Griffin Maxwell

9/26/17

CSE 5441

Programming Assignment 1 – Results and Summary

# Results at AFFECT\_RATE=0.15 and EPSILON=0.15:

These values for AFFECT\_RATE and EPSILON were chosen to try to get the total runtime with testgrid\_400\_12206 to be 3-6 minutes. The console output is below:

[maxwell.362@beta CSE5441-AMR]$ time ./amr 0.15 0.15 < /class/cse5441/testgrid\_400\_12206

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temperature dissipation converged in 43234 iterations

with max DSV = 0.088556 and min DSV = 0.075273

AFFECT\_RATE = 0.150000; EPSILON = 0.150000

Num boxes = 12206; Num rows = 400; Num columns = 400

elaspsed convergence loop time:

using clock(): 277260000 clicks (277.260010 s)

using time(): 279 s

using clock\_gettime(): 278701.000 ms

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real 4m38.793s

user 4m37.086s

sys 0m0.259s

# Results at AFFECT\_RATE=0.1 and EPSILON=0.1:

The program was also tested with AFFECT\_RATE=0.1 and EPSILON=0.1 against all of the testgrid\* files to compare the how many iterations it took this program to converge with the values provided in the assignment document.

testgrid\_1 (? iterations):

[maxwell.362@beta CSE5441-AMR]$ time ./amr 0.1 0.1 < /class/cse5441/testgrid\_1

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temperature dissipation converged in 52 iterations

with max DSV = 118.918450 and min DSV = 107.278672

AFFECT\_RATE = 0.100000; EPSILON = 0.100000

Num boxes = 9; Num rows = 3; Num columns = 3

elaspsed convergence loop time:

using clock(): 0 clicks (0.000000 s)

using time(): 0 s

using clock\_gettime(): 0.000 ms

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real 0m0.004s

user 0m0.001s

sys 0m0.002s

testgrid\_2 (245 iterations):

[maxwell.362@epsilon cse5441\_lab1]$ time ./amr 0.1 0.1 < /class/cse5441/testgrid\_2

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temperature dissipation converged in 245 iterations

with max DSV = 55.835885 and min DSV = 50.266851

AFFECT\_RATE = 0.100000; EPSILON = 0.100000

Num boxes = 48; Num rows = 16; Num columns = 16

elaspsed convergence loop time:

using clock(): 0 clicks (0.000000 s)

using time(): 0 s

using clock\_gettime(): 4.000 ms

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real 0m0.019s

user 0m0.005s

sys 0m0.003s

testgrid\_50\_78 (1,508 iterations):

[maxwell.362@beta CSE5441-AMR]$ time ./amr 0.1 0.1 < /class/cse5441/testgrid\_50\_78

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temperature dissipation converged in 1508 iterations

with max DSV = 23.369508 and min DSV = 21.035843

AFFECT\_RATE = 0.100000; EPSILON = 0.100000

Num boxes = 78; Num rows = 50; Num columns = 50

elaspsed convergence loop time:

using clock(): 50000 clicks (0.050000 s)

using time(): 0 s

using clock\_gettime(): 53.000 ms

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real 0m0.099s

user 0m0.052s

sys 0m0.004s

testgrid\_50\_201 (2,286 iterations):

[maxwell.362@beta CSE5441-AMR]$ time ./amr 0.1 0.1 < /class/cse5441/testgrid\_50\_201

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temperature dissipation converged in 2286 iterations

with max DSV = 4.788754 and min DSV = 4.309887

AFFECT\_RATE = 0.100000; EPSILON = 0.100000

Num boxes = 201; Num rows = 50; Num columns = 50

elaspsed convergence loop time:

using clock(): 150000 clicks (0.150000 s)

using time(): 0 s

using clock\_gettime(): 166.000 ms

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real 0m0.186s

user 0m0.156s

sys 0m0.003s

testgrid\_200\_1166 (14,461 iterations):

[maxwell.362@beta CSE5441-AMR]$ time ./amr 0.1 0.1 < /class/cse5441/testgrid\_200\_1166

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temperature dissipation converged in 14458 iterations

with max DSV = 0.812728 and min DSV = 0.731459

AFFECT\_RATE = 0.100000; EPSILON = 0.100000

Num boxes = 1166; Num rows = 200; Num columns = 200

elaspsed convergence loop time:

using clock(): 5310000 clicks (5.310000 s)

using time(): 5 s

using clock\_gettime(): 5309.000 ms

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real 0m5.322s

user 0m5.316s

sys 0m0.001s

testgrid\_400\_1636 (22,283 iterations):

[maxwell.362@beta CSE5441-AMR]$ time ./amr 0.1 0.1 < /class/cse5441/testgrid\_400\_1636

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temperature dissipation converged in 22280 iterations

with max DSV = 1.181786 and min DSV = 1.063610

AFFECT\_RATE = 0.100000; EPSILON = 0.100000

Num boxes = 1636; Num rows = 400; Num columns = 400

elaspsed convergence loop time:

using clock(): 11680000 clicks (11.680000 s)

using time(): 12 s

using clock\_gettime(): 11684.000 ms

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real 0m11.698s

user 0m11.692s

sys 0m0.001s

testgrid\_400\_12206 (75,269 iterations):

[maxwell.362@beta CSE5441-AMR]$ time ./amr 0.1 0.1 < /class/cse5441/testgrid\_400\_12206

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temperature dissipation converged in 75197 iterations

with max DSV = 0.086671 and min DSV = 0.078004

AFFECT\_RATE = 0.100000; EPSILON = 0.100000

Num boxes = 12206; Num rows = 400; Num columns = 400

elaspsed convergence loop time:

using clock(): 436500000 clicks (436.500000 s)

using time(): 437 s

using clock\_gettime(): 436914.000 ms

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real 7m16.986s

user 7m16.435s

sys 0m0.122s

# Summary of Timing Results:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test Grid File | Affect Rate | Epsilon | “Real” Time  to Converge | “clock()” Time to Converge | Expected Iterations to Converge | Actual Iterations to Converge | % error |
| testgrid\_400\_12206 | 0.15 | 0.15 | 4m38.793s | 277.26 s | - | 43,234 | - |
| testgrid\_1 | 0.1 | 0.1 | 0m0.004s | 0.00 s | - | 52 | - |
| testgrid\_2 | 0.1 | 0.1 | 0m0.019s | 0.00 s | 245 | 245 | 0% |
| testgrid\_50\_78 | 0.1 | 0.1 | 0m0.099s | 0.05 s | 1,508 | 1,508 | 0% |
| testgrid\_50\_201 | 0.1 | 0.1 | 0m0.186s | 0.15 s | 2,286 | 2,286 | 0% |
| testgrid\_200\_1166 | 0.1 | 0.1 | 0m5.322s | 5.31 s | 14,461 | 14,458 | 0.021% |
| testgrid\_400\_1636 | 0.1 | 0.1 | 0m11.698s | 11.68 s | 22,283 | 22,280 | 0.013% |
| testgrid\_400\_12206 | 0.1 | 0.1 | 7m16.986s | 436.50 s | 75,269 | 75,197 | 0.096% |

The timing and convergence results are summarized in the table above. As can be seen by the % error column, the number of iterations for my algorithm to converge on each test grid is extremely close to those given in the assignment document. This give me high confidence that my dissipation model very closely matches the one given in the assignment document, which was the goal. These small differences are likely caused by the order in which all the double-precision floating point calculations are done. Even if the error between any of my DSV calculations and the ones used to generate the given numbers is miniscule, the small error can compound over a large number of calculations and a large number of iterations. This is evidenced by the fact that the % error seems to grow as the grid size and number of boxes on the grid grows.

Additionally, the timings of all my runs were fairly reasonable. In order to get a run with the largest grid to last between 3 and 6 minutes, the original values of affect rate and epsilon didn’t have to change too much; affect rate = 0.15 and epsilon = 0.15 makes the program converge in about 4.5 minutes. Furthermore, the time it took to run each test grid grew exponentially as the grid and number of boxes increased. This makes sense because more boxes mean more potential neighbors, which means longer lists of neighbors, which leads to more number crunching to calculate the weighted average adjacent temperature per cell. This, on top of the fact that there are more cells to update per iteration to begin with, is what makes the execution time grow so rapidly. Since this program is currently serial, it can’t gain any of the benefits of parallel processes updating more than one cell at a time, which makes me predict that a more parallelized program will run much faster, and heavily reduce how harsh this exponential growth is.