INFORMATION THEORY

Our common notion of information is reflected in suc everyday examples as what we read in the newspapers or hear on TV, or the instructions packed with every gadget we buy, etc…

This conception of information is fine for our everyday dealing. But when we investigate how people process information, it is important to have an operational definition of the term information and a method for measuring it.

Information theory provides one such definition and a quantitative method for measuring it.

Historical view

Early investigators held out great promise that the theory would help unravel the mysteries of human information processing. Information theory was used to determine the information processing capacity of the different human sensory channels and was also employed extensively in problems of choice reaction time.

It is interesting, however, that in newer areas of cognitive psychology, where detailed models and theories have yet to be formulated, information theory continues to be applied. Information theory still provides a valuable definition of the concept of information and a methodology for measuring it. The concept and unit of measurement are often used to describe the stimuli and respnses making up an information processing task.

Concept

Information theory defines information as the reduction of uncertainty.

The occurences of highly certain events do not convey much information since they only confirm what was expected. The occurences of highly unlikely events, however, convey more information. As example, when the temperature warning lightcomes on in a car, it conveys considerable information because it is an unlikely event. To be noted that the importance of the message is not directly considered in the definition of information; only the likelyhood of its occurence is considered.

Unit of measure of information

Information theory measures information in bits (Symbolized by *H*). A bit is the amount of information required to decide between two equally likely alternatives. When the probabilities of the various alternatives are equal, the amount of information *H* in bits is:

$$H = \log_2 N$$

Therefore, with only two alternatives, the information, in bits, is equal to 1.

When the alternatives are not equally likely, the information conveyed by an event is determined by:

$$h_i = \log_2 (1/p_i)$$

Where h_i is the information (in bits) associated with event i, and p_i is the probability of occurence of that event.

We are often more interested in the average information conveyed by a series of events having different probabilities than in the information of just on such event. The average information H_{av} is computed as follows:

$$H_{av} = \sum_{i=1}^{N} pi(log2(\frac{1}{pi}))$$

The maximum possible information is always obtained when the alternatives are equally probable.

The greater the departure from equal probability, the greater the reduction in information from the maximum. This leads to the concept of redundancy, which is the reduction in information from the maximum owing to unequal probabilities of occurence. Percentage of redundancy is usually computed from the following formula:

$$\%\ \text{redundancy} = (1 - \frac{Hav}{Hmax}) \times 100$$

For example, because not all letters of the English language occur equally often and certain letter combinations occur more frequently than others, the English language has a degree of redundancy of approximately 68 percent.

One other concept that may be encountered in the literature is bandwidth of a communication channel. The bandwidth is simply the rate of information transformation over the channel, measured in bits per second. For example, the bandwidth for the ear is estimated at from 8000 t0 10000 bits per second and for the eye (visual nerve fibers) 1000 bits per second. These are much higher than the amount of information that could possibly be absorbed and interpreted by the brain in that time. That is why much of what is received by our peripheral senses is filtered out before it even reaches our brain.