

ASSIGNMENT NUMBER 1

For each of the problems below, please assume that the input is an array a of length 2^n containing random integers where n is a integer. Furthermore, assume that the range of values in a is $[0, 100)$. Please write CUDA programs for the following problems. Also, please turn in pseudo source code of the problems. Your solution should make “coalesced” access to the global memory and avoid “bank conflicts” as much as possible. Solution to some of the problems are already available in the SDK. To maximize your learning experience, please do not consult them before writing down your own solution. The homework is due on September 30, 2008.

1. **Reduction Operation:** A reduction operator takes a as input and outputs the maximum value in a . Devise an algorithm that implements the reduction operator. Now, modify your algorithm to obtain the sum of all values in a .
2. **Histogram:** Devise an algorithm that takes a as input, where the values of a lie in the range $[0, 100)$, and outputs a histogram of the distribution of values in a . In particular, count the frequency of values in buckets — $[0, 10), [10, 20) \dots [90, 100)$.
3. **Prefix Sum Algorithm:** Devise a parallel program that takes an array a of integers as input and outputs an array b of integers such that

$$b[i] = \sum_{j=0}^i a[j], 0 \leq i < 2^n.$$

In other words, the i th element $b[i]$ in b stores the sum of values ranging between $a[0] \dots a[i]$.

4. **Array Compaction Algorithm:** Given arrays of integers a , b , and c such that elements in b take on the values of 0 or 1. In particular, for any element $a[i]$ in a , let $b[i]$ be its corresponding location in b . The compaction algorithm works as follows by constructing a compacted array c . If $b[i] = 1$, then $a[i]$ is added to the output array c else $a[i]$ is rejected. In other words, output c is an *compacted* array of values in a whose corresponding value in b is not zero. Note that the ordering of elements in a should be preserved in c .
5. **Min 1-D Neighbor:** Given arrays of integers a and b , for every element $a[i]$ in a , $1 \leq i < 2^n$, record in $b[i]$ the smallest value that is less than $a[i]$ in the sub-array $a[0] \dots a[i-1]$. If no such element exists, then set $b[i]$ to -1 . Output b .
6. **Heap Construction:** Given arrays of integers a and b , construct a min-heap on a . The output of the algorithm is an array b representation of the min-heap on a such that if $b[i]$ is a node in the heap then its two children nodes are $b[2i+1]$ and $b[2i+2]$ where $b[i] \leq b[2i+1]$ and $b[i] \leq b[2i+2]$. Note that $b[0]$ is the root node of the min-heap.