

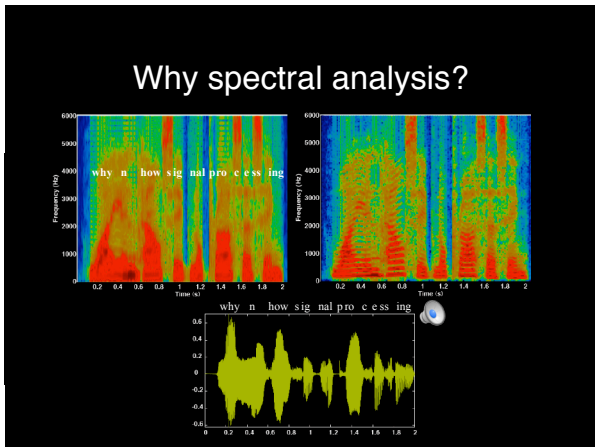
Why do we need Signal Processing N How do we conceptualize it?

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Why.N.How Tutorial Series
May 7, 2009

Format

- ✓ Section 1
 - ✓ Time / Frequency (Duality)
 - ✓ Linear Time-Invariant Systems
 - ✓ Issues with Sampling (Aliasing)
- ✓ Section 2
 - ✓ Windowing / Filter Design
 - ✓ Phase information
 - ✓ K-space / Image Processing Examples



Frequency (Spectral) Analysis

- ✓ Bio-signal is intrinsically rhythmic:
 - ✓ Brain rhythm (alpha; beta; theta etc.)
 - ✓ Heart beat / Respiratory cycle
- ✓ Filtering = Scaling in Frequency
 - ✓ Artifact rejection (60 Hz AC power line)
 - ✓ Lowpass / Highpass / Bandpass filters
 - ✓ Same fundamental concepts in MRI:
 - ✓ K-space = spatial frequency (2D instead of 1D)
 - ✓ Spatial Smoothing = Lowpass filtering in space

Section 1

Time-frequency (Duality)
Convolution / Filtering
Sampling / Aliasing

Are you smarter than a 5th grader?

5th Grade Math Question: Evaluate

$$(1+z)(5z^5 - 5z^4 + 3z^3 - 3z^2 + z - 1)$$

$$0z^6 + 5z^5 - 5z^4 + 3z^3 - 3z^2 + 1z - 1$$

Are you smarter than a 5th grader?

5th Grade Math Question: Evaluate

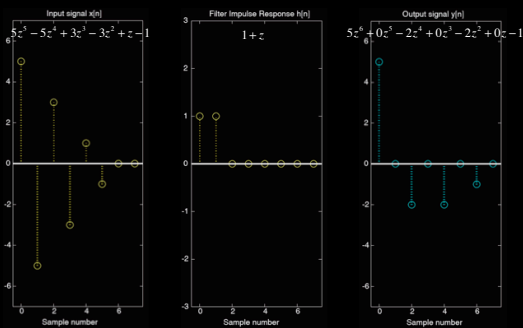
$$(1+z)(5z^5 - 5z^4 + 3z^3 - 3z^2 + z - 1)$$

$$0z^6 + 5z^5 - 5z^4 + 3z^3 - 3z^2 + 1z - 1$$

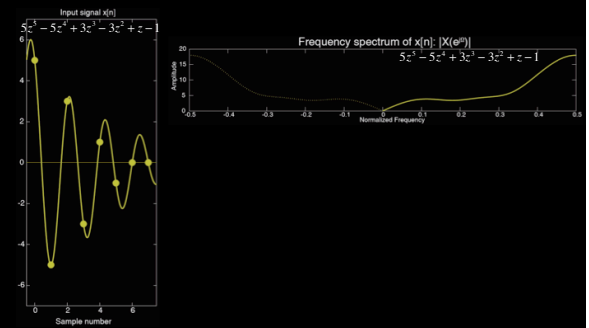
$$+ 5z^6 - 5z^5 + 3z^4 - 3z^3 + 1z^2 - 1z + 0$$

$$5z^6 + 0z^5 - 2z^4 + 0z^3 - 2z^2 + 0z - 1$$

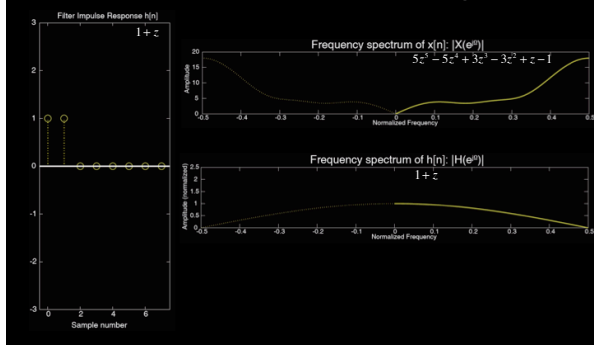
Convolution ⇔ Filtering



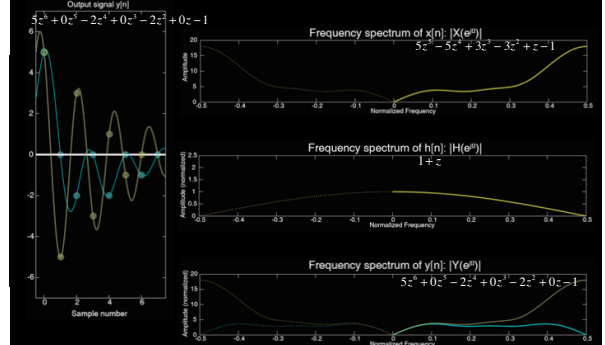
Convolution ⇔ Filtering

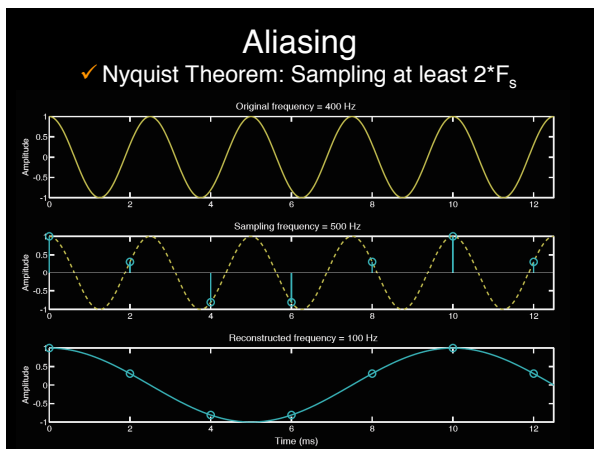
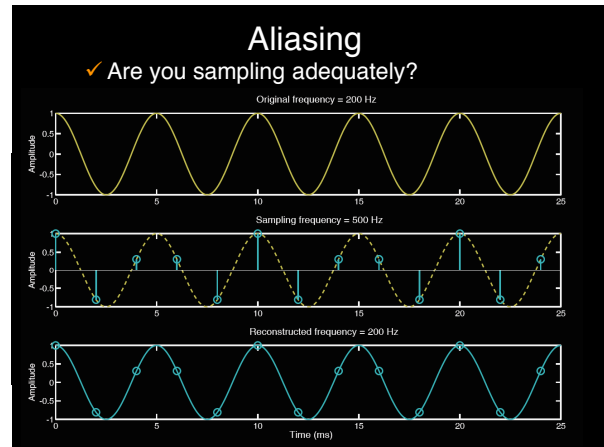
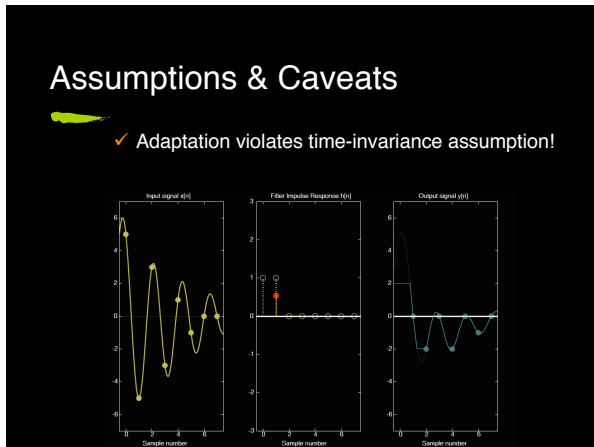
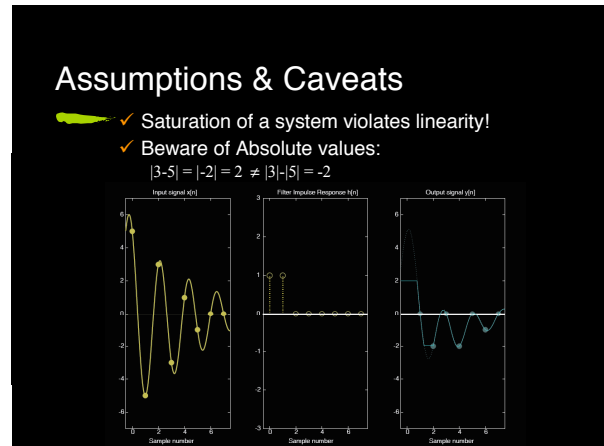
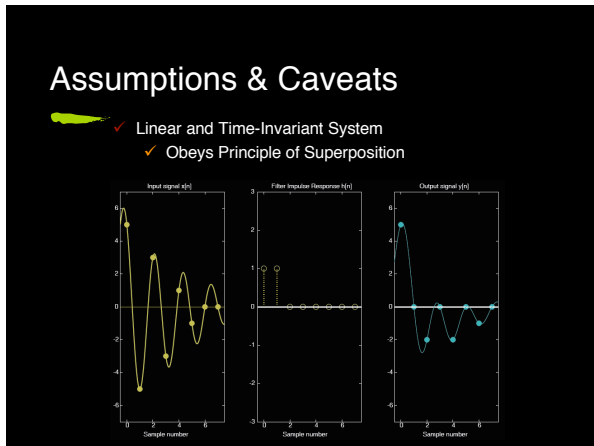


Convolution ⇔ Filtering



Convolution ⇔ Filtering





Section 2

Windowing / Filter Design
Trade-offs & considerations
K-space / Image Processing

