TFApy - Time frequency analysis tools for biological time series

only working title so far..

June 7, 2019

1 Introduction*

comes later...

2 Basic Wavelet Theory*

The historically oldest way of doing time-frequency analysis is the well known and ubiquitously used Fourier analysis. It's working principle is the decomposition of a signal into its harmonic components. A harmonic component is a Sine or Cosine with constant frequency. Mathematically the Fourier transform can be expressed as:

$$\mathcal{F}[s](f) = \int_{-\infty}^{\infty} s(t)\; e^{-2\pi i f t} dt \tag{1}$$

$$= \int_{-\infty}^{\infty} s(t)\; \left[cos(\omega t) + i\; sin(\omega t)\right] dt \tag{2}$$

Here we used the Euler identity to express the complex Exponential as the sum of Cosine and Sine and $\omega = 2\pi f$. The result is the Fourier transformed signal $\mathcal{F}[s] = \hat{s}(f)$ which is a function of the frequency f alone. The Fourier transform therefore translates the signal from the *time domain* into the *frequency domain*: $\mathcal{F} : s(t) \rightarrow \hat{s}(f)$. As a corollary, all time-dependent information of the signal is lost in the frequency domain (see Figure **??**a). Therefore Fourier analysis is best suited for *stationary* signals, meaning here no varying frequencies over time. This is a situation often found in engineering (Smith et al. [1997]), but is rather rare in Biology.

3 Optimal Filtering - Do's and Dont's

4 Readout - Along the Ridge

5 Application UI and API

References

Smith, S. W. et al. (1997). The scientist and engineer's guide to digital signal processing.