ME 571: Homework 5

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Abstract

In this assignment, the trapezoidal rule and Simpson's rule were used with message passing interface approximate an integral of a given function. The amount of intervals, n, was varied and the results were compared to the exact integral. In the end, with a significant amount of intervals, the Simpson's method showed better accuracy for larger values of n.

1 Introduction

The goal of this homework was to approximate the integral shown below using two different methods, the trapezoidal method and Simpson's rule. Both methods were implemented by using parallelism via the message passing interface.

$$\int_0^{\pi} 5 + 3sin(x)\, dx$$

2 Trapezoidal Method

In this method, the integral is approximated by forming n intervals. Each interval is a trapezoid with the width Δx. The formula used is shown below.

$$\int_a^b f(x)\, dx \approx \frac{\Delta x}{2} f(x_0) + 2f(x_1 + 2f(x_2) + 2f(x_3) + \cdots + 2f(x_{n-1}) + f(x_n)$$

where

$$\Delta x = \frac{b-a}{n}$$

3 Simpson's Rule

The second approximation that was implemented using mpi was the Simpson's rule. Simpson's rule uses a parabolic approximation of intervals to approximate the integral. The formula used for Simpson's rule is given below.

$$\int_a^b f(x)\, dx \approx \frac{\Delta x}{3} f(x_0) + 4f(x_1 + 2f(x_2) + 4f(x_3) + \cdots + 2f(x_{n-2}) + 4f(x_{n-1}) + f(x_n)$$

where

$$\Delta x = \frac{b-a}{n}$$

4 Results

The results are presented in the table and it showed as you increase the intervals Simpson's rule becomes more accurate.

n	Trapezoidal Method	Simpson's Rule	Exact Solution
5	21.388672	14.259115	21.699996
20	21.687667	20.261654	21.699996
100	21.699503	21.414297	21.699996
500	21.699976	21.642935	21.699996
1000	21.699991	21.699996	21.699996