A Novel Cultural Evolution-Based Nomadic Pastoralist Optimization Algorithm (NPOA): The Mathematical Models

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***Abstract*—In this paper, the mathematical models for a proposed novel modified Pastoralist Optimization Algorithm (POA) called the Nomadic Pastoralist Optimization Algorithm (NPOA) inspired by the nomadic pastoralists herding strategies and cultural evolution strategy is presented. The nomadic pastoralist herding strategies which are scouting, camping, herding, splitting and merging were mathematically modeled. The mathematical models will be used to develop the proposed algorithm. The algorithm when developed will be tested on several benchmark functions to ascertain the algorithms exploration and exploitative ability. The performance will also be validated by comparing with POA and other popular and similar metaheuristic algorithms such as GOA, PSO, ABC, BBO and ICA**

Keywords— Optimization; Nature Inspiration; Metaheuristics; Cultural Algorithm, Pastoralist Optimization Algorithm (POA); Nomadic Pastoralist Herding Strategy (NPHS);

I. INTRODUCTION

The rapid growth in technology has brought about faster and more accurate solutions to emerging real world problems. At the heart of this technological advancement and optimal solution seeking is optimization. Optimization is basically a search for optimal solution using the right procedures and mathematical representations [1]. [2] defined optimization (or mathematical programming) as a systematic selection of variable values within some allowed limits whose aim is to minimize or maximize an objective function of a decision problem. Optimization is viewed as optimal seeking in nature in which problem dependent objectives (performance index) must be evaluated or achieved and constraints must be satisfied [3]. Optimization problems (OP) are problems that contains several solutions, variables, constraints and a function or performance measure to measure the optimality of a chosen solution. The general approaches for solving OP can be analytical, experimental, graphical or numerical. [4].

Real world OPs are complex and difficult to solve because of their large number variables and constraints, non-linear and multi-modal objective function and are computational expensive, hence, the need for innovative optimization techniques in solving them [5, 6]. This innovative Nature Inspired (NI) optimization techniques which are mostly population based and metaheuristic Optimization Algorithms (OA) have proven to be very efficient in solving most real world problems. Novel nature-inspired metaheuristic OA are being developed because according to the no free lunch theorem, no OA can optimally solve all Op's, even though they are capable of solving most OP.s [7].

NI-OA are inspired by natural phenomenon, and they are classified as either swarm-based, human-based, evolutionary-based, chemistry-based, physics-based and mathematics-based [8]. Example of some of these algorithms include Particle Swarm Optimization (PSO) [9], Ant Colony Optimization (ACO) [10], Artificial Bee Colony (ABC) [11], Biogeography-based Optimization (BBO) [12], Ant Lion Optimization (ALO) [13], Whale Optimization Algorithm (WOA) [14], Lion Optimization Algorithm (LOA) [15] and Grasshopper Optimization Algorithm (GOA) [16], Pastoralist Optimization Algorithm (POA) [17].

Most of the listed algorithms deploy mostly the biological evolution strategy through mutation or crossover or both and agents share information with a narrow temporal and spatial scale. Cultural evolution strategies on the other hand allows agents to evolve share information through a well-structured belief space. Cultural Algorithm (CA) allows agents to learn from a global knowledge domain rather than local as in the case of most OA. This allows culture to evolve faster than biological and other social evolution strategies. CA have been applied for evolution and modification of some algorithms [18].