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Peer Review

Review of: "PSO and the Traveling Salesman Problem: An Intelligent Optimization Approach"

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The manuscript explores the application of Particle Swarm Optimization (PSO) to the Traveling Salesman Problem (TSP), a well-known NP-hard combinatorial optimization challenge. The authors adapt PSO, originally developed for continuous optimization, to the discrete TSP domain by representing city orders as permutations and incorporating 2-opt and 3-opt local search techniques. The study evaluates PSO's performance on a small-scale problem with five cities and briefly compares it to Genetic Algorithms (GA) and Simulated Annealing (SA). While the paper is well-structured and the adaptation of PSO is conceptually interesting, the experimental validation is insufficient, lacking rigorous benchmarking, statistical analysis, and comparative performance evaluation against state-of-the-art methods. The absence of standard datasets, limited problem instances, and lack of methodological novelty significantly weaken the study's contribution. I have some comments:

23. The manuscript lacks a clear justification for choosing PSO over other metaheuristic approaches for solving TSPs. The authors should explicitly discuss the rationale behind selecting PSO and its unique advantages, including practical applications where PSO has demonstrated superior performance.

24. The paper does not critically compare PSO to existing state-of-the-art approaches such as Ant Colony Optimization (ACO), Artificial Bee Colony (ABC), or other hybrid evolutionary methods. A stronger argument is needed to support the claim that PSO is an effective optimization technique for TSP.

25. While the manuscript mentions hybridization, it does not provide a concrete discussion on how the proposed PSO adaptation specifically excels in solving the problem. Empirical evidence or case-

specific justifications should be provided.

26. The pseudocode produces double-precision numbers instead of integer values. The authors should clarify how they handle this in a discrete optimization problem.

27. The termination criterion in the pseudocode is inefficient. The authors should consider advanced stopping criteria such as fitness stagnation or adaptive convergence metrics.

28. The "Motivations" and "Contributions" should be structured as distinct subsections to enhance clarity and coherence. This will help better outline the problem's significance, the existing gap in literature, and the novel contributions of this study.

29. The introduction does not adequately address the limitations of prior approaches, nor does it convincingly establish why PSO is an appropriate choice for tackling TSP. A stronger literature review is required to contextualize the research problem.

30. The manuscript should address some originality concerns. It is crucial to explicitly state how this study advances beyond existing PSO–TSP research, such as Wang et al. (2003) and Ghosh and Dehuri (2011).

31. The experimental setup lacks sufficient details regarding benchmark instances. The authors should specify the dataset sources, problem scales, and how generalizable their results are. The omission of standard datasets like TSPLIB severely limits the ability to assess the performance of the proposed method.

32. The absence of sensitivity analysis and ablation studies weakens the credibility of the results. The paper should analyze how different PSO parameters (e.g., inertia weight, acceleration coefficients) influence performance.

33. There is no computational complexity assessment of the proposed approach. A time complexity analysis or a comparative efficiency evaluation against other heuristic methods is necessary.

34. The use of statistical significance tests such as the Wilcoxon signed–rank test should be included to validate performance differences across different methods.

35. Acronyms such as PSO, TSP, and GA should be explicitly defined at first mention and consistently used throughout the paper.

36. The experimental results with only five cities are inadequate for demonstrating the effectiveness of the algorithm. At least 30 independent trials should be conducted to account for the stochastic nature of PSO.

37. Secondary performance metrics beyond tour length, such as Average Waiting Time or Running Time, should be explored.

38. The conclusion merely summarizes findings without discussing broader practical implications. The authors should elaborate on how their approach can be applied in real-world problems such as logistics, supply chain management, and vehicle routing.

39. There is no discussion on the limitations of the approach. A critical evaluation of the weaknesses and possible failure cases of PSO in solving large-scale TSP instances is necessary.

40. The manuscript requires significant language refinement. Several sections contain awkward phrasing, grammatical errors, and overly verbose explanations that obscure key findings.

41. The logical flow between sections is weak, making the narrative hard to follow. Improved transitions between discussions on PSO theory, problem formulation, and experimental results are needed.

42. The abstract does not effectively summarize the key contributions and findings. It should be rewritten to provide a clearer and more concise overview of the study.

43. Given the substantial deficiencies in experimental rigor, comparative analysis, and methodological justification, a major revision is necessary. The lack of critical statistical validation and absence of meaningful sensitivity analyses diminish the reliability of the results. These issues should be addressed before considering publication.

44. The contribution claims are not sufficiently substantiated, making it difficult to assess the novelty of the work.

Additional Critical Comments

45. The authors should consider integrating hybrid optimization techniques, such as a combination of PSO with local search or reinforcement learning, to enhance the algorithm's robustness.

46. The discussion on PSO adaptation for discrete optimization is too generic and does not introduce novel modifications tailored for TSP. More innovative adaptations should be proposed.

47. Figures and tables lack proper captions and explanatory notes. Graphs illustrating convergence rates and comparisons with other metaheuristics should be added.

48. The manuscript should include a broader set of benchmark problems, including larger instances, to better assess the scalability of the proposed method.

49. The manuscript does not sufficiently cite recent and relevant literature (R4, R6). More references to state-of-the-art methods should be included to strengthen the discussion.

Overall Verdict: Major Revision Required

The manuscript presents an interesting application of PSO to TSP but lacks methodological depth, comparative analysis, and statistical validation. A substantial revision is needed to improve its contribution and clarity. Addressing the concerns raised by multiple reviewers will be essential for this paper to be considered for publication.

Declarations

Potential competing interests: No potential competing interests to declare.