NUMERICAL ANALYSIS I

Newton Method

February 15, 2023

Instructions:

- *When you have finished the exercises, prepare the command line and show me the associated programs.*
- *The exercises must be carried out under Matlab or Gnu Octave (https://octave.org/download).*
- *The work must be individual.* ***You must bring your personal computer fully charged.***
- ***It is your responsibility to install Matlab or Gnu Octave there.*** *Octave is a free open-source alternative to MATLAB; It works under GNU/Linux, macOS and Microsoft Windows.*
- *Create an easily accessible folder that will store all your files from this course. I would suggest calling it "MATH319". In the folder created above, create a first sub-folder and call it "LectureCodes".*
- *Download the MATLAB/OCTAVE script* `newton_tp2.m` *from the Blackboard. Go to Course Contents, click on "Computer-Based Exercises" then download* `newton_tp2.m`*. Make sure the file name remains* `newton_tp2.m` *with no spaces or parentheses. If your machine added extra characters to the file name (e.g.* `newton_tp2,(1).m`*) after saving the file, you must change the name without spaces or parentheses before opening or running the file in MATLAB/OCTAVE.*

Exercise 1
Consider a real-valued function of a real variable $f(x) = x^2 - 5$.

1. Complete the following program corresponding to the Newton method.
2. Use the code to compute the zeros of $f(x) = x^2 - 5$.
3. Provide the approximated solution and the number of iterations needed to obtain a tolerance of 10^{-8}.
4. For each iteration $k > 1$, compute the error ratio: e^k/e^{k-1}. What do you notice?

```
function [zero,res,niter]=newton_tp2(fun,dfun,x0,tol,nmax)
% ======
% STUDENT:
% ID:
% MY COMMAND LINE TO RUN THE CODE:
%
%
% ======
% NEWTON Finds function zeros.
% ZERO=NEWTON_TP2(FUN,DFUN,X0,TOL,NMAX) tries to find the
% zero ZERO of the continuous and differentiable
% function FUN nearest to X0 using the Newton method.
% FUN and its derivative DFUN accept real scalar input
% x and return a real scalar value. If the search
% fails an error message is displayed. FUN and DFUN
% are function handles associated with anonymous fun-
% ctions or Matlab functions.
% [ZERO,RES,NITER]=NEWTON_TP2(FUN,...) returns the value of
% the residual in ZERO and the iteration number at
% which ZERO was computed.
% ************************ Main *****
x = x0;
fx = fun(x);
dfx = dfun(x);
niter = 0;
diff = tol+1 %|x^n+1 - x^n| = error
while diff >= tol & niter < nmax
   niter = niter + 1;
   x = " ... " ;
   diff = " ... " ;
   fx = " ... " ;
   dfx = " ... " ;
end
if (niter==nmax & diff > tol)
    fprintf(['    ...   ']);
end
zero = x;
res = fx;
```