

# Monte Carlo Methods

Univariate

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# Introduction

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The general form of Monte Carlo methods is:

$$\mathbb{E}[f(X)] = \int f(x)p(x)dx \approx \frac{1}{N} \sum_{i=1}^N f(x_i) \quad (1)$$

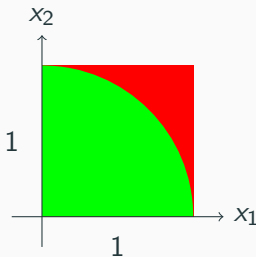
where  $x_i \sim p(x)$ .

# Estimating Pi using Monte Carlo (Part 1)

We can estimate the value of pi using Monte Carlo methods by considering a unit square with a quarter circle inscribed within it.

- Let  $p(x)$  be defined over the unit square using the uniform distribution in two dimensions, i.e.,  $p(x) = 1$  for  $x \in [0, 1]^2$ .
- Let  $f(x)$  be the indicator function defined as follows:

$$f(x) = \begin{cases} \text{Green}(1), & \text{if } x \text{ falls inside the quarter circle,} \\ \text{Red}(0), & \text{otherwise.} \end{cases}$$



$$\frac{\pi}{4} \approx \frac{\text{Green area}}{\text{Green area} + \text{Red area}}$$