

Final Year B. Tech., Sem VI 2021-22

High Performance Computing Lab

Assignment submission

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Assignment: 2

SPMD: Single Program Multiple Data

It is a parallel programming style. In SPMD style tasks are split up and run simultaneously on multiple processors with different data. This is done to achieve results faster.

Worksharing

Threads are assigned, an independent subset of the total workload For example, different chunks of an iteration are distributed among the threads.

eg.

T1 -> iteration from 1 to 5

T2 -> iteration from 6 to 10 and so on...

OpenMP provides various constructs for worksharing.

OpenMP loop worksharing construct

OpenMP's loop worksharing construct splits loop iterations among all active threads

#pragma omp for

Types of variables

1. Shared Variables :

There exist one instance of this variable which is shared among all threads

2. Private Variables :

Each thread in a team of threads has its own local copy of the private variable

Two ways to assign variables as private and shared are

Implicit and Explicit

Implicit : All the variables declared outside of the pragma are by default shared and all the variables declared inside pragma are private

Explicit:

Shared Clause

eg. *#pragma omp parallel for shared(n, a)* => n and a are declared as shared variables

Private Clause

eg. *#pragma omp parallel for shared(n, a) private(c)* => here c is private variable

Default Clause

eg. *#pragma omp parallel for default(shared)* => now all variables are shared

#pragma omp parallel for default(private) => now all variables are private

firstprivate

firstprivate make the variable private but that variable is initialised with the value that it has before the parallel region

lastprivate

lastprivate make the variable private but it retain the last value of that private variable outside of the private region

Schedule

a specification of how iterations of associated loops are divided into contiguous non-empty subsets.

syntax: *#pragma omp parallel for schedule([modifier [modifier]:]kind[,chunk_size])*

Five kinds of schedules for OpenMP loop:

- static
- dynamic
- guided
- auto
- runtime

Static Schedule

In static scheduling openMP assigns iterations to threads in a cyclic order

eg: *#pragma omp parallel for schedule(static,1)*

=> Number “1” indicates that we assign one iteration to each thread before switching to the next thread — we use chunks of size 1.

Dynamic Schedule

In dynamic scheduling, each thread will take one iteration, process it, and then see what is the next iteration that is currently not being processed by anyone. This way it will never happen that one thread finishes while other threads have still lots of work to do:

eg: *#pragma omp parallel for schedule(dynamic,1)*

nowait

When we use a parallel region, OpenMP will automatically wait for all threads to finish before execution continues. There is also a synchronization point after each omp for loop

However, if we do not need synchronization after the loop, we can disable it with nowait

eg: *#pragma omp for nowait*

reduction

The OpenMP reduction clause lets you specify one or more thread-private variables that are subject to a reduction operation at the end of the parallel region.

eg: if we want to calculate sum of first 100 natural numbers and want to save it into variable 'sum', we can save individual thread sums and then add all sum to get resultant sum.

Or we can use reduction clause and it will automatically handle each threads sum and then the final sum, syntax is

#pragma omp for reduction(+:sum)

Problems:

1. vector vector addition

```
#include <omp.h>
#include <stdio.h>

void main()
{
    printf("Adding Two Arrays\n");
    int a1[] = {1, 2, 3, 4, 5};
    int a2[] = {11, 12, 13, 14, 15};
    int a3[5];
    int i;
    #pragma omp parallel
    for (i = 0; i < 5; i++)
    {
        a3[i] = a1[i] + a2[i];
    }
    for (i = 0; i < 5; i++)
    {
        printf("%d ", a3[i]);
    }
}
```

Output:-

```
C:\Users\DELL\Desktop\sem7\hpc assignment\assignment2\addingTwoArrays.exe
Adding Two Arrays
12 14 16 18 20
-----
Process exited after 0.04307 seconds with return value 3
Press any key to continue . . .
```

Vector Scaler Addition:-

Code:-

```
#include <omp.h>
#include <stdio.h>

void main()
{
    printf("Adding Vector into Scalar\n");
    int a1[] = {1, 2, 3, 4, 5};
    int answer = 0;
    int i;
    #pragma omp parallel
    for (i = 0; i < 5; i++)
    {
        answer += a1[i];
    }
    printf("Answer %d ", answer);
}
```

Output:-

```
C:\Users\DELL\Desktop\sem7\hpc assignment\assignment2\addingVectorScalar.exe
Adding Vector into Scalar
Answer 15
-----
Process exited after 0.03433 seconds with return value 11
Press any key to continue . . .
```