Quantifying Frontal EEG Asymmetry

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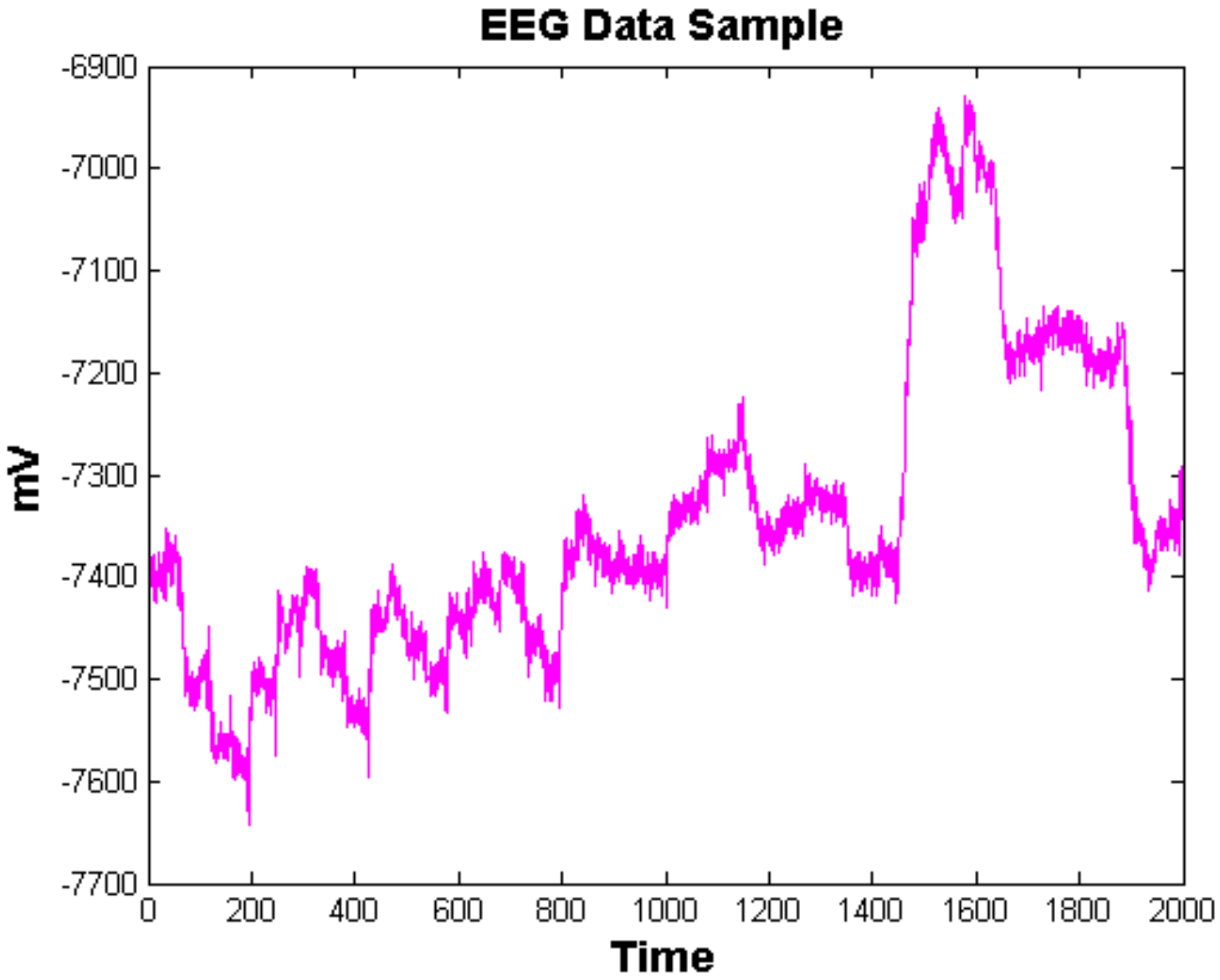
EEG Asymmetry in Neuroscience

- Emotional differences
  - For our experiment they are looking at the difference between high anxiety and low anxiety groups.
- Examples
  - The asymmetry has been said to be a emotional moderator and mediator
  - Asymmetries have also been associated with risk of depression

EEG Data

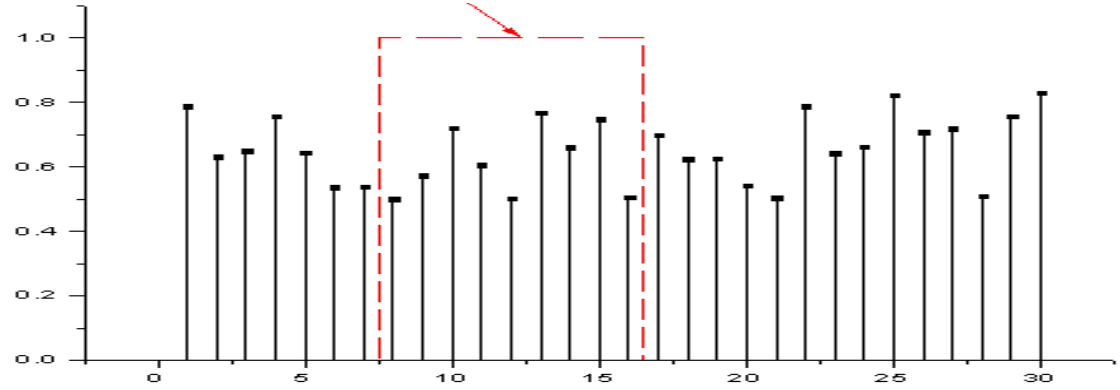
- For each individual there are 129 channels.
  - One reference channel.
- Eight minutes of data at a sampling rate of 250 Hz.
  - Four minutes with eyes open.
  - Four minutes with eyes closed.
- Our code takes channels from the left and the right, transforms them and "averages".



Sample from the raw EEG data.

Alpha Score

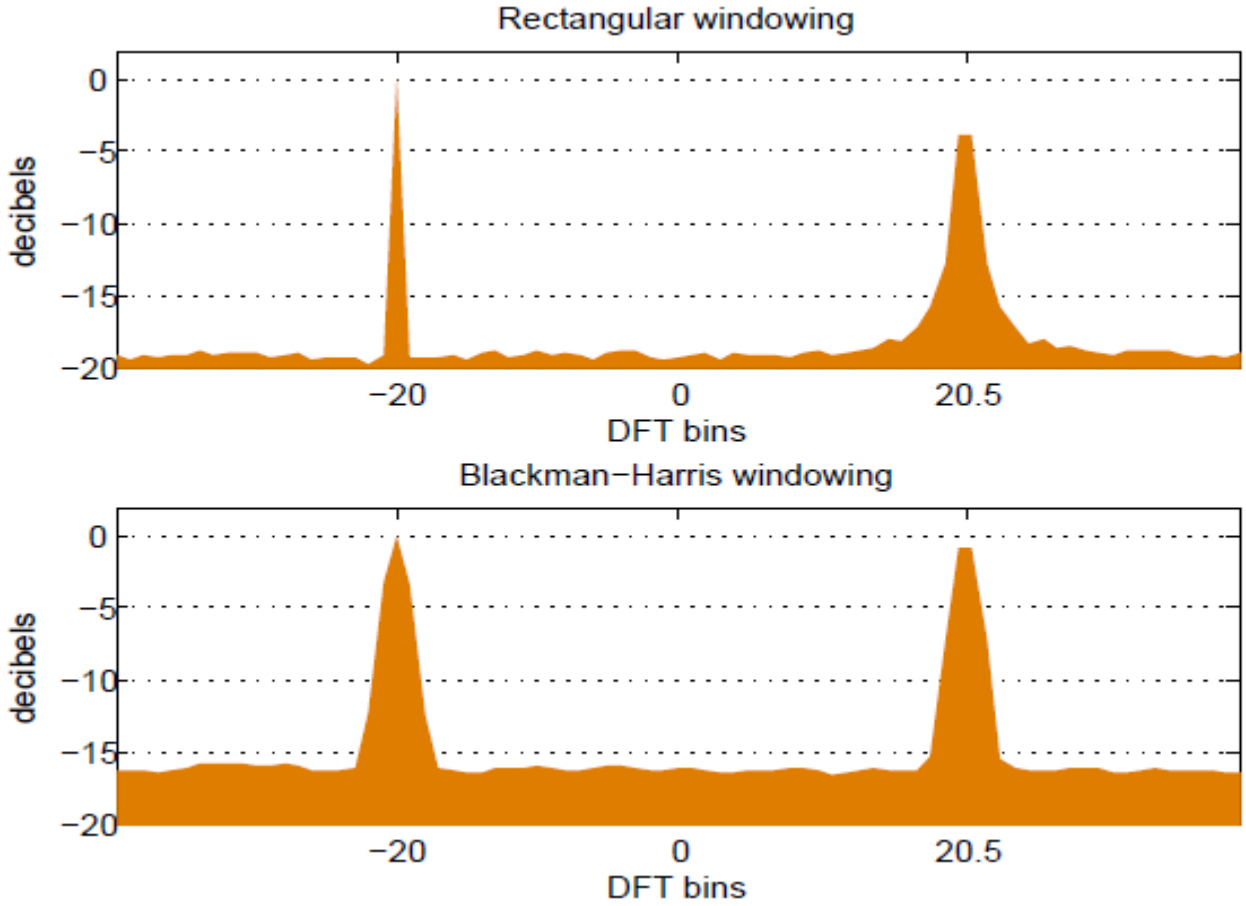
- Our GOAL
- Frontal lobe differences occur for waves with 8-13 hz frequencies.



- Create a score from this set of values

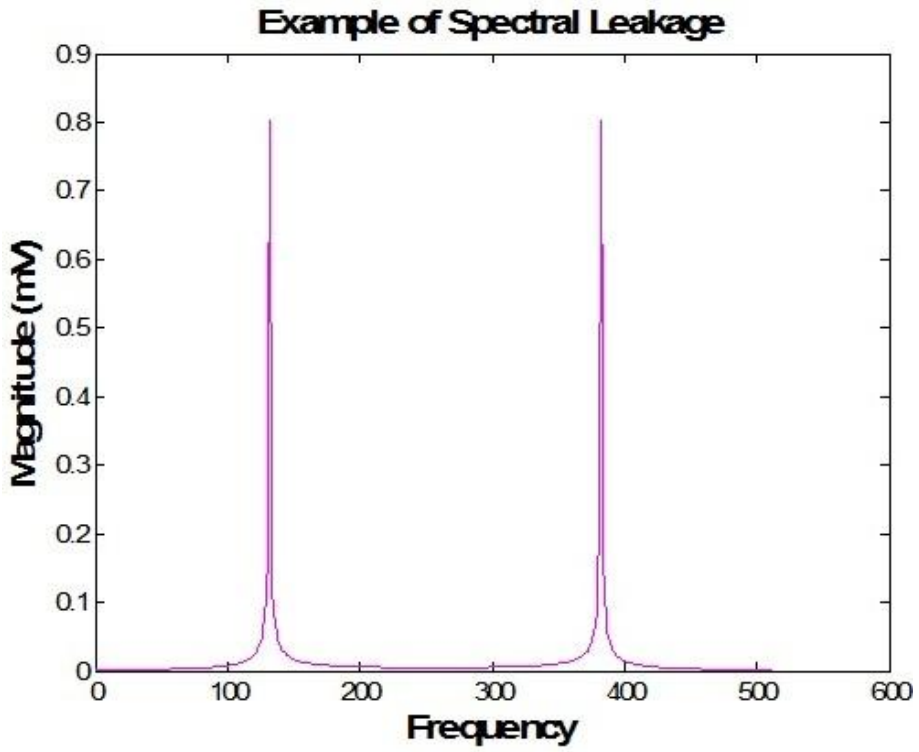
Why Apply a Window?

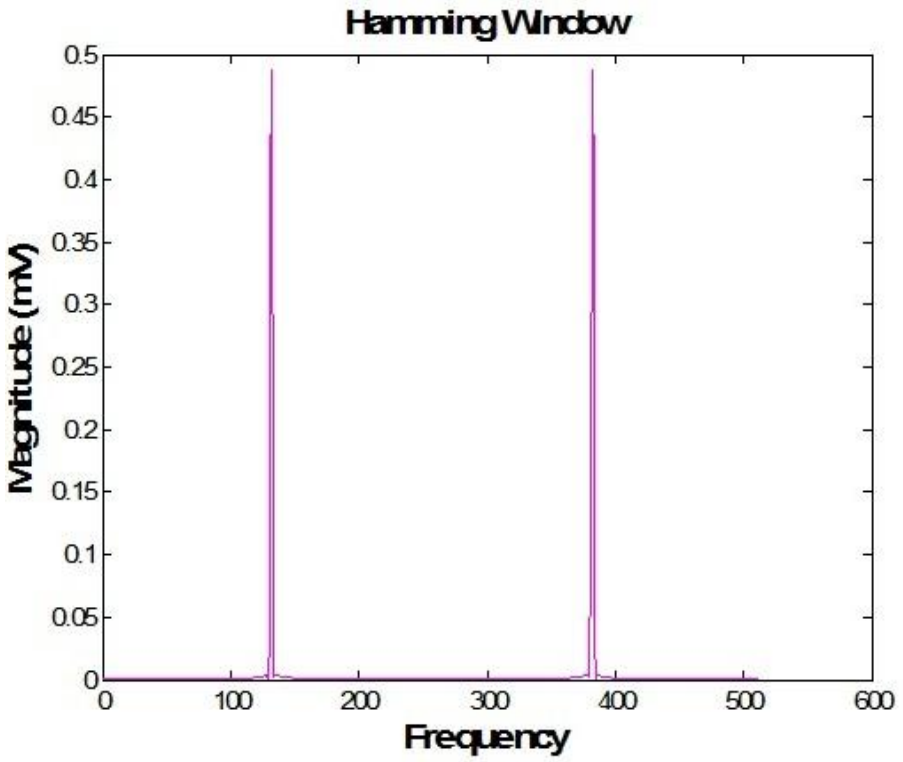
- Reduces spectral leakage.
- Makes different signals more distinguishable.



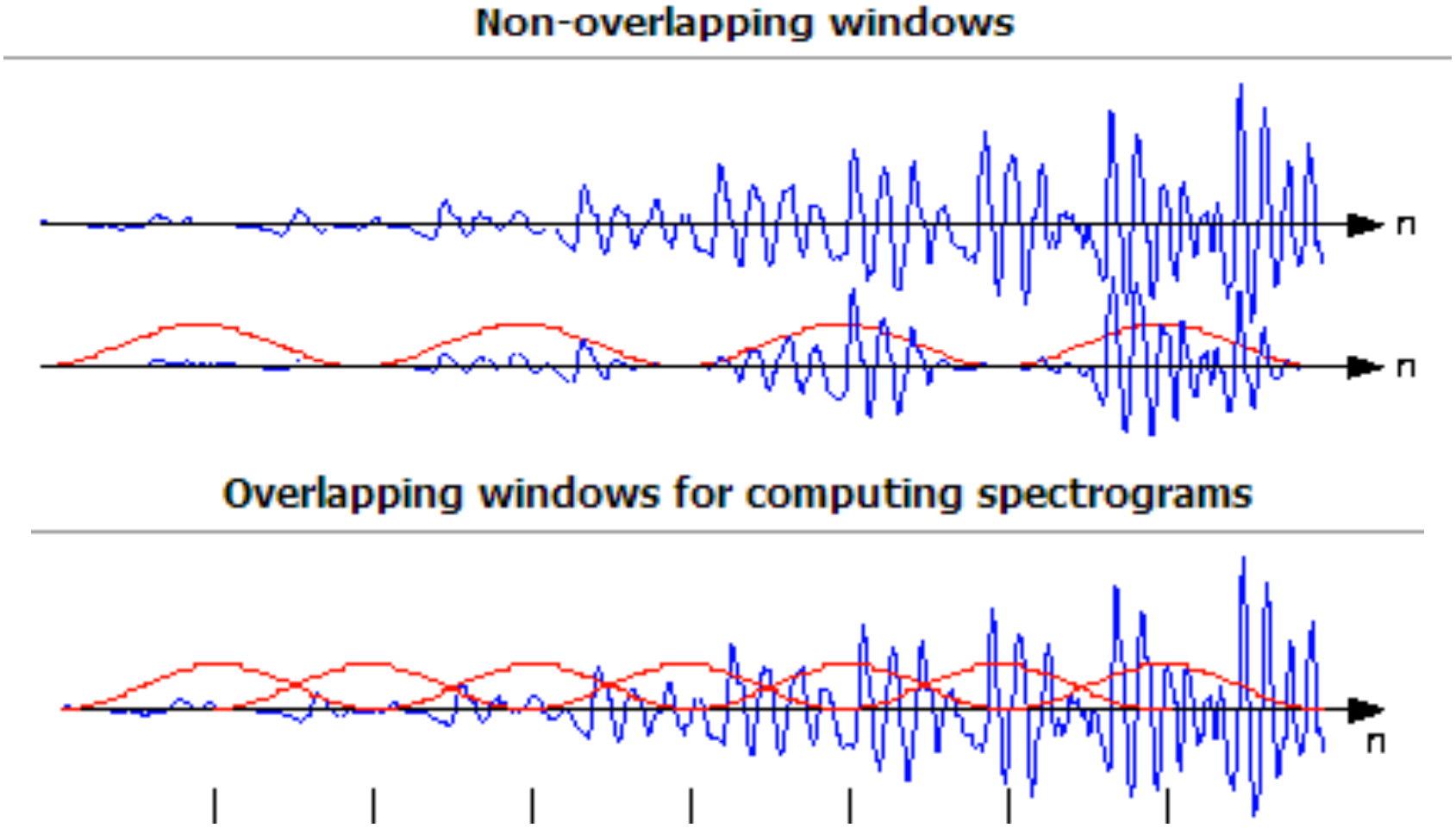
Hamming Window

- Hamming and Hann windows are moderate windows and find a good balance between the trade off's of windowing.

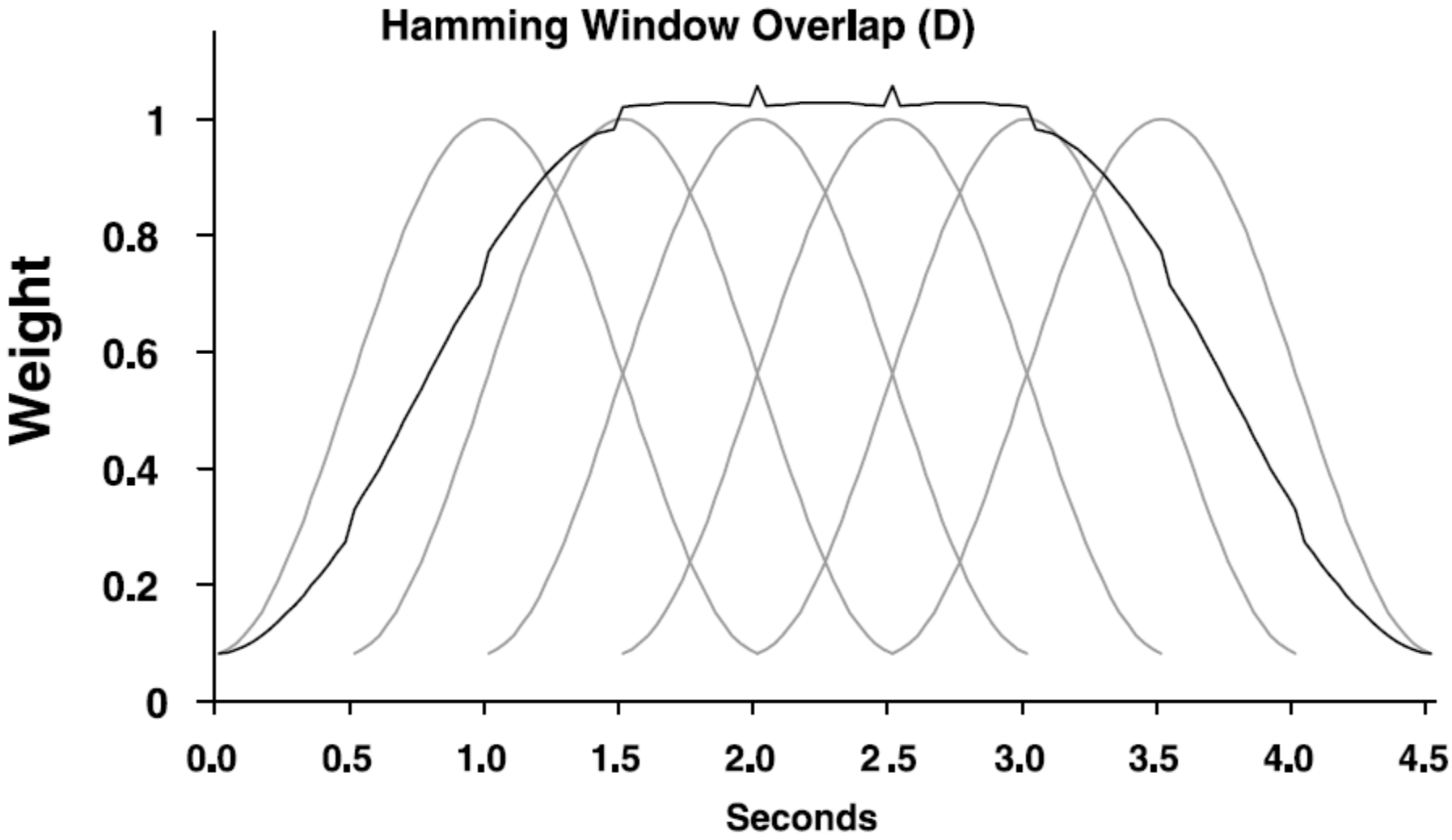




Overlapping Windows



50% overlap.


Hamming Window Overlap (D)
Weight
1
0.8
0.6
0.4
0.2
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Seconds

75% overlap.

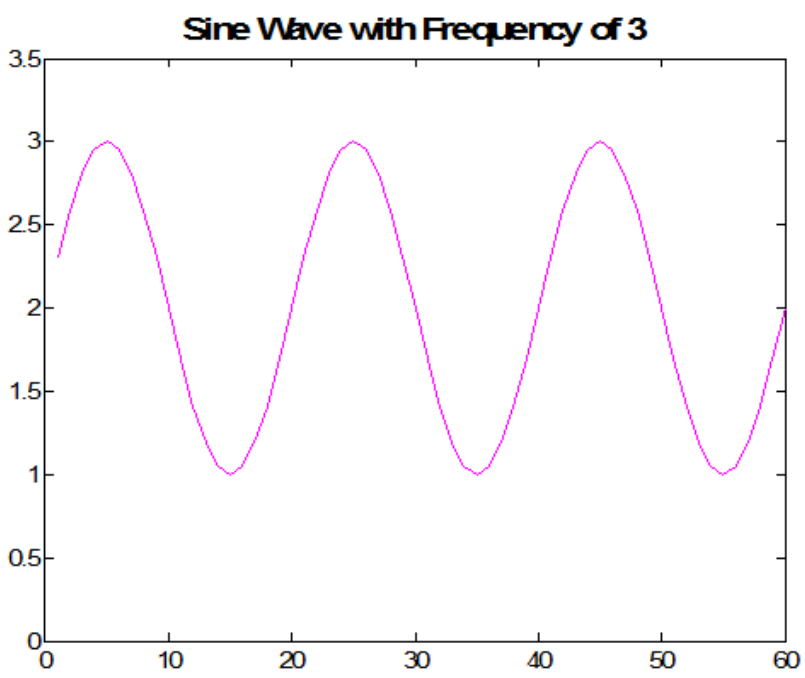
Window Lengths

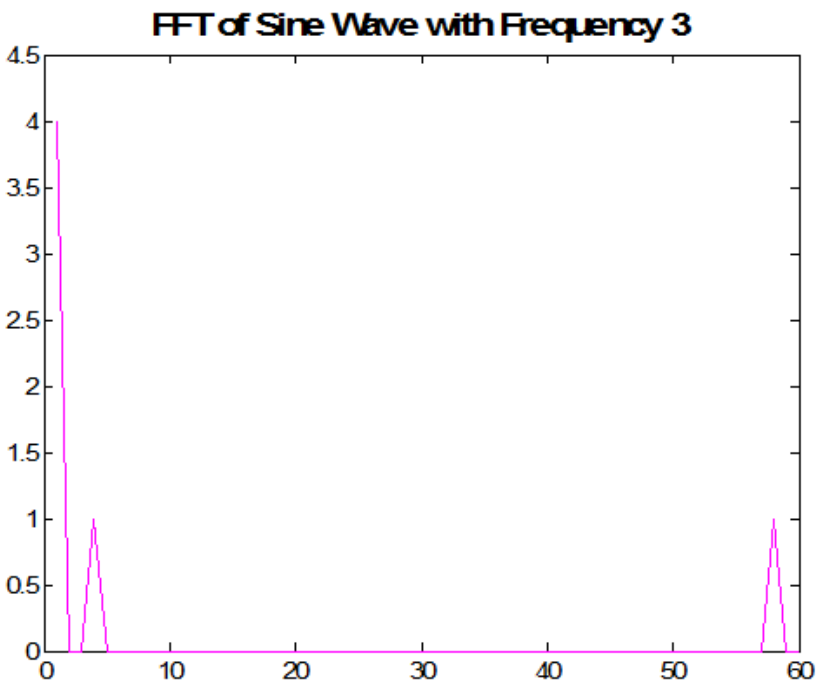
- Must use a power of 2 samples for efficient fast fourier transform.
- Need to transform enough samples to obtain sufficient frequency resolution.
- Want data to be weighted evenly, even in the face of windowing.
- Fast fourier transform assumes periodic behavior, and a smaller window will appear more periodic.

Interpreting the Fast Fourier Transform

- Fast fourier transform returns coefficients of sin and cosine terms.
- Each coefficient indicates the amplitude of the given component.
- Which values of the frequency spectrum represent the amplitude of a frequency of interest?

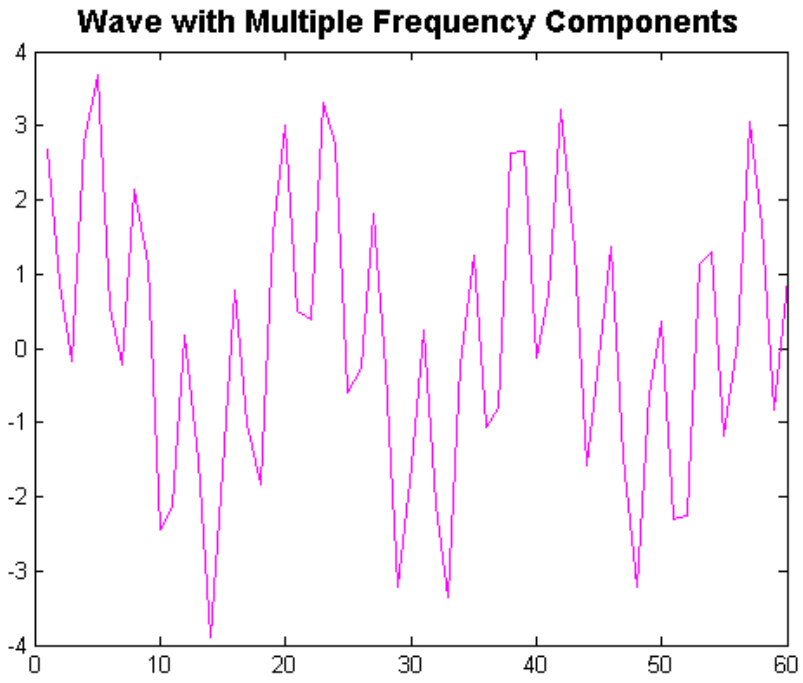
Fast Fourier Transform Example

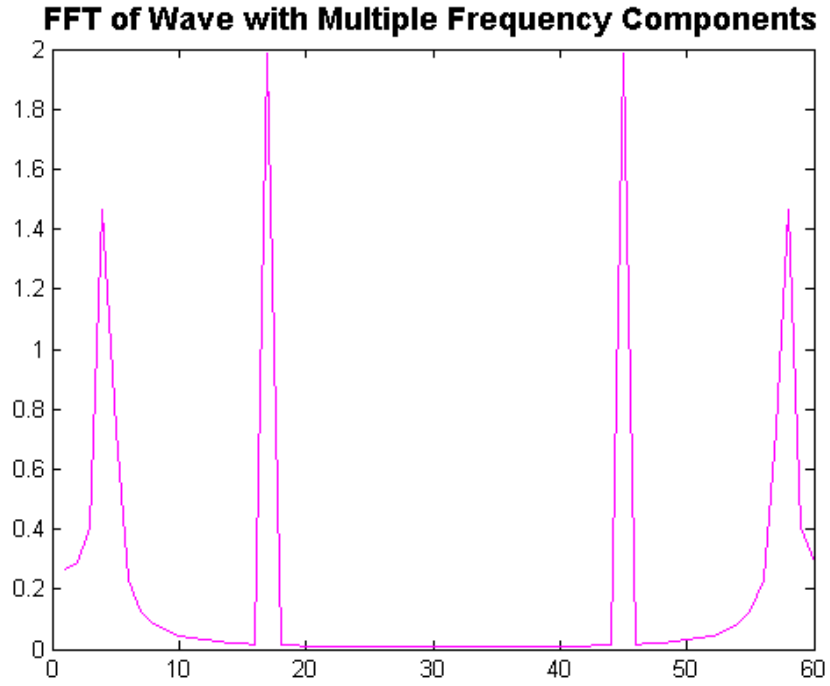




Another FFT Example...

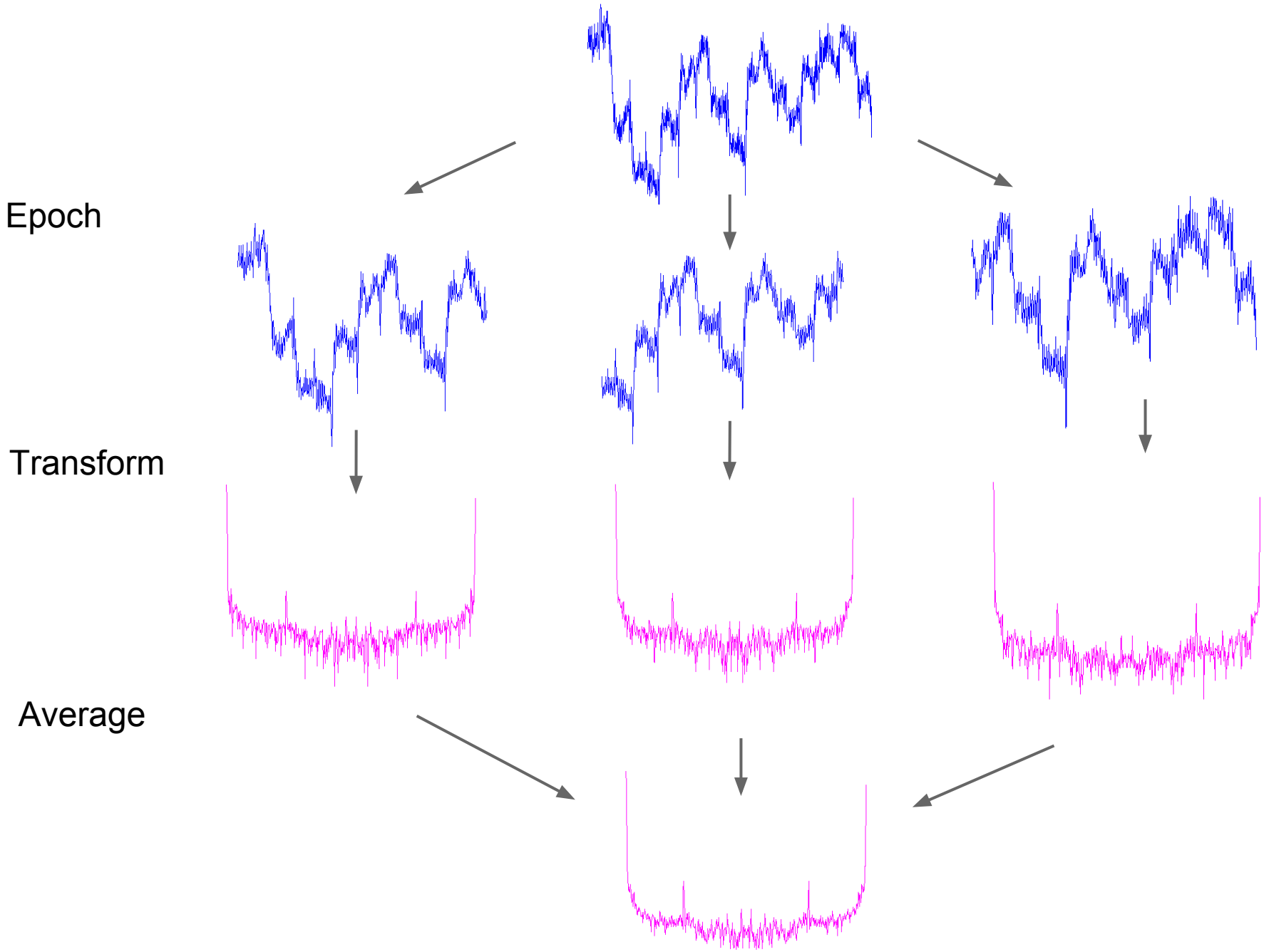
1 amp 3.2 hz, 1 amp 3.5hz, 2 amp 16 hz





When Sampling Rate and window Length Don't Match

- The previous examples assumed the same window length as sampling frequency, and had 1hz long buckets.
- Using twice as many samples as our sampling frequency we'd have 1/2 hz buckets
- bucket = frequency * (samples/sampling rate) + 1


Epoch
Transform
Average

Calculating Asymmetry

- Why do we square the bucket values?
  - Alpha power is typically analyzed in μV^2
- Score the participants using a ratio.
  - ln(Right alpha score) - ln(Left alpha score) or
  - ln(Right alpha score/Left alpha score)
  - The distribution of the alpha values is less skewed and less kurtosis, therefore making the data more normal.
  - Hypothesis tests can be more accurately run on normal distributions.

Overview of Analysis

- Extract specific channels for the right and left brain.
- Create properly sized and spaced windows.
- Apply Hamming window.
- Apply Fourier Transform.
- Average transformed windows for right and left side.
- Extract alpha values.
- Calculate ratio of the alpha scores.