CAP-372 / 2019 - Sexta Lista de Exercícios

Data: 2/09/19

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SÉRIE

Versão série rodando no nó de acesso

```
program list06s

! CAP372 - exercise 06 - serial version - 2019-09-21
! integration of pi : 4.0/(1+x*) dx, interval: 0 to steps
! module load intel_psxe/2019
! ifort -g -check all -fpe0 -warn -traceback -debug extended -qopenmp -o ilist06s
list06s.f90
! ./ilist06s

  use omp_lib
  implicit none

  integer, parameter :: n=2**26     ! 1
!  integer, parameter :: n=2**28    ! 2
!  integer, parameter :: n=2**30    ! 3
  double precision, parameter  :: a=0.0, b=1.0
  double precision :: pi, t1, t2, x, h, integral=0.0
  integer :: i

  call cpu_time(t1)
  integral = ( f(a) + f(b) ) / 2.0
  x = a
  h = ( b - a ) / n
  do i = 1, n -1
    x = a + h * i
    integral = integral + 4.0 / (1.0 + x * x)
  end do
  pi = integral * h
  call cpu_time(t2)
  print*, "Result:", pi, " Error:", dacos(-1.d0) - pi
  print*, "Partitions:", n, "    Elapsed time:", t2 - t1

contains

  function f(x)
```

```
    implicit none

    double precision :: f
    double precision, intent(in) :: x

    f = ( 4.0 / ( 1.0 + x * x ) )

  end function f

end program list06s
```

Resultados no nó de acesso

```
[xxxxxx.xxxxxx@sdumont13 ~]$ ./ilist06s1
 Result:    3.14159265358906        Error:   7.380762667708041E-013
 Partitions:     67108864     Elapsed time:   0.946053000000000
[xxxxxx.xxxxxx@sdumont13 ~]$ ./ilist06s2
 Result:    3.14159265358987        Error: -8.038014698286133E-014
 Partitions:    268435456     Elapsed time:    3.78579700000000
[xxxxxx.xxxxxx@sdumont13 ~]$ ./ilist06s3
 Result:    3.14159265359012        Error: -3.312905505481467E-013
 Partitions:   1073741824     Elapsed time:    15.2604800000000
```

PARALELIZAÇÃO - SANTOS DUMONT

Programa:

```
program list06p

! CAP372 - exercise 06 - parallel version - 2019-09-21
! integration of pi : 4.0/(1+x*) dx, interval: 0 to hs
! module load intel_psxe/2019
! ifort -g -check all -fpe0 -warn -traceback -debug extended -qopenmp &
!       -o ilist06p list06p.f90
! ./ilist06s

  use omp_lib
  implicit none

  integer, parameter :: n=2**26, t=2    ! 1
!  integer, parameter :: n=2**26, t=12   ! 2
!  integer, parameter :: n=2**26, t=24   ! 3
!  integer, parameter :: n=2**28, t=2    ! 4
!  integer, parameter :: n=2**28, t=12   ! 5
!  integer, parameter :: n=2**28, t=24   ! 6
!  integer, parameter :: n=2**30, t=2    ! 7
!  integer, parameter :: n=2**30, t=12   ! 8
!  integer, parameter :: n=2**30, t=24   ! 9
  double precision, parameter  :: a=0.0, b=1.0
  double precision :: pi, t1, t2, x, h, integral=0.0
  integer :: i

  call cpu_time(t1)
  integral = ( f(a) + f(b) ) / 2.0
  x = a
  h = ( b - a ) / n

  !$omp parallel do private(x) reduction(+:integral) num_threads(t)
  do i = 1, n -1
    x = a + h * i
    integral = integral + 4.0 / (1.0 + x * x)
  end do
  !$omp end parallel do

  pi = integral * h
```

```
  call cpu_time(t2)
  print*, "Result:", pi, " Error:", dacos(-1.d0) - pi
  print*, "Partitions:", n,"    Threads:", t, "    Elapsed time:", t2 - t1

contains

  function f(x)
    implicit none

    double precision :: f
    double precision, intent(in) :: x

    f = ( 4.0 / ( 1.0 + x * x ) )

  end function f

end program list06p
```

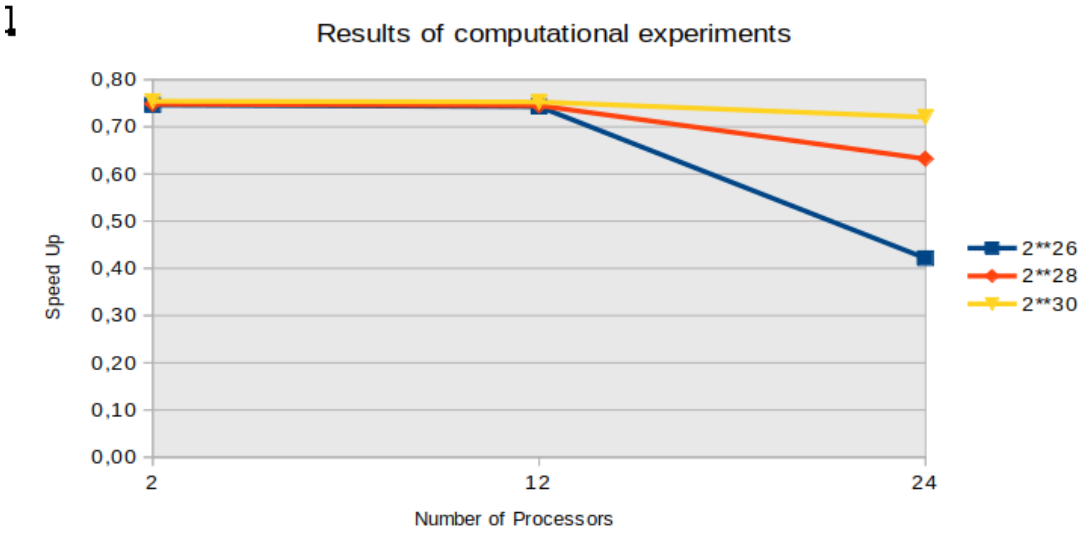
Resultados

slurm-405350.out

```
sdumont1047
sdumont1047
       linux-vdso.so.1 =>  (0x00007fff0c4c3000)
       libm.so.6 => /usr/lib64/libm.so.6 (0x00002b9d30093000)
       libiomp5.so =>
/opt/intel/parallel_studio_xe_2019/intelpython3/lib/libiomp5.so
(0x00002b9d30395000)
       libpthread.so.0 => /usr/lib64/libpthread.so.0 (0x00002b9d3078a000)
       libdl.so.2 => /usr/lib64/libdl.so.2 (0x00002b9d309a6000)
       libc.so.6 => /usr/lib64/libc.so.6 (0x00002b9d30baa000)
       libgcc_s.so.1 => /usr/lib64/libgcc_s.so.1 (0x00002b9d30f77000)
       /lib64/ld-linux-x86-64.so.2 (0x00002b9d2fe6f000)
24
 Result:    3.14159265358926       Error:  5.311306949806749E-013
 Partitions:     67108864     Threads:           2     Elapsed time:
   1.26824300000000
 Result:    3.14159265358975       Error:  4.085620730620576E-014
 Partitions:     67108864     Threads:          12     Elapsed time:
   1.27384000000000
 Result:    3.14159265358980       Error: -4.884981308350689E-015
 Partitions:     67108864     Threads:          24     Elapsed time:
   2.24448100000000
 Result:    3.14159265359007       Error: -2.735589532676386E-013
 Partitions:    268435456     Threads:           2     Elapsed time:
   5.06095500000000
 Result:    3.14159265358970       Error:  9.459100169806334E-014
 Partitions:    268435456     Threads:          12     Elapsed time:
   5.08238300000000
 Result:    3.14159265358973       Error:  6.128431095930864E-014
 Partitions:    268435456     Threads:          24     Elapsed time:
   5.99056500000000
 Result:    3.14159265358997       Error: -1.816324868286756E-013
 Partitions:   1073741824     Threads:           2     Elapsed time:
   20.2332610000000
 Result:    3.14159265358975       Error:  3.996802888650564E-014
 Partitions:   1073741824     Threads:          12     Elapsed time:
   20.2776420000000
 Result:    3.14159265358977       Error:  2.531308496145357E-014
 Partitions:   1073741824     Threads:          24     Elapsed time:
   21.1839170000000
```

SPEED UP

Partitions	Serial Algorithm	2			12			24		
		Time	Speed Up	Efficiency	Time	Speed Up	Efficiency	Time	Speed Up	Efficiency
2**26	0,946053	1,268243	0,75	0,37	1,27384	0,74	0,06	2,244481	0,42	0,02
2**28	3,785797	5,060955	0,75	0,37	5,082383	0,74	0,06	5,990565	0,63	0,03
2**30	15,26048	20,233261	0,75	0,38	20,277642	0,75	0,06	21,183917	0,72	0,03



RODANDO NA MÁQUINA LOCAL

Versão série

Programa e resultados

```
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06s1 list06s1.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06s2 list06s2.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06s3 list06s3.f90
$ ./list06s1
 Result:    3.1415926535890550       Error:    7.3807626677080407E-013
 Partitions:     67108864     Elapsed time:   0.17735599999999999
$ ./list06s2
 Result:    3.1415926535898735       Error:   -8.0380146982861334E-014
 Partitions:    268435456     Elapsed time:   0.69758700000000007
$ ./list06s3
 Result:    3.1415926535901244       Error:   -3.3129055054814671E-013
 Partitions:   1073741824     Elapsed time:    2.7814429999999999
```

Versão Paralela

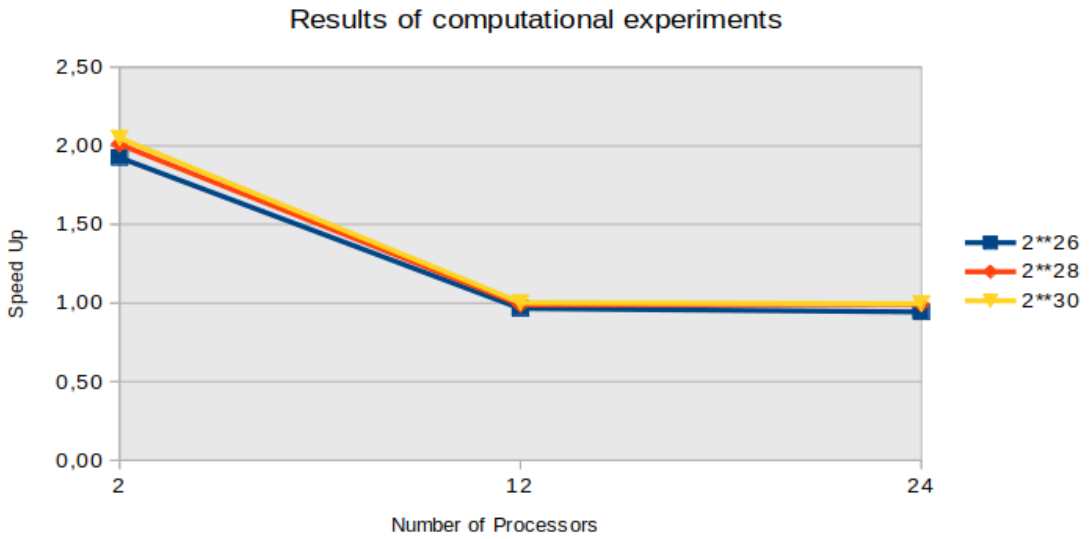
Programa e resultados

```
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p1 list06p1.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p2 list06p2.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p3 list06p3.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p4 list06p4.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p5 list06p5.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p6 list06p6.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p7 list06p7.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p8 list06p8.f90
$ gfortran -Og -Wall -fcheck=all -fopenmp -o list06p9 list06p9.f90
$ ./list06p1
```

```
 Result:    3.1415926535892620        Error:    5.3113069498067489E-013
 Partitions:     67108864     Threads:           2      Elapsed time:
9.2115999999999990E-002
$ ./list06p2
 Result:    3.1415926535897531        Error:    3.9968028886505635E-014
 Partitions:     67108864     Threads:           12     Elapsed time:
0.18365899999999999
$ ./list06p3
 Result:    3.1415926535897980        Error:   -4.8849813083506888E-015
 Partitions:     67108864     Threads:           24     Elapsed time:
0.18792800000000001
$ ./list06p4
 Result:    3.1415926535900667        Error:   -2.7355895326763857E-013
 Partitions:    268435456     Threads:           2      Elapsed time:
0.34722199999999998
$ ./list06p5
 Result:    3.1415926535896981        Error:    9.5035090907913400E-014
 Partitions:    268435456     Threads:           12     Elapsed time:
0.70533299999999999
$ ./list06p6
 Result:    3.1415926535897318        Error:    6.1284310959308641E-014
 Partitions:    268435456     Threads:           24     Elapsed time:
0.70303399999999994
$ ./list06p7
 Result:    3.1415926535899747        Error:   -1.8163248682867561E-013
 Partitions:   1073741824     Threads:           2      Elapsed time:
1.3575180000000000
$ ./list06p8
 Result:    3.1415926535897531        Error:    3.9968028886505635E-014
 Partitions:   1073741824     Threads:           12     Elapsed time:
2.7746019999999998
$ ./list06p9
 Result:    3.1415926535897678        Error:    2.5313084961453569E-014
 Partitions:   1073741824     Threads:           24     Elapsed time:
2.7913720000000000
```

SPEED UP NA MÁQUINA LOCAL

Partitions	Serial Algorithm	2			12			24		
		Time	Speed Up	Efficiency	Time	Speed Up	Efficiency	Time	Speed Up	Efficiency
2**26	0,177356	9,21E-02	1,93	0,96	0,183659	0,97	0,08	0,187928	0,94	0,04
2**28	0,697587	0,347222	2,01	1,00	0,705333	0,99	0,08	0,703034	0,99	0,04
2**30	2,781443	1,357518	2,05	1,02	2,774602	1,00	0,08	2,791372	1,00	0,04



REFERÊNCIAS

- http://www.lac.inpe.br/~stephan/CAP-372/
- https://stackoverflow.com