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A norm descent derivative-free algorithm for solving large-scale nonlinear symmetric equations

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Abstract

In this paper, we propose a norm descent derivative-free algorithm for solving large-scale nonlinear symmetric equations without involving any information of the gradient or Jacobian matrix by using some approximate substitutions. The proposed algorithm is extended from an efficient three-term conjugate gradient method for solving unconstrained optimization problems, and inherits some nice properties such as simple structure, low storage requirements and symmetric property. Under some appropriate conditions, the global convergence is proved. Finally, the numerical experiments and comparisons show that the proposed algorithm is very effective for large-scale problems.

Keywords: Nonlinear symmetric equations, Derivative-free method, Conjugate gradient method, Global convergence.

1. Introduction

In this paper, we mainly consider finding the solutions of the following nonlinear symmetric equations

$$F(x) = 0, \tag{1.1}$$

where $F : R^n \to R^n$ is a continuously differentiable mapping, and its Jacobian $J(x) = \nabla F(x)$ is symmetric, i.e., $J(x) = J(x)^T$. This equations originates from many practical problems such as the KKT systems of equality constrained optimization, the discredited two-point boundary value problem, the discredited elliptic boundary value problem, the saddle points problems, and finding a stationary point for unconstrained optimization problem where F is the corresponding gradient of the objective function, etc.

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