The report for second home work:

I have used MATLAB to generate my Random Numbers (attached in ATLAS/Random Number Generator). All random numbers are between 0 and 1. *main.c* (in ATLAS folder) is the code that uses *cblas\_dgemm(...)* for matrix multiplication. The matrices are constructed based on obtained random numbers and are written to file myfile.txt which is the input file for *main.c* and all other functions, i.e. *ijk.c ikj.c* ... .Also in *main.c*, *atlas.txt* is generated which contains the resulted final matrix (C) and its dimension (prior to matrix itself). Then *atlas.txt* is used in all *ijk.c* ... in order to get the residual (defined based on HW problem). For Optimization, I used -O2 for complete optimization available in compiler. I did not use -O3 because I've read online that it has some commands that may increase the process time. I have also used -Os in order to optimize the space. However, the receptiveness was: *gcc .. -Os -O2 ..* in order to make sure that -O2 is the dominating algorithm (as it is the last one). The rate of execution is obtained by PAPI timer introduced in HW problem (see figure.1). It is obvious that ATLAS has much more efficient algorithm than all other methods.

Moreover, the algorithms with the same Last Index have approximately same rate of execution.

The *ikj* and *jik* has the largest execution rate. This is may be because of the fact that elements of the rows of C[i][j] would be more easier accessed and changed, as in 'C language' the arrays have Row major order. In other words, because in the loop, first i is set and then j changes which would be along the rows of C.



Figure 1. MFlops for ATLAS and different multiplication algorithm.



Figure . The residual of ATLAS and different algorithms

The results of the residual shows that the calculations have been done correctly. Residual of ijk ikj and .. are the same as they are practicaly doing the same calculation with different algorithm. So I expected them to be the same.

Part 2:

For this section, I did two jobs. 1. I have introduced A, B, C as vector rather than tensor (the same data input as ATLAS) and I expected that it would enhance the MFlops. But it did the reverse thing. 2. I also changed the multiplication method in the way that first we multiply A and B elements and then do the addition. But it also did not improve the result. The corresponding files are in Part 2 Folder as ikjm and ijkmm respectively