

Numerical Methods for Solving Nonlinear Equations: Advances and Applications in Modern Engineering and Science

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Abstract. Nonlinear equations, both scalar and system-based, are crucial for accurately modeling complex phenomena across a range of scientific and engineering fields. However, their inherent nonlinearity introduces significant challenges in computational cost, convergence reliability, and verification of results in iterative solutions. This presentation delves into recent advances in both traditional numerical methods and emerging nature-inspired algorithms, which offer alternative approaches to solving nonlinear equations effectively. These bio-inspired algorithms provide robust frameworks for handling issues like solution diversity, convergence stability, and adaptation to complex landscapes in scalar and system-level nonlinear equations. Emphasis will be placed on addressing challenges in result verification, ensuring convergence, and achieving computational efficiency, which are vital for reliable applications. Applications across various fields will be highlighted to demonstrate how precise solutions to nonlinear equations are essential for tackling complex real-world problems.