Homework 4: Fourier Transform

Exercise 4.1: Fourier transforms of simple functions

Write programs to calculate the coefficients in the discrete Fourier transforms of the following periodic functions sampled at N = 1000 evenly spaced points, and make plots of their amplitudes:

- a) A single cycle of a square-wave with amplitude 1
- b) The sawtooth wave $y_n = n$
- c) The modulated sine wave $y_n = \sin(\pi n/N) \sin(20\pi n/N)$

Exercise 4.2: Fourier filtering and smoothing

A data file called dow.txt has been given. It contains the daily closing value for each business day from late 2006 until the end of 2010 of the Dow Jones Industrial Average, which is a measure of average prices on the stock market.

Write a program to do the following:

- a) Read in the data from dow.txt and plot them on a graph.
- b) Calculate the coefficients of the discrete Fourier transform of the data using the function rfft from numpy.fft, which produces an array of $\frac{1}{2}N + 1$ complex numbers.
- c) Now set all but the first 10% of the elements of this array to zero (i.e., set the last 90% to zero but keep the values of the first 10%).
- d) Calculate the inverse Fourier transform of the resulting array, zeros and all, using the function irfft, and plot it on the same graph as the original data. You may need to vary the colors of the two curves to make sure they both show up on the graph. Comment on what you see. What is happening when you set the Fourier coefficients to zero?
- e) Modify your program so that it sets all but the first 2% of the coefficients to zero and run it again.