Write-up for Homework2

September 11, 2016

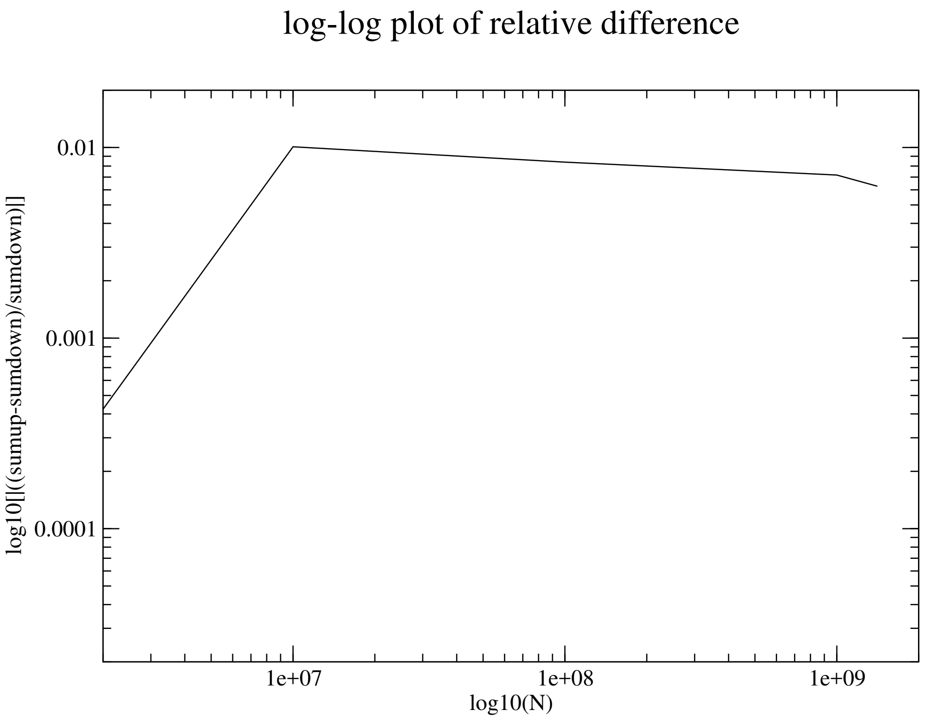
1 Summing series

As the problem states, I have written a fortran90 code that reads N from screen and writes the final output to the screen to find S_{up} and S_{down}.I have used both single and double precision method to find the corresponding values.

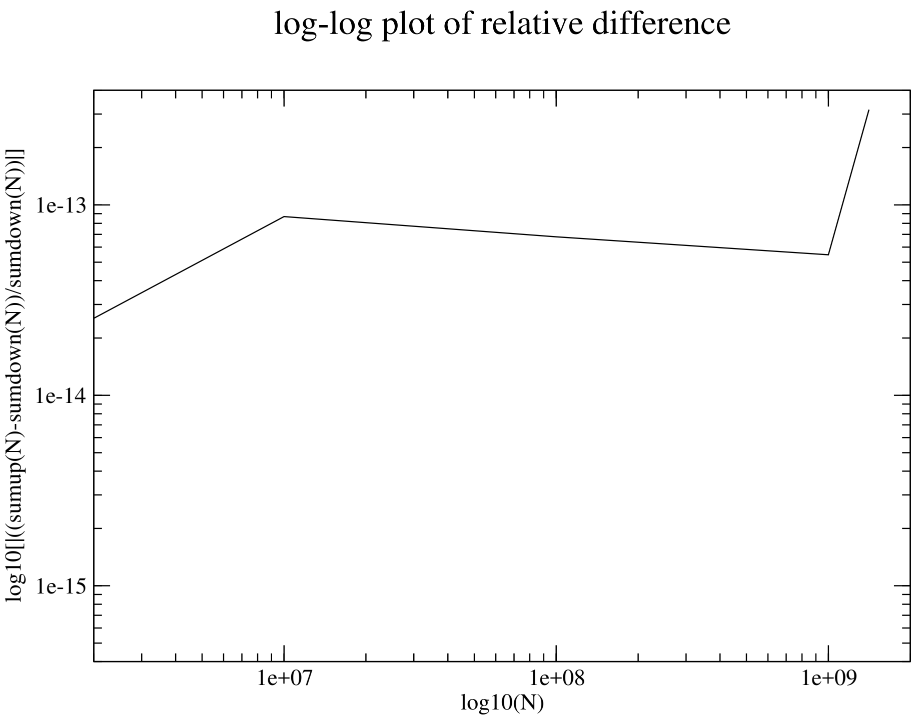
For single precision:
The code file to run this command is saved and included in the filename *sumsp.f90*, data file in the filename *sumsp_data.dat*, and the xmgrace plot in the filename *logsp.eps* in the subfolder-name *single* inside the folder *prob1.*

For double precision:
The code file to run this command is saved and included in the filename *sumdp.f90*, data file in the *filename sumdp_data.dat*, and the xmgrace plot in the filename *logdp.eps* in the subfolder-name *double* inside the folder *prob1.*

The plot I thus obtained for single precision data is as follows:


log-log plot of relative difference
0.01
0.001
0.0001
log10[|(sumup-sumdown)/sumdown)|]
1e+07
1e+08
1e+09
log10(N)

And the plot I thus obtained for double precision data is as follows:



2 Continued Fractions

As the problem states, I've used an iteration process to find the root of the given function $x^2 + 4x - 1 = 0$, and I found out the root to be of the value $x = 0.236067977$.
The fortran code for following problem is included in the filename *roots.f90* and the data file is saved in the filename *roots_data.dat*.

3 Bessel functions via Recursion

In this problem I have used followig recursion relation of the spherical bessel function:
$j_{l-1}(x) = \frac{2l+1}{x} j_l(x) - j_{l+1}(x)$ (for downward recursion)
and
$j_{l+1}(x) = \frac{2l+1}{x} j_l(x) - j_{l-1}(x)$ (for upward recursion)

Also, the first two bessel function taken were:

$j_0(x) = \frac{\sin x}{x}$
$j_1(x) = \frac{\sin x}{x^2} - \frac{cosx}{x}$

While coding I have used the values of $x = 0.1, 1.0, 10$ to find the values of the first 25l corresponding of the bessel function. In this process owing to the linearity of the bessel funtion, I've choosen any arbitrary value of $j(50)$ and $j(49)$ which is rescaled to the actual value by the rescaling factor taken within the code. Correspondingly the values of the upward recursion, downward recursion and their difference were computed and then tabulated.
In this process of recursion, since we are evaluating the difference between two bigger numbers in upward recursion, this process always gives us less precise value in comparision to the downward recursion.
We also see that as the value of x increases (eg at $x = 10$), the values obtained from both upward and downward recursion method have similar results. The possible reason behind might be that since the values of $j_0(x)$ and $j_1(x)$ are inversely proportional to value of x, this implies their value gets smaller for a larger value of x. Thus,when value of x is large, there is no longer the subtraction of two larger bessel function values which had been decreasing the precision in our data points and we get similar results for both recursion methods.

The fortran code for following problem is included in the filename *bessel.f90* and the data file is saved in the filename *bessel.dat*.

4 Solving Nonlinear Equations

To find the roots of the function $f(x) = x^2 - 7x - ln(x)$, I have written the fortran code for both bisection and hybrid method.

Bisecton method:
The fortran code for solving given function via bisection method is included in the filename *bisect1.f90* and *f1ofx.f90* and the data file is saved in the filename *bisect_data.dat* in the subfolder *bisect* inside the folder *prob4*.

Hybrid method:
The fortran code for solving given function via Hybrid method is included in the filename *newton1.f90* and *sec1.f90* and the data file is saved in the filename *newton.dat* in the subfolder *fnewton* inside the folder *prob4*.