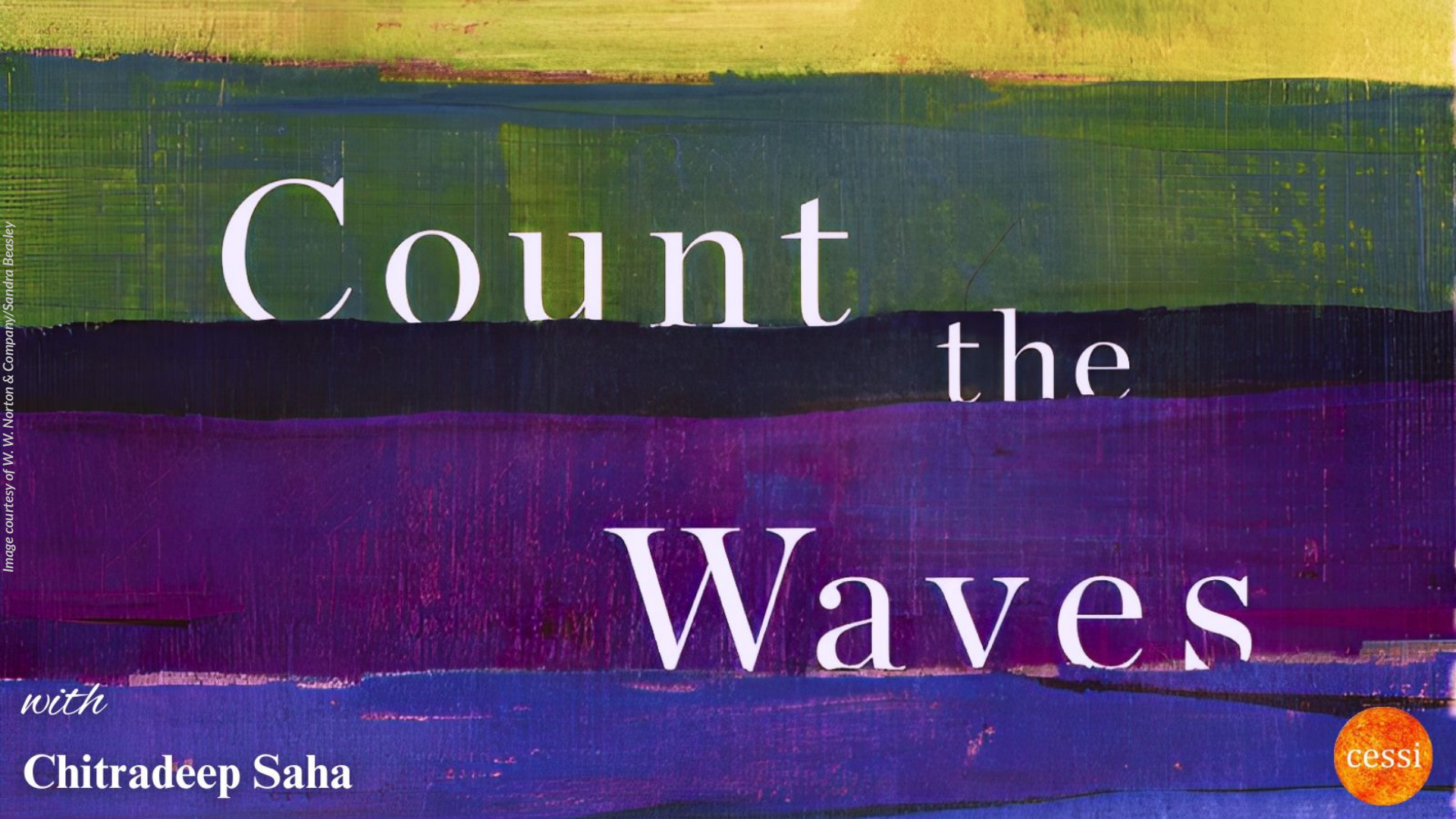


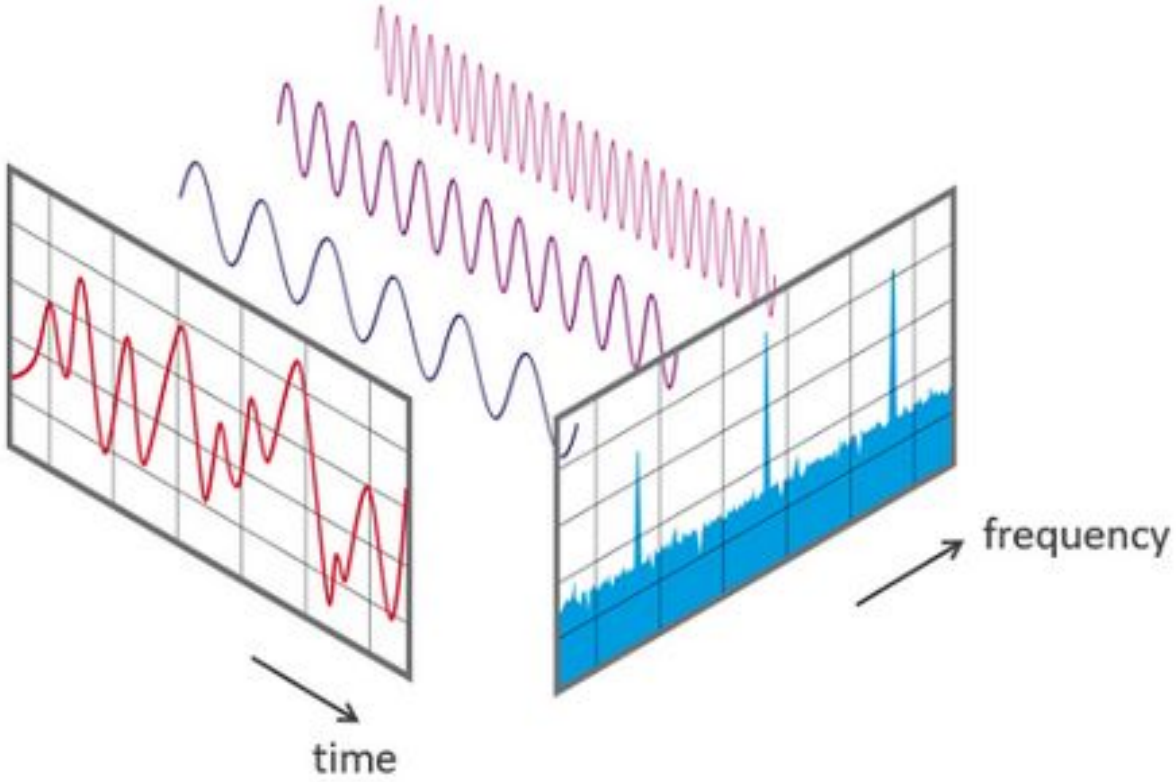
Image courtesy of W. W. Norton & Company/Sandra Beasley

Time Series Analysis

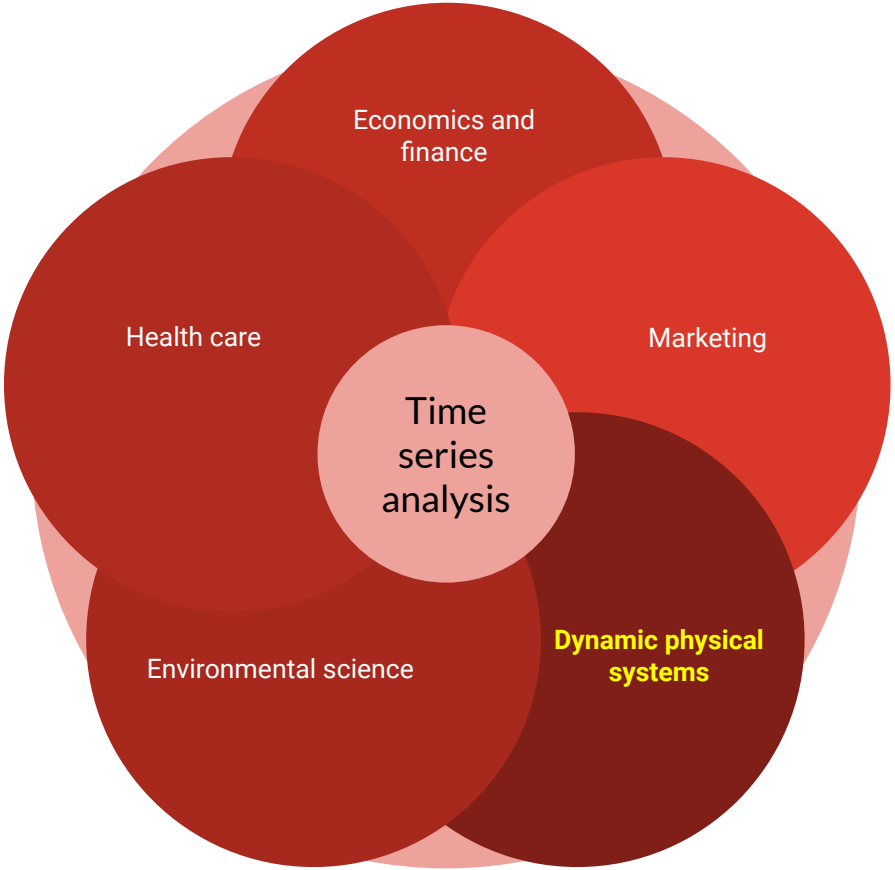
Time domain analysis is an analysis of physical signals, mathematical functions, or time series of economic or environmental data, etc., in reference to time. A time-domain graph displays the changes in a signal over a span of time.

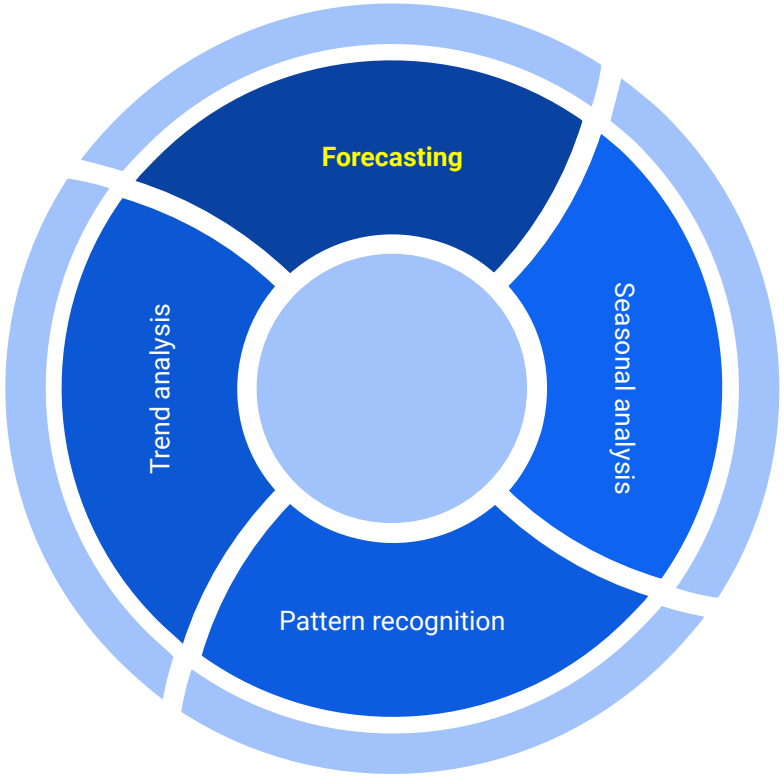
Frequency domain analysis displays how much of the signal exists within a given frequency band concerning a range of frequencies. Also, a frequency-domain representation can include information on the phase shift that must be applied to each sinusoid to be able to recombine the frequency components to recover the original time signal.

The big picture

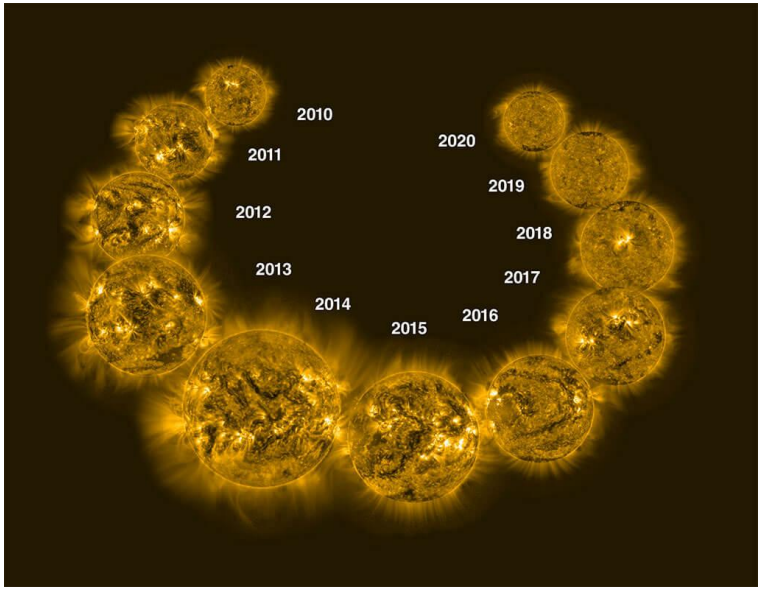


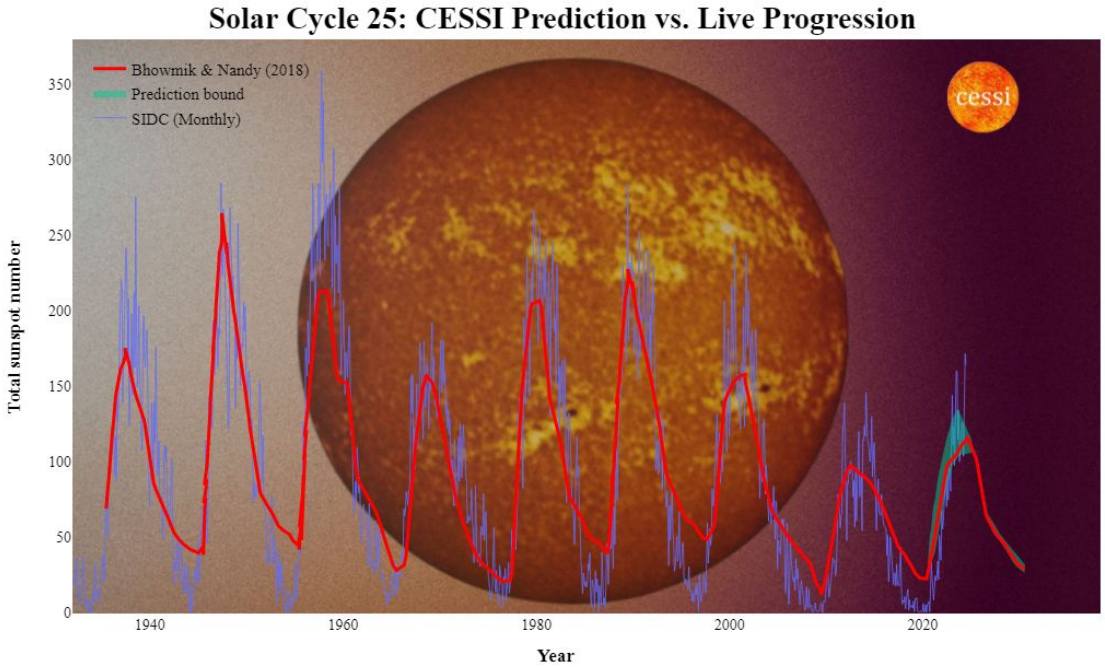
Wide applications across various domains

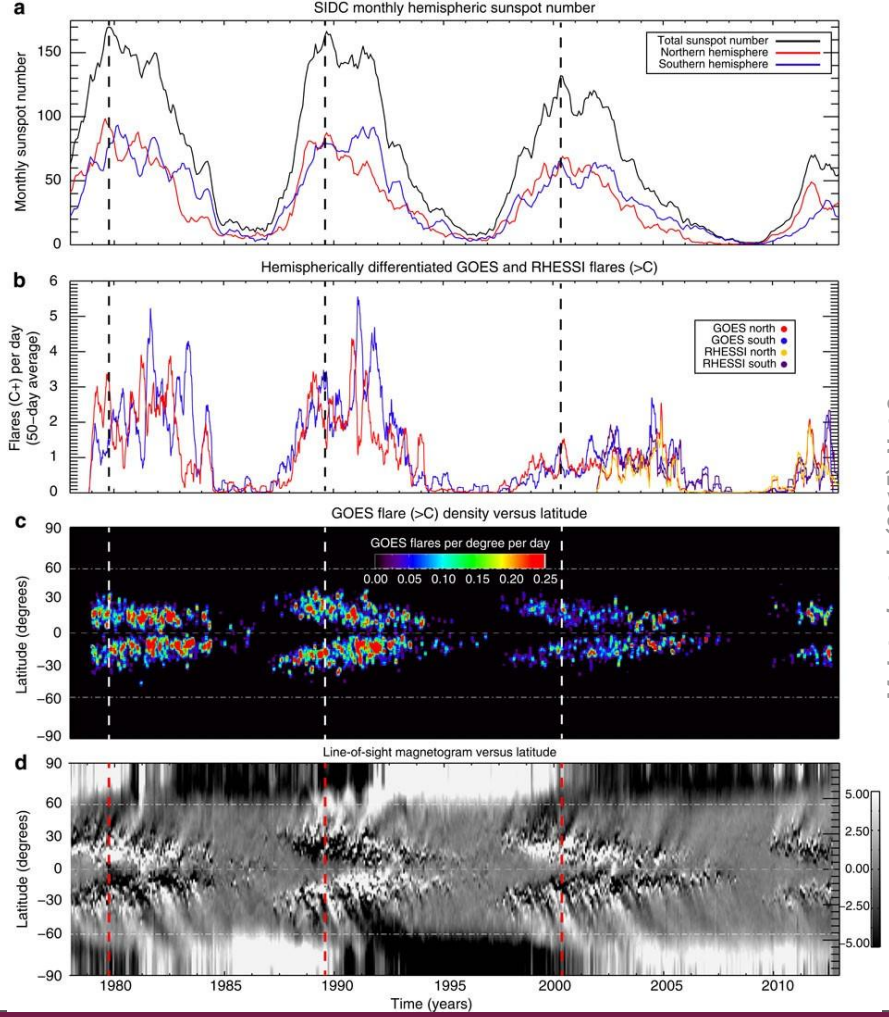




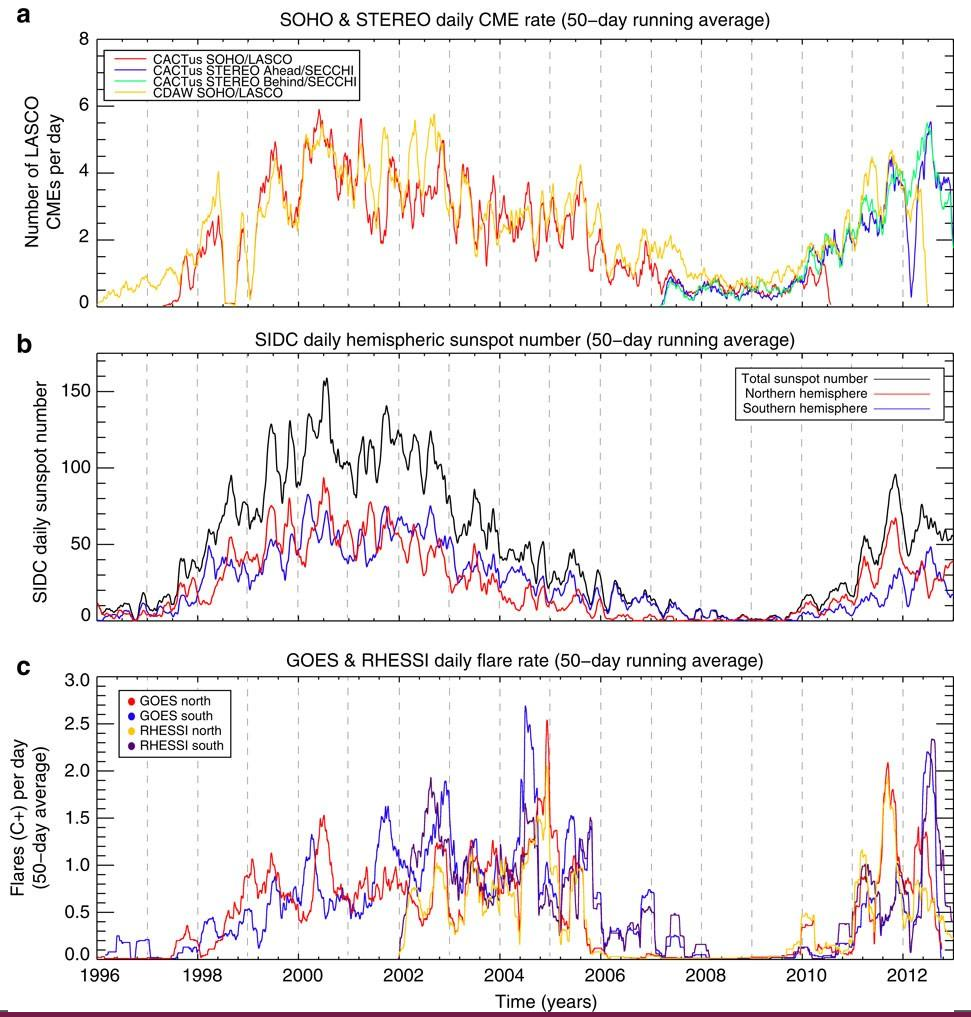
The Sun is a Dynamic star







McIntosh et al. (2015), Nat Comm



Outline of this module

Module 4A — **Time series analysis: Fourier transform**

Submodule I — **Count the Waves**

A brief overview

Submodule II — **The Fast & the Fourier**

Fourier series – Gibbs phenomenon – discrete Fourier transform – fast Fourier transform – Nyquist sampling – Aliasing – Window function – Power density spectrum

Submodule III — **A needle in a haystack**

Stationarity test – noise characterization – autoregressive modeling of noise – Significance estimation of spectral peaks

Outline of this module

Module 4B — **Time series analysis: Wavelet transform**

Submodule I — **Catch the rhythm with wavelets**

A brief overview

Submodule II — **Hands on MATLAB**

Standardization of time series – discrete wavelet transform – approximate and detailed coefficients – low and high pass signal decomposition – continuous wavelet transform – global wavelet spectrum – cone-of-influence study

What we will Not cover here

- **Seasonality, trend analysis, etc.**
- **Time series analysis of non-uniformly sampled signal (refer to Lomb-Scargle periodogram).**
- **Higher dimensional (>1) signal analysis.**

Summary

Module 4A — Time series analysis: Fourier transform

Submodule I — Count the Waves

A brief overview

Submodule II — The Fast & the Fourier

Fourier series – Gibbs phenomenon – discrete Fourier transform – fast Fourier transform – Nyquist sampling – Aliasing – Window function – Power density spectrum

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Module 4B — Time series analysis: Wavelet transform

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