Bio Inspired Swarm Intelligence: Bacteria Foraging Optimization Algorithm Review and Applications

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***ABSTRACT*: This paper reviews and investigates the foundation of BFO technique and its corresponding applications. Recently, germ intelligence Bacteria Foraging has grabbed the attention of researchers pursuing their work on optimization because of its competency in solving real-life optimization problems arising in several application domains. Bacteria Foraging Optimization (BFO), a nature inspired optimization, has been an attention seeker due to its high performance optimizer which is a faster convergence and global search approach. Researchers have extended the BFO technique in diverse fields, namely, Image Quantization, Data Mining, Natural Computing, Soft Computing, Computational Intelligence, Neural systems, various Hybrid Artificial Intelligent Systems (HAIS) and the count is on. BFO technique for find the optimal solution of a problem.**

***KEYWORDS* : Bacteria Foraging, Swarm Intelligence, Chemotaxis, Swim, Tumble, Optimal Path.**

LIST OF ACRONYMS

SI - Swarm Intelligence
BF - Bacterial Foraging
BFO - Bacteria Foraging Optimization
BFOA - Bacteria Foraging Optimization Algorithm

1. INTRODUCTION

In 2002, an innovative article was published by Prof. K.M. Passino, presented an optimization method recognised as Bacterial Foraging Optimization Algorithm (BFOA) established on the social chemotaxis performance of Escherichia Coli (E. Coli) bacteria existent in human intestine(Passino, 2002). Bacteria Foraging Optimization Algorithm (BFOA), proposed by Passino, is a novice to the family of nature-inspired optimization algorithms. Since foundation, the BFOA has strained attention of academics as a high performance optimizer and various successful applications of BFOA in ideal control engineering (Passino, 2002; Korani, 2008), network scheduling, image processing ,data mining[9], neural networks etc have been stated till date. BFOA combined with method of moment (MOM) has also been used in antenna solicitations. For more than last five years, optimization algorithms like Genetic Algorithms (GAs), Evolutionary Programming (EP), Evolutionary Strategies (ES), which lure their stimulus from progression and natural genetics, have been ruling the kingdom of optimization algorithms. Lately natural swarm enthused algorithms like Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) have originated their means into this domain and proved their efficiency.

1.1 GENERAL ALGORITHM

Enter the bacterial foraging parameters followed by independent variable, then specify lower and upper limits of the variables. Now initiate the elimination-dispersal steps, reproduction and chemotactic.

- Generate the positions of the independent variable randomly for a population of bacteria. Evaluate the objective value of each bacterium.
- By using the tumbling or swimming process, alters the place of the variables for all the bacteria. Perform reproduction and elimination operation.
- In case maximum number of chemotactic, reproduction and elimination-dispersal stages are reached, then output the variable corresponding to the overall best bacterium; Otherwise, repeat the process by modifying the position of the variables for all the bacteria using the tumbling /swimming process.

2. APPLICATIONS OF BFOA

2.1 Assortment of Nature Inspired Computing

H. Kundra et al. : Nature is actually a generous source of inspiration which demonstrates strongly disparate, robust dynamic, and difficult phenomenon. Nature inspired algorithms have been gaining vogue in recent years due to the statistic that many enormous, dynamic, complex, real-world problems like , classification, decision making, optimization, imprecise reasoning have been delivered effectively and efficient solutions. For the past decades, abundant research achievements have been made. This paper presents a broad outline of natured inspired computational prototypes. Also, an effort is made to present a nomenclature on the nature inspired algorithms.

2.2 Image Quantization Using HSI Based On Bacteria Foraging Optimization

D. Kumar et al. : Bacteria Foraging Optimization a nature-inspired optimization has drawn the consideration of scholars because of its competency in resolving real-world optimization glitches arising in several presentation domains. Color image quantization is a vital procedure of indicating true color images using a small number of colors. Current color

reduction methods tend to modify image color construction and dissemination. Thus the examiners are always discovering alternative approaches for color quantization. In cylindrical color spaces like HSI, color is signified by hue, intensity, and saturation. These components are nearby to the way humans recognizes and describes color. Hue, saturation and intensity can also disclose image topographies that are not so clear in other color spaces. The objective of this investigation, is to project an algorithm for Image Quantization using HSI color space well-known on Bacteria Foraging Optimization. To implement and investigation the suggested algorithm. To relate the designed algorithm with other quantization techniques. The directed experiments specify that recommended algorithm generally effects the momentous enhancement of image quality corresponding to other recognised approaches.

2.3 A Hybrid Bacterial Foraging Algorithm for Solving Job Shop Scheduling Problems

Narendhar. S et al. : Bio-Inspired computing is the division of Nature-Inspired computing. Job Shop Scheduling Problem is characterised under widespread scheduling problems. In this study, Bacterial Foraging Optimization was hybridised with Ant Colony Optimization and a fresh technique Hybrid Bacterial Foraging Optimization for solving Job Shop Scheduling Problem was suggested. The ideal solutions found by proposed Hybrid Bacterial Foraging Optimization algorithms are much improved when associated with the solutions acquired by Bacterial Foraging Optimization algorithm for famous test problems of diverse sizes. From the application of this work, it can be perceived that the proposed Hybrid Bacterial Foraging Optimization was operative than Bacterial Foraging Optimization algorithm in elucidating Job Shop Scheduling Problems. Hybrid Bacterial Foraging Optimization is used to apply real world Job Shop Scheduling Problems.

2.4 Adaptive Bacterial Foraging Optimization Algorithm Based on Social Foraging Strategy

H. Shen et al. : in 2002, K. M. Passino proposed Bacterial Foraging Optimization Algorithm (BFOA) for disseminated optimization and mechanism. Biologic foraging strategies are diverse. Based on collective and intellectual foraging theory, this paper recommends an adaptive bacterial foraging optimization algorithm, and presented six foraging operatives: assimilation run operator, reproduction operator, tumble operator, chaos run operator, swimming operator, and elimination-dispersal operator. Amongst those operators, chaos run operator, assimilation run operator and reproduction operator were redefined in agreement with social foraging policy. And others were similar to the novel algorithm. Researches were directed on 10 multimodal unrestricted benchmark optimization problems for demonstrating the efficiency and steadiness. The result validates significant performance of the recommended algorithm on all selected benchmark tasks when matched with several successful optimization techniques.

2.0.5 Color Reduction in RGB based on Bacteria Foraging Optimization

P. Sandhu et al. : Bacterial foraging optimization algorithm (BFOA) has been broadly recognized as a universal optimization algorithm of existing interest for dispersed optimization and control. BFOA is stimulated by the social foraging behaviour of Escherichia coli. BFOA has already strained the responsiveness of researchers because of its productivity in solving practical optimization problems rising in several application fields. The essential biology behind the foraging strategy of E.coli is imitated in an unusual method and used as a modest optimization algorithm. It's an optimization used for undertaking difficult search problems of the real-life. The experts have been illustrating encouragement from nature and natural individuals for years. Bacterial Foraging Optimization is an escalating nature inspired system for discovering the optimum solution of the problem. A Color images Quantization is essential if the display on which a precise image is obtainable works with less colors than the novel image. While a lot of color reduction techniques occur in the writings, they are mainly considered for image firmness as they incline to change image color structure and distribution; the investigators are always verdicts different strategies for color quantization so that they may be equipped to choose the most suitable technique for the color quantization.

2.6 Bacterial Foraging Optimization Algorithm: Theoretical Foundations, Analysis, and Applications

A. Biswas et al. : Bacterial foraging optimization algorithm (BFOA) has been extensively acknowledged as a universal optimization algorithm of present notice for scattered optimization and control. BFOA is enthused by the communal foraging performance of Escherichia coli. BFOA has now drained the courtesy of academics as of its effectiveness in cracking everyday optimization problems ascending in several application spheres. The fundamental biology behind the foraging strategy of E.coli is rivalled in a strange manner and used as a guileless optimization algorithm. This section starts with a coherent outline of the traditional BFOA. It then examines the dynamics of the replicated chemotaxis step in BFOA with the support of a simple mathematical model. Taking a prompt from the analysis, it boons a new adaptive alternative of BFOA, where the chemotactic step size is accustomed on the run according to the current appropriateness of a simulated bacterium. Nest, an analysis of the dynamics of reproduction operator in BFOA is also discussed.

2.0.7 Intelligent routing approaches using Bacteria Foraging Algorithm and Artificial Bee Colony

K. Sooda et al. : Networks nowadays are constantly changing and network routing is a major task. This is because of the datum that the networks difficulty is growing and foremost in today's internet. To handle this problem we use the progressive notions of artificial intelligence and give a reasoning approach to the issues confronted in networking. This paper contributes the detailed explanation of the application of the two algorithms to be precise Bacteria Foraging Algorithm (BFA) and Artificial Bee Colony (ABC). These algorithms were preferred to evaluate how foraging algorithm and evolutionary algorithm run on network routing

setup. This study notifies that when BFA is used in our network setup we acquire an optimal path and then on the same setup if we run ABC algorithm we get an optimal path with enhanced IDs. The focus here was to discover the optimum path constructed on the bandwidth. We considered the setup for union rate, hop count and ideal cost found by the algorithms. We established that ABC was good than BFA in relations to the three factors measured overhead in the replication results.

2.8 Editorial Survey: Swarm Intelligence for Data Mining

D. Martens et al. : Reviews the juncture of two captivating and gradually popular domains: swarm intelligence and data mining. However data mining is a widespread academic subject for years, swarm intelligence is a comparatively novel subfield of artificial intelligence which revises the developing collective intelligence of clusters of guileless agents. It is built on social conduct that can be pragmatic in nature, such as flocks of birds, ant colonies, bee hives, and fish schools, where numerous individuals with partial capabilities are capable to come to intelligent solutions for composite problems. The swarm intelligence pattern has received widespread attention in research during the recent years, mainly as Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO). These are moreover the most prevalent swarm intelligence metaheuristics for data mining. Furthermore, an outline of these nature inspired computing approaches, we deliberate widespread data mining systems based on these ideologies and schematically grades the key modifications. Furthermore, we delivers a merging context that classifies the swarm intelligence based data mining algorithms into two approaches: operative search and data unifying. Finally, this paper inclines exciting issues for future study, hereby classifying organizational gaps in recent research as well as mapping prospects provided by swarm intelligence to present tests within data mining research.

2.9 Analysis of Reproduction Operator in Bacterial Foraging Optimization Algorithm

A. Abraham et al. : Some of the main driving forces of Bacterial Foraging Optimization Algorithm (BFOA) is the reproduction phenomenon of virtual bacteria each of which prototypes one model solution of the optimization problem. During replication, the least recovered bacteria (with a minor collected worth of the objective task in one chemotactic lifetime) die and the former healthier bacteria each divide into two, which formerly starts discovering the exploration place from the same position. This retains the population size constant in BFOA. The technique has a straight similarity with the choice mechanism of traditional evolutionary algorithms. This editorial, offers a modest mathematical examination of the consequence of reproduction on bacterial dynamics. This explores that the reproduction incident subsidizes to the quick conjunction of the bacterial population close to targets.

2.10 Bacterial Foraging Optimization Based Neural Network for Short-term Load Forecasting

Y. Zhang et al. : Since the nonlinear features of the control system loads, the temporary capacity estimating is tough to comprehend. The neural network (NN) was active in this revision for projecting. Though, NN is tranquil to be stuck in local jots and congregate too slow. The outdated drill approaches inclined on searching technique which are not in effect and fast. Consequently, bacterial foraging optimization (BFO) was embraced to train the NN. BFO is a new and authoritative universal search technique, and it can find the burdens/prejudices of the neural network rapidly and precisely. Research indicate that the future BFO-NN is higher to GA-NN with deference to conjunction speed and predicted precision.

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