MATH 4610 w/ Joe Koebbe
Fall 2021

Task Sheet 4
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1. I created the two routines, one for relative error and one for absolute error. The code for these routines can be found in this directory in my math4610 repo,

   `https://github.com/spencerwheeler2077/math4610/tree/main/error`

   I also updated my software manual to include these new routines, these new pages can be found at these links

   `https://github.com/spencerwheeler2077/math4610/blob/main/software_manual/softwareman_abserror.md`

   `https://github.com/spencerwheeler2077/math4610/blob/main/software_manual/softwareman_relerror.md`

2. I created this function, I called it plot, the code for this can be found here

   `https://github.com/spencerwheeler2077/math4610/blob/main/plot/plot.py`

   The software manual page for this routine can be found here

   `https://github.com/spencerwheeler2077/math4610/blob/main/software_manual/softwareman_plot.md`

3. I created a routine that finds a root of a given function by fixed point iteration. This routine can be found here in my repository for this class.

   `https://github.com/spencerwheeler2077/math4610/blob/main/RootFinding/fixedPointIter.py`

   I also updated my software manual, and the page for this routine can be found at using this link.

   `https://github.com/spencerwheeler2077/math4610/blob/main/software_manual/softwareman_fixedPointIter`

4. I tried applying the fixed point iteration routine I created for task 3, when I ran it as is with the given function I had an overflow error. So using it normally for this function would not work.

   Applying some ϵ will help the function converge making this method viable to find a root of the function.

   In our program we define $g(x) = x - f(x)$. Lets change this to include $epsilon$, or $g(x) = x - \epsilon f(x)$. The convergence criterion is $g'(x) \leqslant 1$

   So taking $g'(x) = 1 - \epsilon f'(x)$ substitute that in the convergence criterion.

   Giving $1 \geqslant |1 - \epsilon f'(x)|$

   $1 \geqslant (1 - \epsilon f'(x))^2$

   $1 \geqslant 1 - 2\epsilon f'(x) + \epsilon^2 f'(x)^2$

   $2\epsilon f'(x) \geqslant \epsilon^2 f'(x)^2$

   $2 \geqslant \epsilon f'(x)$

   $2/f'(x) \geqslant \epsilon$

   So any epsilon that is less than $2/f'(x)$ will make the routine work. So to get the routine I made in task 3 to work I would just to add this to my function that I was passing into my equation.

5. I created a routine for a bisection method as was asked in the task sheet this routine can be found in my math4610 repository at the following link.

   https://github.com/spencerwheeler2077/math4610/blob/main/RootFinding/Bisection.py

   I also updated my software manual to include a page for this new routine. This can be found at this link.

   https://github.com/spencerwheeler2077/math4610/blob/main/software_manual/softwareman_bisection.md

6. Reading from this website, it became pretty clear why these kinds of methods are really needed. These methods can find roots of very complicated polynomials, that won't have integer roots, very easily. This article didn't bring up any new methods that we haven't done in class, but it did make it clear why these methods are so important.