CS 4370 - Parallel Programming

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Project 2: Tiled Matrix Multiplication - Project Report

Report

For this lab, we were able to get our code fully functional and working. We executed the code using the command, `nvcc Project2.cu && ./a.out`. The program does both cpu multiplication and gpu tiled matrix multiplication correctly. For runtimes for the configurations and the performance differentials are listed in the table below.

Runtime Table

Time	**128 * 128**	**1024 * 1024**	**4096 * 4096**
CPU Comp Time (s)	0.011143	5.552852	1196.504552
GPU Comp Time (ms)	0.075584 (Tile width of 8) / 0.06752 (Tile width of 16)	6.23139 (Tile width of 8) / 5.28634 (Tile width of 16)	388.023 (Tile width of 8) / 286.391 (Tile width of 16) / 203.53 (Tile width of 32)
Speedup	-85% / -84%	-10% / 5%	208% / 318%

Execution Results

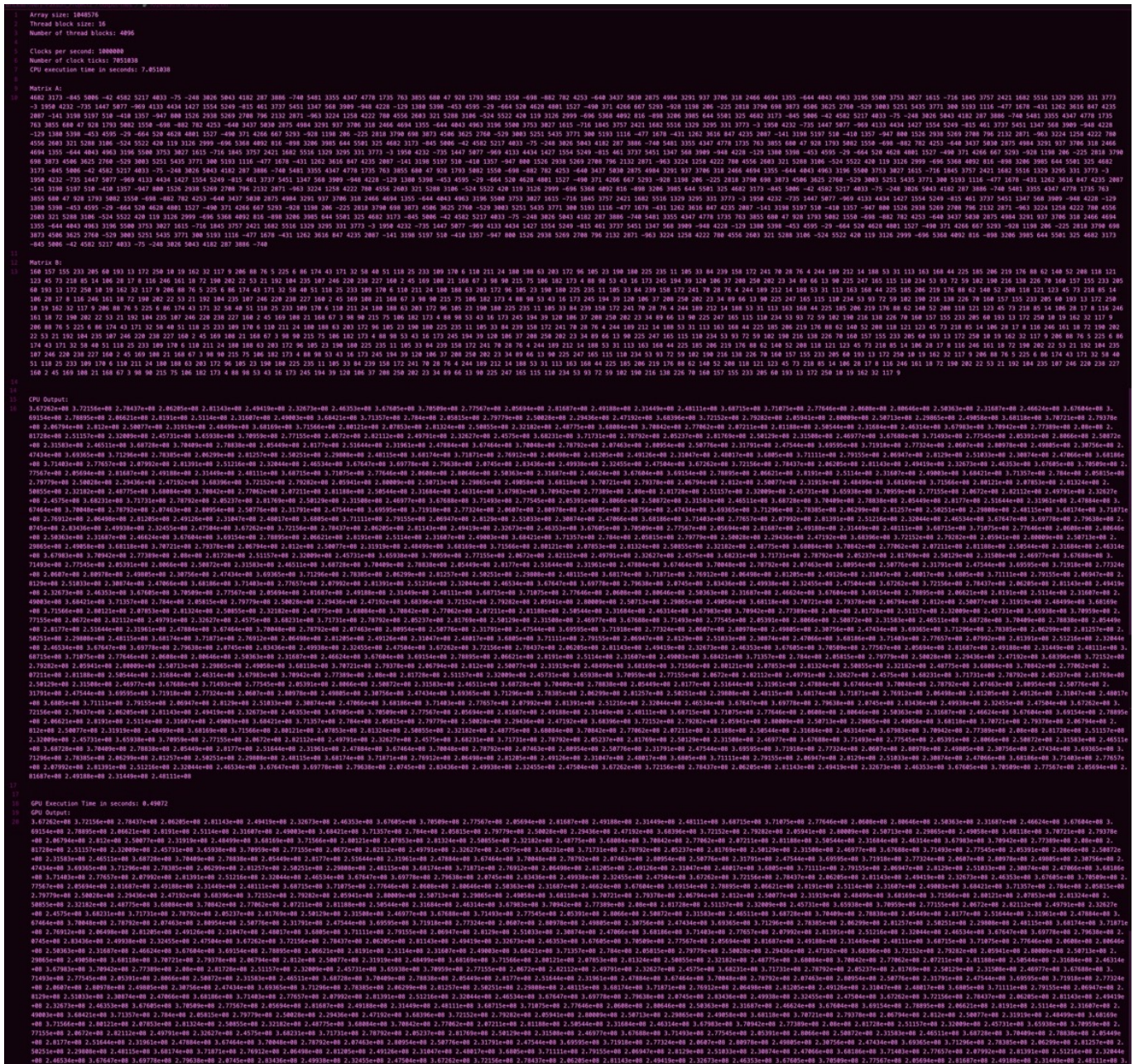
8*8 matrix with a tile width of 4:

```
Array size: 64
Thread block size: 4
Number of thread blocks: 4

Clocks per second: 1000000
Number of clock ticks: 4
CPU execution time in seconds: 0.000004

Matrix A:
4682   3173   -845 5006   -42 4582   5217   4033
-75 -248 3026   5043   4182   287   3886   -740
5481   3355   4347   4778   1735   763   3855   680
47   928   1793   5082   1550   -698 -882 782
4253   -640 3437   5030   2875   4984   3291   937
3706   318   2466   4694   1355   -644 4043   4963
3196   5500   3753   3027   1615   -716 1845   3757
2421   1682   5516   1329   3295   331   3773   -3

Matrix B:
160   157   155   233   205   60   193   13
172   250   10   19   162   32   117   9
206   88   76   5   225   6   86   174
43   171   32   58   40   51   118   25
233   109   170   6   110   211   24   180
188   63   203   172   96   105   23   190
180   225   235   11   105   33   84   239
158   172   241   70   28   76   4   244

CPU Output:
3.76397e+06   4.46158e+06   3.97437e+06   2.56486e+06   2.57991e+06   1.58361e+06   2.35164e+06   3.16148e+06
2.39647e+06   2.27586e+06   1.88132e+06   350839   1.7019e+06   1.24745e+06   1.24225e+06   2.20488e+06
3.904e+06   4.12036e+06   2.88602e+06   1.87133e+06   3.52422e+06   1.33108e+06   2.77374e+06   2.52181e+06
949742   1.32722e+06   418455   266586   799454   586542   821707   574385
3.842e+06   3.19931e+06   3.57469e+06   2.264e+06   2.90922e+06   1.82161e+06   2.0989e+06   3.25295e+06
3.06403e+06   3.55146e+06   3.16104e+06   1.44337e+06   2.20456e+06   1.21562e+06   1.8956e+06   2.89626e+06
3.52803e+06   3.91691e+06   2.40069e+06   1.21332e+06   2.91952e+06   1.15666e+06   2.13257e+06   2.33207e+06
3.37874e+06   2.74168e+06   2.36709e+06   818708   2.85336e+06   1.15424e+06   1.69886e+06   2.59662e+06

GPU Execution Time in seconds: 0.027648
GPU Output:
3.76397e+06   4.46158e+06   3.97437e+06   2.56486e+06   2.57991e+06   1.58361e+06   2.35164e+06   3.16148e+06
2.39647e+06   2.27586e+06   1.88132e+06   350839   1.7019e+06   1.24745e+06   1.24225e+06   2.20488e+06
3.904e+06   4.12036e+06   2.88602e+06   1.87133e+06   3.52422e+06   1.33108e+06   2.77374e+06   2.52181e+06
949742   1.32722e+06   418455   266586   799454   586542   821707   574385
3.842e+06   3.19931e+06   3.57469e+06   2.264e+06   2.90922e+06   1.82161e+06   2.0989e+06   3.25295e+06
3.06403e+06   3.55146e+06   3.16104e+06   1.44337e+06   2.20456e+06   1.21562e+06   1.8956e+06   2.89626e+06
3.52803e+06   3.91691e+06   2.40069e+06   1.21332e+06   2.91952e+06   1.15666e+06   2.13257e+06   2.33207e+06
3.37874e+06   2.74168e+06   2.36709e+06   818708   2.85336e+06   1.15424e+06   1.69886e+06   2.59662e+06

TEST PASSED
```

128*128 matrix with a tile width of 8:

```
Array size: 16384
Thread block size: 8
Number of thread blocks: 256

Clocks per second: 1000000
Number of clock ticks: 12932
CPU execution time in seconds: 0.012932

Matrix A:
4682 3173 -845 5006 -42 4582 5217 4033 -75 -248 3026 5043 4182 287 3886 -740 5481 3355 4347 4778 1735 763 3855 680 47 928 1793 5082 1550 -698 -882 782 4253 -640 3437 5030 2875 4984 3291 937
3706 318 2466 4694 1355 -644 4043 4963 3196 5500 3753 3027 1615 -716 1845 3757 2421 1682 5516 1329 3295 331 3773 -3 1950 4232 -735 1447 5077 -969 4133 4434 1427 1554 5249 -815 461 3737 5451
1347 568 3909 -948 4228 -129 1380 5398 -453 4595 -29 -664 520 4628 4801 1527 -490 371 4266 667 5293 -928 1198 206 -225 2818 3790 698 3873 4506 3625 2760 -529 3003 5251 5435 3771 300 5193 1116
-477 1678 -431 1262 3616 847 4235 2087 -141

Matrix B:
160 157 155 233 205 60 193 13 172 250 10 19 162 32 117 9 206 88 76 5 225 6 86 174 43 171 32 58 40 51 118 25 233 109 170 6 110 211 24 180 188 63 203 172 96 105 23 190 180 225 235 11 105 33 84
239 158 172 241 70 28 76 4 244 189 212 14 188 53 31 113 163 168 44 225 185 206 219 176 88 62 140 52 208 118 121 123 45 73 218 85 14 106 28 17 8 116 246 161 18 72 190 202 22 53 21 192 104 235
107 246 220 238 227 160 2 45 169 108 21 168 67 3 98 90 215 75 106

CPU Output:
4.85583e+07 4.64994e+07 3.60377e+07 2.54219e+07 3.55543e+07 3.21106e+07 2.71499e+07 3.27279e+07 4.72397e+07 4.76792e+07 3.29305e+07 2.67279e+07 3.49154e+07 3.09593e+07 2.92394e+07 3.12407e+07
4.69259e+07 4.6622e+07 3.71314e+07 2.56271e+07 3.6358e+07 3.26254e+07 2.79544e+07 3.24244e+07 4.65808e+07 4.84451e+07 3.43854e+07 2.72633e+07 3.40767e+07 3.18711e+07 2.84911e+07 3.05706e+07 4.
67202e+07 4.64058e+07 3.61034e+07 2.71798e+07 3.74415e+07 3.14823e+07 3.02675e+07 3.1734e+07 4.63705e+07 4.76396e+07 3.65707e+07 2.67802e+07 3.62315e+07 3.21613e+07 3.12925e+07 3.0152e+07 4.
56137e+07 4.60408e+07 3.44061e+07 2.65345e+07 3.70755e+07 2.9982e+07 3.00099e+07 3.26255e+07 4.72232e+07 4.79378e+07 3.36432e+07 2.51609e+07 3.45164e+07 3.13347e+07 2.92591e+07 2.81355e+07 4.
58948e+07 4.5495e+07 3.49493e+07 2.6391e+07 3.65528e+07 3.30604e+07 3.00571e+07 3.25698e+07 4.62832e+07 4.60345e+07 3.54068e+07 2.53734e+07 3.56758e+07 3.00538e+07 2.82991e+07 3.13818e+07 4.
76282e+07 4.90672e+07 3.69956e+07 2.45419e+07 3.37594e+07 3.27373e+07 2.77778e+07 3.25802e+07 4.67635e+07 4.58666e+07 3.50708e+07 2.56728e+07 3.50781e+07 3.1794e+07 2.85254e+07 3.27609e+07 4.
74023e+07 4.76949e+07 3.76502e+07 2.75536e+07 3.53918e+07 3.20078e+07 2.9655e+07 3.31012e+07 4.59598e+07 4.62647e+07 3.5191e+07 2.72411e+07 3.5737e+07 3.17419e+07 3.02747e+07 3.15534e+07 4.
82411e+07 4.76849e+07 3.42971e+07 2.73033e+07 3.55976e+07 3.1836e+07 2.84387e+07 3.03643e+07 4.48763e+07 4.74911e+07 3.38801e+07 2.65106e+07 3.59473e+07 3.12547e+07 2.94976e+07 3.0184e+07

GPU Execution Time in seconds: 0.033792
GPU Output:
4.85583e+07 4.64994e+07 3.60377e+07 2.54219e+07 3.55543e+07 3.21106e+07 2.71499e+07 3.27279e+07 4.72397e+07 4.76792e+07 3.29305e+07 2.67279e+07 3.49154e+07 3.09593e+07 2.92394e+07 3.12407e+07
4.69259e+07 4.6622e+07 3.71314e+07 2.56271e+07 3.6358e+07 3.26254e+07 2.79544e+07 3.24244e+07 4.65808e+07 4.84451e+07 3.43854e+07 2.72633e+07 3.40767e+07 3.18711e+07 2.84911e+07 3.05706e+07 4.
67202e+07 4.64058e+07 3.61034e+07 2.71798e+07 3.74415e+07 3.14823e+07 3.02675e+07 3.1734e+07 4.63705e+07 4.76396e+07 3.65707e+07 2.67802e+07 3.62315e+07 3.21613e+07 3.12925e+07 3.0152e+07 4.
56137e+07 4.60408e+07 3.44061e+07 2.65345e+07 3.70755e+07 2.9982e+07 3.00099e+07 3.26255e+07 4.72232e+07 4.79378e+07 3.36432e+07 2.51609e+07 3.45164e+07 3.13347e+07 2.92591e+07 2.81355e+07 4.
58948e+07 4.5495e+07 3.49493e+07 2.6391e+07 3.65528e+07 3.30604e+07 3.00571e+07 3.25698e+07 4.62832e+07 4.60345e+07 3.54068e+07 2.53734e+07 3.56758e+07 3.00538e+07 2.82991e+07 3.13818e+07 4.
76282e+07 4.90672e+07 3.69956e+07 2.45419e+07 3.37594e+07 3.27373e+07 2.77778e+07 3.25802e+07 4.67635e+07 4.58666e+07 3.50708e+07 2.56728e+07 3.50781e+07 3.1794e+07 2.85254e+07 3.27609e+07 4.
74023e+07 4.76949e+07 3.76502e+07 2.75536e+07 3.53918e+07 3.20078e+07 2.9655e+07 3.31012e+07 4.59598e+07 4.62647e+07 3.5191e+07 2.72411e+07 3.5737e+07 3.17419e+07 3.02747e+07 3.15534e+07 4.
82411e+07 4.76849e+07 3.42971e+07 2.73033e+07 3.55976e+07 3.1836e+07 2.84387e+07 3.03643e+07 4.48763e+07 4.74911e+07 3.38801e+07 2.65106e+07 3.59473e+07 3.12547e+07 2.94976e+07 3.0184e+07

TEST PASSED
```

1024*1024 matrix with a tile width of 16:



4096*4096 matrix with a tile width of 32 (had to zoom out a lot to capture a screenshot, but TEST PASSED can still be seen at the bottom of the image, and a textfile version of this output can be found in the output-files folder):