Xgboost ML Algorithm (Classification)

$\hat{y} = 0.5$

Binary Classification

Dataset

Salary	Credit	y Approval	R1	ŷ	R2
<=50K	B	0	-0.5	0.52	-0.48
<=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	—	—

- Both step help us to find out which feature should we select, whether salary is the best feature to select and split my decision tree.

Steps

1. Construct a base Model
2. Construct a Decision Tree with root.
3. Calculate Similarity Weight

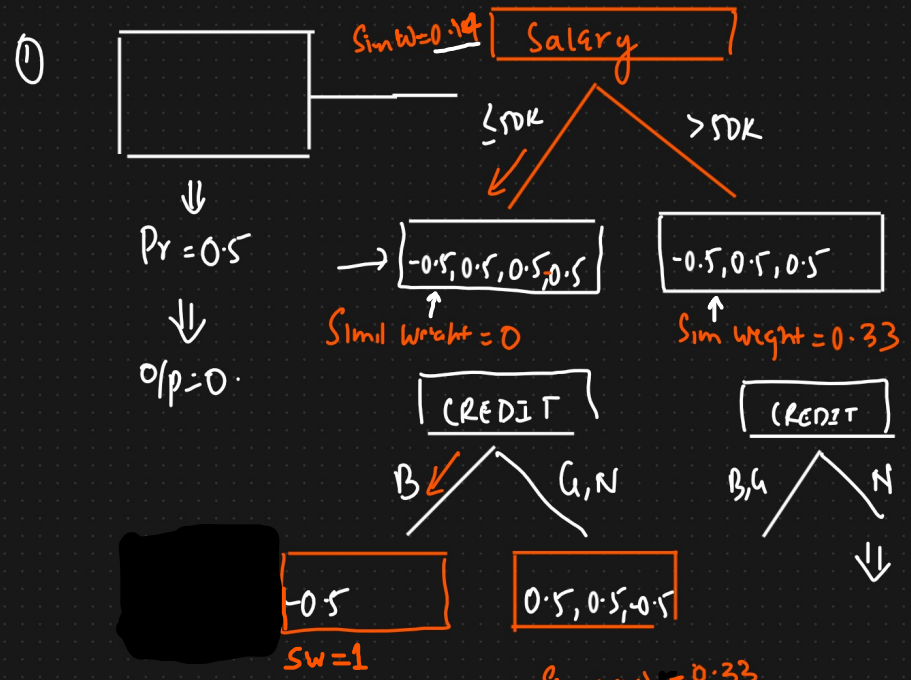
$$= \frac{(\sum \text{Residual})^2}{\sum Pr(1-Pr) + \lambda}$$

Cover Value ←

Hyperparameter

4. Calculate Gain

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



For New Test data :- 1st of all it pass through base model. We can't pass probability directly, so use log(odds)

$$\log(\text{odds}) = \log\left(\frac{P}{1-P}\right)$$

For 1st record :-

$$\log(\text{odds}) = \log\left(\frac{0.5}{0.5}\right)$$

$$= 0$$

Left Child

$$\text{Similarity (LC)} = \frac{0.25}{0.25} = 1$$

Right Child

$$\text{Similarity (RC)} = \frac{0.25}{0.75} = 0.33$$

$$\text{Gain} = 1 + 0.33 - 0 = 1.33$$

- Cover value = $\sum$ Prb(1-Prb)
  Whenever Similarity Weight is less than cover value, we slice down the decision tree.

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

$= \frac{[(-0.5+0.5+0.5-0.5)^2]}{} = 0$

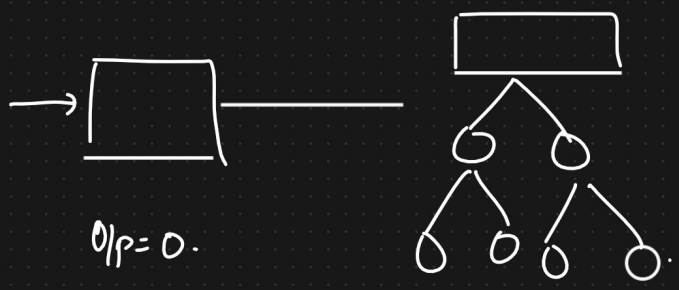
Similarity weight (RC) $= \frac{(+0.5+0.5+0.5)^2}{0.75} = \frac{0.25}{0.75} = \frac{1}{3}$

$= 0.33$

$1 \Leftarrow [0.5(1-.5)+0.5(1-.5)+.5(1-.5)+0.5(1-.5)]$

Gain $= 0 + 0.33 - .14 = .21$

Final O/p



New Data $\rightarrow$ $= \sigma\left(0 + \alpha(1)\right)$ (1 = Similarity weight)

$\alpha = 0.1$; Learning Rate

Logistic function $\Leftarrow$ Sigmoid Activation $= \sigma\left(0 + (0.1)(1)\right)$

$= \frac{1}{1+e^{-0.1}} = 0.52$

Second Record O/p $= \sigma\left(0 + \alpha(0.33)\right)$

$= \sigma\left(0 + 0.1(0.33)\right)$

$$= \frac{1}{1+e^{-0.033}} = 0.508$$

Xgboost classifier

$$\text{O/P} = \sigma\left(\underset{\text{Score}}{\text{Base learner}} + \alpha_1(DT1) + \alpha_2(DT2) + \alpha_3(DT3)\right).$$