

# Matrix Vector Multiplication on Bigred3 Supercomputer

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## Introduction

### What are supercomputers?

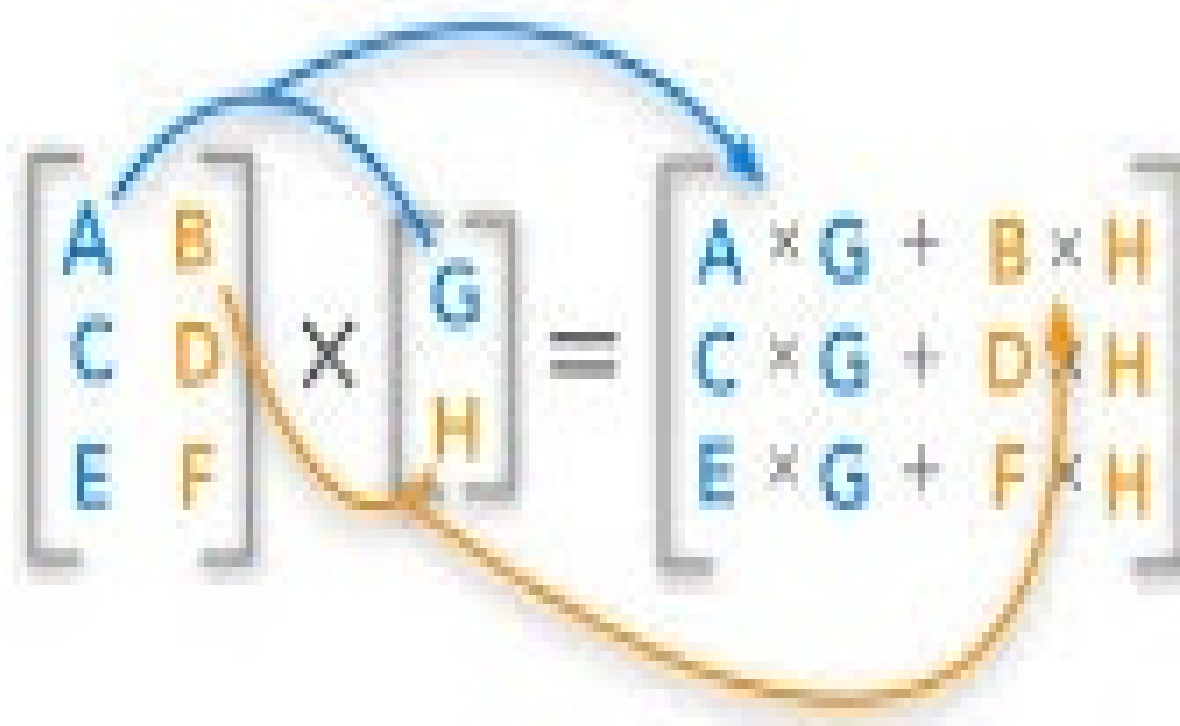
- Supercomputers are computers designed to perform tasks that normal computers can not perform.
- Supercomputers can-do large-scale computation and are used in fields like weather forecasting and other science and engineering application.
- Japan, United States, and China are dominating the optimizing and manufacturing of supercomputers.
- Fugaku from Japan is the fastest supercomputer in the world.



Fugaku Japan

## What is Matrix and Vector?

- Matrix is an array in rectangle or square size in which each place has specific value
- Vector is an array with multiple rows but has only one column.



## About Big Red 3

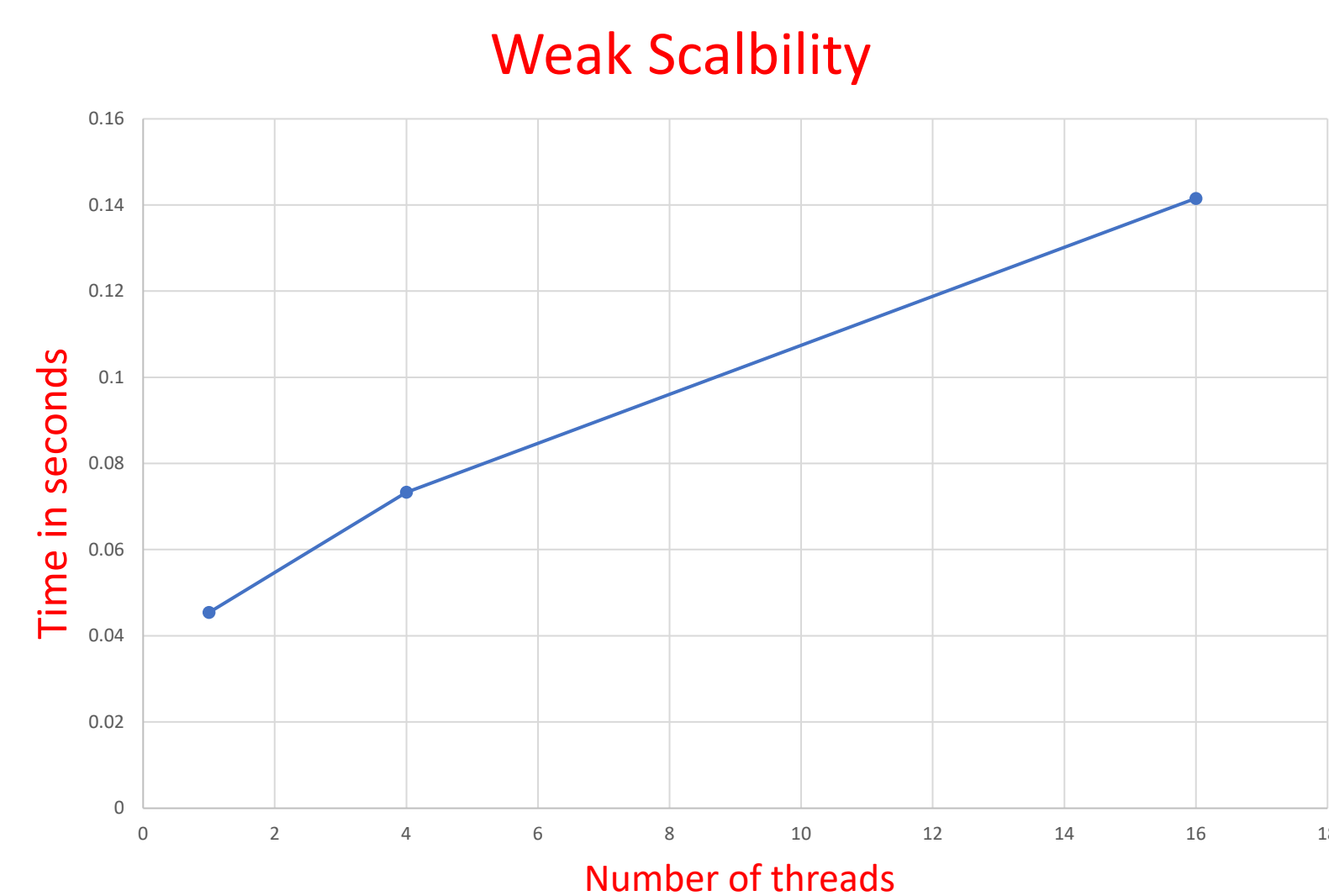
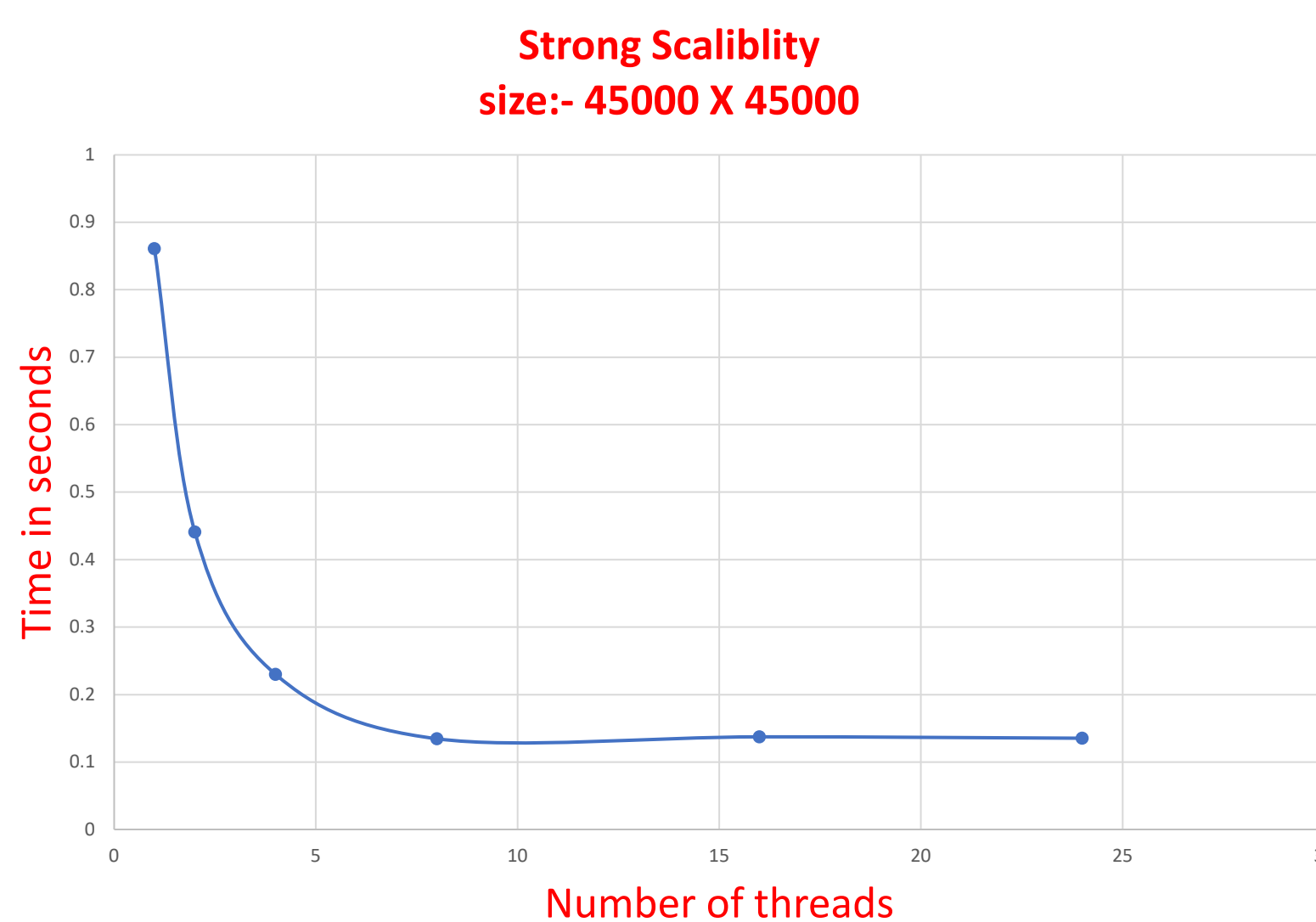
- Cray XC40 supercomputer.
- Intel Haswell Xeon processors
- 22,464 compute cores
- Capable of 934 trillion floating-point operations per second.
- 934 teraFLOPS -930 dual-socket compute nodes

## Strong and Weak Scalability

**Strong Scaling:** Decrement in time of calculation due to increment in threads.

**Weak Scaling:** Receiving a constant value of time as number of threads and scale of computation increases.

- Here the graph of weak scaling is not in a straight line because I was not allocated with the required memory storage to perform certain tasks that provide accurate constant value.



## Code for computation

- Learning how to code in C language.
- Understanding of 'Sheard memory' concept in supercomputers.
- Learning how to use of 'openmp' software.
- Incorporating multiple files to input the data in a file format.
- Learning Basic commands to run supercomputer like srun and export.

```
#pragma omp parallel private(i,j)
{
  #pragma omp for
  for(i=0; i<N; i++){
    for(j=0; j<N; j++){
      y[i] += A[i*N+j] * x[j];
    }
  }
}
```

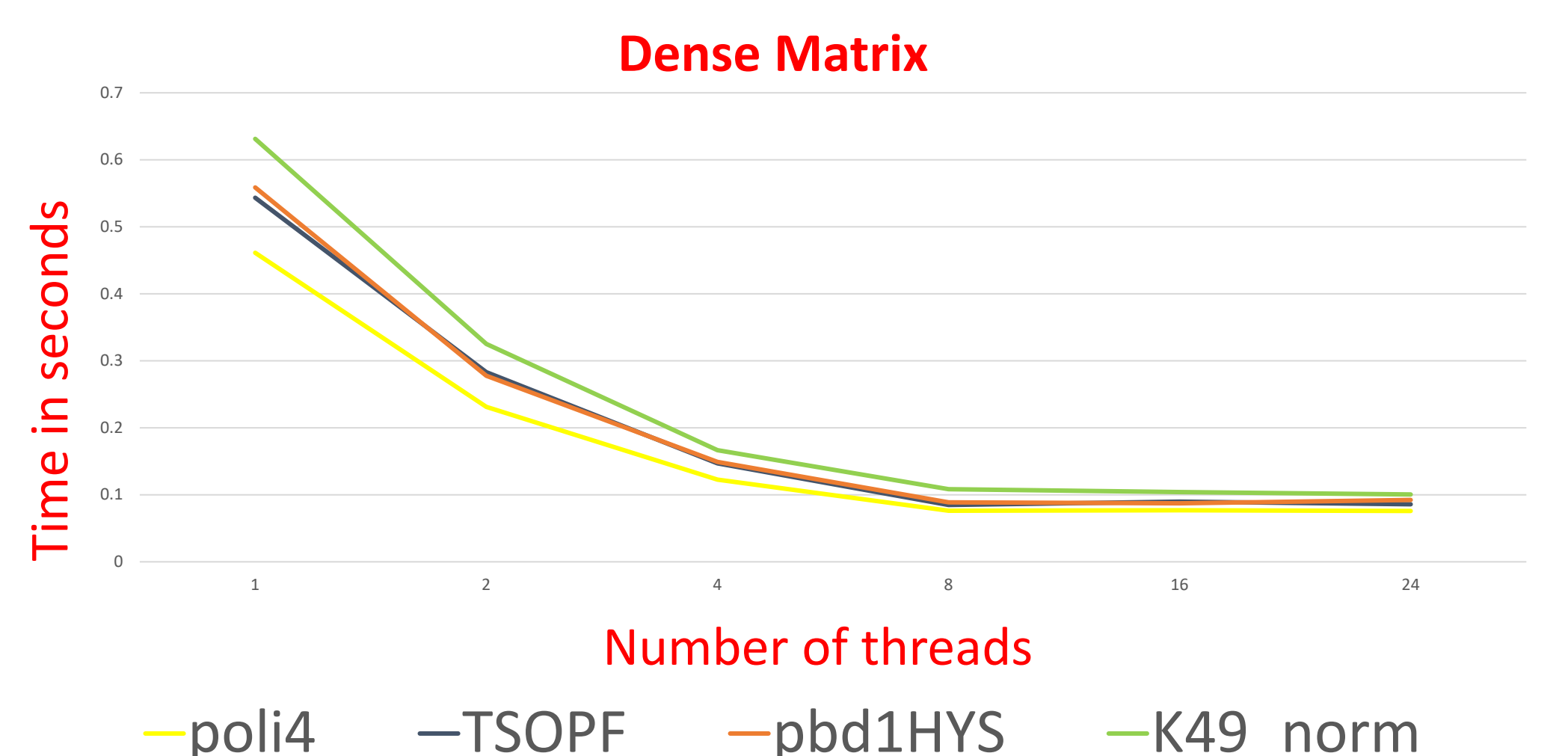
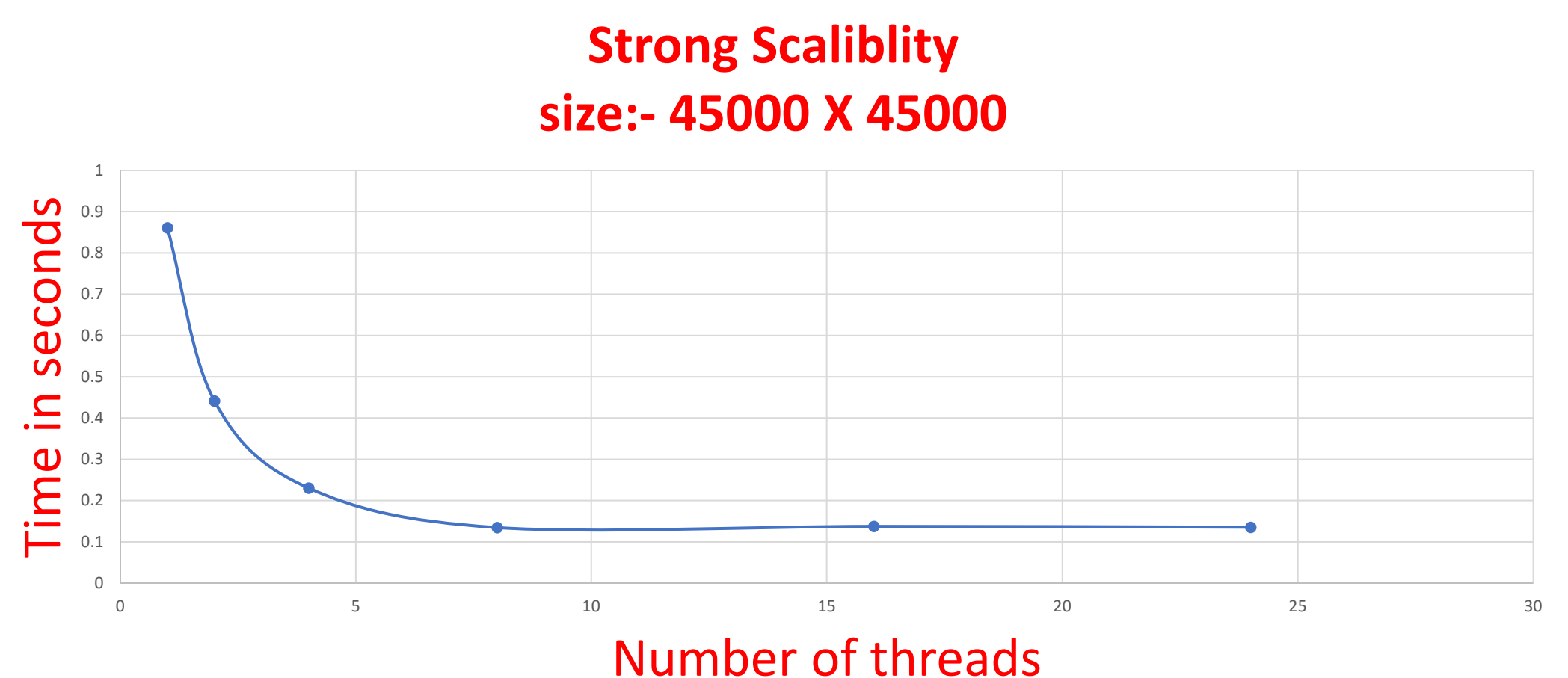
Code for computing matrix vector multiplication with OPENMP

## Overhead

This issue occurred when I was not noticing improvement in performance after eight cores. In some instances, performance decreased rather than increasing because of lack of computational tasks. Therefore, me and my mentor decided to use dense matrix.

## Dense Matrix

- A dense matrix is a large scale of matrix that include all number regardless of their values. This type of matrix also provides large amount of basic mathematical tasks to solve the issue of overhead to some extent.
- The dense matrix do not completely solve the issue of overhead because I was not able to run very-large scale matrix due lack of required memory storage.



## Future Work:

- Dense matrix includes zero value whereas sparse Matrix only includes nonzero values.
- Therefore, with the help of sparse matrix storage technique such as compressed sparse row (CSR) we can eliminate unnecessary values and increase the performance by multiplying only non-zero values.