**Signal processing Outline**

**01\_plot-dc5**

plot\_dc05\_ssr\_hvsr-a.ipynb

Created plots using python that are similar to geophone spectra plots created in Excell. It may be easier to make spectral plots using python. It may be possible to extend the analysis to include computation of frequency spectra by discrete Fourier transform of the geophone data that is in the time domain.

Files in the directory:

add readme.txt file

HVSR.DC05.txt

HVSRvsSSR\_GaussianFits\_01192018.xlsx

HVSRvsSSR\_Results\_08272017\_alleq\_except115and115a (1).xlsx

SSR.DC05.txt

meetup\_python\_02\_20\_2018a.pptx

I think Lisa has correction

plot\_dc5\_ssr\_hvsr-a.ipynb

**02\_convolve**

convolution\_tutorial.ipynb

Convolutional filtering is a basic signal processing technique used in electrical engineering, geophysics, image processing, machine learning, and many other fields. This tutorial assumes no prior experience and explains basic concepts using a geophone response example. Concepts described in this tutorial include:

* Impulse response
* Linear and stationary
* Convolution using superposition
* A casual encounter with the z-transform
* Convolution by polynomial multiplication
* The standard computation method for convolution

Filter\_exercise5.ipynb

Removing noise is a common step in data analysis. Convolutional filters are often used. If the noise is higher frequency than the signal you can use a high cut filter. A high cut filter removes high frequencies and “passes” low frequencies. A high cut filter is also called a low pass filter.

This jupyter notebook downloads seismometer data from an internet repository and applies a suite of high cut filters to remove noise. We selected the best filter.

Files in directory

add readme.txt file

convolution\_tutorial.ipynb

filter\_exercise5.ipynb

It would be good to get a good video explaining convolution

https://www.youtube.com/watch?v=N\_tCslTLcRU good shortcut illustration

**03\_fourier\_series**

Fourier analysis is another basic tool for signal processing. It decomposes a time signal into the sum of mono frequency sine and cosine waves. We started this topic watching Khan academy video on the Fourier series:

<https://www.khanacademy.org/science/electrical-engineering/ee-signals/modal/v/ee-fourier-series-intro>

The Jupyter Notebook fourierseries\_exercise.ipynb created plots like in the Khan academy video and also plotted the coefficients of the Fourier series. Plots of the Fourier coefficients are a Frequency spectrum.

You watched a youtube video on Fourier transforms:

<https://www.youtube.com/watch?v=1JnayXHhjlg>

This youtube video picked up the Fourier series and introduced the idea of transforming the signal from time to frequency domains. Both domains have all the information and you can use the forward and inverse Fourier transform to ”map” between the domains.

I provided a hand written page; connect\_series\_discrete.pdf. This connects notation in Khan Academy Fourier series with the youtube Fourier transform notation.

dft\_exercise.ipynb computes the discrete Fourier transform of the same seismometer data used in filter\_exercise5.ipynb in the section 02\_convolve. The data before and during the landslide event were Fourier transformed and plotted. Comparing these plots I selected a frequency range that looked like signal and zeroed frequencies outside this range. I used a transition zone between this “keep” and “reject” zones at both high and low frequencies.

The notebook properties\_of\_dft.ipynb listed several properties of the Fourier transform. This is just the first few properties. The final property is “convolution in the frequency domain is the same as multiplication in the Fourier domain”. This is the property that ties the convolutional filtering in filter\_exercise5.ipynb with frequency domain multiplications in dft\_exercise.ipynb.

files in directory

1 connect\_fourierseries\_dft.pptx

5 properties\_of\_dft.ipynb

3 connect\_series\_discrete.pdf

correct error in equation 2

summation should be over n, exponent needs i

0 readme.txt

4 dft\_exercise.ipynb

2 fourierseries\_exercise.ipynb

**04\_complex\_numbers**

The previous section, 03\_fourier\_series, indicated a need to study more about complex numbers. You watched the Khan academy precalculus videos on complex numbers to learn basic concepts including addition, multiplication, division, amplitude/phase (also called magnitude/arg and absolute value/angle), and complex conjugate. This section included homework and a jupyter notebook to check the homework results.

Files in the directory:

add readme.txt file

complex\_number\_amp\_phase.pdf

exercise.txt

check\_complex\_homework.ipynb