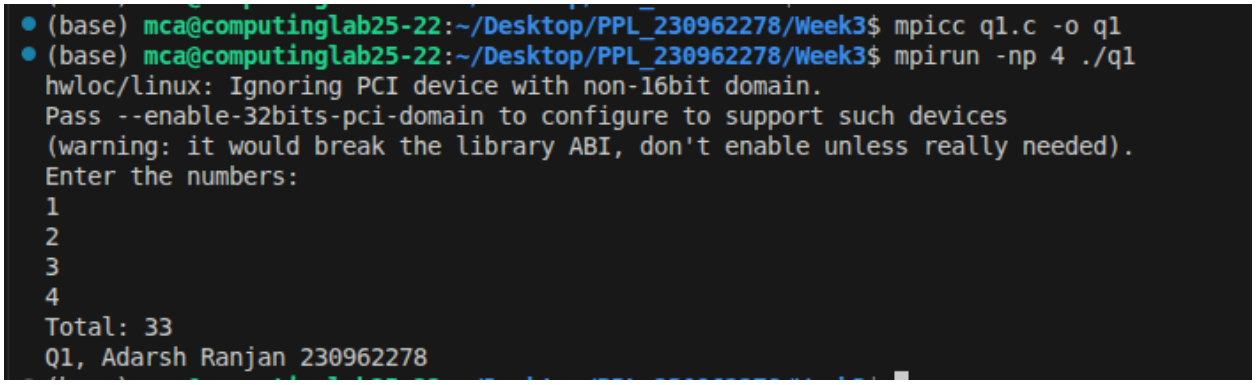
C q1.c | C q2.c | C q3.c | C q4.c

Week3 > C q1.c

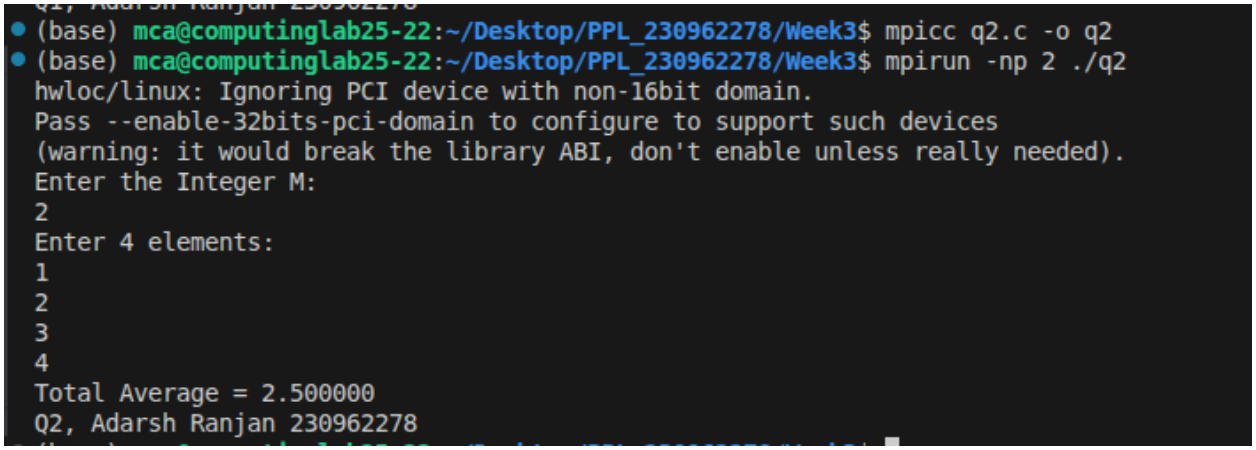
```c
#include <mpi.h>
#include <stdio.h>

long long factorial(int n) {
    long long fact = 1;
    for (int i = 1; i <= n; i++)
        fact *= i;
    return fact;
}

int main(int argc, char *argv[]) {
    int rank, size;
    int number;
    long long fact, sum = 0;
    int values[100];
    long long facts[100];

    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    if (rank == 0) {
        printf("Enter the numbers: \n");
        for (int i = 0; i < size; i++) {
            scanf("%d", &values[i]);
        }
    }

    MPI_Scatter(values, 1, MPI_INT,
                &number, 1, MPI_INT,
                0, MPI_COMM_WORLD);

    fact = factorial(number);

    MPI_Gather(&fact, 1, MPI_LONG_LONG_INT,
               facts, 1, MPI_LONG_LONG_INT,
               0, MPI_COMM_WORLD);

    if (rank == 0) {
        for (int i = 0; i < size; i++) {
            sum += facts[i];
        }
        printf("Total: %lld\n", sum);
        printf("Q1, Adarsh Ranjan 230962278\n");
    }

    MPI_Finalize();
    return 0;
}
```


(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpicc q1.c -o q1
(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpirun -np 4 ./q1
hwloc/linux: Ignoring PCI device with non-16bit domain.
Pass --enable-32bits-pci-domain to configure to support such devices
(warning: it would break the library ABI, don't enable unless really needed).
Enter the numbers:
1
2
3
4
Total: 33
Q1, Adarsh Ranjan 230962278

q1.c | q2.c | q3.c | q4.c

Week3 > q2.c

```c
#include <mpi.h>
#include <stdio.h>

int main(int argc, char *argv[]) {
    int rank, size, M;
    int id[10000];
    int recv[10000];
    double local_avg, total_avg;
    double avgs[1000];

    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    if (rank == 0) {
        printf("Enter the Integer M:\n");
        scanf("%d", &M);

        printf("Enter %d elements:\n", M * size);
        for (int i = 0; i < M * size; i++) {
            scanf("%d", &id[i]);
        }
    }

    MPI_Bcast(&M, 1, MPI_INT, 0, MPI_COMM_WORLD);

    MPI_Scatter(id, M, MPI_INT,
                recv, M, MPI_INT,
                0, MPI_COMM_WORLD);

    int sum = 0;
    for (int i = 0; i < M; i++) {
        sum += recv[i];
    }

    local_avg = (double)sum / M;

    MPI_Gather(&local_avg, 1, MPI_DOUBLE,
               avgs, 1, MPI_DOUBLE,
               0, MPI_COMM_WORLD);

    if (rank == 0) {
        double total = 0.0;
        for (int i = 0; i < size; i++) {
            total += avgs[i];
        }
        total_avg = total / size;
        printf("Total Average = %lf\n", total_avg);
        printf("Q2, Adarsh Ranjan 230962278\n");
    }

    MPI_Finalize();
    return 0;
}
```


(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpicc q2.c -o q2
(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpirun -np 2 ./q2
hwloc/linux: Ignoring PCI device with non-16bit domain.
Pass --enable-32bits-pci-domain to configure to support such devices
(warning: it would break the library ABI, don't enable unless really needed).
Enter the Integer M:
2
Enter 4 elements:
1
2
3
4
Total Average = 2.500000
Q2, Adarsh Ranjan 230962278

q1.c | q2.c | q3.c | q4.c

Week3 > q3.c

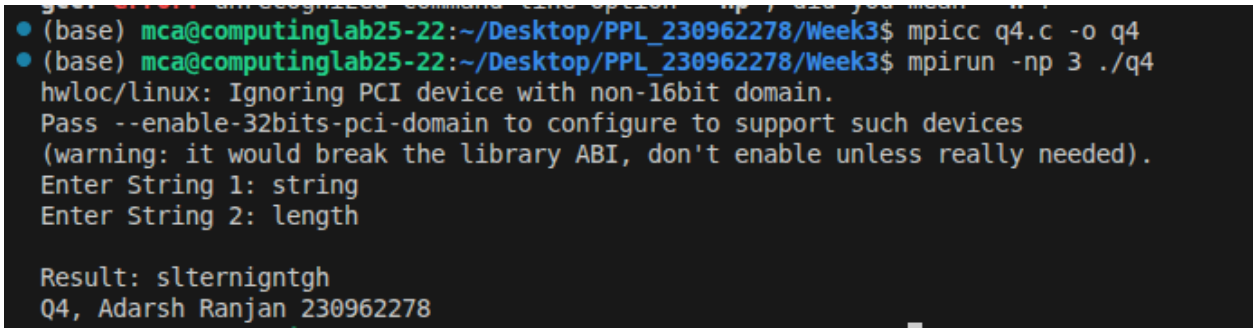
```c
#include <mpi.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <ctype.h>

int is_vowel(char c)
{
    c = tolower(c);
    return (c=='a'||c=='e'||c=='i'||c=='o'||c=='u');
}

int main(int argc, char *argv[])
{
    int rank, size;
    char *str = NULL;
    char *local_str;
    int n, local_n;
    int local_count = 0;
    int *counts = NULL;
    int total = 0;

    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    if (rank == 0)
    {
        str = (char *)malloc(1024 * sizeof(char));
        printf("Enter the string: ");
        fflush(stdout);
        fgets(str, 1024, stdin);
        str[strcspn(str, "\n")] = '\0';
        n = strlen(str);
    }

    MPI_Bcast(&n, 1, MPI_INT, 0, MPI_COMM_WORLD);

    if (n % size != 0)
    {
        if (rank == 0)
            printf("Error: String length must be evenly divisible by number of processes\n");
        MPI_Finalize();
        return 0;
    }

    local_n = n / size;
    local_str = (char *)malloc(local_n * sizeof(char));

    MPI_Scatter(str, local_n, MPI_CHAR, local_str, local_n, MPI_CHAR, 0, MPI_COMM_WORLD);

    for (int i = 0; i < local_n; i++)
    {
        if (!is_vowel(local_str[i]))
            local_count++;
    }

    if (rank == 0)
        counts = (int *)malloc(size * sizeof(int));

    MPI_Gather(&local_count, 1, MPI_INT, counts, 1, MPI_INT, 0, MPI_COMM_WORLD);
    MPI_Reduce(&local_count, &total, 1, MPI_INT, MPI_SUM, 0, MPI_COMM_WORLD);

    if (rank == 0)
    {
        for (int i = 0; i < size; i++)
            printf("Process %d: %d\n", i, counts[i]);
        printf("Total non-vowels: %d\n", total);
        printf("Q3, Adarsh Ranjan 230962278\n");
    }

    MPI_Finalize();
    return 0;
}
```

```
(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpicc q3.c -o q3
(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpirun -np 3 ./q3
hwloc/linux: Ignoring PCI device with non-16bit domain.
Pass --enable-32bits-pci-domain to configure to support such devices
(warning: it would break the library ABI, don't enable unless really needed).
Enter the string: adarsh
Process 0: 1
Process 1: 1
Process 2: 2
Total non-vowels: 4
Q3, Adarsh Ranjan 230962278
```

q1.c | q2.c | q3.c | q4.c

Week3 > q4.c

```c
#include <mpi.h>
#include <stdio.h>
#include <string.h>
#include <stdlib.h>

int main(int argc, char** argv) {
    int rank, size;
    char s1[100], s2[100];
    char *res = NULL;
    char *sub_s1, *sub_s2, *sub_res;
    int n, m;

    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    MPI_Comm_size(MPI_COMM_WORLD, &size);

    if (rank == 0) {
        printf("Enter String 1: ");
        fflush(stdout);
        scanf("%s", s1);
        printf("Enter String 2: ");
        fflush(stdout);
        scanf("%s", s2);

        n = strlen(s1);

        if (n % size != 0) {
            fflush(stdout);
            MPI_Abort(MPI_COMM_WORLD, 1);
        }

        m = n / size;
    }

    MPI_Bcast(&m, 1, MPI_INT, 0, MPI_COMM_WORLD);
    MPI_Bcast(&n, 1, MPI_INT, 0, MPI_COMM_WORLD);

    sub_s1 = (char*)malloc(m * sizeof(char));
    sub_s2 = (char*)malloc(m * sizeof(char));
    sub_res = (char*)malloc(2 * m * sizeof(char));

    MPI_Scatter(s1, m, MPI_CHAR, sub_s1, m, MPI_CHAR, 0, MPI_COMM_WORLD);
    MPI_Scatter(s2, m, MPI_CHAR, sub_s2, m, MPI_CHAR, 0, MPI_COMM_WORLD);

    for (int i = 0; i < m; i++) {
        sub_res[2 * i] = sub_s1[i];
        sub_res[2 * i + 1] = sub_s2[i];
    }

    if (rank == 0) {
        res = (char*)malloc((2 * n + 1) * sizeof(char));
    }

    MPI_Gather(sub_res, 2 * m, MPI_CHAR, res, 2 * m, MPI_CHAR, 0, MPI_COMM_WORLD);

    if (rank == 0) {
        res[2 * n] = '\0';
        printf("\nResult: %s\n", res);
        printf("Q4, Adarsh Ranjan 230962278\n");

        free(res);
    }

    free(sub_s1);
    free(sub_s2);
    free(sub_res);

    MPI_Finalize();
    return 0;
}
```


(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpicc q4.c -o q4
(base) mca@computinglab25-22:~/Desktop/PPL_230962278/Week3$ mpirun -np 3 ./q4
hwloc/linux: Ignoring PCI device with non-16bit domain.
Pass --enable-32bits-pci-domain to configure to support such devices
(warning: it would break the library ABI, don't enable unless really needed).
Enter String 1: string
Enter String 2: length
Result: slternigntgh
Q4, Adarsh Ranjan 230962278