MA635P-Scientific Programming Laboratory

Chebyshev Interpolation

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Deadline: March 16, 2025

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Chebyshev Interpolation

Title of the Project

Chebyshev Interpolation: Accuracy, Convergence, and Applications

Background

- Chebyshev interpolation is a powerful technique for approximating functions, especially in avoiding Runge's phenomenon, which affects standard polynomial interpolation at equally spaced points.

Objective

- To implement Chebyshev interpolation and comparing it with other interpolation methods.
- To analyze its error behavior and convergence properties.
- To Apply it to real-world problems like function approximation and machine learning regression.

Requirements

Read the following papers/Lecture Notes:

1. CHEBYSHEV INTERPOLATION
2. CHEBYSHEV INTERPOLATION FOR FUNCTION IN 1D
3. Chebyshev Interpolation: an interactive tour

Steps to Solve

1. Code
   - 1.1 Python Code for computing Chebyshev nodes and use it in Lagrange / Barycentric interpolation.
2. Mathematical Report
   - 2.1 Introduction to Chebyshev polynomials and their properties.
   - 2.2 Why Chebyshev nodes help in avoiding Runge's phenomenon.
   - 2.3 Mathematical derivation of the interpolation formula.
3. Compare with Polynomial Interpolation
   - 3.1 Comparison with equally spaced interpolation (Lagrange, Newton).
   - 3.2 Error analysis: How interpolation error depends on function smoothness.
4. Applications
   - 4.1 Numerical Integration: Use Chebyshev interpolation for fast integral approximation. Machine Learning Regression: Use Chebyshev basis for efficient function approximation.

Deliverable

1. Python-code
2. A report on error analysis, comparison with polynomial interpolation and Runge's phenomenon
3. Identify applications

Team

Team

- MA23M007 GURMEET SINGH
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- MA23M009 PACHIGOLLA SAI KUMAR

Thanks

Doubts and Suggestions

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