Digital Communications

Signals, Random Processes and Spectral Analisys

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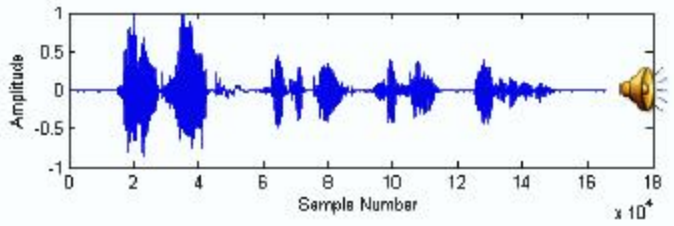
DIGITAL COMUNICATION SYSTEM
Signals

What is Signal?

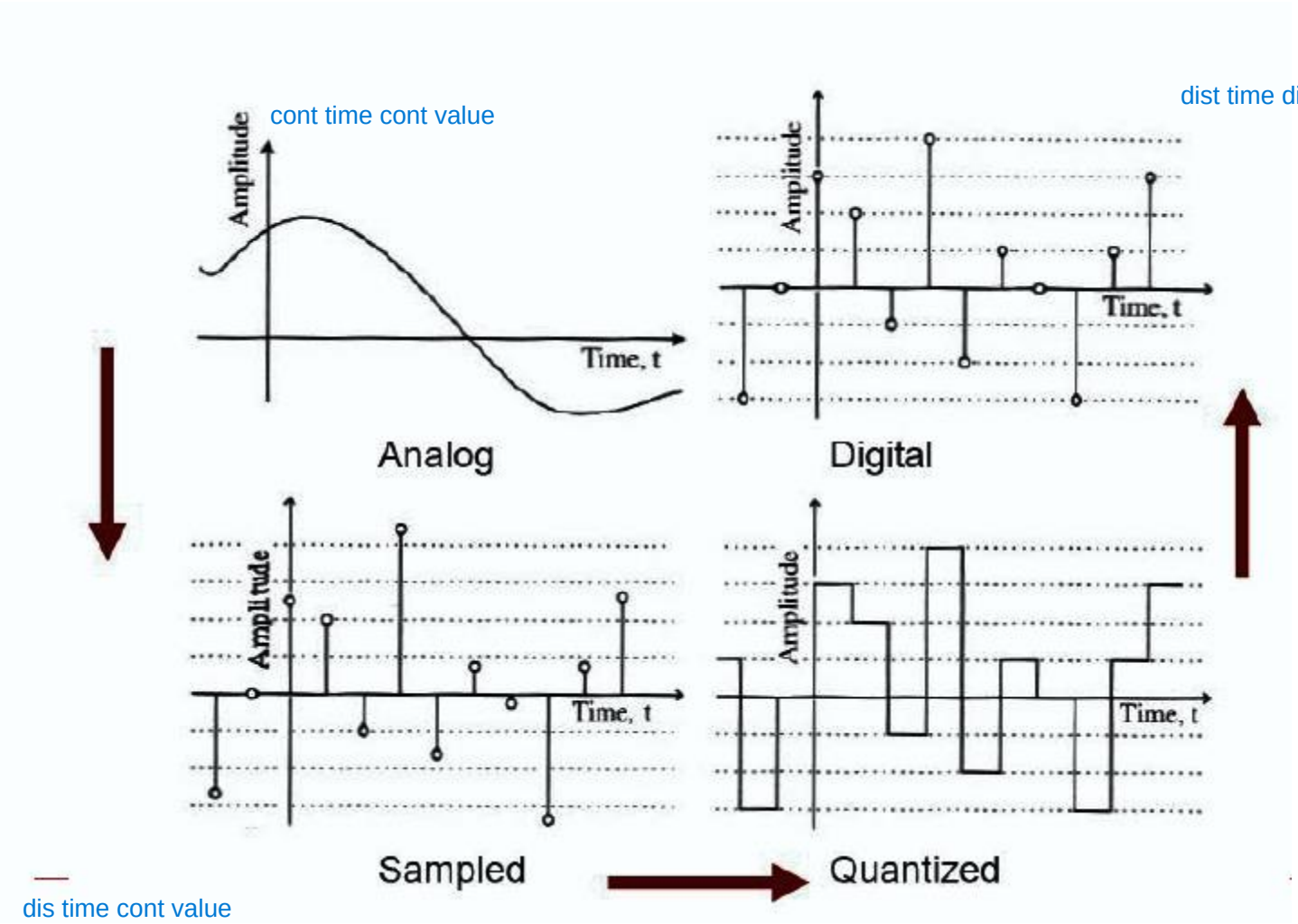
- In communication systems, a signal is any function that carries information. Also called information bearing signal



DIGITAL COMUNICATION SYSTEM
Signals

- Continuous-time signal vs. discrete-time signal
- Continuous valued signal vs. discrete-valued signal
  - Continuous-time and continuous valued: analog signal
  - Discrete-time and discrete valued: digital signal
  - Discrete-time and continuous valued: sampled signal
  - Continuous-time and discrete valued: quantized signal

DIGITAL COMUNICATION SYSTEM
Signals



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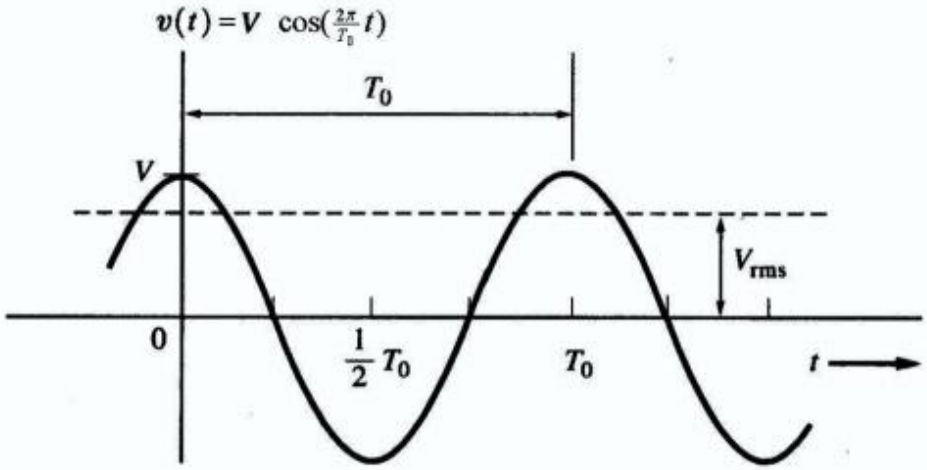
Signals

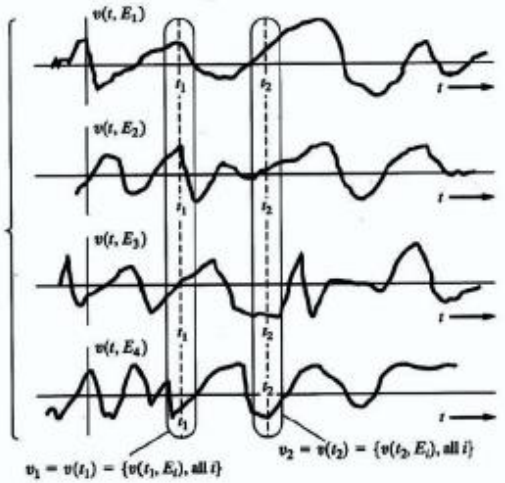
no uncertinatry we know value of one time period we can find the value of any time value

uncertentiy this signal cannot be represented by math equation and can be represent by range average value and probability distribution

eg of rand is noise

- Deterministic signal vs. random signal





DIGITAL COMUNICATION SYSTEM
Signals

- Energy signal vs. power signal
  - Energy $E_x = \int_{-\infty}^{\infty} |x(t)^2| dt = \lim_{T\to\infty} \int_{-T/2}^{T/2} |x(t)^2| dt$

finite energy and 0 power

  - Power $P_x = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} |x(t)^2| dt$

finite averge power but infinite energy

  - A signal is an **energy signal** iff Ex is finite
  - A signal is **a power signal** iff Px is finite

In general, energy signals are used to transmit information over a long distance or to store information for a long period of time. Examples of energy signals include radio waves, which can transmit information over long distances, and magnetic fields, which can store information on a magnetic tape or hard drive. In contrast, power signals are typically used to transmit information over short distances or to transmit information in real-time. Examples of power signals include electrical currents, which can transmit information over short distances through wires, and light waves, which can transmit information in real-time through fiber optic cables.

DIGITAL COMUNICATION SYSTEM
Fourier Transform

$$X(f) = \int_{-\infty}^{+\infty} x(t)e^{-j2\pi ft}dt, \quad x(t) = \int_{-\infty}^{+\infty} X(f)e^{j2\pi ft}df$$