MA588

R-Programming Lab

Lab 8

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Data Science

Question1

Find the minimum of the function **f(x)=0.65-(0.75/(1+x^2))-0.65*x*atan(1/x)** using Newton's method.

Defining function

f(x)

```
func <- function(x) {

  0.65-(0.75/(1+x^2))-0.65*x*atan(1/x)

}
```

f'(x)<-first derivative of f(x)

```
func1<- function(x) {
  (1.5*(x/(1+x^2)^2))+0.65*x/(1+x^2)-0.65*atan(1/x)
}
```

f''(x)<-Second derivative of f(x)

```
func2 <- function(x) {
  (1.5*(1-3*x^2)/(1+x^2)^3)+0.65/(1+x^2)+0.65*(1-x^2)/(1+x^2)^2
}
```

func1 is first derivative of func(or f(x))
func2 is Second derivative of func(or f(x))

choosing randomly 100 guess and tolerance is 0.00001

```
guess <-seq(0.005,0.5,0.005) #100 guess
tolerance <- .00001     #tolerance

cat("randomly chosen guess is:\n",guess)

## randomly chosen guess is:
##  0.005 0.01 0.015 0.02 0.025 0.03 0.035 0.04 0.045 0.05 0.055 0.06 0.065
0.07 0.075 0.08 0.085 0.09 0.095 0.1 0.105 0.11 0.115 0.12 0.125 0.13 0.135
0.14 0.145 0.15 0.155 0.16 0.165 0.17 0.175 0.18 0.185 0.19 0.195 0.2 0.205
0.21 0.215 0.22 0.225 0.23 0.235 0.24 0.245 0.25 0.255 0.26 0.265 0.27 0.275
0.28 0.285 0.29 0.295 0.3 0.305 0.31 0.315 0.32 0.325 0.33 0.335 0.34 0.345
0.35 0.355 0.36 0.365 0.37 0.375 0.38 0.385 0.39 0.395 0.4 0.405 0.41 0.415
0.42 0.425 0.43 0.435 0.44 0.445 0.45 0.455 0.46 0.465 0.47 0.475 0.48 0.485
0.49 0.495 0.5
```

code of newton raphson for finding minima of function

```
root <- function(func1,func2, guess, tolerance) {
  x = guess
  while (abs(func1(x)) > tolerance) {
    x = x - func1(x)/func2(x)
  }
  return(x)
}
```

Finding minima of function for 100 points

for finding minima of function using newton raphson method we need one guess (one arbitaray point)

```
minima<-0
for(i in 1:100){
  x=guess[i]
  minima[i]<-root(func1,func2,x,tolerance)
}
```

minimum value of f(x)

```
minima
```

```
##   [1] 0.4808636 0.4808636 0.4808636 0.4808637 0.4808637 0.4808637
0.4808637
##   [8] 0.4808637 0.4808638 0.4808638 0.4808638 0.4808638 0.4808639
0.4808639
##  [15] 0.4808639 0.4808640 0.4808640 0.4808640 0.4808641 0.4808641
0.4808641
##  [22] 0.4808641 0.4808642 0.4808642 0.4808642 0.4808642 0.4808643
0.4808643
##  [29] 0.4808643 0.4808643 0.4808643 0.4808644 0.4808644 0.4808644
0.4808644
##  [36] 0.4808644 0.4808644 0.4808644 0.4808644 0.4808644 0.4808645
0.4808645
##  [43] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [50] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [57] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808561
##  [64] 0.4808575 0.4808588 0.4808598 0.4808607 0.4808615 0.4808621
0.4808626
##  [71] 0.4808630 0.4808634 0.4808636 0.4808639 0.4808640 0.4808642
0.4808643
##  [78] 0.4808643 0.4808644 0.4808644 0.4808644 0.4808645 0.4808645
0.4808645
##  [85] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808591
```

```
0.4808617
##  [92] 0.4808633 0.4808641 0.4808644 0.4808645 0.4808631 0.4808645
0.4808644
##  [99] 0.4808642 0.4808634
```

Value of function f(x) at minima (x=0.48)

```
func(minima)
```

```
##   [1] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##   [7] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [13] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [19] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [25] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [31] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [37] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [43] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [49] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [55] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [61] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [67] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [73] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [79] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [85] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [91] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [97] -0.3100205 -0.3100205 -0.3100205 -0.3100205
```

using inbuilt function(newtonRaphson)

Finding minima function using library function

```
library(pracma)

out<-0

for(i in 1:100){
  x=guess[i]
  out[i]<-newtonRaphson(func1,x,tol=0.00001)$root


}
```

minimum value of f(x)

```
out
```

```
##   [1] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##   [8] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [15] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [22] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [29] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [36] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [43] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [50] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [57] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [64] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [71] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [78] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [85] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [92] 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645 0.4808645
0.4808645
##  [99] 0.4808645 0.4808645
```

Value of function f(x) at mimima (using inbuilt function)

```
func(out)
```

```
##   [1] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##   [7] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [13] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [19] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [25] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [31] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [37] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [43] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [49] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [55] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [61] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [67] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [73] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [79] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [85] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [91] -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205 -0.3100205
##  [97] -0.3100205 -0.3100205 -0.3100205 -0.3100205
```

Solution Agreement with library function

```
own_ans<-func(minima)
lib_ans<-func(out)

data.frame(own_ans,lib_ans)
```

```
##        own_ans    lib_ans
## 1   -0.3100205 -0.3100205
## 2   -0.3100205 -0.3100205
## 3   -0.3100205 -0.3100205
## 4   -0.3100205 -0.3100205
## 5   -0.3100205 -0.3100205
## 6   -0.3100205 -0.3100205
## 7   -0.3100205 -0.3100205
## 8   -0.3100205 -0.3100205
## 9   -0.3100205 -0.3100205
## 10  -0.3100205 -0.3100205
## 11  -0.3100205 -0.3100205
## 12  -0.3100205 -0.3100205
## 13  -0.3100205 -0.3100205
## 14  -0.3100205 -0.3100205
## 15  -0.3100205 -0.3100205
## 16  -0.3100205 -0.3100205
## 17  -0.3100205 -0.3100205
## 18  -0.3100205 -0.3100205
## 19  -0.3100205 -0.3100205
## 20  -0.3100205 -0.3100205
## 21  -0.3100205 -0.3100205
## 22  -0.3100205 -0.3100205
## 23  -0.3100205 -0.3100205
## 24  -0.3100205 -0.3100205
## 25  -0.3100205 -0.3100205
## 26  -0.3100205 -0.3100205
## 27  -0.3100205 -0.3100205
## 28  -0.3100205 -0.3100205
## 29  -0.3100205 -0.3100205
## 30  -0.3100205 -0.3100205
## 31  -0.3100205 -0.3100205
## 32  -0.3100205 -0.3100205
## 33  -0.3100205 -0.3100205
## 34  -0.3100205 -0.3100205
## 35  -0.3100205 -0.3100205
## 36  -0.3100205 -0.3100205
## 37  -0.3100205 -0.3100205
## 38  -0.3100205 -0.3100205
## 39  -0.3100205 -0.3100205
## 40  -0.3100205 -0.3100205
## 41  -0.3100205 -0.3100205
```

```
## 42  -0.3100205 -0.3100205
## 43  -0.3100205 -0.3100205
## 44  -0.3100205 -0.3100205
## 45  -0.3100205 -0.3100205
## 46  -0.3100205 -0.3100205
## 47  -0.3100205 -0.3100205
## 48  -0.3100205 -0.3100205
## 49  -0.3100205 -0.3100205
## 50  -0.3100205 -0.3100205
## 51  -0.3100205 -0.3100205
## 52  -0.3100205 -0.3100205
## 53  -0.3100205 -0.3100205
## 54  -0.3100205 -0.3100205
## 55  -0.3100205 -0.3100205
## 56  -0.3100205 -0.3100205
## 57  -0.3100205 -0.3100205
## 58  -0.3100205 -0.3100205
## 59  -0.3100205 -0.3100205
## 60  -0.3100205 -0.3100205
## 61  -0.3100205 -0.3100205
## 62  -0.3100205 -0.3100205
## 63  -0.3100205 -0.3100205
## 64  -0.3100205 -0.3100205
## 65  -0.3100205 -0.3100205
## 66  -0.3100205 -0.3100205
## 67  -0.3100205 -0.3100205
## 68  -0.3100205 -0.3100205
## 69  -0.3100205 -0.3100205
## 70  -0.3100205 -0.3100205
## 71  -0.3100205 -0.3100205
## 72  -0.3100205 -0.3100205
## 73  -0.3100205 -0.3100205
## 74  -0.3100205 -0.3100205
## 75  -0.3100205 -0.3100205
## 76  -0.3100205 -0.3100205
## 77  -0.3100205 -0.3100205
## 78  -0.3100205 -0.3100205
## 79  -0.3100205 -0.3100205
## 80  -0.3100205 -0.3100205
## 81  -0.3100205 -0.3100205
## 82  -0.3100205 -0.3100205
## 83  -0.3100205 -0.3100205
## 84  -0.3100205 -0.3100205
## 85  -0.3100205 -0.3100205
## 86  -0.3100205 -0.3100205
## 87  -0.3100205 -0.3100205
## 88  -0.3100205 -0.3100205
## 89  -0.3100205 -0.3100205
## 90  -0.3100205 -0.3100205
## 91  -0.3100205 -0.3100205
```

```
## 92  -0.3100205 -0.3100205
## 93  -0.3100205 -0.3100205
## 94  -0.3100205 -0.3100205
## 95  -0.3100205 -0.3100205
## 96  -0.3100205 -0.3100205
## 97  -0.3100205 -0.3100205
## 98  -0.3100205 -0.3100205
## 99  -0.3100205 -0.3100205
## 100 -0.3100205 -0.3100205
```

from above dataframe you can observe that the data in column 1(own_ans) is exactly equal to column 2(lib_ans) as expected.