Question 2

The platform used to run experiments for this question is the **Discovery Cluster** using sbatch. More information on the code and how to run is provided in the Readme and in the log file.

Part A:

In this part, the total input data is divided into (1/# classes) and provided to each node. Each node performs histogram binning with the local data and gathers all the local histograms to produce the final histogram of data for all C classes.
Below snapshot provides range of classes, length of local data for each of the node, displacement for local data and the final histogram for each class.

```
Number of values: 100000
Number of classes: 4
Class range:
Class 0 Min: 1.000000, Max: 251.000000
Class 1 Min: 251.000000, Max: 501.000000
Class 2 Min: 501.000000, Max: 751.000000
Class 3 Min: 751.000000, Max: 1001.000000
Data send count for each proc:
proc 0: 100000
Displacement for each proc:
proc 0: 0
processor rank: 0 len: 100000
Final Histogram:
Number of values in Class 0: 25180
Number of values in Class 1: 24793
Number of values in Class 2: 24962
Number of values in Class 3: 25065
total values in histogram: 100000
Elapsed time: 0.004047 seconds
```

```
Number of values: 100000
Number of classes: 4
Class range:
Class 0 Min: 1.000000, Max: 251.000000
Class 1 Min: 251.000000, Max: 501.000000
Class 2 Min: 501.000000, Max: 751.000000
Class 3 Min: 751.000000, Max: 1001.000000
Data send count for each proc:
proc 0: 50000
proc 1: 50000
Displacement for each proc:
proc 0: 0
proc 1: 50000
processor rank: 0 len: 50000
processor rank: 1 len: 50000
Final Histogram:
Number of values in Class 0: 25180
Number of values in Class 1: 24793
Number of values in Class 2: 24962
Number of values in Class 3: 25065
total values in histogram: 100000
Elapsed time: 0.001749 seconds
```

```
Number of values: 100000
Number of classes: 4
Class range:
Class 0 Min: 1.000000, Max: 251.000000
Class 1 Min: 251.000000, Max: 501.000000
Class 2 Min: 501.000000, Max: 751.000000
Class 3 Min: 751.000000, Max: 1001.000000
Data send count for each proc:
proc 0: 25000
proc 1: 25000
proc 2: 25000
proc 3: 25000
Displacement for each proc:
proc 0: 0
proc 1: 25000
proc 2: 50000
proc 3: 75000
processor rank: 1 len: 25000
processor rank: 2 len: 25000
processor rank: 0 len: 25000
processor rank: 3 len: 25000
Final Histogram:
Number of values in Class 0: 25180
Number of values in Class 1: 24793
Number of values in Class 2: 24962
Number of values in Class 3: 25065
total values in histogram: 100000
Elapsed time: 0.001366 seconds
```

Number of values	Number of classes	Number of Nodes	Time Elapsed (seconds)
100, 000	4	1	0.0040
100, 000	4	2	0.0017
100, 000	4	4	0.0013

Number of values	Number of classes	Number of Nodes	Time Elapsed (micro seconds)
10, 000	1	4	70
10, 000	5	4	120
10, 000	10	4	140

Part B:

In this part, each node produces values for only a single class of the input data values for all the C classes. If the number of classes are more than the number of nodes, then each may contain more than one classes.
Below snapshot provides range of classes, length of local data for each of the node, displacement for local data and the final histogram for each class.

```
Number of values: 100000
Number of classes: 4
Min: 1.000000, Max: 251.000000
Min: 251.000000, Max: 501.000000
Min: 501.000000, Max: 751.000000
Min: 751.000000, Max: 1001.000000
proc ID 0: 0 1 2 3
Final Histogram:
Number of values in Class 0: 25180
Number of values in Class 1: 24793
Number of values in Class 2: 24962
Number of values in Class 3: 25065
total values in histogram: 100000
Elapsed time: 0.004967 seconds
```

```
Number of values: 100000
Number of classes: 4
Min: 1.000000, Max: 251.000000
Min: 251.000000, Max: 501.000000
Min: 501.000000, Max: 751.000000
Min: 751.000000, Max: 1001.000000
proc ID 0: 0 2
proc ID 1: 1 3
Final Histogram:
Number of values in Class 0: 25180
Number of values in Class 1: 24793
Number of values in Class 2: 24962
Number of values in Class 3: 25065
total values in histogram: 100000
Elapsed time: 0.003159 seconds
```

```
Number of values: 100000
Number of classes: 4
Min: 1.000000, Max: 251.000000
Min: 251.000000, Max: 501.000000
Min: 501.000000, Max: 751.000000
Min: 751.000000, Max: 1001.000000
proc ID 0: 0
proc ID 1: 1
proc ID 2: 2
proc ID 3: 3
Final Histogram:
Number of values in Class 0: 25180
Number of values in Class 1: 24793
Number of values in Class 2: 24962
Number of values in Class 3: 25065
total values in histogram: 100000
Elapsed time: 0.003748 seconds
```

Number of values	Number of classes	Number of Nodes	Time Elapsed (seconds)
100, 000	4	1	0.0049
100, 000	4	2	0.0031
100, 000	4	4	0.0037

Number of values	Number of classes	Number of Nodes	Time Elapsed (micro seconds)
10, 000	1	4	110
10, 000	5	4	150
10, 000	10	4	190