Lab 1: Discrete-Time Signals and Systems

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Exercise 1

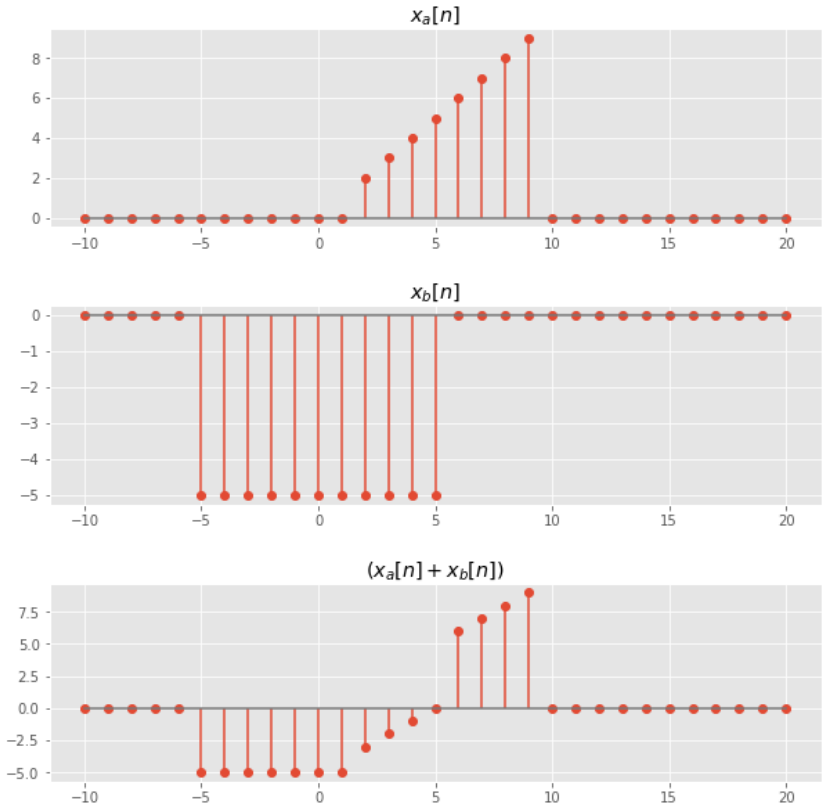

Figure 1. Plot of $x_a[n]$, $x_b[n]$, $(x_a[n] + x_b[n])$

Exercise 2 - Time-Invariant and Time-Varying Systems

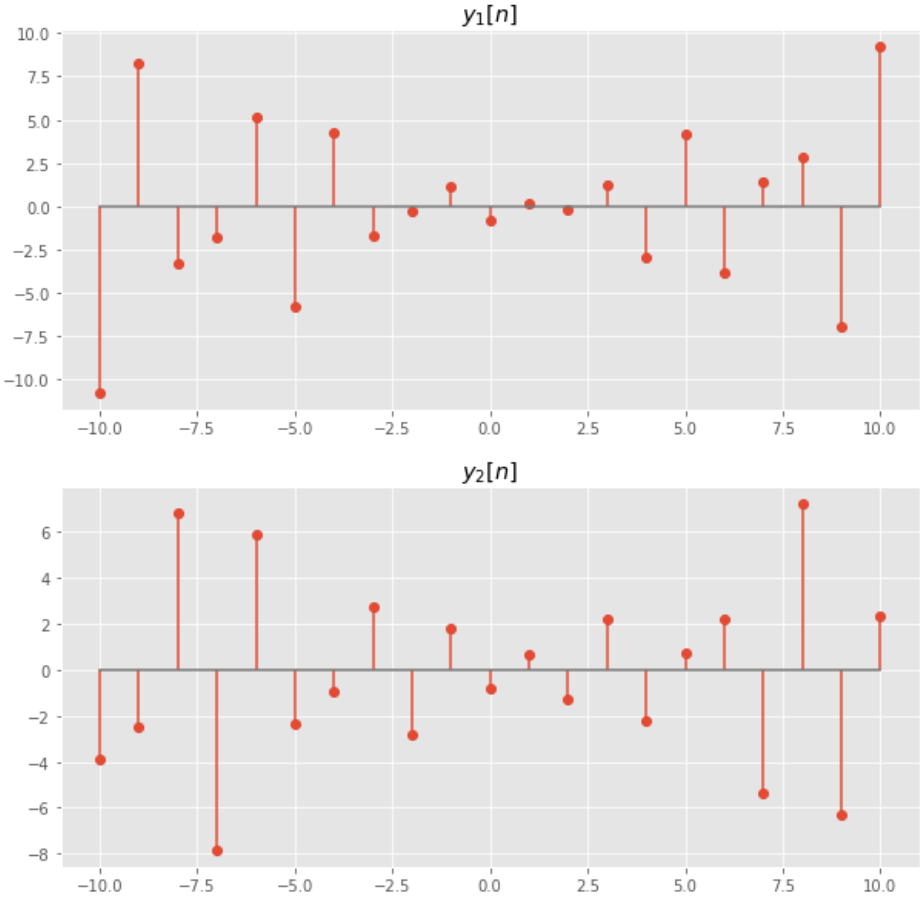

Figure 2. Plot of Systems $y_1[n]$ and $y_2[n]$

The system $y[n] = nx[n] + x[n - 1]$ is not time-invariant because of the term $x[n]$ being multiplied by the time variable n. $x_1[n]$ and $x_2[n]$ are shifted versions of each other, but as we can see from the plots $y_1[n]$ and $y_2[n]$ are not simply shifted versions of each other.

Exercise 3 - Linear and Nonlinear Systems

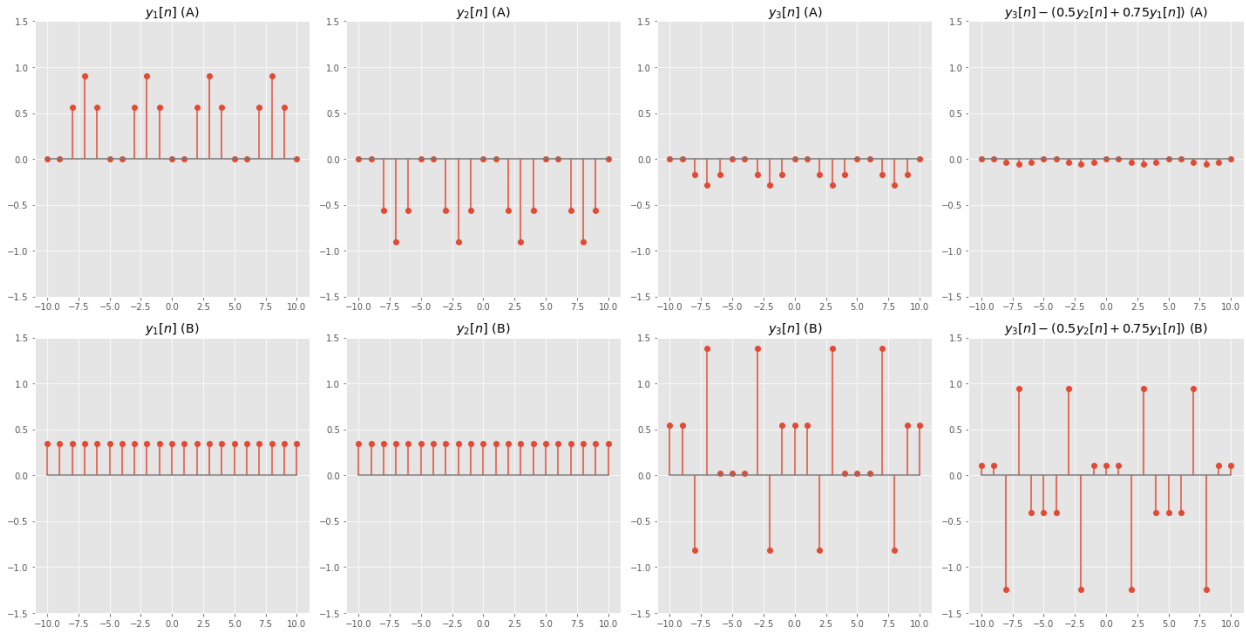

Figure 3. Plot of Systems A and B

Both systems A and B are not linear because both contain systems an $x[n]x[n-1]$ term which cannot be linear.

Exercise 4

In the sample with echo, it sounds like there are only two instances of the sample playing at once.
In the sample with reverb, it sounds like there are many instances of the sample playing at once.

Exercise 5

Figure 3. Plot of Input, Moving Averages using for-loops and convolution

The signal $y_1[n]$ seems to average 50 samples with a range starting at $n - 50$ to n, while $y_2[n]$ averages 50 samples with a range starting at $n - 25$ to $n + 25$. $y_1[n]$ is causal because the system only depends on past input, while $y_2[n]$ is not causal because it depends on past and future input.

The choice for $h_1[n]$ is $h_1[n] = u(n) - u(n - 50)$ which is a 50-unit square pulse signal.
The choice for $h_2[n]$ is $h_2[n] = u(n + 25) - u(n - 25)$ which is a 50-unit square pulse signal shifted 25 units to the left.