

# A JMP Script to Enhance Spectral Density Analysis in JMP's Time Series Analysis Platform

Jerry Fish  
President, Experistats LLC

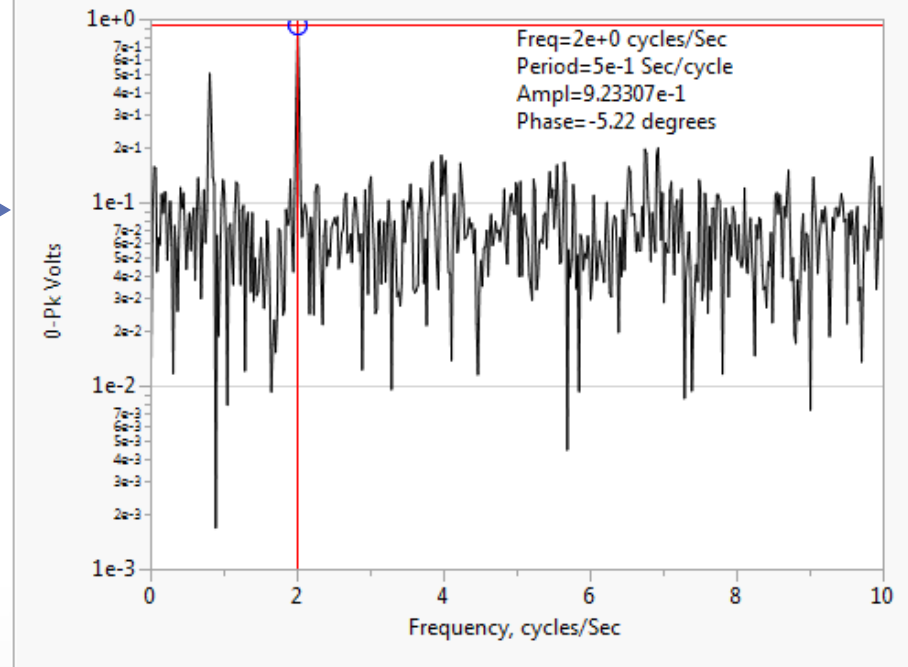
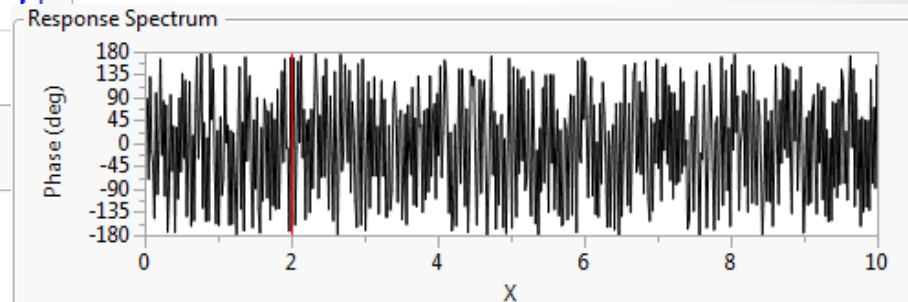
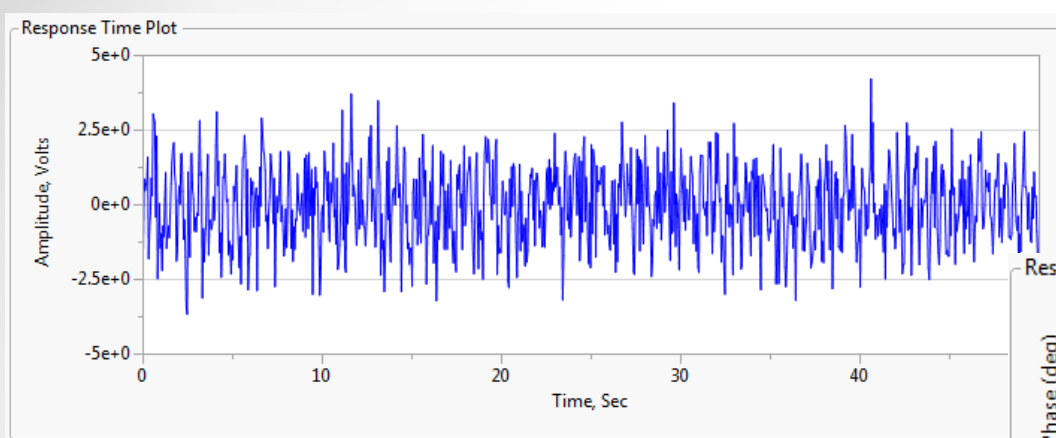


# A Quick Intro on Fourier Transforms

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- Fourier Transform fits a number of sine waves to a time-based signal.
  - Each sine wave has an associated Frequency, Amplitude, and Phase
- Amplitudes plotted against Frequency are called a Frequency Spectrum

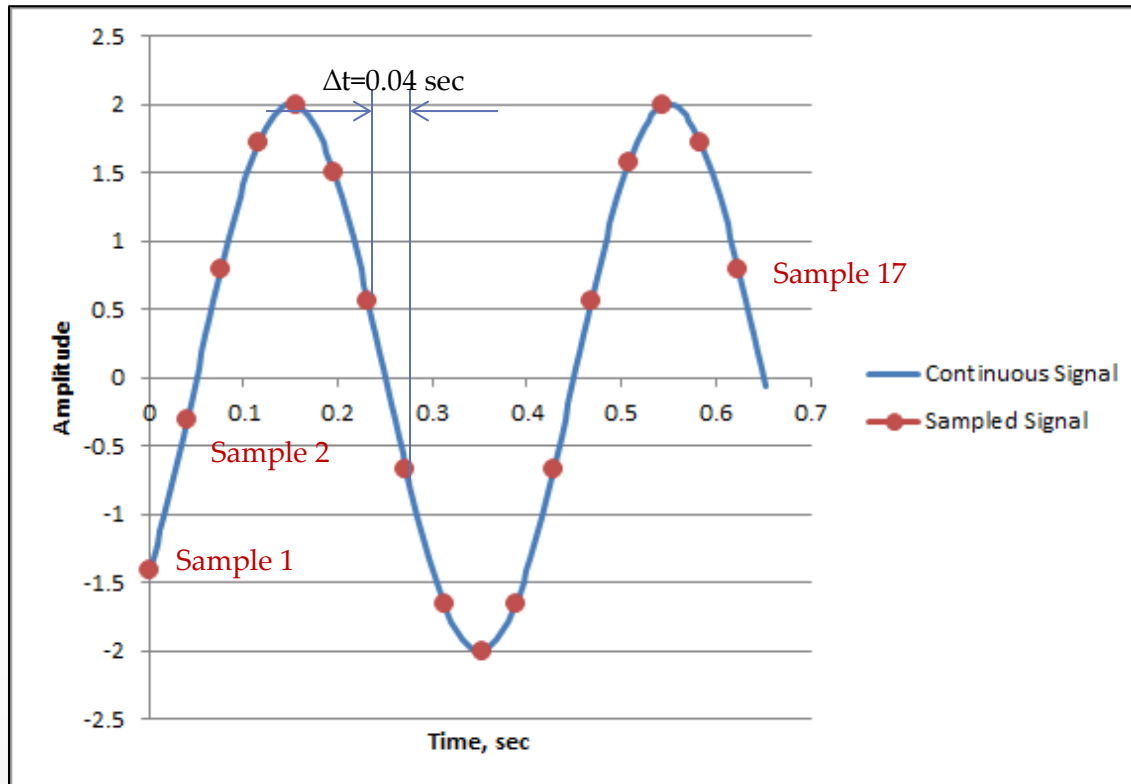
# A Quick Intro on Fourier Transforms



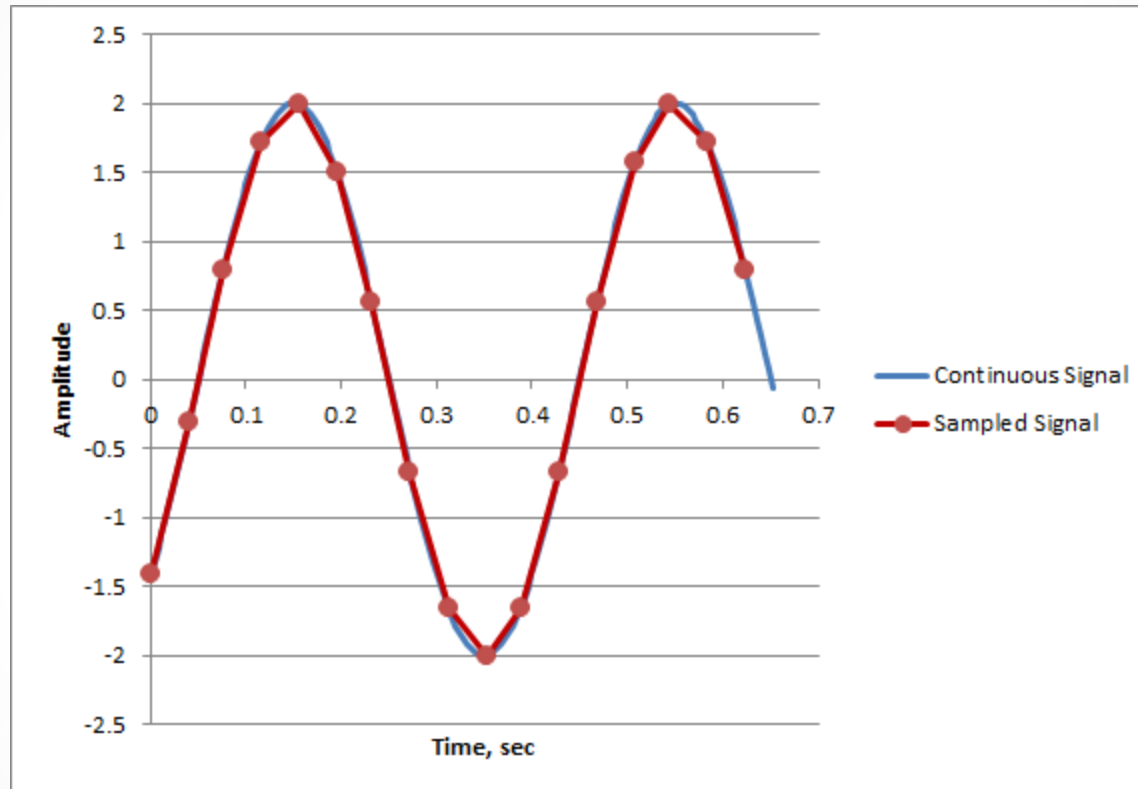
$$f(t) = A + \sum_{n=1}^{\infty} B_n \sin(nt - \varphi_n)$$

# Discrete Sampling Effects

- A Discrete Fourier Series operates on a Discrete Time Series
- Discrete Time Series Parameters
  - Sampling Interval (or Sampling Frequency)
  - Total Number of Sampled Points

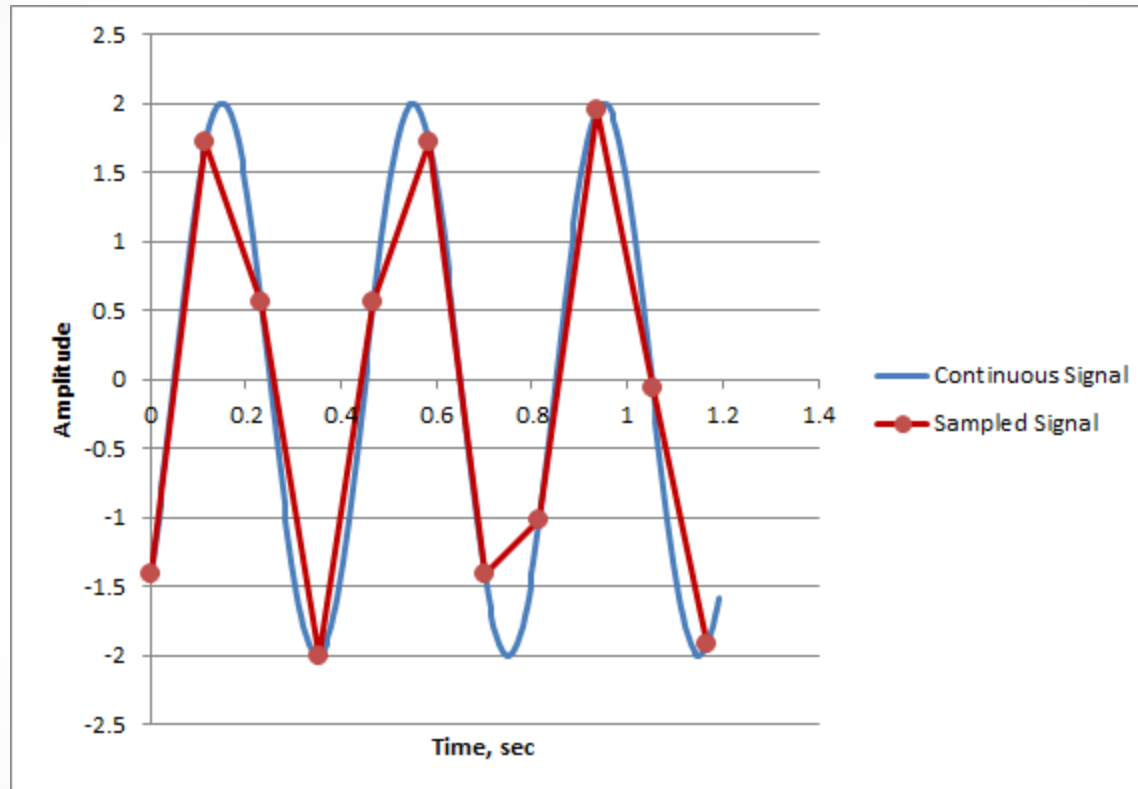


# Effect of Sampling Frequency



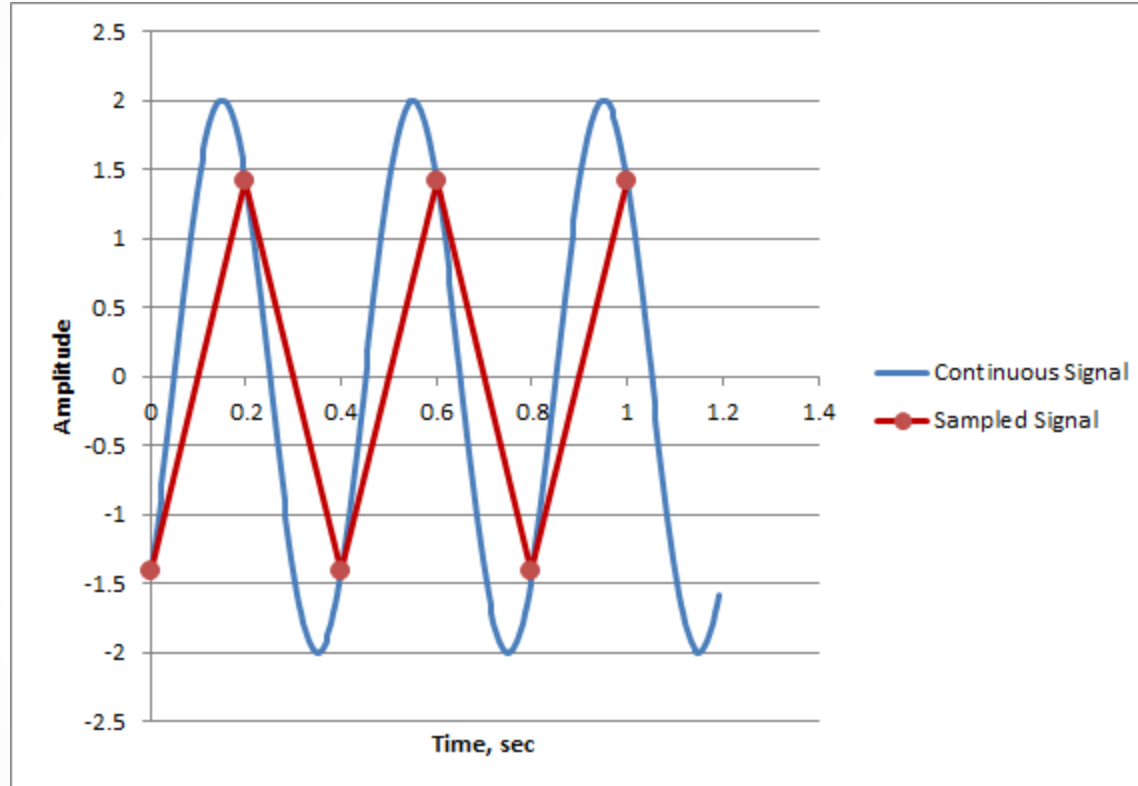
18 samples  
per cycle

# Effect of Sampling Frequency



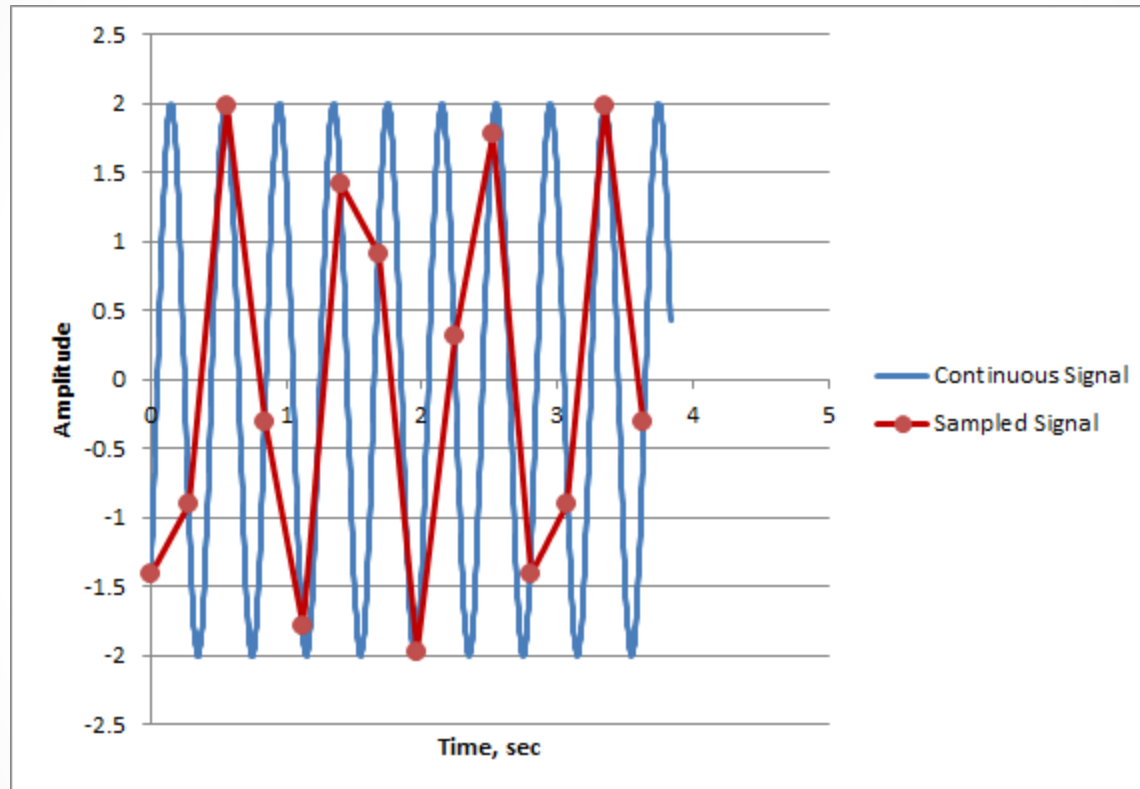
3 samples  
per cycle

# Effect of Sampling Frequency



2 samples  
per cycle

# Effect of Sampling Frequency



1.33  
samples  
per cycle



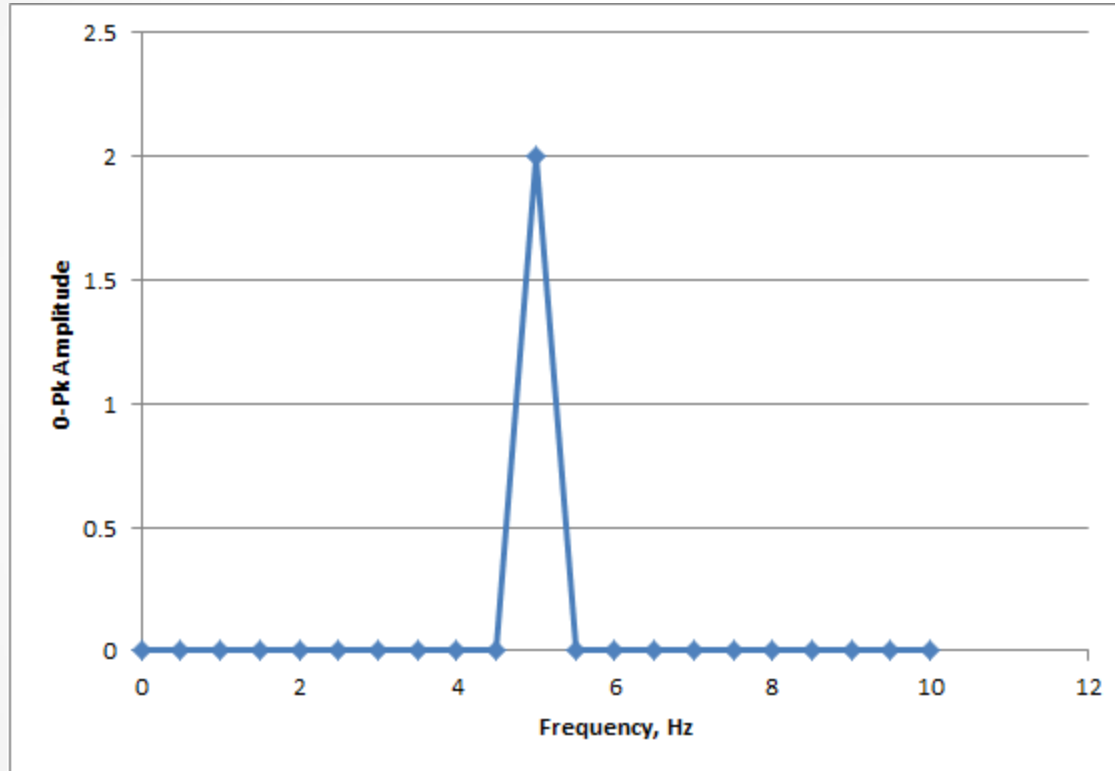
# Discrete Sampling Effects – Nyquist Freq

- The maximum frequency that can be accurately fit to the sampled data is the Nyquist Frequency

$$f_{max} = f_{Nyquist} = \frac{1}{2\Delta t}$$

# Discrete Sampling Effects – Nlines

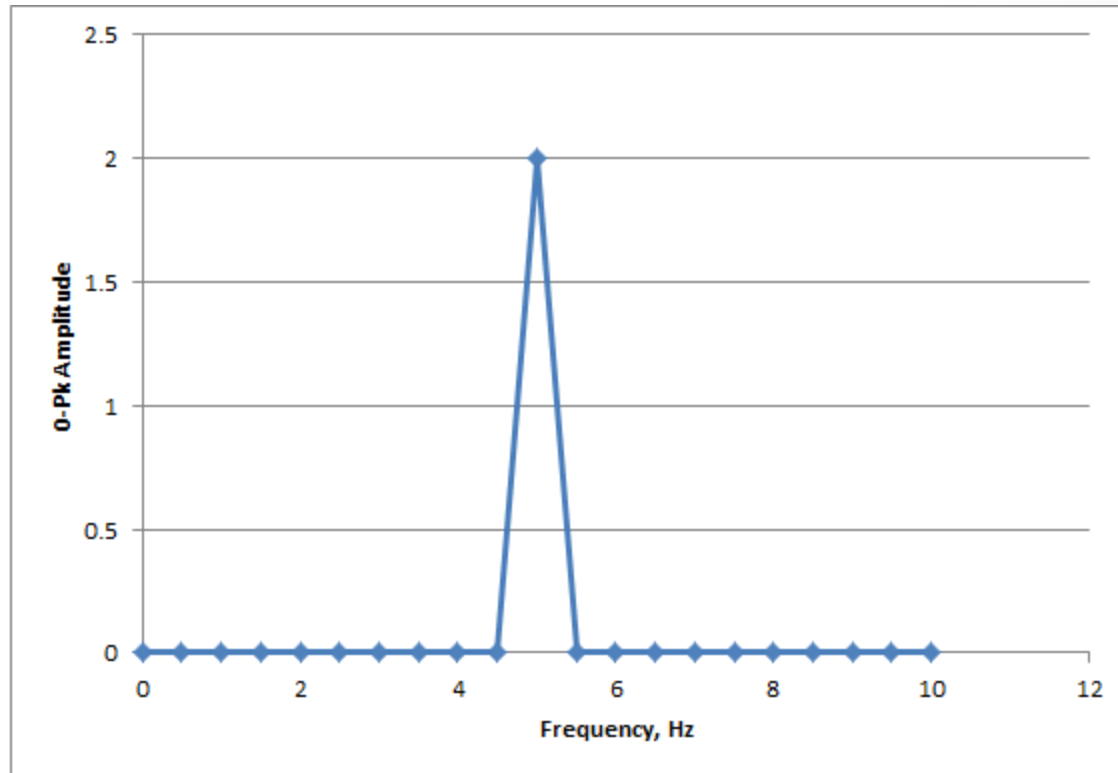
- A discrete frequency spectrum has a finite number of frequency “lines”, depending on the sample size.



$$N_{lines} = \frac{N}{2}$$

# Discrete Sampling Effects – Frequency Resolution

- Frequency Resolution is the distance between spectral lines



$$f_{res} = \frac{f_{max}}{N_{lines}} = \frac{1/(2\Delta t)}{N/2} = \frac{1}{N\Delta t}$$

# Discrete Sampling Effects – Summary

		Affected Parameters			
		sampfreq	Nyquist Frequency	Number of Spectral Lines	Spectral Resolution
Sampling Parameters	$\Delta t$	$\Delta t$ is inversely proportional to sampling frequency: $f_s = 1/\Delta t$	$\Delta t$ sets the maximum frequency that can be analyzed: $f_{max} = f_s/2 = 1/(2\Delta t)$		$\Delta t$ is inversely proportional to spectral resolution. If you want a smaller frequency increment between spectral lines, increase $\Delta t$ : $\Delta f = f_{max}/N_{lines} = 1/(N\Delta t)$
	N			N is twice the number of lines in the spectrum: $N_{lines} = N/2$	N is inversely proportional to spectral resolution. If you want a smaller frequency increment between spectral lines, increase N: $\Delta f = f_{max}/N_{lines} = 1/(N\Delta t)$

# What's an FFT

- Fast Fourier Transform
  - Very fast software algorithm for computing sine wave amplitudes and frequencies.
  - Limited to sample sizes that are powers of 2 (32, 64, 128, ...)
    - This limits spectral lines to 16, 32, 64, ...
- JMP does not use FFT.
  - No limits on sample size
- Frequency Analysis Script uses JMP methods

# The Frequency Analysis Script

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- A live demo of the script.
- See submitted paper for more information.

# Future Script Features

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- Amplitude Axis Options
- A-Weighting Function
- Coherence Function
- Power Between Cursors
- Periodogram
- Additional Windowing Options
- Save data to table
- Collect data from external instruments
- Add an “About” Button
- Use Column Names on Plots

# About the Author

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- Jerry Fish is owner and President of Experistats LLC. He is a trained Lean Six Sigma Black Belt, and has many years of experience in statistics and DOE while working for Caterpillar Tractor, Cummins Engine, GE Aircraft Engines, and Lexmark International. He and his wife live in Lexington, KY.
- Contact Info:

Jerry Fish

Experistats LLC

[experistats@gmail.com](mailto:experistats@gmail.com)

859-433-6231

