

Assignment III

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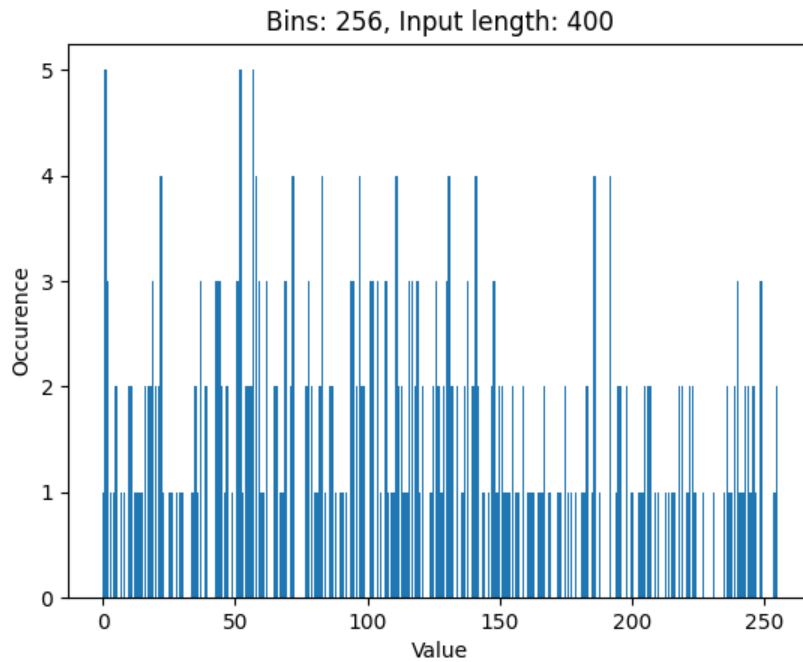
December 10, 2023

Url to code: <https://github.com/adamorucu/gpu-programming-course>

Exercise 1

- 1. Describe all optimizations you tried regardless of whether you committed to them or abandoned them and whether they improved or hurt performance.**
 - I've started with a kernel that does not use shared memory.
 - I upgraded it to use shared memory, however in this case it didn't work for large NUM_BINS.
 - I've changed the code but colab didn't let me use any more of their GPUs so I could test the results.
- 2. Which optimizations you chose in the end and why?** I used a local bins counter for shared memory and then add the local values together to get the result.
- 3. How many global memory reads are being performed by your kernel? Explain** For the `convert_kernel` 1 for each bin in the histogram. For the `histogram_kernel` the length of input. Therefore $4096 + 400 = 4496$.
- 4. How many atomic operations are being performed by your kernel? Explain** One for every element in the input array, plus one for every thread.
- 5. How much shared memory is used in your code? Explain**
- 6. How would the value distribution of the input array affect the contention among threads? For instance, what contentions would you expect if every element in the array has the same value?**

Could not compare output, because colab runtime ended before I was able to look at the results.
- 7. Plot a histogram generated by your code and specify your input length, thread block and grid.** Input length: 400, num.bins: 256, TPB: 256, BPG: 2



8. For a input array of 1024 elements, profile with Nvidia Nsight and report Shared Memory Configuration Size and Achieved Occupancy. Did Nvsight report any potential performance issues? Could not perform analysis, because I ran out of limit on the compute allowed in colab.

Exercise 2

1. Describe the environment you used, what changes you made to the Makefile, and how you ran the simulation. I ran the code on Google Colab on the Tesla T4 GPU. For the code to compile I had to change the ARCH flag in the Makefile so that it equals sm_75. I ran the code with the following commands `make` and `./bin/sputniPIC.out inputfiles/GEM_2D.inp`.
2. Describe your design of the GPU implementation of `mover_PC()` briefly.
I added all the memory allocation, copy and memory freeing functionality in the `mover_PC_gpu` function and moved the operations to a separate kernel.
3. Compare the output of both CPU and GPU implementation to guarantee that your GPU implementations produce correct answers.
4. Compare the execution time of your GPU implementation with its CPU version.

✓
1m



!./bin/sputniPIC.out inputfiles/GEM_2D.inp

```
*****
cycle = 5
*****
*** MOVER with SUBCYCLYING 1 - species 0 ***
*** MOVER with SUBCYCLYING 1 - species 1 ***
*** MOVER with SUBCYCLYING 1 - species 2 ***
*** MOVER with SUBCYCLYING 1 - species 3 ***

*****
cycle = 6
*****
*** MOVER with SUBCYCLYING 1 - species 0 ***
*** MOVER with SUBCYCLYING 1 - species 1 ***
*** MOVER with SUBCYCLYING 1 - species 2 ***
*** MOVER with SUBCYCLYING 1 - species 3 ***

*****
cycle = 7
*****
*** MOVER with SUBCYCLYING 1 - species 0 ***
*** MOVER with SUBCYCLYING 1 - species 1 ***
*** MOVER with SUBCYCLYING 1 - species 2 ***
*** MOVER with SUBCYCLYING 1 - species 3 ***

*****
cycle = 8
*****
*** MOVER with SUBCYCLYING 1 - species 0 ***
*** MOVER with SUBCYCLYING 1 - species 1 ***
*** MOVER with SUBCYCLYING 1 - species 2 ***
*** MOVER with SUBCYCLYING 1 - species 3 ***

*****
cycle = 9
*****
*** MOVER with SUBCYCLYING 1 - species 0 ***
*** MOVER with SUBCYCLYING 1 - species 1 ***
*** MOVER with SUBCYCLYING 1 - species 2 ***
*** MOVER with SUBCYCLYING 1 - species 3 ***

*****
cycle = 10
*****
*** MOVER with SUBCYCLYING 1 - species 0 ***
*** MOVER with SUBCYCLYING 1 - species 1 ***
*** MOVER with SUBCYCLYING 1 - species 2 ***
*** MOVER with SUBCYCLYING 1 - species 3 ***
Opening file: ./data/E_10.vtk
Opening file: ./data/B_10.vtk
Opening file: ./data/rhoe_10.vtk
Opening file: ./data/rhoi_10.vtk
Opening file: ./data/rho_net_10.vtk

*****
Tot. Simulation Time (s) = 64.8572
Mover Time / Cycle (s) = 3.59779
Interp. Time / Cycle (s) = 2.5946
*****
```

```

[ ] !./bin/sputniPIC.out inputfiles/GEM_2D.inp

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*** MOVER with SUBCYCLING 1 - species 0 ***
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Opening file: ./data/B_10.vtk
Opening file: ./data/rhoe_10.vtk
Opening file: ./data/rhoi_10.vtk
Opening file: ./data/rho_net_10.vtk

*****
Tot. Simulation Time (s) = 32.9966
Mover Time / Cycle (s) = 0.251933
Interp. Time / Cycle (s) = 2.57875
*****

```