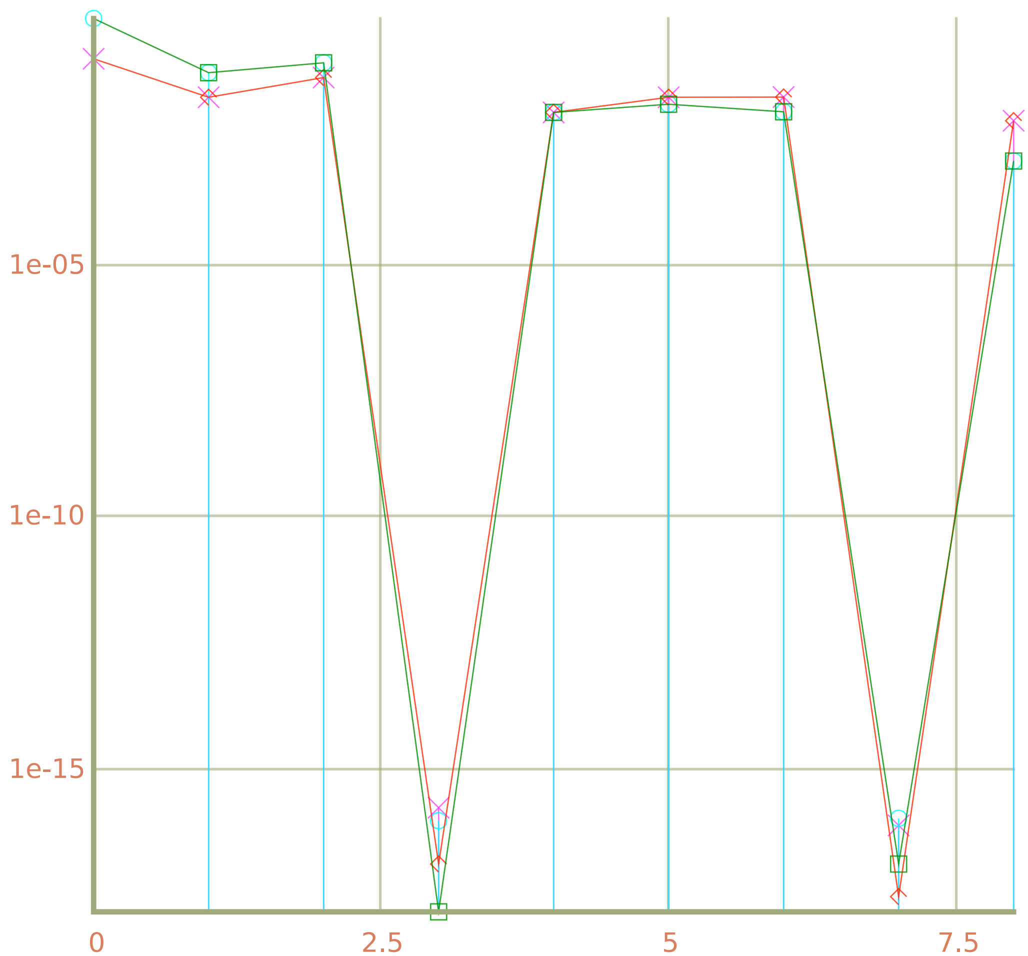
Question #2 Part 2

In this section, the results from the DFT operator are compared with results from Octave (an open-source Matlab clone). In order to account for the scaling factors and packing from the FFT operator, all of the Matlab results are scaled by 2/N where N is the number of coefficients/samples. The magnitudes of the results from both my DFT operator and Matlab are plotted on the same graph. As shown in the notes, the results are plotted separately for the Sine and Cosine components. In order to interpret the graph, the following information is useful (and applies to all of the graphs in this section).

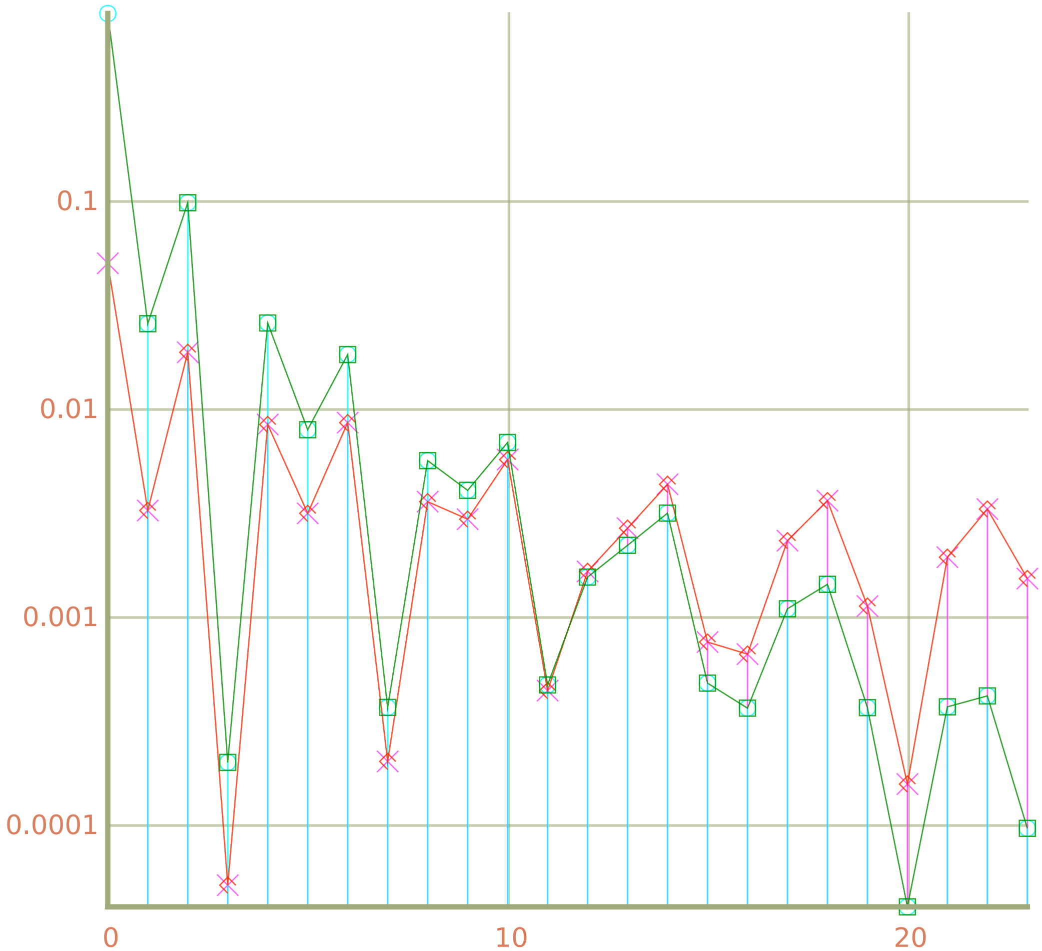
- Box: Matlab imaginary components plotted with lines
- Diamond: Matlab real components plotted with lines
- Circle: My imaginary components plotted with impulses
- Cross: My real components plotted with impulses

It is easy to see that the results match nearly perfectly. The only deviations are for the very small numbers on the order of < 1e-15 which represents numerical error. In fact, some of these values were actually zero in my results and I needed to add a small offset (1e-16) to the results because my plotter would not handle log plots with values of zero.

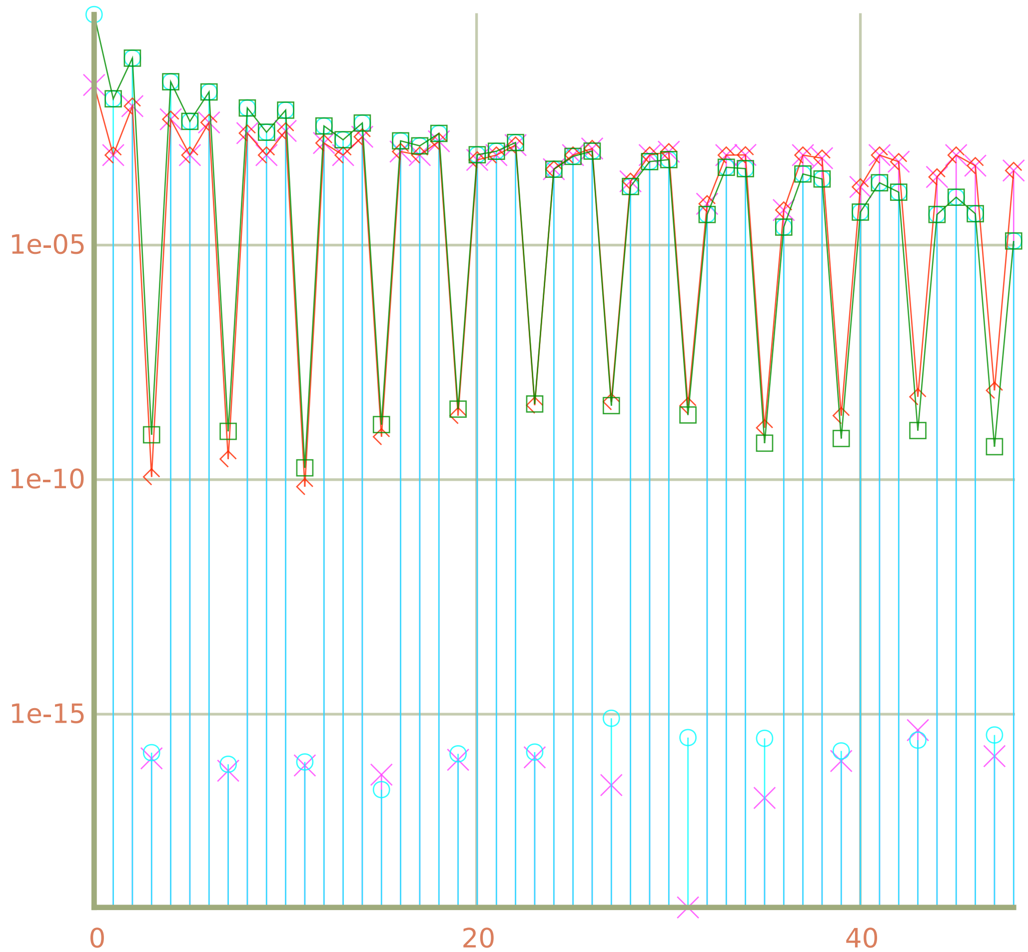
a) Number of coefficients = 20



b) Number of coefficients = 50



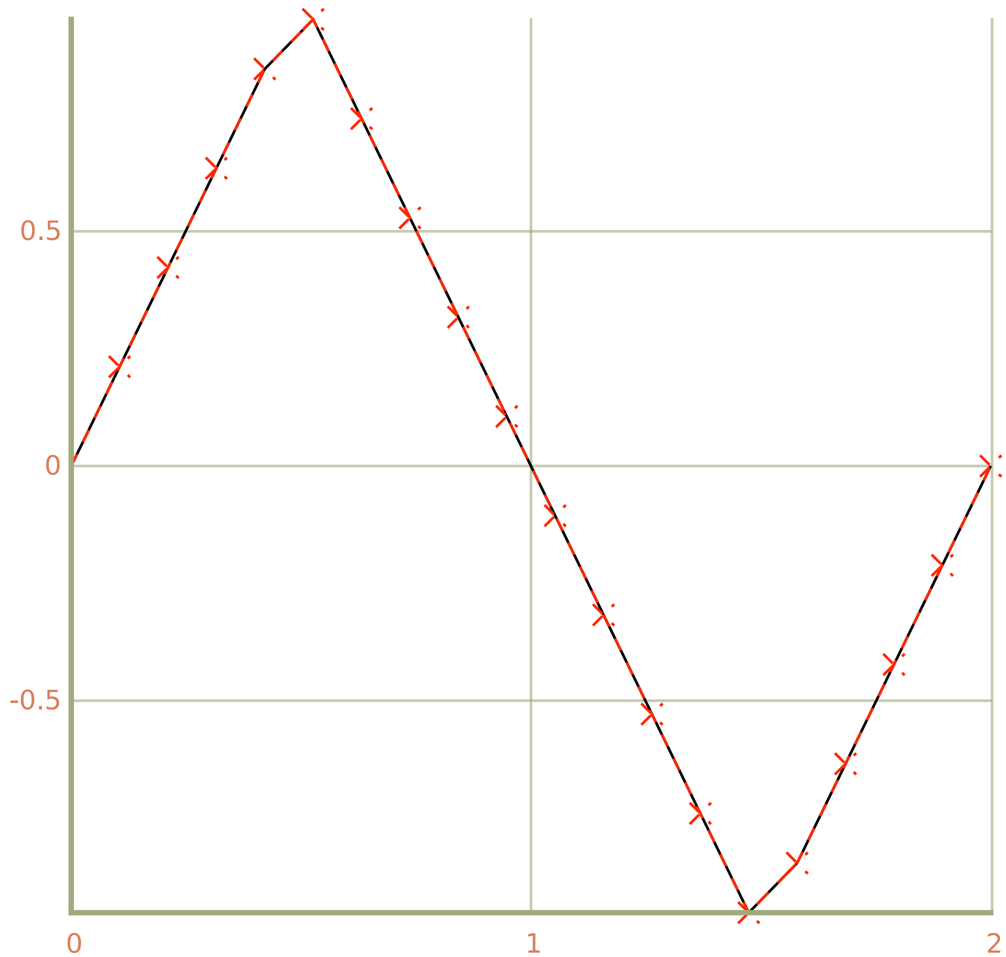
c) Number of coefficients = 100



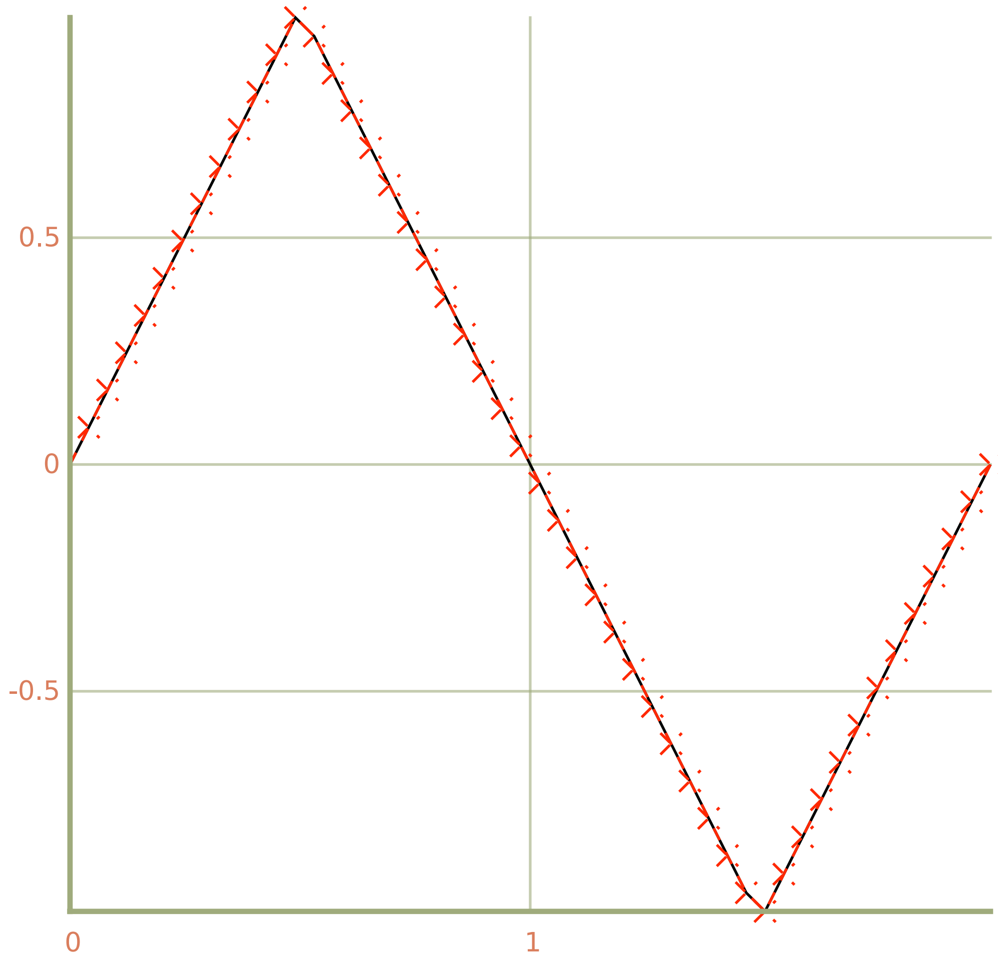
Question #2 Part 3

In this section, the test signal given in the assignment is sampled at different sampling rates. A DFT followed by a IDFT is then taken in order to reconstruct the signal. This is plotted on the same graph in order demonstrate that the results are identical and the operators perform a true inverse. In all cases, the original sampled signal is plotted as a dashed RED line and the reconstructed one is plotted as a solid BLACK line. This is difficult to tell from the graph because the signal overlap perfectly.

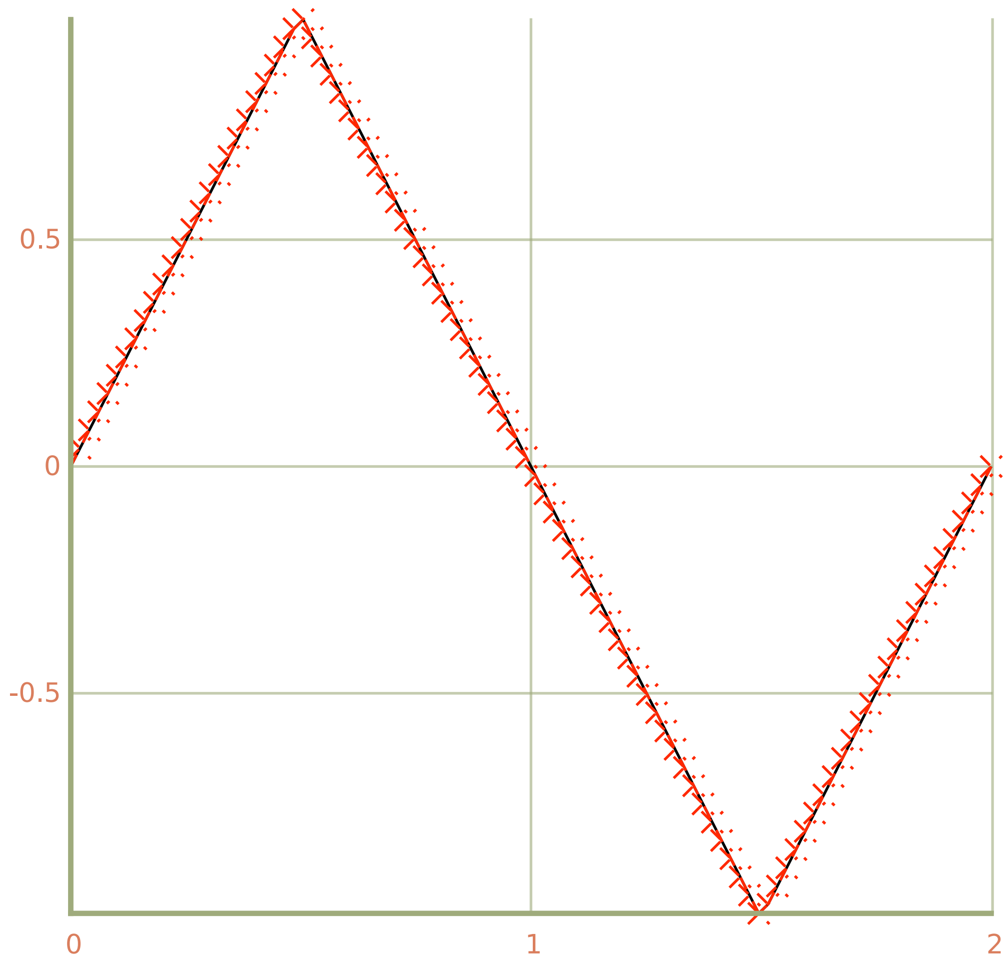
a) Number of coefficients = 20



b) Number of coefficients = 50



c) Number of coefficients = 100



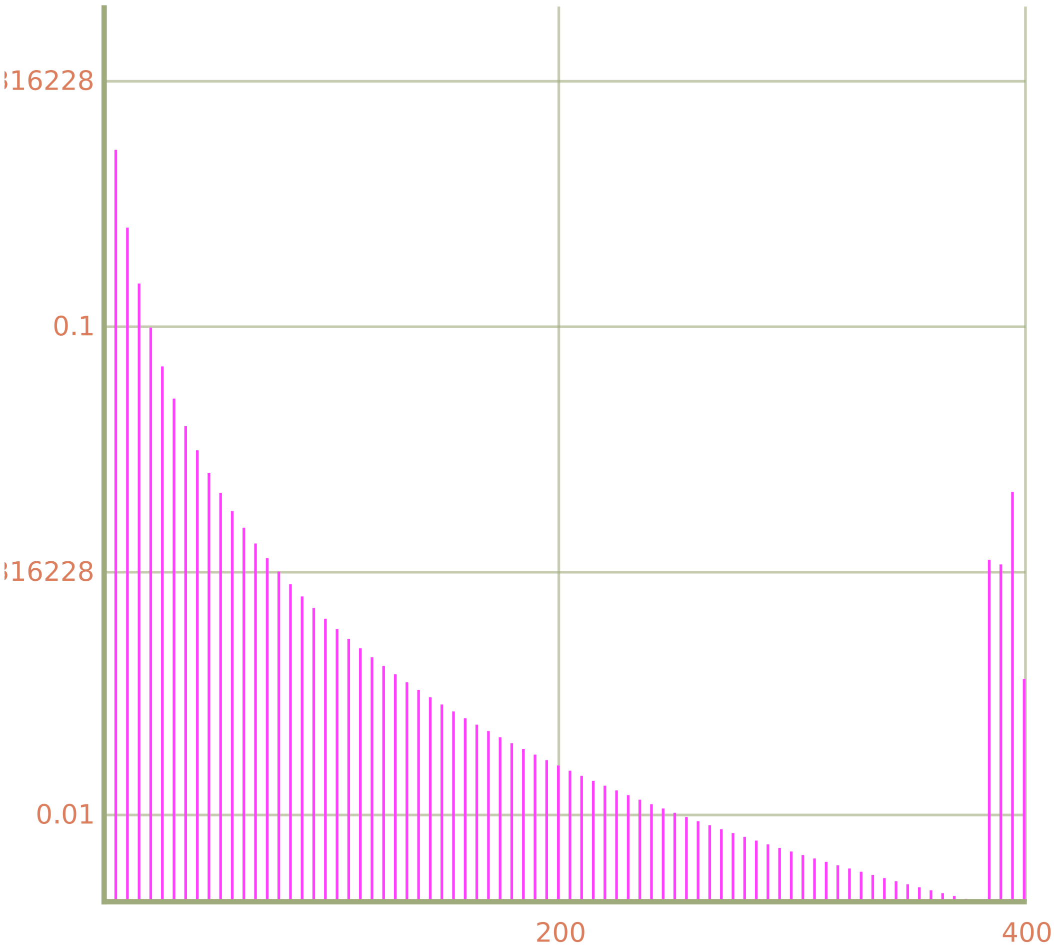
Question #2 Part 4

In this section, the DFT operator is applied to the signal sampled at different sampling rates such that the number of samples varies from 1 to 400 in increments of 5. The magnitudes of the first component and last components are plotted as a function of the number of samples. Please excuse the bug in my plotting code which prints some erroneous labels on the y-axis.

Comments for both cases can be found below.

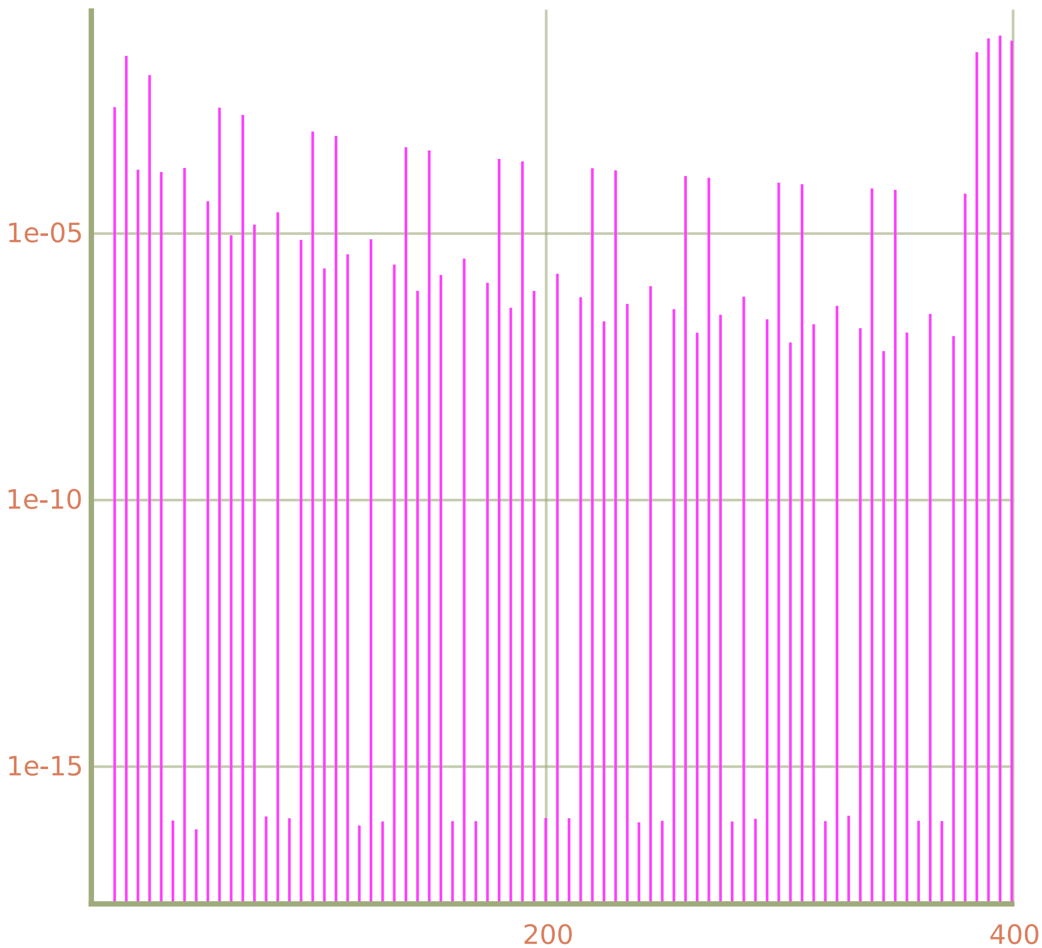
a) Low-order (FIRST) coefficients

Of course, a triangular wave is components of many very high-frequency components required to produce the sharp piece-wise linear edges and corners. However, at low sampling rates, these high frequency components are impossible to detect, and in fact, the sampled signal looks very much like a sinusoid. As the number of samples is increased, the spectrum power shifts away from the low frequency components to the higher-frequency components.



b) Highest-order (LAST) coefficients

The periodic nature of the frequency power spectrum we saw in previous plots is, of course, reflected in the plot below since we are looking at the last coefficient which represents an increasing frequency component.



1e-05
1e-10
1e-15
200
400