

Digital Signal Processing

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Lecture 5 - Topics

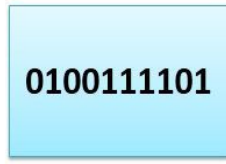
Misc:

- Spectral density
- Sampling
- Quantization and error
- Nyquist rate



Analog
Signal

Vs



Digital
Signal

Spectral Density



- The power spectral density (PSD) of the signal describes the power present in the signal as a function of frequency, per unit frequency.
- Power spectral density is commonly expressed in watts per hertz (W/Hz).
- In other words, for each frequency, the spectral density function shows whether the energy that is present is higher or lower.

Sampling



Sampling is defined as, “The process of measuring the instantaneous values of continuous-time signal in a discrete form.”

Sample is a piece of data taken from the whole data which is continuous in the time domain.

Nyquist Rate

Suppose that a signal is band-limited with no frequency components higher than **W** Hertz. That means, **W** is the highest frequency. For such a signal, for effective reproduction of the original signal, the sampling rate should be twice the highest frequency.

Which means,

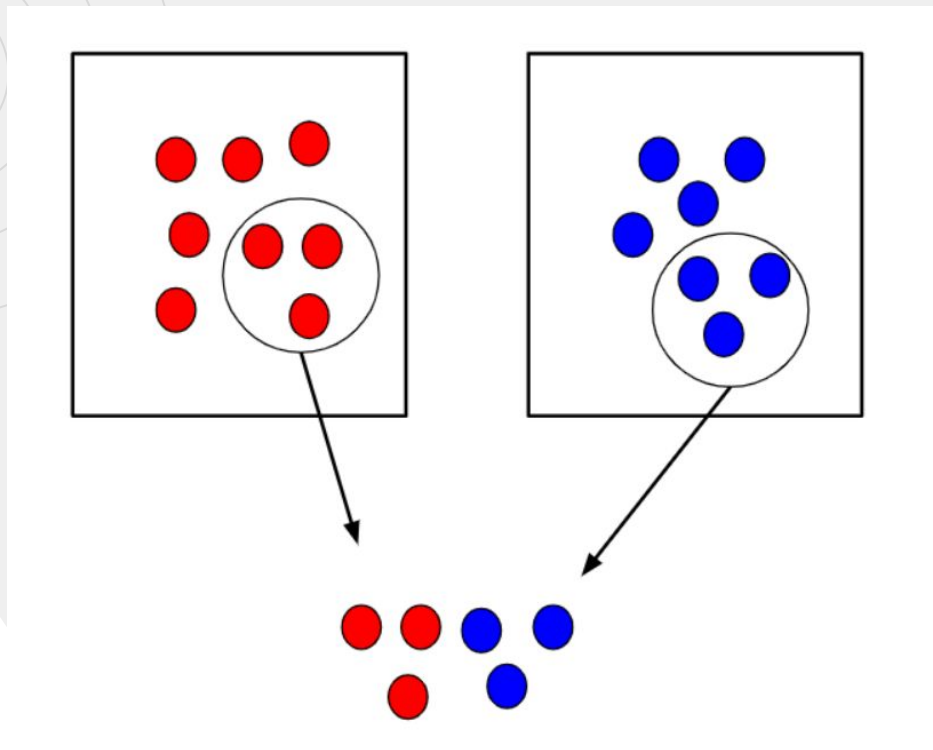
$$f_s = 2W$$

Where,

- f_s is the sampling rate
- **W** is the highest frequency

This rate of sampling is called as **Nyquist rate**.

Sampling



Quantization



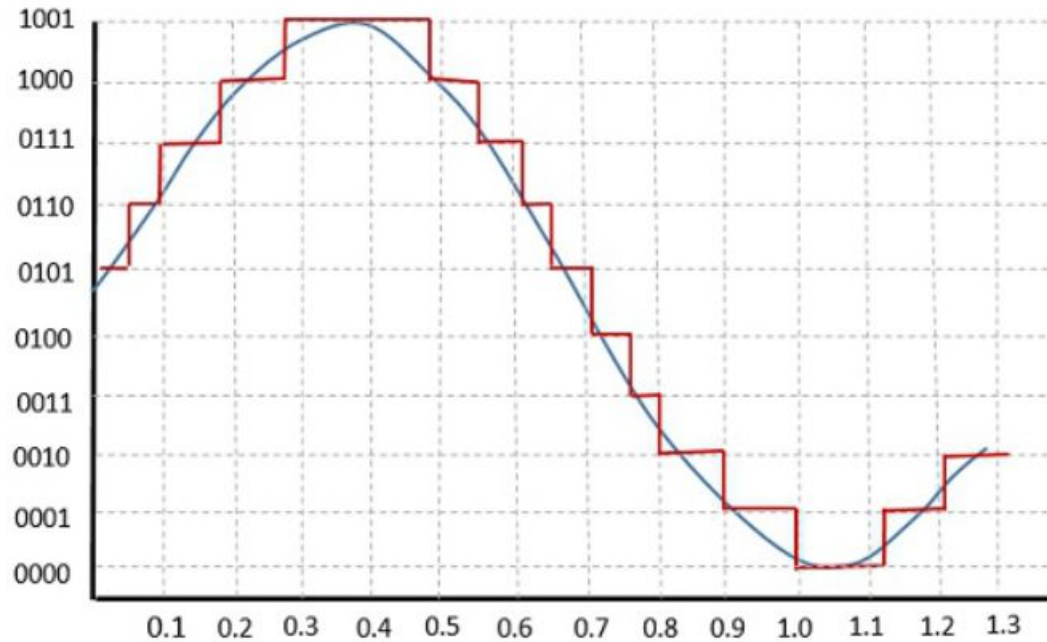
Quantization is the process of mapping continuous infinite values to a smaller set of discrete finite values.

The digitization of analog signals involves the rounding off of the values which are approximately equal to the analog values.

The method of sampling chooses a few points on the analog signal and then these points are joined to round off the value to a near stabilized value. Such a process is called as Quantization.

The spacing between the two adjacent representation levels is called a quantum or step-size.

Quantization



Quantization Error



For any system, during its functioning, there is always a difference in the values of its input and output. The processing of the system results in an error, which is the difference of those values.

The difference between an input value and its quantized value is called a Quantization Error.



Sampling vs Quantization

- In the sampling process, a single amplitude value is selected from the time interval to represent it while, in quantization, the values representing the time intervals are rounded off, to create a finite set of possible amplitude values.
- Sampling is prior after the quantization process.



Thank you