Classical Information Theory
Basic Concepts and Mathematics

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1   Basic Classical Information Theory - Shannons paper

The fundamental problem of communication is to be able to produce at one point either exactly or approximately a message selected at another point. Frequently the message has both meaning and is part of a set of possible messages, which is not possible to know prior to the transmission.

If the number of messages in the set is finite then this number or any monotonic function of this number [1] can be a measurement for information. The logarithmic measure is our choice because:

1. It is practically more useful. Parameters of engineering importance such as time, bandwidth, number of relays, etc., tend to vary linearly with the logarithm of the number of possibilities. For example, adding one relay to a group doubles the number of possible states of the relays. It adds 1 to the base 2 logarithm of this number. Doubling the time roughly squares the number of possible messages, or doubles the logarithm, etc.

2. It is nearer to our intuitive feeling as to the proper measure. This is closely related to (1) since we intuitively measures entities by linear comparison with common standards. One feels, for example, that two punched cards should have twice the capacity of one for information storage, and two identical channels twice the capacity of one for transmitting information.

3. It is mathematically more suitable. Many of the limiting operations are simple in terms of the logarithm but would require clumsy restatement in terms of the number of possibilities.
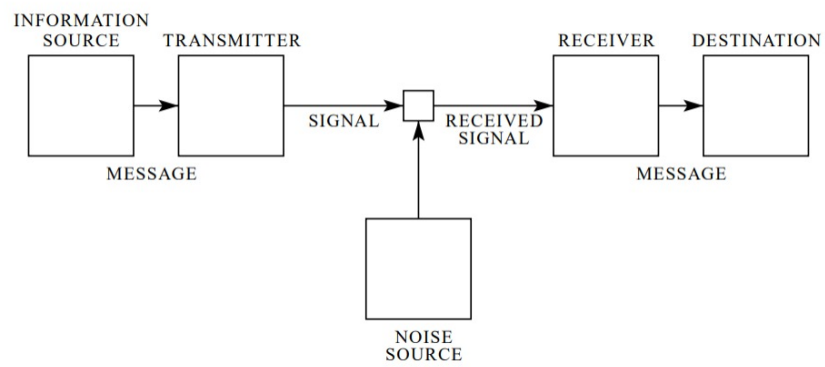
1.1   General Communication System

A communication system is a system that has the following parts:

- **Information Source:** The first part is the information source, this is where the sequence of messages are being produced, and given to the transmitter.

- **Transmitter:** After having our message we must find a suitable way (based on the channel we have) to transmit the messages. A segment of getting ready for transmission is encoding, which we will catch up with later on.

- **Channel:** Any physical medium in which the encoded message by the transmitter can travel. This can be air for sound waves, electromagnetic fields for light, or a wire for electrons to flow in. Evidently the channel can alter the information itself, which is most of the time an undesiered occurrence, this is normally looked at as the concept of noise.

- **Receiver:** The receiver ordinarily performs the inverse operation of that done by the transmitter, reconstructing the message from the signal.

- **Destination:** is the person (or thing) for whom the message is intended.

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[1] A monotonic function is a function which is either entirely nonincreasing or nondecreasing. A function is monotonic if its first derivative (which need not be continuous) does not change sign. The term monotonic may also be used to describe set functions which map subsets of the domain to non-decreasing values of the codomain.

fig: 1 – Schematic diagram of a general communication system.

1.2   Discrete Noiseless Channel