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A Scaled Nonlinear Conjugate Gradient Method for Unrestricted Optimizations

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Abstract: The conjugate gradient (CG) methods are a family of iterative algorithms used to repeatedly (or iteratively) solve nonlinear systems and control theory problems that can be formulated as unconstrained optimisation. The conjugate gradient method is used for some algorithms; a subclass of it is the hybrid conjugate gradient method. This paper provides new spectral and hybrid conjugate gradient methods. The innovative spectral conjugate gradient technique demonstrates global convergence features, supported by many presumptions and a rigorous Wolfe line search. Moreover, the hybrid conjugate gradient technique fulfils the requirements for achieving global convergence when employing accurate line searches. Additionally, we demonstrate that the approaches provided in this study meet the necessary conditions for descent. The suggested solutions exhibit a high level of competitiveness and efficiency, as evidenced by the numerical results obtained from several test problems.

Keywords: *conjugate gradient approach; spectral conjugate gradient; global convergence analysis; Wolfe line condition.*

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1 Introduction

In numerous nonlinear dynamic systems, the objective is to determine the best state or combination of parameters that leads to the desired behavior. Optimizing parameters in control systems is frequently required to ensure stability and prevent oscillations. Gradient methods can also be applied to address nonlinear systems that arise from electronic and electrical circuits. Hence, the difficulty arising from the concerns mentioned above

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