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M2 PI / ED S3M DataFit – Data acquisition and analysis

Module 2: Data analysis and modelling – Tutorial / workshop 4

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Introduction

This workshop is designed to introduce you to the use of Fourier methods as applied to convolution and deconvolution.

Convolution – using FFT

1. Generate a 1000 point signal xwave running from x = 0 to 10 and place a Gaussian peak centred at x = 1, with width 1 and amplitude 1 (you can use the GAUSS1D function for this, and the help provided by Igor). Display this peak.

2. Generate a 1000 point signal hwave containing an exponential decay with amplitude 1 and time constant 1 running from x = 0 to 10. Display this signal.

3. Use FFT methods to perform the convolution of these two signals using the Convolution Theorem. Display the result. (We have chosen equal length signals to reduce the complexity, but of course this may not always be the case, for more information you could refer to the DSPGUIDE, Chapter 18: http://www.dspguide.com/ch18/2.htm). You can get the same result using the Igor function CONVOLVE.

Compare this with simple linear convolution adapting the routines you already wrote. As noted there, this is inefficient for such short signals. If you wish, try it again for a much longer xwave signal.

4. As an additional exercise, explore how to perform *deconvolution* using FFT methods and the Convolution Theorem. Deconvolution is not possible without the use of such methods. Attempt to recover the original Gaussian peak.

5. Deconvolution is rather sensitive to noise in signals. Add approximately 10% Gaussian noise to your convolved signal *and* to your impulse response function (only when using it for deconvolution). This simulates what you might find in real measurements where you would record both the final experimental signal and the response function of your instrument with associated experimental noise.