I-RegulaFalsi O-1

pkg load interval

% RF Finds single roots of a function in given range.

%

% RF(func,a,b,tol)

%

% Uses an interval version of Regula Falsi Family method (Pegasus) to provide

% rigorous bounds on the single roots of a function f.

% Bounds are displayed as they are found.

% Roots are displayed if radius of enclosure < tol

% or if enclosure is no longer becoming tighter.

%

% INPUT: f function of nonlinear equation.

% a,b limits of the interval containing the root.

% tol used as stopping criterion.

%

function [root,It] = RF(f,a, b, tol)

It=0;ItMax=50;

fa=f(a);

if fa == 0; root=infsup(a,a); return; end

fb=f(b);

if fb == 0; root=infsup(b,b); return; end

if fa\*fb > 0

'Root is not bracketed in (a,b)'

x=infsup(NaN, NaN);

return;

end

x=b;fx=fb;

while 1

It=It+1;dx=-fx/(fb-fa)\*(b-a);

x=x+dx;fx=f(x);

% [It,a,b,x,fx,dx]

if fx == 0.0

root=infsup(x, x);

width0=wid(root)

break

end

if fx\*fb <0

a=b;fa=fb;

else

fa=fa\*fb/(fb+fx);

end

b=x; fb=fx;

% Conversion to interval by infimum and supremum computed

% such that root is enclosed in [root] interval

if a < b

root=infsup(a, b);

else

root=infsup(b, a);

end

if or(wid(root) < tol, It > ItMax )

width=wid(root)

break

end

end

if It > ItMax

Erro=1

else

Erro=0

end

endfunction

>> % pkg load interval

>> format long

>> tol = 1e-14

tol = 1.000000000000000e-14

>> '##### 1'

ans = ##### 1

>> f = @(x)x^3-1

f =

@(x) x ^ 3 - 1

>> [root,t]=RF(f,0.5,1.5,tol)

width0 = 0

Erro = 0

root = [1]

t = 8

>> f(root)

ans = [0]

>> '##### 2'

ans = ##### 2

>> f =@(x)x^2\*(x^2/3+sqrt(2)\*sin(x))-sqrt(3)/18

f =

@(x) x ^ 2 \* (x ^ 2 / 3 + sqrt (2) \* sin (x)) - sqrt (3) / 18

>> [root,t]=RF(f,0.1,1,tol)

width = 6.772360450213455e-15

Erro = 0

root ⊂ [0.3994222917109681, 0.399422291710975]

t = 10

>> f(root)

ans ⊂ [-5.551115123125783e-17, +4.98212582300539e-15]

>> '##### 3'

ans = ##### 3

>> f =@(x)11\*x^11-1

f =

@(x) 11 \* x ^ 11 - 1

>> [root,t]=RF(f,0.1,1,tol)

width = 1.110223024625157e-16

Erro = 0

root ⊂ [0.8041330975036642, 0.8041330975036644]

t = 15

>> f(root)

ans ⊂ [-1.221245327087673e-15, +6.66133814775094e-16]

>> '##### 4'

ans = ##### 4

>> f = @(x)x^3+1

f =

@(x) x ^ 3 + 1

>> [root,t]=RF(f,-1.8,0,tol)

width0 = 0

Erro = 0

root = [-1]

t = 9

>> f(root)

ans = [0]

>> '##### 5'

ans = ##### 5

>> f = @(x)x^3-2\*x-5

f =

@(x) x ^ 3 - 2 \* x - 5

>> [root,t]=RF(f,2,3,tol)

width = 4.440892098500626e-16

Erro = 0

root ⊂ [2.094551481542326, 2.094551481542327]

t = 10

>> f(root)

ans ⊂ [-3.552713678800501e-15, +6.217248937900877e-15]

>> '##### 6'

ans = ##### 6

>> f = @(x)2\*x\*exp(-5)+1-2\*exp(-5\*x)

f =

@(x) 2 \* x \* exp (-5) + 1 - 2 \* exp (-5 \* x)

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.138257155056824, 0.1382571550568241]

t = 8

>> f(root)

ans ⊂ [-2.220446049250314e-16, +4.440892098500627e-16]

>> '##### 7'

ans = ##### 7

>> f = @(x)2\*x\*exp(-10)+1-2\*exp(-10\*x)

f =

@(x) 2 \* x \* exp (-10) + 1 - 2 \* exp (-10 \* x)

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.06931408868702346, 0.06931408868702347]

t = 9

>> f(root)

ans ⊂ [-4.440892098500627e-16, +2.220446049250314e-16]

>> '##### 8'

ans = ##### 8

>> f = @(x)2\*x\*exp(-20)+1-2\*exp(-20\*x)

f =

@(x) 2 \* x \* exp (-20) + 1 - 2 \* exp (-20 \* x)

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.03465735902085384, 0.03465735902085385]

t = 9

>> f(root)

ans ⊂ [-4.440892098500627e-16, 0]

>> '##### 9'

ans = ##### 9

>> f = @(x)(1+(1-5)^2)\*x-(1-5\*x)^2

f =

@(x) (1 + (1 - 5) ^ 2) \* x - (1 - 5 \* x) ^ 2

>> [root,t]=RF(f,0,1,tol)

width = 6.938893903907228e-18

Erro = 0

root ⊂ [0.03840255184062189, 0.0384025518406219]

t = 9

>> f(root)

ans ⊂ [-3.33066907387547e-16, +1.110223024625157e-16]

>> '##### 10'

ans = ##### 10

>> f = @(x)(1+(1-10)^2)\*x-(1-10\*x)^2

f =

@(x) (1 + (1 - 10) ^ 2) \* x - (1 - 10 \* x) ^ 2

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.009900009998000499, 0.0099000099980005]

t = 8

>> f(root)

ans ⊂ [-3.33066907387547e-16, +1.110223024625157e-16]

>> '##### 11'

ans = ##### 11

>> f = @(x)(1+(1-20)^2)\*x-(1-20\*x)^2

f =

@(x) (1 + (1 - 20) ^ 2) \* x - (1 - 20 \* x) ^ 2

>> [root,t]=RF(f,0,1,tol)

width = 4.336808689942018e-19

Erro = 0

root ⊂ [0.002493750039062011, 0.002493750039062013]

t = 8

>> f(root)

ans ⊂ [-1.110223024625157e-16, +3.33066907387547e-16]

>> '##### 12'

ans = ##### 12

>> f = @(x)x^2-(1-x)^5

f =

@(x) x ^ 2 - (1 - x) ^ 5

>> [root,t]=RF(f,0,1,tol)

width = 5.551115123125783e-17

Erro = 0

root ⊂ [0.345954815848242, 0.3459548158482421]

t = 8

>> f(root)

ans ⊂ [-9.71445146547012e-17, +8.326672684688675e-17]

>> '##### 13'

ans = ##### 13

>> f = @(x)x^2-(1-x)^10

f =

@(x) x ^ 2 - (1 - x) ^ 10

>> [root,t]=RF(f,0,1,tol)

width = 5.551115123125783e-17

Erro = 0

root ⊂ [0.2451223337533071, 0.2451223337533073]

t = 11

>> f(root)

ans ⊂ [-9.020562075079397e-17, +4.163336342344338e-17]

>> '##### 14'

ans = ##### 14

>> f = @(x)x^2-(1-x)^20

f =

@(x) x ^ 2 - (1 - x) ^ 20

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.1649209572764409, 0.164920957276441]

t = 12

>> f(root)

ans ⊂ [-7.632783294297952e-17, +3.469446951953615e-18]

>> '##### 15'

ans = ##### 15

>> f = @(x)(1+(1-5)^4)\*x-(1-5\*x)^4

f =

@(x) (1 + (1 - 5) ^ 4) \* x - (1 - 5 \* x) ^ 4

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.003617108178904063, 0.003617108178904064]

t = 7

>> f(root)

ans ⊂ [-1.110223024625157e-16, +5.551115123125783e-16]

>> '##### 16'

ans = ##### 16

>> f = @(x)(1+(1-10)^4)\*x-(1-10\*x)^4

f =

@(x) (1 + (1 - 10) ^ 4) \* x - (1 - 10 \* x) ^ 4

>> [root,t]=RF(f,0,1,tol)

width = 2.710505431213761e-20

Erro = 0

root ⊂ [0.0001514713347838913, 0.0001514713347838914]

t = 7

>> f(root)

ans ⊂ [-7.771561172376096e-16, +1.110223024625157e-16]

>> '##### 17'

ans = ##### 17

>> f = @(x)(1+(1-20)^4)\*x-(1-20\*x)^4

f =

@(x) (1 + (1 - 20) ^ 4) \* x - (1 - 20 \* x) ^ 4

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [7.668595122185337e-06, 7.668595122185338e-06]

t = 6

>> f(root)

ans ⊂ [-1.110223024625157e-16, +5.551115123125783e-16]

>> '##### 18'

ans = ##### 18

>> f = @(x)exp(-5\*x)\*(x-1)+x^5

f =

@(x) exp (-5 \* x) \* (x - 1) + x ^ 5

>> [root,t]=RF(f,0,1,tol)

width = 1.110223024625157e-16

Erro = 0

root ⊂ [0.5161535187579334, 0.5161535187579336]

t = 12

>> f(root)

ans ⊂ [-7.632783294297952e-17, +2.081668171172169e-17]

>> '##### 19'

ans = ##### 19

>> f = @(x)exp(-10\*x)\*(x-1)+x^10

f =

@(x) exp (-10 \* x) \* (x - 1) + x ^ 10

>> [root,t]=RF(f,0,1,tol)

width = 1.110223024625157e-16

Erro = 0

root ⊂ [0.5395222269084157, 0.5395222269084159]

t = 14

>> f(root)

ans ⊂ [-5.637851296924624e-18, +3.903127820947816e-18]

>> '##### 20'

ans = ##### 20

>> f = @(x)exp(-20\*x)\*(x-1)+x^20

f =

@(x) exp (-20 \* x) \* (x - 1) + x ^ 20

>> [root,t]=RF(f,0,1,tol)

width = 9.436895709313831e-15

Erro = 0

root ⊂ [0.5527046666784783, 0.5527046666784879]

t = 20

>> f(root)

ans ⊂ [-3.894657491475273e-18, +2.032879073410321e-20]

>> '##### 21'

ans = ##### 21

>> f = @(x)x^2+sin(x/5)-1/4

f =

@(x) x ^ 2 + sin (x / 5) - 1 / 4

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.4099920179891371, 0.4099920179891372]

t = 8

>> f(root)

ans ⊂ [0, 5.551115123125783e-17]

>> '##### 22'

ans = ##### 22

>> f = @(x)x^2+sin(x/10)-1/4

f =

@(x) x ^ 2 + sin (x / 10) - 1 / 4

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.4525091455776412, 0.4525091455776413]

t = 8

>> f(root)

ans ⊂ [-5.551115123125783e-17, 0]

>> '##### 23'

ans = ##### 23

>> f = @(x)x^2+sin(x/20)-1/4

f =

@(x) x ^ 2 + sin (x / 20) - 1 / 4

>> [root,t]=RF(f,0,1,tol)

width0 = 0

Erro = 0

root ⊂ [0.4756268485960624, 0.4756268485960625]

t = 8

>> f(root)

ans ⊂ [-2.775557561562892e-17, +5.551115123125783e-17]

>>