Assignment 1

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1 Qn.1

In this question we studied to plot the Bessel functions j0(x) and j1(x).

Pseudo-code to plot jo(x) is:

open a file to store data
if(x¡=0)
y = sin(x)/x
close file

Caveat: There is singularity at x = 0, so we used Taylor expansion at points near x = 0.
Similar caution was taken to j1(x).
The source codes are attaced in the tar file under location: Homeworks/qn1/

2 Qn.2

2.1 part a

A beginnig version of source code called 'cnumbers.f90' was provided. The question asked to prepare a table of different operations of a given complex number 'z'. I chose r = 1 and wrote the source code, however,the code works for any other values of r. We just have to change the value of 1 to any other value in my source code 'qn1p1.f90'.

2.2 part b

I saved the data of phi vs atan(y/x) and atan2(y,x) in a file called 'qn2WithJumps.dat' In this code I did not account for the infinity value of tan(pi/2) or other integral multiples of pi/2.

I used xmgrace to plot the graph.

In next code I fixed sudden jumps about tangents of integral multiples of pi/2, by using more points near singularity and precisely avoiding just the singularity points.

Figure 1: Graph with jumps.

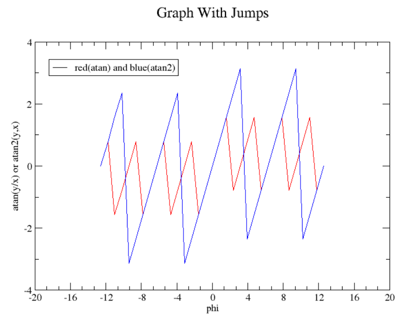
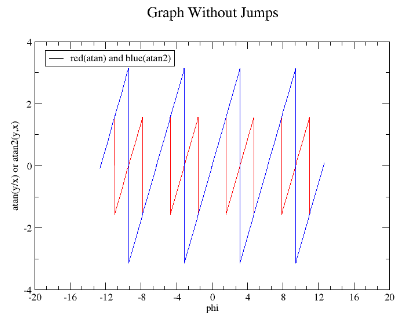


Figure 2: Graph without jumps



2.3 part c

When I plotted the graph without taking care for infinity effect, it made some strange jumps. Then i used more points near a multiples of pi/2 and avoided being precisely at a integral multiples of pi/2. The plots are shown above.

2.4 part d

I am using SunStudio 12 Fortran Compiler. It is bright enough to automatically use a complex library routine.

2.5 part e

From the descriptions of SunStudio 12 Fortran Libray, I found following:

2.5.1 sqrt function

for a complex number

$z = x + iy$
the square root has also two parts,viz.,real part and imaginary part.
$z = re^{i\phi}$
$z = rcos(\phi) + rsin(\phi)$
$\sqrt{z} = \sqrt{r}cos(\phi/2) + \sqrt{r}sin(\phi/2)$

2.5.2 ln function

$z = re^{i\phi}$
$lnz = ln(r) + i * \phi$

2.5.3 atan(y/x) function

The function atan(y/x) takes only ONE argument,viz. (y/x). This is the general arc tangent function. The function tan(pi/2) gives infinity. So atan(pi/2) gives infinity. In the plot of atan(y/x) vs phi we get jumps at the integral multiples of pi/2 and fixed by taking more points near singularity and avoiding singular point.

2.5.4 atan2(y,x) function

The function atan2(y,x) takes TWO arguments,viz. y and x. This is different than arc tangent function. In our case,

The function tan(pi/2) gives infinity. So atan2(y,x) gives infinity in such cases. In the plot of atan2(y,x) vs phi we get jumps at the integral multiples of pi/2 and fixed by taking more points near singularity and avoiding singular point.

3 Qn.3

In this exercise we examined the power series for the exponential function exp(-x)

3.1 part a

The whole source code is given inside /Homeworks/assign1/q3/qn3bad.f90
the pseudo-code to calculate exp(-x) is following:
program expnbad
define variables
write table headers
!use do while loop for different values of x
x = 0.01d0 ! initialize the value of x to be changed later
do while (x ¡ 1000) ! loop to get x = 0.1,1.0,10.0,100.0 and 100.0
x = x*10
term = 1.d0 !first term = 1
sum = 1.d0 !sum upto first term

n = 0
factorial = 1.d0 !initialize factorial value
!example 1st iteration: x =1, we will calculate exp(-x) within the error
do while ((abs(term/sum) ¿ err))
n = n + 1
factorial = factorial *n ! BADWAY
term = term*(-x)/factorial
sum = sum + term
end do
ratio = abs(sum - exp(-x))/sum ! given in the question
write(kwrite,100) x,term,sum,ratio
100 format (3x,F6.1,3(3x,E11.4)) ! formatting the output
! 3x = 3space, f6.1 = float of width 6, and 3 other scientific values
end do ! end of loop for eg x = 0.1/1.0/etc write the output into a file The corrected code fragment for good way is following:
!use do while loop for different values of x
x = 0.01d0 ! initialize the value of x to be changed later
do while (x ¡ 1000) ! loop to get x = 0.1,1.0,10.0,100.0 and 100.0
x = x*10
term = 1.d0 !first term = 1
sum = 1.d0 !sum upto first term
n = 0
!example 1st iteration: x =1, we will calculate exp(-x) within the error
do while ((abs(term/sum) ¿ err))
n = n + 1
term = term*(-x)/float(n)
sum = sum + term
end do
ratio = abs(sum - exp(-x))/sum ! given in the question
write(kwrite,100) x,term,sum,ratio
100 format (3x,F6.1,3(3x,E11.4)) ! formatting the output
! 3x = 3space, f6.1 = float of width 6, and 3 other scientific values
end do ! end of loop for eg x = 0.1/1.0/etc

3.2 part b

The output of bad way is following:
x imax sum ratio
0.1 -0.2894E-09 0.9049E+00 0.8796E-04
1.0 -0.7974E-11 0.4201E+00 0.1243E+00
10.0 0.1978E-07 -0.1046E+02 -0.1000E+01
100.0 0.1502E-07 0.1883E+05 0.1000E+01
1000.0 -0.3762E-02 0.6865E+10 0.1000E+01
$Thecpu_time = 1.4500000000000006E-004seconds$
real 0m0.002s
user 0m0.000s

sys 0m0.001s
The output of good way is following:
x imax sum ratio
0.1 0.1389E-08 0.9048E+00 0.2166E-10
1.0 0.2088E-08 0.3679E+00 0.4073E-09
10.0 -0.3867E-12 0.4540E-04 0.4544E-08
100.0 0.1787E+18 -0.2914E+26 -0.1000E+01
1000.0 -Infinity -Infinity NaN
$Thecpu_time = 3.2000000000000019E - 004seconds$
real 0m0.042s
user 0m0.000s
sys 0m0.002s

3.3 part b1

The illustration of underflow of numbers when using bad way and good way is presented above.

3.4 part b2

The table for bad code as well as table for good code was produced.

3.5 part b3

I used built in function 'time' in the bash command to find the time of compilation. Also i used $'callcpu_time()'$ inside fortran code to find the time of compilation.

Figure 3: Graph with jumps.

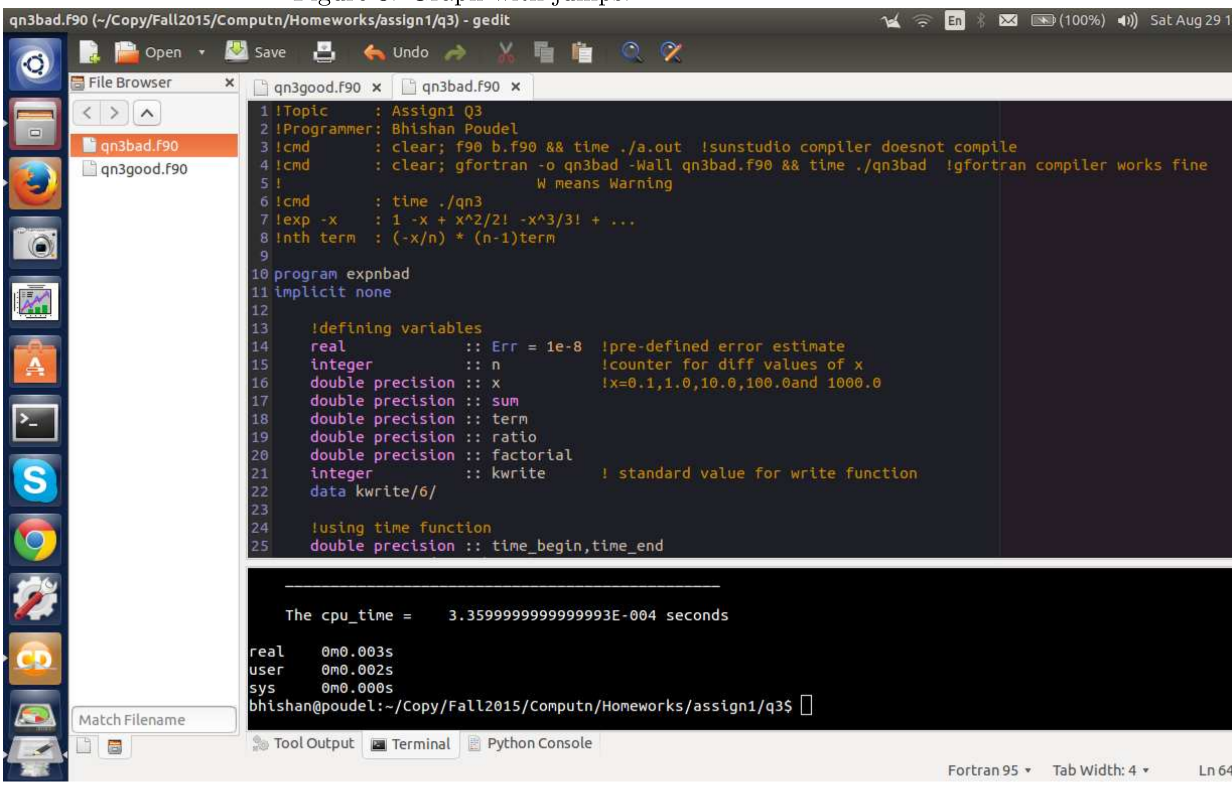


Figure 4: Graph without jumps