FUZZY ADAPTIVE EMPEROR PENGUIN OPTIMIZER FOR GLOBAL OPTIMIZATION PROBLEMS

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DOCTOR OF PHILOSOPHY

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy.

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STUDENTS'S DECLARATION

I hereby declare that the work in this thesis is my own for quotations and summaries which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in fulfilment of the requirements
for the award of the degree of
Doctor of Philosophy

Faculty of Computing
UNIVERSITI MALAYSIA PAHANG

APRIL 2023

ACKNOWLEDGEMENTS

I would like to take this opportunity with great pleasure to acknowledge and extend my heartfelt gratitude to the following persons who have made the successful completion of this PhD thesis possible.

First and foremost, my deepest gratitude goes to the Lord, Allah s.w.t., and his messenger, Prophet Muhammad (PBUH). Allah gave me the strength, patience, and guidance to overcome all obstacles in my life and during my study time, as well as the ability to complete this thesis.

Secondly, my gratitude goes to my father, mother, and all family members for their countless prayers, endless love, unconditional support, tireless patience, and continuous encouragement. Special thanks go to my lovely wife Fatema Tuz Zohora for her support, encouragement, quiet patience, and unwavering love. You are my inspiration. I appreciate your encouragement and support. May Allah bless you all.

Thirdly, I would like to thank my supervisor, Professor Ts. Dr. Kamal Zuhairi Bin Zamli for his advice, motivation, productive discussions, professional supervision, and patience throughout the process until the completion of the thesis. Under his supervision, I am well-trained to work independently. Thanks for the endlessly vital encouragement and support given.

This work described in this thesis is funded in partial by the KPT Fundamental Research Grants: (FRGS/1/2019/ICT02/UMP/02/13) (Formulation of Bi-objective Elitist Dragonfly Algorithm for Constructing Prioritized T-Way Test Cases) and RDU192211 (An Automatic Research Profiling System for UMP Employing UMPIR Data) from Universiti Malaysia Pahang.

My thanks also go to the staff of the Faculty of Computing at UMP, especially those members of my doctoral committee, for their input, valuable discussions, and accessibility.

I pray for the safety and security of my beloved country – Bangladesh.

ABSTRAK

Pengoptimum Penguin Maharaja (EPO) ialah algoritma baharu berasasaskan populasi yang meniru tingkah laku berkelompok dan berhimpit-himpit penguin maharaja. Keputusan bercampur dapat dilihat merujuk kepada prestasi EPO dalam menyelesaikan masaalah pengoptimuman. Dalam EPO, dua parameter perlu ditala (iaitu f dan l) untuk memastikan keseimbangan antara penerokaan (iaitu, perayauan lokasi baharu) dan eksploitasi (iaitu, memanipulasi nilai semasa terbaik). Oleh kerana kontur carian adalah berbeza-beza, penalaan parameter f dan l adalah sukar, dan tiada pendekatan yang sesuai yang boleh diterimapakai untuk semua permasalahan pengoptimuman. Untuk mengurangkan masalah ini, mekanisme penyesuaian boleh diperkenalkan dalam EPO. Penyelidikan ini mencadangkan varian penyesuaian fuzzy EPO, iaitu FAEPO, untuk menyelesaikan masalah ini. Seperti namanya, FAEPO boleh menyesuaikan parameter f dan l sepanjang carian berdasarkan tiga ukuran (iaitu, kualiti, kadar kejayaan dan kepelbagaian carian semasa) melalui keputusan fuzzy. Satu set ujian dua belas fungsi penanda aras dan tiga masalah pengoptimuman global: Pengoptimuman Pembentukan Pasukan (TFO), Jujukan Perduaan Autokorelasi Rendah (LABS) dan Masalah Penjanaan Kes Ujian Keadaan Terubahsuai/Liputan Keputusan (MC/DC) telah diselesaikan menggunakan algoritma yang dicadangkan. Keputusan penyelesaian masing-masing bagi algoritma metaeuristik yang bersaing telah dibandingkan. Keputusan eksperimen menunjukkan bahawa FAEPO telah meningkatkan prestasi dengan ketara terutamanya pendahulunya (EPO), varian EPO (iaitu, IEPO) yang dipertingkatkan dan varian ChOA berasaskan fuzzy (iaitu, FChOA) dan memberikan prestasi unggul berbanding metaheuristik algoritma lainnya. Selain itu, FAEPO yang dicadangkan memerlukan 50% kurang penilaian fungsi dalam setiap lelaran daripada algorithma asal EPO disamping mempamerkan prestasi kompetitif dan dapat memberi saingan kepada meta-heuristik lain dengan tahap keyakinan 90%.

ABSTRACT

The Emperor Penguin Optimizer (EPO) is a recently developed population-based meta-heuristic algorithm that simulates the huddling behaviour of emperor penguins. Mixed results have been observed in the performance of EPO in solving general optimization problems. Within the EPO, two parameters need to be tuned (namely f and l) to ensure a good balance between exploration (i.e., roaming unknown locations) and exploitation (i.e., manipulating the current known best). Since the search contour varies depending on the optimization problem, the tuning of parameters f and l is problem-dependent, and there is no one-size-fits-all approach. To alleviate this parameter tuning problem, an adaptive mechanism can be introduced in EPO. This research work proposes a fuzzy adaptive variant of EPO, namely FAEPO, to solve this problem. As the name suggests, FAEPO can adaptively tune the parameters f and l throughout the search based on three measures (i.e., quality, success rate, and diversity of the current search) via fuzzy decisions. A test suite of twelve benchmark test functions and three global optimization problems: Team Formation Optimization (TFO), Low Autocorrelation Binary Sequence (LABS), and Modified Condition/Decision coverage (MC/DC) test case generation problem were solved using the proposed algorithm. The respective solution results of the competing metaheuristic algorithms were compared. The experimental results demonstrate that FAEPO significantly improved the performance especially of its predecessor (EPO), an improved variant of EPO (i.e., IEPO), and a fuzzy-based variant of ChOA (i.e., FChOA) and gives superior performance against the competing metaheuristic algorithms. Moreover, the proposed FAEPO requires 50% less fitness function evaluation in each iteration than the ancestor EPO and exhibits competitive performance in terms of convergence and computational time against its predecessor (EPO) and other competing meta-heuristic algorithms with a 90% confidence level.

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