Introduction to Digital Signal Processing

Sampling Theorem

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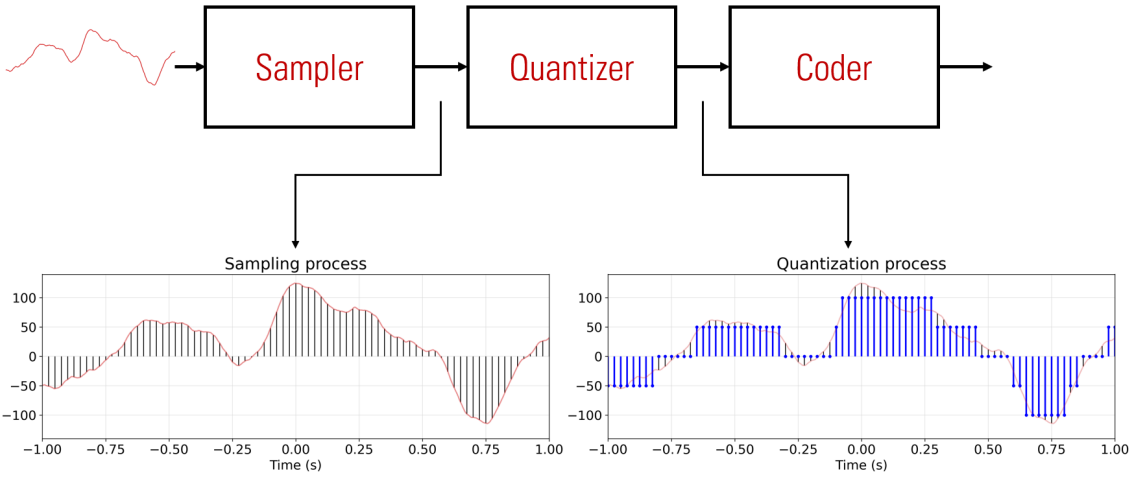
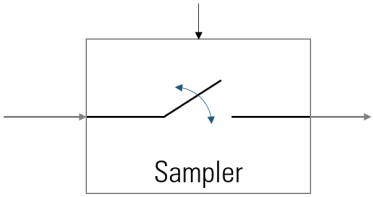
Sampling Theorem

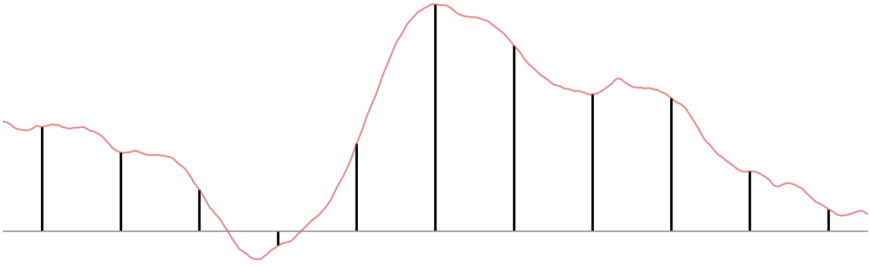
- How do we get signals into a computer?

Analog to Digital Conversion: getting information into a computer

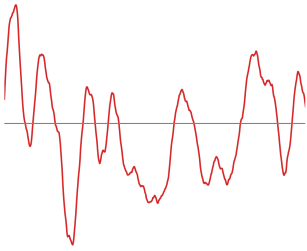


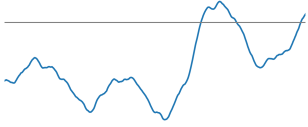
Sampling process

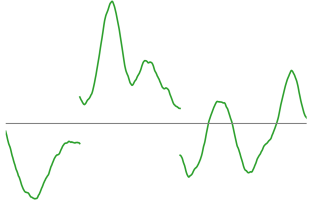




How frequently do we need to sample?

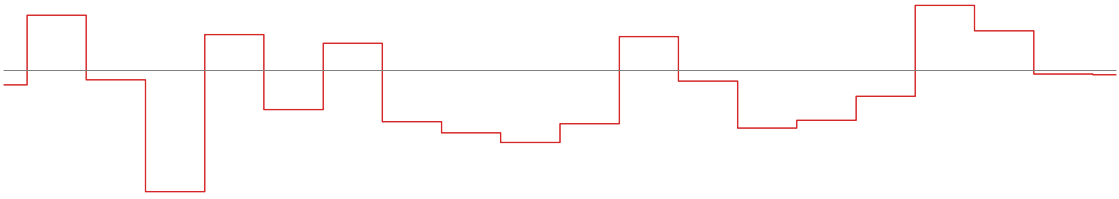






Can we sample without any loss of information?

Yes, we can! If we restrict ourselves to specific classes of signals.
An example:



Sampling theorem

$$x(t) \longrightarrow x[n] \longrightarrow x(t)$$

This is possible if the **signal is bandlimited** $\implies$ limit on the how fast the signal varies.

A measure of how fast the signal varies $\longrightarrow$ Max. frequency component.

Nyquist-Shanon Sampling Theorem.
If a signal $x(t)$ contains no frequencies higher than f_{sig} Hz, then it is completely determined by its values at time points spaced less than $1/(2f_{sig})$ seconds apart.

$$\implies \text{Sampling rate} = F_s > 2f_{sig}$$

What happens when we undersample?

Higher frequencies will look like lower frequecies.