Chapter-12 : Morlet Wavelet and Wavelet Convolution

Limitations of FT

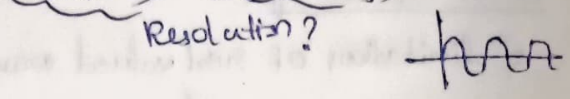
FT ↓ used to Can be obtain frequency domain representation

1) changes in fro structure over time
   ↳ difficult to visualize.
2) Stationary assumption of Fourier Analysis.
   ↑ violates this
   EEG data

Temporal | Frequency

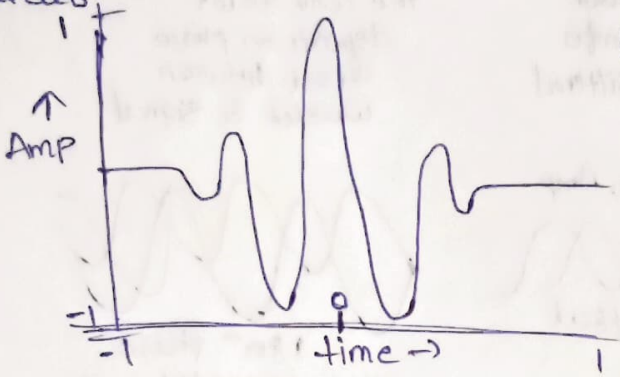
Resolution?

Diff T-F representations of EEG Data?

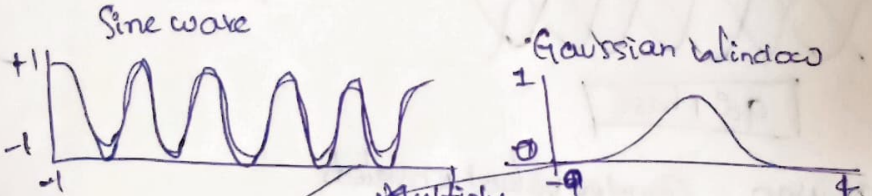


Kernel in FT ⇒ Sine wave
↓
No temporal localization
Amp Fluctuations ↳ −∞ to +∞

→ Wavelets



Sine wave windowed with Guassian
↓
Morlet wavelet
No sharp edges
↓
No Edge artifacts



Should have same No. of time Points & same sampling rate
↳ Same sampling rate as EEG Data

them point by point ⇒

Gaussian win = $ae^{-(t-m)^2/2s^2}$

$s = \frac{n}{2\pi f}$

→ freq of wavelet ⇕ freq of sine wave

freq of wavelet ⇒ cannot be more than Nyquist freq
⇒ 1/2 sampling rate

Wavelets ⇔ Band pass filters?

Conv in time domain = Multiplication in fre Domain

1) EEG signal in time domain
2) Signal & wavelet ⇒ FD ⇒ FFT
3) Multiply the 2 Freq spectra

when multiplying 2 signals
↓
freq present in wavelet & signal
frequencies from the signal.

4) Transform back to time domain (INVERSE FFT).
↳ we'll get filtered signal that only contains freq that were in both the signal & wavelet

→ Phase offset Dependency:

2 limitations of real valued wavelets

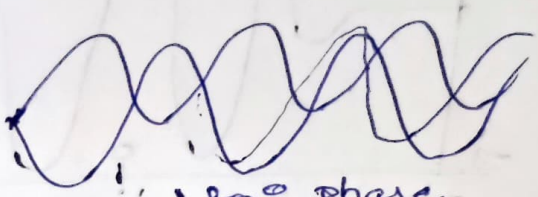
1

① Difficult to Extract power & phase info directly from filtered signal.

② The conv result depends on phase offset between wavelet & signal

Same fre, Amp

delay ⇒ phase offset



180° phase
opposite / Anti phase

90° phase

Solution : Complex valued wavelets
↑
real + Imagined parts
Let's us measure power + phase instantaneously even if the signal is shifted

EEG Analysis → we need to measure brain activity at specific freq regardless of phase