Convolution

Getting Started

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

2. To become familiar with some of the “gee-whiz” capabilities of MATLAB, try running \texttt{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 \texttt{demo} and exploring the options.

3. Run \texttt{echodemo intro} to get an idea of the basic capabilities of MATLAB.

4. You can type \texttt{doc} at any time to get a hypertext version of the MATLAB Reference Guide or \texttt{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 \texttt{help <function>} at the MATLAB prompt.

Exercises

1. Write a MATLAB function to generate a periodic waveform of total length $L$. Each period must be a truncated, decaying exponential $A \exp(-bn)$ with decay rate $b$ that begins with amplitude $A$ and lasts a total of $M$ samples. The result should look something like a series of waves. 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-20 vector representing an impulse ($\texttt{delta1} = [1 \texttt{zeros}(1,19)]$). Note that this is an impulse with some of the zeros shown, not a pulse.
   
   (b) Create a periodic decaying exponential wave $s1$ using the function you wrote with $A = 2$, $L = 60$, $b = 0.5$, and $M = 6$, as inputs.

3. Use \texttt{conv} to convolve $s1$ and $\texttt{delta1}$, and plot the result using \texttt{stem}.

4. Examine another convolution:
   
   (a) Create another vector of length 20 representing an impulse at 0 and 19. ($\texttt{delta2} = [1 \texttt{zeros}(1,18) \ 1]$).
   
   (b) Convolve $\texttt{delta2}$ with $s1$ 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 \( h_{n3} \) 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.

6. Let \( x[n] = u[n] - u[n - 10] \). Let \( h[n] = 3\delta[n] + \delta[n - 3] \). Determine \( x[n] * h[n] \) analytically,
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