Received: August 20, 2021. Revised: September 16, 2021.

International Journal of
Intelligent Engineering & Systems

http://www.inass.org/

Adaptive Grey Wolf Optimization Algorithm with Neighborhood Search Operations: An Application for Traveling Salesman Problem

Ayad Mohammed Jabbar[1]* **Ku Ruhana Ku-Mahamud[2]**

[1]*Department of Computer Science, Shatt Al-Arab University College, Basra, Iraq*
[2]*School of Computing, Universiti Utara Malaysia, Malaysia*
*Corresponding author's Email: AyadMohammed@sa-uc.edu.iq

Abstract: Grey wolf optimization (GWO) algorithm is one of the best population-based algorithms. GWO allows sharing information in the wolf population based on the leadership hierarchy using the hunting mechanism behavior of real wolves in nature. However, the algorithm does not represent any key exchange information sharing for the traveling salesman problem because of two issues. The candidate solutions are improved dependently, similar to local search concepts, losing their capability as a population-based algorithm. The algorithm is limited in its search process in finding only the local regions and ignoring any chance to explore search space effectively. This study introduced an adaptive grey wolf optimization algorithm (A-GWO) to solve the information-sharing problem. The proposed A-GWO maintains sufficient diverse solutions among the best three wolves and the rest of the population. It also improves its neighborhood search by obtaining more locally explored regions to enhance information sharing among the wolves. An adaptive crossover operator with neighborhood search is proposed to inherit the information between the wolves and provide several neighborhoods to find more solutions in the local region. Experiments are performed on 25 benchmark datasets, and results are compared against 12 state-of-the-art algorithms based on three scenarios. The credibility of the proposed algorithm produces approximately 53%, 58%, and 63% better tour distance in the first, second, and third scenarios, respectively. The proposed A-GWO achieves approximately 87% better minimum tour distance compared with the GWO algorithm.

Keywords: Crossover operator, Exploration, Exploitation, Machine learning, Position update, Swarm algorithms.

1. Introduction

The search for optimal solutions in artificial intelligence aims to find the "best" solution among various solutions in the search space. This type of problem is known as combinatorial optimization and is considered an NP-hard problem [1]. Several examples of combinatorial optimization problems are vehicle routing problem (VRP) [2], traveling salesman problem (TSP), clustering [3], classification [4], and feature selection [5]. Stochastic methods have been introduced with alternative randomness called metaheuristics because of the many complexities and limitations in most combinatorial optimization problems. This result concerns the exponential expansion in the area of search for the best solutions and avoids problems to have early convergence and local optima problems. Metaheuristics is a problem-independent algorithm in finding several near-optimal solutions. The main characteristic of metaheuristics combines several heuristic methods that perform in higher-level metaphors [7, 8]. These metaphors are inspired by different behaviors, representing the swarm of insects, including foraging, dancing of bees, collection of eggs of ants, and odor for membership recognition in a colony. The swarm approach, an intelligence system, describes the collective behavior of social insects while interacting with their environment and one another to solve a specific problem [9, 10]. The interaction occurs because of external influences representing positive feedback used as a communication in the population. For example, pheromones in the ant colony optimization algorithm (ACO) make the insects converge and perform a