Tutorial - 4

In this tutorial, you will write and test OpenMP programs for matrix addition, matrix multiplication and explicit finite differences.

1. Develop an OpenMP program to add two square matrices A and B of size $N \times N$ that contains floating point values. Test the program for 2, 4 and 8 threads for $N = 50$ and 100. Time your program using the timing functions that we learnt in the class. Do you notice any performance improvement?

2. Extend the above program for multiplication of the two matrices A and B. Using the same values as specified in the above problem, time your program. Do you observe any improvement in performance.

3. Consider the following equation that arises in the solution of transient heat conduction in a plane wall:

$$u(x) = 7 - x\tan(x), \tag{1}$$

and $x = [-1, 1]$. Write an OpenMP program to compute the first derivative of $u(x)$ that is $du(x)/dx$ over the range of x given using first, second and fourth-order accurate formulae as given below. You can use first-order accurate formulae on the boundary and near-boundary points. Use grid sizes of $\Delta x = 0.01$ and 0.001. Test your code using 2, 4 and 8 processors. Compare the results you obtain using the analytical solution and make sure the numerical solution obtained using your OpenMP code is correct. The finite difference formulae are given below:

$$f'(x) = \frac{f(x+\Delta x) - f(x)}{\Delta x} + O(\Delta x) \tag{2}$$

$$f'(x) = \frac{f(x) - f(x-\Delta x)}{\Delta x} + O(\Delta x) \tag{3}$$

$$f'(x) = \frac{f(x+\Delta x) - f(x-\Delta x)}{2\Delta x} + O(\Delta x^2) \tag{4}$$

$$f'(x) = \frac{f(x-2\Delta x) - 8f(x-\Delta x) + 8f(x+\Delta x) - f(x+2\Delta x)}{12\Delta x} + O(\Delta x^4). \tag{5}$$

$$\tag{6}$$