# Information Theory Notes

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## Introductory Notes

Information Theory is concerned with quantifying Information and analyzing its properties. Information Theory has direct applications in finding a) compact representations of data as well as b) robust and secure ways of data transmission. Information Theory is related to Probability Theory in a variety of contexts.

### Noisy Channel

Information quantifies the abstract possibility of an occurrence of a defined event. Shannon and Weaver ([1]) introduced the term *bit* as a unit of information following John Tukey’s suggestion ([1], page 9).

How do we use term *bit* to measure information - there is a famous Gedankenexperiment where a transmitter can send or receive two types of codes symbols: or . In this experiment the symbols and are equally likely to occur and are produced independently, so that the distribution of a given symbol is unaffected by all previous digits. The digits are to be communicated over a *channel*. The nature of the communication channel is unimportant.

The probability that a code symbol is received in error is ¼. The channel acts on successive inputs independently. The two independence assumptions – one about the nature of the distribution of the generated symbols at the source and the other about the nature about the channel interaction with the data – are quite important as those simplify the analysis considerably.

Figure: Gedankenexperiment setup

Source:

1 binary digit

Per second

Transmits up to 1 binary digit per second; probability of error = 1/4

Figure: Communication system

Noise

Source of

Messages

Encoder

Channel

Decoder

Destination

### Self-Information and Entropy

**Definition**: *Entropy*

## Appendix

## References

[1] [The Mathematical Theory of Communication, Claude Shannon, Warren Weaver, 10th printing, 1964 (original prints 1948 and 1949 in *Scientific American* and *Bell System Technical Journal*)](https://github.com/dimitarpg13/information_theory_and_statistical_mechanics/blob/main/literature/books/Shannon_Claude_E_Weaver_Warren_The_Mathematical_Theory_of_Communication_1963.pdf)

[2] [Information Theory, Robert Ash, 1965](https://github.com/dimitarpg13/information_theory_and_statistical_mechanics/blob/main/literature/books/Information_Theory-Robert_Ash.pdf)

[3] [Entropy and Information Theory, Robert M. Gray, Stanford, 2023](https://github.com/dimitarpg13/information_theory_and_statistical_mechanics/blob/main/literature/books/EntropyAndInformationTheory_Gray_Stanford_2023.pdf)