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Welcome

Calibration slide

Stand by

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Scientific Programming and Computing for the Behavioral Sciences

Frequency space

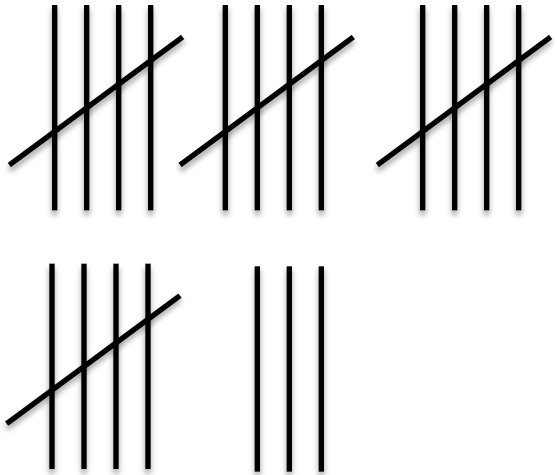
The Fourier transform

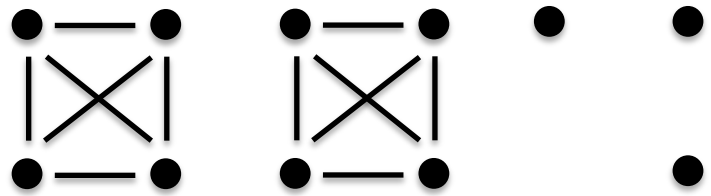
- Is a portal to Frequency space.
- But for many years, it remained underutilized.
- It took off in the 20^{th} century, due to 2 developments.

Game changers: 1 - FFT

- Original Fourier Transform has been known since early 19th century.
- “Fast Fourier Transform” does a discrete Fourier Transform.
- It is fast.
- Given modern computers, it is even faster.
- Fourier Transform becomes useful

John Tukey on tallying

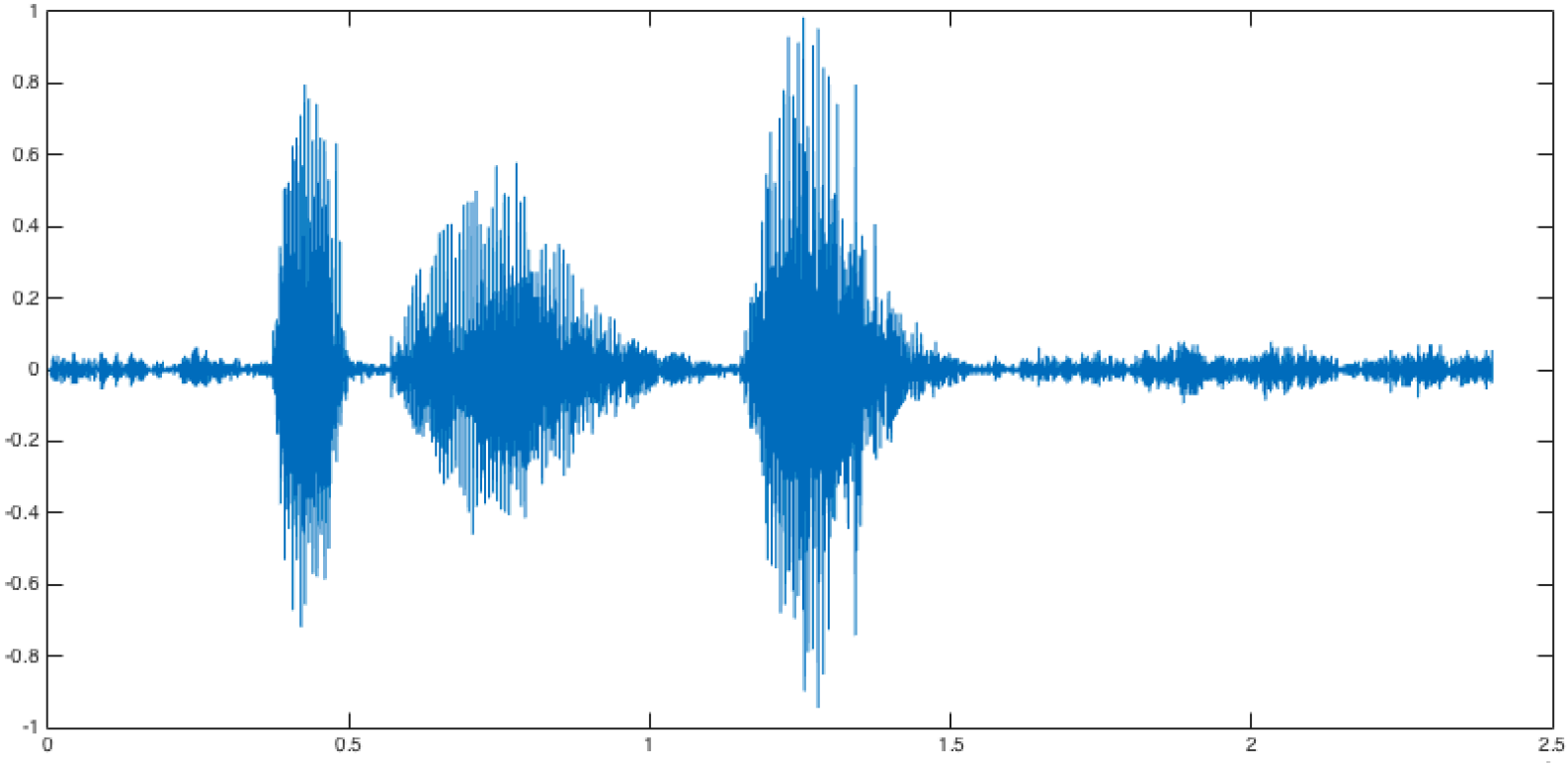




1915-2000

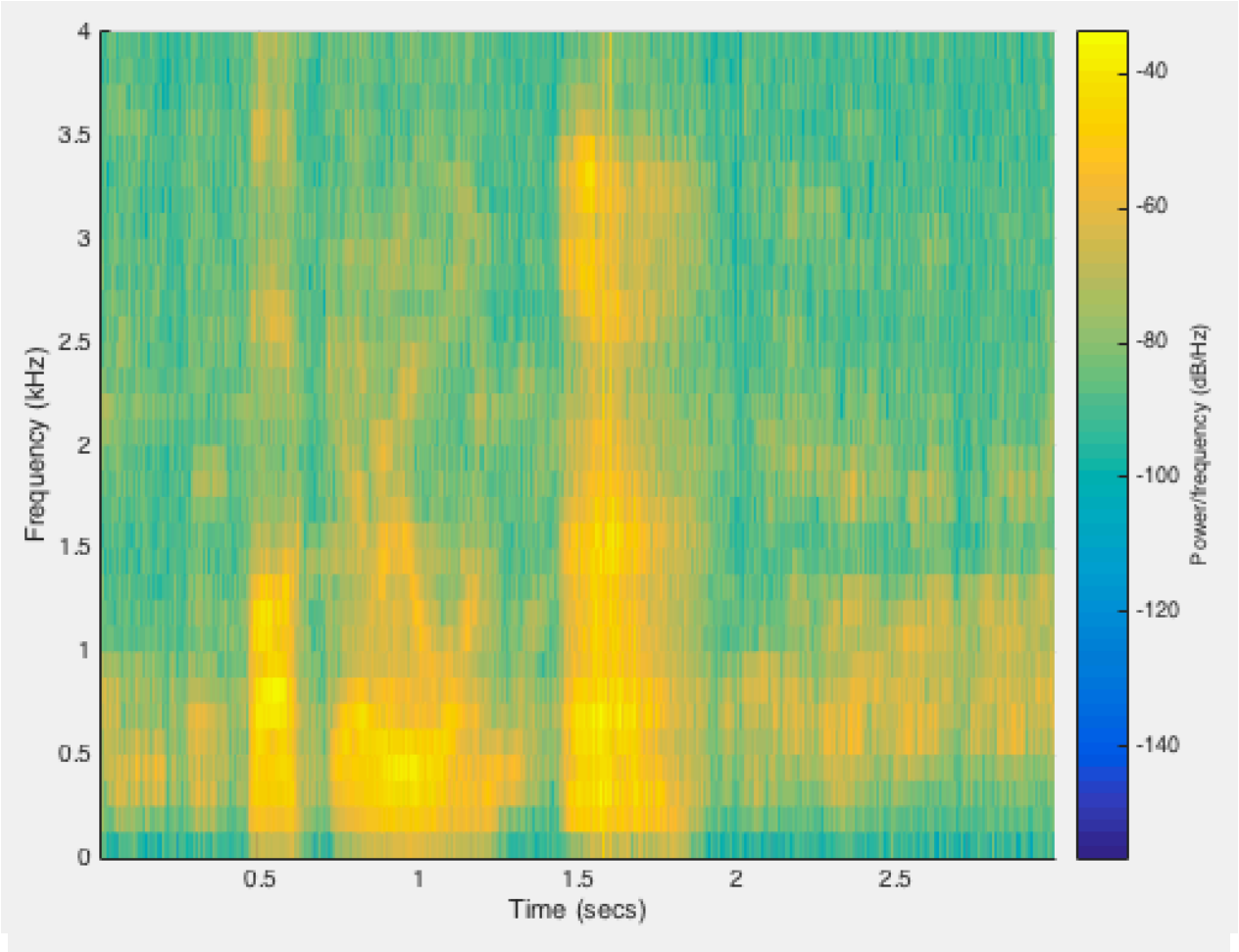
Game changers 2 - STFT

- Most interesting real life signals are changing over time.



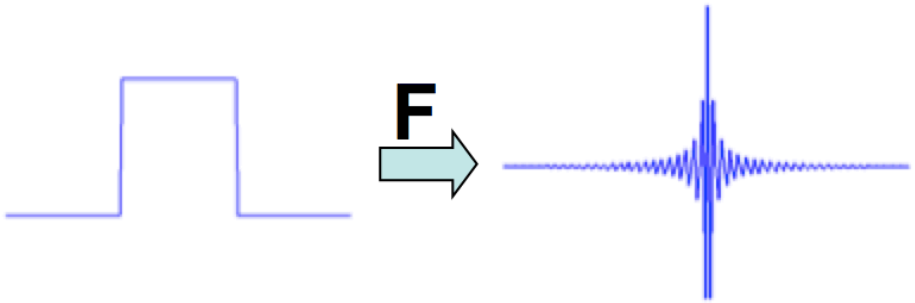
- The frequency composition changes moment by moment.
- Key: Compute the FFT only for a short snippet over which frequency content is presumably stable. Plot that – that is a spectrogram.

“The” spectrogram



Windowing causes artifacts

- The full Fourier theorem only applies for infinite time and involving an infinite number of frequencies.



Nyquist frequency

- The maximal frequency that one can represent without aliasing the signal is the “Nyquist frequency”.
- It corresponds to half the sampling rate.
- We’ll do stuff in Matlab to understand this.

So what is the big deal?

- Why care about any of this?
- In terms of psychology and neuroscience, frequency space analysis is the standard way to look at a variety of time-varying signals like speech patterns, but also EEG and LFP data.
- Allows to study the power distributions in those signals (in sharp contrast to a power analysis in experimental psychology or the study of power distributions in social psychology).