CS 475/575 -- Spring Quarter 2022

Project #6

OpenCL Array Multiply, Multiply-Add, and Multiply-Reduce

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1. What machine you ran this on

   I ran it on the rabbit server, which contains a Nvidia driver for GPU with the specs as follows.

   Name = 'NVIDIA CUDA'

   Vendor = 'NVIDIA Corporation'

   Version = 'OpenCL 3.0 CUDA 11.4.158'

   Profile = 'FULL_PROFILE'

   Number of Devices = 1

   Device #0:

   Type = 0x0004 = CL_DEVICE_TYPE_GPU

   Device Vendor ID = 0x10de (NVIDIA)

   Device Maximum Compute Units = 15

   Device Maximum Work Item Dimensions = 3

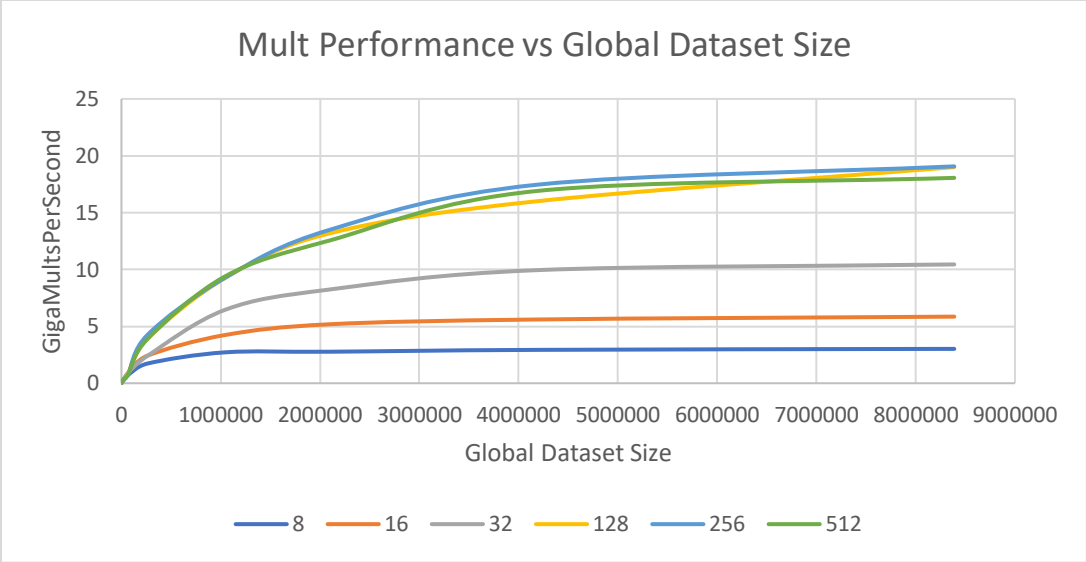
   Device Maximum Work Item Sizes = 1024 x 1024 x 64

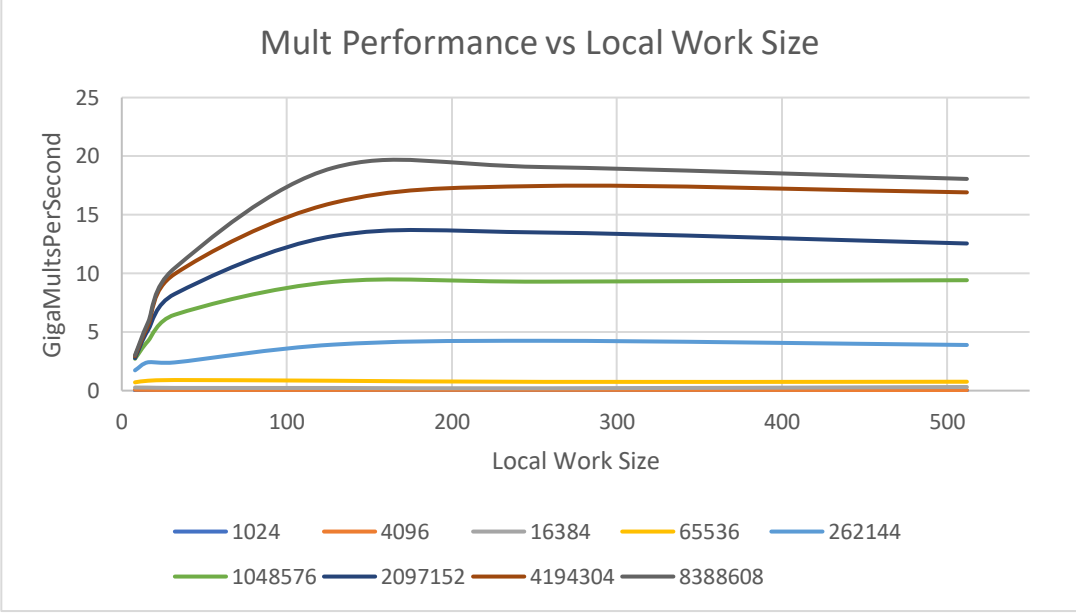
   Device Maximum Work Group Size = 1024

   Device Maximum Clock Frequency = 1071 MHz

2. Show the tables and graphs

Dataset Size \ Local Size	8	16	32	128	256	512
1024	0.014	0.014	0.009	0.012	0.017	0.012
4096	0.064	0.07	0.061	0.086	0.083	0.065
16384	0.281	0.371	0.26	0.192	0.225	0.257
65536	0.721	0.8	0.832	0.94	0.739	1.087
262144	1.683	2.487	2.782	3.214	2.819	1.81
1048576	2.568	4.289	5.71	8.665	7.055	8.284
2097152	2.615	4.655	8.025	10.364	10.916	9.861
4194304	2.833	5.334	8.892	13.922	13.594	13.933
8388608	2.852	5.55	9.84	15.324	15.135	13.819





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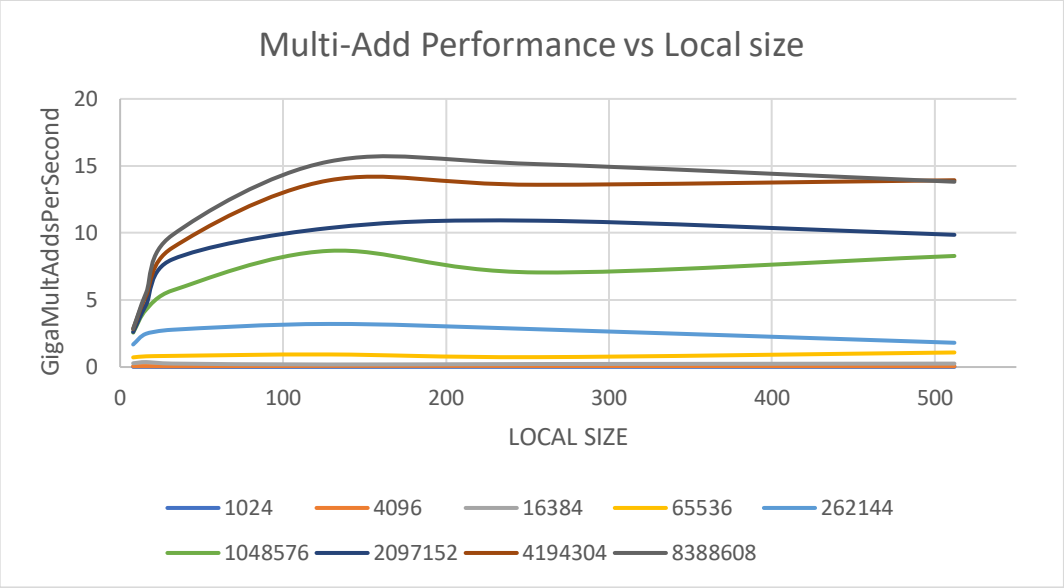
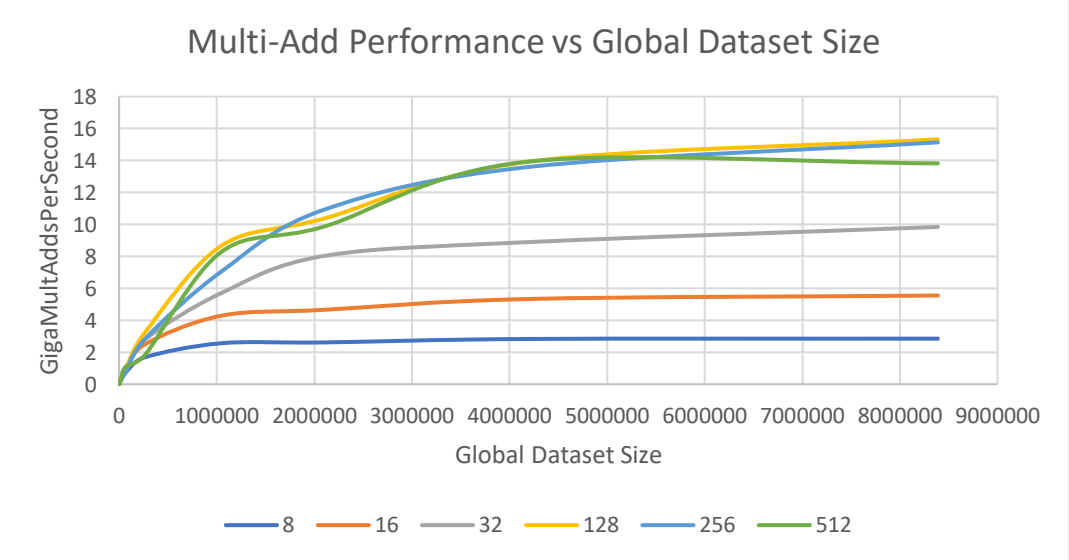
Dataset Size \ Local Size	8	16	32	128	256	512
1024	0.013	0.014	0.015	0.017	0.018	0.014
4096	0.078	0.067	0.057	0.063	0.068	0.051
16384	0.266	0.259	0.232	0.228	0.201	0.309
65536	0.708	0.847	0.907	0.845	0.748	0.761
262144	1.731	2.424	2.408	3.924	4.252	3.895
1048576	2.719	4.247	6.472	9.276	9.298	9.419
2097152	2.77	5.185	8.242	13.182	13.487	12.553
4194304	2.934	5.605	9.948	16.011	17.462	16.913
8388608	3.022	5.856	10.447	19.002	19.068	18.058





3. What patterns are you seeing in the performance curves?

   In the above performance vs Data Set graphs, performance lines increase till 128 and remain constant on top of them

   In the performance vs local size graph, performance increase with the increase in the local size.

4. Why do you think the patterns look this way?

   When there is a small data set then there will be a lot of gpu memory and threads waiting to process the data so the computation is faster as the size increases the performance can be observed accordingly.

   Now, when the local block size is less that means there is more data needs to be processed and there is a lot of wait for each block to complete. Hence the graph appears in that way like each like is stacked over each other.

5. What is the performance difference between doing a Multiply and doing a Multiply-Add?

   During the multiplying arrays, there is no wait or a process that needs to be done after the multiplication but during the multiplication and addition, we have to multiply and add a number which will take this process a bit more time to complete.

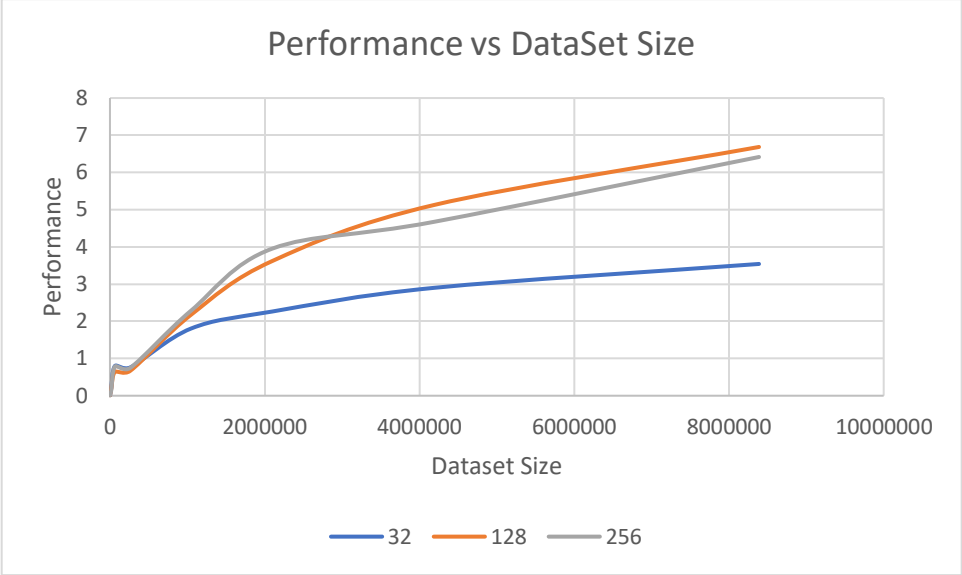
6. What does that mean for the proper use of GPU parallel computing?

   Based on the graphs, 128 block size is the best option. When we observe the graph, even if we take a block size of more than 128, it settles at the same performance and when we take a lower block size, the performance decreases.

Part 2:

1. Show this table and graph

DatasetSize\Local size	32	128	256
1024	0.011	0.011	0.013
4096	0.039	0.051	0.053
16384	0.199	0.185	0.139
65536	0.803	0.643	0.789
262144	0.76	0.669	0.747
1048576	1.806	2.177	2.287
2097152	2.262	3.619	3.952
4194304	2.9	5.128	4.675
8388608	3.541	6.685	6.415



2. What pattern are you seeing in this performance curve?

   From the above graph, we can observe that the performance increases with an increase in the local block size

3. Why do you think the pattern looks this way?

   When the dataset size is less that there is a lot of GPU remaining idle so the performance is less and with the increase in the dataset the GPU is more efficiently used.

4. What does that mean for the proper use of GPU parallel computing?

   Proper use of GPU is when we have a large dataset and a lot of independent processes to do. If there is a small dataset then it is better to use the processor to do the processing.