Ph22- Assignment 2

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PROBLEM 2

To begin, I used the same parsing function I wrote for the last assignment. This function allows me to input a string representing a function (written as if under NumPy) and let's me evaluate the function. Then I wrote functions for a forward Euler and a Midpoint method to approximate the value of a function after some step h. For the Euler, we need an expression for the derivative of the function. For the Midpoint method this is not necessary. I iterated each function 10 times and plotted how the Global Error changes as we performed each iteration for $f = \frac{1}{10}t^2$.

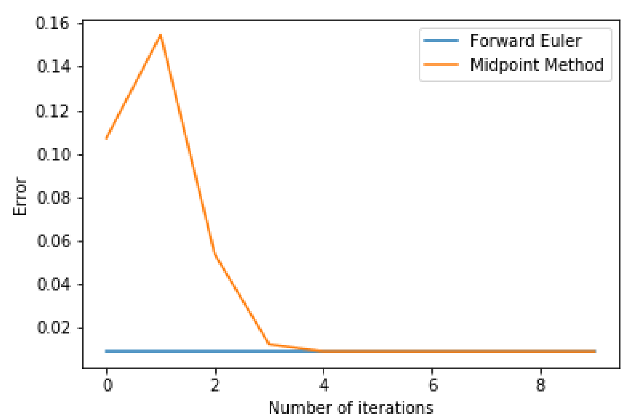

Figure 1: Error value per iteration.

We see here that the Midpoint method tends to deviate a decent amount while the Euler method returns very little error compared to the actual value almost from the beginning. I found this peculiar since I expected the Midpoint method to result in a smaller error convergence than that for the Euler method. However, depending on the function I introduced, the value of the function tended to explode so it might be possible that it flies to infinity the same way the newton-Raphson method does depending on the function.

PROBLEM 3

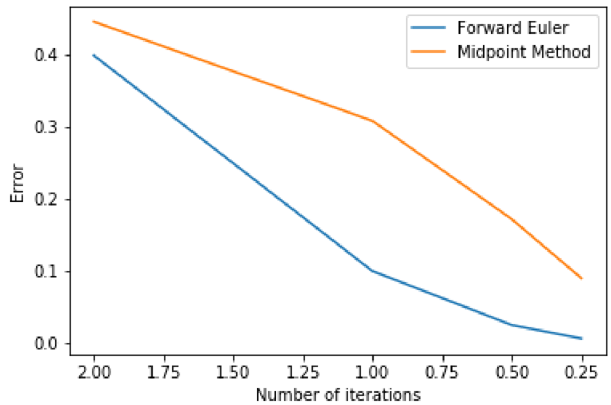

Figure 2: Error value as h changes.

Here I used the same functions, but instead of iterating them, I just plotted how the error changes as we make the step size h smaller. I flipped the x-axis so that we see how the error gets smaller and smaller for both cases as we decrease the value of the step size. I began with an initial value of $h = 2$, and divided the step size in half very time until reaching $h = \frac{2}{16}$. Once again the Euler method converged quicker, likely for the same reasons as before since I used the same function $f = \frac{1}{10}t^2$.

PROBLEM 5

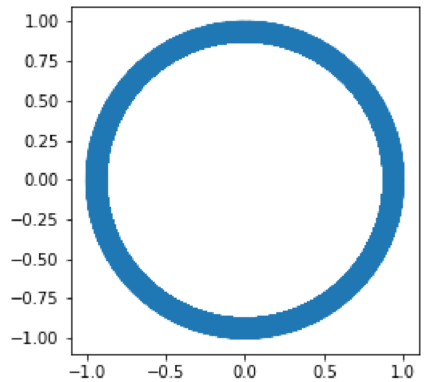

Figure 3: Orbit found using Runge-Kutta routine.

Initially, I have to determine the value of R and set the forces equal to one another. Since we want a circular orbit, I decided to set $R = 1$ and made it constant since it will not change over time.This led to the equation $1 = x^2(t) + y^2(t)$. I also set the initial $v = 0$ for the final step so that the equations matched, and this allowed the forces on both side to equal

$$\frac{v^2}{R} = \sqrt{v_x'^2(t) + v_y'^2(t)}$$
$$v^2 = \sqrt{x^2(t) + y^2(t)}$$
$$v = \sqrt{x^2(t) + y^2(t)}$$
$$1 = x^2(t) + y^2(t)$$

This allows me to parametrize the equation as

$$x(t) = Cos(t)$$
$$y(t) = Sin(t)$$

I plugged both these equations into the routine for a range of t and plotted the results. Sure enough, we see circular orbit about the center, reminiscent of the orbit we expect from this system of equations.