Parallel Homework #2

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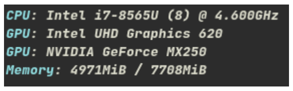
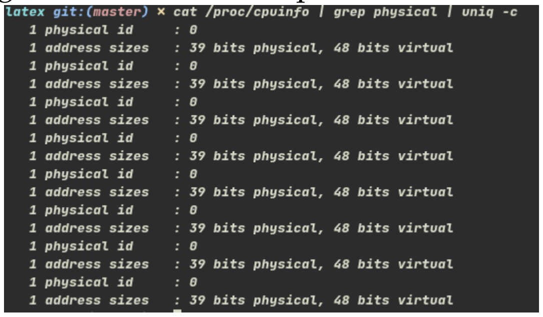
May 11, 2021

Figure 1: Here is the hardware's information



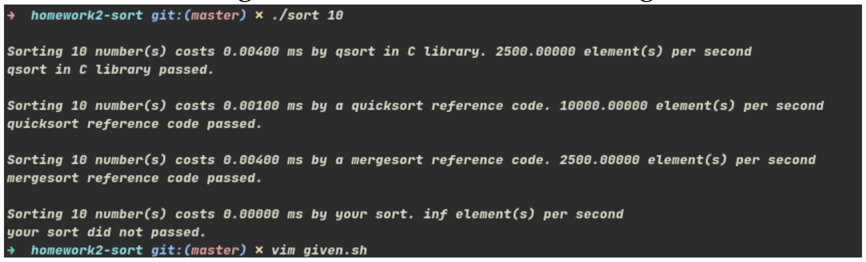
```
CPU: Intel i7-8565U (8) @ 4.600GHz
GPU: Intel UHD Graphics 620
GPU: NVIDIA GeForce MX250
Memory: 4971MiB / 7708MiB
```

Figure 2: Here is the cupcores' information



```
latex git:(master) × cat /proc/cpuinfo | grep physical | uniq -c
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
   1 physical id     : 0
   1 address sizes   : 39 bits physical, 48 bits virtual
```

Figure 3: Here is the test runing



```
→  homework2-sort git:(master) × ./sort 10

Sorting 10 number(s) costs 0.00400 ms by qsort in C library. 2500.00000 element(s) per second
qsort in C library passed.

Sorting 10 number(s) costs 0.00100 ms by a quicksort reference code. 10000.00000 element(s) per second
quicksort reference code passed.

Sorting 10 number(s) costs 0.00400 ms by a mergesort reference code. 2500.00000 element(s) per second
mergesort reference code passed.

Sorting 10 number(s) costs 0.00000 ms by your sort. inf element(s) per second
your sort did not passed.
→  homework2-sort git:(master) × vim given.sh
```

I don't know what the meaning of 'under different threads' is... So I just put the original code and the code using OMP here.

1 running time under different threads

Sorting 10 number(s) costs 0.00200 ms by qsort in C library. 5000.00000 element(s) per second qsort in C library passed.

Sorting 10 number(s) costs 0.00100 ms by a quicksort reference code. 10000.00000 element(s) per second quicksort reference code passed.

Sorting 10 number(s) costs 0.00200 ms by a mergesort reference code. 5000.00000 element(s) per second mergesort reference code passed.

Sorting 100 number(s) costs 0.01200 ms by qsort in C library. 8333.33333 element(s) per second qsort in C library passed.

Sorting 100 number(s) costs 0.00500 ms by a quicksort reference code. 20000.00000 element(s) per second quicksort reference code passed.

Sorting 100 number(s) costs 0.01100 ms by a mergesort reference code. 9090.90909 element(s) per second mergesort reference code passed.

Sorting 1000 number(s) costs 0.14800 ms by qsort in C library. 6756.75676 element(s) per second qsort in C library passed.

Sorting 1000 number(s) costs 0.08500 ms by a quicksort reference code. 11764.70588 element(s) per second quicksort reference code passed.

Sorting 1000 number(s) costs 0.11800 ms by a mergesort reference code. 8474.57627 element(s) per second mergesort reference code passed.

Sorting 10000 number(s) costs 1.93400 ms by qsort in C library. 5170.63082 element(s) per second qsort in C library passed.

Sorting 10000 number(s) costs 1.18100 ms by a quicksort reference code. 8467.40051 element(s) per second quicksort reference code passed.

Sorting 10000 number(s) costs 1.53600 ms by a mergesort reference code. 6510.41667 element(s) per second mergesort reference code passed.

Sorting 100000 number(s) costs 25.19200 ms by qsort in C library. 3969.51413 element(s) per second qsort in C library passed.

Sorting 100000 number(s) costs 20.83600 ms by a quicksort reference code. 4799.38568 element(s) per second quicksort reference code passed.

Sorting 100000 number(s) costs 27.92400 ms by a mergesort reference code. 3581.14883 element(s) per second mergesort reference code passed.

Sorting 1000000 number(s) costs 177.89700 ms by qsort in C library. 5621.23026 element(s) per second qsort in C library passed.

Sorting 1000000 number(s) costs 104.67600 ms by a quicksort reference code. 9553.28824 element(s) per second quicksort reference code passed.

Sorting 1000000 number(s) costs 147.30300 ms by a mergesort reference code. 6788.72800 element(s) per second mergesort reference code passed.

Sorting 10000000 number(s) costs 1969.10700 ms by qsort in C library. 5078.44419 element(s) per second qsort in C library passed.

Sorting 10000000 number(s) costs 1158.48200 ms by a quicksort reference code. 8631.98565 element(s) per second quicksort reference code passed.

Sorting 10000000 number(s) costs 1706.52700 ms by a mergesort reference code. 5859.85455 element(s) per second mergesort reference code passed.

Sorting 100000000 number(s) costs 22948.90000 ms by qsort in C library. 4357.50733 element(s) per second qsort in C library passed.

Sorting 100000000 number(s) costs 13038.44200 ms by a quicksort reference code. 7669.62801 element(s) per second quicksort reference code passed.

Sorting 100000000 number(s) costs 18980.15300 ms by a mergesort reference code. 5268.66143 element(s) per second mergesort reference code passed.

Use OMP: Sorting 10 number(s) costs 0.00200 ms by qsort in C library. 5000.00000 element(s) per second qsort in C library passed.

Sorting 10 number(s) costs 0.00100 ms by a quicksort reference code. 10000.00000 element(s) per second quicksort reference code passed.

Sorting 10 number(s) costs 0.00200 ms by a mergesort reference code. 5000.00000 element(s) per second mergesort reference code passed.

Sorting 100 number(s) costs 0.01100 ms by qsort in C library. 9090.90909 element(s) per second qsort in C library passed.

Sorting 100 number(s) costs 0.00500 ms by a quicksort reference code. 20000.00000 element(s) per second quicksort reference code passed.

Sorting 100 number(s) costs 0.01000 ms by a mergesort reference code. 10000.00000 element(s) per second mergesort reference code passed.

Sorting 1000 number(s) costs 0.13900 ms by qsort in C library. 7194.24460 element(s) per second qsort in C library passed.

Sorting 1000 number(s) costs 0.07400 ms by a quicksort reference code. 13513.51351 element(s) per second quicksort reference code passed.

Sorting 1000 number(s) costs 0.11200 ms by a mergesort reference code. 8928.57143 element(s) per second mergesort reference code passed.

Sorting 10000 number(s) costs 1.52100 ms by qsort in C library. 6574.62196 element(s) per second qsort in C library passed.

Sorting 10000 number(s) costs 1.08100 ms by a quicksort reference code. 9250.69380 element(s) per second quicksort reference code passed.

Sorting 10000 number(s) costs 1.55800 ms by a mergesort reference code. 6418.48524 element(s) per second mergesort reference code passed.

Sorting 100000 number(s) costs 28.70700 ms by qsort in C library. 3483.47093 element(s) per second qsort in C library passed.

Sorting 100000 number(s) costs 19.24300 ms by a quicksort reference code. 5196.69490 element(s) per second quicksort reference code passed.

Sorting 100000 number(s) costs 25.70000 ms by a mergesort reference code. 3891.05058 element(s) per second mergesort reference code passed.

Sorting 1000000 number(s) costs 179.66700 ms by qsort in C library. 5565.85238 element(s) per second qsort in C library passed.

Sorting 1000000 number(s) costs 101.98400 ms by a quicksort reference code. 9805.45968 element(s) per second quicksort reference code passed.

Sorting 1000000 number(s) costs 143.57000 ms by a mergesort reference code. 6965.24344 element(s) per second mergesort reference code passed.

Sorting 10000000 number(s) costs 2026.79300 ms by qsort in C library. 4933.90297 element(s) per second qsort in C library passed.

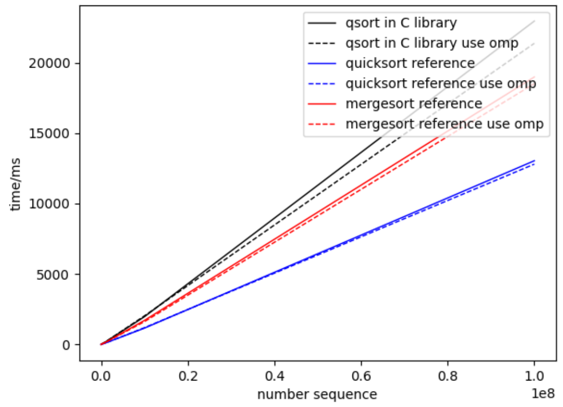
Sorting 10000000 number(s) costs 1189.48300 ms by a quicksort reference code. 8407.01380 element(s) per second quicksort reference code passed.

Sorting 10000000 number(s) costs 1619.14400 ms by a mergesort reference code. 6176.10293 element(s) per second mergesort reference code passed.

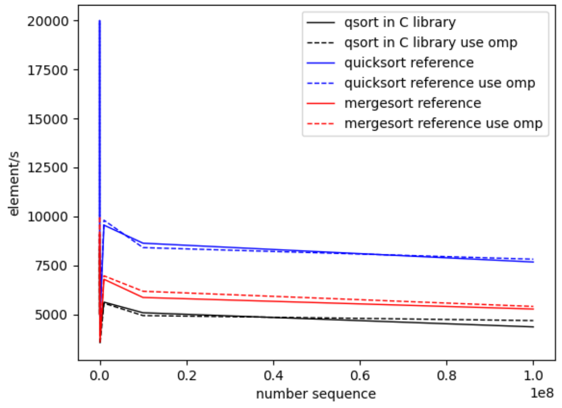
Sorting 100000000 number(s) costs 21370.63600 ms by qsort in C library. 4679.31792 element(s) per second qsort in C library passed.

Sorting 100000000 number(s) costs 12797.54700 ms by a quicksort reference code. 7813.99748 element(s) per second quicksort reference code passed.

Sorting 100000000 number(s) costs 18511.83500 ms by a mergesort reference code. 5401.94962 element(s) per second mergesort reference code passed.



2 memory space consumption under different threads



3 performance under different input data, using three different input data:

The following code all use OMP.

3.1 random number sequence

Look at 1 and 2.

3.2 ascending sequence

The quicksort reference can only run in 10^5

Sorting 10 number(s) costs 0.41900 ms by a quicksort reference code. 23.86635 element(s) per second, ascending sequence

Sorting 100 number(s) costs 0.50900 ms by a quicksort reference code. 196.46365 element(s) per second, ascending sequence

Sorting 1000 number(s) costs 1.98900 ms by a quicksort reference code. 502.76521 element(s) per second, ascending sequence

Sorting 10000 number(s) costs 131.97800 ms by a quicksort reference code. 75.77020 element(s) per second, ascending sequence

Sorting 100000 number(s) costs 5768.34500 ms by a quicksort reference code. 17.33599 element(s) per second, ascending sequence

Sorting 10 number(s) costs 0.00100 ms by qsort in C library. 10000.00000 element(s) per second, ascending sequence qsort in C library passed.

Sorting 10 number(s) costs 0.21000 ms by a mergesort reference code. 47.61905 element(s) per second, ascending sequence mergesort reference code passed.

Sorting 100 number(s) costs 0.00300 ms by qsort in C library. 33333.33333 element(s) per second, ascending sequence qsort in C library passed.

Sorting 100 number(s) costs 0.69900 ms by a mergesort reference code. 143.06152 element(s) per second, ascending sequence mergesort reference code passed.

Sorting 1000 number(s) costs 0.03300 ms by qsort in C library. 30303.03030 element(s) per second, ascending sequence qsort in C library passed.

Sorting 1000 number(s) costs 0.37600 ms by a mergesort reference code. 2659.57447 element(s) per second, ascending sequence mergesort reference code passed.

Sorting 10000 number(s) costs 0.38200 ms by qsort in C library. 26178.01047 element(s) per second, ascending sequence qsort in C library passed.

Sorting 10000 number(s) costs 0.56100 ms by a mergesort reference code. 17825.31194 element(s) per second, ascending sequence mergesort reference code passed.

Sorting 100000 number(s) costs 7.53900 ms by qsort in C library. 13264.35867 element(s) per second, ascending sequence qsort in C library passed.

Sorting 100000 number(s) costs 3.37400 ms by a mergesort reference code. 29638.41138 element(s) per second, ascending sequence mergesort reference code passed.

Sorting 1000000 number(s) costs 41.28900 ms by qsort in C library. 24219.52578 element(s) per second, ascending sequence qsort in C library passed.

Sorting 1000000 number(s) costs 14.83600 ms by a mergesort reference code. 67403.61283 element(s) per second, ascending sequence mergesort reference code passed.

Sorting 10000000 number(s) costs 437.34700 ms by qsort in C library. 22865.13912 element(s) per second, ascending sequence qsort in C library passed.

Sorting 10000000 number(s) costs 187.33600 ms by a mergesort reference code. 53380.02306 element(s) per second, ascending sequence mergesort reference code passed.

Sorting 100000000 number(s) costs 5470.62600 ms by qsort in C library. 18279.44371 element(s) per second, ascending sequence qsort in C library passed.

Sorting 100000000 number(s) costs 2079.96300 ms by a mergesort reference code. 48077.77831 element(s) per second, ascending sequence mergesort reference code passed.

3.3 descending sequence

Sorting 10 number(s) costs 0.43000 ms by a quicksort reference code. 23.25581 element(s) per second, descending sequence

Sorting 100 number(s) costs 0.47400 ms by a quicksort reference code. 210.97046 element(s) per second, descending sequence

Sorting 1000 number(s) costs 2.72500 ms by a quicksort reference code. 366.97248 element(s) per second, descending sequence

Sorting 10000 number(s) costs 215.21200 ms by a quicksort reference code. 46.46581 element(s) per second, descending sequence

Sorting 100000 number(s) costs 9663.31900 ms by a quicksort reference code. 10.34841 element(s) per second, descending sequence

Sorting 10 number(s) costs 0.00100 ms by qsort in C library. 10000.00000 element(s) per second, descending sequence qsort in C library did not passed.

Sorting 10 number(s) costs 0.19200 ms by a mergesort reference code. 52.08333 element(s) per second, descending sequence mergesort reference code passed.

Sorting 100 number(s) costs 0.00400 ms by qsort in C library. 25000.00000 element(s) per second, descending sequence qsort in C library did not passed.

Sorting 100 number(s) costs 0.21000 ms by a mergesort reference code. 476.19048 element(s) per second, descending sequence mergesort reference code passed.

Sorting 1000 number(s) costs 0.03300 ms by qsort in C library. 30303.03030 element(s) per second, descending sequence qsort in C library did not passed.

Sorting 1000 number(s) costs 8.48500 ms by a mergesort reference code. 117.85504 element(s) per second, descending sequence mergesort reference code passed.

Sorting 10000 number(s) costs 0.45900 ms by qsort in C library. 21786.49237 element(s) per second, descending sequence qsort in C library did not passed.

Sorting 10000 number(s) costs 2.91500 ms by a mergesort reference code. 3430.53173 element(s) per second, descending sequence mergesort reference code passed.

Sorting 100000 number(s) costs 8.08400 ms by qsort in C library. 12370.11381 element(s) per second, descending sequence qsort in C library did not passed.

Sorting 100000 number(s) costs 3.34800 ms by a mergesort reference code. 29868.57826 element(s) per second, descending sequence mergesort reference code passed.

Sorting 1000000 number(s) costs 38.52800 ms by qsort in C library. 25955.14950 element(s) per second, descending sequence qsort in C library did not passed.

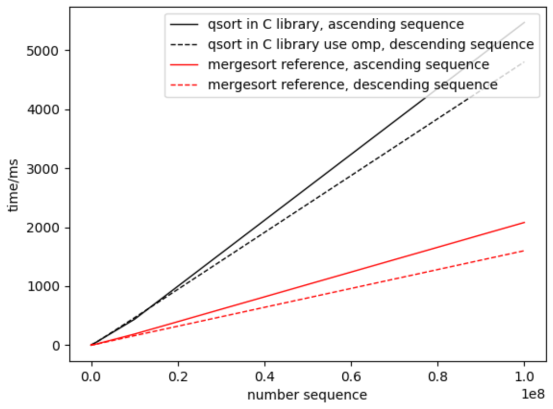
Sorting 1000000 number(s) costs 13.23200 ms by a mergesort reference code. 75574.36518 element(s) per second, descending sequence mergesort reference code passed.

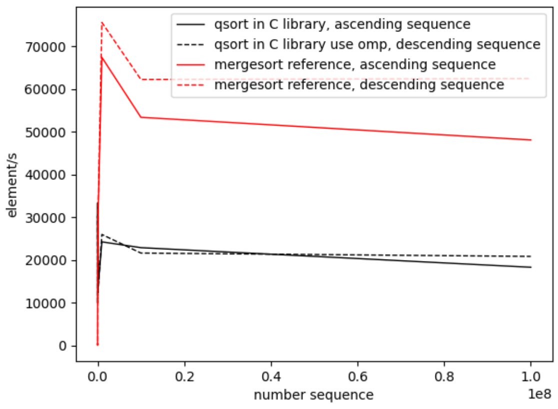
Sorting 10000000 number(s) costs 462.86300 ms by qsort in C library. 21604.66488 element(s) per second, descending sequence qsort in C library did not passed.

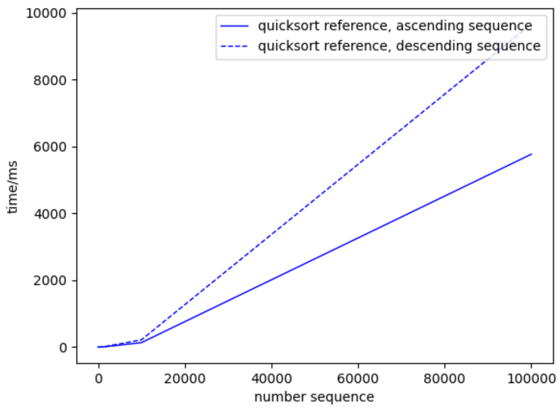
Sorting 10000000 number(s) costs 160.67600 ms by a mergesort reference code. 62237.04847 element(s) per second, descending sequence mergesort reference code passed.

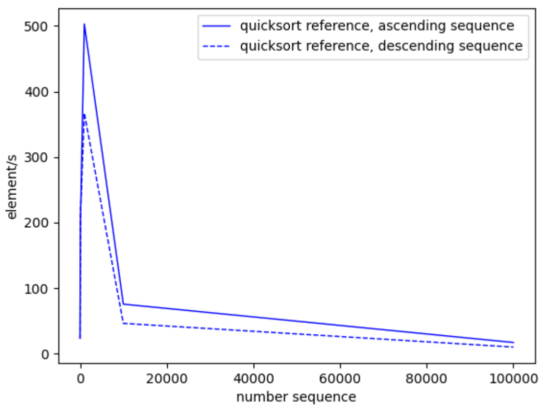
Sorting 100000000 number(s) costs 4802.92300 ms by qsort in C library. 20820.65442 element(s) per second, descending sequence qsort in C library did not passed.

Sorting 100000000 number(s) costs 1601.46600 ms by a mergesort reference code. 62442.78680 element(s) per second, descending sequence mergesort reference code passed.









The ascending sequence runs slower than the descending sequence firstly, but then it will run faster than that.

4 performance of qsort () code

1, 2, 3 all have it, use black color in graphics

5 Original sorting code optimized in any way

If I have more time, I may find a good sorting code online and to analyse it... But as I can know, the qsort code in C library is the fastest, just use nlogn time average.

That's all!
End!