

## \* Problem 3: Adaboost.

ID	1	2	3	4	5	6	7	8	9	10
X	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
Y	1	1	1	-1	-1	-1	-1	-1	-1	1

$$\rightarrow D_1(1) = \dots = D_1(10) = \frac{1}{N} = \frac{1}{10} = 0.1$$

①

(i) for weak classifier (Hypothesis)  $H_1$ , $H_1$ : if  $x \leq 0.35 \rightarrow Y=1$ , else  $Y=-1$ 

$$\therefore \text{err}_1 = 0.1 \times 2 = 0.2$$

$$\therefore \alpha_1 = \frac{1}{2} \ln \left( \frac{1 - \text{err}_1}{\text{err}_1} \right) = \frac{1}{2} \ln \left( \frac{1 - 0.2}{0.2} \right) = 0.693$$

$$\rightarrow \text{Update, } D_t(i) = D_t(i) \exp(-\alpha_t y_i h_t(x_i))$$

 $\therefore$  For those classified not correctly,

$$D_2(i) = 0.1 \times e^{-0.69 \times (1)} = \boxed{0.5016}$$

 $\therefore$  for those classified correctly,

$$D_2(i) = 0.1 \times e^{0.69 \times (1)} = \boxed{0.1994}$$

(ii) For weak classifier,  $H_2$ ,

$$H_2: \text{if } x \leq 0.75 \rightarrow Y = -1, \text{ else } Y = 1$$

$$\therefore \text{err}_1 = 0.1 \times 4 = 0.4$$

$$\therefore \alpha_1 = \frac{1}{2} \ln \left( \frac{1 - 0.4}{0.4} \right) = 0.20$$

$$\rightarrow \text{Update, } D_2(i) = D_1(i) \exp(-\alpha_1 y_i h_1(x_i))$$

$\therefore$  for those classified not correctly,

$$D_2(i) = 0.1 \times e^{0.2 \times 1} = \boxed{0.1221}$$

$\therefore$  for those classified correctly,

$$D_2(i) = 0.1 \times e^{0.2 \times (-1)} = \boxed{0.0819}$$

(ii) For weak classifier,  $H_3$ ,

$$H_3: \text{if } x \leq 0.3 \text{ or } x \geq 0.95 \rightarrow Y = 1, \\ \text{else } Y = -1$$

$$\therefore \text{err}_1 = 0.1 \times 1 = 0.1$$

$$\therefore \alpha_1 = \frac{1}{2} \ln \left( \frac{1 - 0.1}{0.1} \right) = 1.1$$

$$\rightarrow \text{Update, } D_2(i) = D_1(i) \exp(-\alpha_1 y_i h_1(x_i))$$

∴ for those classified not correctly,

$$D_2(i) = 0.1 \times e^{1.1 \times 1} = \boxed{0.3004}$$

∴ for those classified correctly,

$$D_2(i) = 0.1 \times e^{1.1 \times (-1)} = \boxed{0.0333}$$

② ~~For example~~

- For H1: Due to instances 9 and 10, all the instances need to be reweighted after the first iteration.
- For H2: Due to instances 1, 2, 3 and 8, all the instances need to be reweighted after the first iteration.
- For H3: Due to instance 9, all the instances need to be reweighted after the first iteration.