Convolution

Getting Started

1. To start MATLAB on a PC, simply go to Start->Programs and start MATLAB from the menu.

2. To become familiar with some of the “gee-whiz” capabilities of MATLAB, try running `echodemo xfourier`. The text shows the MATLAB commands that were used to generate the examples. You may also wish to explore some of the other examples by running `demo` and exploring the options.

3. Run `echodemo intro` to get an idea of the basic capabilities of MATLAB.

4. You can type `doc` at any time to get a hypertext version of the MATLAB Reference Guide or `help <cmd>` to get help on specific commands (assuming this is installed on the machine where you are).

5. If you need help on a MATLAB function and the hyperlink doesn’t work, simply type `help <function>` at the MATLAB prompt.

Exercises

1. Write a MATLAB function to generate a sawtooth waveform that begins at height $A$ and descends in a straight line to height 0 and then repeats. The period of each sawtooth should be $T$ samples, and it should repeat for a total of $P$ periods. Your function should have input parameters $A$, $T$, and $P$. You can learn some tricks from the triangular waveform function example in MATLAB for DSP to write this function without loops. (This is not necessary for full credit.) Include a listing of your function. The function may not call a signal-generating function in the MATLAB Signal Processing Toolbox.

2. Create two signals:
   (a) Create a length-15 vector representing an impulse (`delta1 = [1 zeros(1,14)]`). Note that this is an impulse with some of the zeros shown, not a pulse.
   (b) Create a periodic exponential wave $s_1$ using the function you wrote with $A = 3$, $T = 20$, and $P = 5$, as inputs.

3. Use `conv` to convolve $s_1$ and $delta_1$, and plot the result using `stem`.

4. Examine another convolution:
   (a) Create another vector of length 15 representing an impulse at 0 and 14. (`delta2 = [1 zeros(1,13) 1]`).
   (b) Convolve $delta_2$ with $s_1$ and plot the result.
   (c) Explain the relationship between this plot and the previous one.

5. Examine another type of impulse response:
(a) Create a flat impulse response $hn3$ that is three points long and normalized by the length 
($hn3 = 1/3*[\text{ones}(1,3)];$).

(b) Convolve $hn3$ with $s1$.

(c) Increase the length of the impulse response to 5 and 10 (normalizing by the length) and 
redo the convolution.

(d) What happens to the result as the length of the impulse response is increased? Explain.

explaining each step. (Keep $x[n]$ in the form of a difference of two step functions and not a list of numbers. Your answer should be a functional expression, not an explicitly written sequence of numbers.) Check your result using MATLAB. Explain how you checked the result.

Write a concise report describing your findings following my format instructions. The report should contain a concise description of your results and all plots you were required to generate. Be sure to answer all questions.

NOTE: All out-of-class work is to be done independently. Sharing of programming tips and discussing general concepts is ok. Collaborating on experiments or code-writing is not. Any such collaboration on these assignments will be considered an act of dishonesty and will be treated accordingly.

For further help:

- [MATLAB Primer]
- [MATLAB Help Desk]