
ME 766- HW2

Numerical Integration using Openc1 and MPI

Submitted on: April 7th, 2018

Time analysis and convergence using Openc1 (Time is in seconds)

Number of sampling points have been taken in the powers of 2 so as to maximise the efficiencies of the work-groups and equally distributing the number of sampling points among the work-groups.

In the program, size of the work-group is determined and the number of work-goups have been made according to the number of sampling points so as to mazimise the efficiency of the program.

Error somewhat increases slighlty on very large values of N.

The analytical solution for the given problem is 2.

Trapezoid Integration

N	Answer	Error (%)	Time
256	-0.001264	1.999975	0.004387
512	1.999994	-0.000298	0.004337
1024	1.999998	-0.000083	0.004419
4096	2.00000	0.00000	0.004238
16384	2.00000	0.00000	0.0044366
65536	2.00000	0.00005	0.0041966
262144	2.00000	0.00007	0.004389
524288	2.00000	0.00006	0.00447
1048576	2.00000	0.00020	0.004462

N	Answer	Error (%)	Time
4194304	2.00000	0.00013	0.004527
16777216	2.00002	0.00077	0.005318
67108864	2.00007	0.00366	0.007406
268435456	2.00088	0.04376	0.013171
1073741824	2.00256	0.12794	0.033347

Montecarlo Integration

N	Answer	Error (%)	Time
256	2.000311	0.015545	0.004385
512	2.030991	1.549530	0.004230
1024	2.012583	0.629139	0.004448
4096	2.012583	0.629139	0.004224
16384	2.003571	0.178528	0.004304
65536	1.999640	-0.018007	0.004278
262144	1.999820	-0.009018	0.004620
524288	1.999023	-0.048870	0.004470
1048576	1.999547	-0.022650	0.004316
4194304	1.999929	-0.003552	0.004894
16777216	2.000035	0.001740	0.005086
67108864	2.000019	0.000930	0.007523
268435456	2.000093	0.004673	0.012967
1073741824	2.022893	1.144636	0.033903

Time analysis and convergence using MPI (Time is in seconds)

The analytical solution for the given problem is 2.

Trapezoid Integration

N	2 processes	4 processes	6 processes	8 processes	Answer	Error (%)
10	0.000099	0.000144	0.003566	0.000226	1.57685	-21.15727
100	0.000088	0.00012	0.00029	0.000308	1.99984	-0.00822
500	0.000069	0.000196	0.000324	0.000128	1.99999	-0.00033
1000	0.000105	0.000134	0.000278	0.000136	2.00000	0.00000
5000	0.000114	0.000262	0.00032	0.00022	2.00000	0.00000
10000	0.000216	0.000264	0.00026	0.000252	2.00000	0.00000
100000	0.001356	0.000784	0.00074	0.0089	2.00000	0.00000
1000000	0.012540	0.005796	0.004994	0.0037664	2.00000	0.00000
10000000	0.113945	0.057108	0.042594	0.034776	2.00000	0.00000
100000000	1.044143	0.542464	0.39225	0.307428	2.00000	0.00000
1000000000	10.57658	5.47166	3.863534	3.111712	2.00000	0.00000

Montecarlo Integration

N	2 processes	4 processes	6 processes	8 processes	Answer	Error (%)
10	0.00009	0.000012	0.0000552	0.000058	1.25664	-37.16815
100	0.00011	0.00009	0.00005	0.00009	2.14885	7.44247
1000	0.00012	0.00012	0.00016	0.001452	2.04455	2.22742
10000	0.0003	0.00017	0.000476	0.00027	2.01062	0.53096
100000	0.002206	0.00108	0.001106	0.00184	2.00974	0.48698
1000000	0.019994	0.01075	0.009196	0.006986	2.00479	0.23943
10000000	0.18008	0.092142	0.007714	0.005972	1.99938	-0.03119
100000000	1.652034	0.858726	0.7026	0.5910	1.99974	-0.01307
1000000000	16.0156	8.8337	7.0374	5.7946	2.00005	0.00254