

## Assignment 2: Discrete Fourier Transformation

*Due date:* 12:00 noon Monday February 27.

*Late date:* 12:00 noon Thursday March 1 (-25%).

*Hand in:* Electronic submission of all source code, data files, example output, plots. Hard-copies of source code, plots, and **first pages only** of TXT files and DFT output files. Clearly name all files with respect to the question and part number that they are solutions to.

Implement the basic Discrete Fourier Transformation (DFT) algorithm. You should read in an audio file in the TXT format supported by Adobe Audition (see assignment 1). You can presume that the file is monaural and 16-bit. Apply the DFT to the file, and generate the following tabular output in a text file (1 row per harmonic):

- a) Harmonic # (including 0th)
- b) The a and b coefficients for the harmonic (i.e. cosine and sine amplitudes)
- c) The amplitude and phase of the harmonic

The total number of harmonics processed is up to you. It should be parameterized. Create a reasonable number, and enough to create a decent result in part D below. Remember the sampling theorem's limitation on the number of harmonics you can accurately create (1/2 the sampling rate).

Try the DFT on the following wave files:

1. Square wave (eg. from assignment 1)
2. Periodic acoustic wave (eg. Cut a piece out of the didgeridoo sample in the 4P98 wave folder)
3. Two or more seconds of recorded audio. (eg. music, TV show, etc.)

### For each of these wave files, do the following:

A. Make a time-amplitude plot of the wave. You can make a screen shot of Audition (or suitable editor), or plot the samples in Excel.

B. Create the DFT tables for each plot as described above, and save them as a text file. (Note: Just hand in a hardcopy of the **first page** of each file, as the entire file may be enormous!)

C. Using Excel, make a histogram plot of the amplitudes of the lowest K harmonics, where you can choose a K between 20 to 40.

D. Perform a reverse transformation, by using the DFT harmonics to recreate the wave. Output the wave as a TXT audio file. Plot the wave in Audition or Excel (hand these plots in). Verify that it sounds and looks similar to the original. You should use as many harmonics as is required to faithfully recreate the original wave file (discounting normal roundoff, etc.). The number of harmonics to use should be parameterized in your code.

Also, in the case of the square wave, create another version that uses only 10 harmonics. Plot this as well. Notice the difference in sound quality between it and the full-harmonic version.

### Files locations:

4P98 wave folder location: <http://www.cosc.brocku.ca/Offerings/4P98/waves/>

Free samples: <http://www.freesound.org/>

<http://www.sampleswap.org/>