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Q8] consider the following values y and $\hat{y}$ calculate Categorical cross-entropy loss.

Ans:

$$y = \begin{bmatrix} 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\hat{y} = \begin{bmatrix} 0.1 & 0.2 & 0.5 & 0.2 & 0 \\ 0.5 & 0.1 & 0.2 & 0.2 & 0 \\ 0.3 & 0.2 & 0.1 & 0.2 & 0.2 \\ 0.1 & 0.4 & 0.4 & 0 & 0 \\ 0.5 & 0.5 & 0 & 0 & 0 \end{bmatrix}$$

Categorical cross-entropy loss

$$= -\frac{1}{m} \sum_{i=1}^{n} \sum_{j=1}^{m} Y_i \log \hat{Y}$$

Lets take first training sample:-

$$Y_1 = [0 \quad 0 \quad 1 \quad 0 \quad 0]$$

$$\hat{Y}_j = [0.1 \quad 0.2 \quad 0.5 \quad 0.2 \quad 0]$$

$$L_1 = \sum_{j=1}^{m} [0 \times \log(0.1) + 0 \times \log(0.2) + 1 \times \log(0.5) + 0 \times \log 2 + 0 \times \log(0)]$$

$$= [0 + 0 + -0.30 + 0 + 0]$$

$$[L_1 = -0.301]$$

Teacher's Signature

Lets consider second sample.

$L_2 = 1$

$y_2 = [0\ 1\ 0\ 0\ 0]$

$\hat{y}_2 = [0.5\ \ 0.1\ 0.2\ 0.2\ 0]$

$L_2 = 0 \times \log(0.5) + 1 \times \log(0.1) + 0 \times \log(0.2) + 0 \times \log(0.2) + 0 \times \log(0)$

$\boxed{L_2 = -1.}$

$y_3 = [0\ 0\ 0\ 1\ 0]$

$\hat{y}_3 = [0.3\ 0.2\ 0.1\ 0.2\ 0.2]$

$L_3 = 0 \times \log(0.3) + 0 \times \log(0.2) + 0 \times \log(0.1) + 1 \times \log(0.2) + 0 \times \log(0.2)$

$\boxed{L_3 = -0.6989}$

$y_4 = [0\ 0\ 0\ 1\ 0]$

$\hat{y}_4 = [0.1\ 0.4\ 0.4\ 0\ 0]$

$L_4 = 0 \times \log(0.1) + 0 \times \log(0.4) + 0 \times \log(0.4) + 1 \times \log(0) + 0 \times \log(0)$

$\boxed{L_4 = 0}$

$y_5 = [1\ 0\ 0\ 0\ 0]$

$\hat{y}_5 = [0.5\ 0.5\ 0\ 0\ 0]$

$= 1 \times \log(0.5) + 0 + 0 + 0 + 0$

$= -0.301$

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$$\text{Loss} = -\frac{1}{n}\left[-0.301*(-1) - 0.6989 + 0 - 0.301\right]$$

$$= -\frac{1}{5}\left[-2.3009\right]$$

$$\boxed{\text{Loss} = 0.46018.}$$

Entropy

Categorical loss of given samples is 0.46018.