Shannon - Fano coding →

An efficient code can be obtained by the following simple procedure known as Shannon - Fano algorithm.

Steps →

1-) List the source symbol in order of decreasing probability.

2-) Partition the set into two sets that are as close to equiprobable as possible and assign '0' to the upper set and '1' to the lower set.

3-) continue this process, each time partitioning the sets with as nearly equal probabilities as possible until further partitioning is not possible.

ex → A discrete memoryless source has five symbols x_1, x_2, x_3, x_4, x_5 with probabilities 0.4, 0.19, 0.16, 0.15 and 0.15 respectively attached to every symbol.

1 Construct a Shannon - Fano code for the source.

2 calculate code efficiency

$\underline{\underline{Sol^n}}$ (1) To obtain shannon – Fano code →

Message	Probability of message	Codeword for message	Length
x_1	0.4	0	1
x_2	0.19	100	3
x_3	0.16	101	3
x_4	0.15	110	3
x_5	0.15	111	3

(2) Efficiency → $\eta = \frac{H}{\bar{N}}$

where $\bar{N} = \sum_{i=1}^{m} p_i n_i$ is avg code word length per symbol.

n_i → code word length.

$$H = 0.4\log_2\left(\frac{1}{0.4}\right) + 0.19\log_2\left(\frac{1}{0.19}\right) + 0.16\log_2\left(\frac{1}{0.16}\right) + 0.15\log_2\left(\frac{1}{0.15}\right) + 0.15\log_2\left(\frac{1}{0.15}\right)$$

$$H = \frac{0.4\log_{10}\left(\frac{1}{0.4}\right)}{\log_{10}2} + \frac{0.19\log_{10}\left(\frac{1}{0.19}\right)}{\log_{10}2} + \frac{0.16\log_{10}\left(\frac{1}{0.16}\right)}{\log_{10}2} + \frac{0.3\log_{10}\left(\frac{1}{0.15}\right)}{\log_{10}2}$$

$H = 2.2280$ bits/message

$$\bar{N} = 0.4\times1 + 0.19\times3 + 0.16\times3 + 0.15\times3 + 0.15\times3$$

$$\bar{N} = 2.35$$

So code efficiency →

$$\eta = \frac{H}{\bar{N}}$$

$$\eta = \frac{2.2280}{2.35}$$

$$\eta = 0.948$$

$$\eta = 94.8\%$$

Ans