Artificial Intelligence HW8

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1.

因为决策树是通过属性来划分的，每个叶结点由唯一的一串属性索引。所以相同属性的样本最后会进入相同的叶结点，一个叶结点只有一个分类。如果样本属性相同但分类不同，则会产生训练误差。由于训练集不含冲突数据，所以决策树根据深度优先法构造，只会在当前样本集合是同一类或者所有属性相同时才会停止划分，最终得到训练误差为 0 的决策树。

2.

首先构造并求解最优约束化问题:

$$\min_{\alpha} \frac{1}{2}\sum_{i=1}^{5}\sum_{j=1}^{5}\alpha_i\alpha_j y_i y_j (x_i \cdot x_j) - \sum_{i=1}^{5}\alpha_i$$

$\min_\alpha \frac{1}{2}(5\alpha_1^2 + 13\alpha_2^2 + 18\alpha_3^2 + 5\alpha_4^2 + 13\alpha_5^2 + 18\alpha_1\alpha_2 + 18\alpha_1\alpha_3 - 8\alpha_1\alpha_4 - 14\alpha_1\alpha_5 + 30\alpha_2\alpha_3 - 14\alpha_2\alpha_4 - 24\alpha_2\alpha_5 - 18\alpha_3\alpha_4 - 30\alpha_3\alpha_5 + 16\alpha_4\alpha_5) - (\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5)$
条件为 $\alpha_1 + \alpha_2 + \alpha_3 - \alpha_4 - \alpha_5 = 0, \alpha_i \geq 0$
分别对 α_1,α_2,α_3,α_4,α_5 求导：
$5\alpha_1 + 9\alpha_2 + 9\alpha_3 - 4\alpha_4 - 7\alpha_5 - 1 = 0$
$13\alpha_2 + 9\alpha_1 + 15\alpha_3 - 7\alpha_4 - 12\alpha_5 - 1 = 0$
$18\alpha_3 + 9\alpha_1 + 15\alpha_2 - 9\alpha_4 - 15\alpha_5 - 1 = 0$
$5\alpha_4 - 4\alpha_1 - 7\alpha_2 - 9\alpha_3 + 8\alpha_5 - 1 = 0$
$13\alpha_5 - 7\alpha_1 - 12\alpha_2 - 15\alpha_3 + 8\alpha_4 - 1 = 0$
再根据 $\alpha_1 + \alpha_2 + \alpha_3 - \alpha_4 - \alpha_5 = 0$ 解方程组得：
$\alpha = (\frac{1}{2}, 1, 0, 1, \frac{1}{2})^T$
所以 $w^* = (-1, 2)^T, b = -2$

分离超平面为 $-x^{(1)}+2x^{(2)}-2=0$

分类决策函数 $f(x)=sign(-x^{(1)}+2x^{(2)}-2)$