Variational Bayesian Methods (in Neuroscience)

Tyler Benster & Aaron Andalman
Deisseroth (Tyler & Aaron) and Druckmann (Tyler) Labs

Computational Neuroscience Journal Club
Stanford University

July 10, 2019

2019-07-10

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Roadmap

Introduction: Why care about the distribution of data?

Problem: Analyzing high dimensional data is hard

Background: Monte Carlo and variational methods

Example: variational autoencoder

Discussion: Neuroscience applications

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Problem: Analyzing high dimensional data is hard

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Background: Monte Carlo and variational methods

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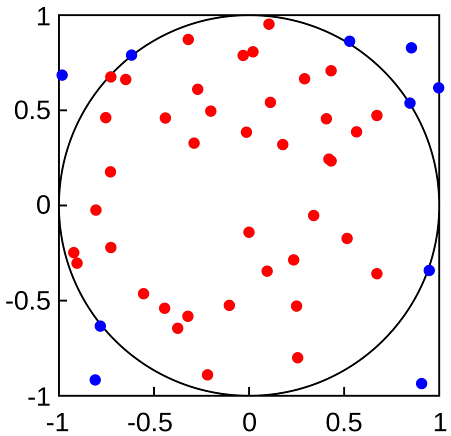
Approximating the area of a circle with Monte Carlo



40/50 samples in circle gives area of $4 * 0.8 = 3.2 \approx \pi$. $\sim 2\%$ error

CC0 1.0, wikimedia, MonteCarloIntegrationCircle.svg

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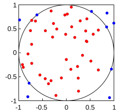

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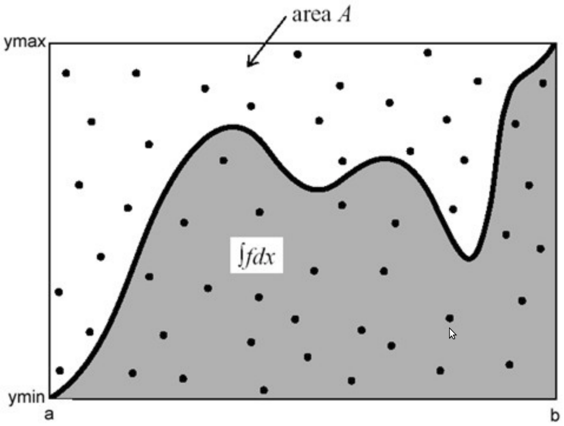
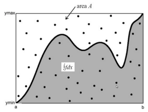
Useful for analytically intractable integrals



Robert Lin - Monte Carlo Integration



Robert Lin - Monte Carlo Integration

Extension to unit hypercube

We can approximate a high-dimensional integral using a Monte Carlo approximation:

$$\int_0^1 \cdots \int_0^1 g(x_1, \ldots, x_n) dx_1, \ldots, dx_n \approx \frac{1}{N} \sum_{j=1}^{N} g(\bar{x}_j)$$

where $\bar{x}_1, \ldots, \bar{x}_N \sim \mathcal{U}(0,1)$ is the i^{th} random sample

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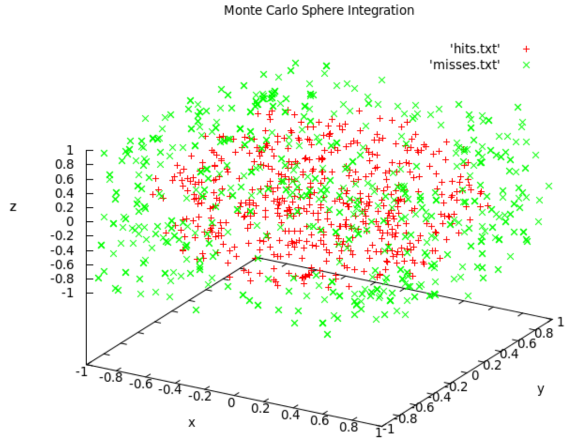
Performance scales poorly with number of dimensions



1000 samples, estimate = 4.072, actual = 4.189, $\sim$ 3% error

http://www2.hawaii.edu/ yuxian/phys305/a6/

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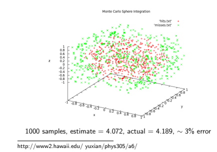

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Discussion: Neuroscience applications
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