% In-Lecture Assignment #3 on October 26, 2020

% (a) Generate/plot 31 random +1 and -1 values to create a discrete-time random signal

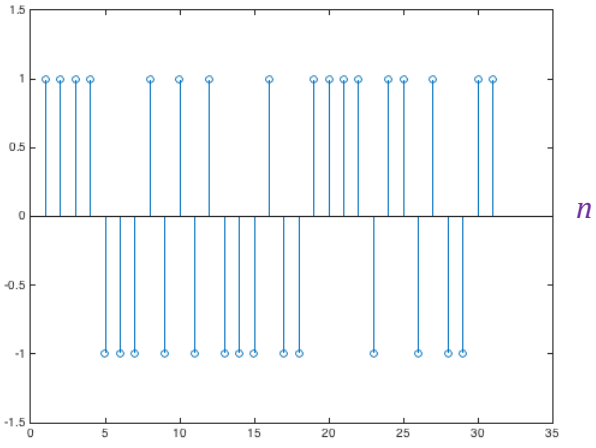
```
N = 31;
%% N Gaussian random numbers, zero mean, unit variance
randomSignal = randn(1,N);
%%% Converts to +1 and -1 values
randomValues = sign(randomSignal);
%%% Plot random +1 and -1 values
stem(randomValues);
%%% Add blank space to make plot easier to read/view
ylim( [-1.5, 1.5] );
```

% (b) Plot the autocorrelation of the random values $x[n]$: $R_x[n] = \sum_{k=-\infty}^{\infty} x[k]\, x[n+k]$.
% Maximum autocorrelation value occurs at the origin: $R_x[0] = \sum_{k=-\infty}^{\infty} x^2[k]$

```
figure;
n = -(N-1) : (N-1);
stem(n, xcorr(randomValues));
```

% (c) Why use +1 and -1 values (Volts) and not 0 and 1 values (Volts)?
% Reason #1: Using 0 and 1 values needs a DC offset of 0.5 V. Having a non-zero
% DC component wastes energy because it does not convey any information.
% Reason #2: Transmitting 0V is easily swamped by noise by the time it reaches
% the receiver.
% Reason #3: The difference between -1V and +1V is larger than the difference
% between 0V and 1V. Hence, the -1V and +1V values will be more resilient
% to noise, i.e. have a higher SNR.
% Reason #4: We need +1V and -1V (not 0V and 1V) to distinguish between
% transmitting a binary 0 and there being a transmission fault (no signal)
% Reason #5: Autocorrelation is dot product, so if we had 0's we would be adding
% zeros in the sum, so by having non-zero values (1) from the dot products,
% we can produce peaks/matches correctly
% Plots

Random +1 and -1 values $x[n]$



Autocorrelation of $x[n]$