# Time Series Analysis

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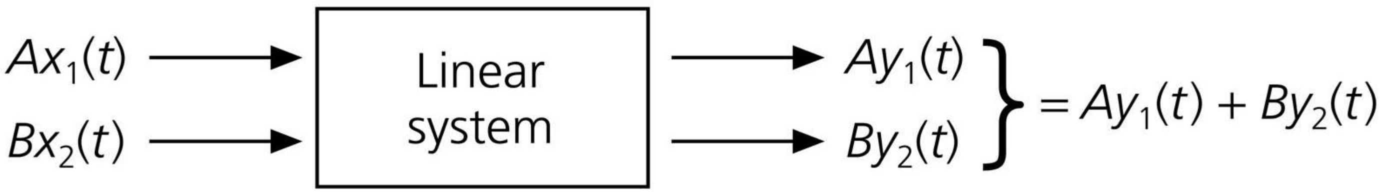
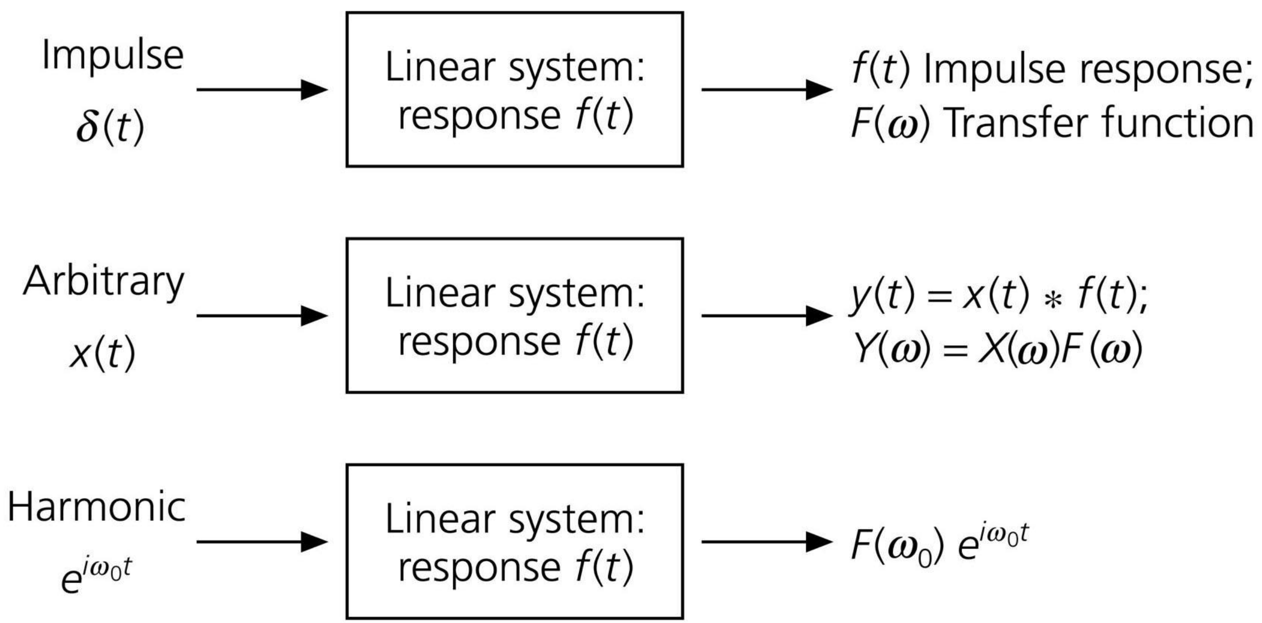
# Linear Systems

# Scope

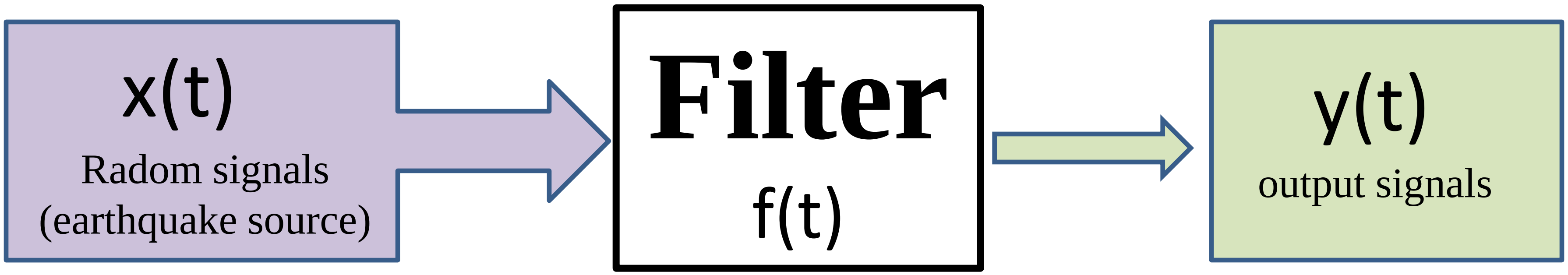
- The scope of this lecture is to understand students that many problems in geophysics can be reduced to a linear system (filtering, tomography, inverse problems).

# Linear Systems



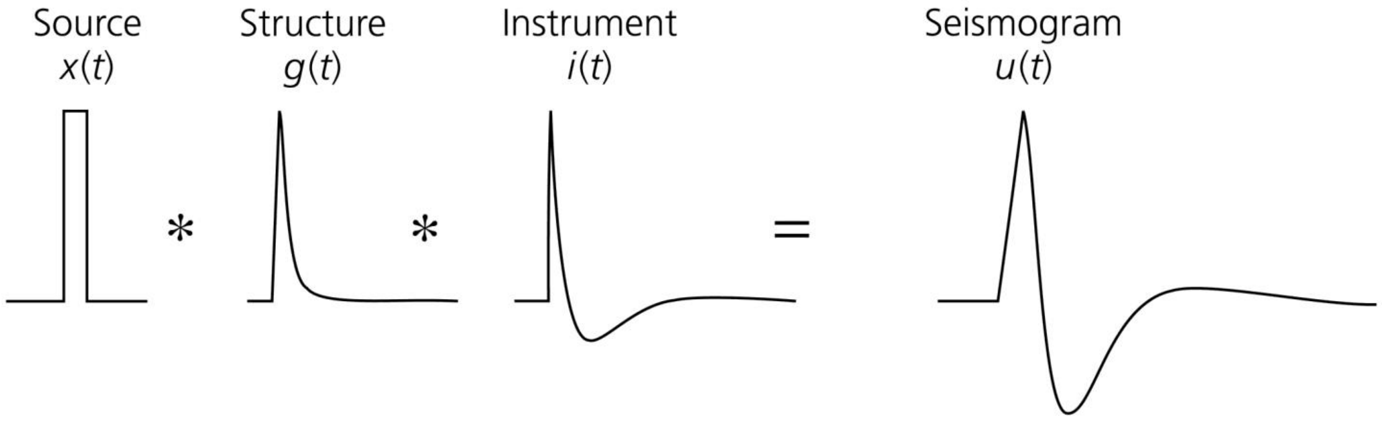



# What do time series come form?




- This is given by the physical model y(t)=x(t) * f(t)
- The output of a linear system is the convolution of the input and the impulse response of filter system
- Separating the input from the output given the impulse response of the filter system is the deconvolution, or inverse filter or integral

# Example
## (Seismograms)




Seismogram as the convolution of the source, medium, instrument signals

This is known as stochastic ground motion

**How to characterize the signals realizing due to the source, medium, and instrument effects?**

?

# Simple Harmonic Motion

- A simple harmonic motion is fully described in time domain by its amplitude, frequency, and phase difference.
- A simple harmonic motion is fully described in space domain by its amplitude, wavelength, and phase shift.

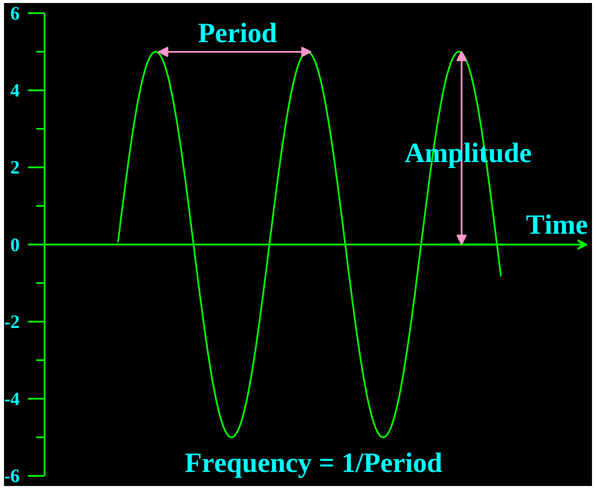
$$f(t) = A\sin(n\omega t)$$

*Where*

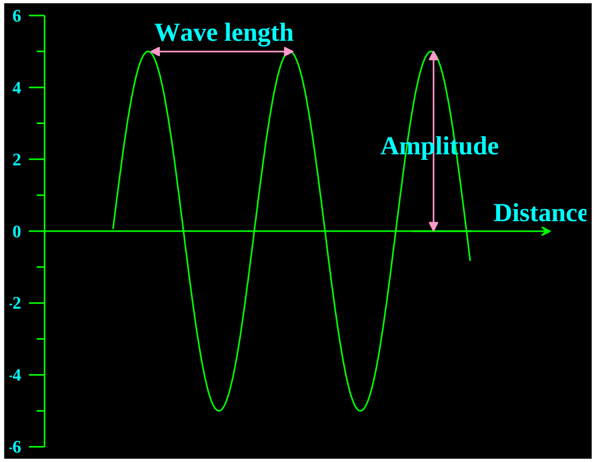
$A$ → is the amplitude

$\omega$ → is the angular frequency

$t$ → is the time

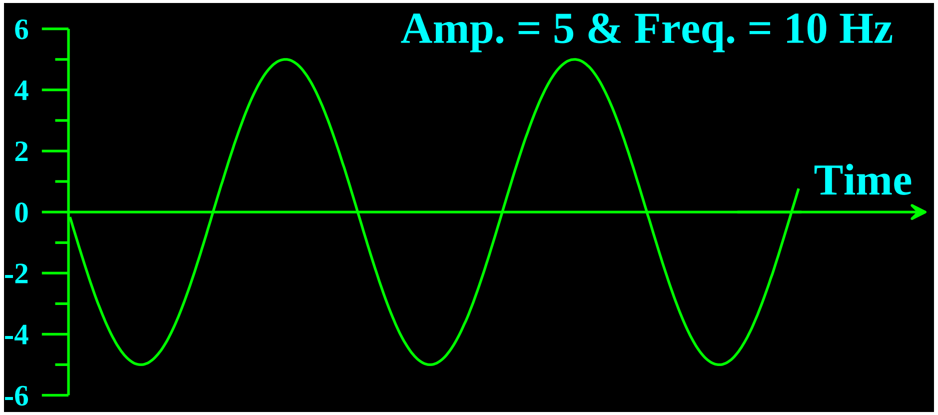


A wave in time domain

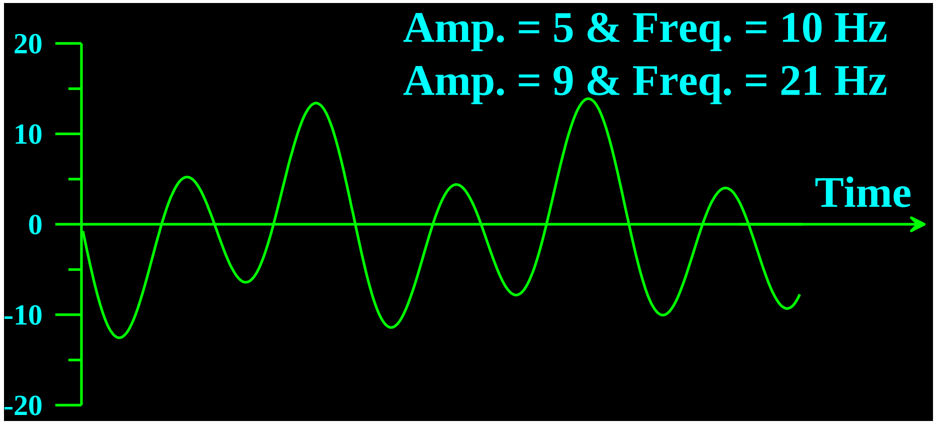


A wave in space domain

- Consider the simple harmonic motions




- Consider the complex harmonic motions



# If we have the sinusoidal wave in time domain, could we know the frequencies making it?

## Yes, using transforms