SIGNAL PROCESSING

JEFFREY BERRY

OVERVIEW

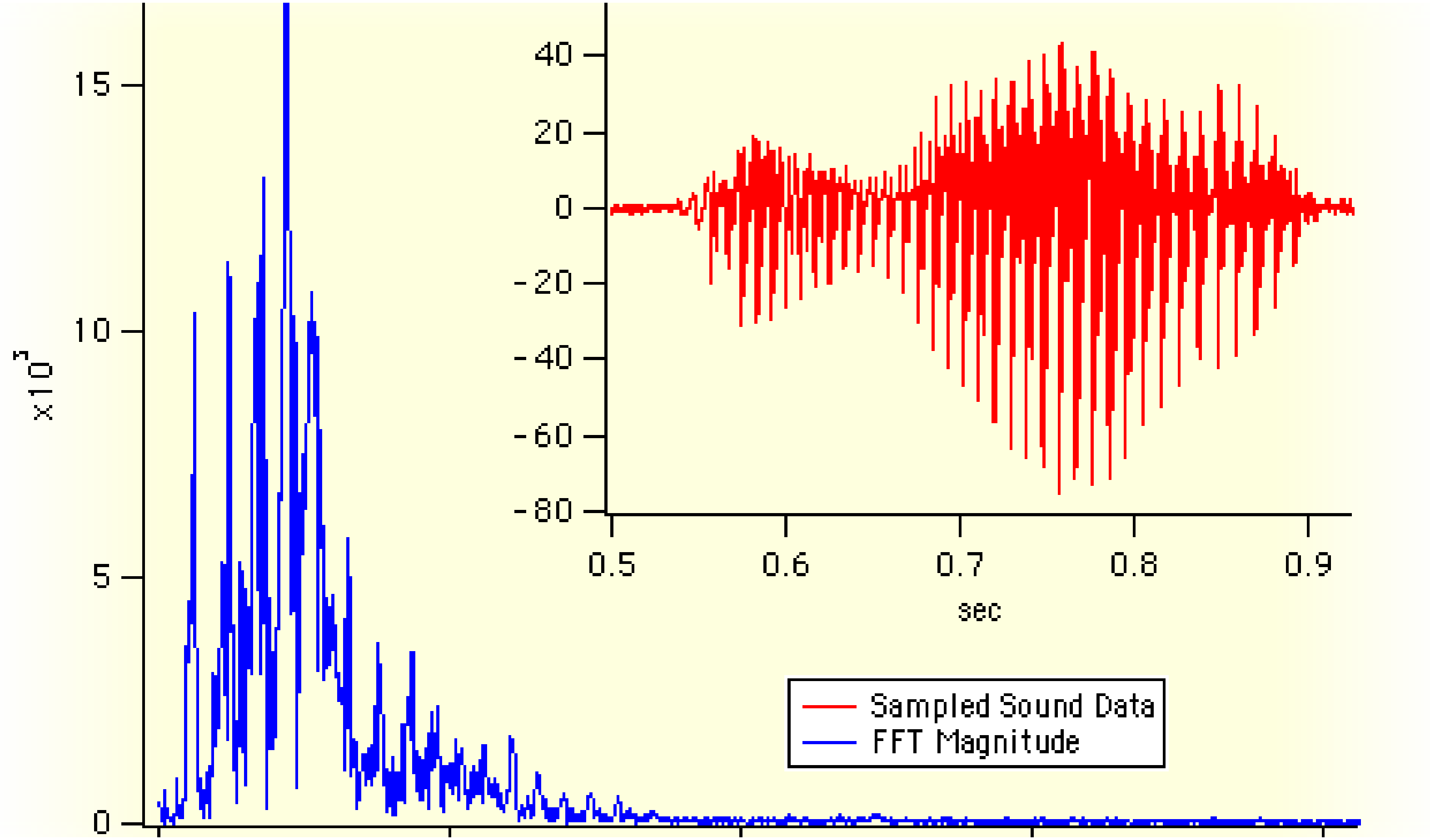
* Background

* Types of Waves and Signals

* Filtering

* Example

BACKGROUND



WaveMetrics. WaveMetrics. *IGOR Pro*. December 07, 2004. Available at: http://www.wavemetrics.com/products/igorpro/dataanalysis/signalprocessing.htm. Accessed November 01, 2012.

BACKGROUND

All take some form of:

$$recorded\ signal(x) = interfering\ signal(x) * true\ signal(x)$$

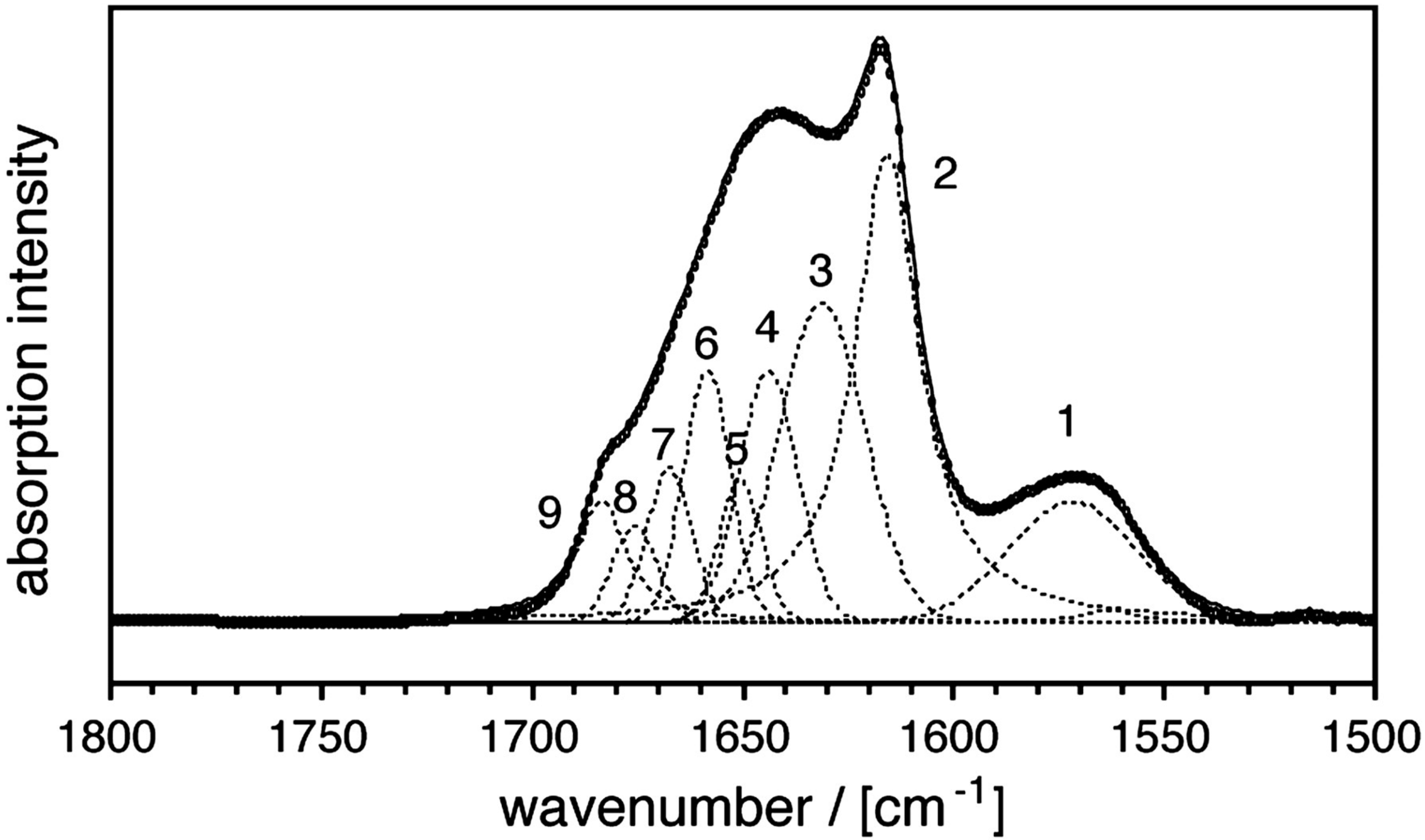
Where * is some operation such as addition, subtraction, multiplication, convolution, etc.

BACKGROUND

- Depending on how the signal is being treated (ie the interfering signal acting on the true) will determine the analytic techniques used to find the true signal
- Unlike most real life problems, there are easy and hard signals to decipher

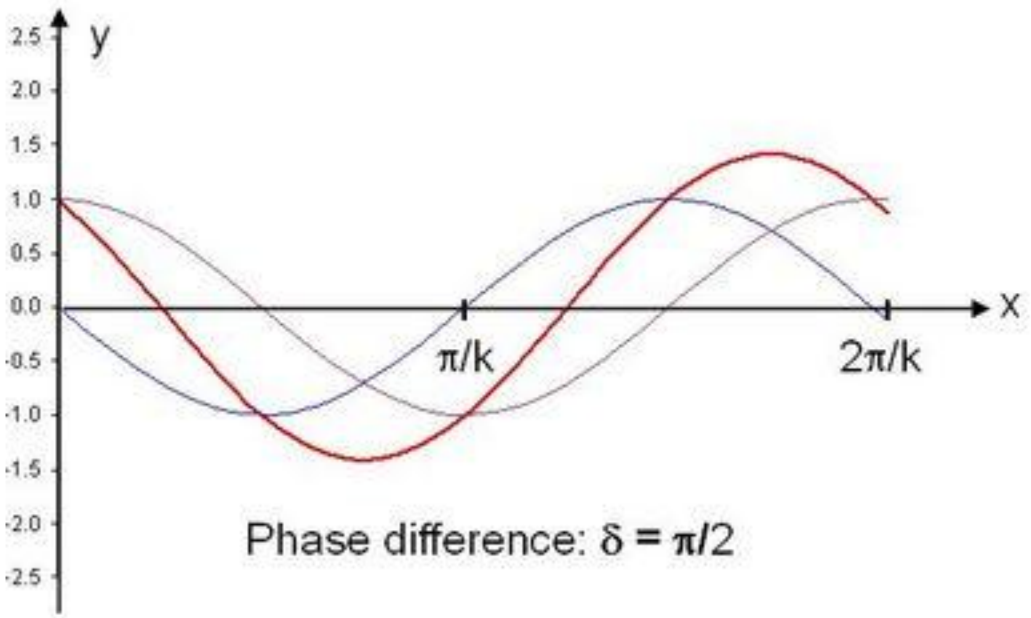
TYPES OF WAVES AND SIGNALS

Additive (Constructive Interference)



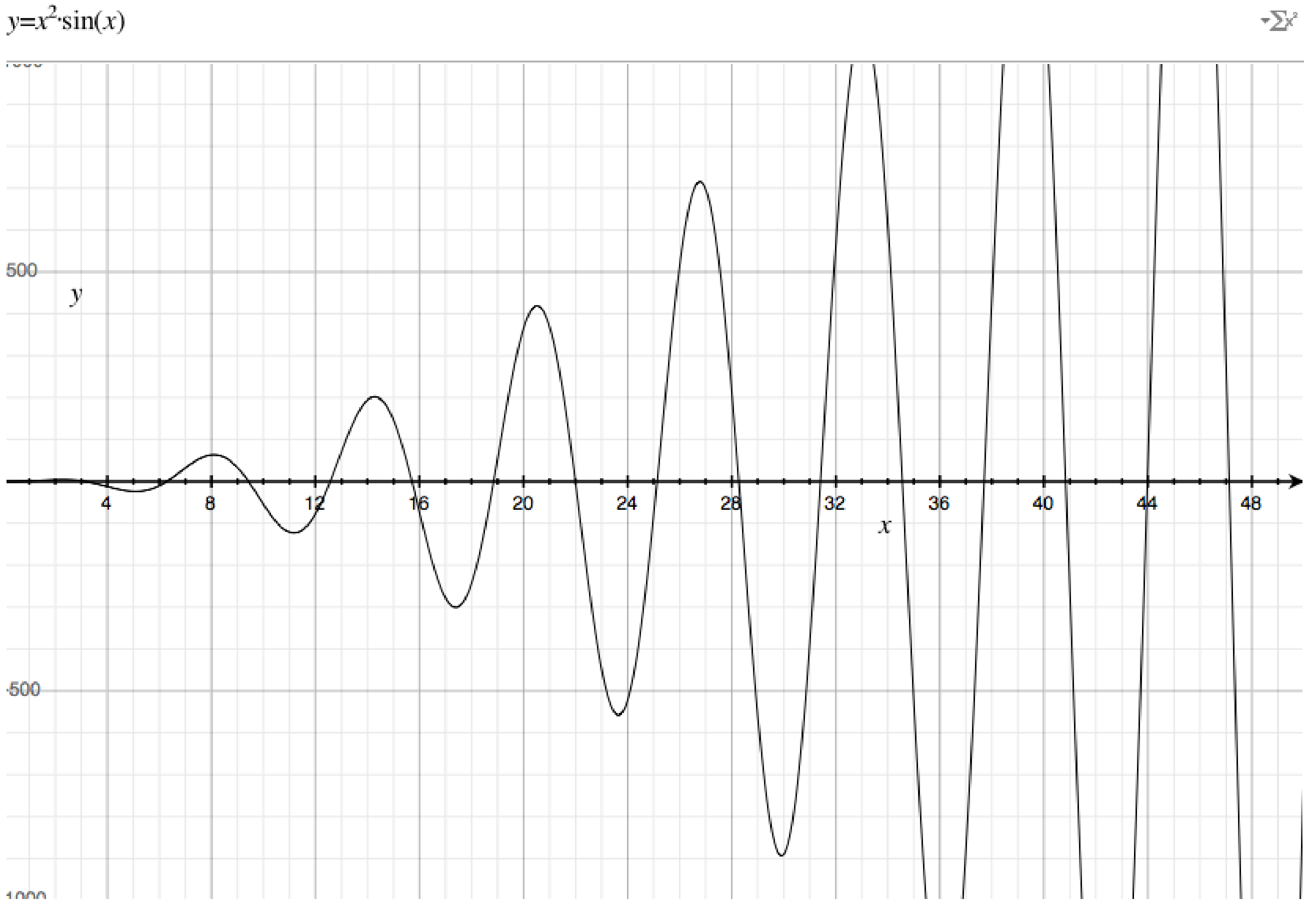
TYPES OF WAVES AND SIGNALS

Subtractive (Destructive Interference)



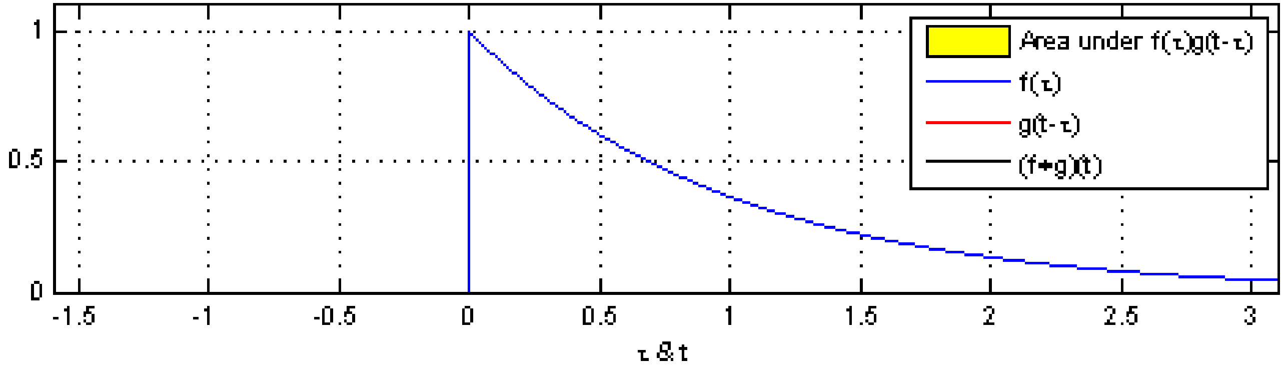
TYPES OF WAVES AND SIGNALS

Multiplicative (Either Constructive of Destructive)



TYPES OF WAVES AND SIGNALS

Convolution (Weighted Interference)



Wikipedia contributors. "Convolution."

FILTERING

Additive, Subtractive and Multiplicative interfering signals are easy to deal with

Simply do the inverse of the interfering process otherwise known as correcting for background noise

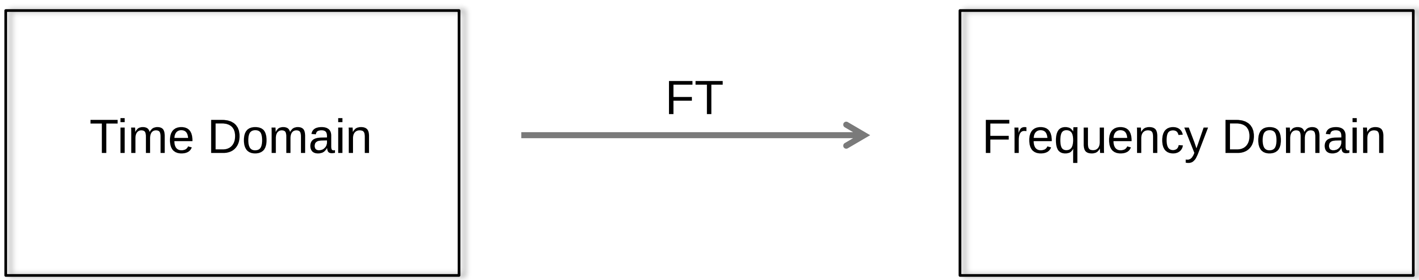
FILTERING

$$C(u) = \int_{-\infty}^{\infty} f(x)\,g(u-x)\,dx$$

$$\begin{aligned}
\mathrm{FT}_\omega(x * y) &\triangleq \int_{-\infty}^{\infty} \left[\int_{-\infty}^{\infty} x(\tau)y(t-\tau)d\tau\right] e^{-j\omega t} dt \\
&= \int_{-\infty}^{\infty} d\tau\, x(\tau) \int_{-\infty}^{\infty} dt\, y(t-\tau)e^{-j\omega t} \\
&= \int_{-\infty}^{\infty} d\tau\, x(\tau)e^{-j\omega\tau} Y(\omega) \\
&= X(\omega)Y(\omega),
\end{aligned}$$

FILTERING

IMPORTANT NOTE



FILTERING

Three functions at play:

$$recorded\ signal(x) = interfering\ signal(x) * true\ signal(x)$$

$$r(x) = \int_{-\infty}^{\infty} [i(\tau) \cdot t(x - \tau)] d\tau$$

Convolution Eq

$$R(\omega) = I(\omega) \cdot T(\omega)$$

Fourier Transform

$$\frac{R(\omega)}{I(\omega)} = T(\omega)$$

Solve for True Signal

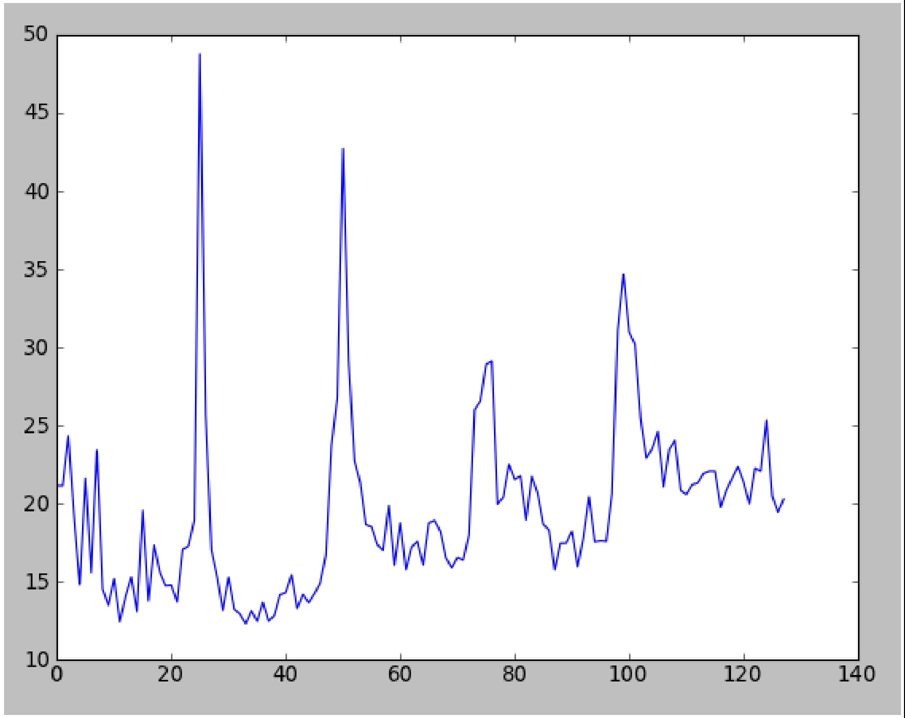
FILTERING

$$\frac{R(\omega)}{I(\omega)} = T(\omega)$$

T(omega) is very large when:
*I(omega) is very small OR
*R(omega) is very large

T(omega) is very small when:
*I(omega) is very large OR
*R(omega) is very small

T(omega) is zero when:
*R(omega) is zero



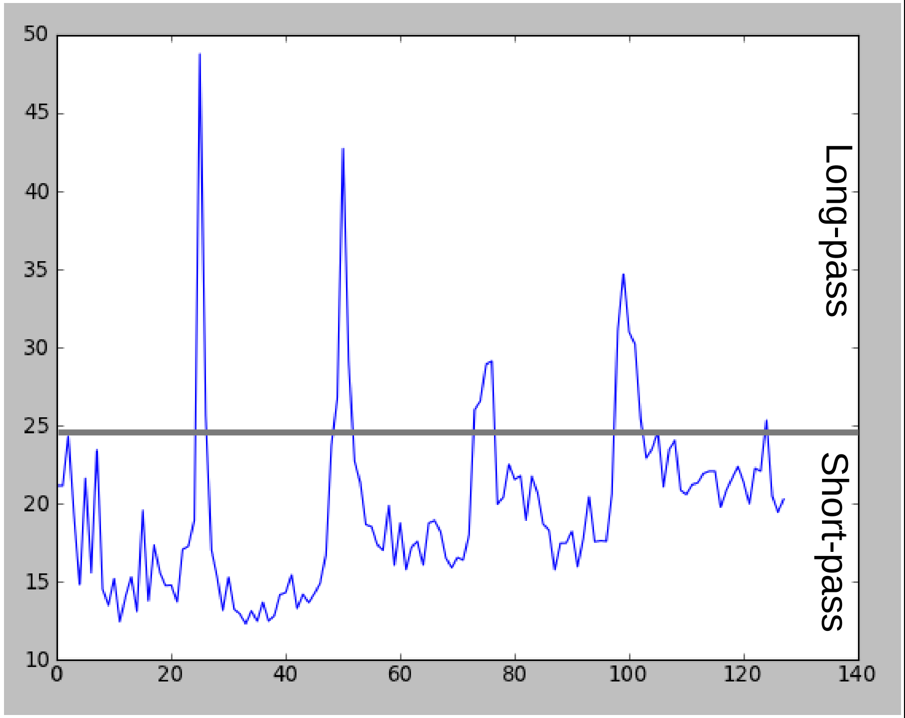
FILTERING

$$\frac{R(\omega)}{I(\omega)} = T(\omega)$$

Depending on the data:

*the lower amplitude frequencies are desired: short pass filter

*the higher amplitude frequencies are desired: long pass filter



FILTERING

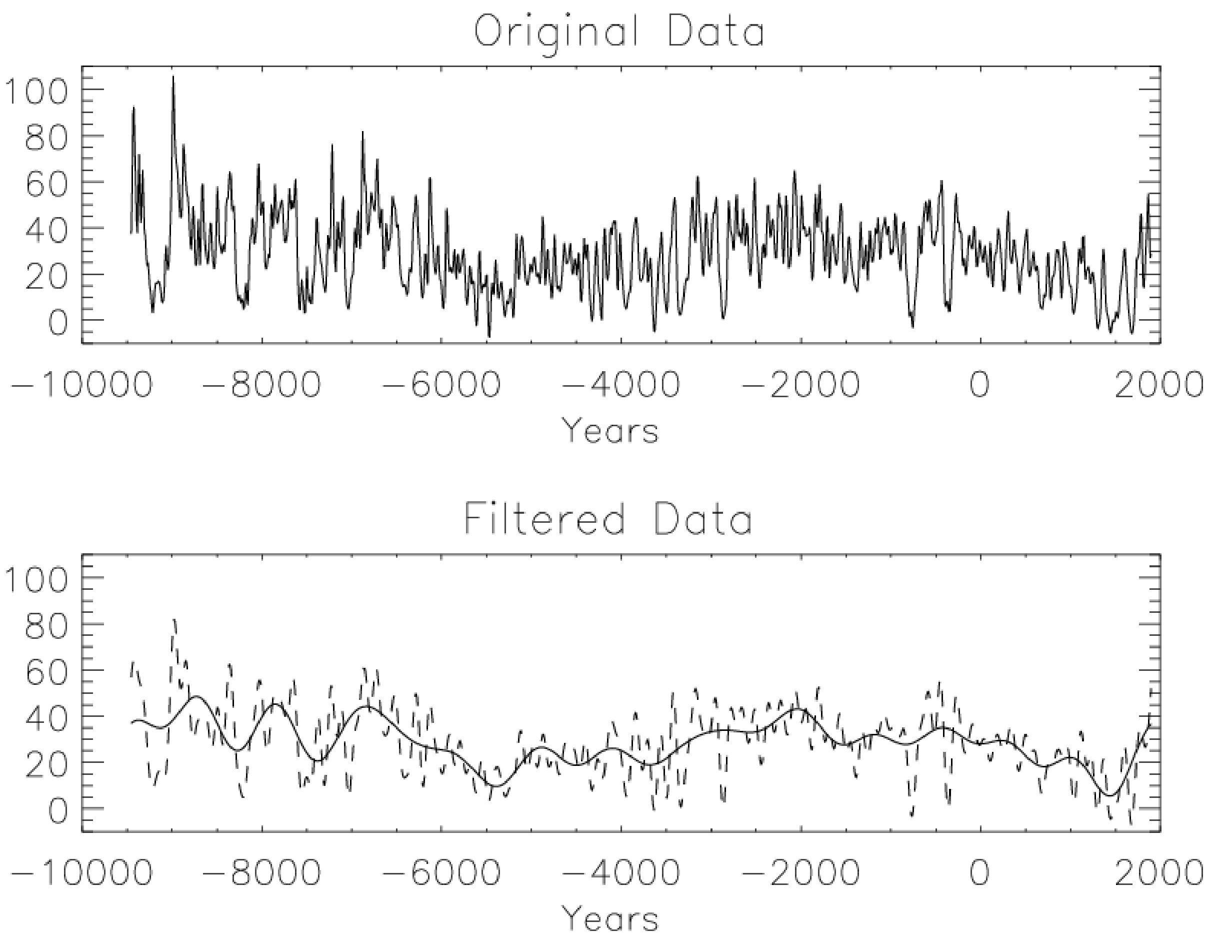
*Judgment is made by analyzer on how much to filter out

*Potentially leads to incorrect data

$$\left(\frac{R(\omega)}{I(\omega)}\right)_{Fil} = T(\omega)_{Fil}$$

$$t(x)_{fil} = \int_{-\infty}^{\infty} T(\omega)_{fil} \cdot e^{i\omega t}\, d\omega$$

EXAMPLE



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Wikipedia contributors. "Convolution." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 29 Oct. 2012. Web. 4 Nov. 2012.

QUESTIONS?