

Discussion Section #7**Due: To be submitted to CatCourses by 11:59pm.****Instructions:**

The power of random sampling is all over mathematics! In fact, there are classes of computational methods that use random sampling to solve challenging applied mathematics problems such as optimization, parameter inference, and integration. Such methods are typically called **Monte Carlo methods**¹.

Today you will explore one of the simplest Monte Carlo techniques, **Monte Carlo Integration!**

Follow the example your TA goes through and then modify the R code (or write your own) to answer the following problems.

This week, you are responsible for submitting:

- (1 Point) Compiled written report single PDF.
- (1 Point) Modified R code for at least 1 of your problems below.
- Solutions to each problem below

Assignment:

1. (2 Points) Use Monte Carlo Integration to integrate:

$$f(x) = \sqrt{\left(1 + \frac{1}{2x}\right)}$$

from 1 to 3.

Note: For this example skip the by hand integration and simply supply the plots.

2. (3 Points) Provide both a write-up of your solution by hand (1 Point), and figures from your Monte Carlo Integration (2 Points) of

$$f(x) = \frac{1}{x^2(x^2 + 25)}$$

from 1 to 5.

Note: This example is challenging to integrate by hand, but involves partial fractions.

3. (3 Points) Another function of your choosing from the list below. But you must show both your by hand integration and your results from Monte Carlo Integration.

- (a) Integrate $f(x) = x^{-1/3} + x/10$ from 0 to 1.
- (b) Integrate $f(x) = 4/(1 + x^2)$ from 0 to 1.
- (c) Integrate $f(x) = 2x \exp x^2$ from 0 to 1.
- (d) Integrate $f(x) = \sin(x)$ from 0 to 1.
- (e) Integrate $f(x) = 4\sqrt{(1 - x^2)}$ from 0 to 1.

¹Monte Carlo methods take their name after a popular gambling destination in Monaco.