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The Utilization Of The Simple Multi Attribute Rating Exploiting Ranks Can Enhance The Performance Of The Aco Algorithm

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ABSTRAK

In a comparative study, the performance of the ACO algorithm and a modified genetic algorithm (MGA) were evaluated for solving the multiple salesman traveling problem (MTSP) using various datasets from TSPLIB. The results revealed that although the proposed algorithm did not achieve the best solution, it exhibited improved time efficiency as the dataset size increased. The objective of this study is to improve the performance of the ACO algorithm by integrating the SMARTER algorithm, which aims to find the optimal route and minimize travel time. The combination of these algorithms offers alternative path solutions that can be effectively applied to solve TSP case examples and advance the development of new algorithms that excel in identifying the closest path. The study utilized TSPLIB datasets ranging in size from 76 to 1002 cities, sourced from the Felts and Nelson Krolak repositories. Within this study, the ACO algorithm was employed to optimize the overall distance in the TSP dataset, while the SMARTER algorithm generated suggestions for the optimal routes based on the total trip distance calculated by ACO. Experimental results demonstrated that the ACO algorithm, combined with SMARTER, achieved an average time improvement of 74.09% compared to the MGA algorithm, representing the most optimal performance.

Keywords*:* Traveling Salesman Problem, Ant Colony Optimization algorithm, SMARTER and Modified Genetic Algorithm (MGA).

INTRODUCTION

In Junjie and Dingwei's (2016) research titled " Algorithm ACO for the problem of multiple traveling salesmen," the focus was on optimizing the complex combinatorial combination problem of multiple salesman traveling (MTSP), which is a variant of the traveling salesman problem.(Hoffman et al., 2013). The aim of this study was to showcase the application of ant colony optimization (ACO) in tackling the MTSP problem. (Gutin & Punnen, 2006) In this article, the efficiency of both the ACO algorithm and the modified genetic algorithm (MGA) is assessed evaluated through a comparison using diverse datasets from TSPLIB.(Liu et al., 2017) The evaluation involved testing the problem using standard TSPLIB datasets and comparing the performance of ACO with MGA. Although the proposed algorithm did not always identify the optimal solutions, it generated competitive solutions within a reasonable timeframe, particularly for large-scale data problems.(Luo et al., 2020) ACO exhibited the ability to find satisfactory results for approximately 1% of the known optimum solutions in small-scale problems.
However In this study, the efficiency of finding solutions for larger datasets was not as high as observed in previous research..(Ebadinezhad, 2020) The research conducted by Junjie and Dingwei focuses on improving the ACO algorithm through the integration of the SMARTER (Simple Multi-Attribute Rating Technique Exploiting Ranks) algorithm. (Liang et al., 2022) The objective of this study is to address the Traveling Salesman Problem (TSP),(Rizkiyanto & Anugrah, 2019) which involves finding the shortest route for a traveling merchant.(Fu & Zhou, 2021) The researchers aim

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to achieve the most optimal route by combining the SMARTER algorithm with ACO.(Band et al., 2022) The Traveling Salesman Problem (TSP) is a well-known combinatorial optimization problem that carries significant significance in the field of engineering. and knowledge-oriented domains, such as planning, scheduling, and searching.(Badruddoja et al., 2022) It relates to finding optimal solutions in various everyday scenarios, such as determining the shortest route or identifying the optimal inventory quantities. The search for optimal values involves seeking the highest or lowest values for a given problem.(Ningsih et al., 2023).

One widely addressed problem that can be tackled through optimization algorithms is the Traveling Salesman Problem (TSP), which aims to determine the most efficient route using the Ant Colony Optimization algorithm.(Efendi et al., 2020)

RESEARCH METHOD

This study aimed to improve the ACO algorithm by integrating SMARTER to ascertain the most optimal route for the Traveling Salesman Problem (TSP). (Ha et al., 2020) Figure 1 presents the research findings, displaying a comparison of the optimization results obtained using the ACO algorithm with MGA and the ACO-SMARTER algorithm with MGA

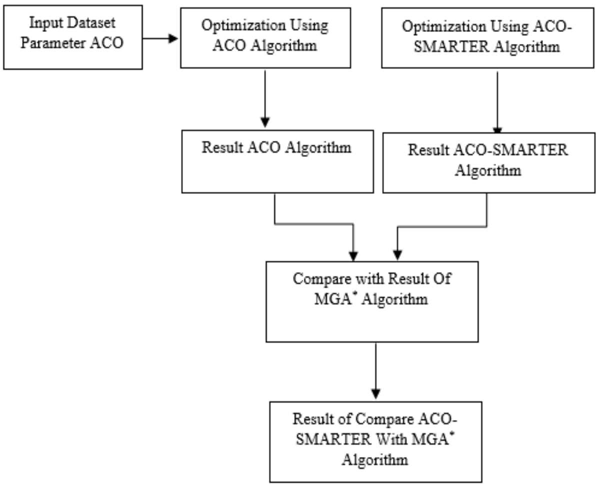

Figure 1. ACO-SMARTER Research Chart

The provided chart compares the results of route search processing and processing time for the ACO and ACO-SMARTER algorithms, considering the dataset and ant parameters. The outcomes are then compared to those obtained in other studies, specifically MGA.

In the research conducted by Hlaing and Khine (2016), titled "In the study titled "Improved Ant Colony Optimization Algorithm for Solving the Traveling Salesman Problem," the Ant Colony Optimization (ACO) algorithm is acknowledged as a highly effective heuristic approach extensively utilized in solving diverse combinatorial optimization problems. It is regarded as a high-performance computing method for tackling the Traveling Salesman Problem (TSP), which is a widely known combinatorial optimization problem with diverse applications. Although ACO exhibits excellent search capabilities for optimization problems, it suffers from two limitations: long convergence time and susceptibility to getting trapped in local optima when seeking optimal solutions for TSP problems. This paper introduces an enhanced algorithm for ant colony optimization, with particular focus on two important aspects.

Firstly, the utilization of a candidate set strategy accelerates the convergence speed. Additionally, a dynamic updating rule that relies on entropy is suggested to improve the performance of solving the problem. Traveling Salesman Problem (TSP). Benchmark problems from TSPLIB are employed to test the algorithms, The results demonstrate that the proposed algorithm outperforms the conventional ACO algorithm in terms of performance. The experimental findings indicate the satisfactory outcomes of the proposed algorithms.The ACO algorithm was

developed by Marco Dorigo, as mentioned in the study by Ping Duan (2016).
ACO is a heuristic technique that draws inspiration from the foraging behavior of ants in finding the most efficient path to a food source. It employs an optimization technique based on communication between ant colonies. In essence, ants leave a trail of special substances called pheromones, which serve as a guide for other ants during their search. The concentration of pheromones is higher in paths with shorter distances, as there is less evaporation. Consequently, ants are inclined to follow paths with higher pheromone The introduction of the SMARTER Algorithm dates back to 1994 when Edwards and Baron proposed it as a method for making decisions based on multiple criteria. This method operates based on the principle that every option comprises multiple criteria with assigned values, and each criterion is allocated a weight that signifies its relative importance compared to other criteria. The weighting process in the SMARTER method employs a range from 0 to 1, which facilitates the calculation and comparison of values for each alternative.

RESULTS AND DISCUSSION

Currently, the developed software serves as a tool for conducting a comparison between the ACO algorithm and the MGA algorithm, as well as the ACO-SMARTER combination with the MGA. The results of the initial endeavor to find the best route and minimize the time using the Ant Colony Optimization algorithm in conjunction with the Modified Genetic Algorithm (MGA) can be observed in the table.

Table 1. ACO and MGA Experiment Results

No	Data	ACO			MGA		
		Best	Average Distance	Time (s)	Best	Average Distance	Time (s)
1	Pr76	178597	180690	51	157444	160574	43
2	Pr152	130953	136341	128	127839	133337	91
3	Pr226	167646	170877	143	166827	178501	165
4	Pr299	82106	83845	288	82176	85796	363
5	Pr439	161955	165035	563	173839	183698	623
6	Pr1002	382198	387205	2620	427269	459179	2892

Table 2 presents the outcomes of the second attempt in finding the optimal route and achieving the fastest time using the Ant Colony Optimization (ACO) algorithm in conjunction with the SMARTER algorithm and the Modified Genetic Algorithm (MGA).

Table 2. ACO-SMARTER and MGA Experiment Results

No	Data	ACO-SMARTER			MGA		
		Best	Average Distance	Time (s)	Best	Average Distance	Time (s)
1	Pr76	162524	171254	56	157444	160574	43
2	Pr152	129524	132000	112	127839	133337	91
3	Pr226	166325	170120	134	166827	178501	165
4	Pr299	81254	83425	294	82176	85796	363
5	Pr439	160352	164563	521	173839	183698	623
6	Pr1002	379562	386541	2758	427269	459179	2892

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Based on the data provided in Tables 2 and 3, the Average Optimum Distance achieved through the best optimization results using the ACO-SMARTER algorithm is 65743 km, while with the ACO algorithm it is 72896.5 km. However, the running time did not yield significant results when utilizing the MGA algorithm. By comparing the results from Table

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1 and Table 2, a comparison chart depicting the optimization process time for the MGA, ACO, and ACO-SMARTER algorithms is presented in Figure 3.

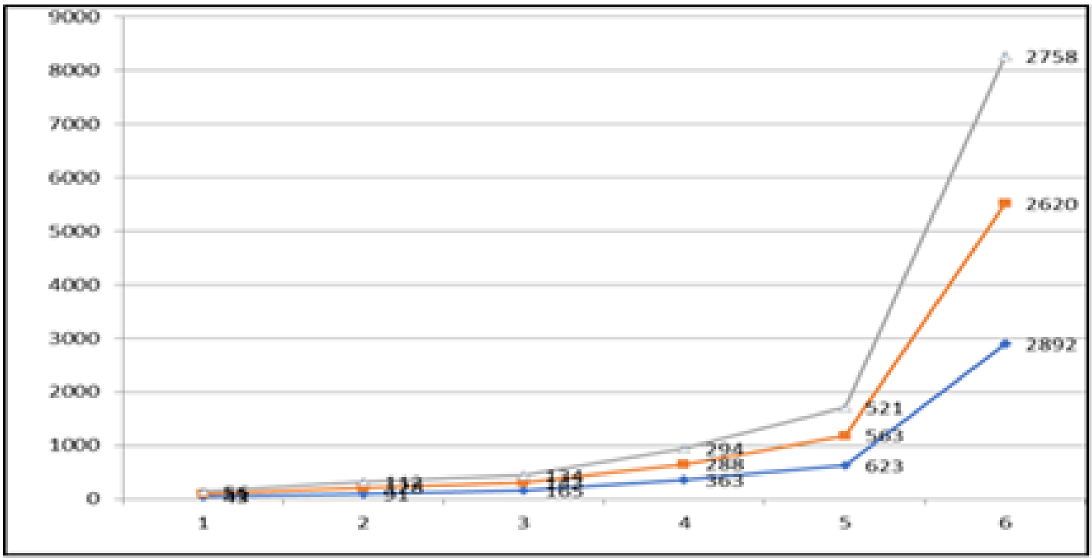

Figure 3. Time Graph of MGA, ACO, ACO-SMARTER Algorithms

CONCLUSION

From the results of Table 1 and Table 2, it is obtained a comparison chart of the time of the optimization process of the MGA, ACO, ACO-SMARTER algorithm**.** The proposed algorithm (ACO-SMARTER) gives better results in terms of route length by 5.6% and data processing time by 17.76%.

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