Numerical Methods for Root-Finding: Bisection, Newton-Raphson, Iterative, and False Position

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Abstract

In this project, we explore fundamental numerical methods used for finding the roots of non-linear equations, focusing on four key techniques: the **Bisection Method, Newton-Raphson Method, Iterative Method, and Regula Falsi Method / False Position Method** . These methods play a critical role in solving equations where analytical solutions are either difficult or impossible to obtain, making them essential tools in engineering, science, and applied mathematics.

The **Bisection Method** is a bracketing approach that repeatedly halves an interval containing the root, ensuring convergence, though it may be slower compared to other methods. The **Newton-Raphson Method** offers faster convergence through the use of tangents, but relies on the availability of derivative information and is sensitive to initial guesses. The **Iterative Method** provides a flexible and simple technique, ideal for problems where function evaluations are expensive or derivatives are unavailable. Lastly, the **Regula Falsi (False Position) Method**, a hybrid between the Bisection and Newton-Raphson methods, utilizes a linear interpolation between two points, offering better convergence than the Bisection Method while maintaining some robustness.

In this project, we apply each method to a set of test functions and analyze their performance in terms of convergence speed, accuracy, and computational efficiency. By comparing these methods under different conditions, we aim to understand their advantages, limitations, and suitable applications. The outcomes will provide insights into the selection of appropriate numerical techniques for solving practical problems in various fields.