

# Parallel Processing

## Assignment 3

**This assignment is individual assignment, every student should submit by himself.**

**Due: Next Section**

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### 1. True or False:

- There are two criteria to measure a parallel program efficiency, Steps and Total work.
- If Total work of a parallel program equals the Total work of a sequential program for the same problem then we have a Work Efficient program.
- Reduce operator must be unary operator.
- Serial Reduce program has a work complexity =  $O(n \log n)$ .
- Parallel Reduce program has a work complexity =  $O(\log n)$ .
- Reduce pattern requires an Identity element.
- The division operation is a reduction operator.
- Zero is an Identity element for the multiplication operator.
- Hillis & Steele Reduce algorithm is the best solution if we have a massive input size.
- We can program Histogram algorithm using Atomic operations which is the best solution to solve the algorithm in a parallel fashion

**2. The following program to add two matrices. Compute the number of steps and the total work complexity for the for addition operation of this program.**

```
#include <stdio.h>
int main()
{
    int m, n, c, d, first[10][10], second[10][10], sum[10][10];

    printf("Enter the number of rows and columns of matrix\n");
    scanf("%d%d", &m, &n);
    printf("Enter the elements of first matrix\n");

    for (c = 0; c < m; c++)
        for (d = 0; d < n; d++)
            scanf("%d", &first[c][d]);

    printf("Enter the elements of second matrix\n");

    for (c = 0; c < m; c++)
        for (d = 0; d < n; d++)
            scanf("%d", &second[c][d]);

    printf("Sum of entered matrices:-\n");

    for (c = 0; c < m; c++) {
        for (d = 0; d < n; d++) {
            sum[c][d] = first[c][d] + second[c][d];
            printf("%d\t", sum[c][d]);
        }
        printf("\n");
    }

    return 0;
}
```

**3. Write a CUDA program to solve the matrices addition in a parallel fashion. Then compute the number of steps and the total work complexity for addition operation of this program.**

**4. Compare the complexity in questions 3 and 4.**

**5. Use the following array to answer the questions: [1, 2, 0, 5, 8, -4, 7]**

- a. Apply a sum reduce on the given array.
- b. Apply a max reduce on the given array.
- c. Apply an inclusive multiplication scan on the given array.
- d. Apply an exclusive multiplication scan on the given array.
- e. Use Hillis & Steele algorithm to apply sum scan on the given array and show every step.
- f. Use Blelloch algorithm to apply sum scan on the given array and show every step.

**6. (Bonus) Using Cimg and Cuda to write a program take an image and modify their luminosity (tone mapping) to lighten them. We could also darken the images, or apply changes only to parts of the images.**

PS: Review the following program to help you:

<https://code.msdn.microsoft.com/windowsdesktop/HDR-Tone-Mapping-with-CUDA-93b83bf5>