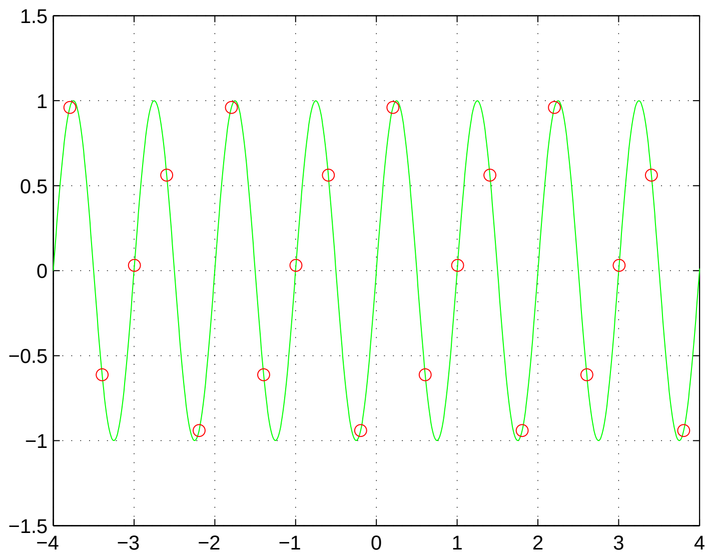
ECE 301, A Half-Time Delay Demonstration

Input: Given an band-limited input $x(t)$ with bandwidth $W_M = 2.5\pi$. Sample it with sampling period $T = 2/5$ ($\omega_s = 5\pi$). Let $x[n]$ denote the sampled discrete-time (digital) array.

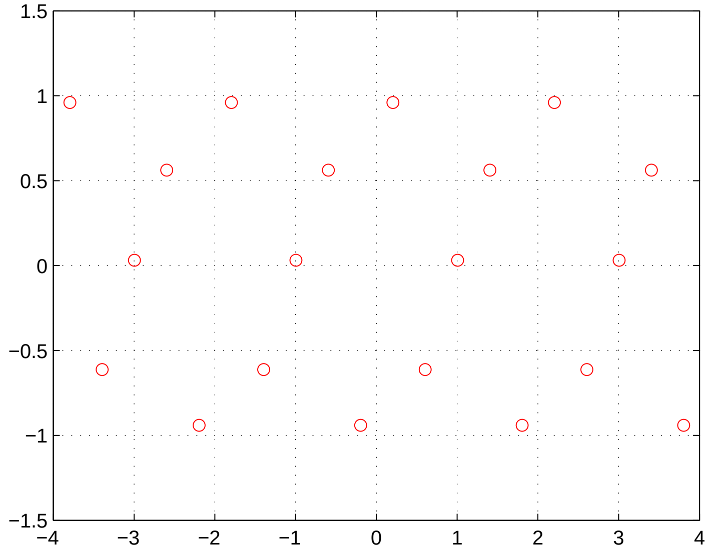
Goal: Design a discrete-time processing $h[n]$ satisfying the following. Let $y[n]$ denote the output of the discrete-time system: $y[n] = x[n] * h[n]$. Use perfect band-limited reconstruction to generate a continuous signal $y(t)$. We desire that $y(t)$ being the half-time delay $x(t)$. That is, $T = \frac{2}{5}$ and $y(t) = x(t - \frac{1}{5})$. (Note that all we can handle/manipuate is the samples $x[n]$, not the original signal $x(t)$.)

Example: $x(t) = \sin(2\pi t)$

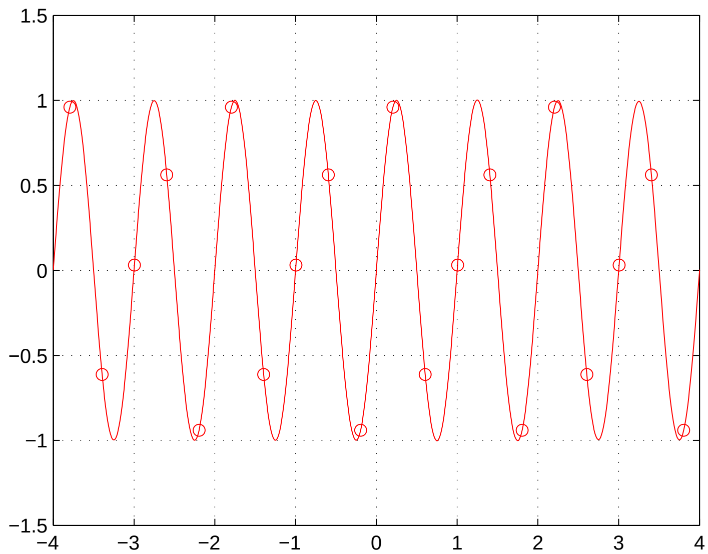
Original signal



What you really have is the sampled values:

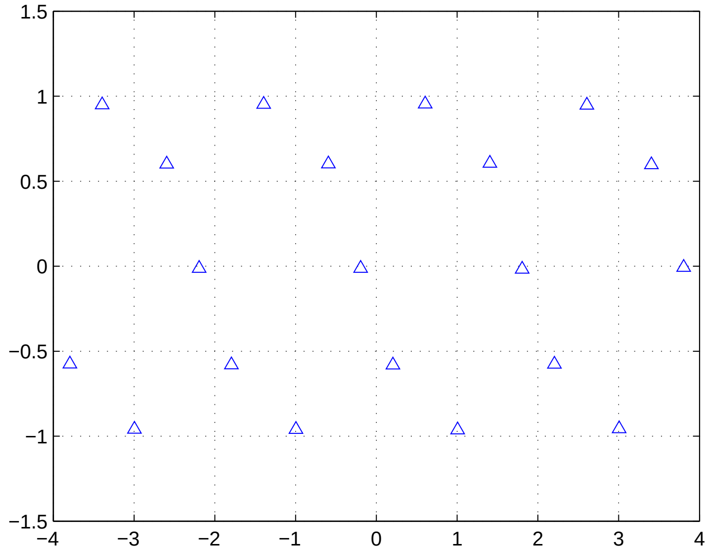


Perfect reconstruction without any processing:

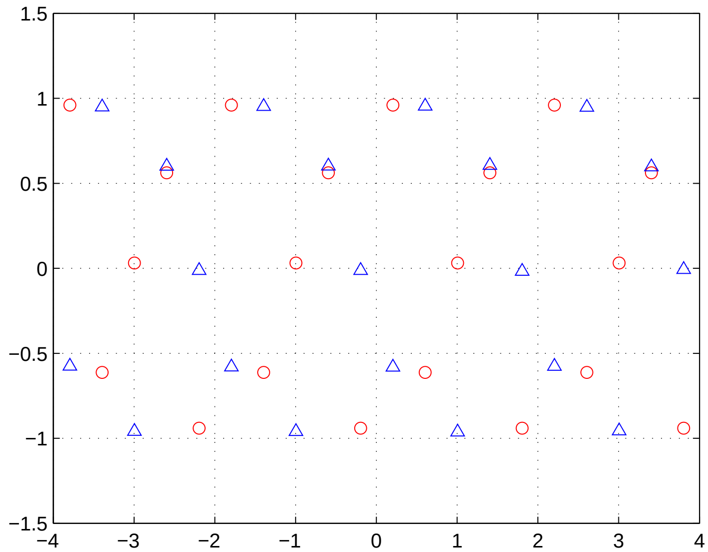


Introducing half-time delay by discrete time signal processing: (see lecture notes)

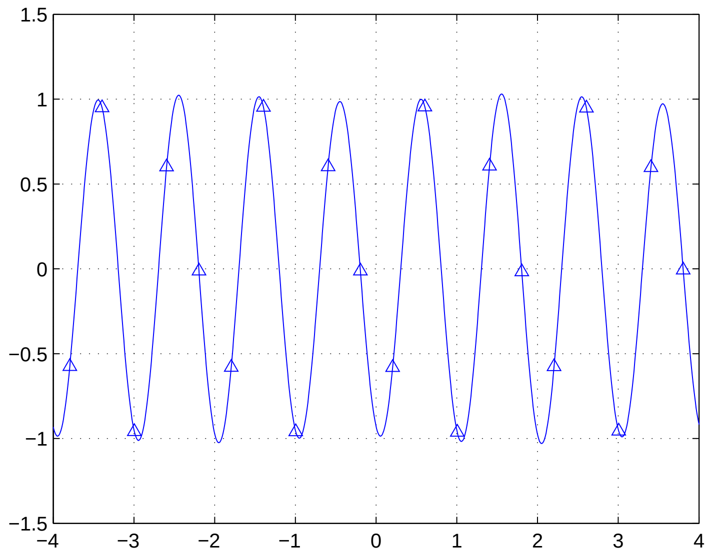
$$h[n] = \frac{(-1)^{n+1}}{\pi(n - \frac{1}{2})}. \tag{1}$$



Comparison to the original samples:



Half-time delay + perfect reconstruction:



Comparison to the original reconstructed curve: