CS 491/521 Parallel Programming
Homework 1
Data Locality and Fine-Grained Parallelism

Optimize the performance of the following code via the techniques you have learned in the class:

```
double A[N][N][N], C[N][N], B[N][N][N];
for (i=0; i<N; i++)
        for (j=0; j<N; j++)
                for (k=0; k<N; k++)
                        for (l=0; l<N; l++)
                                C[i][j] += A[l][i][k]*B[k][l][j];
```

1. Optimize the code via loop permutation. Report the performance of the best **two** versions you can achieve.
2. Optimize the code via loop unrolling. Report the performance of the best **two** versions you can achieve.
3. Optimize the code via loop blocking (tiling). Report the performance of the best **two** versions you can achieve.
4. Optimize the code via a combination of permutation/unrolling/blocking. Report the best performance you can achieve (note that you may not need to apply all three techniques to achieve the best performance).

Write a report about how you perform the optimization for each step, and explain any unexpected results you observed. Also, for each version of the code, you should run the code for at least 3 times and report the average performance.

A template code will be provided, which you can edit to create your optimized version (note that the template code includes measurements of execution time as well as a check for verifying correctness).

Submit your report as well as your optimized code with the best performance (i.e., the version reported in step 4) to Canvas. Your report should also include instructions for the TA about how to compile and execute your code on a CS departmental machine.