

**UNIVERSITI TEKNOLOGI MARA**

**HYBRID CONJUGATE GRADIENT  
METHOD WITH  
EXACT LINE SEARCH FOR  
GREY WOLF OPTIMIZATION  
ALGORITHM**

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**July 2025**

## ABSTRACT

Optimization is obtaining optimal solution in solving objective function. Conjugate gradient (CG) method is known for solving unconstrained optimization problems due to its simplicity, low memory storage and global convergence properties. CG method has been implemented in various application such as data fitting, robotic motion control and Grey Wolf Optimization (GWO) algorithm. GWO is a metaheuristic optimization algorithm that has credibility in solving multiple optimization problems. However, GWO is said to have poor population diversity, slow convergence in later stages and prone to get stuck in local optimums where it proves the imbalance of exploration and exploitation search. Thus, this research aims to find the best hybrid CG (HCG) under exact line search and implement it in GWO to improve search process through the hybrid GWO-CG algorithm. The performance of five HCG methods, LAMR-KMAR, LAMR-NRMI, LAMR-HS, LAMR-PRP and LAMR-LS coefficients are tested using 15 standard test functions with different initial points and variables ranging from 2 to 10,000. The numerical results are computed based on number of iteration (NOI) and CPU time. The results are plotted using performance profile to evaluate its efficiency and robustness. Numerically, LAMR-PRP outperforms other methods by solving all test functions with least NOI and CPU time. Lastly, LAMR-PRP is implemented in GWO and resulting effective implementation as it performs better than original GWO.

## ACKNOWLEDGEMENT

Firstly, I wish to thank God for giving me the opportunity to embark on my bachelor's degree and for completing this long and challenging journey successfully. Also, my gratitude and thanks go to my supervisor and lecturer in charge (Lic) for my final year project (FYP), Dr. Norhaslinda binti Zull Pakkal who have guided me with knowledge and supported me throughout doing my FYP. Her passion in teaching motivates me deeper in gaining knowledge and indeed really help in completing my project. Her inputs and feedback may it be report writings or software application contributed greatly to the success of this research.

My appreciation also goes to Dr. Nur Atikah binti Salahudin as the Lic for CDCS267 FYP and Madam Noor Erni Fazlina Mohd Akhir as the academic advisor CDCS267 who have assisted in coordinating my degree study outline.

Finally, special thanks to my family, seniors and friends for helping me with this research. Some may be physically far but without their prayers and emotional supports, I may not be able to complete this journey.

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