**Flie: pi.c**

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

#define MAX_NAME 80
#define MASTER 0
int main(int argc,char *argv[])
{
    int rank,nprocs,i,len;
    int n=1000;
    double PI25DT =3.141592653589793238462643;
    double mypi,pi,step,sum,x;
    char name[MAX_NAME];
    double start_time,end_time,computation_time;

    MPI_INIT(&argc,&argv);
    MPI_Comm_size(MPI_COMM_WORLD,&nprocs);
    MPI_Comm_rank(MPI_COMM_WORLD,&rank);
    MPI_Get_processor_name(name,&len);
    start_time=MPI_Wtime();

    step=1.0 /(double)n;
    sum=0.0;
    for(i=rank+1;i<=n;i+=nprocs)
    {
    x=step * ((double)i-.5);
    sum +=4.0/(1.0+x*x);
    }

    mypi=step*sum;
    printf("\nProcessor: %d Name: %s Sum: %.16f \n",rank,name,mypi);
    MPI_Reduce(&mypi,&pi,1,MPI_DOUBLE,MPI_SUM,0,MPI_COMM_WORLD);
    if(rank==0)
    {
    printf("\nValue of Pi is %.16f approximately .Error is %.16f
\n",pi,fabs(pi-PI25DT));
    end_time=MPI_Wtime();
    computation_time=end_time-start_time;
    printf("\nComputation time is: %f seconds.\n",computation_time);
    }
 MPI_Finalize();
}
```

**#OUTPUT:**

**1 Node:**

```
student@PUN:-$ mpirun -np 18 -f mf.txt ./pil
Processor: 2 Name: node1 Sum: 0.2426004700000000
Processor: 6 Name: node1 Sum: 0.2428242460000000
Processor: 17 Name: node1 Sum: 0.2384338137499999
Processor: 13 Name: node1 Sum: 0.2382131537500001
Processor: 9 Name: node1 Sum: 0.2429932540000000
Processor: 3 Name: node1 Sum: 0.2426562460000000
Processor: 0 Name: node1 Sum: 0.242489254000000e
Processor: 4 Name: node1 Sum: 0.2427121340000001
Processor: 5 Name: node1 Sum: 0.2427681340000001
Processor: 7 Name: node1 Sum: 0.2428804700000000
Processor: 10 Name: node1 Sum: 0.2380488137499999
Processor: 12 Name: node1 Sum: 0.238158263750000e
Processor: 14 Name: node1 Sum: 0.238268153750000e
Processor: 15 Name: node1 Sum: 0.2383232637500001
Processor: 16 Name: node1 Sum: 0.238378483750000e
Processor: 11 Name: node1 Sum: 0.2381034837499999
Processor: 1 Name: node1 Sum: 0.2425448060000001
Processor: 8 Name: node1 Sum: 0.2429368060000000
Value of Pi is 3.1415927369231267 approximately .Error is
0.0000000833333336
Computation time is: 0.047992 seconds.
```

**2 Nodes:**

```
student@PUN:-$ mpirun -np 18 -f mf.txt ./pi1
Processor: 1 Name: node2 sum: 0.2425448060000001
Processor: 7 Name: node2 Sum: 0.24288047eeeeeeee
Processor: 17 Name: node2 Sum: 0.2384338137499999
Processor: 3 Name: node2 Sum: 0.2426562460000000
Processor: 11 Name: node2 Sum: 0.2381034837499999
Processor: 9 Name: node2 Sum: 0.242993254000000e
Processor: 13 Name: node2 Sum: 0.2382131537500001
Processor: 4 Name: node1 Sum: 0.2427121340000001
Processor: 10 Name: node1 Sum: 0.2380488137499999
Processor: 16 Name: node1 Sum: 0.2383784837500000
Processor: 12 Name: node1 Sum: 0.23815826375eeeee
Processor: 2 Name: node1 sum: 0.2426064700000000
Processor: 6 Name: node1 Sum: 0.242824246000000e
Processor: 14 Name: node1 Sum: 0.2382681537500000
Processor: 15 Name: node2 Sum: 0.2383232637500001
Processor: 5 Name: node2 Sum: 0.2427681340000001
Processor: e Name: node1 Sum: 6.242489254000000e
Processor: 8  Name: node1 Sum: 0.2429368060000000
Value of Pi is 3.1415927369231267 approximately .Error is
0.0000000833333336
Computation time is: 0.028116 seconds.
```

**3 Nodes:**

```
student@node1:-$ mpirun -np 18 -f mf.txt ./pi1
Processor: 3 Name: node1 Sum: 0.2426562460000000
Processor: 9 Name: node1 Sum: 0.2429932540000000
Processor: 12 Name: node1 Sum: 0.238158263750000e
Processor: 15 Name: node1 Sum: 0.2383232637500001
Processor: 1 Name: node2 sum: 0.2425448060000001
Processor: 4 Name: node2 Sum: 0.2427121340000001
Processor: 7 Name: node2 Sum: 0.2428804700000000
Processor: le Name: node2 Sum: 0.2380488137499999
Processor: 6 Name: node1 Sum: 0.2428242460000000
Processor: 16 Name: node2 Sum: 0.2383784837500000
Processor: 0 Name: node1 Sum: 0.2424892540000000
Processor: 2 Name: node3 Sum: 0.2426004700000000
Processor: 8 Name: node3 Sum: 0.2429368060000000
Processor: 14 Name: node3 Sum: 0.2382681537500000
Processor: 17 Name: node3 Sum: 0.2384338137499999
Processor: 13 Name: node2 Sum: 0.2382131537500001
Processor: 11 Name: node3 Sum: 0.2381034837499999
Processor: 5 Name: node3 Sum: 0.2427681340000001
Value of Pi is 3.1415927369231267 approximately .Error is
0.0000000833333336
Computation time is: 0.027974 seconds.
```

**4 Nodes:**

```
student@node1:-$ mpirun -np 18 -f mf.txt ./pil
Processor: 3 Name: node4 Sum: 0.2426562460000000
Processor: 2 Name: node3 Sum: 0.2426004700000000
Processor: 7 Name: node4 Sum: 0.2428804700000000
Processor: 6 Name: node3 Sum: 0.2428242460000000
Processor: 11 Name: node4 Sum: 0.2381034837499999
Processor: le Name: node3 Sum: 0.2380488137499999
Processor: 15 Name: node4 Sum: 0.2383232637500001
Processor: 14 Name: node3 Sum: 0.2382681537500000
Processor: 1 Name: node2 Sum: 0.2425448060000001
Processor: 5 Name: node2 Sum: 0.2427681340000001
Processor: 9 Name: node2 Sum: 0.2429932540000000
Processor: 17 Name: node2 Sum: 0.2384338137499999
Processor: e Name: node1 Sum: 0.2424892540000000
Processor: 4 Name: node1 Sum: 0.2427121340600001
Processor: 12 Name: node1 Sum: 0.2381582637500000
Processor: 16 Name: node1 Sum: 0.2383784837500000
Processor: 8 Name: node1 Sum: 0.2429368060000000
Processor: 13 Name: node2 Sum: 0.2382131537500001
Value of Pi is 3.1415927369231267 approximately .Error is
0.0000000833333336
Computation time is: 0.009060 seconds.
```

**5 Nodes:**

```
student@node5:-$ mpirun -np 18 -f mf.txt ./pi1
Processor: 4 Name: node5 Sum: 0.2427121340000001
Processor: 3 Name: node4 Sum: 0.2426562460000000
Processor: 9 Name: node1 Sum: 0.242993254000000e
Processor: 8 Name: node2 Sum: 0.2428368060000000
Processor: 14 Name: node5 Sum: 0.238268153750000e
Processor: 13 Name: node4 sum: 0.2382131537500001
Processor: 2 Name: node3 Sum: 0.2426004700000000
Processor: 7 Name: node1 Sum: 0.2428804700000000
Processor: 12 Name: node3 Sum: 0.2381582637500000
Processor: 17 Name: node3 Sum: 0.2384338137499999
Processor: 1 Name: node4 Sum: 0.2425448060000001
Processor: 6 Name: node2 Sum: 0.242824246000000e
Processor: 11 Name: node4 Sum: 0.2381034837499999
Processor: 16 Name: node2 Sum: 0.2383784837500000
Processor: 0 Name: node1 sum: 0.242489254000000e
Processor: 5 Name: node5 Sum: 0.2427681340000001
Processor: 10 Name: node1 Sum: 0.2380488137499999
Processor: 15 Name: node5 Sum: 0.2383232637500001
Value of Pi is 3.1415927369231267 approximately .Error is
0.0000000833333336
Computation time is: 0.003994 seconds.
```

**6 Nodes:**

```
student@node1:-5 mpirun -np 18 -f mf.txt ./pi1
Processor: 4 Name: node5 Sum: 0.2427121340000001
Processor: 1 Name: node2 Sum: 0.2425448060000001
Processor: 10 Name: node5 Sum: 0.2380488137499999
Processor: 7 Name: node2 Sum: 0.2428804 70000000e
Processor: 16 Name: node5 Sum: 0.2383784837500000
Processor: 13 Name: node2 Sum: 0.2302131537500001
Processor: 2 Name: node3 Sum: 0.2426004 700000000
Processor: 3 Name: node4 Sum: 0.2426562460000000
Processor: 8 Name: node3 Sum: 0.2429368060000000
Processor: 9 Name: node4 Sum: 0.2429932540000000
Processor: 14 Name: node3 Sum: 0.2382681537500000
Processor: 0 Name: node1 Sum: 0.242409254000000e
Processor: 15 Name: node4 Sum: 0.2383232637500001
Processor: 5 Name: node6 Sum: 0.2427681340000001
Processor: 6 Name: node1 Sum: 0.242024246000000e
Processor: 11 Name: node6 Sum: 0.2381034837499999
Processor: 12 Name: node1 Sum: 0.238158263750000e
Processor: 17 Name: node6 Sum: 0.2384338137499999
Value of Pi is 3.1415927369231267 approximately .Error is
0.0000000833333336
Computation time is: 0.001363 seconds.
```

**mf.txt:**

```
node1:3
node2:3
node3:3
node4:3
node5:3
node6:3
```

Graph of **Execution time** vs **No. Of Nodes**: