**Class:** Final Year (Computer Science and Engineering)

**Year:** 2023-24 **Semester:** 1

**Course:** High Performance Computing Lab

**Practical No. 2**

**Exam Seat No: 2020BTECS00023**

**Name: Sumit Narake**

**Title of practical: Study and implementation of basic OpenMP clauses**

Implement following Programs using OpenMP with C:

1. Vector Scalar Addition
2. Calculation of value of Pi

Analyse the performance of your programs for different number of threads and Data size.

**Problem Statement 1: Vector Scalar Addition**

**Screenshots:**

**Vector Scalar Addition Sequential Code:**

#include <omp.h>

#include <stdio.h>

#include <pthread.h>

void main()

{

    int N = 100;

    int A[N];

    for(int i=0;i<N;i++)A[i] = i + 1;

    int S = 2000;

    double itime, ftime, exec\_time;

    itime = omp\_get\_wtime();

    for (int i = 0; i < N; i++)

    {

        A[i] += S;

        printf("Thread: %d Index: %d\n", omp\_get\_thread\_num(),i);

    }

    ftime = omp\_get\_wtime();

    exec\_time = ftime - itime;

    // for(int i=0;i<N;i++){

    //     printf("%d ", A[i]);

    // }

    printf("\nTime taken is %f\n", exec\_time);

    printf("\n");

}

**Vector Scalar Addition Sequential Output:**





**Vector Scalar Addition Parallel Code:**

#include <omp.h>

#include <stdio.h>

#include <pthread.h>

void main()

{

    int N = 100;

    int A[N];

    for(int i=0;i<N;i++)A[i] = i + 1;

    int S = 212354454;

    omp\_set\_num\_threads(6);

    double itime, ftime, exec\_time;

    itime = omp\_get\_wtime();

    #pragma omp parallel for private(S)

    for (int i = 0; i < N; i++)

    {

        A[i] += S;

        // printf("Thread: %d Index: %d\n", omp\_get\_thread\_num(),i);

    }

    ftime = omp\_get\_wtime();

    exec\_time = ftime - itime;

    // for(int i=0;i<N;i++){

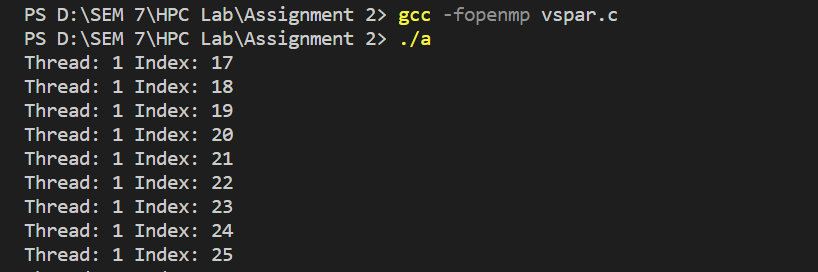
    //     printf("%d ", A[i]);

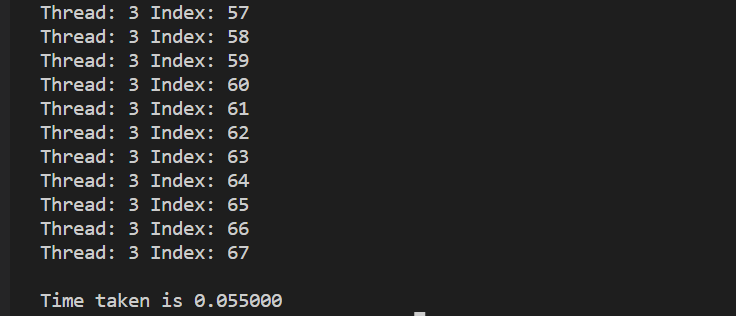
    // }

    printf("\nTime taken is %f\n", exec\_time);

}

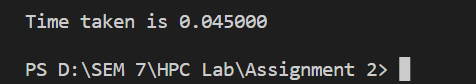
**Vector Scalar Addition Parallel Output:**



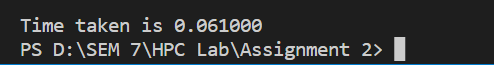


**Information:**

Execution time for sequential processing is:



Execution time for parallel processing is:



**Analysis:**

Increasing the thread count beyond the number of CPU cores can potentially reduce execution time up to a point. Beyond that point, excessive threads may introduce overhead. Changing the thread count won't directly affect execution time since it's fixed at 6 threads. However, execution time can still vary depending on hardware and workload characteristics.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Threads | 1 | 2 | 4 | 8 | 16 |
| time | 0.14000 | 0.025000 | 0.040000 | 0.026000 | 0.020000 |

**Problem Statement 2: Calculation of value of Pi**

**Screenshots:**

**Calculation of value of Pi Sequential Code:**

#include <stdio.h>

#include <stdlib.h>

#include <time.h>

#define NUM\_POINTS 1000000

int main() {

    srand(time(NULL));

    clock\_t start\_time = clock();

    int inside\_circle = 0;

    for (int i = 0; i < NUM\_POINTS; i++) {

        double x = (double)rand() / RAND\_MAX;

        double y = (double)rand() / RAND\_MAX;

        double distance = x \* x + y \* y;

        if (distance <= 1.0) {

            inside\_circle++;

        }

    }

    double pi = 4.0 \* inside\_circle / NUM\_POINTS;

    printf("Estimated Pi value (sequential): %lf\n", pi);

    clock\_t end\_time = clock();

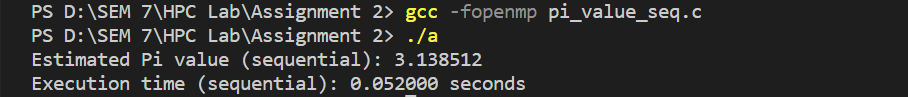
    double execution\_time = (double)(end\_time - start\_time) / CLOCKS\_PER\_SEC;

    printf("Execution time (sequential): %lf seconds\n", execution\_time);

    return 0;

}

**Calculation of value of Pi Sequential Output:**



**Calculation of value of Pi Parallel Code:**

#include <stdio.h>

#include <stdlib.h>

#include <time.h>

#include <omp.h>

#define NUM\_POINTS 1000000

int main() {

    srand(time(NULL));

    clock\_t start\_time = clock();

    int inside\_circle = 0;

    #pragma omp parallel for reduction(+:inside\_circle)

    for (int i = 0; i < NUM\_POINTS; i++) {

        double x = (double)rand() / RAND\_MAX;

        double y = (double)rand() / RAND\_MAX;

        double distance = x \* x + y \* y;

        if (distance <= 1.0) {

            inside\_circle++;

        }

    }

    double pi = 4.0 \* inside\_circle / NUM\_POINTS;

    printf("Estimated Pi value (parallel): %lf\n", pi);

    clock\_t end\_time = clock();

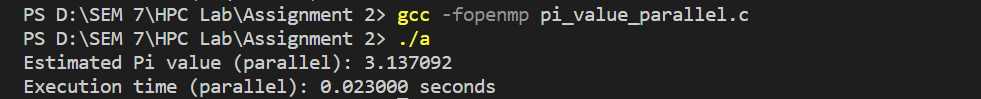
    double execution\_time = (double)(end\_time - start\_time) / CLOCKS\_PER\_SEC;

    printf("Execution time (parallel): %lf seconds\n", execution\_time);

    return 0;

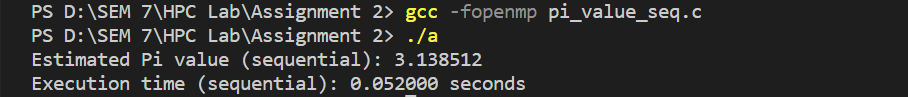
}

**Calculation of value of Pi Parallel Output:**

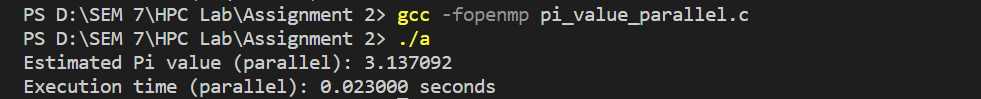


**Information:**

Execution time for sequential processing is:



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|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **THread** | **1** | **2** | **4** | **8** | **16** |
| **Time** | **0.0024** | **0.022000** | **0.016000** | **0.015000** | **0.016000** |

**Github Link:** [**https://github.com/sumitnarake/HPC/tree/main/HPC-Lab-main**](https://github.com/sumitnarake/HPC/tree/main/HPC-Lab-main)