

PH4390 Computational Methods in Physics

Assignment 04: π at Monte Carlo

Fall 2017

Problem 1

A crude formula for Monte Carlo integration is as follows, where x_N is a randomly generated number between a and b :

$$F = \int_a^b f(x)dx \approx \frac{1}{N}(b-a) \sum_1^N f(x_N)$$

Use this formula to solve the following integrals with the following sample sizes:
 10^n ($n = 0-6$).

$$F = \int_0^1 x^2 dx$$

$$F = \int_0^2 x^2 dx$$

$$F = \int_{-1}^1 x^3 dx$$

$$F = \int_0^{\frac{\pi}{2}} \cos(x) dx$$

$$F = \int_{-1}^1 \frac{3}{(4-x^2)^{1/2}} dx$$

$$F = \int_{-1}^1 \frac{2}{1+x^2} dx$$

$$F = \int_{-\infty}^{\infty} \left(\frac{1}{2\pi}\right)^{1/2} e^{-\frac{x^2}{2}} dx$$

Coding

Write a Monte Carlo function that takes only the limits of integration and sample size(n). The way you implement this is up to you, but only pass those three things (using as many variables or arrays as you like) to the Monte Carlo function. Do not worry about changing the random number generator seed.

Recommended: Have a function with each "equation" you need to integrate. This function will be called by your Monte Carlo function.

For Example (bare bones):

```
int main(){
    Monte_Carlo(0,1,1000);
}
double Monte_Carlo(x1,x2,n){
    DUMMY_VAR = func(x);
}
double func(x){
    RESULT = pow(x,2);
    return RESULT;
}
```

Feel free to program it however you want as long as the Monte Carlo function only takes the previously stated arguments.

Random Number Function

Calling a random number in C:

† `rand()` : will generate a random integer between 0 and `RAND_MAX`
Where `RAND_MAX` is 2147483647 (C global variable)

† `rand()/(double)RAND_MAX` : will generate a random double between 0 and 1

Data

Display the data for all sample sizes for each function. You are free to pick your medium, but make sure the results are clear and labeled.

Question(s)

1. Given that this is a crude method, provide one way to improve it, explain how it improves the method.
-