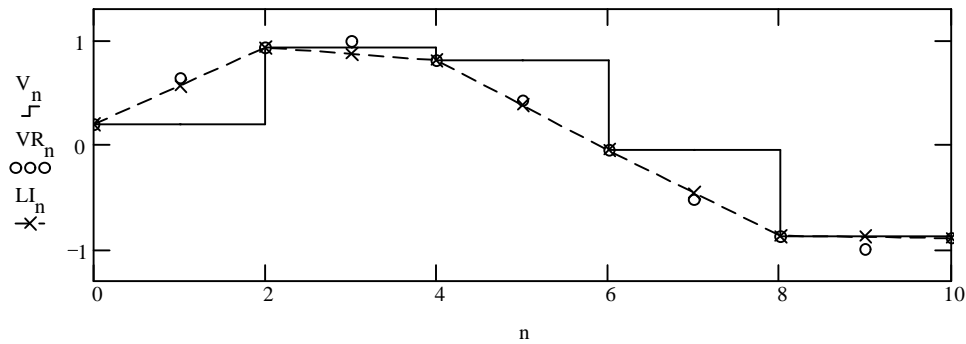
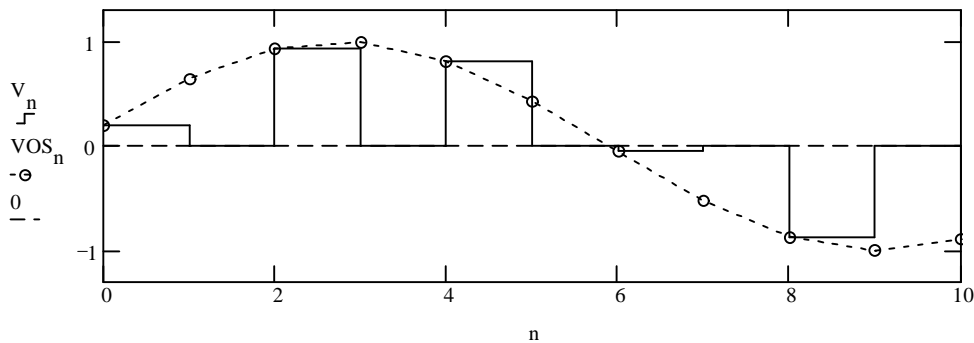


Interpolation and imaging:

Up-sampling is a mathematical process receiving incoming samples at a given rate and "creating samples" for a higher sampling rate. Let us examine an interpolation of a 7KHz tone from 44.1 to 88.2KHz (X2 oversampling ratio). The solid line represents the incoming data. The O's show the desired goal for X2 sample values. The dotted line with X's show the outcome of a simple two point straight line interpolation.



A linear straight line interpolation does not yield much precision (the X's are not centered on the O's). Increasing the order of algebraic interpolators (higher order polynomials) yield better results, yet the optimum performance is achieved by use non algebraic interpolation. If we could come up with sample values such that the all the error energy reside in out of band frequencies, we could then get the desired results by filtering. Filtering and averaging are close cosines. All we need to do is to insert zero values at the missing locations and filter out the undesirable energy at the new sample rate. The better the filter, (better attenuation of out of band undesirable energy) the better the interpolation. The next plot shows the process of zero insertion (solid line) and the filtered outcome (dotted line):



Insertion of zero values (or alternatively repeating previous sample values) does creates unwanted error energy, but all the undesirable energy reside in higher frequencies. Such error energy is distributed in a well predictable manner referred to as imaging. The unwanted frequency spikes described in the "sampling" sections are images. The X2 picture below shows the "mirror like" behavior of the images around the new sampling frequency (88.2KHz). The image of the highest original tone (20KHz) is found at 68.2KHz (88.2-20) thus can be filtered out.

