Homework 0 Selected Solutions
APPM/MATH 4650 Fall 2020 Numerical Analysis

Due date: Friday, August 28, before 5 PM
Theme: Matlab/Python practice

Instructor: Prof. Becker

solutions version 8/24/2020

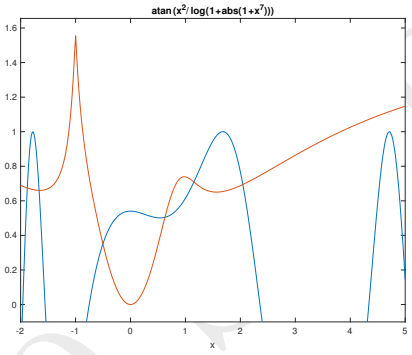
Comment This is an **optional** homework, and will not be graded. It's designed to brush up any rusty python/Matlab skills (or if you are a Matlab user, you could use this to try out Python).

Problem 1: Graph the functions (in the same figure)

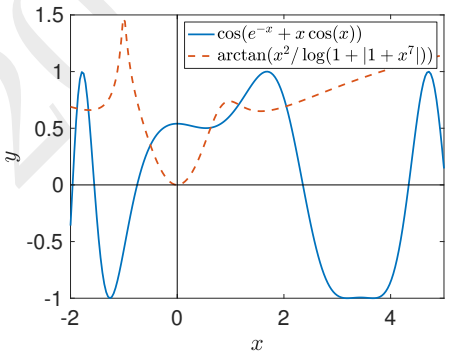
$$f(x) = \cos(e^{-x} + x\cos(x)), \qquad g(x) = \arctan\left(\frac{x^2}{\log(1+|1+x^7|)}\right),$$

on the domain $-2 \le x \le 5$.

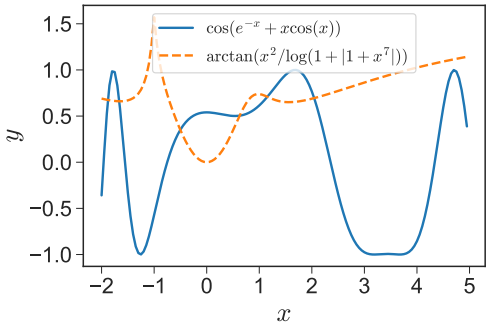
Make your plot nice, i.e., don't just make it like this



but rather make it professional, like



or



(made in Matlab and Python, respectively).

Matlab tips To save your figure as a nice PDF (use PDF rather than PNG/JPEG, because PDF can embed fonts, rather than convert them to bitmapped graphics that look bad if you resize them), use export_fig.

Python tips Use `numpy` rather than `math` for the trig and exponential functions, since then it is automatically vectorized and will work with `numpy.arange` or `numpy.linspace` nicely. I suggest using `matplotlib`, especially `matplotlib.pyplot` if you're used to Matlab style plotting.

Some good quickstart guides are at /github.com/matplotlib/cheatsheets. Very fancy tweaks are described at seaborn.pydata.org/tutorial/aesthetics.html.

If you're using a Jupyter notebook (common for Python, but in fact also possible for Matlab: see the internet for how-to), and want to export the entire Jupyter notebook to a PDF (a nice way to turn in homework), you can do so via "Download > PDF via LaTeX" if you've installed pandoc. This step is probably best done on a local instance of Jupyter (as opposed to JupyterHub on a server, or using google's colab).

Doing it this way, the figures are rasterized, which is ugly; you might have more luck fine-tuning by using nbconvert directly.

Solution:

For Matlab, here's one way

```
f = @(x) cos(exp(-x)+x.*cos(x));
g = @(x) atan(x.^2./log(1+abs(1+x.^7)));

%% The default, basic plot

ezplot( f, [-2,5] );
hold on
ezplot( g , [-2,5] )

export_fig 'WarmupPlot_simple' -pdf -transparent

%% The nicer plot

x   = linspace(-2,5,200);

h1=plot( x, f(x), 'linewidth',2,'DisplayName', '$\cos(e^{-x}+x\cos(x))$');
hold all
h2=plot( x, g(x), '--','linewidth',2,'DisplayName', '$\arctan(x^2/\log(1+|1+x^7|)
    )$');

line([-2,5],[0,0] ,'Color','k');
line([0,0],[-1,1.5] ,'Color','k');

set(gca,'FontSize',24');
xlim([-2,5]);
xlabel('$x$','Interpreter','latex')
ylabel('$y$','Interpreter','latex')

h=legend([h1,h2]);
h.Interpreter = 'latex';
h.FontSize = 20;

export_fig 'WarmupPlot_nicer' -pdf -transparent
```

For Python, here's one way (see next page for exported Jupyter notebook)

Warmup

August 24, 2020

1 APPM 4650 Homework 0: plotting practice

This homework is not quired and is not graded

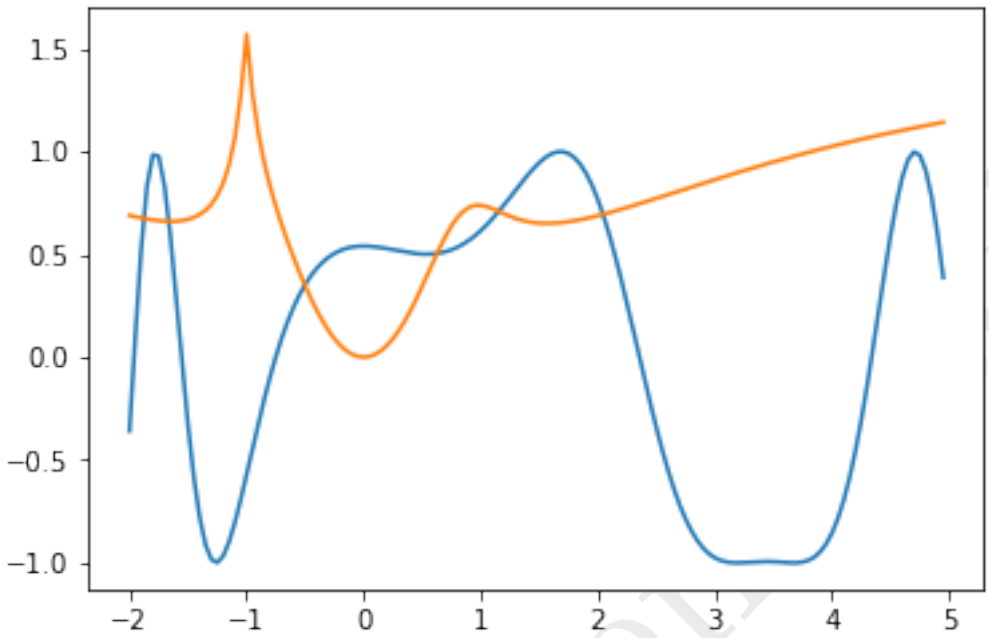
Assignment: Plot these functions on the same graph and make them look nice:

$$f(x) = \cos(e^{-x} + x\cos(x)), \quad g(x) = \arctan\left(\frac{x^2}{\log(1+|1+x^7|)}\right),$$

```
In [3]: import math
        import numpy as np

        import matplotlib.pyplot as plt
        #%matplotlib notebook  # interactive
        %matplotlib inline

        # You can do math.cos or np.cos
        #   The advantage of np.cos is that it is "vectorized" and can operate on a numpy arra
        # If you do math.cos, then you need to use np.vectorize, but this is not efficient

        f = lambda x : np.cos( np.exp(-x) + x*np.cos(x)  )
        g = lambda x : np.arctan( x**2/np.log(1+abs(1+x**7)) )
```

1.1 Basic plot

```
In [4]: x = np.arange(-2.0, 5.0, 0.05) # or np.linspace
        plt.figure()
        plt.plot(x, f(x), x, g(x) );
```



1.2 Fancier plot

```
In [33]: import matplotlib as mpl
         mpl.rcParams['mathtext.fontset'] = 'cm'

         plt.style.use('seaborn-ticks') # default, seaborn, etc. are common
         # For very fancy tweaking, see
         # https://seaborn.pydata.org/tutorial/aesthetics.html

         plt.figure()
         #plt.set_cmap('Set1')
         fig, ax = plt.subplots()
         ax.plot(x, f(x),label=r'$\cos(e^{-x}+x\cos(x))$',
                 linewidth=2.0)
         ax.plot(x, g(x),'--',label=r'$\arctan(x^2/\log(1+|1+x^7|))$',linewidth=2.0)
         plt.xlabel(r'$x$', fontsize=22)
         plt.ylabel(r'$y$', fontsize=22)
         plt.xticks(fontsize=18)
         plt.yticks(fontsize=18)
         ax.legend(fontsize=14,frameon=True,loc=9)

         # The bbox_inches fixes some cropping issues that chopped of the labels
         plt.savefig('WarmupPlot_python.pdf',bbox_inches='tight')
```

```
<Figure size 432x288 with 0 Axes>
```