Astro 128 First Project Outline

Raspberry Byes

How will we structure our report??

I. Abstract/Thesis/Synthesis of our Goals

- discussion of quantitative results: resolution data (is an eyeball estimate good enough??), SNR data??, sidebands for SSB??

II. Introduction/Background

- signal processing and how it is vital for radio astronomy, Fourier transforms, power spectra, mixers
- what math do we need to show??

III. Equipment

- block diagrams of mixers
- raspberry pi
- function generator
- oscilloscope
- picosampler
- all coded in Python

IV. Data Analysis

A. *Sampling, Aliasing, and Nyquist Criterion*

- can aliasing and the Nyquist Criterion be described elsewhere? Is spectral leakage a sufficient description, in which case this can be baked into Convolution section...DSB circuit demonstrates aliasing??
- impedance mismatching, had to lower amplitude (V_{pp}) and attach attenuator, as clipping problem added a "sinc function" structure with quantized, repeated spikes in the data (harmonics of the square wave)

B. *DFTs for Power Spectrum*

- plots of power spectra with properly labelled frequency and power axes
- resolution from duration and cadence of samples in time series

C. *Noise and Fourier Transform*

- SNR characterized

D. *Convolution Theorem, Spectral Leakage, and ACF*

- spectral leakage shows how a finite sample of data is necessarily interpreted by the DFT as a combination of an infinite sine wave modulated by an infinite square wave that only peaks within the boundaries of our data, thereby demonstrating the convolution theorem in the power spectrum in which we see a delta function and a sinc function, characteristic of a sine wave and square wave, respectively
- when the two functions are equal in time space, the correlation theorem states that the power spectrum is equal to the transform of the function into frequency space??

E. *Heterodyne Technique and Mixers*

1) *Heterodyne Technique:*

- define Heterodyne Technique: shift the frequency of an entire input frequency ν_{RF}(?) by mixing another set frequency (ν_{LO}) - show plots of power spectra and determine HOW they demonstrate the imperfection of physical mixers, how they DIFFER from a perfect theoretical mixer
- for a perfect mixer, a single peak is expected, but we see another small peak (they are mirrored for $\nu_{RF} = \nu_{LO} \pm \Delta\nu$)
- description of sidebands, where they show up, possible quantitative result?
- raspberry pi SDR (software defined radio) filtered out our data, so we needed to take data with the picosampler

2) *Negative Frequencies and their Degeneracies:*

- negative frequencies contain phase data, and can swap between sine and cosine or something, possibly through comparing SSB mixer data to DSB mixer data

V. Conclusion

- how well do the results match onto what we expect
- learning curve of working with equipment and code

VI. Acknowledgements

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Fig. 1. An example image of a frog.