PROJECT REPORT:

HIGH PERFORMANCE COMPUTING

TEAM – 4: Participants:

1. NAGA MAMATHA GONUGUNTLA - 216206223
2. KIRAN VANI HIMAJA SARMA RAVADA - 216206201
3. DURGA PRASAD CHENNAMSHETTY - 216205830
4. VIKRANTH UTHAYAKUMAR - 216206183

AIM: To multiply two Matrices using Sequential and Parallel Programming and comparing the their execution times. Also, to generate Random Matrices and to display a heatmap out of the Random Matrix.

The most powerful feature of Matrix Multiplication is several transformations can be combined into a single matrix.

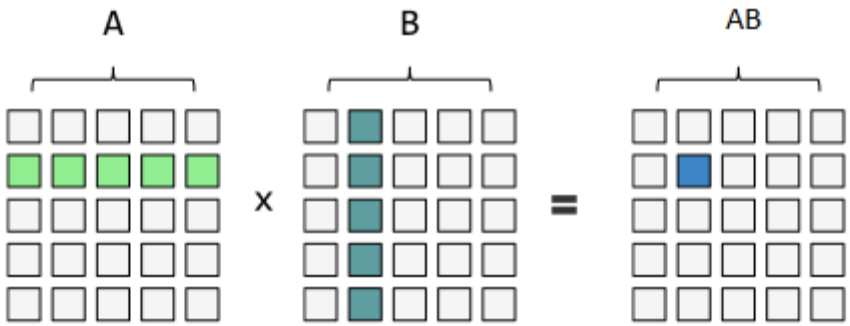
Matrix Multiplication plays an important role in quantum mechanics. Examples include the moment of inertia tensor, continuous-time descriptions of the evolution of physical systems using Hamiltonians (especially in systems with a finite number of basis states), and the most general formulation of the Lorentz transformation from special relativity. General relativity also makes use of tensors, which are a generalization of the sorts of objects which row-vectors, column-vectors, and matrices all are.

Also, powers of a given matrix *A* — are a useful tool in graph theory.

Description of Matrix Multiplication:

If A is a 3x4 matrix and B is a 4x3 matrix then we get the resultant matrix (say AB) of 3x3.

Multiplication of two matrices is possible only when number of columns of Matrix A is equal to number of rows of Matrix B.



While multiplying two matrices the logic used is:

```
for(i=0;i<n;i++){
    for(j=0;j<m;j++){
        for(k=0;k<p;k++){
            sum += A[i][k]*B[k][j];
        }

        AB[i][j] = sum;
        sum = 0;
    }
}
```

Let us take n=m=p=6. When computed, the above code takes 125 iterations to finish the job. The compiler goes to the next step after carrying out 125 iterations one after the

other, thereby taking lot of time to finish the job. This is where Parallel Programming comes into picture to save our time.

What is Parallel Programming and why does one need to parallelize a program?

Parallel Programming is a type of computation in which many calculations or the execution of processes are carried out simultaneously. Large problems can often be divided into smaller ones, which can then be solved at the same time computing the job much faster than the Sequential Programming.

```
#pragma omp parallel for private(j,k) shared(n,m,A,B,AB)
num_threads(8)
    for(i=0;i<n;i++){
        for(j=0;j<m;j++){
              AB[i][j] = 0;
            for(k=0;k<p;k++){
                AB[i][j] += A[i][k]*B[k][j];
           t=omp_get_num_threads();
            }

        }
    }
```

Applications and Example for Matrices with Random Numbers:

The matrixes with Random numbers are used widely in the area of High range of data analysis such as computer graphics and Wireless communications.

An example that generates a random matrix is given below:

```
srand(101);
for(i=0;i<n;i++){
    for(j=0;j<m;j++){
        A[i][j] = float(rand())/float(RAND_MAX);
    }
}
```

```
0.678   0.7     0.0452  0.309
0.312   0.277   0.936   0.268
0.823   0.0201  0.921   0.815
0.995   0.688   0.108   0.879
0.795   0.139   0.467   0.791
```