Gradient Boosting Algorithm [Boosting Algorithm]

Regression

x_1 Exp	x_2 Degree	↓ O/P Salary y	$\hat{y}$	$(y-\hat{y})$ R_1	R_2	$\hat{y}$	R_3	R_4	$\hat{y}$	R_4	R_5	$\hat{y}$
→ 2	B.E	50k	75	-25	-23	72.7	-22.7	—				
→ 3	Macms	70k	75	-5	-3	74.7	-4.7	—				
5	Master	80k	75	5	3	75.3	4.7	—				
6	PhD	100k	75	25	20	77	23	—				
		75k										

O/p of DT

$75 + 0.1(-23) =$

Lets Assume

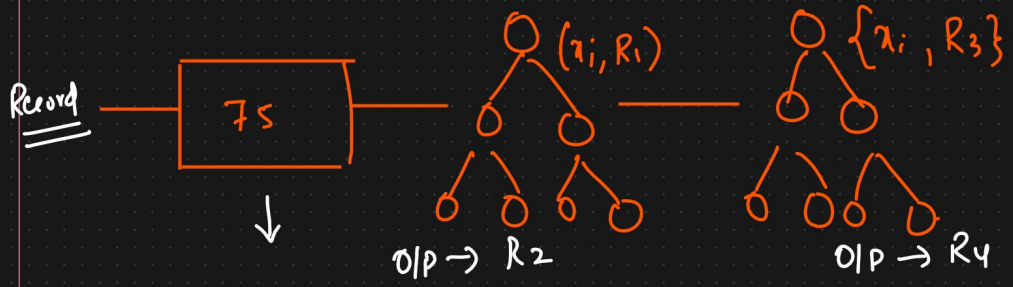
Step 1: Create a Base Model

75K

$\text{Average} = \frac{50+70+80+100}{4} = 75k$

Step 2: Compute Residuals or Error

Step 3: We construct next sequential Decision Tree with i/p x_i and O/p Residuals $[R_1]$.



$75 + (-23) = 75 - 23 = 52.$ ⇒ Overfitting

$\text{Predicted} = 75 + \alpha(-23)$

$= 75 + 0.1\ (-23)$

$= 72.7$

α = Learning Rate. 0 to 1

$\alpha = 0.1$

Final function

Base Learner ↑ M_1 ↓

$$F(x) = \alpha_0 h_0(x) + \alpha_1 (h_1(x)) + \alpha_2 (h_2(x) + \alpha_3 (h_3(x)) + \cdots + \alpha_n (h_n(x))$$

$$\boxed{F(x) = \sum_{i=0}^{n} \alpha_i h_i(x)} \Longrightarrow \text{Gradient Boost}$$

⑧ Xgboost classifier = Extreme Gradient Boost

$0 + 0.1(0.33) = 0.58$

Dataset

0.52

Salary	Credit	y Approval	R1	$\hat{y}$	R2
<=50K	B	0	-0.5	0.52	-0.52
<=50K	G	1	0.5	0.58	0.42
<=50K	G	1	0.5	—	—
>50K	B	0	-0.5	—	—
>50K	G	1	0.5	—	—
>50K	N	1	0.5	—	—
<=50K	N	0	-0.5	—	—

① Step 1 : Base Model

(logOdds) 0.5 → $\log\left(\frac{p}{1-p}\right)$ → 0

SW: 0.142.

[-0.5, 0.5, 0.5, -0.5, -0.5, 0.5, 0.5]

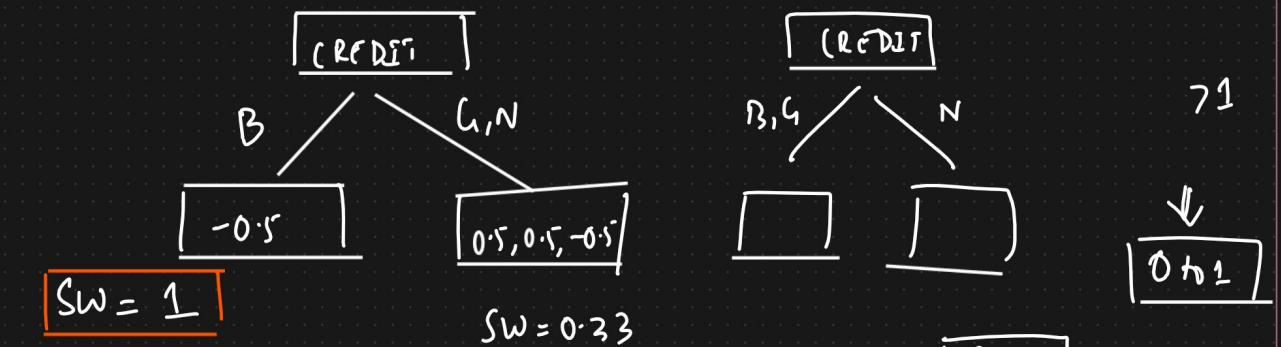
Salary

≤50K → SW = 0 → [-0.5, 0.5, 0.5, -0.5]

>50K → SW: 0.33 → [-0.5, 0.5, 0.5]

Step 3: We calculate Similarity weight

$$= \frac{(\sum \text{Residual})^2}{\sum Pr(1-Pr)}$$



$\alpha = 0.1$

Model o/p $= \sigma[0 + \underbrace{\alpha(1)}_{0.1}] = \dfrac{1}{1+e^{-0.1}} = 0.52$

$\sigma = \dfrac{1}{1+e^{-z}}$

$SW(\leq 10k) = \dfrac{(-0.5+0.5+0.5-0.5)^2}{} \Rightarrow 0$

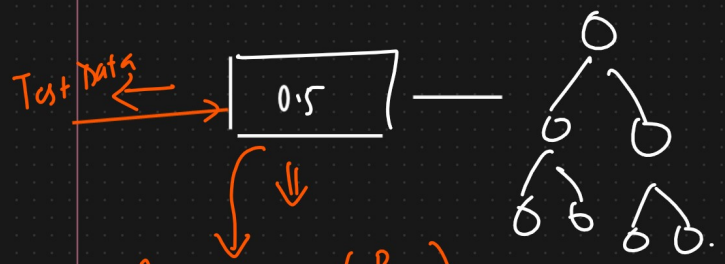
$1 \Leftarrow 0.5(1-0.5)+0.5(1-0.5)+0.5(1-0.5)+0.5(1-0.5)$

$SW(>10k) = \dfrac{0.25}{0.75} = 0.33$

Gain $= 0 + 0.33 - 0.142 = 0.19$

Final O/P

Binary classification $\longrightarrow$ Logistic Regression $\Rightarrow$ Log loss



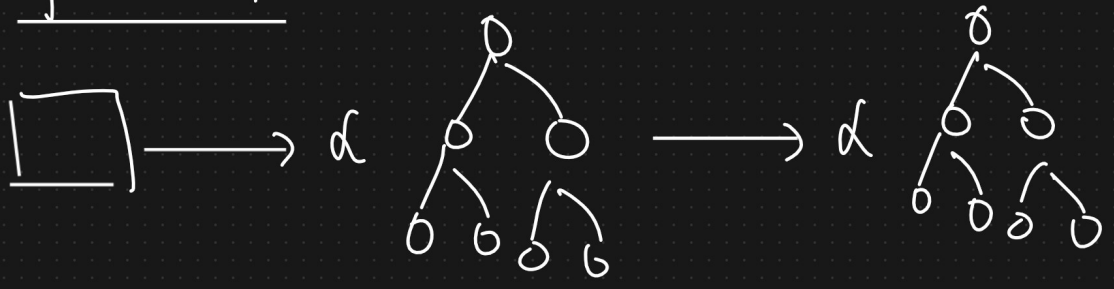
$\log(\text{odds}) = \log\left(\dfrac{p}{1-p}\right)$

$= \log\left(\dfrac{0.5}{0.5}\right)$

$= \log 1$

$= 0$

Xgboost classifier



$$O/p = \sigma\left[\left(\text{Base learner} + f_1(DT_1) + f_2(DT_2) + \cdots f_n(DT_n)\right)\right]$$

(base learner: ↓ log loss)