Tutorial - 8

In this tutorial, you will work on few modifications to the numerical integration using trapezoidal rule code that was discussed in the lecture.

1. Consider evaluation of the following integral,

$$I = \int_{1}^{\pi} \frac{\sin(x)}{2x^3} dx, \tag{1}$$

using $n = 256$ trapezoids and number of processes $p = 2, 4$ and 8. Obtain the exact value of the integration I, and calculate the error involved between the exact and the numerically obtained value.

2. It is always a good practice to write MPI codes such that they run on a single process as well as on multiple processes. Can the trapezoidal rule program be run using a single process? Make any necessary modifications if it can't be run. Convince yourself that the result obtained using a single process is the same as the result obtained using multiple processes.

3. Modify the code such that the input quantities such as a, b and n are not hard-coded but read from user on process-0. Using MPI_Send/MPI_Recv function calls communicate these values to all the processes.

4. Modify the program such that the MPI_Reduce function is used instead of MPI_Send/MPI_Recv in the calculation of the global sum of the integration. Convince yourself that the program runs correctly using different number of processes.

5. Consider Simpson's rule for the numerical integration, given as follows,

$$I \approx \frac{h}{3}\left(f_0 + f_n + 4\left[\sum_{j=1,3,5,7,...}^{n-1} f_j \right] + 2\left[\sum_{j=2,4,6,8,..}^{n-2} f_j \right] \right). \tag{2}$$

Modify the numerical integration code to evaluate I given in Eq. 1 using Simpson's rule. Use $n = 32$ and 256 and $p = 2$ and 4. Convince yourself that the error is much smaller with Simpson's rule.