

Biomedical applications of spectral analysis

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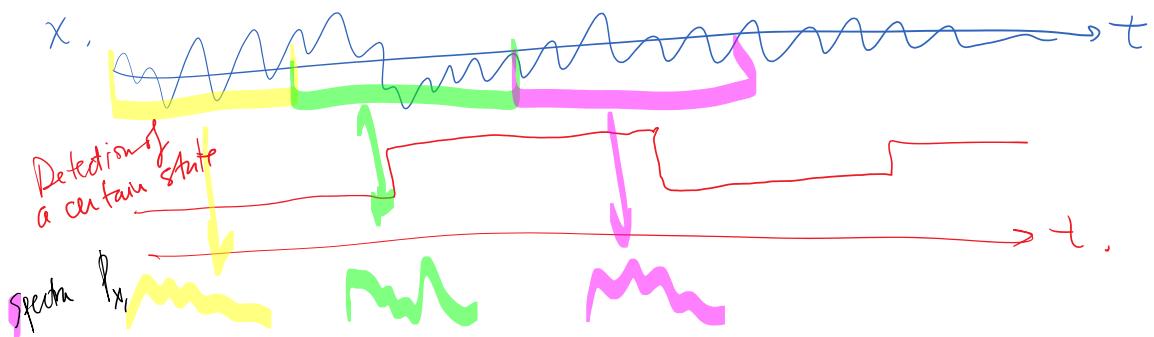
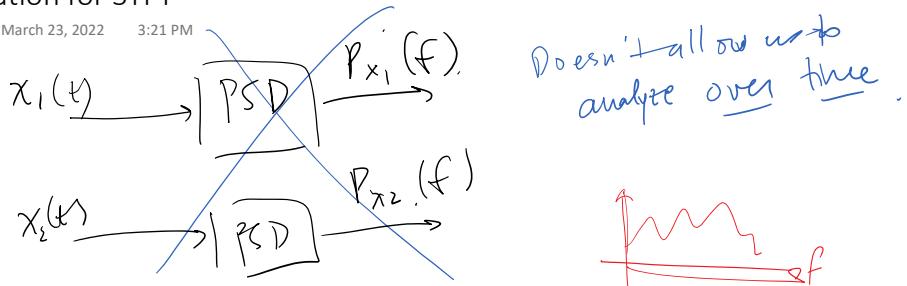
- Heart rate - does it have arrhythmias, or what state are we in? e.g. stressed vs relaxed; meditative vs normal
- Neurological disorders - diagnosing ... epilepsy? Parkinson's disease
- Sleep studies -- analyze brain rhythms in eeg.
- Assessing consciousness - again looking for rhythms in brain activity

=> want to know how spectral activity is changing over time

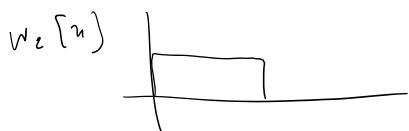
Motivation for STFT

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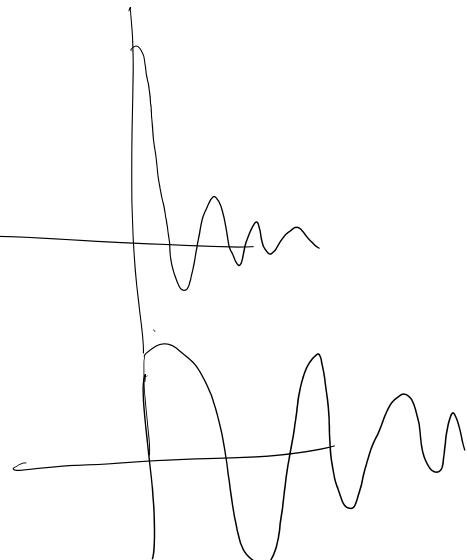


$$X_1(f) * W(f).$$



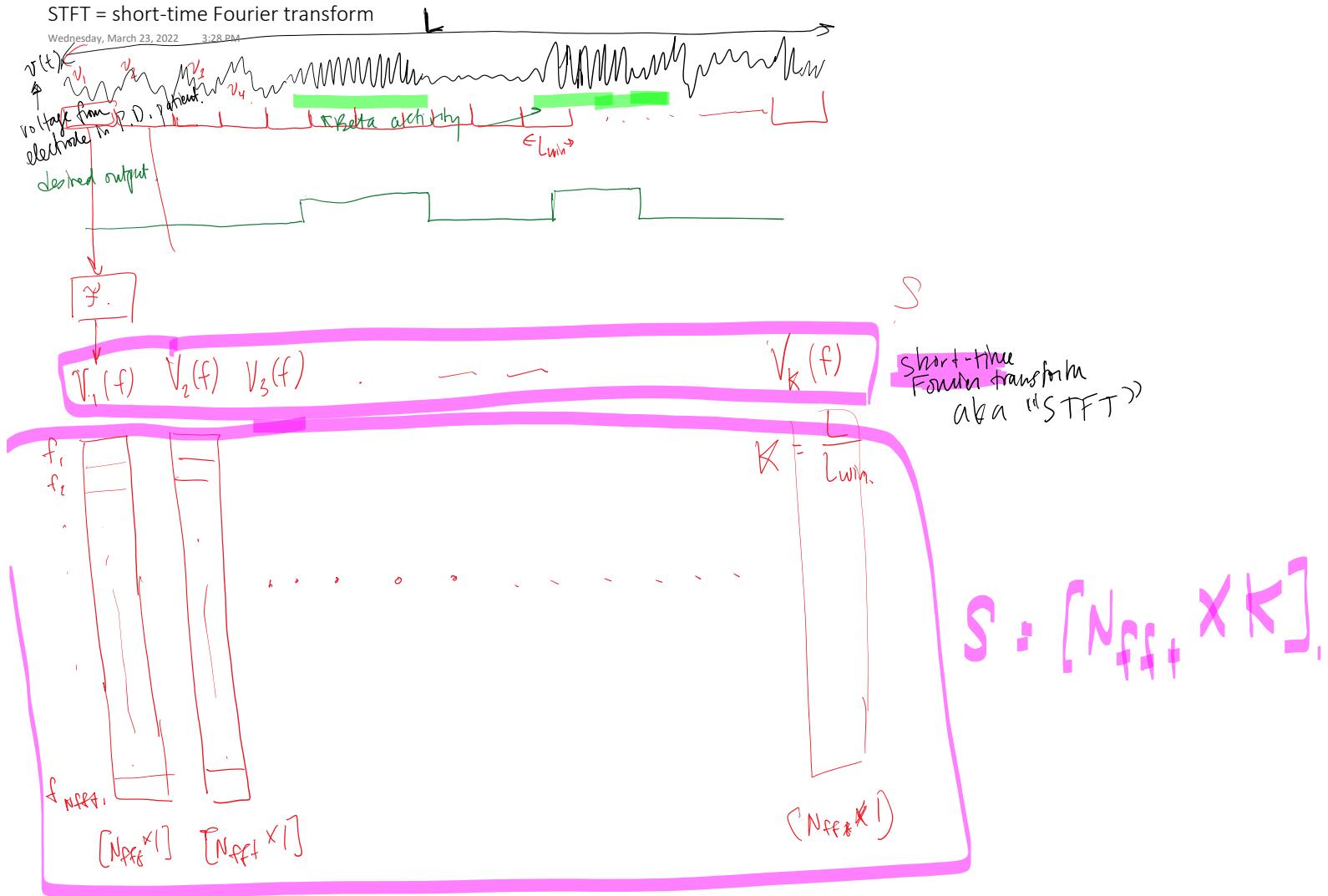
$$W_1(f)$$

$$W_2(f)$$



STFT = short-time Fourier transform

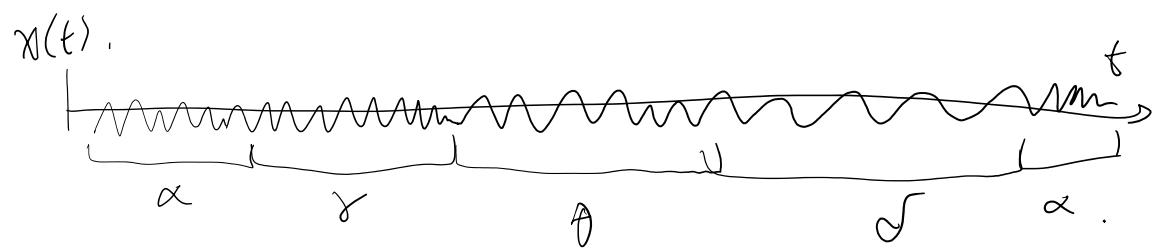
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Class exercise - Guess the rhythms over time

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δ 1
 θ 4
 α 7
 γ 12 .



To access class files

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To save your mystery file for others to see:

In Matlab, use the "save" command:

```
save filename.mat variable_name_of_mystery_signal
```

In Canvas:

- Go to People (on left panel)
- Groups tab
- Media Share -> visit
- On left there should be a new link called "Files"

STFT in MATLAB

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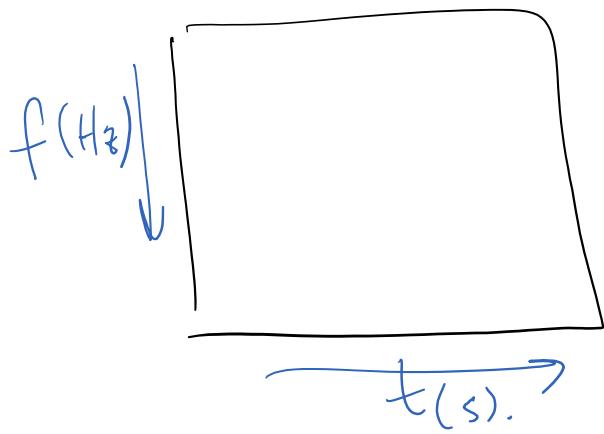
What do we have control over? (ie. What are the input parameters to the STFT?)

1. # of segments
2. Overlap of segments (percentage or number of samples to overlap by)
3. Window - type
4. Window -length
5. # of frequencies to evaluate- i.e., Nfft

```
S = stft(x, 'Window', win, 'OverlapLength', Noverlap, 'FFTlength', Nfft);
```

Contour plots and imagesc

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$\text{plot}(\emptyset, \underline{x})$
 $\text{plot}(\emptyset, \underline{x_f})$

$\text{imagesc}(\emptyset, \underline{f}, \underline{\text{abs}(Sf)})$
 f

Just to play around with the imagesc command and know how it works

```
x = repmat([1:10], 5, 1);  
imagesc(x)  
colorbar
```

Figure;

```
M = rand(5,10)*100;  
imagesc(M)  
colorbar
```

STFT vs Spectrogram

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$$\begin{array}{ccc} \text{FFT} & \text{vs} & \text{PSD} \\ |X(f)| & \text{vs.} & |X(f)|^2 \\ \text{STFT} & \text{vs.} & \text{Spectrogram} \\ |X(f)| \text{ vs. time} & & |X(f)|^2 \text{ vs. time} \end{array}$$