Applied Computational Methods in Mechanical Sciences

(ME466)

Assignment 5

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August 30, 2019

**Problem Statement:**

Consider the figure given below. The cross sectional area *A* of a gutter with base length *b=2* and edge length *l*=2 is given by:

Find the angle which maximizes the cross-sectional area. Use Golden-section method with:

and compare the results when Newton’s method is used with and initial guess as: .

*l=2*

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*b=2*

Relative error limit is taken as 0.00000001.

**Python Code:**

import math

import time

def area(y,theta):

return(4\*math.sin(theta)\*(1+math.cos(theta)))

def golden\_sec(f,args,range\_):

phi = (pow(5,0.5)-1)/2

a = range\_[0]

b = range\_[1]

err\_lim = 0.00000001

itr = 0

while(1):

itr = itr+1

d = phi\*(b-a)

x1 = a+d

x2 = b-d

arg\_v1 = args +(x1,)

v1 = f(\*arg\_v1)

arg\_v2 = args +(x2,)

v2 = f(\*arg\_v2)

if(v1>v2):

a = x2

elif(v2>v1):

b = x1

else:

res = a

break

err = b-a

if(err<0):

err = (-1)\*err

res = (b+a)/2

# print("\n\nval is :",res)

# print("error is :",err)

if(err<err\_lim):

break

print("\n\nresult is ",res)

print("\n Iterations:",itr)

print ("\n CPU time: ", time.process\_time(),'s')

return(res)

def f\_d(x):

return( 4\*( math.cos(x) + math.cos(2\*x) ) )

def f\_dd(x):

return( -4\*( math.sin(x) + 2\*math.sin(2\*x) ) )

def newton(f\_d,f\_dd,init\_guess):

err\_lim = 0.00000001

itr = 0

x = init\_guess

while(1):

itr = itr+1

y = x - (f\_d(x)/f\_dd(x))

err = (y-x)/y

if(err<0):

err = (-1)\*err

# print("\n\nval is :",y)

# print("error is :",err)

if(err<err\_lim):

break

x=y

print("\n\nresult is ",y)

print("\n Iterations:",itr)

print ("\n CPU time: ", time.process\_time(),'s')

return(y)

#ans = golden\_sec(area,(3,),(0,(math.pi/2)))

ans = newton(f\_d,f\_dd,(math.pi/4))

**Results:**

1. **With golden-section method:**

result is 1.0471975355130767

Iterations: 38

CPU time: 0.40625 s

1. **With Newton’s method:**

**result is 1.0471975511965976**

**Iterations: 4**

**CPU time: 0.1875 s**