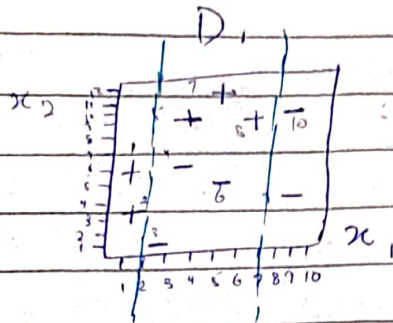


Day: \_\_\_\_\_

# Alaboost (Boosting)

Date: \_\_\_\_\_

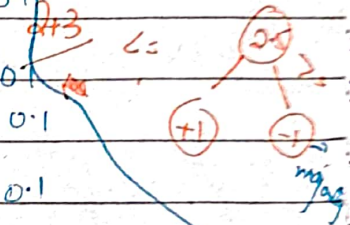


Weak learner

decision stump

depth  $\rightarrow 1$

	$x_1$	$x_2$	Class	Prediction	Weight
1)	1	6	+	+1	0.1
2)	2	3	+	+1	0.1
3)	3	1	-	-1	0.1
4)	4	7	-	-1	0.1
5)	5	9	+	-1	0.1
6)	6	6	-	-1	0.1
7)	7	11	+	-1	0.1
8)	8	8	+	-1	0.1
9)	9	3	-	-1	0.1 <sup>2</sup>
10)	9	9	-	-1	0.1



Sort	$x_1$	$x_2$	$x_1 < 5$
1	1	-1	
2	3	+1	
3	3	-1	
4	6	+1	
5	6	-1	
6	7	-1	
7	8	+1	
8	9	-1	
9	9	+1	
10	11	+1	

more powerful

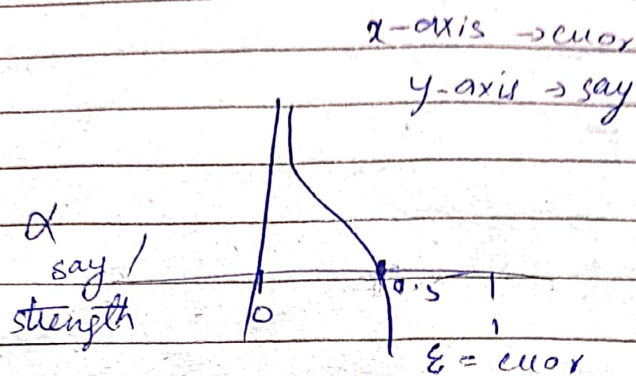
accuracy 100%  
Say weight max  
accuracy 50%  
not reliable

accuracy 0  
max(-weight)  
negation

Day: \_\_\_\_\_

Date: \_\_\_\_\_

$$y = \frac{1}{2} \ln \left( \frac{(1-x)}{x} \right)$$



error is between  
zero and 1

$$\alpha = \frac{1}{2} \ln \left( \frac{1 - \text{error}}{\text{error}} \right)$$

natural

$$\alpha_1 = \frac{1}{2} \ln \left( \frac{1 - \epsilon_1}{\epsilon_1} \right)$$

$$\alpha_1 = \frac{1}{2} \ln \left( \frac{1 - 0.5}{0.5} \right)$$

$$\approx \frac{1}{2} \times 0$$

strong  $\alpha_1 \approx 0$



Day: \_\_\_\_\_

for first cycle  $\rightarrow$  error value  $\rightarrow$  weight sum  $\rightarrow$  total error.

Date: \_\_\_\_\_

$$\alpha_1 = \frac{1}{2} \ln \left( \frac{1 - \epsilon_1}{\epsilon_1} \right)$$

for cycle 1  $\alpha_1 = \frac{1}{2} \ln \left( \frac{1 - 0.3}{0.3} \right)$

$$= \frac{1}{2} \ln \left( \frac{0.7}{0.3} \right)$$

$$= \frac{1}{2} \ln (2.33)$$

$$\alpha_1 = 0.42$$

Original  
dataset

weight update

 $W_{\text{new}} = W_{\text{org}} + e$  (for correctly classified) $W_{\text{new}} = W_{\text{org}} + e^{\alpha}$  (for incorrectly classified)

	$x_1$	$x_2$	class	prediction	weight	updated weight
1	6	6	+1	+1	0.1	0.06
2	3	3	+1	+1	0.1	0.06
3	1	1	-1	-1	0.1	0.06
4	7	7	-1	-1	0.1	0.06
5	4	4	+1	-1	0.1	0.06
6	6	6	-1	-1	0.1	0.15
7	11	11	+1	-1	0.1	0.06
8	8	8	+1	-1	0.1	0.15
9	3	3	-1	-1	0.1	0.15
9	9	9	-1	-1	0.1	0.06
					Sum	

for incorrectly

for correctly

$$W_{\text{new}} = 0.1 * e^{0.42}$$

$$= 0.15$$

$$W_{\text{new}} = 0.1 * e^{-0.42}$$

$$= 0.1 * \frac{1}{e^{0.42}}$$

$$W_{\text{new}} = 0.06$$

$$\begin{aligned} \text{Sum} &= 0.06 \times 7 + \\ & 0.15 \times 3 \\ &= 0.87 \end{aligned}$$

Day: \_\_\_\_\_

Date: \_\_\_\_\_

for normalize

$$\frac{0.06}{0.87} = \frac{0.15}{0.87}$$

Normalized

$$0.07 \quad 0.17$$

$$\text{Sum} = (0.07 \times 7) + (0.17 \times 3)$$

Sum s		$x_2$	class	Prede weight	Normalized weight	Range
✓ 0	1	6	+1	+1	0.1	0.07 [0-0.07]
✓ 1	2	3	+1	+1	0.1	0.07 [0.07-0.14]
2	3	1	0.1	0.1	0.1	0.07 0.14-0.21
3	4	7	-1	0.1	0.1	0.07 0.21-0.28
✓ 4	5	4	+1	0.1	0.1	0.17 0.28-0.45
✓ 5	6	6	-1	-1	0.1	0.07 0.45-0.52
✓ 6	7	11	+1	-1	0.1	0.17 0.52-0.69
✓ 7	8	8	+1	-1	0.1	0.17 0.69-0.86
8	9	3	-1	-1	0.1	0.07 0.86-0.93
✓ 9	9	9	-1	-1	0.1	0.07 0.93-1

Random numbers



Day: \_\_\_\_\_

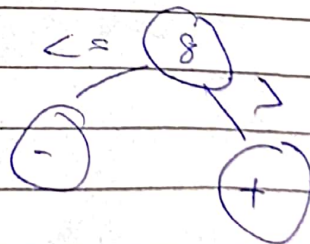
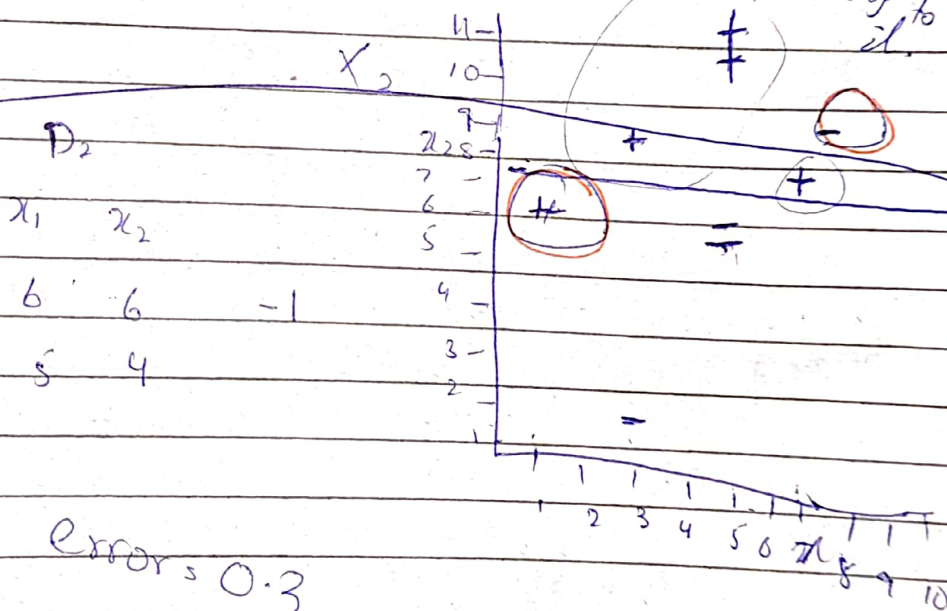
50 weak learners by default

Date: \_\_\_\_\_

create  
weak learners  
generate  
it says  
in end  
for sample  
weak learner  
its straight

index 5, 4, 6, 6, 0, 2, 9, 7, 5, 0

we added  
error, so  
that old  
bagging  
we can justify  
our model  
according to  
it.



$\{ \}$   
 $\alpha_2$

$$H_{final} = \text{Sign} (0.42 (-1) + 0.65 (+1) + 0.92 (-1))$$

Day: \_\_\_\_\_

Date: \_\_\_\_\_

$$y \in \{-1, +1\}$$

Initial Weight Initialization =  $\frac{1}{N} = \frac{1}{10} = 0.1$



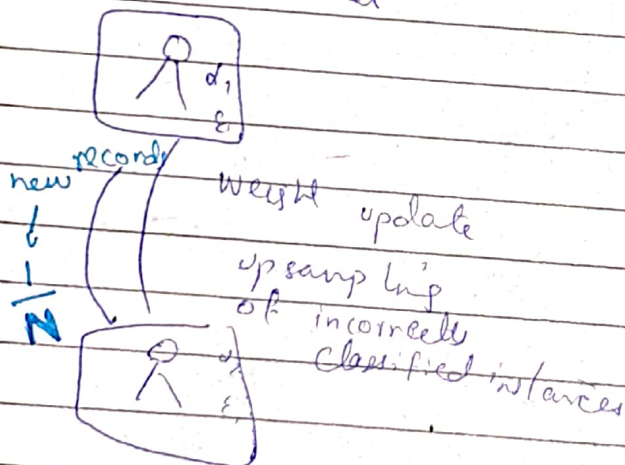
Weak learner / Decision Stumps depth = 1



$$\alpha = \frac{1}{2} \ln \left( \frac{1 - \epsilon}{\epsilon} \right)$$

$\epsilon = 0.1$   
 $\alpha = 0.1$

Weak learner



$$\epsilon > 0.5$$

$$\alpha < 0$$

$$\epsilon < 0.5$$

$$\alpha > 0$$

(misclassified)  $w_{\text{new}} = w_{\text{old}} * e^{\alpha}$

Correct (classified)  $w_{\text{new}} = w_{\text{old}} * e^{-\alpha}$

Stopping criteria  
↓  
Weight no update.

Day: \_\_\_\_\_

Semi

Date: \_\_\_\_\_

multiclass

Input  $x_1, x_2$       # of weak learners

$$H(x) = \text{sign} \left( \sum_{m=1}^M \alpha_m h_m(x) \right)$$

prediction  
of weak learners

$m_1 = +1$        $\alpha_1 = 0.7$

$$\begin{aligned} &= \text{sign} (0.7 \times (+1) + 0.2 \times (-1) \\ &\quad + 0.8 \times (+1)) \\ &= \text{sign} (1.3) \\ &= +1 \end{aligned}$$

$m_1 = +1$        $\alpha_1 = 0.7$

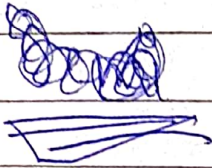
$m_2 = -1$        $\alpha_2 = 0.2$

$m_3 = +1$        $\alpha_3 = 0.8$



Day: \_\_\_\_\_

Date: \_\_\_\_\_



## SAMME

Stage wise additive Modelling  
using Multi-class exponential function.

$$\alpha = \ln \left( \frac{1-\epsilon}{\epsilon} \right) + \ln(k-1)$$

$$k=3$$

$$\alpha < 0$$

$$\epsilon > 1 - \frac{1}{k}$$

$$\epsilon > 1 - \frac{1}{3}$$

$$\epsilon > 0.67$$

$$1 - \frac{1}{2}$$

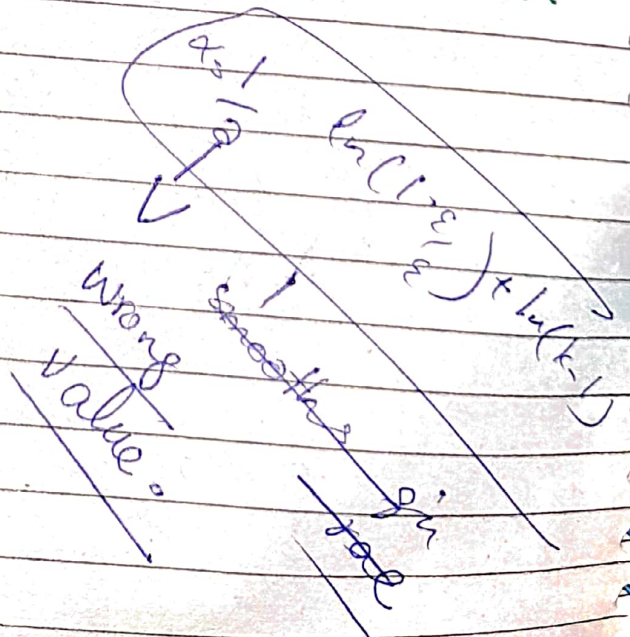
$$\epsilon > 0.5$$

$$k=2$$

$$\alpha < 0$$

$$\epsilon > 1 - \frac{1}{k}$$

$$\text{weight} \rightarrow \frac{1}{k}$$





Day: \_\_\_\_\_

Date: \_\_\_\_\_

## CONCLUSION

$$H(x) = \arg \max_{k} \sum_{m=1}^M \alpha_m \cdot I(h_m(x)=k)$$

strength

class label  
0, 1, 2

$h_m(x)$	$k$	0	1	2
$m_1 = 0$		[1 0 0]		
$m_2 = 1$		[0 1 0]		
$m_3 = 2$		[0 0 1]		
$m_4 = 0$		[1 0 0]		
			[0 1 0]	
				[0 0 1]

0.6 0.2 0.3  
D-mismatch  
1-match

$$\alpha_1 = 0.6$$

$$\alpha_2 = 0.2$$

$$\alpha_3 = 0.3$$

$$\alpha_4 = 0.1$$

0.7 0.2 0.3  
max

class = 0