Signal Decimation - Downsampling

In this example we illustrates the process of signal decimation using existing MatDeck functions. The decimation is the decrease of the sampling rate. First, the test signal is generated. We use the sum of the two sinusoidal signals of different frequencies.

$Fs := 20000$ Hz , sampling rate

$Ts := 1 / Fs$ Sampling period

$Dt := \text{curve2d}(x , 0 , 0.005 - Ts , 100)$

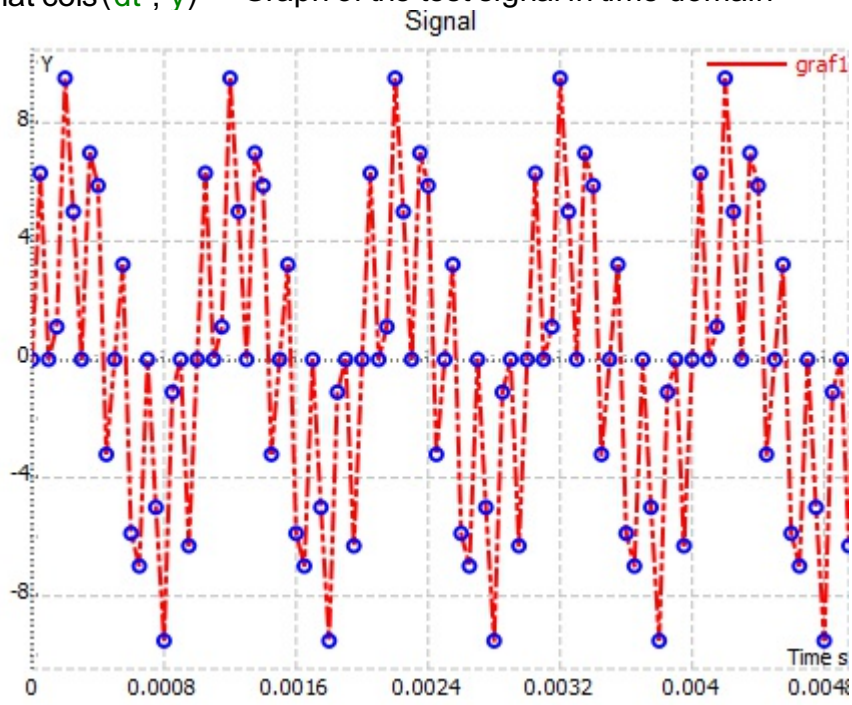
$dt := \text{col2vec}(Dt , 0)$ Time variable

$f1 := 1000$ Hz

$f2 := 6000$ Hz

$y := 5 \sin(2 \pi \cdot f1\ dt) + 5 \sin(2 \pi \cdot f2\ dt)$ Test signal

$graf1 := \text{join mat cols}(dt , y)$ Graph of the test signal in time domain



We can investigate the signal spectrum as well. We determine the spectrum by using fft.

$nfft := \text{size}(y)$ Length of the test signal

$fy := \text{fft1}(y)$ Spectrum of the test signal

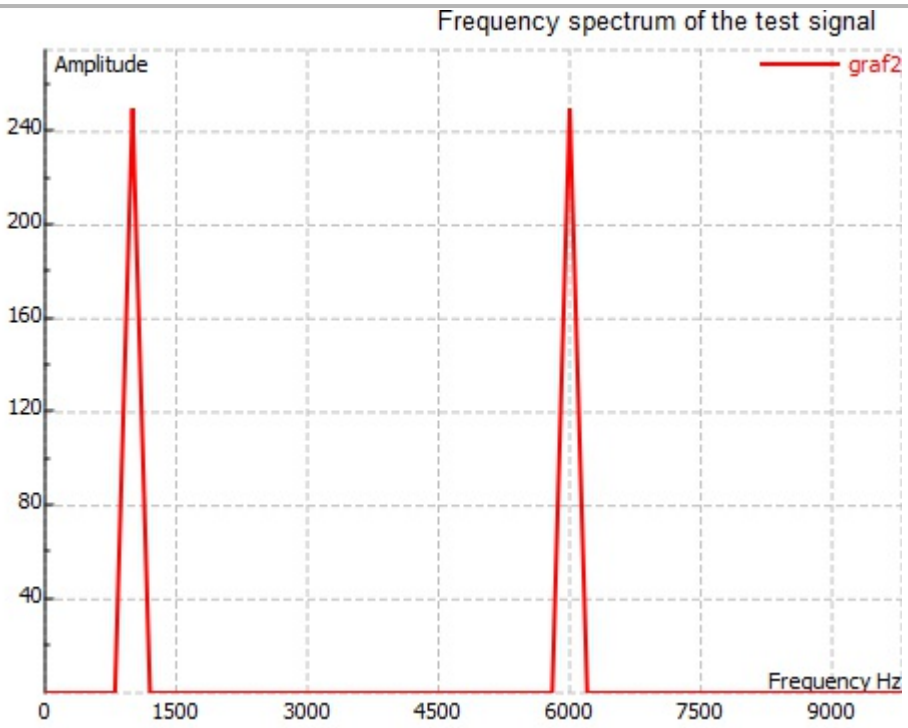
$fy1 := \text{subset}(fy , 0 , 0 , nfft/2 - 1 , 0)$ Only half of the spectrum is needed due to the symmetry

$xfft := \text{curve2d}(x , 0 , (Fs/2) \cdot (nfft/2 - 1)/(nfft/2) , 50)$ Ferquency axis

$xfft1 := \text{col2vec}(xfft , 1)$

$fyy1 := |fy1|$ Amplitude spectrum

$graf2 := \text{join mat cols}(xfft1 , fyy1)$ Graph of the amplitude spectrum of the test signal



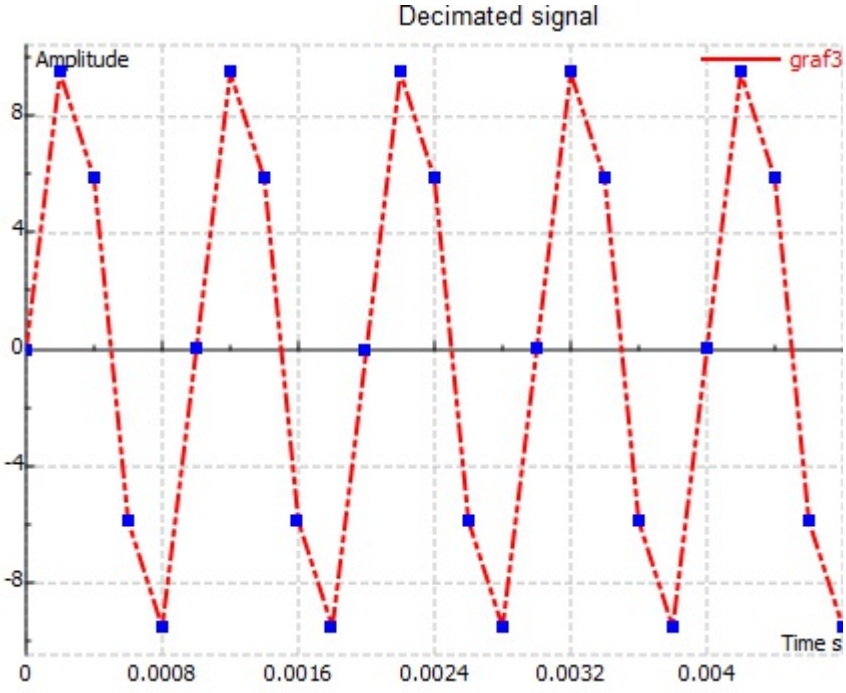
The following task is to decrease the sampling rate by a factor of four, reducing the number of samples. When decimation is performed, one should take care about proper timing, in order to illustrate the decimation.

$N := 4$ Downsampling factor

$ydecim := downsample(y, N)$ Downsampled signal

$dt1 := downsample(dt, N)$ New time axis is obtained by downsampling

$graf3 := join\ mat\ cols(dt1, ydecim)$ Graph of the downsampled signal in time domain



We can analyze the frequency spectrum of the decimated signal.

$nfftd := size(ydecim)$ Length of the downsampled signal

$fydcim := fft1(ydecim)$ Spectrum of the downsampled signal

$fy1d := subset(fydcim, 0, 0, (nfftd + 1)/2, 0)$ Only half of the spectrum is needed due to the symmetry

$xfftd := curve2d(x, 0, (Fs/(2\ N)) \cdot ((nfftd + 1)/2)/(nfftd/2), 14)$ New frequency axis

$xfft1d := col2vec(xfftd, 1)$

$fyy1d := |fy1d|$ Amplitude spectrum of the decimated signal

$graf4 := join\ mat\ cols(xfft1d, fyy1d)$ Graph of the amplitude spectrum of the decimated signal