

HPC Final Project

Shreya Singh

Sameeran Joshi

openMP

Code/Report/scripts link

https://github.com/Sameeranjoshi/hpc_proj_utah_sem1

Excel which contains the report:

<https://docs.google.com/spreadsheets/d/1ir2cIa9oyMpzsyp6Z6ynQKn3QNsJmzfG10438fz-rAs/edit?usp=sharing>

Question 1.

```
void atb_par(const double * __restrict__ A, const double * __restrict__ B, double * __restrict__ C, int Ni, int Nj, int Nk)
{
    int i, j, k;

#pragma omp parallel private(i,j,k)
{
#pragma omp master
    for (i = 0; i < Ni; i++)
        for (k = 0; k < Nk; k++)
            for (j = 0; j < Nj; j++)
// C[i][j] = C[i][j] + A[k][i]*B[k][j];
                C[i*Nj+j]=C[i*Nj+j]+A[k*Ni+i]*B[k*Nj+j];
}
}
```

Solution:

There are a few gradual progression options and experiments we tried, we started with the code given by professor, the code had a for loop iteration sequence which had high stride which we changed to the most best and optimal stride (IKJ). The stride was calculated using the stride analysis $C[i^*Nj+j]=C[i^*Nj+j]+A[k^*Ni+i]^*B[k^*Nj+j];$

In this equation when (J) is the innermost loop the stride is 0/1 otherwise we get higher stride leading to higher misses in cache, so we chose (J) as the innermost loop and thus leading to 2 loop nests with Ijk and kij sequences.

We tried many various openmp optimizations in order to get the best results(you can find those results below in the excel sheet linked to this document). Those optimizations are as following:

a. Loop ikj

1. Replaced `#pragma omp master` with `#pragma omp for` above the `i` loop for loop nest (ikj).
2. Unroll - J loop by 2.
3. Unroll - J loop by 4
4. Tile - I loop by 32

5. Tile - IK loop by 32
6. Tile - IKJ loop by 32
7. Tile i loop by 32 & unroll j by 2
8. Tile i loop by 128 & unroll j by 2
9. Tile i,k loop by 32 & unroll j by 2
10. Tile i,k loop by 128 & unroll j by 2
11. Tile i loop by 32 & unroll j by 4
12. Tile i loop by 128 & unroll j by 4
13. Tile i,k loop by 32 & unroll j by 4
14. Tile i,k loop by 128 & unroll j by 4

b. Loop kij

1. Replaced `#pragma omp master` with `#pragma omp for` above the `i` loop for loop nest (kij).
2. Unroll - J loop by 2.
3. Unroll - J loop by 4
4. Tile - k loop by 32
5. Tile - k, i loop by 32
6. Tile - k,i,j loop by 32
7. Tile k loop by 32 & unroll j by 2
8. Tile k loop by 128 & unroll j by 2
9. Tile i,k loop by 32 & unroll j by 2
10. Tile i,k loop by 128 & unroll j by 2
11. Tile k loop by 32 & unroll j by 4
12. Tile k loop by 128 & unroll j by 4
13. Tile i,k loop by 32 & unroll j by 4
14. Tile i,k loop by 128 & unroll j by 4

Q2.

```
void atbt_par(const double * __restrict__ A, const double
* __restrict__ B, double * __restrict__ C, int Ni, int Nj,
int Nk)
{
    int i, j, k;

#pragma omp parallel private(i,j,k)
{
#pragma omp master
    for (i = 0; i < Ni; i++)
        for (j = 0; j < Nj; j++)
            for (k = 0; k < Nk; k++)
// C[i][j] = C[i][j] + A[k][i]*B[j][k];
                C[i*Nj+j]=C[i*Nj+j]+A[k*Ni+i]*B[j*Nk+k];
}
}
```

Solution:

Here stride will differ for different input and different innermost loops. We tried different scenarios in order to find the best way to optimize and get optimal results.

1. Use #pragma omp for instead of #pragma omp master above ‘i’ loop for loop nest IKJ
2. Use #pragma omp for above ‘i’ for loop nest KIJ
3. Use #pragma omp for above ‘j’ for loop nest KJI
4. Use #pragma omp for above ‘i’ for loop nest IJK
5. Use #pragma omp for above ‘i’ for loop nest IKJ
6. Use #pragma omp for above ‘j’ for loop nest JIK
7. Use #pragma omp for above ‘j’ for loop nest JKI

By analyzing the result of the above cases we found that IKJ and JIK are the best loop nest and we proceed with these two loops and put #omp pragma for at the outermost loop.

8. Unroll ‘j’ loop by 2,4 in loop nest IKJ
9. Unroll ‘k’ loop by 2,4 in loop nest JIK
10. Tile ‘i’ loop by 32 in loop nest IKJ
11. Tile ‘i,k’ loop by 32 in loop nest IKJ
12. Tile ‘i,k,j’ loop by 32 in loop nest IKJ
13. tile ‘j’ loop by 32 in loop nest JIK
14. Unroll ‘j,i’ loop by 32 in loop nest JIK
15. Unroll ‘j,i,k’ loop by 32 in loop nest JIK
16. Unroll ‘j’ loop by 2,4 and tile i loop by 32 in loop nest IKJ
17. Unroll ‘k’ loop by 2,4 and tile j loop by 32 in loop nest JIK

CUDA

Q1.

The codes are to be optimized for GPU which changes as per the input.

We choose a block size as <8,8> and <16,16>.

The following 2 versions are implemented

1. Basic with no shared memory
2. With shared memory - With the fact that shared memory is faster than global
3. UnrollingK - non-shared memory.

The results are captured in the excel linked and the codes for the GPU are in the github link.

Q2.

The codes are to be optimized for GPU which changes as per the input.

We choose a block size as <8,8> and <16,16>.

The following 2 versions are implemented

4. Basic with no shared memory
5. With shared memory - With the fact that shared memory is faster than global
6. UnrollingK - non-shared memory.

The results are captured in the excel linked and the codes for the GPU are in the github link.

<EXCEL>

<GITHUB>

Whereas we even wrote 2 version of loop nests, which were permuted

- These 2 sequences of loop nest were tried in various inputs given by professor and we found that the results were the most best on the loop nest

1.0Atb

1.Results of atb_unrollk and atb_basic (In most of the cases unroll is better than basic)

```
atb_unrollk.txt
1 #b unrollk
2 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>
3 <Ni=8192,Nj=8192,Nk=16>; Trial 1: GFLOPS: 365.78
4 <Ni=8192,Nj=8192,Nk=16>; Trial 2: GFLOPS: 377.82
5 <Ni=8192,Nj=8192,Nk=16>; Trial 3: GFLOPS: 376.98
6 <Ni=8192,Nj=8192,Nk=16>; Trial 4: GFLOPS: 376.72
7 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=64>
8 <Ni=8192,Nj=8192,Nk=64>; Trial 1: GFLOPS: 97.69
9 <Ni=8192,Nj=8192,Nk=64>; Trial 2: GFLOPS: 97.69
10 <Ni=8192,Nj=8192,Nk=64>; Trial 3: GFLOPS: 97.70
11 <Ni=8192,Nj=8192,Nk=64>; Trial 4: GFLOPS: 97.64
12 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>
13 <Ni=2048,Nj=2048,Nk=256>; Trial 1: GFLOPS: 53.57
14 <Ni=2048,Nj=2048,Nk=256>; Trial 2: GFLOPS: 355.49
15 <Ni=2048,Nj=2048,Nk=256>; Trial 3: GFLOPS: 355.63
16 <Ni=2048,Nj=2048,Nk=256>; Trial 4: GFLOPS: 355.68
17 Specify Matrix dimension Ni, Nj, Nk: <Ni=1024,Nj=1024,Nk=1024>
18 <Ni=1024,Nj=1024,Nk=1024>; Trial 1: GFLOPS: 362.44
19 <Ni=1024,Nj=1024,Nk=1024>; Trial 2: GFLOPS: 358.33
20 <Ni=1024,Nj=1024,Nk=1024>; Trial 3: GFLOPS: 354.93
21 <Ni=1024,Nj=1024,Nk=1024>; Trial 4: GFLOPS: 355.55
22 Specify Matrix dimension Ni, Nj, Nk: <Ni=256,Nj=256,Nk=16384>
23 <Ni=256,Nj=256,Nk=16384>; Trial 1: GFLOPS: 339.37
24 <Ni=256,Nj=256,Nk=16384>; Trial 2: GFLOPS: 327.19
25 <Ni=256,Nj=256,Nk=16384>; Trial 3: GFLOPS: 302.12
26 <Ni=256,Nj=256,Nk=16384>; Trial 4: GFLOPS: 326.87
27 Specify Matrix dimension Ni, Nj, Nk: <Ni=64,Nj=64,Nk=262144>
28 <Ni=64,Nj=64,Nk=262144>; Trial 1: GFLOPS: 90.52
29 <Ni=64,Nj=64,Nk=262144>; Trial 2: GFLOPS: 90.02
30 <Ni=64,Nj=64,Nk=262144>; Trial 3: GFLOPS: 90.77
31 <Ni=64,Nj=64,Nk=262144>; Trial 4: GFLOPS: 90.13
32 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=4194304>
33 <Ni=16,Nj=16,Nk=4194304>; Trial 1: GFLOPS: 5.88
34 <Ni=16,Nj=16,Nk=4194304>; Trial 2: GFLOPS: 5.76
35 <Ni=16,Nj=16,Nk=4194304>; Trial 3: GFLOPS: 5.78
36 <Ni=16,Nj=16,Nk=4194304>; Trial 4: GFLOPS: 5.76
37 Specify Matrix dimension Ni, Nj, Nk: <Ni=8991,Nj=8991,Nk=37>
38 <Ni=8991,Nj=8991,Nk=37>; Trial 1: GFLOPS: 308.70
39 <Ni=8991,Nj=8991,Nk=37>; Trial 2: GFLOPS: 308.71
40 <Ni=8991,Nj=8991,Nk=37>; Trial 3: GFLOPS: 308.73
41 <Ni=8991,Nj=8991,Nk=37>; Trial 4: GFLOPS: 308.71
42 Specify Matrix dimension Ni, Nj, Nk: <Ni=2997,Nj=2997,Nk=111>
43 <Ni=2997,Nj=2997,Nk=111>; Trial 1: GFLOPS: 386.77
44 <Ni=2997,Nj=2997,Nk=111>; Trial 2: GFLOPS: 387.29
45 <Ni=2997,Nj=2997,Nk=111>; Trial 3: GFLOPS: 387.15
46 <Ni=2997,Nj=2997,Nk=111>; Trial 4: GFLOPS: 386.51
47 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=999>
48 <Ni=333,Nj=333,Nk=999>; Trial 1: GFLOPS: 353.49
49 <Ni=333,Nj=333,Nk=999>; Trial 2: GFLOPS: 354.98
50 <Ni=333,Nj=333,Nk=999>; Trial 3: GFLOPS: 354.19
51 <Ni=333,Nj=333,Nk=999>; Trial 4: GFLOPS: 353.08
52 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>
53 <Ni=333,Nj=333,Nk=8991>; Trial 1: GFLOPS: 281.56
54 <Ni=333,Nj=333,Nk=8991>; Trial 2: GFLOPS: 301.31
55 <Ni=333,Nj=333,Nk=8991>; Trial 3: GFLOPS: 297.39
56 <Ni=333,Nj=333,Nk=8991>; Trial 4: GFLOPS: 283.85
57 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=8091>
58 <Ni=111,Nj=111,Nk=8091>; Trial 1: GFLOPS: 249.82
59 <Ni=111,Nj=111,Nk=8091>; Trial 2: GFLOPS: 249.27
60 <Ni=111,Nj=111,Nk=8091>; Trial 3: GFLOPS: 249.35
61 <Ni=111,Nj=111,Nk=8091>; Trial 4: GFLOPS: 249.85
62 Specify Matrix dimension Ni, Nj, Nk: <Ni=37,Nj=37,Nk=728271>
63 <Ni=37,Nj=37,Nk=728271>; Trial 1: GFLOPS: 31.55
64 <Ni=37,Nj=37,Nk=728271>; Trial 2: GFLOPS: 31.55
65 <Ni=37,Nj=37,Nk=728271>; Trial 3: GFLOPS: 31.54
66 <Ni=37,Nj=37,Nk=728271>; Trial 4: GFLOPS: 31.51
1 #b basic
2 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>; Trial 0: GFLOPS: 314.86
3 <Ni=8192,Nj=8192,Nk=16>; Trial 1: GFLOPS: 344.85
4 <Ni=8192,Nj=8192,Nk=16>; Trial 2: GFLOPS: 398.35
5 <Ni=8192,Nj=8192,Nk=16>; Trial 3: GFLOPS: 393.64
6 <Ni=8192,Nj=8192,Nk=16>; Trial 4: GFLOPS: 393.2
7 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=4096,Nk=64>; Trial 0: GFLOPS: 412.91
8 <Ni=8192,Nj=8192,Nk=4096,Nk=64>; Trial 1: GFLOPS: 411.71
9 <Ni=8192,Nj=8192,Nk=64>; Trial 2: GFLOPS: 412.04
10 <Ni=8192,Nj=8192,Nk=64>; Trial 3: GFLOPS: 411.98
11 <Ni=8192,Nj=8192,Nk=64>; Trial 4: GFLOPS: 411.99
12 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>;
13 <Ni=2048,Nj=2048,Nk=256>; Trial 1: GFLOPS: 568.36
14 <Ni=2048,Nj=2048,Nk=256>; Trial 2: GFLOPS: 359.80
15 <Ni=2048,Nj=2048,Nk=256>; Trial 3: GFLOPS: 568.03
16 <Ni=2048,Nj=2048,Nk=256>; Trial 4: GFLOPS: 359.93
17 Specify Matrix dimension Ni, Nj, Nk: <Ni=1024,Nj=1024,Nk=1024>; Trial 0: GFLOPS: 374.18
18 <Ni=1024,Nj=1024,Nk=1024>; Trial 1: GFLOPS: 374.56
19 <Ni=1024,Nj=1024,Nk=1024>; Trial 2: GFLOPS: 372.56
20 <Ni=1024,Nj=1024,Nk=1024>; Trial 3: GFLOPS: 378.86
21 <Ni=1024,Nj=1024,Nk=1024>; Trial 4: GFLOPS: 341.36
22 Specify Matrix dimension Ni, Nj, Nk: <Ni=256,Nj=256,Nk=16384>; Trial 0: GFLOPS: 341.36
23 <Ni=256,Nj=256,Nk=16384>; Trial 1: GFLOPS: 341.73
24 <Ni=256,Nj=256,Nk=16384>; Trial 2: GFLOPS: 341.31
25 <Ni=256,Nj=256,Nk=16384>; Trial 3: GFLOPS: 361.14
26 <Ni=256,Nj=256,Nk=16384>; Trial 4: GFLOPS: 342.97
27 Specify Matrix dimension Ni, Nj, Nk: <Ni=64,Nj=64,Nk=262144>; Trial 0: GFLOPS: 77.53
28 <Ni=64,Nj=64,Nk=262144>; Trial 1: GFLOPS: 78.31
29 <Ni=64,Nj=64,Nk=262144>; Trial 2: GFLOPS: 78.43
30 <Ni=64,Nj=64,Nk=262144>; Trial 3: GFLOPS: 78.84
31 <Ni=64,Nj=64,Nk=262144>; Trial 4: GFLOPS: 78.36
32 Specify Matrix dimension Ni, Nj, Nk: <Ni=64,Nj=64,Nk=4194304>; Trial 0: GFLOPS: 5.89
33 <Ni=16,Nj=16,Nk=4194304>; Trial 1: GFLOPS: 5.69
34 <Ni=16,Nj=16,Nk=4194304>; Trial 2: GFLOPS: 5.67
35 <Ni=16,Nj=16,Nk=4194304>; Trial 3: GFLOPS: 5.69
36 <Ni=16,Nj=16,Nk=4194304>; Trial 4: GFLOPS: 5.67
37 Specify Matrix dimension Ni, Nj, Nk: <Ni=8991,Nj=8991,Nk=37>; Trial 0: GFLOPS: 320.04
38 <Ni=8991,Nj=8991,Nk=37>; Trial 1: GFLOPS: 328.45
39 <Ni=8991,Nj=8991,Nk=37>; Trial 2: GFLOPS: 328.49
40 <Ni=8991,Nj=8991,Nk=37>; Trial 3: GFLOPS: 328.42
41 <Ni=8991,Nj=8991,Nk=37>; Trial 4: GFLOPS: 328.41
42 Specify Matrix dimension Ni, Nj, Nk: <Ni=2997,Nj=2997,Nk=111>; Trial 0: GFLOPS: 397.21
43 <Ni=2997,Nj=2997,Nk=111>; Trial 1: GFLOPS: 566.28
44 <Ni=2997,Nj=2997,Nk=111>; Trial 2: GFLOPS: 566.37
45 <Ni=2997,Nj=2997,Nk=111>; Trial 3: GFLOPS: 565.81
46 <Ni=2997,Nj=2997,Nk=111>; Trial 4: GFLOPS: 566.34
47 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=999>; Trial 0: GFLOPS: 372.89
48 <Ni=333,Nj=333,Nk=999>; Trial 1: GFLOPS: 355.83
49 <Ni=333,Nj=333,Nk=999>; Trial 2: GFLOPS: 376.94
50 <Ni=333,Nj=333,Nk=999>; Trial 3: GFLOPS: 372.61
51 <Ni=333,Nj=333,Nk=999>; Trial 4: GFLOPS: 372.71
52 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>; Trial 0: GFLOPS: 335.58
53 <Ni=333,Nj=333,Nk=8991>; Trial 1: GFLOPS: 813.68
54 <Ni=333,Nj=333,Nk=8991>; Trial 2: GFLOPS: 349.15
55 <Ni=333,Nj=333,Nk=8991>; Trial 3: GFLOPS: 349.15
56 <Ni=333,Nj=333,Nk=8991>; Trial 4: GFLOPS: 324.39
57 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=8091>; Trial 0: GFLOPS: 259.84
58 <Ni=111,Nj=111,Nk=8091>; Trial 1: GFLOPS: 241.85
59 <Ni=111,Nj=111,Nk=8091>; Trial 2: GFLOPS: 241.39
60 <Ni=111,Nj=111,Nk=8091>; Trial 3: GFLOPS: 241.44
61 <Ni=111,Nj=111,Nk=8091>; Trial 4: GFLOPS: 241.09
62 Specify Matrix dimension Ni, Nj, Nk: <Ni=37,Nj=37,Nk=728271>; Trial 0: GFLOPS: 30.96
63 <Ni=37,Nj=37,Nk=728271>; Trial 1: GFLOPS: 30.98
64 <Ni=37,Nj=37,Nk=728271>; Trial 2: GFLOPS: 31.00
65 <Ni=37,Nj=37,Nk=728271>; Trial 3: GFLOPS: 31.00
66 <Ni=37,Nj=37,Nk=728271>; Trial 4: GFLOPS: 30.98
```

2. Results of atb_shared and atb_unrollk(Unroll k has more promising result than shared)

```

2 atb_unrollk.txt
1 #include<iostream>
2 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>; Trial 0: GFLOPS: 598.86
3 <Ni=192,Nj=192,Nk=16>; Trial 1: GFLOPS: 396.76
4 <Ni=192,Nj=192,Nk=16>; Trial 2: GFLOPS: 397.82
5 <Ni=192,Nj=192,Nk=16>; Trial 3: GFLOPS: 397.79
6 <Ni=192,Nj=192,Nk=16>; Trial 4: GFLOPS: 396.72
7 Specify Matrix dimension Ni, Nj, Nk: <Ni=496,Nj=496,Nk=64>; Trial 0: GFLOPS: 408.91
8 <Ni=496,Nj=496,Nk=64>; Trial 1: GFLOPS: 407.69
9 <Ni=496,Nj=496,Nk=64>; Trial 2: GFLOPS: 407.69
10 <Ni=496,Nj=496,Nk=64>; Trial 3: GFLOPS: 407.73
11 <Ni=496,Nj=496,Nk=64>; Trial 4: GFLOPS: 407.64
12 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>; Trial 0: GFLOPS: 864.91
13 <Ni=2048,Nj=2048,Nk=256>; Trial 1: GFLOPS: 353.57
14 <Ni=2048,Nj=2048,Nk=256>; Trial 2: GFLOPS: 354.04
15 <Ni=2048,Nj=2048,Nk=256>; Trial 3: GFLOPS: 355.65
16 <Ni=2048,Nj=2048,Nk=256>; Trial 4: GFLOPS: 355.68
17 Specify Matrix dimension Ni, Nj, Nk: <Ni=1024,Nj=1024,Nk=1024>; Trial 0: GFLOPS: 303.79
18 <Ni=1024,Nj=1024,Nk=1024>; Trial 1: GFLOPS: 298.33
19 <Ni=1024,Nj=1024,Nk=1024>; Trial 2: GFLOPS: 298.33
20 <Ni=1024,Nj=1024,Nk=1024>; Trial 3: GFLOPS: 354.98
21 <Ni=1024,Nj=1024,Nk=1024>; Trial 4: GFLOPS: 355.65
22 Specify Matrix dimension Ni, Nj, Nk: <Ni=16384,Nj=16384,Nk=16384>; Trial 0: GFLOPS: 339.89
23 <Ni=16384,Nj=16384,Nk=16384>; Trial 1: GFLOPS: 339.37
24 <Ni=16384,Nj=16384,Nk=16384>; Trial 2: GFLOPS: 327.19
25 <Ni=16384,Nj=16384,Nk=16384>; Trial 3: GFLOPS: 382.15
26 <Ni=16384,Nj=16384,Nk=16384>; Trial 4: GFLOPS: 326.87
27 Specify Matrix dimension Ni, Nj, Nk: <Ni=262144,Nj=262144,Nk=262144>; Trial 0: GFLOPS: 78.09
28 <Ni=64,Nj=64,Nk=262144>; Trial 1: GFLOPS: 98.52
29 <Ni=64,Nj=64,Nk=262144>; Trial 2: GFLOPS: 98.02
30 <Ni=64,Nj=64,Nk=262144>; Trial 3: GFLOPS: 98.70
31 <Ni=64,Nj=64,Nk=262144>; Trial 4: GFLOPS: 98.33
32 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=16384>; Trial 0: GFLOPS: 5.27
33 <Ni=16,Nj=16,Nk=16384>; Trial 1: GFLOPS: 5.88
34 <Ni=16,Nj=16,Nk=16384>; Trial 2: GFLOPS: 5.76
35 <Ni=16,Nj=16,Nk=16384>; Trial 3: GFLOPS: 5.76
36 <Ni=16,Nj=16,Nk=16384>; Trial 4: GFLOPS: 5.76
37 Specify Matrix dimension Ni, Nj, Nk: <Ni=891,Nj=891,Nk=37>; Trial 0: GFLOPS: 308.06
38 <Ni=891,Nj=891,Nk=37>; Trial 1: GFLOPS: 308.70
39 <Ni=891,Nj=891,Nk=37>; Trial 2: GFLOPS: 308.73
40 <Ni=891,Nj=891,Nk=37>; Trial 3: GFLOPS: 308.73
41 <Ni=891,Nj=891,Nk=37>; Trial 4: GFLOPS: 308.71
42 Specify Matrix dimension Ni, Nj, Nk: <Ni=2997,Nj=2997,Nk=111>; Trial 0: GFLOPS: 889.63
43 <Ni=2997,Nj=2997,Nk=111>; Trial 1: GFLOPS: 386.77
44 <Ni=2997,Nj=2997,Nk=111>; Trial 2: GFLOPS: 386.77
45 <Ni=2997,Nj=2997,Nk=111>; Trial 3: GFLOPS: 387.15
46 <Ni=2997,Nj=2997,Nk=111>; Trial 4: GFLOPS: 386.58
47 Specify Matrix dimension Ni, Nj, Nk: <Ni=999,Nj=999,Nk=999>; Trial 0: GFLOPS: 354.38
48 <Ni=999,Nj=999,Nk=999>; Trial 1: GFLOPS: 355.03
49 <Ni=999,Nj=999,Nk=999>; Trial 2: GFLOPS: 354.88
50 <Ni=999,Nj=999,Nk=999>; Trial 3: GFLOPS: 354.10
51 <Ni=999,Nj=999,Nk=999>; Trial 4: GFLOPS: 353.08
52 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>; Trial 0: GFLOPS: 209.89
53 <Ni=333,Nj=333,Nk=8991>; Trial 1: GFLOPS: 301.56
54 <Ni=333,Nj=333,Nk=8991>; Trial 2: GFLOPS: 301.31
55 <Ni=333,Nj=333,Nk=8991>; Trial 3: GFLOPS: 207.39
56 <Ni=333,Nj=333,Nk=8991>; Trial 4: GFLOPS: 205.55
57 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=8991>; Trial 0: GFLOPS: 20.87
58 <Ni=111,Nj=111,Nk=8991>; Trial 1: GFLOPS: 26.82
59 <Ni=111,Nj=111,Nk=8991>; Trial 2: GFLOPS: 26.27
60 <Ni=111,Nj=111,Nk=8991>; Trial 3: GFLOPS: 26.67
61 <Ni=111,Nj=111,Nk=8991>; Trial 4: GFLOPS: 26.85
62 Specify Matrix dimension Ni, Nj, Nk: <Ni=37,Nj=37,Nk=728271>; Trial 0: GFLOPS: 31.22
63 <Ni=37,Nj=37,Nk=728271>; Trial 1: GFLOPS: 31.65
64 <Ni=37,Nj=37,Nk=728271>; Trial 2: GFLOPS: 30.85
65 <Ni=37,Nj=37,Nk=728271>; Trial 3: GFLOPS: 31.54
66 <Ni=37,Nj=37,Nk=728271>; Trial 4: GFLOPS: 31.51
1 #include<iostream>
2 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>; Trial 0: GFLOPS: 235.94
3 <Ni=8192,Nj=8192,Nk=16>; Trial 1: GFLOPS: 235.37
4 <Ni=8192,Nj=8192,Nk=16>; Trial 2: GFLOPS: 235.36
5 <Ni=8192,Nj=8192,Nk=16>; Trial 3: GFLOPS: 235.35
6 <Ni=8192,Nj=8192,Nk=16>; Trial 4: GFLOPS: 235.37
7 Specify Matrix dimension Ni, Nj, Nk: <Ni=496,Nj=496,Nk=64>; Trial 0: GFLOPS: 257.84
8 <Ni=496,Nj=496,Nk=64>; Trial 1: GFLOPS: 257.38
9 <Ni=496,Nj=496,Nk=64>; Trial 2: GFLOPS: 257.38
10 <Ni=496,Nj=496,Nk=64>; Trial 3: GFLOPS: 257.41
11 <Ni=496,Nj=496,Nk=64>; Trial 4: GFLOPS: 257.39
12 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>; Trial 0: GFLOPS: 263.77
13 <Ni=2048,Nj=2048,Nk=256>; Trial 1: GFLOPS: 263.25
14 <Ni=2048,Nj=2048,Nk=256>; Trial 2: GFLOPS: 263.25
15 <Ni=2048,Nj=2048,Nk=256>; Trial 3: GFLOPS: 263.29
16 <Ni=2048,Nj=2048,Nk=256>; Trial 4: GFLOPS: 263.25
17 Specify Matrix dimension Ni, Nj, Nk: <Ni=1024,Nj=1024,Nk=1024>; Trial 0: GFLOPS: 262.02
18 <Ni=1024,Nj=1024,Nk=1024>; Trial 1: GFLOPS: 261.56
19 <Ni=1024,Nj=1024,Nk=1024>; Trial 2: GFLOPS: 261.56
20 <Ni=1024,Nj=1024,Nk=1024>; Trial 3: GFLOPS: 261.61
21 <Ni=1024,Nj=1024,Nk=1024>; Trial 4: GFLOPS: 261.64
22 Specify Matrix dimension Ni, Nj, Nk: <Ni=16384,Nj=16384,Nk=16384>; Trial 0: GFLOPS: 210.68
23 <Ni=16384,Nj=16384,Nk=16384>; Trial 1: GFLOPS: 210.49
24 <Ni=16384,Nj=16384,Nk=16384>; Trial 2: GFLOPS: 223.68
25 <Ni=16384,Nj=16384,Nk=16384>; Trial 3: GFLOPS: 226.82
26 <Ni=16384,Nj=16384,Nk=16384>; Trial 4: GFLOPS: 219.06
27 Specify Matrix dimension Ni, Nj, Nk: <Ni=44,Nj=44,Nk=262144>; Trial 0: GFLOPS: 100.31
28 <Ni=64,Nj=64,Nk=262144>; Trial 1: GFLOPS: 100.36
29 <Ni=64,Nj=64,Nk=262144>; Trial 2: GFLOPS: 100.27
30 <Ni=64,Nj=64,Nk=262144>; Trial 3: GFLOPS: 100.23
31 <Ni=64,Nj=64,Nk=262144>; Trial 4: GFLOPS: 100.23
32 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=16384>; Trial 0: GFLOPS: 6.83
33 <Ni=16,Nj=16,Nk=16384>; Trial 1: GFLOPS: 6.86
34 <Ni=16,Nj=16,Nk=16384>; Trial 2: GFLOPS: 6.83
35 <Ni=16,Nj=16,Nk=16384>; Trial 3: GFLOPS: 6.85
36 <Ni=16,Nj=16,Nk=16384>; Trial 4: GFLOPS: 6.83
37 Specify Matrix dimension Ni, Nj, Nk: <Ni=891,Nj=891,Nk=37>; Trial 0: GFLOPS: 232.65
38 <Ni=891,Nj=891,Nk=37>; Trial 1: GFLOPS: 232.87
39 <Ni=891,Nj=891,Nk=37>; Trial 2: GFLOPS: 232.87
40 <Ni=891,Nj=891,Nk=37>; Trial 3: GFLOPS: 232.87
41 <Ni=891,Nj=891,Nk=37>; Trial 4: GFLOPS: 232.85
42 Specify Matrix dimension Ni, Nj, Nk: <Ni=2997,Nj=2997,Nk=111>; Trial 0: GFLOPS: 256.42
43 <Ni=2997,Nj=2997,Nk=111>; Trial 1: GFLOPS: 255.91
44 <Ni=2997,Nj=2997,Nk=111>; Trial 2: GFLOPS: 255.91
45 <Ni=2997,Nj=2997,Nk=111>; Trial 3: GFLOPS: 256.47
46 <Ni=2997,Nj=2997,Nk=111>; Trial 4: GFLOPS: 256.52
47 Specify Matrix dimension Ni, Nj, Nk: <Ni=999,Nj=999,Nk=999>; Trial 0: GFLOPS: 261.93
48 <Ni=999,Nj=999,Nk=999>; Trial 1: GFLOPS: 261.31
49 <Ni=999,Nj=999,Nk=999>; Trial 2: GFLOPS: 261.31
50 <Ni=999,Nj=999,Nk=999>; Trial 3: GFLOPS: 261.33
51 <Ni=999,Nj=999,Nk=999>; Trial 4: GFLOPS: 261.39
52 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>; Trial 0: GFLOPS: 54.63
53 <Ni=333,Nj=333,Nk=8991>; Trial 1: GFLOPS: 254.67
54 <Ni=333,Nj=333,Nk=8991>; Trial 2: GFLOPS: 255.05
55 <Ni=333,Nj=333,Nk=8991>; Trial 3: GFLOPS: 255.36
56 <Ni=333,Nj=333,Nk=8991>; Trial 4: GFLOPS: 255.72
57 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=8991>; Trial 0: GFLOPS: 206.78
58 <Ni=111,Nj=111,Nk=8991>; Trial 1: GFLOPS: 204.96
59 <Ni=111,Nj=111,Nk=8991>; Trial 2: GFLOPS: 207.66
60 <Ni=111,Nj=111,Nk=8991>; Trial 3: GFLOPS: 207.66
61 <Ni=111,Nj=111,Nk=8991>; Trial 4: GFLOPS: 207.66
62 Specify Matrix dimension Ni, Nj, Nk: <Ni=37,Nj=37,Nk=728271>; Trial 0: GFLOPS: 56.44
63 <Ni=37,Nj=37,Nk=728271>; Trial 1: GFLOPS: 36.59
64 <Ni=37,Nj=37,Nk=728271>; Trial 2: GFLOPS: 36.58
65 <Ni=37,Nj=37,Nk=728271>; Trial 3: GFLOPS: 36.59
66 <Ni=37,Nj=37,Nk=728271>; Trial 4: GFLOPS: 36.55

```

3.Result of atb_shared and atb_basic (In most of the cases shared is better than basic)

```

2 atb_basic.txt
1 atb_basic
2 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>; Trial 0: GFLOPS: 314.36
3 <Ni=8192,Nj=8192,Nk=16>; Trial 1: GFLOPS: 344.05
4 <Ni=8192,Nj=8192,Nk=16>; Trial 2: GFLOPS: 393.35
5 <Ni=8192,Nj=8192,Nk=16>; Trial 3: GFLOPS: 393.64
6 <Ni=8192,Nj=8192,Nk=16>; Trial 4: GFLOPS: 393.05
7 Specify Matrix dimension Ni, Nj, Nk: <Ni=4096,Nj=4096,Nk=64>; Trial 0: GFLOPS: 412.91
8 <Ni=4096,Nj=4096,Nk=64>; Trial 1: GFLOPS: 411.94
9 <Ni=4096,Nj=4096,Nk=64>; Trial 2: GFLOPS: 412.04
10 <Ni=4096,Nj=4096,Nk=64>; Trial 3: GFLOPS: 393.93
11 <Ni=4096,Nj=4096,Nk=64>; Trial 4: GFLOPS: 411.99
12 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>; Trial 0: GFLOPS: 360.28
13 <Ni=2048,Nj=2048,Nk=256>; Trial 1: GFLOPS: 368.36
14 <Ni=2048,Nj=2048,Nk=256>; Trial 2: GFLOPS: 359.89
15 <Ni=2048,Nj=2048,Nk=256>; Trial 3: GFLOPS: 359.01
16 <Ni=2048,Nj=2048,Nk=256>; Trial 4: GFLOPS: 359.93
17 Specify Matrix dimension Ni, Nj, Nk: <Ni=1024,Nj=1024,Nk=1024>; Trial 0: GFLOPS: 374.18
18 <Ni=1024,Nj=1024,Nk=1024>; Trial 1: GFLOPS: 374.56
19 <Ni=1024,Nj=1024,Nk=1024>; Trial 2: GFLOPS: 374.06
20 <Ni=1024,Nj=1024,Nk=1024>; Trial 3: GFLOPS: 371.92
21 <Ni=1024,Nj=1024,Nk=1024>; Trial 4: GFLOPS: 370.86
22 Specify Matrix dimension Ni, Nj, Nk: <Ni=256,Nj=256,Nk=16384>; Trial 0: GFLOPS: 341.36
23 <Ni=256,Nj=256,Nk=16384>; Trial 1: GFLOPS: 341.14
24 <Ni=256,Nj=256,Nk=16384>; Trial 2: GFLOPS: 341.31
25 <Ni=256,Nj=256,Nk=16384>; Trial 3: GFLOPS: 361.14
26 <Ni=256,Nj=256,Nk=16384>; Trial 4: GFLOPS: 342.97
27 Specify Matrix dimension Ni, Nj, Nk: <Ni=64,Nj=64,Nk=262144>; Trial 0: GFLOPS: 77.63
28 <Ni=64,Nj=64,Nk=262144>; Trial 1: GFLOPS: 78.03
29 <Ni=64,Nj=64,Nk=262144>; Trial 2: GFLOPS: 78.43
30 <Ni=64,Nj=64,Nk=262144>; Trial 3: GFLOPS: 78.84
31 <Ni=64,Nj=64,Nk=262144>; Trial 4: GFLOPS: 78.36
32 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=4194304>; Trial 0: GFLOPS: 5.39
33 <Ni=16,Nj=16,Nk=4194304>; Trial 1: GFLOPS: 5.49
34 <Ni=16,Nj=16,Nk=4194304>; Trial 2: GFLOPS: 5.67
35 <Ni=16,Nj=16,Nk=4194304>; Trial 3: GFLOPS: 5.69
36 <Ni=16,Nj=16,Nk=4194304>; Trial 4: GFLOPS: 5.69
37 Specify Matrix dimension Ni, Nj, Nk: <Ni=8991,Nj=8991,Nk=37>; Trial 0: GFLOPS: 520.84
38 <Ni=8991,Nj=8991,Nk=37>; Trial 1: GFLOPS: 320.45
39 <Ni=8991,Nj=8991,Nk=37>; Trial 2: GFLOPS: 320.49
40 <Ni=8991,Nj=8991,Nk=37>; Trial 3: GFLOPS: 320.42
41 <Ni=8991,Nj=8991,Nk=37>; Trial 4: GFLOPS: 320.45
42 Specify Matrix dimension Ni, Nj, Nk: <Ni=2997,Nj=2997,Nk=111>; Trial 0: GFLOPS: 397.21
43 <Ni=2997,Nj=2997,Nk=111>; Trial 1: GFLOPS: 396.28
44 <Ni=2997,Nj=2997,Nk=111>; Trial 2: GFLOPS: 396.37
45 <Ni=2997,Nj=2997,Nk=111>; Trial 3: GFLOPS: 396.91
46 <Ni=2997,Nj=2997,Nk=111>; Trial 4: GFLOPS: 396.34
47 Specify Matrix dimension Ni, Nj, Nk: <Ni=999,Nj=999,Nk=999>; Trial 0: GFLOPS: 372.39
48 <Ni=999,Nj=999,Nk=999>; Trial 1: GFLOPS: 365.81
49 <Ni=999,Nj=999,Nk=999>; Trial 2: GFLOPS: 364.94
50 <Ni=999,Nj=999,Nk=999>; Trial 3: GFLOPS: 372.61
51 <Ni=999,Nj=999,Nk=999>; Trial 4: GFLOPS: 372.71
52 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>; Trial 0: GFLOPS: 335.58
53 <Ni=333,Nj=333,Nk=8991>; Trial 1: GFLOPS: 313.68
54 <Ni=333,Nj=333,Nk=8991>; Trial 2: GFLOPS: 313.55
55 <Ni=333,Nj=333,Nk=8991>; Trial 3: GFLOPS: 348.15
56 <Ni=333,Nj=333,Nk=8991>; Trial 4: GFLOPS: 324.39
57 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=88919>; Trial 0: GFLOPS: 359.84
58 <Ni=111,Nj=111,Nk=88919>; Trial 1: GFLOPS: 361.61
59 <Ni=111,Nj=111,Nk=88919>; Trial 2: GFLOPS: 361.39
60 <Ni=111,Nj=111,Nk=88919>; Trial 3: GFLOPS: 261.44
61 <Ni=111,Nj=111,Nk=88919>; Trial 4: GFLOPS: 261.09
62 Specify Matrix dimension Ni, Nj, Nk: <Ni=37,Nj=37,Nk=728271>; Trial 0: GFLOPS: 30.98
63 <Ni=37,Nj=37,Nk=728271>; Trial 1: GFLOPS: 30.98
64 <Ni=37,Nj=37,Nk=728271>; Trial 2: GFLOPS: 30.99
65 <Ni=37,Nj=37,Nk=728271>; Trial 3: GFLOPS: 31.00
66 <Ni=37,Nj=37,Nk=728271>; Trial 4: GFLOPS: 30.98
1 atb_shar
2 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>; Trial 1: GFLOPS: 235.37
3 <Ni=8192,Nj=8192,Nk=16>; Trial 2: GFLOPS: 235.36
4 <Ni=8192,Nj=8192,Nk=16>; Trial 3: GFLOPS: 235.46
5 <Ni=8192,Nj=8192,Nk=16>; Trial 4: GFLOPS: 235.37
Specify Matrix dimension Ni, Nj, Nk: <Ni=4096,Nj=4096,Nk=64>; Trial 0: GFLOPS: 267.36
6 <Ni=4096,Nj=4096,Nk=64>; Trial 1: GFLOPS: 267.33
7 <Ni=4096,Nj=4096,Nk=64>; Trial 2: GFLOPS: 267.36
8 <Ni=4096,Nj=4096,Nk=64>; Trial 3: GFLOPS: 267.31
9 <Ni=4096,Nj=4096,Nk=64>; Trial 4: GFLOPS: 267.39
10 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>; Trial 0: GFLOPS: 263.77
11 <Ni=2048,Nj=2048,Nk=256>; Trial 1: GFLOPS: 263.26
12 Specify Matrix dimension Ni, Nj, Nk: <Ni=1024,Nj=1024,Nk=1024>; Trial 0: GFLOPS: 262.82
13 <Ni=1024,Nj=1024,Nk=1024>; Trial 1: GFLOPS: 261.52
14 <Ni=1024,Nj=1024,Nk=1024>; Trial 2: GFLOPS: 261.52
15 <Ni=1024,Nj=1024,Nk=1024>; Trial 3: GFLOPS: 261.61
16 <Ni=1024,Nj=1024,Nk=1024>; Trial 4: GFLOPS: 261.59
17 Specify Matrix dimension Ni, Nj, Nk: <Ni=256,Nj=256,Nk=16384>; Trial 0: GFLOPS: 219.68
18 <Ni=256,Nj=256,Nk=16384>; Trial 1: GFLOPS: 219.76
19 <Ni=256,Nj=256,Nk=16384>; Trial 2: GFLOPS: 228.69
20 <Ni=256,Nj=256,Nk=16384>; Trial 3: GFLOPS: 228.82
21 <Ni=256,Nj=256,Nk=16384>; Trial 4: GFLOPS: 219.76
22 Specify Matrix dimension Ni, Nj, Nk: <Ni=64,Nj=64,Nk=262144>; Trial 0: GFLOPS: 160.31
23 <Ni=64,Nj=64,Nk=262144>; Trial 1: GFLOPS: 160.31
24 <Ni=64,Nj=64,Nk=262144>; Trial 2: GFLOPS: 160.27
25 <Ni=64,Nj=64,Nk=262144>; Trial 3: GFLOPS: 160.23
26 <Ni=64,Nj=64,Nk=262144>; Trial 4: GFLOPS: 160.23
27 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=4194304>; Trial 0: GFLOPS: 8.85
28 <Ni=16,Nj=16,Nk=4194304>; Trial 1: GFLOPS: 8.49
29 <Ni=16,Nj=16,Nk=4194304>; Trial 2: GFLOPS: 6.83
30 <Ni=16,Nj=16,Nk=4194304>; Trial 3: GFLOPS: 6.88
31 <Ni=16,Nj=16,Nk=4194304>; Trial 4: GFLOPS: 6.88
32 Specify Matrix dimension Ni, Nj, Nk: <Ni=8991,Nj=8991,Nk=37>; Trial 0: GFLOPS: 232.55
33 <Ni=8991,Nj=8991,Nk=37>; Trial 1: GFLOPS: 232.87
34 <Ni=8991,Nj=8991,Nk=37>; Trial 2: GFLOPS: 232.87
35 <Ni=8991,Nj=8991,Nk=37>; Trial 3: GFLOPS: 232.84
36 <Ni=8991,Nj=8991,Nk=37>; Trial 4: GFLOPS: 232.85
37 Specify Matrix dimension Ni, Nj, Nk: <Ni=2997,Nj=2997,Nk=111>; Trial 0: GFLOPS: 256.42
38 <Ni=2997,Nj=2997,Nk=111>; Trial 1: GFLOPS: 256.91
39 <Ni=2997,Nj=2997,Nk=111>; Trial 2: GFLOPS: 256.48
40 <Ni=2997,Nj=2997,Nk=111>; Trial 3: GFLOPS: 256.57
41 <Ni=2997,Nj=2997,Nk=111>; Trial 4: GFLOPS: 256.57
42 Specify Matrix dimension Ni, Nj, Nk: <Ni=999,Nj=999,Nk=999>; Trial 0: GFLOPS: 261.93
43 <Ni=999,Nj=999,Nk=999>; Trial 1: GFLOPS: 261.34
44 <Ni=999,Nj=999,Nk=999>; Trial 2: GFLOPS: 261.31
45 <Ni=999,Nj=999,Nk=999>; Trial 3: GFLOPS: 261.31
46 <Ni=999,Nj=999,Nk=999>; Trial 4: GFLOPS: 261.39
47 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>; Trial 0: GFLOPS: 254.65
48 <Ni=333,Nj=333,Nk=8991>; Trial 1: GFLOPS: 254.67
49 <Ni=333,Nj=333,Nk=8991>; Trial 2: GFLOPS: 254.65
50 <Ni=333,Nj=333,Nk=8991>; Trial 3: GFLOPS: 254.65
51 <Ni=333,Nj=333,Nk=8991>; Trial 4: GFLOPS: 254.74
52 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>; Trial 0: GFLOPS: 254.65
53 <Ni=333,Nj=333,Nk=8991>; Trial 1: GFLOPS: 254.67
54 <Ni=333,Nj=333,Nk=8991>; Trial 2: GFLOPS: 254.65
55 <Ni=333,Nj=333,Nk=8991>; Trial 3: GFLOPS: 254.65
56 <Ni=333,Nj=333,Nk=8991>; Trial 4: GFLOPS: 254.74
57 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=88919>; Trial 0: GFLOPS: 206.78
58 <Ni=111,Nj=111,Nk=88919>; Trial 1: GFLOPS: 206.98
59 <Ni=111,Nj=111,Nk=88919>; Trial 2: GFLOPS: 207.44
60 <Ni=111,Nj=111,Nk=88919>; Trial 3: GFLOPS: 207.03
61 <Ni=111,Nj=111,Nk=88919>; Trial 4: GFLOPS: 207.42
62 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=88919>; Trial 0: GFLOPS: 30.44
63 <Ni=111,Nj=111,Nk=88919>; Trial 1: GFLOPS: 30.45
64 <Ni=111,Nj=111,Nk=88919>; Trial 2: GFLOPS: 30.55
65 <Ni=111,Nj=111,Nk=88919>; Trial 3: GFLOPS: 30.59
66 <Ni=111,Nj=111,Nk=88919>; Trial 4: GFLOPS: 30.59

```

2.0.Atbt

1.Result of atbt_shared and atbt_basic (In most of the cases shared is better than basic)

2. Results of atbt_unrollk and atbt_basic (In most of the cases unroll is better than basic)

3. Results of atbt_shared and atbt_unrollk(Results are almost similar sometimes unrolling is better and in some cases shared memory is better)

```

tbt
1 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>; Trial 0: GFLOPS: 234.18
2 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16>; Trial 1: GFLOPS: 234.18
3 Ni=8192,Nj=8192,Nk=16: Trial 2: GFLOPS: 234.33
4 Ni=8192,Nj=8192,Nk=16: Trial 3: GFLOPS: 234.29
5 Ni=8192,Nj=8192,Nk=16: Trial 4: GFLOPS: 234.17
6 Specify Matrix dimension Ni, Nj, Nk: <Ni=4096,Nj=4096,Nk=64>; Trial 0: GFLOPS: 256.12
7 Ni=4096,Nj=4096,Nk=64: Trial 1: GFLOPS: 256.16
8 Ni=4096,Nj=4096,Nk=64: Trial 2: GFLOPS: 256.19
9 Ni=4096,Nj=4096,Nk=64: Trial 3: GFLOPS: 256.17
10 Ni=4096,Nj=4096,Nk=64: Trial 4: GFLOPS: 256.17
11 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>; Trial 0: GFLOPS: 261.87
12 Ni=2048,Nj=2048,Nk=256: Trial 1: GFLOPS: 61.33
13 Ni=2048,Nj=2048,Nk=256: Trial 2: GFLOPS: 61.33
14 Ni=2048,Nj=2048,Nk=256: Trial 3: GFLOPS: 61.33
15 Ni=2048,Nj=2048,Nk=256: Trial 4: GFLOPS: 61.33
16 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=1024>; Trial 0: GFLOPS: 260.35
17 Ni=8192,Nj=8192,Nk=1024: Trial 1: GFLOPS: 260.39
18 Ni=8192,Nj=8192,Nk=1024: Trial 2: GFLOPS: 260.37
19 Ni=8192,Nj=8192,Nk=1024: Trial 3: GFLOPS: 260.36
20 Ni=8192,Nj=8192,Nk=1024: Trial 4: GFLOPS: 260.37
21 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16384>; Trial 0: GFLOPS: -98.52
22 Ni=8192,Nj=8192,Nk=16384: Trial 1: GFLOPS: -98.52
23 Ni=8192,Nj=8192,Nk=16384: Trial 2: GFLOPS: -98.52
24 Ni=8192,Nj=8192,Nk=16384: Trial 3: GFLOPS: -98.52
25 Ni=8192,Nj=8192,Nk=16384: Trial 4: GFLOPS: -98.52
26 Specify Matrix dimension Ni, Nj, Nk: <Ni=4096,Nj=4096,Nk=26144>; Trial 0: GFLOPS: 83.87
27 Ni=4096,Nj=4096,Nk=26144: Trial 1: GFLOPS: 83.88
28 Ni=4096,Nj=4096,Nk=26144: Trial 2: GFLOPS: 83.84
29 Ni=4096,Nj=4096,Nk=26144: Trial 3: GFLOPS: 83.86
30 Ni=4096,Nj=4096,Nk=26144: Trial 4: GFLOPS: 83.88
31 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=16>; Trial 0: GFLOPS: 6.58
32 Ni=16,Nj=16,Nk=16: Trial 1: GFLOPS: 6.60
33 Ni=16,Nj=16,Nk=16: Trial 2: GFLOPS: 6.58
34 Ni=16,Nj=16,Nk=16: Trial 3: GFLOPS: 6.58
35 Ni=16,Nj=16,Nk=16: Trial 4: GFLOPS: 6.58
36 Specify Matrix dimension Ni, Nj, Nk: <Ni=8991,Nj=8991,Nk=37>; Trial 0: GFLOPS: 232.57
37 Ni=8991,Nj=8991,Nk=37: Trial 1: GFLOPS: 232.65
38 Ni=8991,Nj=8991,Nk=37: Trial 2: GFLOPS: 232.65
39 Ni=8991,Nj=8991,Nk=37: Trial 3: GFLOPS: 232.65
40 Ni=8991,Nj=8991,Nk=37: Trial 4: GFLOPS: 232.65
41 Ni=8991,Nj=8991,Nk=37: Trial 0: GFLOPS: 232.84
42 Ni=8991,Nj=8991,Nk=37: Trial 1: GFLOPS: 232.97
43 Ni=8991,Nj=8991,Nk=37: Trial 2: GFLOPS: 232.97
44 Ni=8991,Nj=8991,Nk=37: Trial 3: GFLOPS: 232.97
45 Ni=8991,Nj=8991,Nk=37: Trial 4: GFLOPS: 232.97
46 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=999>; Trial 0: GFLOPS: -56.43
47 Ni=333,Nj=333,Nk=999: Trial 1: GFLOPS: -56.49
48 Ni=333,Nj=333,Nk=999: Trial 2: GFLOPS: -56.49
49 Ni=333,Nj=333,Nk=999: Trial 3: GFLOPS: -56.49
50 Ni=333,Nj=333,Nk=999: Trial 4: GFLOPS: -56.49
51 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=999>; Trial 0: GFLOPS: 206.47
52 Ni=111,Nj=111,Nk=999: Trial 1: GFLOPS: 206.47
53 Ni=111,Nj=111,Nk=999: Trial 2: GFLOPS: 206.47
54 Ni=111,Nj=111,Nk=999: Trial 3: GFLOPS: 206.47
55 Ni=111,Nj=111,Nk=999: Trial 4: GFLOPS: 206.47
56 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=8991>; Trial 0: GFLOPS: 254.74
57 Ni=333,Nj=333,Nk=8991: Trial 1: GFLOPS: 254.63
58 Ni=333,Nj=333,Nk=8991: Trial 2: GFLOPS: 254.67
59 Ni=333,Nj=333,Nk=8991: Trial 3: GFLOPS: 254.64
60 Ni=333,Nj=333,Nk=8991: Trial 4: GFLOPS: 254.91
61 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=8991>; Trial 0: GFLOPS: 207.67
62 Ni=111,Nj=111,Nk=8991: Trial 1: GFLOPS: 208.24
63 Ni=111,Nj=111,Nk=8991: Trial 2: GFLOPS: 208.27
64 Ni=111,Nj=111,Nk=8991: Trial 3: GFLOPS: 208.56
65 Ni=111,Nj=111,Nk=8991: Trial 4: GFLOPS: 208.29
66 Specify Matrix dimension Ni, Nj, Nk: <Ni=37,Nj=37,Nk=728271>; Trial 0: GFLOPS: 36.77
67 Ni=37,Nj=37,Nk=728271: Trial 1: GFLOPS: 36.77
68 Ni=37,Nj=37,Nk=728271: Trial 2: GFLOPS: 36.77
69 Ni=37,Nj=37,Nk=728271: Trial 3: GFLOPS: 36.77
70 Ni=37,Nj=37,Nk=728271: Trial 4: GFLOPS: 36.78
71 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=89919>; Trial 0: GFLOPS: 26.27
72 Ni=111,Nj=111,Nk=89919: Trial 1: GFLOPS: 26.03
73 Ni=111,Nj=111,Nk=89919: Trial 2: GFLOPS: 25.96
74 Ni=111,Nj=111,Nk=89919: Trial 3: GFLOPS: 25.93
75 Ni=111,Nj=111,Nk=89919: Trial 4: GFLOPS: 25.93
76 Specify Matrix dimension Ni, Nj, Nk: <Ni=4096,Nj=4096,Nk=64>; Trial 0: GFLOPS: 262.16
77 Ni=4096,Nj=4096,Nk=64: Trial 1: GFLOPS: 261.84
78 Ni=4096,Nj=4096,Nk=64: Trial 2: GFLOPS: 261.70
79 Ni=4096,Nj=4096,Nk=64: Trial 3: GFLOPS: 261.64
80 Ni=4096,Nj=4096,Nk=64: Trial 4: GFLOPS: 261.65
81 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>; Trial 0: GFLOPS: 265.32
82 Ni=2048,Nj=2048,Nk=256: Trial 1: GFLOPS: 265.95
83 Ni=2048,Nj=2048,Nk=256: Trial 2: GFLOPS: 265.97
84 Ni=2048,Nj=2048,Nk=256: Trial 3: GFLOPS: 265.48
85 Ni=2048,Nj=2048,Nk=256: Trial 4: GFLOPS: 265.89
86 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=1024>; Trial 0: GFLOPS: 264.97
87 Ni=8192,Nj=8192,Nk=1024: Trial 1: GFLOPS: 264.94
88 Ni=8192,Nj=8192,Nk=1024: Trial 2: GFLOPS: 264.94
89 Ni=8192,Nj=8192,Nk=1024: Trial 3: GFLOPS: 264.94
90 Ni=8192,Nj=8192,Nk=1024: Trial 4: GFLOPS: 264.94
91 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=16384>; Trial 0: GFLOPS: 58.48
92 Ni=8192,Nj=8192,Nk=16384: Trial 1: GFLOPS: 58.45
93 Ni=8192,Nj=8192,Nk=16384: Trial 2: GFLOPS: 58.47
94 Ni=8192,Nj=8192,Nk=16384: Trial 3: GFLOPS: 58.47
95 Ni=8192,Nj=8192,Nk=16384: Trial 4: GFLOPS: 58.47
96 Specify Matrix dimension Ni, Nj, Nk: <Ni=2048,Nj=2048,Nk=256>; Trial 0: GFLOPS: 264.97
97 Ni=2048,Nj=2048,Nk=256: Trial 1: GFLOPS: 264.97
98 Ni=2048,Nj=2048,Nk=256: Trial 2: GFLOPS: 264.97
99 Ni=2048,Nj=2048,Nk=256: Trial 3: GFLOPS: 264.97
100 Ni=2048,Nj=2048,Nk=256: Trial 4: GFLOPS: 264.97
101 Specify Matrix dimension Ni, Nj, Nk: <Ni=8192,Nj=8192,Nk=26144>; Trial 0: GFLOPS: 8.55
102 Ni=8192,Nj=8192,Nk=26144: Trial 1: GFLOPS: 8.59
103 Ni=8192,Nj=8192,Nk=26144: Trial 2: GFLOPS: 88.67
104 Ni=8192,Nj=8192,Nk=26144: Trial 3: GFLOPS: 88.67
105 Ni=8192,Nj=8192,Nk=26144: Trial 4: GFLOPS: 88.78
106 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=16>; Trial 0: GFLOPS: 5.56
107 Ni=16,Nj=16,Nk=16: Trial 1: GFLOPS: 5.64
108 Ni=16,Nj=16,Nk=16: Trial 2: GFLOPS: 5.61
109 Ni=16,Nj=16,Nk=16: Trial 3: GFLOPS: 5.61
110 Ni=16,Nj=16,Nk=16: Trial 4: GFLOPS: 5.61
111 Specify Matrix dimension Ni, Nj, Nk: <Ni=16,Nj=16,Nk=4194384>; Trial 0: GFLOPS: 187.06
112 Ni=16,Nj=16,Nk=4194384: Trial 1: GFLOPS: 187.06
113 Ni=16,Nj=16,Nk=4194384: Trial 2: GFLOPS: 187.30
114 Ni=16,Nj=16,Nk=4194384: Trial 3: GFLOPS: 187.30
115 Ni=16,Nj=16,Nk=4194384: Trial 4: GFLOPS: 187.30
116 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=999>; Trial 0: GFLOPS: 208.37
117 Ni=111,Nj=111,Nk=999: Trial 1: GFLOPS: 219.91
118 Ni=111,Nj=111,Nk=999: Trial 2: GFLOPS: 214.64
119 Ni=111,Nj=111,Nk=999: Trial 3: GFLOPS: 220.45
120 Ni=111,Nj=111,Nk=999: Trial 4: GFLOPS: 208.84
121 Specify Matrix dimension Ni, Nj, Nk: <Ni=333,Nj=333,Nk=89919>; Trial 0: GFLOPS: 209.92
122 Ni=333,Nj=333,Nk=89919: Trial 1: GFLOPS: 208.98
123 Ni=333,Nj=333,Nk=89919: Trial 2: GFLOPS: 205.89
124 Ni=333,Nj=333,Nk=89919: Trial 3: GFLOPS: 205.81
125 Ni=333,Nj=333,Nk=89919: Trial 4: GFLOPS: 205.27
126 Specify Matrix dimension Ni, Nj, Nk: <Ni=111,Nj=111,Nk=89919>; Trial 0: GFLOPS: 177.88
127 Ni=111,Nj=111,Nk=89919: Trial 1: GFLOPS: 177.21
128 Ni=111,Nj=111,Nk=89919: Trial 2: GFLOPS: 175.35
129 Ni=111,Nj=111,Nk=89919: Trial 3: GFLOPS: 175.97
130 Ni=111,Nj=111,Nk=89919: Trial 4: GFLOPS: 176.02
131 Specify Matrix dimension Ni, Nj, Nk: <Ni=37,Nj=37,Nk=728271>; Trial 0: GFLOPS: 11.21
132 Ni=37,Nj=37,Nk=728271: Trial 1: GFLOPS: 11.22
133 Ni=37,Nj=37,Nk=728271: Trial 2: GFLOPS: 11.22
134 Ni=37,Nj=37,Nk=728271: Trial 3: GFLOPS: 11.20
135 Ni=37,Nj=37,Nk=728271: Trial 4: GFLOPS: 11.15

```

4. Atbt_basic and atbt_shared when block size is 32 (shared is optimized)