Discrete Convolution

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ECE 351-51

Lab Report 3

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1 Introduction

The objective of this lab was to create a user-defined convolution function and test it with three functions composed of the step and ramp functions created during last lab. The user-defined convolution function outputs will be compared with the outputs of the same convolutions done via the scipy.signal.convolve function.

2 Methodology

I began by importing the step_func() and ramp_func() functions I created in the previous lab. I later ran into an issue with my imported functions, but I will address this in the Conclusion section. Using my imported functions, I created a new set of functions to $f_1(t)$, $f_2(t)$, and $f_3(t)$. These functions may be seen below and their plots may be seen in Figure 1 of the results section.

$$f_1(t) = u(t-2) - u(t-9)$$

$$f_2(t) = e^{-t}u(t)$$

$$f_3(t) = r(t-2)[u(t-2) - u(t-3)] + r(4-t)[u(t-3) - u(t-4)]$$

Next, I created a convolution function. I used my convolution function to find the plot the convolutions $f_1(t) * f_2(t)$, $f_2(t) * f_3(t), and f_1(t) * f_3(t)$. I used the scipy.signal.convolve function to verify the results of my convolution function. A side-by-side of the user-defined and built-in convolutions may be seen in Figure 2 of the results section.

3 Results

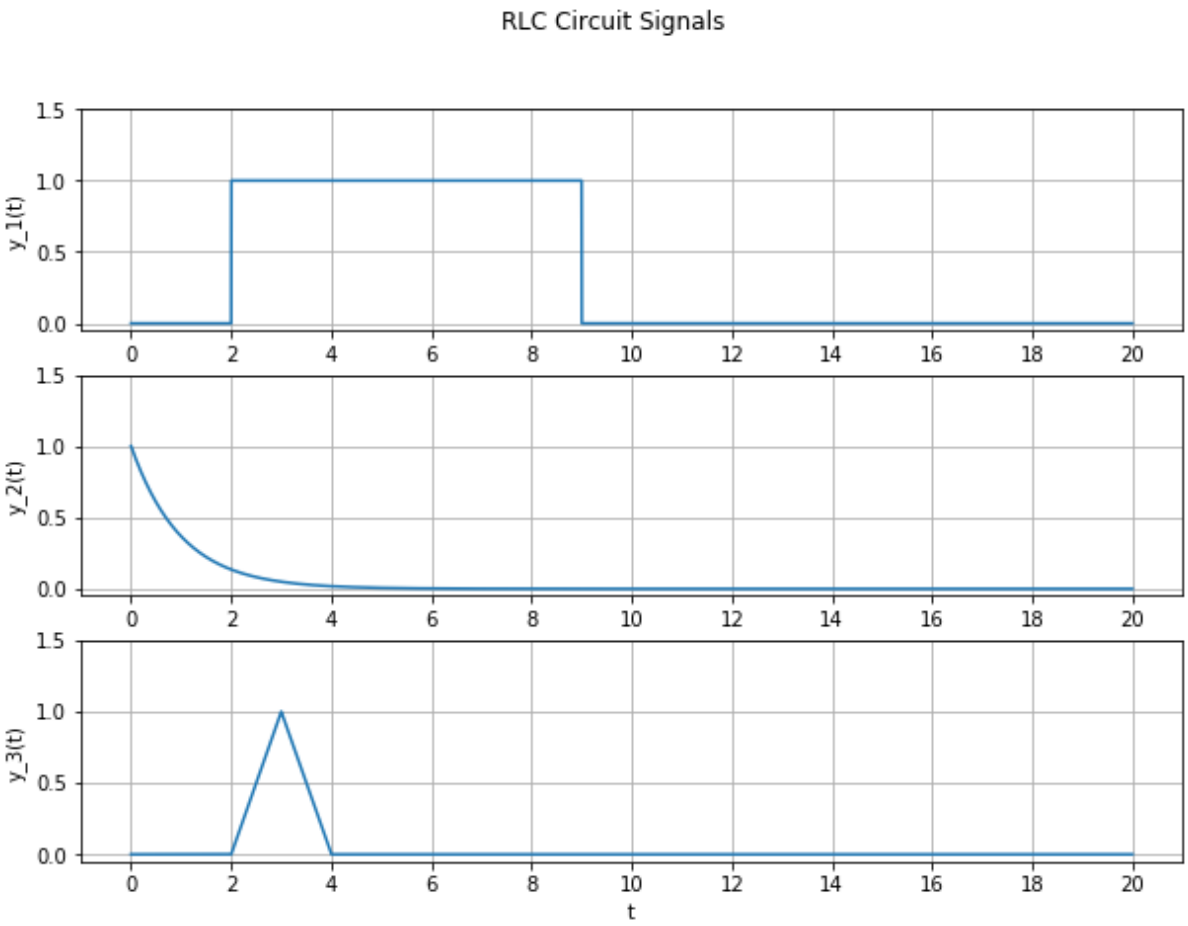

Figure 1: Plots of functions provided.

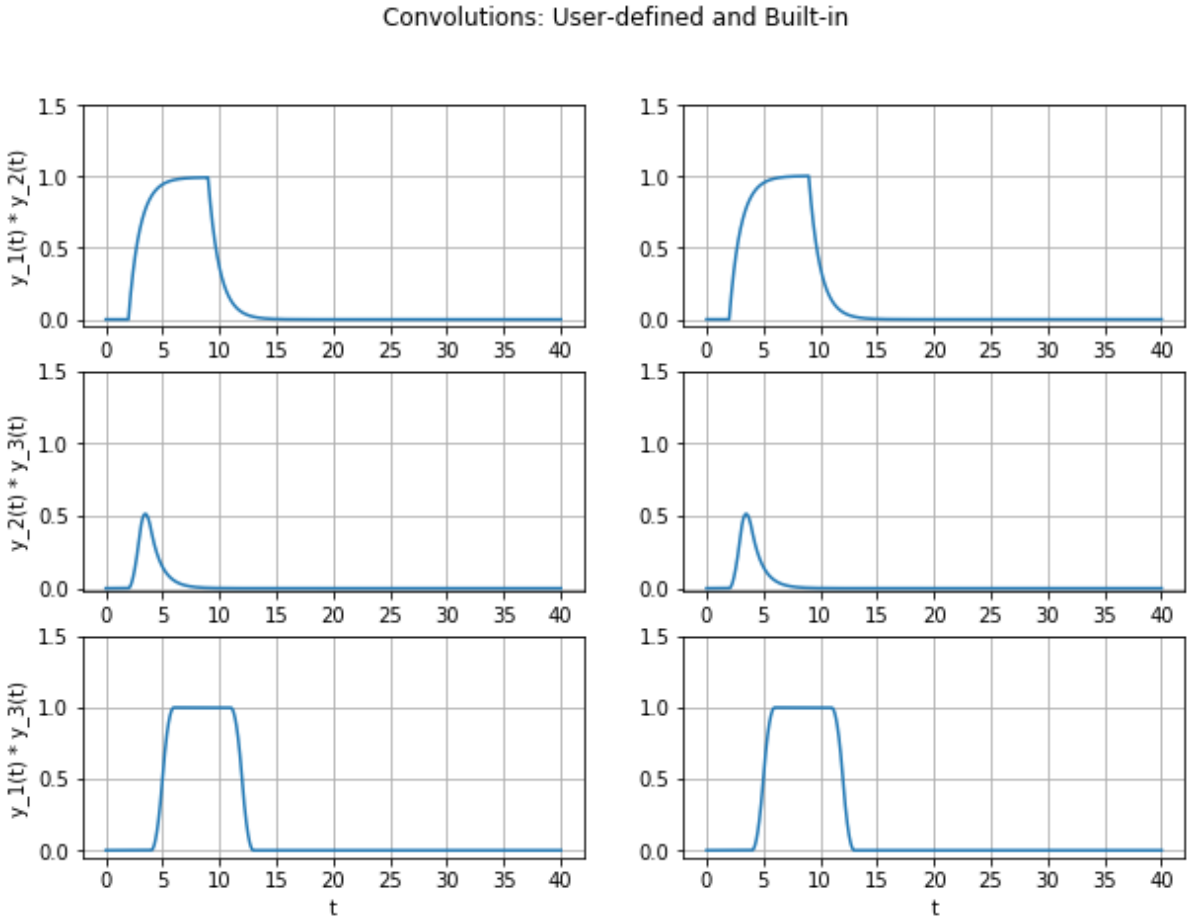

Figure 2: Plots of convolutions.

4 Conclusion

I completed most of the lab without great difficulty thanks to the guidance that was provided for creating the convolution function. However, I ran into a big problem when using the built-in convolution function. The function would run for a long time and then fail, giving an error stating that "volume and kernel should have the same dimensionality". I tried searching for a solution to this error, but couldn't find anything online. I eventually discovered that my step function and ramp function were implemented in a slightly different way than they were on the key provided. While the functions worked fine for the rest of the lab, this caused an issue with the built-in scipy.convolve function. A snippet of my initial code was as follows:

```
y = np.zeros((len(t), 1))
```

When I changed this line to match the key (as seen below), I no longer received the dimensionality error and I was able to successfully generate the plots comparing my convolution function to the built in one.

```
y = np.zeros(t.shape)
```

Questions

1. Did you work alone or with classmates on this lab? If you collaborated to get to the solution, what did that process look like?

For the majority of the lab, I worked alone. However, there were a couple times that I consulted with a nearby classmate to verify that my results were reasonable.

2. What was the most difficult part of this lab for you, and what did your problem-solving process look like?

The most difficult part of the lab was trying to solve the dimensionality error that I discussed in the Conclusion section. After searching online for a solution and not finding one, I started with debugging by commenting out sections of the code and re-running until I found the offending line. I narrowed it down to the scipy.convolve function. From there, I found that it wasn't working with my implementation of the step and ramp functions.

3. Did you approach writing the code with analytical or graphical convolution in mind? Why did you chose this approach?

I approached the problem initially with graphical convolution in mind because the visualization in graphical convolution is what made me understand convolution in the first place.

4. Leave any feedback on the clarity of lab tasks, expectations, and deliverables.

There were some guidelines written in class about the expected format of the plots. It would be nice if these were made available online as I believe they differ from what is mentioned in the lab handout.