Task 1

root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpicc -o MPI_Comm.exe MPI_Comm.c
root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpiexec --allow-run-as-root -n 4 MPI_Comm.exe
Rank 0: x = 10000
Rank 0: x = 100114514, time = 0.000010 seconds
Rank 1: x = 100114514, time = 0.000114 seconds
Rank 2: x = 100114514, time = 0.000114 seconds
Rank 3: x = 100114514, time = 0.000052 seconds

root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpiexec --allow-run-as-root -n 6 MPI_Comm.exe
Rank 0: x = 10000
Rank 2: x = 100114514, time = 0.000143 seconds
Rank 3: x = 100114514, time = 0.000008 seconds
Rank 4: x = 100114514, time = 0.000078 seconds
Rank 5: x = 100114514, time = 0.000108 seconds
Rank 0: x = 100114514, time = 0.000011 seconds
Rank 1: x = 100114514, time = 0.000103 seconds

root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpicc -o MPI_Comm2.exe MPI_Comm2.c
root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpiexec --allow-run-as-root -n 6 MPI_Comm2.exe
Initial array:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
Final array:
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11001 12001 13001 14001 15001 16001 17001 18001 19001 20001 21002 22002 23002 24002 25002 26002 27002 28002 29002 30002 31003 32003 33003 34003 35003 36003 37003 38003 39003 40003 41004 42004 43004 44004 45004 46004 47004 48004 49004 50004 51005 52005 53005 54005 55005 56005 57005 58005 59005 60005
Time = 0.000089 seconds

root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpiexec --allow-run-as-root -n 4 MPI_Comm2.exe
Initial array:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Final array:
1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11001 12001 13001 14001 15001 16001 17001 18001 19001 20001 21002 22002 23002 24002 25002 26002 27002 28002 29002 30002 31003 32003 33003 34003 35003 36003 37003 38003 39003 40003
Time = 0.000036 seconds

The MPI program successfully scattered, and gathered the array using 4 and 6 processes. Each process modified its portion of the array by multiplying 1000 and adding its rank.

Task 2

root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpicc -o MPI_Cart.exe MPI_Cart.c
root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpiexec
--allow-run-as-root --oversubscribe -n 16 MPI_Cart.exe
Rank 0, Coords: (0,0), N: 12, S: 4, E: 1, W: 3, Avg: 4.00
Rank 1, Coords: (0,1), N: 13, S: 5, E: 2, W: 0, Avg: 4.20
Rank 2, Coords: (0,2), N: 14, S: 6, E: 3, W: 1, Avg: 5.20
Rank 3, Coords: (0,3), N: 15, S: 7, E: 0, W: 2, Avg: 5.40
Rank 4, Coords: (1,0), N: 0, S: 8, E: 5, W: 7, Avg: 4.80
Rank 5, Coords: (1,1), N: 1, S: 9, E: 6, W: 4, Avg: 5.00
Rank 6, Coords: (1,2), N: 2, S: 10, E: 7, W: 5, Avg: 6.00
Rank 7, Coords: (1,3), N: 3, S: 11, E: 4, W: 6, Avg: 6.20
Rank 8, Coords: (2,0), N: 4, S: 12, E: 9, W: 11, Avg: 8.80
Rank 9, Coords: (2,1), N: 5, S: 13, E: 10, W: 8, Avg: 9.00
Rank 10, Coords: (2,2), N: 6, S: 14, E: 11, W: 9, Avg: 10.00
Rank 11, Coords: (2,3), N: 7, S: 15, E: 8, W: 10, Avg: 10.20
Rank 12, Coords: (3,0), N: 8, S: 0, E: 13, W: 15, Avg: 9.60
Rank 13, Coords: (3,1), N: 9, S: 1, E: 14, W: 12, Avg: 9.80
Rank 14, Coords: (3,2), N: 10, S: 2, E: 15, W: 13, Avg: 10.80
Rank 15, Coords: (3,3), N: 11, S: 3, E: 12, W: 14, Avg: 11.00

Task 3

```
root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpicc -o MPI_IO.exe
MPI_IO.c
root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# mpiexec
--allow-run-as-root -n 4 MPI_IO.exe
Rank 0 data: 0 1 2 3 4 5 6 7 8 9
Rank 1 data: 10 11 12 13 14 15 16 17 18 19
Rank 2 data: 20 21 22 23 24 25 26 27 28 29
Rank 3 data: 30 31 32 33 34 35 36 37 38 39
root@WIN-17422NPDIIJ:/mnt/c/Users/Administrator/CSE179/lab6# od -i data.bin
0000000          0         1        10        11
0000020         20        21        30        31
0000040          2         3        12        13
0000060         22        23        32        33
0000100          4         5        14        15
0000120         24        25        34        35
0000140          6         7        16        17
0000160         26        27        36        37
0000200          8         9        18        19
0000220         28        29        38        39
0000240
```

This MPI program efficiently writes data into a shared binary file using MPI_File_set_view()
and MPI_Type_vector(). Each process generates a unique dataset and performs
synchronized writing with MPI_File_write_all().