Errors and Precision Lab

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May 2023

1. Accumulate 0.001 million times and compare it with the actual value 1000.
2. Using float and double data types calculate the minimum temperature at which you can calculate the Fermi-Dirac statistics. Assume $E - E_F = E_G$

$$f(E) = \frac{1}{1 + exp\left(\frac{E-E_F}{k_B T}\right)} \tag{1}$$

3. Mathematically the harmonic series diverges. Perform the sum using float data type and see if it really diverges. Analyse your answer
4. Calculate the root of the following quadratic equation ($x^2 - 100000x + 1.0 = 0$) using the float and double data types. Compare your answers.
5. Calculate the function $f(x)$ for different values of x

$$f(x) = \sqrt{x+1} - \sqrt{x}$$

   Reason your answers and see if you can improve the calculations
6. Calculate and plot the error in computing derivative of sin(x) for different values of Δx at x = 0. The definition of the numerical derivative is given by

$$\frac{d}{dx} Sin(x) = \frac{Sin(x + \Delta x) - Sin(x)}{\Delta x}$$

   Compare it with the true value of the derivative ($\frac{dSin(x)}{dx} = Cos(x)$ at x = 0)
7. Consider yourself as a part of the Patriot Missile Project 2.0. You are a tasked with developing a timer such that the catastrophic disaster doesn't reoccur. However, there are some limitations.
   (a) The time between two successive scans cannot be less than 0.1 sec
   (b) The maximum time between two scans has to be less than 1 sec

   Write a small piece of code that calculates the time without incurring round-off errors or having very minimal round-off errors over a very long period of time. You can emulate the time by simply having a very while/for loop that iterates over many many times. Use float as data type