Optimization using Bacterial Foraging based algorithm for proficient communication

Prof. Ranjit Singh Chauhan,

Director, JMIETI, Radaur, Yamuna Nagar (Haryana) INDIA. *drranjitsingh78@gmail.com*

ABSTRACT

In today's era each and every company is toiling to produce the optimize outcome. Optimization is the key decision theory for numerous purposes to infer an important outcome. The goal and aim of every engineering application is to produce the amenities which can be optimized for efficient and proficient communication. Evolutionary computation is one of the most preferred theories which use any scientific, mathematical or logical means regarding optimized results in different operations. A novel scheme for optimization of numerous problems using bacterial foraging based heuristic techniques is discussed in this paper. The power of proposed methodology is illustrated with the help of flow diagram.

I. INTRODUCTION

All living being interconnects with each other by articulating their views, information, data and other modes. There were eras when communication was time consuming and storage was a tedious task. I remember storage of data in floppy disk, use of cassettes for listening songs, cameras for photo click and weight of smart phone. I still remember the days when dimension of floppy drive was about 3.5 inch and had the capacity in few kilobytes. The performance of personal computers and smart phones was very less. Now floppydrives...cassettes…cameras…has been proclaimed as 'retired'.
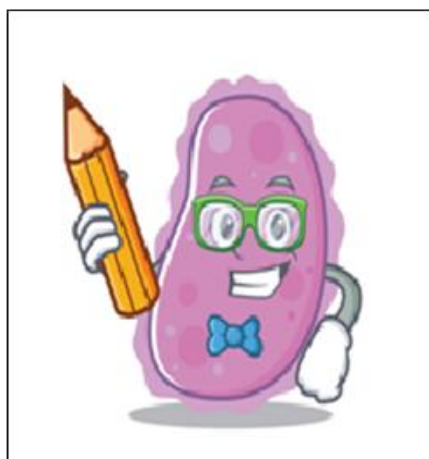
In today's era, we desire proficient and fast communication with high storage of information. Let us assume, there is vast data which is to be transmit somewhere through Internet. The objective will be that more data to be transferred in less time through internet things (IoT). This transfer of less data or delay in transfer of data may cause a big loss for organization where client might choose to refuse business amenities. So we are believed to offer *maximum* but in *minimum* duration. This type of argument can be defined as optimization of function.

In these days, Optimization is the key decision theory of numerical study that can be useful for numerous purposes to infer important outcomes that can help the society in various ways. Optimization is the most preferred concept which uses any logical, mathematical or scientific means regarding optimized results in different operations. The area of optimization deals with the learning of minimization and maximization of mathematical functions. In such diverse areas as economics, finance, statistics, applied science, engineering, and medicine, optimization holds an important position in the practical and scientific

world. In the Eighteenth Century, the famous physicist and swiss mathematician Leonhard Euler (1707-1783) announced that . . . nothing at all takes place in the space in which some rule of minimum or maximum does not show. The subject is so insidious that we even find few optimization terms in our daily life. Consequently, there is great need of optimization methods that can be used to minimize or maximize the parameter to satisfy prescribed specifications.

To find optimization, the problem can be classified in two general categories, firstly, the continuous methods and secondly the discrete (combinatorial) methods. Further, combinatorial (discrete) optimization problem (COP) can be classified as *Static (exact) COP* and *Dynamic (approximate) COP*. In static COP, the features of the problem are defined once. It does not vary while the problem is being solved. While dynamic COP are defined as a function of few quantities when the problem is initialized. The approximate types of optimization problems are further divided into two major categories i.e. Heuristic types and Metaheuristic types of dynamics COP.

Further, Metaheuristic types of dynamics COP are of type categories which are based on population and neighborhood. The various types of classifications of optimization methodologies are illustrated in the figure 1 given below. Swarm based algorithms is termed as an archetype for ingenuous designing of metaheuristic algorithms that are commonly and popularly used for combinatorial optimization problems. MATLAB (Matrix Laboratory) as compared to other softwares like TORA, is used for designing of metaheuristic algorithms. It is a software package for high-performance numerical computation and visualization. It provides an interactive environment with hundreds of built-in functions for technical computation, graphics, and animation.
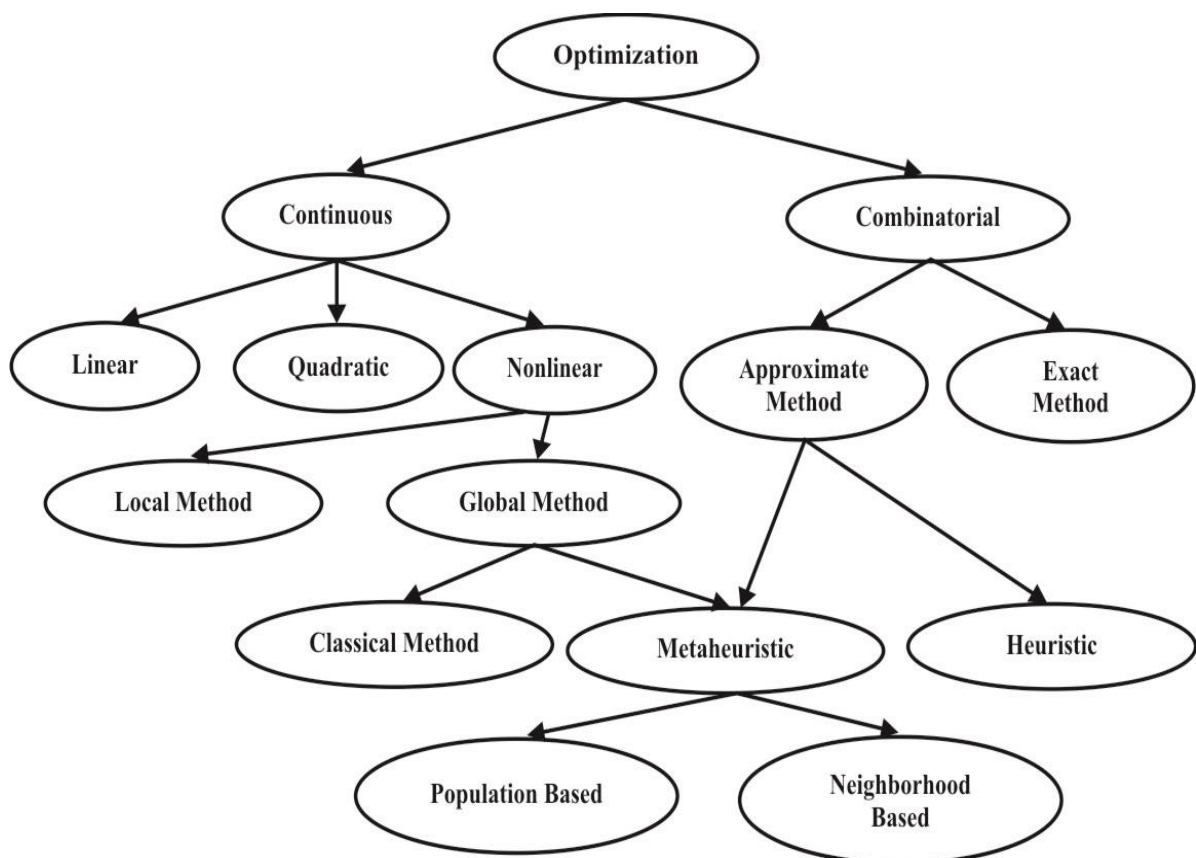

Figure 1: Classification of common search methodologies

Over the last decades, few biologically inspired computational technologies have been introduced, such as Evolutionary type Algorithms which contain Simulated annealing (SA), Genetic Algorithm (GA) and Swarm Intelligence (SI).

In this paper, a novel optimization algorithm of swarm intelligence, Bacterial Forging Optimization (BFA) algorithm has been discussed. BFO incorporates ideas through the modeling of bacterial foraging patterns. The behaviors of run & tumble actions of bacteria and modeling of these actions have been incorporated to calculate the fitness functions.

II.   SWARM INTELLIGENCE

Swarm intelligence has become a research interest to many researchers, scientists or technocrats from various areas in recent years. Swarm Intelligence (SI) is defined as an evolutionary computation or distributed problem-solving strategy inspired by collective behavior of social insect colonies & other animal societies. A number of swarms are placed under this group namely the social insects like wasps, bees, ants & termites. It is an innovative computational and behavioral allegory to solve distributed problems that formerly took its motivation from the biological example provided by social insects such as birds, ants, bees, termites, fishes etc. and by flocking, swarming, shoaling and herding phenomena in vertebrates. Flexibility, Robustness and Self-Organization are the major advantages of Swarm Intelligence. Swarm Intelligence (SI) is newly produced High Performance Technique for Optimization that is the goal and aim of every Engineering application.

Recently, two important Swarm Intelligence paradigms have been developed to tackle many optimization problems for which robust solutions are impossible or difficult to find using traditional approaches. One of them is Ant Colony Optimization (ACO), which was encouraged by ant steering behavior. The other is Particle Swarms Optimization (PSO), which is motivated by simulating animal swarm behavior like birds flocking in the sky, fishes, bee colony etc. However, although the ACO and PSO have been comprehensively studied, these methods are facing difficulties in application to large-scale high-dimensional optimization problems, mainly because of the vast computational burden they impose. More recently, the study of Bacterial Forage Optimization (BFO) has received great attention in the Computational Intelligence community worldwide.

III.   BACTERIAL FORAGING OPTIMIZATION

Bacteria Foraging based Optimization (BFO) is field of SI based on study of the bacterial foraging behaviour. The organized activities exhibited in bacterial foraging patterns could inspire a novel approach for optimization problems. The underlying mechanism of the surviving of bacteria, especially *E. coli* in a complex environment has been described by researchers in the field of biological sciences as illustrated in figure 2. Inspired from these phenomena, BFO was established as an optimization algorithm, in which self-adaptability of individuals in the group searching activities has engrossed a great deal of interests. BFO algorithm (BFA) was designed by K. M. Passino (2002).
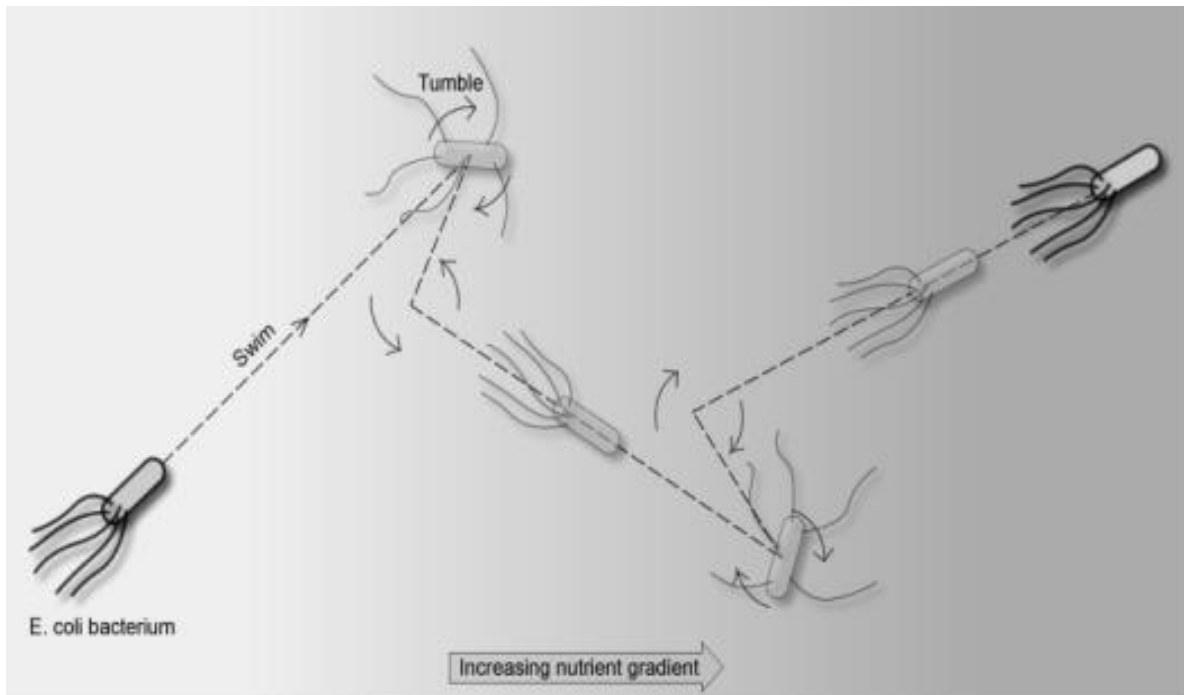
Figure 2: Illustration of behaviour of bacteria.

The concept of BFA can be utilized for optimizing non-linear functions. The global searching activity of this algorithm is executed in three local search processes, i.e., chemotaxis then reproduction and dispersion. Basically, bacterial chemotaxis is combination of swimming & tumbling that keep bacteria in spaces of higher concentration of nutrients. Tumble and run operator are used to improve the local and global search capability of the algorithm. First set of bacteria after several chemotaxis stages undergo the reproduction stage where the bacteria is split into two groups as per reproduction. The set of least healthy bacteria disperses and expire and other healthy set of bacteria divide into two at same location keeping population constant.

IV.   METHODOLOGY

The solution from BFA is used as an *Initialization* in first step which includes initial parameters. In second step evaluation of problem is done which is forward to chemotaxis for higher concentration.

In next step, it is ensured that value of chemotaxis has been reached to maximum value as per specification. After reproduction and dispersion it is ensured that the solution is giving

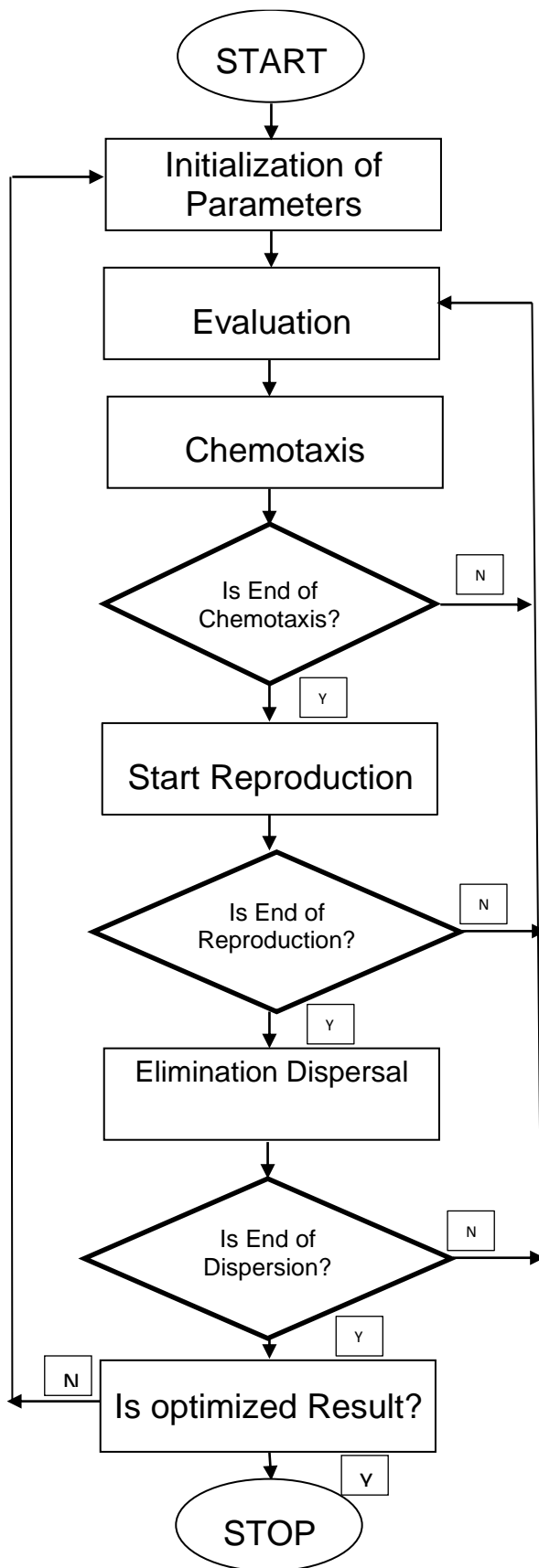optimized values as per fitness function. The steps are shown below in the figure 3.

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Figure 3: Flow diagram of Bacterial Forging Algorithm.

This type of proposed algorithm can be compared to GA, ACO, and PSO on the set of standard functions, to demonstrate the superiority of BFA.

V.   CONCLUSION:

The data or information which is required for storage or transmission for the growth of business can be optimized through BFA. Companies seems to be entering into a new era such as internet of things, artificial intelligence etc. This is a fascinating algorithm used for optimization, which may be useful in the internet revolution for effective communication. Enterprises may use BFA to identify trend and insight in huge amounts of data and prepare optimized decisions that efficiently place them to be superior in real time. BFA concentrate in the relationship between a customer's intent to buy item and apprehension of good returns by the organization. BFA combines internet and things to determine which products might appeal to a prospective client. It is a well thought "*dumb parts, properly connected into a SWARM, yield smart results*".

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