Parallel Programming

**Assignment:**  
In this assignment you will design and implement three methods; parallel matrix-matrix subtraction, parallel matrix-vector multiplication, and parallel 2-norm calculation. These methods will then be used in the power and shifted-power methods. In the shifted-power method, by using the largest eigenvalue and corresponding eigenvector we can compute the second largest eigenvalue and its eigenvector. You will implement your algorithm in C or C++ programming language with MPI + OpenMP.

In the algorithm you start with a vector *x* whose entries are all 1and iteratively compute the largest eigenvalue and eigenvector pair. The below Matlab code shows the steps of the algorithm. You can also make a fixed length *for* loop that iterates 10 times.

eigvec1 = ones(12,1);

for (i=0; i<10; i++)

eigvec1 = A \* eigvec1; //this will be done in parallel

eigvec1 = eigvec1/norm(eigvec1); //this will be done in parallel

eigval1 = \* A \* eigvec1; //this will be done in parallel

end

eigvec2 = ones(12,1);

**B** = A - eigval1 \* (eigvec1 \* );

*//* eigval1 *and eigvec1 are the largest eigenvalue and its eigenvector of A*

// this will be done in parallel

for (i=0;i<10;i++)

eigvec2 = **B** \* eigvec2; //this will be done in parallel

eigvec2 = eigvec2/norm(eigvec2); //this will be done in parallel

eigval2 = \* **B** \* x;

end

what is eigval2 for A?

You will implement only one program which adopts MPI + OpenMP. Your program takes the name of the input file from the command line (argv[1]) and prints out the eigenvector to a file named ‘eigenvector.txt’ and the respective eigenvalue to the screen.

**Format for reading the matrix and vector:**

In the files, the first two integers are the number of rows and columns in the matrix, and the remaining floating-point numbers are the cell values in the matrix.

During testing and developing your code, a sample 12 x 12 matrix is provided in testA.txt. The largest eigenvalue of that matrix is: 48.904 and the second largest eigenvalue is **17.592**

For parallel scalability tests, you should use bigA.txt file. You may need 10,000 iterations to reach enough accuracy for the second largest eigenvalue.

The two eigenvalues of bigA.txt with the largest magnitudes are: 511.967, -9.382