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ENGINEERING FACULTY
COMPUTER ENGINEERING DEPARTMENT



**BM479E – PARALLEL COMPUTING ARCHITECTURES AND
PROGRAMMING**

**ASSIGNMENT– 1: CALCULATING THE PI NUMBER USING MONTE
CARLO METHOD AND MPI LIBRARY**

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OCTOBER 2017

1. Introduction

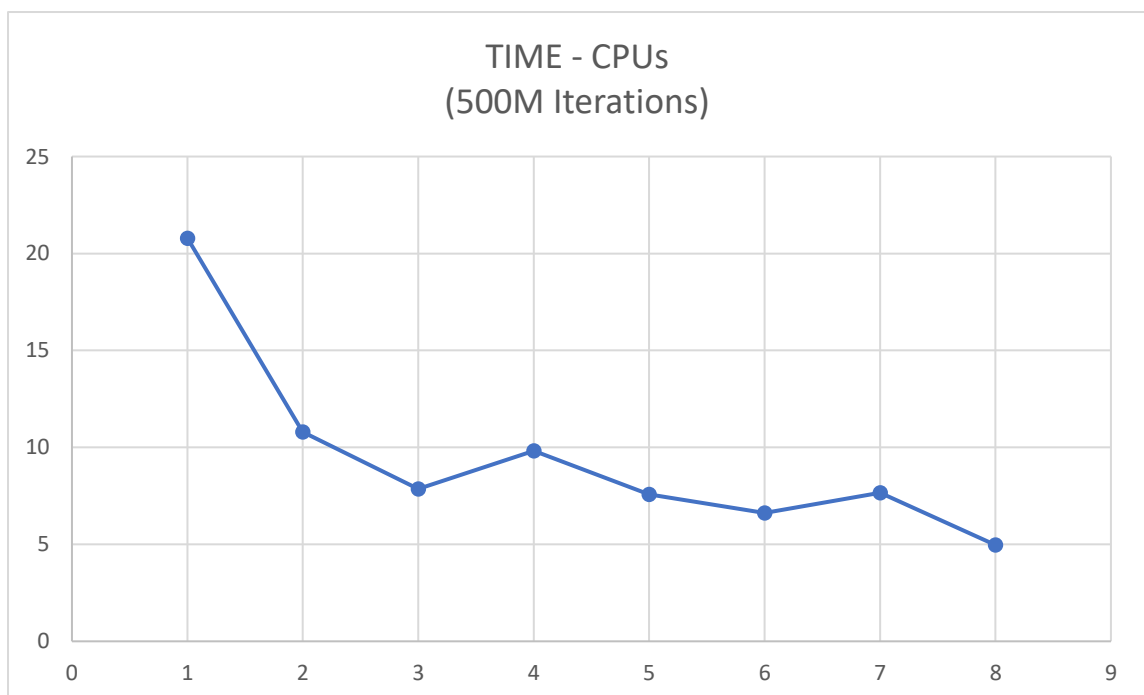
In this assignment, we are going to compute the Pi number up to a point with Monte Carlo method, using the MPI library. Then, we will get some results and show them in a bunch of charts.

2. Code

Given in the appendix. All explanations written as comment in code.

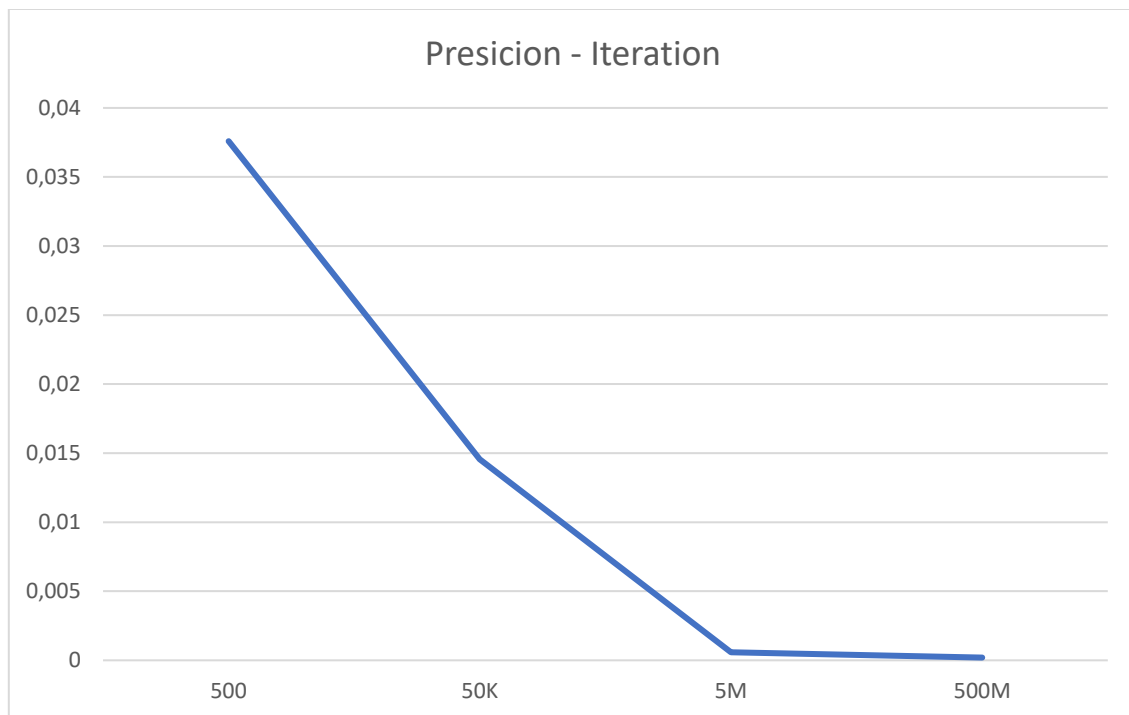
3. Graphics and Analysis

In Time (seconds) – CPU (amount) chart for 500M iterations (500 million darts), we clearly see that by the amount of CPUs is rising, the amount of time to compute 500M iterations is clearly drops. The drop rate is much higher at low amount of CPUs, it's nearly 2x faster compared to 2 CPUs to 1 CPU; but it's not when comparing to 4 CPUs to 8 CPUs:



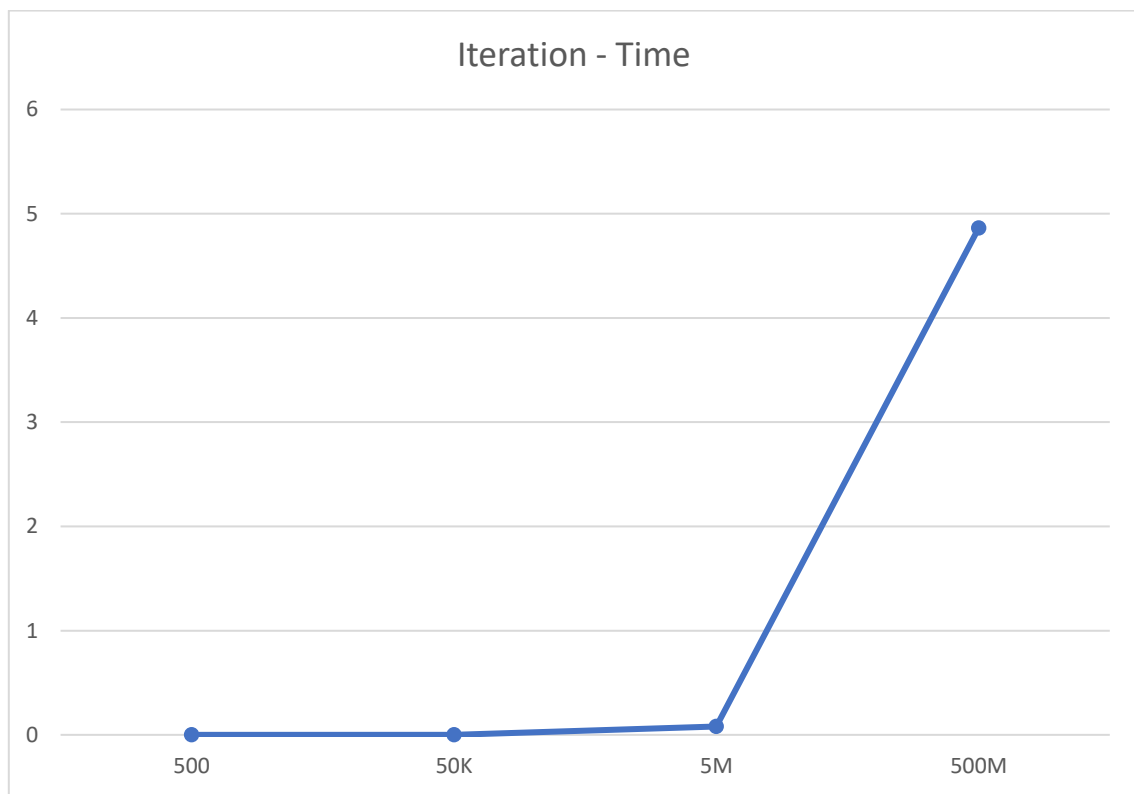
1.1. TIME-CPU chart FOR 500M darts

And here is Precision – Iteration chart. It's clear that the higher amount of iterations we made, the higher precision (lower difference between actual Pi and our computed Pi number) we have:



1.2. Precision – Iteration chart for 4 CPUs

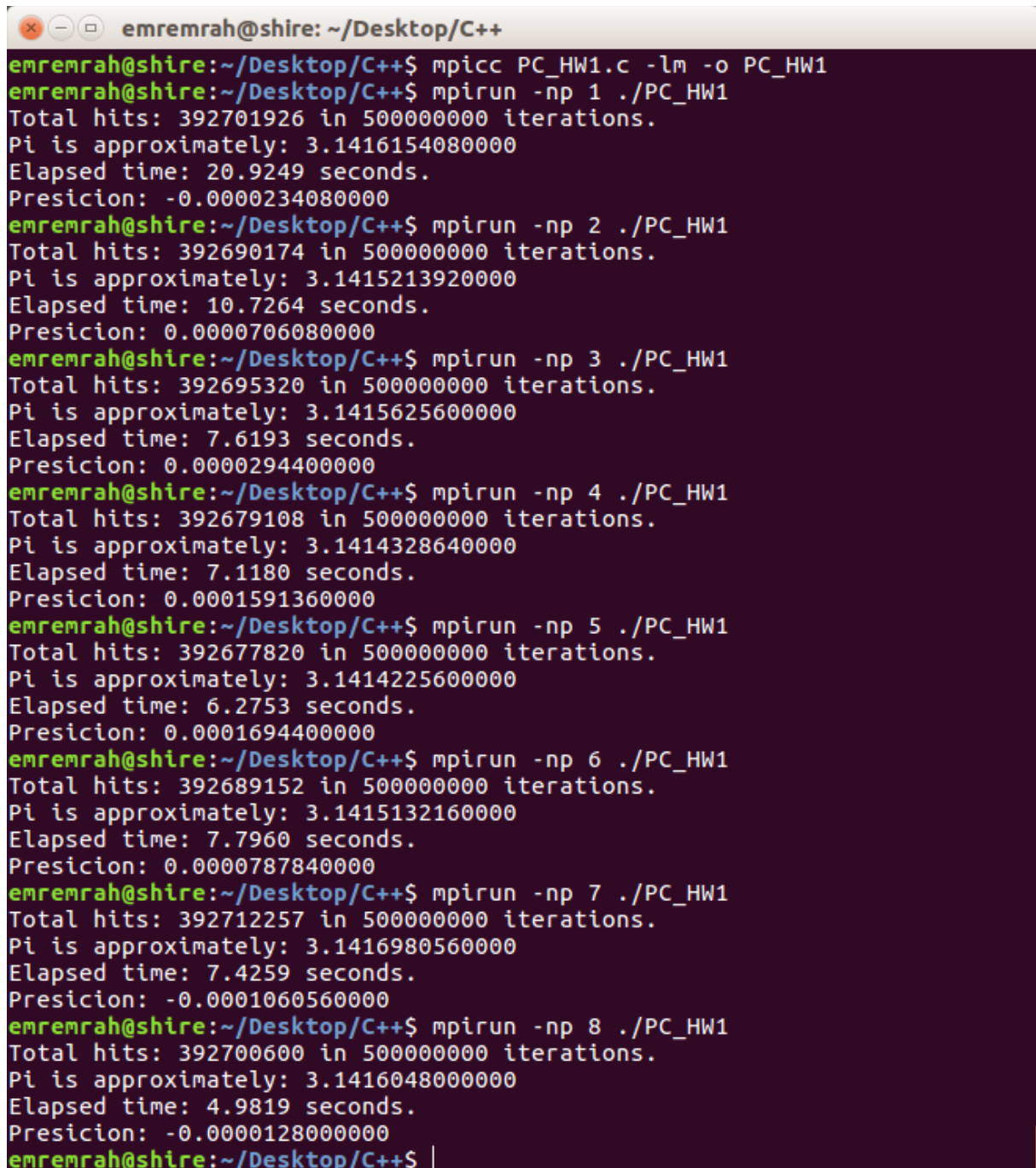
And for last, here is Time – Iteration chart for 8 CPUs.



1.3. Iteration – Time (seconds) chart for 8 CPUs.

4. APPENDIX

4.1. Screenshots for HOTP (task manager).



```
emremrah@shire: ~/Desktop/C++
emremrah@shire:~/Desktop/C++$ mpicc PC_HW1.c -lm -o PC_HW1
emremrah@shire:~/Desktop/C++$ mpirun -np 1 ./PC_HW1
Total hits: 392701926 in 500000000 iterations.
Pi is approximately: 3.1416154080000
Elapsed time: 20.9249 seconds.
Presicion: -0.0000234080000
emremrah@shire:~/Desktop/C++$ mpirun -np 2 ./PC_HW1
Total hits: 392690174 in 500000000 iterations.
Pi is approximately: 3.1415213920000
Elapsed time: 10.7264 seconds.
Presicion: 0.0000706080000
emremrah@shire:~/Desktop/C++$ mpirun -np 3 ./PC_HW1
Total hits: 392695320 in 500000000 iterations.
Pi is approximately: 3.1415625600000
Elapsed time: 7.6193 seconds.
Presicion: 0.0000294400000
emremrah@shire:~/Desktop/C++$ mpirun -np 4 ./PC_HW1
Total hits: 392679108 in 500000000 iterations.
Pi is approximately: 3.1414328640000
Elapsed time: 7.1180 seconds.
Presicion: 0.0001591360000
emremrah@shire:~/Desktop/C++$ mpirun -np 5 ./PC_HW1
Total hits: 392677820 in 500000000 iterations.
Pi is approximately: 3.1414225600000
Elapsed time: 6.2753 seconds.
Presicion: 0.0001694400000
emremrah@shire:~/Desktop/C++$ mpirun -np 6 ./PC_HW1
Total hits: 392689152 in 500000000 iterations.
Pi is approximately: 3.1415132160000
Elapsed time: 7.7960 seconds.
Presicion: 0.0000787840000
emremrah@shire:~/Desktop/C++$ mpirun -np 7 ./PC_HW1
Total hits: 392712257 in 500000000 iterations.
Pi is approximately: 3.1416980560000
Elapsed time: 7.4259 seconds.
Presicion: -0.0001060560000
emremrah@shire:~/Desktop/C++$ mpirun -np 8 ./PC_HW1
Total hits: 392700600 in 500000000 iterations.
Pi is approximately: 3.1416048000000
Elapsed time: 4.9819 seconds.
Presicion: -0.0000128000000
emremrah@shire:~/Desktop/C++$
```

4.1.1. Linux terminal when we run our code from 1 to 8 CPUs increasing one-by-one

```

Terminal

1 [|||||||||||||100.0%] 5 [|||||||||||||100.0%]
2 [|||||||||||||100.0%] 6 [|||||||||||||100.0%]
3 [|||||||||||||100.0%] 7 [|||||||||||||100.0%]
4 [|||||||||||||100.0%] 8 [|||||||||||||100.0%]
Mem[|||||||1.26G/7.66G] Tasks: 132, 368 thr; 11 running
Swp[|||||0K/8.00G] Load average: 2.02 0.97 0.58
Uptime: 00:44:43

PID USER PRI NI VIRT RES SHR S CPU% MEM% TIME+ Command
4431 emremrah 20 0 65116 7996 3760 R 100. 0.1 0:04.80 ./PC_HW1
4430 emremrah 20 0 65116 7724 3552 R 100. 0.1 0:04.79 ./PC_HW1
4427 emremrah 20 0 65116 7712 3480 R 99.6 0.1 0:04.76 ./PC_HW1
4425 emremrah 20 0 65116 7840 3600 R 98.9 0.1 0:04.76 ./PC_HW1
4426 emremrah 20 0 65116 7852 3616 R 98.3 0.1 0:04.71 ./PC_HW1
4429 emremrah 20 0 65116 7876 3708 R 98.3 0.1 0:04.76 ./PC_HW1
4428 emremrah 20 0 65116 7800 3564 R 97.6 0.1 0:04.76 ./PC_HW1
4424 emremrah 20 0 65116 8004 3764 R 95.0 0.1 0:04.56 ./PC_HW1
1843 emremrah 20 0 1619M 199M 74820 S 3.3 2.5 0:59.66 compiz
1154 root 20 0 275M 75600 48872 S 2.6 0.9 1:37.24 /usr/lib
1604 emremrah 20 0 411M 8256 5520 S 2.0 0.1 0:10.18 /usr/bin
2818 emremrah 20 0 663M 49428 29260 S 1.3 0.6 0:59.03 /usr/lib
4147 emremrah 20 0 27972 4452 3344 R 0.7 0.1 0:05.78 htop
1652 emremrah 20 0 467M 29776 24728 S 0.7 0.4 0:03.25 /usr/lib
1631 emremrah 20 0 411M 8256 5520 S 0.7 0.1 0:06.20 /usr/bin
1664 emremrah 20 0 467M 29776 24728 S 0.7 0.4 0:01.76 /usr/lib
2821 emremrah 20 0 663M 49428 29260 S 0.7 0.6 0:00.53 /usr/lib
1690 emremrah 20 0 302M 33272 18852 S 0.0 0.4 0:05.01 /usr/lib
1676 emremrah 20 0 513M 28296 22012 S 0.0 0.4 0:02.81 /usr/lib
1858 emremrah 20 0 1065M 63912 38572 S 0.0 0.8 0:08.22 nautilus
1707 emremrah 20 0 564M 46216 26652 S 0.0 0.6 0:04.96 /usr/lib
1719 emremrah 20 0 564M 46216 26652 S 0.0 0.6 0:01.55 /usr/lib
1573 emremrah 20 0 44092 4512 2876 S 0.0 0.1 0:02.44 dbus-dae
2051 emremrah 20 0 302M 33272 18852 S 0.0 0.4 0:00.72 /usr/lib
1914 emremrah 20 0 1065M 63912 38572 S 0.0 0.8 0:00.33 nautilus
3617 emremrah 20 0 2128M 300M 122M S 0.0 3.8 0:16.26 /usr/lib
3741 emremrah 20 0 2188M 222M 114M S 0.0 2.8 0:19.68 /usr/lib
1615 emremrah 20 0 34204 320 12 S 0.0 0.0 0:00.51 upstart-
1667 emremrah 20 0 185M 5584 5232 S 0.0 0.1 0:02.76 /usr/lib
2438 emremrah 20 0 2176M 134M 70420 S 0.0 1.7 1:04.33 /usr/lib
925 messagebu 20 0 44460 5496 3536 S 0.0 0.1 0:02.22 /usr/bin
F1Help F2Setup F3Search F4Filter F5Tree F6SortBy F7Nice -F8Nice +F9Kill

```

4.1.2. Linux terminal when computing 500M iterations with 8 CPUs

```

emremrah@shire:~/Desktop/C++$ mpirun -np 4 ./PC_HW1
Total hits: 404 in 500 iterations.
Pi is approximately: 3.23200000000000
Elapsed time: 0.0001 seconds.
Presicion: -0.090408000000000
emremrah@shire:~/Desktop/C++$ mpicc PC_HW1.c -lm -o PC_HW1
emremrah@shire:~/Desktop/C++$ mpirun -np 4 ./PC_HW1
Total hits: 39288 in 50000 iterations.
Pi is approximately: 3.14304000000000
Elapsed time: 0.0015 seconds.
Presicion: -0.001448000000000
emremrah@shire:~/Desktop/C++$ mpicc PC_HW1.c -lm -o PC_HW1
emremrah@shire:~/Desktop/C++$ mpirun -np 4 ./PC_HW1
Total hits: 3927264 in 5000000 iterations.
Pi is approximately: 3.14181120000000
Elapsed time: 0.1286 seconds.
Presicion: -0.000219200000000
emremrah@shire:~/Desktop/C++$ mpicc PC_HW1.c -lm -o PC_HW1
emremrah@shire:~/Desktop/C++$ mpirun -np 4 ./PC_HW1
Total hits: 392701372 in 500000000 iterations.
Pi is approximately: 3.14161097600000
Elapsed time: 5.9544 seconds.
Presicion: -0.00001897600000
emremrah@shire:~/Desktop/C++$ |

```

4.1.3. Linux terminal when we run 8 CPUs to compute 500 to 500M iterations

4.2. My Code

Given in next page.