

# The optimal sample length to use when calculating transfer functions from discrete experimental data

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Transfer functions are useful tools in observing the behaviour of non-linear systems. Transfer functions convert an input signal into an output signal, and for non-linear systems can be calculated separately for each order of response using the Volterra series. The Volterra series quantifies the linear and non-linear (eg quadratic, cubic etc) responses separately for systems with either Gaussian or non-Gaussian inputs, and is particularly useful when calculating transfer functions from experimental data, as the calculations can be performed using a discrete frequency-domain format.

The application of the Volterra series to discrete experimental data requires careful consideration of various factors that can impact on the successful calculation of transfer functions. The single largest problem faced when using discrete experimental data is the difficulty presented when determining the optimal sample length of the data used during the calculation process. Equal lengths of sample data are extracted from each individual record to calculate averaged input and output spectra. When using experimental data of finite record lengths, a trade off between the number of sample lengths obtained from each record and the frequency interval of the resulting transfer functions occurs. This paper will in particular focus on those factors that lead to the selection of an optimal sample length.

The paper will present an overview of the Volterra series approach, and how experimental data can be used to calculate transfer functions. The factors that influence the selection of the optimal sample length will be described and methods that ensure the most meaningful results are obtained will be outlined. To demonstrate these methods, the results from an experimental procedure performed on a model Tension Leg Platform will be presented.