



# LẬP TRÌNH SONG SONG TRÊN GPU

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## 1 Yêu cầu và phân bố công việc

STT	Yêu cầu	Thời gian (ms)	File (*.cu)	Hoàn thành
0	Cài đặt bằng thrust	62.504	Thrust.cu	Tấn
1	Thuật toán Radix Sort tuần tự	1108.569	RadixSort-Base1.cu	Tấn
2	Song song tính hist	3131.499	RadixSort-Base2.1.cu	Tấn
3	Song song 2 bước hist và scan	2766.765	RadixSort-Base2.2.cu	Tấn
4	Thuật toán Radix Sort song song với $k = 1$	820.311	RadixSort-Base3.cu	Tấn
5	Thuật toán Radix Sort tuần tự theo hướng dẫn	6017.512	RadixSort-Base4.1.cu	Thanh
6	Cải tiến Song song 2 bước tính hist và scan	783.338	RadixSort-Base4.2.cu	Thanh
7	Cải tiến cài đặt preScatter và scatter song song	345.774	RadixSort-Base4.3.cu	Thanh
8	Cải tiến cài Scatter song song	326.793	RadixSort-Base4.4.cu	Thanh
9	Bản clean code	137.674	RadixSort-CleanCode.cu	Thanh
10	Bản cuối cùng	79.713	RadixSort-Final.cu	Thanh
11	Kết quả tốt nhất (Bản build)	76.330	Build.cu	Thanh

## 2 Mã nguồn chương trình

Google Colab :

<https://drive.google.com/file/d/1WVOGq5s0kQCv0x9l81ifpJYFmQqOCiYL/view?usp=sharing>



### 3 Kết quả chương trình

#### 3.1 Kết quả tốt nhất :

\*\*\*\*\*GPU info\*\*\*\*\*

Name: Tesla V100-SXM2-16GB  
Compute capability: 7.0  
Num SMs: 80  
Max num threads per SM: 2048  
Max num warps per SM: 64  
GMEM: 16914055168 byte  
SMEM per SM: 98304 byte  
SMEM per block: 49152 byte  
\*\*\*\*\*

Input size: 16777217  
Block size : 512

Radix Sort by host  
Time: 1190.619 ms

Baseline Radix Sort (highlight)  
Time: 6756.386 ms  
CORRECT :)

Radix Sort by device  
Time: 79.689 ms  
CORRECT :)

Radix Sort with thrust  
Time: 66.303 ms  
CORRECT :)

#### 3.2 Thực thi trên các block size khác nhau

- 128



\*\*\*\*\*GPU info\*\*\*\*\*

Name: Tesla P100-PCIE-16GB  
Compute capability: 6.0  
Num SMs: 56  
Max num threads per SM: 2048  
Max num warps per SM: 64  
GMEM: 17071734784 byte  
SMEM per SM: 65536 byte  
SMEM per block: 49152 byte  
\*\*\*\*\*

Input size: 16777217  
Block size : 128

Radix Sort by host  
Time: 1155.428 ms

Baseline Radix Sort (highlight)  
Time: 6378.104 ms  
CORRECT :)

Radix Sort by device  
Time: 144.930 ms  
CORRECT :)

Radix Sort with thrust  
Time: 64.635 ms  
CORRECT :)

- 256



Name: Tesla P100-PCIE-16GB  
Compute capability: 6.0  
Num SMs: 56  
Max num threads per SM: 2048  
Max num warps per SM: 64  
GMEM: 17071734784 byte  
SMEM per SM: 65536 byte  
SMEM per block: 49152 byte  
\*\*\*\*\*

Input size: 16777217  
Block size : 256

Radix Sort by host  
Time: 1142.361 ms

Baseline Radix Sort (highlight)  
Time: 6392.780 ms  
CORRECT :)

Radix Sort by device  
Time: 126.807 ms  
CORRECT :)

Radix Sort with thrust  
Time: 64.410 ms  
CORRECT :)

- 512

Input size: 16777217  
Block size : 512

Radix Sort by host  
Time: 1157.686 ms

Baseline Radix Sort (highlight)  
Time: 6223.896 ms  
CORRECT :)

Radix Sort by device  
Time: 107.973 ms  
CORRECT :)

Radix Sort with thrust  
Time: 61.450 ms  
CORRECT :)

- 1024



```
*****GPU info*****
Name: Tesla P100-PCIE-16GB
Compute capability: 6.0
Num SMs: 56
Max num threads per SM: 2048
Max num warps per SM: 64
GMEM: 17071734784 byte
SMEM per SM: 65536 byte
SMEM per block: 49152 byte
*****
```

```
Input size: 16777217
Block size : 1024
```

```
Radix Sort by host
Time: 1163.608 ms
```

```
Baseline Radix Sort (highlight)
Time: 6285.182 ms
CORRECT :)
```

```
Radix Sort by device
Time: 120.331 ms
CORRECT :)
```

```
Radix Sort with thrust
Time: 66.337 ms
CORRECT :)
```

## 4 Thời gian thực thi các thành phần

```
Time: 63.225 ms
CORRECT :)
+230== Profiling application: ./build
+230== Profiling result:
Type      Time(%)   Time      Calls      Avg      Min      Max      Name
GPU activities: 65.51%  87.110ms    6  14.518ms  6.2720us  43.572ms  [CUDA memcpy DtoH]
                22.25%  29.592ms    6   4.9320ms  8.5110us  14.789ms  [CUDA memcpy HtoD]
                7.77%  10.335ms    4   2.5838ms  2.5509ms  2.6823ms  scatter(unsigned int*, int, int, int, int, int, unsigned int*)
                1.69%  2.2434ms    4   560.84us  535.21us  571.88us  computeHistogram(unsigned int*, int, int*, int, int)
                0.54%  719.43us    3   239.81us  163.90us  278.33us  void thrust::cuda_cub::cub::DeviceRadixSortDownsweepKernel<thrust:
                0.54%  714.05us    4   178.51us  178.23us  178.78us  scanExclusiveBlk(int*, int, int*, int*)
                0.50%  659.72us    4   164.93us  164.06us  166.14us  void thrust::cuda_cub::cub::DeviceRadixSortDownsweepKernel<thrust:
                0.34%  457.49us    7   65.355us  64.605us  66.429us  void thrust::cuda_cub::cub::RadixSortScanBinsKernel<thrust::cuda
                0.27%  360.31us    4   90.076us  89.597us  90.524us  void thrust::cuda_cub::cub::DeviceRadixSortUpsweepKernel<thrust:
                0.26%  347.41us    4   86.853us  86.653us  87.037us  computeHistScan(int*, int, int*)
                0.20%  264.21us    3   88.071us  86.045us  91.197us  void thrust::cuda_cub::cub::DeviceRadixSortUpsweepKernel<thrust:
                0.13%  172.03us    1   172.03us  172.03us  172.03us  void thrust::cuda_cub::core::kernel_agent<thrust::cuda_cub::p
                0.00%  6.2080us    4   1.5520us  1.5040us  1.6320us  [CUDA memset]
API calls:      79.21%  546.72ms    8   68.340ms  1.0420us  546.68ms  cudaEventCreate
                8.62%  59.525ms   10   5.9525ms  18.187us  44.315ms  cudaMemcpy
                8.58%  59.214ms    2   29.607ms  15.004ms  44.209ms  cudaMemcpyAsync
                2.37%  16.352ms   17   961.89us  92.984us  2.6881ms  cudaDeviceSynchronize
                0.72%  4.9781ms    6   829.68us  180.11us  2.1380ms  cudaFree
                0.22%  1.5394ms    6   256.57us  92.357us  371.84us  cudaMalloc
                0.06%  441.10us    1   441.10us  441.10us  441.10us  cuDeviceTotalMem
                0.05%  358.27us   38   9.4280us  5.3060us  46.566us  cudaLaunchKernel
                0.04%  296.87us   97   3.0600us  143ns  147.36us  cuDeviceGetAttribute
                0.04%  268.02us    1   268.02us  268.02us  268.02us  cudaGetDeviceProperties
                0.02%  135.08us    8   16.884us  3.9290us  35.728us  cudaEventRecord
                0.01%  95.837us    4   23.959us  12.452us  55.663us  cudaMemset
                0.01%  89.830us    2   44.915us  6.2910us  83.539us  cudaStreamSynchronize
                0.01%  78.773us    8   9.8460us  7.9720us  12.138us  cudaEventSynchronize
                0.01%  40.372us    1   40.372us  40.372us  40.372us  cuDeviceGetName
```



Time	Calls	Avg	Min	Max	Name
65.51%	87.110ms	6	14.518ms	6.2720us	43.572ms [CUDA memcpy DtoH]
22.25%	29.592ms	6	4.9320ms	8.5110us	14.789ms [CUDA memcpy HtoD]
7.77%	10.335ms	4	2.5838ms	2.5509ms	2.6823ms scatter(unsigned int*, int, int, int, int, int*, unsig
1.69%	2.2434ms	4	560.84us	535.21us	571.88us computeHistogram(unsigned int*, int, int*, int, int)
0.54%	719.43us	3	239.81us	163.90us	278.33us void thrust::cuda_cub::cub::DeviceRadixSortDownsweepKer
0.54%	714.05us	4	178.51us	178.23us	178.78us scanExclusiveBlk(int*, int, int*, int*)
0.50%	659.72us	4	164.93us	164.06us	166.14us void thrust::cuda_cub::cub::DeviceRadixSortDownsweepKer
0.34%	457.49us	7	65.355us	64.605us	66.429us void thrust::cuda_cub::cub::RadixSortScanBinsKernel<thr
0.27%	360.31us	4	90.076us	89.597us	90.524us void thrust::cuda_cub::cub::DeviceRadixSortUpsweepKerne
0.26%	347.41us	4	86.853us	86.653us	87.037us computeHistScan(int*, int, int*)
0.20%	264.21us	3	88.071us	86.045us	91.197us void thrust::cuda_cub::cub::DeviceRadixSortUpsweepKerne
0.13%	172.03us	1	172.03us	172.03us	172.03us void thrust::cuda_cub::core::_kernel_agent<thrust::cuda
0.00%	6.2080us	4	1.5520us	1.5040us	1.6320us [CUDA memset]