

# Използване на OpenMP.

*Курс „Паралелно програмиране“*



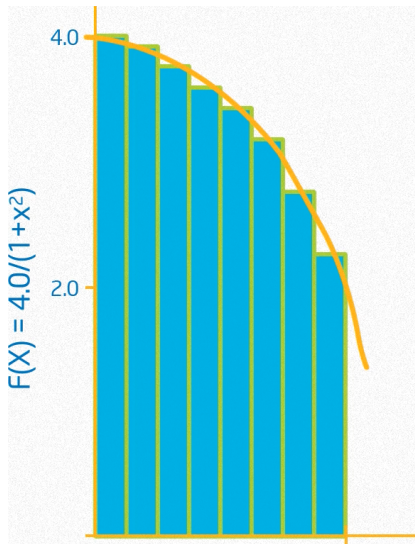
ИНСТИТУТ за СЪВРЕМЕННИ  
ФИЗИЧЕСКИ ИЗСЛЕДВАНИЯ

Стоян Мишев



$$\int_0^1 \frac{4}{1+x^2} dx = \pi$$

$$\int_0^1 \frac{4}{1+x^2} dx = \pi$$



```
1 #include <stdio.h>
2 #include <omp.h>
3 static long num_steps = 100000000;
4 double step;
5 int main ()
6 {
7     int i;
8     double x, pi, sum = 0.0;
9     double start_time, run_time;
10    step = 1.0/(double) num_steps;
11    start_time = omp_get_wtime();
12    for (i=1;i<= num_steps; i++){
13        x = (i-0.5)*step;
14        sum = sum + 4.0/(1.0+x*x);
15    }
16
17    pi = step * sum;
18    run_time = omp_get_wtime() - start_time;
19    printf("\n pi with %ld steps is %lf in %lf
20           seconds\n ", num_steps, pi, run_time);
21 }
```

```
1 #define MAX_THREADS 4
2 static long num_steps = 100000000;
3 double step;
4 int main ()
5 {
6     int i,j;
7     double pi, full_sum = 0.0;
8     double start_time, run_time;
9     double sum[MAX_THREADS];
10    step = 1.0/(double) num_steps;
11    for (j=1;j<=MAX_THREADS ;j++) {
12        omp_set_num_threads(j);
13        full_sum=0.0;
14        start_time = omp_get_wtime();
15        #pragma omp parallel
16        {
17            int i;
18            int id = omp_get_thread_num();
19            int numthreads = omp_get_num_threads();
20            double x;
21            sum[id] = 0.0;
```

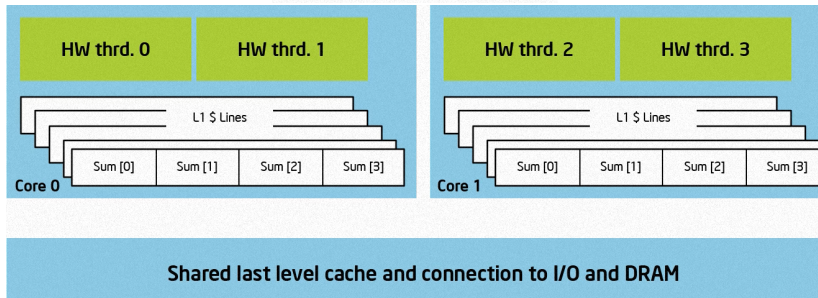
```
1         if (id == 0)
2             printf(" num_threads = %d", numthreads);
3
4         for (i=id; i< num_steps; i+=numthreads){
5             x = (i+0.5)*step;
6             sum[id] = sum[id] + 4.0/(1.0+x*x);
7         }
8     }
9     for(full_sum = 0.0, i=0; i<j; i++){
10         full_sum += sum[i];
11     }
12     pi = step * full_sum;
13     run_time = omp_get_wtime() - start_time;
14     printf("\n pi is %f in %f seconds %d thrds \n", pi
15           , run_time, j);
16 }
```

Threads	1 <sup>st</sup> SPMD
1	1.86
2	1.03
3	1.08
4	0.97



# Решение с паралелни изчисления 1. Мащабируемост. 7

Threads	1 <sup>st</sup> SPMD
1	1.86
2	1.03
3	1.08
4	0.97



```
#include <omp.h>
static long num_steps = 100000;      double step;
#define PAD 8           // assume 64 byte L1 cache line size
#define NUM_THREADS 2
void main ()
{
    int i, nthreads; double pi, sum[NUM_THREADS][PAD];
    step = 1.0/(double) num_steps;
    omp_set_num_threads(NUM_THREADS);
    #pragma omp parallel
    {
        int i, id, nthrds;
        double x;
        id = omp_get_thread_num();
        nthrds = omp_get_num_threads();
        if (id == 0) nthreads = nthrds;
        for (i=id, sum[id]=0.0; i< num_steps; i=i+nthrds) {
            x = (i+0.5)*step;
            sum[id][0] += 4.0/(1.0+x*x);
        }
    }
    for(i=0, pi=0.0; i<nthreads; i++) pi += sum[i][0] * step;
}
```

В част от програмата нишките се изпълняват последователно

```
float res;  
  
#pragma omp parallel  
{  
    float B; int i, id, nthrds;  
    id = omp_get_thread_num();  
    nthrds = omp_get_num_threads();  
    for(i=id; i<niters; i+=nthrds){  
        B = big_job(i);  
  
        #pragma omp critical  
        res += consume (B);  
    }  
}
```

```
1 #include <stdio.h>
2 #include <omp.h>
3
4 #define MAX_THREADS 4
5
6 static long num_steps = 100000000;
7 double step;
8 int main ()
9 {
10     int i, j;
11     double pi, full_sum = 0.0;
12     double start_time, run_time;
13     double sum[MAX_THREADS];
14
15     step = 1.0/(double) num_steps;
16
17
18     for (j=1; j<=MAX_THREADS ; j++){
19         omp_set_num_threads(j);
20         full_sum = 0.0;
21         start_time = omp_get_wtime();
```

```
1 #pragma omp parallel private(i)
2 {
3     int id = omp_get_thread_num();
4     int numthreads = omp_get_num_threads();
5     double x;
6
7     double partial_sum = 0;
8
9 #pragma omp single
10     printf(" num_threads = %d", numthreads);
11
12     for (i=id; i< num_steps; i+=numthreads){
13         x = (i+0.5)*step;
14         partial_sum += 4.0/(1.0+x*x);
15     }
16 #pragma omp critical
17     full_sum += partial_sum;
18 }
19
20 pi = step * full_sum;
21 run_time = omp_get_wtime() - start_time;
```

<https://www.youtube.com/watch?v=cMWGeJyrc9w&list=PLlbPZJxtMs4ZHSamRRYCtvowRS0qIwC-I>  
До “Introduction to OpenMP: 09 part 1 Module 5”