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DISCRETE NOISY CHANNEL

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Annotation: Consider now a situation in which a signal is exposed to noise either during transmission or at one of the ends of the channel. This means that the received signal does not necessarily match the one sent by the transmitter. Two different classes of such situations can be distinguished. If the same transmitted signal always results in the same signal at the receiver, that is, if the received signal is an unambiguous function of the transmitted signal, it can be said that there is signal distortion. If this function is reversed, that is, each signal at the receiver is caused by only one signal at the transmitter, this distortion can be taken into account, at least in principle, by applying an appropriate correcting operation to the received signal.

Keywords: Channel error and bandwidth, Basic theorem for a noisy discrete channel, Representation of a noisy discrete channel.

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$$E=f(S,N)$$

Noise is a random variable, exactly the same as the above message. In the general case, it can be described by the corresponding stochastic process. The most common case of a noisy channel that we will consider is a generalization of the above described noiseless channel with a finite number of states. Suppose there is a finite number of states and a set of probabilities

$$p_{\alpha,i}(\beta,j)$$

This is the probability that if the channel is in state α and symbol $i$is transmitted, symbol j will be received at the output and the channel will transition to state β. Here α and β run over all possible states, i- over all possible transmitted symbols, and j - over all possible received ones. In the case of independent distortion of consecutive 3 symbols, there is only one state, and the channel is described by a set of probabilities p_i (j) to receive symbol j while transmitting$i$.

Error and channel capacity If the channel is noisy, it is generally impossible to reliably recover the original message or the transmitted signal by any transformation of the received signal E. However, there are information transmission methods that are optimal for combating noise. Let'sconsiderthistask.

Let there be two possible characters, 0 and 1, transmitted at a rate of 1000 characters per second with probabilities $p0=p1=\frac{1}{2}$. Thus, the source provides information at a rate of 1000 bits per second. During transmission, the presence of noise leads to errors, so that on average 1 out of 100 characters is received incorrectly (0 instead of 1, or 1 instead of 0). What is the rate of information transfer? It is clear that it is less than 1000 bits per second, since about 1% of the characters are received incorrectly. The first impulse would be to say that the transmission rate is 990 bits per second (obtained by simply subtracting the number of incorrectly received characters), but this answer is unsatisfactory, since it does not take into account the fact that the receiver does not know which characters were received incorrectly. This becomes obvious from consideration of the limiting case in which the received signal is completely independent of the transmitted one. In this case, the probability of getting 1 is $\frac{1}{2}$, and about half of the received characters happen to be correct.

According to the above definition, it turns out that the rate of information transfer is 500 bits per second, although it is obvious that information is not transferred at all. We would have received the same `` good " transmission by completely disconnecting the channel and throwing a coin at the receiving point.
Basic theorem for a discrete noisy channel It may seem surprising that we introduce a certain bandwidth for a noisy channel, while reliable transmission of information is not possible. It is clear, however, that by introducing some redundancy in the transmitted information, the probability of error can be reduced.

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