

Homework 23 - Physics 240

Monte Carlo integration

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1 Introduction

The goal of this homework is to apply random number generator and the Monte Carlo integration method to compute some integral as well as n-dimension function.

2 Discussion and data

a) For part a, I use the function $\int_1^0 \sqrt{x} dx$.

First I generate n random points $x_1, x_2 \dots x_n$ in the interval of $[a, b]$

I then calculate the average value of the function $f' = \frac{1}{n} \sum_{i=1}^n f(x_i)$

then I compute the approximation of the integral $\int_a^b f(x) dx \approx (b-a) * f'$
and the error is calculated as

Error $\approx (b-a) \sqrt{\frac{f'^2 - (f')^2}{n}}$, where $f'^2 = \frac{1}{n} \sum_{i=1}^n f^2(x_i)$

Using that method, with $n = 10$ I get:

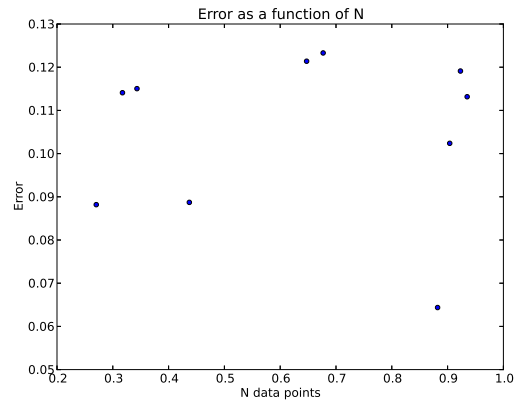


Figure 1: $n=10$

With $n = 100$ I get:

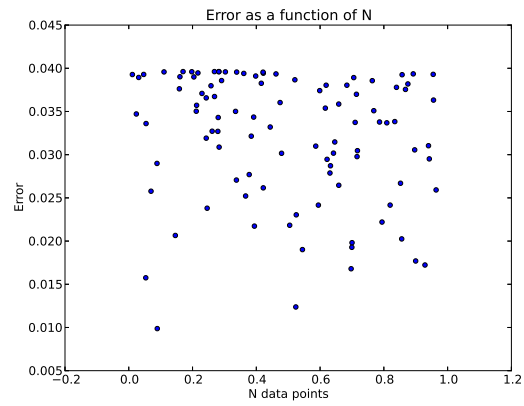


Figure 2: $n=100$

and with $n = 1000$ I get:

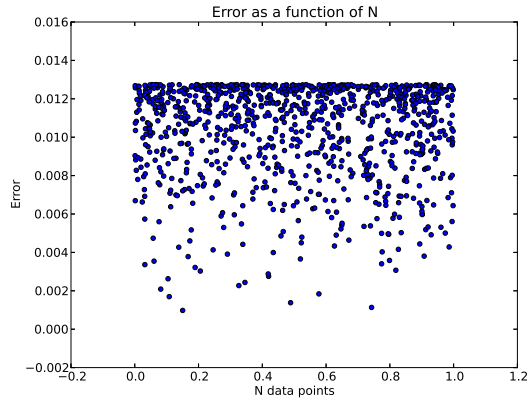


Figure 3: $n=1000$

With the approximate value of 0.651363617822

3 4-D spheres

For 4D sphere, I enclose the hypersphere inside a hypercube. Generate random values for the function (x_1, x_2, x_3, x_4) for each spheres, and compare with 1 to see which one hits the spheres, and calculate the ratio. With that method, I get the value of

- $a = 2$, The union is 9.84064
- $a = 0$, The union is 4.93664
- $a = 1/5$, The union is 5.809080288
- $a = 1$, The union is 8.61516
- $a = 3/2$, The union is 9.626509375