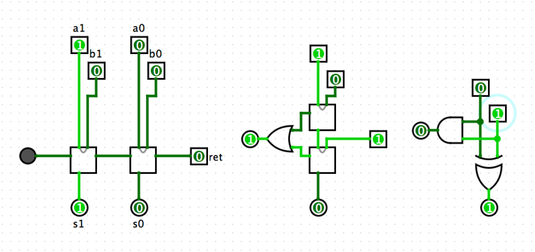
Principes de fonctionnement des machines binaires

2022–2023

Matthieu Picantin

- numération et arithmétique
- numération et arithmétique en machine
- codes, codages, compression,
- contrôle d'erreur (détection, correction)
- logique et calcul propositionnel
- circuits numériques



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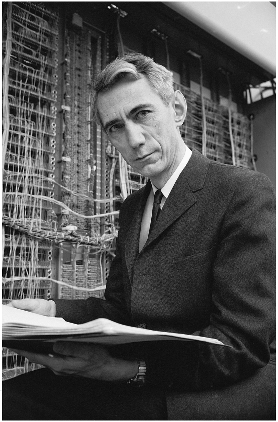
A Mathematical Theory of Communication

By C. E. SHANNON

Introduction

THE recent development of various methods of modulation such as PCM and PPM which exchange bandwidth for signal-to-noise ratio has intensified the interest in a general theory of communication. A basis for such a theory is contained in the important papers of Nyquist[1] and Hartley[2] on this subject. In the present paper we will extend the theory to include a number of new factors, in particular the effect of noise in the channel, and the savings possible due to the statistical structure of the original message and due to the nature of the final destination of the information.

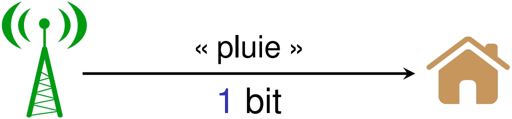
The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have *meaning*; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one *selected from a set* of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design.

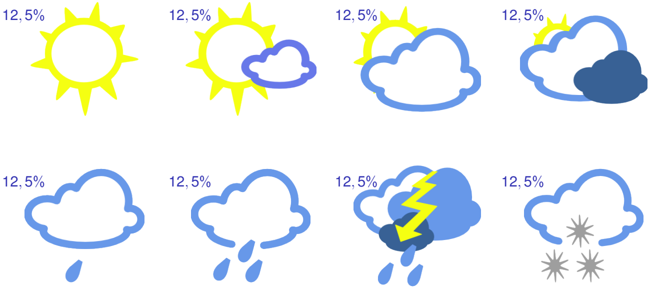


1 bit $\leftrightsquigarrow$ incertitude divisée par 2


50%


50%

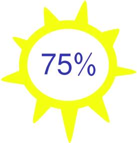

« pluie »
1 bit

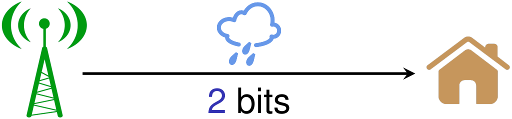


3 bits

$\|$

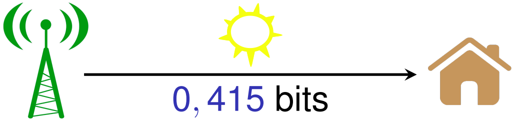
$\log_2 8$



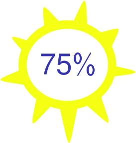


2 bits

$$2 = \log_2 4 = \log_2 \frac{1}{0{,}25}$$

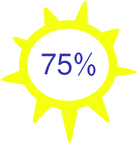


$$0{,}415 \text{ bits} \approx \log_2 \frac{4}{3} = \log_2 \frac{1}{0{,}75}$$



$$\xrightarrow[\color{blue}{0,811}\ \text{bits}]{\text{en moyenne ?}}$$

$$0,811 \text{ bits} \approx 0,75 \log_2 \frac{1}{0{,}75} + 0,25 \log_2 \frac{1}{0{,}25}$$



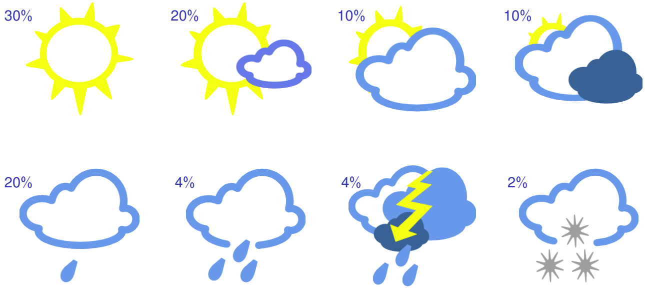
$$H(p) = \sum p_i \log_2 \frac{1}{p_i}$$

entropie

$0,811$ bits

$$\wr$$

$$0,75 \ \log_2 \frac{1}{0,75} + 0,25 \ \log_2 \frac{1}{0,25}$$



$$H(p) = \sum p_i \log_2 \frac{1}{p_i}$$

entropie

$$0,30\ \log_2 \frac{1}{0{,}30} + \cdots + 0,02\ \log_2 \frac{1}{0{,}02} \approx 2,599$$