



Universidade de Aveiro
Mestrado Integrado em Engenharia Computacional
Computação Paralela

Lesson 3: OpenMP

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OpenMP is an API that allows the development of explicit multi-threaded shared memory parallelism. In this Lesson we will perform a few exercises using OpenMP to enhance the performance of serial programs. The base code for this lesson is provided in the package `cp_openmp.zip`.

1. Unpack `cp_openmp.zip`.
2. Read `hello.c` carefully.
 - 2.1. Modify `hello.c` to create an OpenMP parallel region. Compile and execute.
 - 2.2. Change the value of the environment variable `OMP_NUM_THREADS` to different values and execute `hello` again.
 - 2.3. Use the clause `num_threads` to control the number of threads in the parallel region.
 - 2.4. Use the function `omp_set_num_threads()` to control the number of threads in the parallel region
3. The program `pi.c` determines the value of π by integrating numerically:

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

- 3.1. Compile `pi.c` and execute it.
 - 3.2. Use `#pragma omp parallel` (without using `omp for`) to create a parallel version of this algorithm. Determine the speedup.
 - 3.3. Use `#pragma omp for` with mutual exclusion constructs to create a parallel version of this algorithm. Determine the speedup.
 - 3.4. Use `omp for` and `reduction` construct to create a parallel version of this algorithm. Determine the speedup.
4. The program `mandel.c` determines (incorrectly) the area of the Mandelbrot set. The Mandelbrot set is defined by the set of complex numbers c for which the iterating:

$$z_{n+1} = z_n^2 + c \quad \text{with } z_0 = 0$$

keeps $|z_n| < \infty$ as n tends to ∞ . The shape of the Mandelbrot set is a fractal.

- 4.1. Debug and correct the program, so that the area is correctly determined.
5. The program `linked.c` uses a linked list in which each node determines a number in the Fibonacci sequence.
 - 5.1. Create a parallel version of this program using OpenMP without `task`. Determine the speedup.

- 5.2. Create a parallel version of this program using OpenMP using **task**. Determine the speedup.

Bibliography

- [1] “A ‘Hands-on’ Introduction to OpenMP”, Tim Mattson, Intel Corp., timothy.g.mattson@intel.com