CO332 - Heterogenous Parallel Computing

Assignment 4

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Q2

1. Reduction algorithm implemented here can be used to find the sum of elements in a sequence, minimum in a sequence, maximum in a sequence, average of elements in a sequence etc. All these have real life applications in many fields including graphics and image processing.
2. Yes. When `thrust::reduce` is called, the calculated sum is copied from the device memory to host memory.
3. If thrust function does not perform as well as expected, it best to optimise by writing a custom kernel that suits our needs. The custom kernel should take care of adherence to warps, must not have banking conflicts and must make optimal use of memory hierarchy.

Q3

1. Counting sort is an integer sorting algorithm that uses the prefix sum of a histogram of key frequencies to calculate the position of each key in the sorted output array. Parallel prefix (using multiplication as the underlying associative operation) can also be used to build fast algorithms for parallel polynomial interpolation. List ranking, the problem of transforming a linked list into an array that represents the same sequence of items, can be viewed as computing a prefix sum on the sequence 1, 1, 1, ... and then mapping each item to the array position given by its prefix sum value; by combining list ranking, prefix sums, and Euler tours, many important problems on trees may be solved by efficient parallel algorithms.
2. O(n)
3. 2 per kernel instance for a thread
4. 3 per thread
5. **Maximum**: 2log(BLOCK_SIZE)
   Minimum: 0.
6. Thrice
7. To move away from the O(n logn) naive implementation, a balanced binary tree approach was chosen.
8. The code is currently limited to block_size * block_size elements, which is at the most a million elements. With an array storing the auxiliary of the auxiliary array, the scan length can be increased to over a billion elements.
9. The array will have to be loaded in batches, and the kernel should accomodations for that.
10. Yes. The correctness of the result relies on the operator being associative. The operator, however, does not need to be commutative since the order of the operands is maintained
11. No. However small floating point inaccuracies will be present which is natural.

Q4

1. Scan algorithm is used in Counting sort. It is also used in parallel polynomial interpolation, list ranking and certain tree algorithms.
2. Yes. The correctness of the result relies on the operator being associative. The operator, however, does not need to be commutative since the order of the operands is maintained
3. No. However small floating point inaccuracies will be present which is natural.