# HYBRID CONJUGATE GRADIENT METHODS USING STRONG WOLFE LINE SEARCH FOR WHALE OPTIMIZATION ALGORITHM

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# ABSTRACT

Optimization is a mathematical model that can be found in everyday life, business, and scientific research. The aim of study is to determine the maximum and minimum of functions, which are often used in decision making. The nonlinear conjugate gradient (CG) method recently is the most used iterative methods for solving optimizing problems because it requires less storage and easy for implementation. The CG method can be classified into several types such as classical CG, spectral CG, and hybrid CG. The hybrid CG method is a certain combination one of the CG methods, made with the aim to improve the behavior of these methods and to avoid the jamming phenomenon. Based on the previous study, the LAMR coefficient is currently the best CG method under strong Wolfe line search. The purpose of this study is to determine the best coefficient of hybrid CG to solve unconstrained optimization test functions. Five coefficient of CG methods, PRP, FR, HS, LS and NRMI are chosen to be combined with LAMR. These methods are tested to compare their effectiveness and robustness. Based on the results, LAMR-HS achieves the highest percentage of successfully solved test problems and indicates as the best coefficient of hybrid CG method. Lastly, the implementation of LAMR-HS in the Whale Optimization Algorithm (WOA) aims to enhance the convergence speed, ultimately demonstrating the successful hybridization between the two algorithms.

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