

Homework 3 : Reduction in CUDA

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1. Naive Parallel Reduction

- Effective Bandwidth is calculated by amount of data for which a operation is performed per unit time.
- In our naive.sh program we calculate the input size(N) multiply by size of each input to get total number of bytes .We divide that by 10^9 to get Gigabytes that is transferred.
- We divide the Giga bytes by total time taken by GPU to get Effective Bandwidth.

Trial No	Effective Bandwidth (GB/sec)	GPU execution Time(sec)	CPU execution time (sec)
1	34.88	0.000962	0.076544
2	34.92	0.000961	0.076424
3	34.88	0.000962	0.076789
4	34.88	0.000962	0.076424
5	35.06	0.000957	0.076463

Average GPU Execution Time = 0.000961 sec

Average Effective Bandwidth = 34.92 GB/s

2.Stride Access

Trial No	Effective Bandwidth(GB/sec)	GPU exec Time(sec)
1	78.95	0.000425
2	79.14	0.000424
3	78.95	0.000425
4	79.14	0.000424
5	78.95	0.000425

Average GPU Execution Time = 0.000425

Average Effective Bandwidth = 79.02 GB/s

Bandwidth Improvement from previous Step = 2.26 times

3.Sequential Access

Trial No	Effective Bandwidth(GB/sec)	GPU exec Tlme(sec)
1	83.47	0.000402
2	83.47	0.000402
3	83.68	0.000401
4	83.89	0.0004
5	83.89	0.0004

Average Effective bandwidth = 83.68 GB/s

Improvement in Bandwidth from part 2 = 1.056

4. First Add Before Reduce

Trial No	Effective Bandwidth(GB/sec)	GPU exec Tlme(sec)
1	160.55	0.000209
2	160.55	0.000209
3	160.55	0.000209
4	161.32	0.00208
5	161.32	0.00208

Average Effective Bandwidth = 160.858 GB/s

Improvement in Bandwidth from part 3 = $160.858/83.68 = 1.923$

5.Unroll Last Wrap

Unrolling the last 6 iterations of inner loop gives:

Trial No	Effective Bandwidth(GB/sec)	GPU exec Tlme(sec)
1	213.72	0.000157
2	216.48	0.000155
3	216.48	0.000155
4	215.09	0.000156
5	216.48	0.000155

Average Effective Bandwidth = 215.65 GB/s

Improvement in Bandwidth = $215.65/160.8 = 1.340$

6. Algorithm Cascading

Trial No	Effective Bandwidth(GB/sec)	GPU exec Time(sec)
1	217.89	0.000154
2	219.31	0.000153
3	219.31	0.000153
4	219.31	0.000153
5	220.75	0.000152

Average Effective Bandwidth = 219.31 GB/s

Improvement in Bandwidth = $219.31/215.65 = 1.0169$

Overall Improvement in Bandwidth = $219.32 / 34.92 = 6.28$

Bandwidth for 16MB Input Size

Trial No.	Naive	Stride	Sequential	First_Add	Unroll	Multiple	Speedup1_2	Speedup2_3	Speedup3_4	Speedup4_5	Speedup5_6	Speedup1_6
1	35.23	79.14	85.71	166.94	226.72	229.82	2.24638092	1.08301743	1.94773072	1.358092728	1.013673253	6.523417542
2	34.68	79.7	85.82	166.52	226.72	226.72	2.29815455	1.07678795	1.940340247	1.361518136	1	6.537485582
3	35.21	79.7	85.71	166.52	226.72	226.72	2.26356148	1.07540777	1.942830475	1.361518136	1	6.439079807
4	35.15	79.32	85.82	166.94	229.82	225.96	2.25661450	1.08194654	1.945234211	1.376662274	0.983204247	6.428449502
5	35.21	79.89	85.71	166.94	224.44	228.26	2.26895768	1.07285016	1.94773072	1.344435126	1.017020139	6.482817381
Avg	35.09	79.55	85.754	166.772	226.884	227.496	2.26673383	1.07800197	1.944773275	1.36044528	1.002779528	6.482249963

Overall Improvement in Bandwidth = $227.5/35.10 = 6.48$

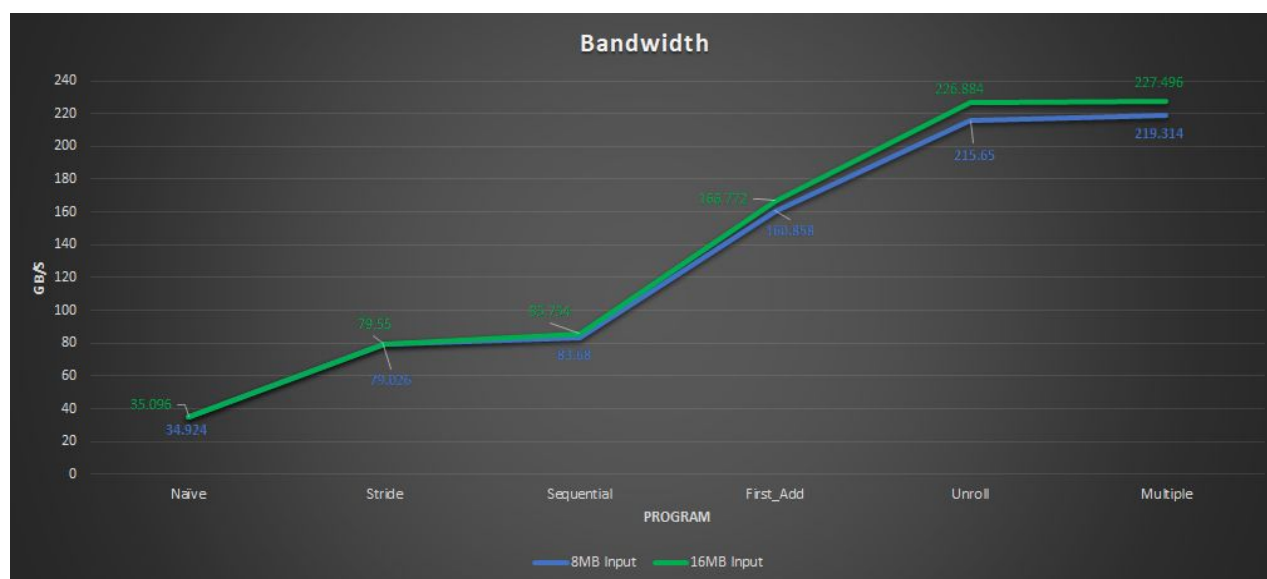


Chart-1 :- Bandwidth of Programs for Various Input Size