Chapter 13
Compare the Performance of Meta-Heuristics Algorithm:
A Review

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ABSTRACT

Metaheuristic algorithms have emerged as powerful optimization techniques capable of efficiently exploring complex solution spaces to find near-optimal solutions. This paper provides a comprehensive review and comparative analysis of several widely used metaheuristic algorithms, including genetic algorithms (GA), particle swarm optimization (PSO), firefly algorithm (FA), grey wolf optimizer (GWO), squirrel search algorithm (SSA), flying fox optimization algorithm (FFO). The comparative analysis encompasses various performance metrics, such as convergence speed, solution quality, robustness, scalability, and applicability across diverse problem domains. The study investigates the strengths and weaknesses of each algorithm through empirical evaluations of benchmark problems, highlighting their suitability for different optimization scenarios. Additionally, the impact of parameter tuning on algorithm performance is discussed, emphasizing the need for careful parameter selection to achieve optimal results.

DOI: 10.4018/979-8-3693-3314-3.ch013

INTRODUCTION

Metaheuristics are like broad problem-solving strategies. The goal of optimization is to make a system work better, faster, or cheaper. It's about minimizing effort or maximizing efficiency. In simpler terms, if the cost of building a system can be described as a formula, optimization is finding the absolute lowest or highest value of that formula while considering certain restrictions. Metaheuristics algorithms will not provide guaranteed answers but provide perfect finding good enough solutions for challenging situations. In essence, metaheuristics are powerful tools that help us navigate complex optimization problems when perfect solutions are out of reach. These techniques are designed to address problems for which exact solution methods are impractical. For example, engineers involved in an engineering system's development, fabrication, and repair operations must make managing and technological decisions about the system while working within specific constraints. Optimization is the best solution to achieve better results under specified constraints. The fundamental objective of the optimization process is to reduce the work and time spent on a system or to achieve maximum efficiency. So, if the system's design cost is stated as a function, optimization can be described as attempting to achieve this function's smallest or greatest value under specific conditions.

Many real-world problems involve finding the "best" solution, like the most efficient design, the shortest route, or the minimum cost. These are called optimization problems. But for complex problems, traditional methods for finding the absolute best solution (optimal solution) can be too slow or even impossible. This is where metaheuristics come in. They are a set of high-level problem-solving strategies inspired by nature or human behavior. Instead of guaranteeing the optimal solution, they aim to find "good enough" solutions in a reasonable amount of time.

Here are some key points about metaheuristics:

- Inspired by nature: Many metaheuristics draw inspiration from natural phenomena, like evolution in genetic algorithms or ant behavior in ant colony optimization.
- Iterative process: They work by iteratively refining solutions, exploring different possibilities, and learning from past iterations.
- Not problem-specific: They can be applied to a wide range of optimization problems across different fields.
- Balance exploration and exploitation: They need to balance exploring new possibilities (finding better solutions) with exploiting what works well (refining current good solutions).

Benefits of using metaheuristics:

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