

Communication theory

Communication theory is a field of information theory and mathematics that studies the technical process of information and the process of human communication.

Origins

- "The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point."^[1] Claude Shannon (1916–2001)
- The origins of communication theory is linked to the development of information theory in the early 1920s. Limited information-theoretic ideas had been developed at Bell Labs, all implicitly assuming events of equal probability.
- Harry Nyquist's 1924 paper, *Certain Factors Affecting Telegraph Speed*, contains a theoretical section quantifying "intelligence" and the "line speed" at which it can be transmitted by a communication system.
- Ralph Hartley's 1928 paper, *Transmission of Information*, uses the word "information" as a measurable quantity, reflecting the receiver's ability to distinguish one sequence of symbols from any other. The natural unit of information was therefore the decimal digit, much later renamed the hartley in his honour as a unit or scale or measure of information.
- Alan Turing in 1940 used similar ideas as part of the statistical analysis of the breaking of the German second world war Enigma ciphers.

The main landmark event that opened the way to the development of communication theory was the publication of an article by Claude Shannon in the *Bell System Technical Journal* in July and October 1948 under the title "A Mathematical Theory of Communication" Shannon focused on the problem of how best to encode the information that a sender wants to transmit. He used also tools in probability theory, developed by Norbert Wiener. They marked the nascent stages of applied communication theory at that time. Shannon developed information entropy as a measure for the uncertainty in a message while essentially inventing the field of information theory.

In 1949, in a declassified version of his wartime work on the mathematical theory of cryptography ("Communication Theory of Secrecy Systems"), he proved that all theoretically unbreakable ciphers must have the same requirements as the one-time pad. He is also credited with the introduction of sampling theory, which is concerned with representing a continuous-time signal from a (uniform) discrete set of samples. This theory was essential in enabling telecommunications to move from analog to digital transmissions systems in the 1960s and later.

In 1951, Shannon made his fundamental contribution to natural language processing and computational linguistics with his article "Prediction and Entropy of Printed English" (1951), providing a clear quantifiable link between cultural practice and probabilistic cognition.

Models of communication

The studies on information theory by Claude Elwood Shannon, Warren Weaver and others, prompted research on new models of communication from other scientific perspectives like psychology and sociology. In science, a model is a structure that represents a theory.

Scholars from disciplines different from mathematics and engineering began to take distance from the Shannon and Weaver models as a 'transmissible model':

They developed a model of communication which was intended to assist in developing a mathematical theory of communication. Shannon and Weaver's work proved valuable for communication engineers in dealing with such issues as the capacity of various communication channels in 'bits per second'. It contributed to computer science. It led to very useful work on redundancy in language. And in making 'information' 'measurable' it gave birth to the mathematical study of 'information theory'

— *D. Chandler,*

Elements of communication

Basic elements of communication made the object of study of the communication theory:

- **Source:** Shannon calls this element the "information source", which "produces a message or sequence of messages to be communicated to the receiving terminal."
- **Sender:** Shannon calls this element the "transmitter", which "operates on the message in some way to produce a signal suitable for transmission over the channel." In Aristotle, this element is the "speaker" (orator).
- **Channel:** For Shannon, the channel is "merely the medium used to transmit the signal from transmitter to receiver."
- **Receiver:** For Shannon, the receiver "performs the inverse operation of that done by the transmitter, reconstructing the message from the signal."
- **Destination:** For Shannon, the destination is "the person (or thing) for whom the message is intended".
- **Message:** from Latin *mittere*, "to send". The message is a concept, information, communication, or statement that is sent in a verbal, written, recorded, or visual form to the recipient.
- **Feedback**
- **Entropic elements, positive and negative**