Homework #3: F-k analysis **Due: 5:00 PM 2017-03-06**

Please read the following questions carefully and make sure to answer the problems completely. In your MATLAB script(s), please include the problem numbers with your answers. Use the *Publish* function in MATLAB to publish your script to a *pdf* document; find something similar if not using MATLAB. LaTeXwith *mcode.sty* or some other language will work. For more on the *Publish* functionality within MATLAB see http://www.mathworks.com/help/matlab/matlab_prog/publishing-matlab-code.html. Upload your *pdf* file to Blackboard under Assignment #3. Your filename should be *GEOPH677_HW3_Lastname.pdf*. Hint: You can achieve this automatically by calling your MATLAB script *GEOPH677_HW3_Lastname.m*.

Intended Learning Outcomes

Students will be able to:

1. Compute the array response function for a given seismic array at any frequency and apparent phase velocity.
2. Apply beamforming to actual seismic data to determine the azimuth and apparent velocity of the dominant energy in a given time window.

Part 1: F-k array response function *(50 pts.)*

- Load the file *stationCoordinatesYX_in_km.txt* and plot in map view. Label axes etc. to make a nice plot of the station coordinates. *(10 pts.)*
- Write a function that computes the array response for a given station array[1]. *(30 pts.)*
- Using f=1 Hz and c_{min}=1 km/s, compute the array response function for a point at $\theta = 45°$ from North at $c_{app} = 3$ km/s. Plot in either a Cartesian system or a polar system. *(10 pts.)*

Part 2: F-k analysis of real data *(50 pts.)*

- Load the file *array_data_example.mat*. This will load the variable *dta*[2]. *(5 pts.)*
- Plot both the time domain and amplitude spectral densities for each station – 1 row per station – in two columns. Make sure to label axes and make nice plots. *(5 pts.)*
- At 1 Hz, apply the F-k beamforming to your data and plot the results. *(20 pts.)*
- Choose two other frequencies at which to apply beamforming and plot the results. *(5 pts.)*
- Discuss the results of the three beamforming plots. Discuss any pre-processing that you did to the data or that you think might improve the beamforming. *(5 pts.)*

[1] It would be smart to include a number of inputs into your function. Perhaps, c_{min} (the minimum velocity you should search over), f (the frequency at which to compute the array response function), the sensors locations in your array. That way you will have reusable code.

[2] This is a matrix that has eight rows, one for each station in the previously used coordinate file. This matrix has 7200 columns. These are the time samples of the particle velocity field at each station. The sample rate is 200 Hz.

Extra credit: F-k analysis at multiple frequencies *(5 pts.)*

Apply beamforming at many frequencies and stack. Plot the results, and discuss what happens when you use multiple frequencies. Explain the reason you see what you see. Think about wavelengths, station spacing, etc. Make sure to identify how you chose the frequency band you used in the stacking process.