Introduction of High Performance Computing
Assignment 1

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Exercise 1 - Parallel approximation of π

the goal of the exercise is to write a code which approximates π. In order to do this, we will calculate, using midpoint formulam the following integrate:

$$\pi = 4 \cdot \int_0^1 \frac{dx}{1+x^2} = \sum_{i=0}^{N-1} f(x_{i+\frac{1}{2}})$$

First of all, we have written a serial code which calculates this integrals and then we move to an "multi-thread" approach using three different commands in order to avoid *race condition*:

1. Critical.
2. Atomic.
3. Reduction.

Code and Results

After having written the code (which is the github repository), we ran it on Ulisse with different number of threads and we have reached the following results:

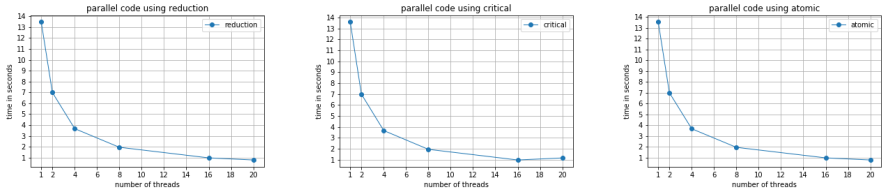


Figure 1: These three plots show to us how time decreases when the number of threads increases: the "left-figure" represents the code with the command *reduction*, the "central" one the code with the command *critical* and right one the code with the command *atomic*.

When we increase the number of threads, obviously time decreases in a very fast way. We notice also that the three different commands give to us almost

the same result: the only different is that using critical things get a little bit worst with 20 threads. Obviously we ran also the serial program, reaching truly worst result:

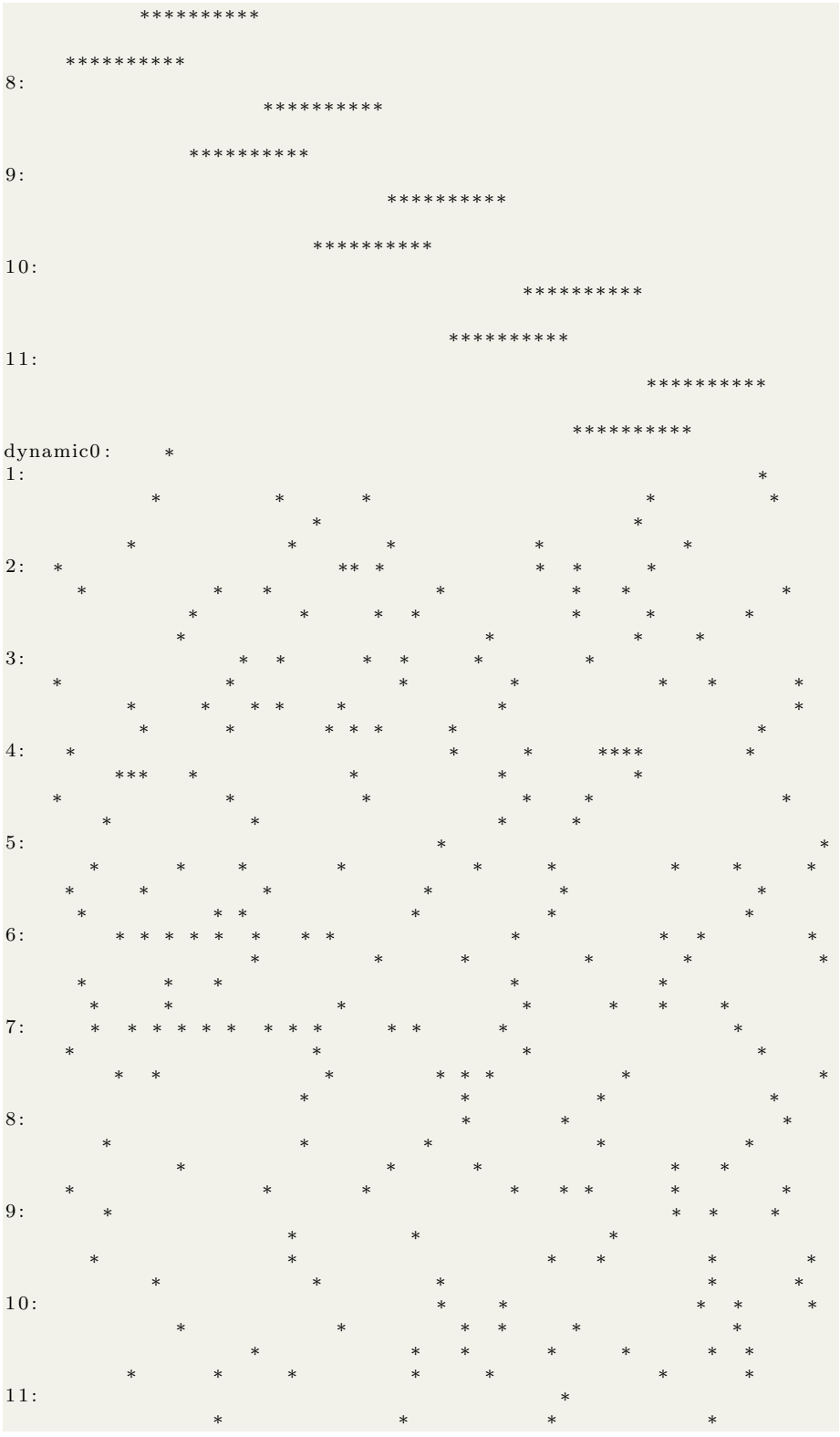
```
value of pi:  3.141593
time for approximating pi with serial code: 18.159840 seconds
```

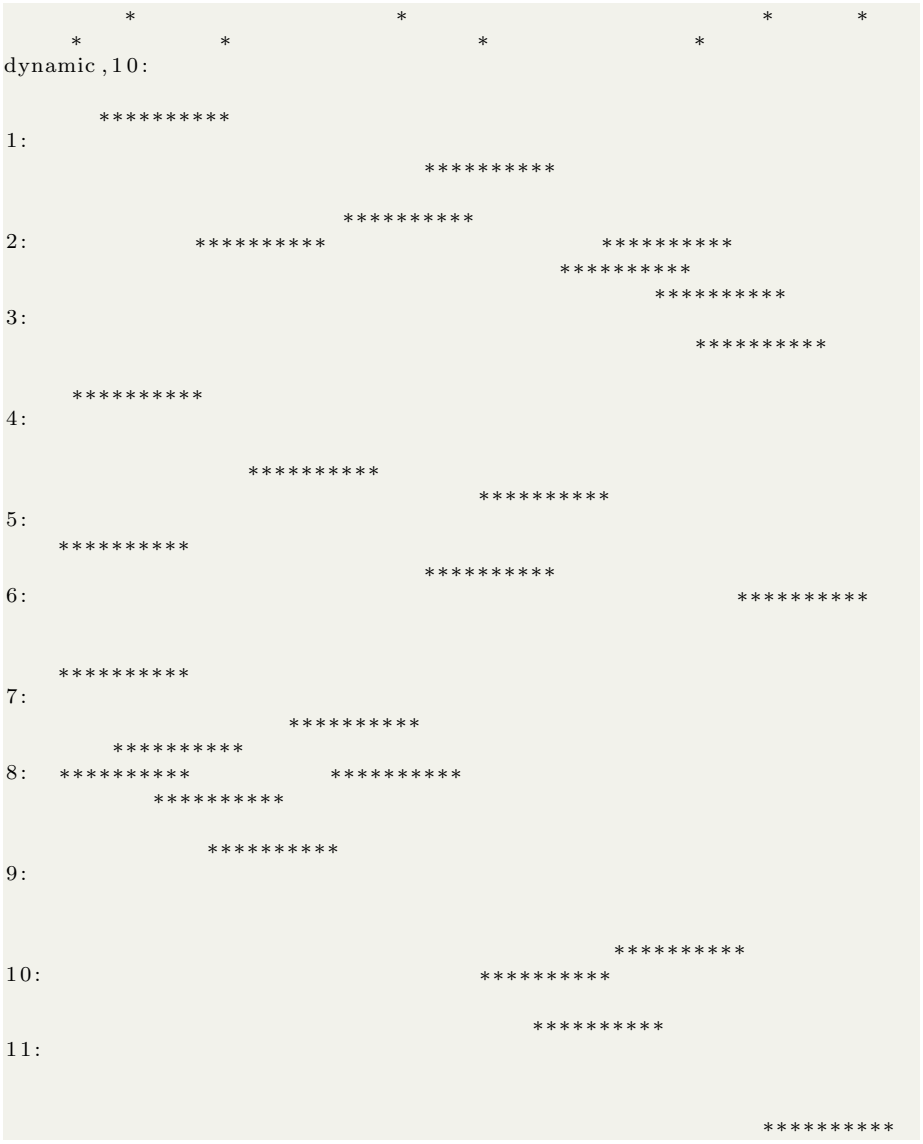
Exercise 2 - OpenMp Loop Schedule

In this exercise the main goal is to create a visualization of two different schedules using different chunks. I implemented the 6 requested schedules aind I run my program in a Ulysses node, using 10 threads (The c-code and the script can be found in the github). Here we are the output:

```
0:
    ********************************************************************************************************************************
static
0:  ********************
1:                      ********************
2:                                           ********************
3:
    ********************
4:
                        ********************
5:
                                             ********************
6:

    ********************
7:

                        ********************
8:
                                             ********************
9:


    ********************
10:


                         ********************
11:


                                              ********************
static, with chunck_size=1
0:  *           *           *           *           *           *           *
              *           *           *           *           *           *
          *           *           *           *           *           *
      *           *           *           *           *           *
1:   *           *           *           *           *           *           *
               *           *           *           *           *           *
           *           *           *           *           *           *
       *           *           *           *           *           *
2:    *           *           *           *           *           *           *
                *           *           *           *           *           *
            *           *           *           *           *           *
        *           *           *           *           *           *
```

```
3:      *            *            *            *            *
     *            *            *            *            *            *
          *            *            *            *            *
             *            *            *            *            *
4:        *            *            *            *            *
      *            *            *            *            *            *
           *            *            *            *            *
              *            *            *            *            *
5:         *            *            *            *            *
       *            *            *            *            *            *
            *            *            *            *            *
               *            *            *            *            *
6:          *            *            *            *            *
        *            *            *            *            *
     *            *            *            *            *            *
          *            *            *            *            *
7:           *            *            *            *            *
         *            *            *            *            *
      *            *            *            *            *            *
           *            *            *            *            *
8:            *            *            *            *            *
          *            *            *            *            *
       *            *            *            *            *            *
             *            *            *            *            *
9:             *            *            *            *            *
           *            *            *            *            *
         *            *            *            *            *
     *            *            *            *            *            *
10:              *            *            *            *            *
            *            *            *            *            *
          *            *            *            *            *
        *            *            *            *            *
11:               *            *            *            *            *
             *            *            *            *            *
           *            *            *            *            *
         *            *            *            *            *
static, with chunck_size=10
0:  **********

    **********

    **********
1:            **********

        **********
2:                      **********

                **********
3:                                **********

                          **********
4:                                      **********

                                  **********
5:                                            **********

                                                **********
6:
    **********

    **********
7:
```


8:
9:
10:
11:
dynamic0:
1:
2:
3:
4:
5:
6:
7:
8:
9:
10:
11:



Also there is the file on github with the output of this function.