PRINCIPLES OF COMMUNICATIONS

UNIT-4

LECTURE-3

Information Theory and Source Coding

- Scope of Information Theory
  1. Determine the irreducible limit below which a signal cannot be compressed.
  2. Deduce the ultimate transmission rate for reliable communication over a noisy channel.
  3. Define Channel Capacity - the intrinsic ability of a channel to convey information.

  The basic setup in Information Theory has:

  - a source,
  - a channel and
  - destination.

  The output from source is conveyed through the channel and received at the destination. The *source* is a random variable S, which takes symbols from a finite alphabet i.e.,

$$S = \{s_0, s_1, s_2, \cdots, s_{k-1}\}$$

with probabilities

$$P(S = s_k) = p_k \quad \text{where } k = 0, 1, 2, \cdots, k-1$$

and

$$\sum_{k=0} p_k = 1$$

The following assumptions are made about the source

1. Source generates symbols that are statistically independent.
2. Source is memoryless i.e., the choice of present symbol does not depend on the previous choices.

• Information: Information is defined as

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$$I(s_k) = \log_{base}\left(\frac{1}{p_k}\right)$$

- In digital commmunication, data is binary, the ‘base’ is always 2.

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Properties of Information

1. Information conveyed by a deterministic event is nothing i.e.,

$$\mathcal{I}(s_k) = 0, \ for \ p_k = 1^{a}.$$

2. Information is always positive i.e.,

$$\mathcal{I}(s_k) \geq 0 \ for \ p_k \leq 1$$

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[a] Give examples about deterministic events, sun rising in the east as opposed to that of the occurence of the Tsunami

3. Information is never lost i.e.,

$$\mathcal{I}(s_k) \text{ is never negative}$$

4. More information is conveyed by a *less* probable event than a *more* probable event

$$\mathcal{I}(s_k) > \mathcal{I}(s_i), \ for \ p_k < p_i$$ [a]

[a] a program that runs *without faults* as opposed to a program that gives a *segmentation fault*