Information →

In communication information is define in terms of message, like, audio, video & image

Information Theory →

It is the science for measuring, preserving, transmitting and estimating information in random data. It was initially proposed by shannon as a mathematical theory of communication more than five decades ago.

uncertainity → Let us consider a message X which is combination of different types of messages $x_1, x_2, x_3 ---- x_n$. and probabilities of these messages are given by $P_1, P_2 --- P_n$ respectively.

i.e $X = \{x_1, x_2 ---- x_n\}$

$P = \{P_1, P_2 ---- P_n\}$

Total Probability $P = \sum_{i=1}^{n} P_i$

if $x_1 \rightarrow P_1 = 0$ (event never occurs)

$x_1 \rightarrow P_1 = 1$ (occuring of event is 100%)

} NO uncertainity

But if $x_1 \rightarrow P_1 = 0.5$

$x_1 \rightarrow P_1 = 0.1$

} high uncertainity

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Information Source →

It may be viewed as an object which produces an event, the outcome of which is selected at random according to a probability distribution.

Discrete memoryless Source (DMS)

A discrete memoryless source can be characterized by the list of the symbols, the probability assignment to these symbols and the specification of the rate of generating these symbols by the source.

Measure of Information →

Let us consider communication system which transmits messages m_1, m_2, m_3 ---- with probabilities of occurrence P_1, P_2 ----. The amount of information transmitted through the message is given by →

Amount of Information $\boxed{I_K = \log_2\left(\frac{1}{P_K}\right) = \frac{\log_{10}(1/P_K)}{\log_{10} 2}}$

unit of Information is bit.

Properties of Information →

1. If there is more uncertainty about the message, information carried is also more. (i.e. if $U_1 > U_2$ then $I_1 > I_2$ for any two messages)
2. If receiver knows the message being transmitted, the amount of information carried is zero. $(P = 1)$
3. If I_1 is the information carried by message m_1 and I_2 is the information carried by m_2, then amount of information carried compositely due to m_1 & m_2 is $= I_1 + I_2$
4. If there are $M = 2^N$ equally likely messages, then amount of information carried by each message will be $= N$ bits

Proof of Property 1 →

Let us consider there are two messages m_1 & m_2 and their probabilities are given by $P_1 = \frac{1}{4}$ & $P_2 = \frac{1}{2}$ respectively then

$P_1 = \frac{1}{4}$ $\qquad$ $P_2 = \frac{1}{2}$

U_1 $\qquad$ U_2

$U_1 > U_2$

$$I_1 = \log_2\left(\frac{1}{P_1}\right)$$

$$= \log_2\left(\frac{1}{1/4}\right)$$

$$\boxed{I_1 = 2 \text{ bits}}$$

$$I_2 = \log_2\left(\frac{1}{P_2}\right)$$

$$I_2 = \log_2 2$$

$$\boxed{I_2 = 1 \text{ bits}}$$

So $I_1 > I_2$ which we have to proved.

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Property ② → If receiver knows message being transmitted then its probability will be $P = 1$

So $I = \log_2\left(\frac{1}{P}\right)$

$I = \log_2 1$

$\boxed{I = 0 \text{ bit}}$ Proved

Property ③ → In this case let us consider probability of m_1 is P_1 & probability of m_2 is P_2 then.

$I_1 = \log_2\left(\frac{1}{P_1}\right)$

$I_2 = \log_2\left(\frac{1}{P_2}\right)$

Since messages m_1 & m_2 are independent, so the probability of combined message is P_1P_2. Therefore information carried due to m_1 & m_2 is →

$$\cancel{I = I_2 + I_1} \quad I = \log_2\left(\frac{1}{P}\right) = \log_2\left(\frac{1}{P_1P_2}\right)$$

$$I = \log_2\left(\frac{1}{P_2}\right) + \log_2\left(\frac{1}{P_1}\right)$$

$$\log_2\left(\frac{1}{P_1P_2}\right) = I_1 + I_2$$

$$\log_2\left(\frac{1}{P_1}\right) + \log_2\left(\frac{1}{P_2}\right) = I$$

$$\boxed{I = I_1 + I_2}$$

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(4) Since all the M messages are equally likely and independent, probability of occurrence of each message will be $\frac{1}{M}$.

we know that $I_K = \log_2\left(\frac{1}{P_K}\right) \rightarrow (1)$

But $P_K = \frac{1}{M}$ so

So from eqn (1) $I_K = \log_2 M \rightarrow (2)$

we know that $M = 2^N$ so put this value in

eqn (2) we get

$I_K = \log_2 2^N$

$I_K = N \log_2 2$

$\boxed{I_K = N \text{ bits}}$ proved