

Assignment: Calculating a Double Integral Using Different Methods

January 5, 2024

Overview

This assignment involves calculating the double integral of the function $f(x, y) = x^2 + y^3$ over a specified domain using three distinct methods: analytical (exact calculation), numerical (using standard numerical integration techniques), and Monte Carlo integration.

Assignment Details

1. Analytical Calculation (Exact Method)

- Calculate the double integral $\int_0^1 \int_x^{2x} x^2 + y^3 dy dx$ analytically.
- Include a discussion on the properties of the integral and the integrand for verification purposes.

2. Numerical Calculation (Standard Numerical Integration)

- Implement a numerical method (like trapezoidal or Simpson's rule) to compute the same double integral.
- Clearly document the algorithm and code for this calculation.
- Explain your choice of numerical method and assess its accuracy.

3. Monte Carlo Integration

- Describe how you configured the Monte Carlo simulation for this particular integral.
- Analyze the accuracy of your Monte Carlo integration, discussing factors that affect it and how they were addressed in your implementation.
- Include an analysis of the variance of the results.

Deliverables

1. Report

- **Structure:** Introduction, Methodology (with subsections for each method), Results, Discussion, and Conclusion.
- **Length:** Maximum of 10 pages.
- **Figures and Tables:** Incorporate relevant figures and tables as needed.
- **References:** Properly cite all sources and tools utilized.

2. Code

- Separate from the report.
- The code should be well-commented and structured for each method.

Evaluation Criteria

- **Analytical Section:** Accuracy and clarity in mathematical steps.
- **Numerical Sections:** Correctness of implementation, code quality, and rationale for chosen method.
- **Monte Carlo Section:** Proper implementation, understanding of Monte Carlo principles, and result analysis.
- **Report Quality:** Organization, clarity, result discussion, and critical thinking.