High Performance Scientific Computing
ME 766 : Homework 1

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February 12, 2021

1 Platform

CPU: Intel Core i3-4030U (2 Physical Cores)
RAM: 8 GB
OS: Ubuntu 16.04, 64-bit
GCC Version: 5.4.0

2 Convergence Study

2.1 Trapezoidal Rule

Table 1: Number of Steps and Integration Value using Trapezoidal Rule with Serial execution

Steps	Integration Value
10	1.983524
15	1.981768
22	1.9966
33	1.996226
49	1.998288
73	1.999228
109	1.999654
163	1.999845
244	1.999972
366	1.999988
549	1.999986
823	1.999994
1234	1.999999
1851	1.999999
2776	2
4164	2
6246	2
9369	2
14053	2
21079	2
31618	2
47427	2
71140	2
106710	2
160065	2
240097	2
360145	2
540217	2
810325	2

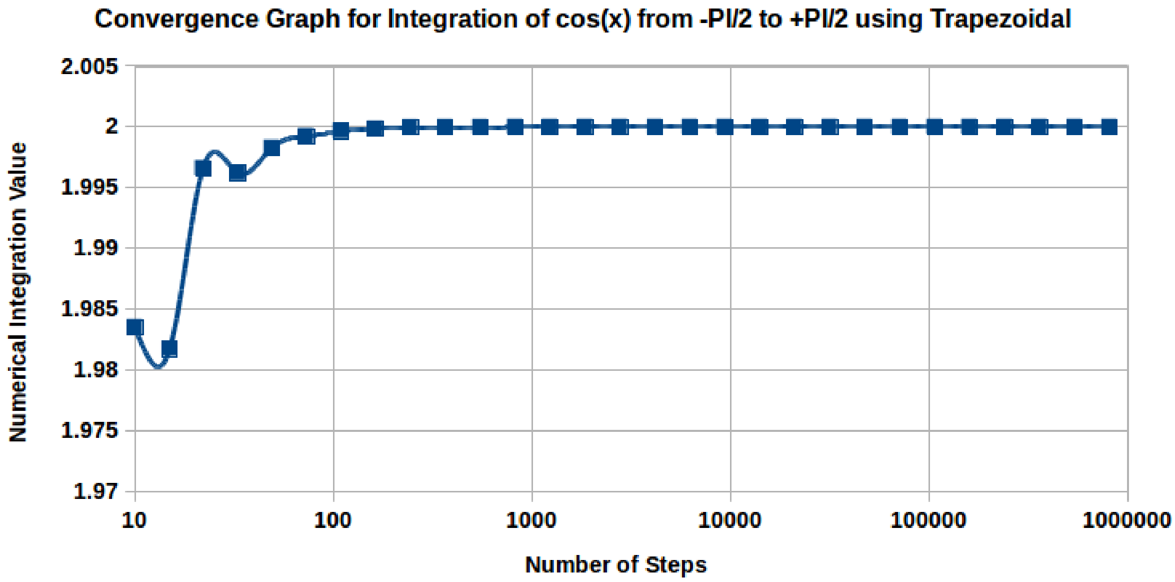

Figure 1: Number of Steps vs Integration Value using Trapezoidal Rule with Serial execution

2.2 Montecarlo Method

Table 2: Number of Sample points and Integration Value using Montecarlo Method with Serial execution

Sample points	Integration Value
10	2.199113
15	1.675515
22	1.713595
33	2.094393
49	1.666966
73	1.936597
109	2.161644
163	2.00445
244	2.021433
366	1.931305
549	2.077226
823	2.015504
1234	2.067238
1851	2.03499
2776	2.00084
4164	2.006121
6246	1.973679
9369	2.000504
14053	2.012424
21079	2.018731
31618	1.989402
47427	2.009407
71140	1.99933
106710	2.006219
160065	1.998555
240097	1.99515
360145	1.997892
540217	2.00004
810325	1.998145

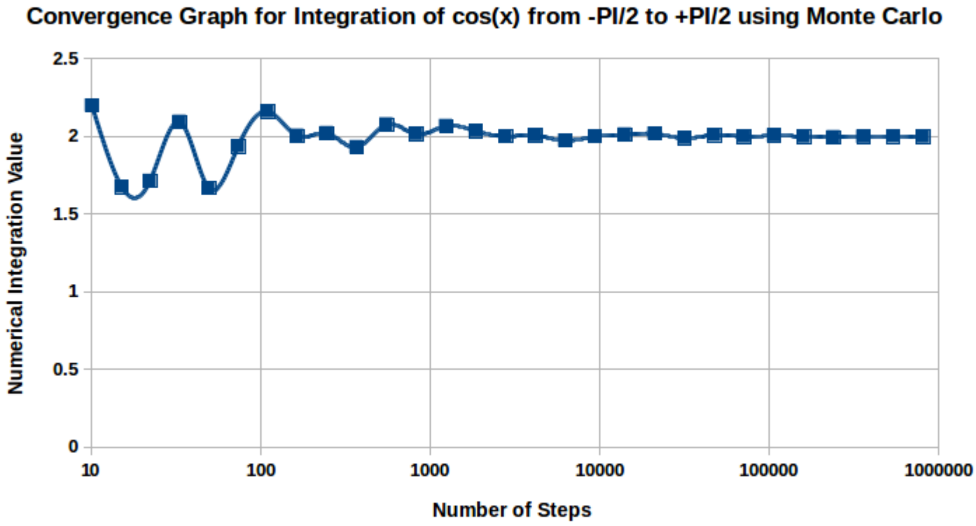

Figure 2: Number of Steps vs Integration Value using Montecarlo Method with Serial execution

2.3 Analytical Integral

Analytical Integral of Cos(x) with 'x' ranging from $-\pi/2\ to + \pi/2$ evaluates to value 2.

Integral value obtained using Trapezoidal Rule eventually settles to value 2 as the number of steps/samples are increased.

Integral value obtained using Montecarlo Method gets very close to the value 2 as the number of steps/samples are increased but does not becomes exactly 2.

3 Timing Study

3.1 Trapezoidal Rule

Table 3: Number of Threads and Real Run-Time(ms) using Trapezoidal Rule (1000000 steps)

Iterations/Threads	**Serial**	**1**	**2**	**4**	**6**	**8**
1	47	43	23	23	19	29
2	56	46	23	20	22	19
3	65	42	23	20	22	21
4	60	48	29	20	21	18
5	43	43	22	20	23	22
Average Run-Time(ms)	**54.2**	**44.4**	**24**	**20.6**	**21.4**	**21.8**
Integral Value	2	2	2	2	2	2

Table 4: Number of Threads and Speedup using Trapezoidal Rule (1000000 steps)

Threads	**Speedup**
1	1
2	1.85
4	2.16
6	2.07
8	2.04

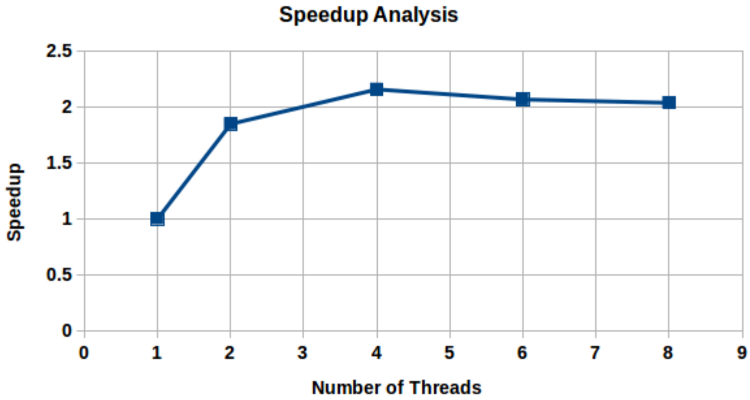

Figure 3: Number of Threads vs Speedup for Trapezoidal Rule

3.2 Montecarlo Method

Table 5: Number of Threads and Real Run-Time(ms) using Montecarlo Method (1000000 sample points)

Iterations/Threads	Serial	1	2	4	6	8
1	120	118	88	80	85	83
2	115	124	84	80	85	81
3	117	117	90	79	80	85
4	112	118	87	85	83	126
5	119	119	85	84	94	118
Average Run-Time(ms)	**116.6**	**119.2**	**86.8**	**81.6**	**85.4**	**98.6**
Integral Value	1.999556	1.999556	1.999556	1.999556	1.999556	1.999556

Table 6: Number of Threads and Speedup using Montecarlo Method (1000000 sample points)

Threads	Speedup
1	1
2	1.37
4	1.46
6	1.39
8	1.21

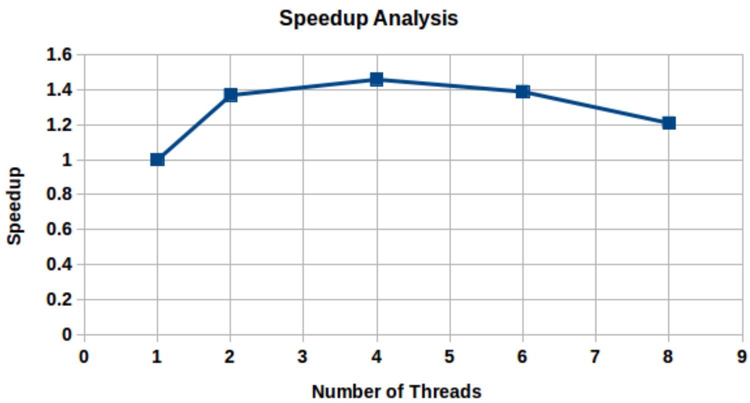

Figure 4: Number of Threads vs Speedup for Montecarlo Method