

# ME 766: High Performance Scientific Computing

## Assignment 01

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## 1 Introduction

This assignment requires the serial and parallel (OpenMP) implementation of the integration of  $f(x) = \cos(x)$  over the interval  $[-\frac{\pi}{2}, \frac{\pi}{2}]$  using trapezoidal integration and Monte Carlo integration. The following section provides insight into the results obtained for the same.

## 2 Results

### 2.1 Convergence Study

We perform a convergence study, using different numbers of divisions (or sampling points), by comparing the integral obtained the numerical (Monte Carlo) method with the analytical (trapezoidal) integral. The study is conducted 11 times using the serial code for each algorithm and across each number of divisions.

Number of Tests	Number of Divisions	Trapezoidal Integration		Monte Carlo Integration	
		Average Value	% Error	Average Value	% Error
11	50	1.999342	0.03290	2.199115	9.95575
	100	1.999836	0.00820	1.947788	2.61060
	500	1.999993	0.00035	1.878672	6.06640
	1000	1.999999	0.00005	1.950929	2.45355
	5000	2.000000	0.00000	2.018787	0.93935
	10000	2.000004	0.00020	2.019416	0.97080
	50000	2.000010	0.00050	1.996859	0.15705
	100000	2.000028	0.00140	1.998210	0.08950
	500000	2.000193	0.00965	2.003268	0.16340
	1000000	2.001454	0.07270	2.002379	0.11895

### 2.2 Timing Study

We perform a timing study using 1 (serial), 2,4,6 and 8 OpenMP threads. The study is conducted 11 times across 10000000 divisions each time for each algorithm and each number of threads.

Number of Tests	Number of Threads	Trapezoidal Integration		Monte Carlo Integration	
		Average Value	Average Time	Average Value	Average Time
11	1	2.023334	0.26444854550	1.999763000	0.4821777273
	2	2.001765	0.14091363640	2.001140091	0.4794478182
	4	2.004890	0.11425772730	2.002341909	0.3650123636
	6	1.996752	0.08831227273	2.001769273	0.3562011818
	8	2.002660	0.08567118182	2.002104182	0.3509631818

## 3 Plots

### 3.1 Convergence Study

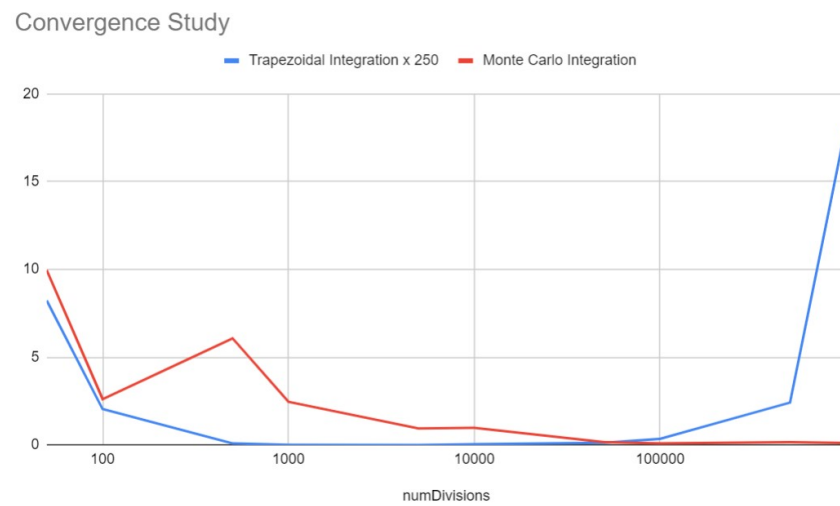


Figure 1: Convergence Study

### 3.2 Timing Study

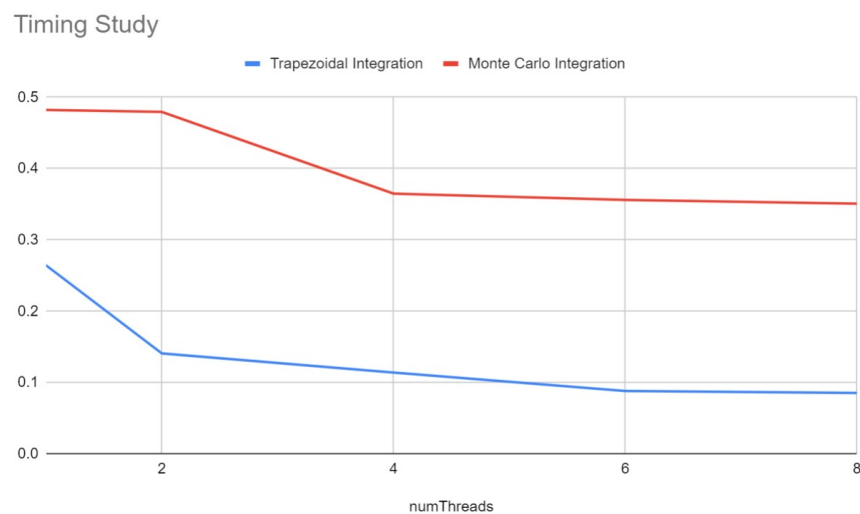


Figure 2: Timing Study