

## Cpu와 Gpu 연산 속도 비교

### 1. Mul cpu, gpu

```
Dot Product of matrix A(m x n) and matrix B(n x k)
please type in m n and k
3 3
3
matrix A :
1 2 3
4 5 6
7 8 9

matrix B :
1 -2 3
3 5 2
-1 3 -4

transpose
mul_cpu[0][0] : 4 , mul_gpu[0][0] : 4
mul_cpu[0][1] : 17 , mul_gpu[0][1] : 17
mul_cpu[0][2] : -5 , mul_gpu[0][2] : -5

mul_cpu[1][0] : 13 , mul_gpu[1][0] : 13
mul_cpu[1][1] : 35 , mul_gpu[1][1] : 35
mul_cpu[1][2] : -2 , mul_gpu[1][2] : -2

mul_cpu[2][0] : 22 , mul_gpu[2][0] : 22
mul_cpu[2][1] : 53 , mul_gpu[2][1] : 53
mul_cpu[2][2] : 1 , mul_gpu[2][2] : 1

Time elapsed on matrix multiplication of 3x3 . 3x3 on GPU: 0.387744 ms.
Time elapsed on matrix multiplication of 3x3 . 3x3 on CPU: 0.002688 ms.
```

### 2. Div cpu, gpu

```
Dot Product of matrix A(m x n) and matrix B(n x k)
please type in m n and k
3 3
3
matrix A :
1 2 3
4 5 6
7 8 9

matrix B :
1 -2 3
3 5 2
-1 3 -4

transpose
div_cpu[0][0] : 6 , div_gpu[0][0] : 6
div_cpu[0][1] : 19 , div_gpu[0][1] : 19
div_cpu[0][2] : -7 , div_gpu[0][2] : -7

div_cpu[1][0] : 12 , div_gpu[1][0] : 12
div_cpu[1][1] : 49 , div_gpu[1][1] : 49
div_cpu[1][2] : -13 , div_gpu[1][2] : -13

div_cpu[2][0] : 18 , div_gpu[2][0] : 18
div_cpu[2][1] : 79 , div_gpu[2][1] : 79
div_cpu[2][2] : -19 , div_gpu[2][2] : -19

Time elapsed on matrix multiplication of 3x3 . 3x3 on GPU: 0.399072 ms.
Time elapsed on matrix multiplication of 3x3 . 3x3 on CPU: 0.002656 ms.
incorrect results... suggest to change the BLOCK_SIZE !!
```

### 3. convolution

| kernel size | 3x3          |            | 5x5           |            |
|-------------|--------------|------------|---------------|------------|
| input size  | CPU          | gpu        | CPU           | gpu        |
| 8x8         | 0.054432ms   | 0.351360ms | 0.025664ms    | 0.349184ms |
| 512x512     | 823.728455ms | 0.892768ms | 1047.462769ms | 0.70752ms  |

8\*8 , 5\*5

```

please type in input : m , filter : n
0
3
input matrix :
0.461156 [0] 0.761052 [1] 0.704735 [2] 0.398521 [3] 0.593859 [4] 0.983687 [5] 0.756583 [6] 0.287489 [7]
0.189493 [8] 0.688716 [9] 0.527694 [10] 0.105131 [11] 0.552677 [12] 0.046759 [13] 0.037438 [14] 0.972445 [15]
0.817028 [16] 0.338865 [17] 0.661534 [18] 0.995617 [19] 0.231935 [20] 0.307128 [21] 0.135914 [22] 0.008638 [23]
0.683012 [24] 0.260610 [25] 0.220827 [26] 0.151386 [27] 0.197416 [28] 0.094867 [29] 0.832794 [30] 0.658572 [31]
0.855919 [32] 0.537529 [33] 0.057093 [34] 0.449778 [35] 0.521216 [36] 0.813676 [37] 0.737267 [38] 0.710709 [39]
0.502292 [40] 0.264961 [41] 0.815840 [42] 0.055068 [43] 0.311720 [44] 0.853278 [45] 0.027514 [46] 0.128748 [47]
0.102143 [48] 0.689048 [49] 0.124365 [50] 0.424078 [51] 0.996176 [52] 0.260279 [53] 0.432716 [54] 0.670188 [55]
0.520889 [56] 0.653544 [57] 0.830575 [58] 0.718305 [59] 0.748411 [60] 0.663369 [61] 0.376877 [62] 0.604330 [63]

filter matrix :
0.200898 [0] 0.433969 [1] 0.054107 [2]
0.722114 [3] 0.247645 [4] 0.791374 [5]
0.432824 [6] 0.750037 [7] 0.056335 [8]

cpu_matrix_convolution
=====cpu convolution matrix=====
1.831103 1.890432 2.237266 1.262980 1.365836 1.589474
2.066460 1.856439 1.309597 1.501873 0.687966 1.043321
1.856343 1.072528 1.322124 1.182015 1.889751 1.862263
1.520768 1.644311 1.097811 1.524714 2.063684 2.145892
2.089329 1.009457 1.512338 2.098183 1.606659 1.722208
1.430291 2.220530 2.128249 1.861024 2.403372 1.626769
=====gpu convolution matrix=====
1.831103 1.890432 2.237266 1.262980 1.365836 1.589474
2.066460 1.856438 1.309597 1.501873 0.687966 1.043321
1.856343 1.072528 1.322124 1.182015 1.889751 1.862263
1.520768 1.644311 1.097811 1.524714 2.063684 2.145892
2.089329 1.009457 1.512338 2.098183 1.606659 1.722208
1.430291 2.220530 2.128249 1.861024 2.403372 1.626769

cpu[0][0] : 1.831103 = gpu[0][0] : 1.831103 , i*k+j = [0]
cpu[0][1] : 1.890432 = gpu[0][1] : 1.890432 , i*k+j = [1]
cpu[0][2] : 2.237266 = gpu[0][2] : 2.237266 , i*k+j = [2]
cpu[0][3] : 1.262980 = gpu[0][3] : 1.262980 , i*k+j = [3]
cpu[0][4] : 1.365836 = gpu[0][4] : 1.365836 , i*k+j = [4]
cpu[0][5] : 1.589474 = gpu[0][5] : 1.589474 , i*k+j = [5]

cpu[1][0] : 2.066460 = gpu[1][0] : 2.066460 , i*k+j = [6]
cpu[1][1] : 1.856439 = gpu[1][1] : 1.856438 , i*k+j = [7]
cpu[1][2] : 1.309597 = gpu[1][2] : 1.309597 , i*k+j = [8]
cpu[1][3] : 1.501873 = gpu[1][3] : 1.501873 , i*k+j = [9]
cpu[1][4] : 0.687966 = gpu[1][4] : 0.687966 , i*k+j = [10]
cpu[1][5] : 1.043321 = gpu[1][5] : 1.043321 , i*k+j = [11]

cpu[2][0] : 1.856343 = gpu[2][0] : 1.856343 , i*k+j = [12]
cpu[2][1] : 1.072528 = gpu[2][1] : 1.072528 , i*k+j = [13]
cpu[2][2] : 1.322124 = gpu[2][2] : 1.322124 , i*k+j = [14]
cpu[2][3] : 1.182015 = gpu[2][3] : 1.182015 , i*k+j = [15]
cpu[2][4] : 1.889751 = gpu[2][4] : 1.889751 , i*k+j = [16]
cpu[2][5] : 1.862263 = gpu[2][5] : 1.862263 , i*k+j = [17]

cpu[3][0] : 1.520768 = gpu[3][0] : 1.520768 , i*k+j = [18]
cpu[3][1] : 1.644311 = gpu[3][1] : 1.644311 , i*k+j = [19]
cpu[3][2] : 1.097811 = gpu[3][2] : 1.097811 , i*k+j = [20]
cpu[3][3] : 1.524714 = gpu[3][3] : 1.524714 , i*k+j = [21]
cpu[3][4] : 2.063684 = gpu[3][4] : 2.063684 , i*k+j = [22]
cpu[3][5] : 2.145892 = gpu[3][5] : 2.145892 , i*k+j = [23]

cpu[4][0] : 2.089329 = gpu[4][0] : 2.089329 , i*k+j = [24]
cpu[4][1] : 1.009457 = gpu[4][1] : 1.009457 , i*k+j = [25]
cpu[4][2] : 1.512338 = gpu[4][2] : 1.512338 , i*k+j = [26]
cpu[4][3] : 2.098183 = gpu[4][3] : 2.098183 , i*k+j = [27]
cpu[4][4] : 1.606659 = gpu[4][4] : 1.606659 , i*k+j = [28]
cpu[4][5] : 1.722208 = gpu[4][5] : 1.722208 , i*k+j = [29]

cpu[5][0] : 1.430291 = gpu[5][0] : 1.430291 , i*k+j = [30]
cpu[5][1] : 2.220530 = gpu[5][1] : 2.220530 , i*k+j = [31]
cpu[5][2] : 2.128249 = gpu[5][2] : 2.128249 , i*k+j = [32]
cpu[5][3] : 1.861024 = gpu[5][3] : 1.861024 , i*k+j = [33]
cpu[5][4] : 2.403372 = gpu[5][4] : 2.403372 , i*k+j = [34]
cpu[5][5] : 1.626769 = gpu[5][5] : 1.626769 , i*k+j = [35]

Time elapsed on matrix convolution of 8x3 . 3x6 on GPU: 0.351360 ms.
Time elapsed on matrix convolution of 8x3 . 3x6 on CPU: 0.054432 ms.

```

8\*8, 5\*5

```
please type in input : m , filter : n
8
5
input matrix :
0.461156 [0] 0.761052 [1] 0.704735 [2] 0.398521 [3] 0.593859 [4] 0.983687 [5] 0.756583 [6] 0.287489 [7]
0.189493 [8] 0.688716 [9] 0.527694 [10] 0.185131 [11] 0.552677 [12] 0.046759 [13] 0.637438 [14] 0.972445 [15]
0.817028 [16] 0.338865 [17] 0.661534 [18] 0.995617 [19] 0.231935 [20] 0.397128 [21] 0.135914 [22] 0.008638 [23]
0.683012 [24] 0.260610 [25] 0.220827 [26] 0.151386 [27] 0.197416 [28] 0.094867 [29] 0.832794 [30] 0.658572 [31]
0.855919 [32] 0.537529 [33] 0.057093 [34] 0.449778 [35] 0.521216 [36] 0.813676 [37] 0.737267 [38] 0.710709 [39]
0.502392 [40] 0.264961 [41] 0.815840 [42] 0.055068 [43] 0.311720 [44] 0.853278 [45] 0.027514 [46] 0.128748 [47]
0.192143 [48] 0.689048 [49] 0.124365 [50] 0.424078 [51] 0.996176 [52] 0.260279 [53] 0.432716 [54] 0.679188 [55]
0.520889 [56] 0.653544 [57] 0.830575 [58] 0.718305 [59] 0.748411 [60] 0.663369 [61] 0.376877 [62] 0.604330 [63]

filter matrix :
0.200898 [0] 0.433969 [1] 0.054107 [2] 0.722114 [3] 0.247645 [4]
0.791374 [5] 0.432824 [6] 0.750037 [7] 0.056335 [8] 0.248663 [9]
0.805105 [10] 0.368056 [11] 0.101941 [12] 0.832619 [13] 0.496804 [14]
0.294084 [15] 0.521667 [16] 0.621169 [17] 0.718162 [18] 0.517844 [19]
0.881448 [20] 0.150879 [21] 0.197032 [22] 0.402337 [23] 0.804423 [24]

cpu_matrix_convolution
=====cpu convolution matrix=====
5.809212 4.923330 5.287128 5.294955
4.950894 5.134673 4.846055 5.070051
5.789652 4.963806 4.654154 4.599612
5.240188 5.603030 5.534059 5.611770
=====gpu convolution matrix=====
5.809212 4.923329 5.287128 5.294955
4.950894 5.134673 4.846055 5.070051
5.789652 4.963805 4.654154 4.599612
5.240188 5.603030 5.534059 5.611770
cpu[0][0] : 5.809212 == gpu[0][0] : 5.809212 , i*k+j = [0]
cpu[0][1] : 4.923330 == gpu[0][1] : 4.923329 , i*k+j = [1]
cpu[0][2] : 5.287128 == gpu[0][2] : 5.287128 , i*k+j = [2]
cpu[0][3] : 5.294955 == gpu[0][3] : 5.294955 , i*k+j = [3]

cpu[1][0] : 4.950894 == gpu[1][0] : 4.950894 , i*k+j = [4]
cpu[1][1] : 5.134673 == gpu[1][1] : 5.134673 , i*k+j = [5]
cpu[1][2] : 4.846055 == gpu[1][2] : 4.846055 , i*k+j = [6]
cpu[1][3] : 5.070051 == gpu[1][3] : 5.070051 , i*k+j = [7]

cpu[2][0] : 5.789652 == gpu[2][0] : 5.789652 , i*k+j = [8]
cpu[2][1] : 4.963806 == gpu[2][1] : 4.963805 , i*k+j = [9]
cpu[2][2] : 4.654154 == gpu[2][2] : 4.654154 , i*k+j = [10]
cpu[2][3] : 4.599612 == gpu[2][3] : 4.599612 , i*k+j = [11]

cpu[3][0] : 5.240188 == gpu[3][0] : 5.240188 , i*k+j = [12]
cpu[3][1] : 5.603030 == gpu[3][1] : 5.603030 , i*k+j = [13]
cpu[3][2] : 5.534059 == gpu[3][2] : 5.534059 , i*k+j = [14]
cpu[3][3] : 5.611770 == gpu[3][3] : 5.611770 , i*k+j = [15]

Time elapsed on matrix convolution of 8x5 . 5x4 on GPU: 0.349184 ms.
Time elapsed on matrix convolution of 8x5 . 5x4 on CPU: 0.025664 ms.
```