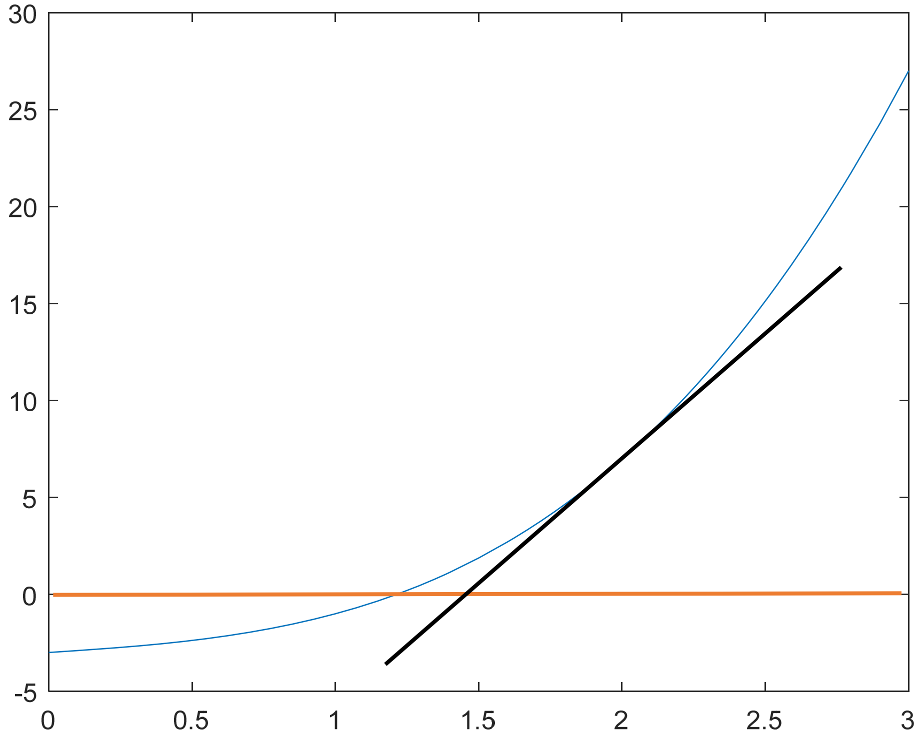
```
% 7.1 EXAMPLE: NEWTON’ S METHOD AGAIN

%    Use the Editor to create and save (in the current MATLAB directory) the function
%    file f.m as follows:

function y = f(x)
y = x^3 + x - 3;

%---------------------------------

%    Then create and save another function file df.m:

function y = df(x)
y = 3*x^2 + 1;

%---------------------------------
%     Now write a separate script file, newtgen.m (in the same directory), which will
%     stop either when the relative error in x is less than 10?8, or after 20 steps, say:

% Newton’ s method in general
% excludes zero roots!

steps = 0; % iteration counter
x = input( 'Initial guess: '); % estimate of root
re = 1e-8; % required relative error
myrel = 1;
while myrel > re & (steps < 20)
        xold = x;
        x = x - f(x)/df(x);
        steps = steps + 1;
        disp( [x f(x)] )
        myrel = abs((x-xold)/x);
end
if myrel <= re
        disp( 'Zero found at' )
        disp( x )
else
        disp( 'Zero NOT found')
end
%=================================================================
=============================
```

%% To rewrite newton's method in book 7.1 by using (for & if break)

Ans:

```
% excludes zero roots!

steps = 0; % iteration counter
x = input( 'Initial guess: '); % estimate of root
re = 1e-8; % required relative error
myrel = 1;
for steps=1:19
    xold = x;
    x = x - f(x)/df(x);
    steps = steps + 1;
    disp( [x f(x)] )
    myrel = abs((x-xold)/x);
    if myrel <= re
        break;
    end
end
if myrel <= re
    disp( 'Zero found at' )
    disp( x )
else
    disp( 'Zero NOT found')
end
```



30
25
20
15
10
5
0
-5
0
0.5
1
1.5
2
2.5
3

%   7.2 BASIC RULES :   p. 165

%   Write a function file stats.m:

```
function [avg, stdev] = stats( x )
% function definition line
%      STATS Mean and standard deviation % H1 line
%      Returns mean (avg) and standard % Help text
%      deviation (stdev) of the data in the
%      vector x, using Matlab functions

avg = mean(x); % function body
stdev = std(x);
%----------------------------------
```

%   Now test it in the Command Window with some random numbers, e.g.,

```
r = rand(100,1);
[a, s] = stats(r);
```

%----------------------------------

(1) Start with the function keyword.
(2) Input & output arguments.
(3) Multiple output arguments.
(4) Function naming. (same as variable)
(5) Help text (start with '%')
    Using help function_name display Help text.
(6) Local variable : exist inside the function
    Here, avg, & stdev are the local variable, they are available only inside the stats subfunction.
(7) Global variable.

    Two rules of using global variables:
    - Before define every workspace, to declare global variable.
    - Using 'capital letters' for Global variable. Make different from the local variable.

    'whos global' :   to check the global variable in the workspace.
    'clear global X' : clear global variable X to all workspace.

(8) Function that do not return values

```
function stars(n)
asteriks = char(abs('*')*ones(1,n));
disp( asteriks );
```

(9) Vector arguments

%   Vector arguments
function d = dice(n)
d = floor(6 * rand(1, n) + 1);   % d is a vector

(10) Input arguments is "Call by Value" to pass the values to the sunfunction.
(11) Checking the number of function arguments
Add a common line 'disp(nargin)', you can find the number of the input.
(12) Call a function with any number of input & output arguments

- Exec: Exec 7.5 in p.179 (a) write as a .m function (b) keep the input (x value)-output in the mean function and call this function as the subfunction.

```
%%  Debugging a script Newton¡¦s method in general
clear all;clc;
value=1; % initial value
x=3;
re = 1e-6; % required relative error
step=1;
myerr = 1;
while (myerr > re)
    value_old=value;
    value =value+(x.^(step))./(fact(step));
    disp( [step value] )
    step=step+1;
    myerr = value-value_old;
end

disp( [x value] )
```

% % Sec 7.2.3 : p-code

- In general, M – function is the script file. Source code can be seen.
- Let someone can run your function, however the source code cannot be seen. Translate it to p-code (Pseudo-Code).
- For example
  pcode stats
  can generate a 'stats.p' p-code.

- P-code can save computation time.

```
%% Sec. 7.3 FUNCTION HANDLES
%   FUNHANDLE = @FUNCTION_NAME returns a handle to the named function,
%       FUNCTION_NAME. A function handle is a MATLAB value that provides a
%       means of calling a function indirectly. You can pass function
%       handles in calls to other functions (which are often called function
%       functions).
%    Try the following on the command line:
fhandle = @sqrt;
feval(fhandle, 9)
feval(fhandle, 25)

% To defined function handle
Fhandle=@ (arglist) expression
For example:
    Two kinds of functions: anonymous function, and parameterized function.
    (1) anonymous function, the parameters value is anonymous (hided in expression)
    Fh1= @ (x) 4*x.^2-50*x+2;
    Fh2= @ (x,y) sqrt(x.^2+y.^2)
    Fh3=@(x) (x-1.5).^2;
    (2) parameterized function: you can change parameter every time you call it
    fh2 = @(x,c) (x-c).^2;% the value of the parameter is not defined
    yet
    c = 1.5;
    fh3 = @ (x) fh2(x,c);  % Now the value is defined
    d=fh3(3)
% Two build-in function to pass the funtion name as the argument
% feval & fminbnd

% feval(F,x1,...,xn) evaluates the function specified by a function
%       handle or function name, F, at the given arguments, x1,...,xn.

fhandle = @sqrt;
feval(fhandle, 9)
feval(fhandle, 25)

        f = @(x,y,c) (x-c).^2+y.^2;    % The parameterized function.
         c = 1.5;                      % The parameter.
         % IN BUILD-IN FUNCTION feval call the function that you define
         b = feval(@(x,y) f(x,y,c),0.6,0.5)
```

```
% fminbnd Single-variable bounded nonlinear function minimization.
%         X = fminbnd(FUN,x1,x2) attempts to find   a local minimizer X of the function
%         FUN in the interval x1 < X < x2.   FUN is a function handle.   FUN accepts
%         scalar input X and returns a scalar function value F evaluated at X.
```

Two function forms for the definition of the function handle:

```
             X = fminbnd(@(x) sin(x)+3,2,8)
              y=2:0.1:8;
           plot(y,sin(y)+3)
%----------------------------------
clear all;clc;
             f = @(x,c) (x-c).^2;   % The parameterized function.
             c = 1.5;                   % The parameter.
             X = fminbnd(@(x) f(x,c),0,2)
% use help to find the fplot
fplot(@(x) f(x,c),[0,2])

% fplot    Plot 2-D function
%         fplot(FUN) plots the function FUN between the limits of the current
%         axes, with a default of [-5 5].
%
%         fplot(FUN,LIMS) plots the function FUN between the x-axis limits
%         specified by LIMS = [XMIN XMAX].

%    Example: fplot(@(x) x.^2.*sin(1./x),[-1,1])


%     As an example, we would like to
%     rewrite our newtgen script as a function newtfun, to be called as follows:

function y = f(x)
y = x^3 + x - 3;

%----------------------------------
% Then create and save another function file df.m:

function y = df(x)
y = 3*x^2 + 1;

% [x f conv] = newtfun( fh, dfh, x0 )
```

```
%      The complete M-file newtfun.m is as follows:

function [x, f1, conv] = newtfun(fh, dfh, x0)
% NEWTON Uses Newton' s method to solve f(x) = 0.
%      fh is handle to f(x), dfh is handle to f' (x).
%      Initial guess is x0.
%      Returns final value of x, f(x), and
%      conv (1 = convergence, 0 = divergence)

steps = 0; % iteration counter
x = x0;
re = 1e-8; % required relative error
myrel = 1;
while myrel > re & (steps < 20)
      xold = x;
      x = x - feval(fh, x)/feval(dfh, x);
      steps = steps + 1;
      disp( [x feval(fh, x)] )
      myrel = abs((x-xold)/x);
end;
if myrel <= re
      conv = 1;
else
      conv = 0;
end;
f1 = feval(fh, x);    % return the function value at x

%----After previous 3 function defined we can use the following command to run newtfun
% ---------------------
% Method 1: define two function handle
clear all;clc;
fhand = @f;
dfhand = @df;
[x,f1,con] = newtfun(fhand, dfhand, 2)


% Method 2
clear all;clc;
fhand = @(x) x^3 + x - 3;    % The parameterized function.
dfhand= @(x) 3*x^2 + 1;
```

[x,f1,con] = newtfun(fhand, dfhand, 2)

- Exer

(a) Find the minimum value for the function $y = 1 + e^{-0.2x}\sin(x+2)$, for the interval of $0 < x < 10$. (Ans: (x,y)=(2.515, 9.0). (Use fminbnd)

(b) Use fplot to plot this function for the interval of $0 < x < 10$.

(c) Write this function as the parametric form, that is

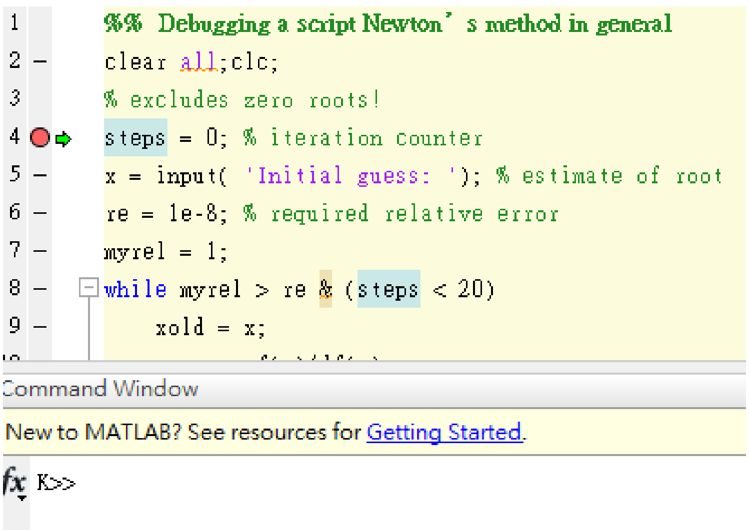
$y = 1 + e^{-0.2x}\sin(x+c)$, where c is the parameter.

Do the same thing as (a) & (b), by given c=2.5.

%% Sec 7.5: function name resolution
% if you having the same name in a variable and a function then the
% priority of the MATLAB (check p. 174):
% variable ---> subfunction ---> private function ---> dictionary

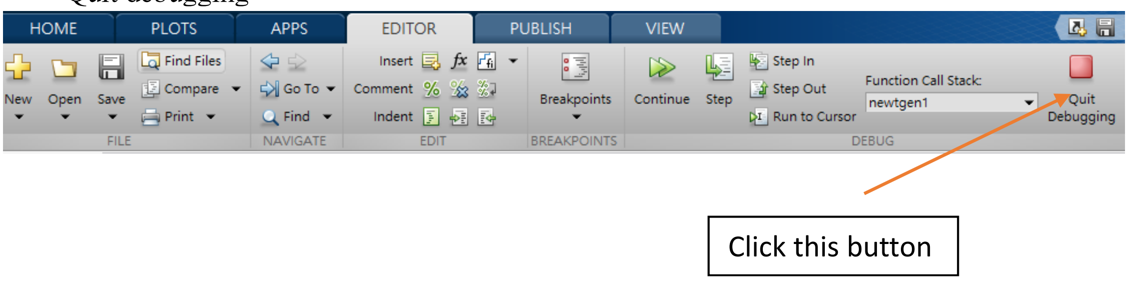
%% Sec. 7.6 Debugging a script: please open the subfunction 'newtgen1.m' and run it in a debugging mode
% Newton's method in general

(1) In command Window '>>k' means that you are in the Debug mode.
(2) Green arrow means the run ending at this point.



```
%%    Check the procedure in p. 175 for the debugging
% Debugging a script Newton's method in general
% (1) set breakpoint at Line 4; and Line 11
% (2) run & continuous to run the program

clear all;clc;
% excludes zero roots!
●    steps = 0; % iteration counter
x = input( 'Initial guess: '); % estimate of root
re = 1e-8; % required relative error
myrel = 1;

while myrel > re & (steps < 20)
     xold = x;
●    x = x - f(x)/df(x);
     steps = steps + 1;
     disp( [x f(x)] )
     myrel = abs((x-xold)/x);
end
if myrel <= re
     disp( 'Zero found at' )
     disp( x )
else
     disp( 'Zero NOT found')
end


%==================================================================================================
```

➢ Quit debugging




```
% Sec 7.7 RECURSION Call by one function itself

%     The factorial function may be written recursively in
%     an M-file fact.m like this:
```

n=10
call fact(n)

```
function y = fact(n)
% FACT Recursive definition of n!
if n > 1
    y = n * fact(n-1);
else
    y = 1;
end;
```

n=9

```
function y = fact(n)
% FACT Recursive
definition of n!
if n > 1
    y = n * fact(n-1);
else
    y = 1;
```

n=8

%==

- Exec 7.8 in p.180 fibonacci number

```
function y = fib(n)
fib(1)=1;
for i=2:n
    if (i<3)
        fib(i)=1+fib(i-1);
    else
    fib(i)=fib(i-2)+fib(i-1);
    end
    disp(fib(i));
end
```

1. To rewrite newton's method in book 7.1 by using (for & if break)

Ans:

```
% excludes zero roots!

steps = 0; % iteration counter
x = input( 'Initial guess: '); % estimate of root
re = 1e-8; % required relative error
myrel = 1;
for steps=1:19
    xold = x;
    x = x - f(x)/df(x);
    steps = steps + 1;
    disp( [x f(x)] )
    myrel = abs((x-xold)/x);
    if myrel <= re
        break;
    end
end
if myrel <= re
    disp( 'Zero found at' )
    disp( x )
else
    disp( 'Zero NOT found')
end
```

2. Function handle: (a) Find the minimum value for the function $y = 1 + e^{-0.2x}\sin(x+2)$, for the interval of $0 < x < 10$. (Ans: (x,y)=(2.515, 9.0). (Use fminbnd)
   (b) Use fplot to plot this function for the interval of $0 < x < 10$.
   (c) Write this function as the parametric form, that is
   $y = 1 + e^{-0.2x}\sin(x+c)$, where c is the parameter.
   Do the same thing as (a) & (b), by given c=2.5.

3. Exer in textbook 7.2,7.4,7.5,7.6, 7.8,7.9.