Administrative

- ML2 and ML3 grades are delayed, but we are working on them
- ML5 posted; relevant for next Wednesday exam, but due next Thursday
- HW due next Monday (included on exam 2) in PDF in today's lecture folder

- Any questions on HW due today, before we start the quiz?

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EE-125:
Digital Signal Processing

Finishing Periodograms

Spectrum analysis of time-varying data: Spectrograms/ Short-time Fourier Transform (STFT)

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Professor Tracey

Reminder: last time

- The DFT/FFT have two main uses
  - Fast FFT-based FIR filtering (overlap/add, etc)
  - Spectrum estimation / spectral analysis
- We may want to do spectral analysis in order to:
  - Learn something about a signal, either by human or automated analysis of the frequency content
  - Do processing in frequency domain (mp3, etc), then go back to time domain
- We'll consider three main topics
  - Deterministic, non-time-varying signals, possibly in random noise
  - Random processes / noise (periodograms)
  - Time-varying but non-random signals (spectrograms)

Outline

Finish up periodograms

<u>Spectrograms</u>

- Overview/motivation

- Basic definitions and examples
  - Calculation
  - Tradeoffs
  - (if time) Signal reconstruction

Background - 1

- So far, we've talked about how to analyze the spectrum deterministic signals using the DFT
  - Longer windows -> better frequency resolution (rule of thumb; resolution,Hz ~ 1 / window length, sec)
  - Taking an FFT at extra points (zero-padding) doesn't improve resolution
  - Smoother, more tapered windows give lower sidelobes, but worse frequency resolution
  - If we have deterministic, unchanging signals, we can always just pick a window we like, and then lengthen the window to improve resolution

Background - 2

- We also talked about how to analyze random signals using the DFT (periodogram)
  - **All considerations about resolution, window type, etc are the same as for deterministic signals**
  - Key new problem is variance: if we analyze a single window, variance is so high that estimate is useless
  - Instead, average the |X(w)|^2 estimate from many (possibly overlapped) windows

- **Tradeoff**: variance vs resolution

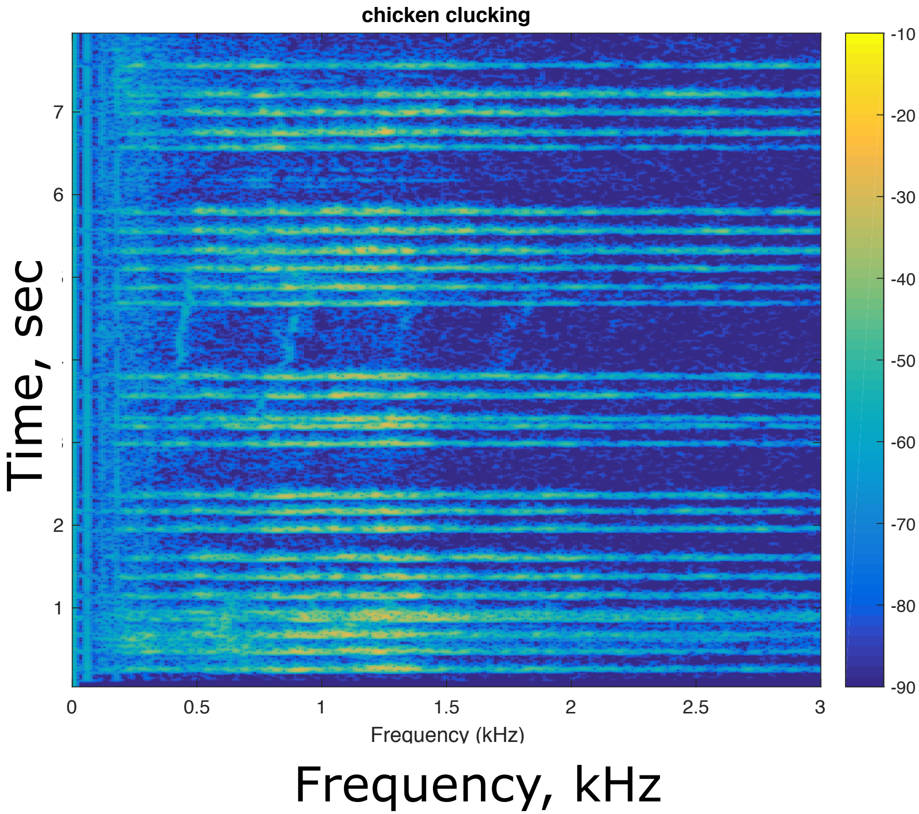
- We assumed that the underlying random process generating the data wasn't changing over time

Background - 3

- Many signals of interest are non-random but time-varying
  - Speech, many biomed signals, comms, …
- We'd like to understand the frequency content of these vs. time
- This is done using the **spectrogram**.

- Our discussion of window effects on resolution, sidelobes, etc. all still apply
- There will be a **tradeoff** between resolution in frequency and resolution in time

My backyard



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