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Course: ECE 3210

Subject: Lab 3, Numerical Convolution

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1 Introduction

Convolution is fundamental to understanding the behavior of signals and systems. Through implementing convolution we can gain a deeper understanding of the mathematics behind it. To implement the convolution we created a Python function as well as a C function to compute the convolution. We then compared these functions to an analytical solution of convolution.

2 Theory

Given two functions, $f(t)$ and $h(t)$ we computed the convolution of these two functions.

$$f(t) = e^{-\frac{t}{2}}(u(t-1) - u(t-10)) \quad (1)$$

$$h(t) = e^{-t}(u(t-2) - u(t-5)) \quad (2)$$

Using the convolution integral we can compute the convolution of these two functions.

$$y(t) = \int_{-\infty}^{\infty} f(\tau)h(t-\tau) d\tau \quad (3)$$

Splitting the integral into the different time intervals needed and solving yields.

$y(t) =$	0	$t < 3$
	$2(e^{-0.5t-1} - e^{0.5-t})$	$3 \leq t < 6$
	$2e^{-0.5t}(e^{-1} - e^{-2.5})$	$6 \leq t < 12$
	$2(e^{5-t} - e^{-0.5t-2.5})$	$12 \leq t < 15$
	0	$t \geq 15$

3 Results

The results of this lab are shown in Fig. 1 which is the graph of our C, Python, and analytical implementations.

Fig. 2 shows the speed of our Python and C implementations on a logarithmic scale.

4 Discussion and Conclusions

Through Fig. 1 we can see that all three implementations of the code match exactly. This proves that the mathematical approach to convolution is correct and that our analytical solutions are correct.

Fig. 2 shows that our C implementation runs faster than the python implementation. The largest time difference is when the step size is largest.

Creating the function in Python was relatively easy especially with some knowledge of array manipulation. Converting this function into a C function was much more difficult. This was due to a lack of familiarity with tying C and Python together.

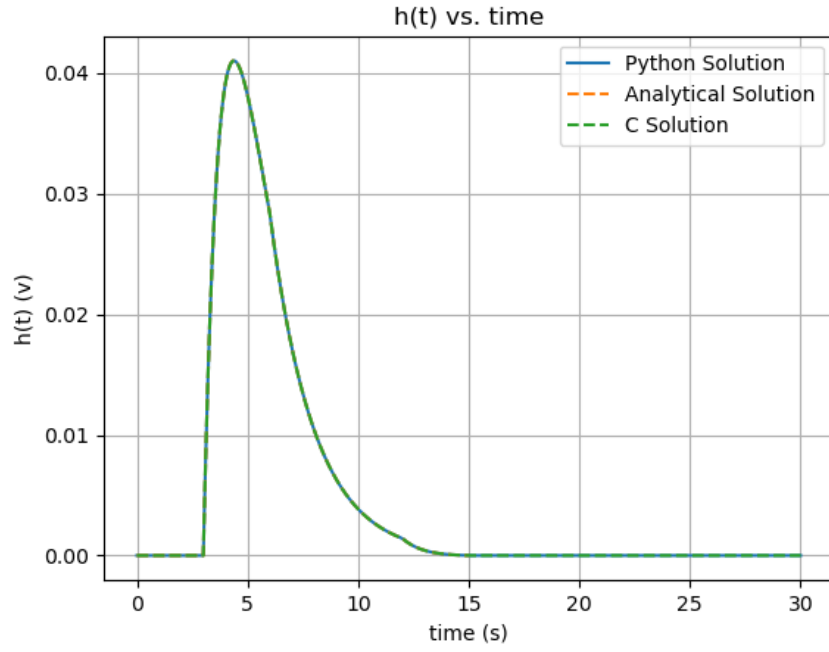


Figure 1: This figure shows the convolution of the two functions earlier using three different methods. All three methods overlap completely. This shows the accuracy of each method.

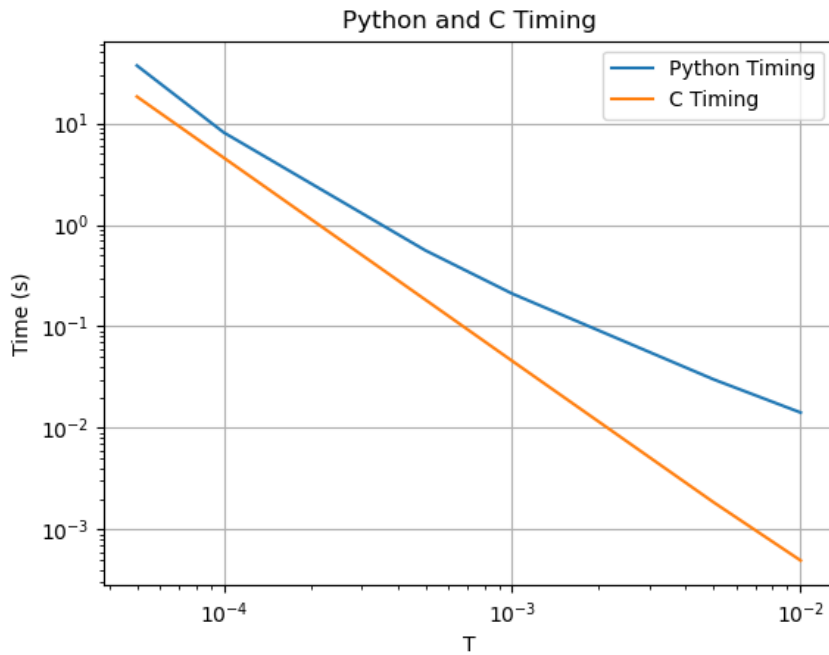


Figure 2: This figure shows the times it takes the Python and C implementations to run. The figure is set on a logarithmic scale.