exercise Set 8

Exercise 1: *Limitation of boosting*

Consider the exclusive-OR (XOR) problem. It is defined by two dimensional points ($\mathbf{x} = (x, y)$) belonging to two classes. These points are

$$\begin{aligned}\omega_1 &: (1, 1)^T, (-1, -1)^T \\ \omega_2 &: (-1, 1)^T, (1, -1)^T\end{aligned}$$

In this question we will investigate if it is possible to build a strong classifier using boosting that correctly classifies these points using lines to separate the two classes.

- i) Plot the points with different symbols for each class. Are they linearly separable ?
- ii) Let the set of weak classifiers be vertical and horizontal lines. So the vertical and horizontal lines define weak classifiers of the form

$$h_v(\mathbf{x}) = \text{sgn}(a_v x + c_v) \quad h_h(\mathbf{x}) = \text{sgn}(a_h y + c_h)$$

Work through one iteration of the boosting algorithm. What is the problem ? Can we use this set of weak classifiers to solve the XOR classification problem ?

- iii) (**Optional**) Next consider the set of weak classifiers that are lines of slope 1 and -1. Thus

$$h_1(\mathbf{x}) = \text{sgn}(a_1 x + a_1 y + c_1) \quad h_2(\mathbf{x}) = \text{sgn}(a_2 x - a_2 y + c_2)$$

Can this set of weak classifiers provide a solution ? Sketch one possible strong classifier and use a couple rounds of the boosting algorithm to compute it. (Remember $e^{\ln(x)} = x$ when $x > 0$.)

For the lecture: 26th April

Bring your hand written solution to this exercise.