AN INVESTIGATION REPORT ON SWARM INTELLIGENCE ALGORITHMS

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ABSTRACT: In real world made up of a large collection of data. The solving of large data is not easy using existing algorithms. To solve the complex algorithm, the researchers developed the algorithm from the behavior of naturals. The swarm intelligence is a type of bio inspired algorithm used to solve the optimization problem. The swarm intelligence is a meta heuristic algorithm inspired by nature, especially biological system. The common algorithm not adequate to solve the optimization problems such as Travelling Salesman Problem (TSP), NP problems, etc. in this paper, we provide the detailed investigation report on recently developed swarm intelligence algorithms.

KEYWORDS: swarm intelligence, bio inspired algorithm.

INTRODUCTION

In recent advancement of computing the data usage and data retrieval from the database is too large. The present world is moving quickly to solve the problem, but the existing solutions are not adequate to solve the problem very efficiently. The bio inspired algorithm (BIA) is very new, effective and optimized technique to solve the complex problem very efficiently. The optimization is common problem encounter in all fields (from science to mathematics). The BIA is a challenging field for researchers to find the optimal algorithm. Today world moving with fast as well as efficiency. So, we need an efficient algorithm to solve the complex problem. The researchers found that the existing common algorithm is not suitable for complex problems. The main aim of the BIA is to provide the optimum solution to a problem (to all fields). The BIA inspired & development using natural behavior. To understand the behavior of the natural is not easy, but this will give the optimized solution for any problem.

The BIA is inspired by the behavior of naturals. The behavior changes have been observed and then algorithm was developed and implemented to complex problems like Travelling Salesman Problem (TSP) and NP problem the result was proved the BIA provide the better result than other common algorithm.
Advantage of BIA:

- Easy to implement.
- Inspired by natural behavior.
- Provide shortest and optimized solutions.
- Easy to solve complex problems.

- Can implement to all fields.

The attractive functionality of the BIA derives the future from nature. This can solve the problem in distributed and adaptable fashion. The BIA tackles the problem in many fields including robotics, production engineering, Data mining, medical electronics, etc. The most successful class of BIAs involves:

- Evolutionary Algorithms – the functionality inspired by natural evolution
- Swarm Intelligence – inspired by the collective behavior of animals.

Swarm Intelligence:

The swarm Intelligence (SI) is a type of BIA used to solve the complex problem and provide the optimization result. SI was inspired by the collective behavior of natural animals. Many SI algorithms have been developed and proved with the better optimized result. Swarm Intelligent (SI) is a collective behavior of decentralized, self-organized system, natural or artificial [1]. The SI concept was originally proposed by Kennady and Ebrhart in 2007 [2]. The SI is inspired by the behavior of animal to solve the optimization problems. SI Algorithms made up of populations of single agents interacting locally with each other and with their environments. The following principle is considered in SI:

- Self organization
- Stigmergy and simulation by work.

Some of the famous SI algorithms follows: Ant Colony Optimization (ACO) is a general purpose of SI algorithm used to solve many combinatorial optimization process. The ACO was originally proposed by Marco Dorigo in 1992 [3]. Firefly algorithm (FFA) is an optimized search algorithm, inspired by the behavior of fireflies. It was Originally proposed by Xin-She Yang from University of Cambridge [4], Intelligent water drops algorithms(IWD) algorithm was originally proposed by shah-Hosseini in 2009 [5].

Firefly algorithm with chaos

Newly developed metaheuristic firefly algorithm with chaos algorithm developed by A. H. Gandomi et all [6] in 2013. The metaheuristic techniques are well-known global optimization methods used to solve a large class of complex problem. The algorithm was developed using the behavior of firefly flashing and attraction. The attraction and light flashing behavior within firefly creates a new metaheuristic optimization algorithm. The fire fly algorithm mimics the behavior in the following ways.

1. When one firefly has less light factor, then it is attracted over the firefly with highest bright factor.
2. Each firefly communicates with each other with the help of light factor.

The working behavior of firefly algorithm based on two important factor 1). Firefly metaphor 2). Distance, attractiveness and limiting cases.

Firefly metaphor:

The pray finding and communication between each other based on the behavior of bioluminescence with flashing pattern. The following three rules have been used for solving firefly algorithm:

1. Same sex firefly attracted each other.
2. The less light one move towards to bright light one.

3. The brightness of a firefly based on a cost function.

Distance, attractiveness and limiting cases

The attractiveness of the firefly is based on brightness of the firefly. As light intensity and thus attractiveness decrease as the distance from the source increases, the variations of light intensity and attractiveness should be monotonically decreasing functions [6].
The existing firefly algorithm when combined with chaotic variable increase the speed of the firefly. The chaotic firefly algorithm is analyzed by 12 different chaotic maps and analyzes the attraction, brightness factor is the gauss map is the best chaotic map.

Krill Herd: A new bio-inspired optimization algorithm
A new novel biologically-inspired swarm intelligence algorithm krill herd (KH) originally developed by Amir Hossein et all in 2012 [7]. The aim of the algorithm is used to solve the complex problem very efficiently. The KH algorithm is based on the collective behavior of krill individuals. The objective function is used to find the minimum distance between krill individuals, and source of the food. Krill is a marine animal so its not static always move from one place to another place. The movement of the krill based on the following factors:

- Movement depends on the individual krill.
- Hunting ability of individuals.
- Random expansion in marine.

Herding behavior of krill swarms
In this algorithm, the author developed the algorithm using Antartic krill, which is the best available marine animal. The main character of the krill kerd is ability to form large swarms [8,9]. The collection of individual is called multi-objective process. The main goal of the multi-objective process is:

- Increasing the density of the krill
- Reaching food

Lagrangian model of the krill herding
Predators (seals, penguins, sea bird) always try to remove krill individuals. This result in reducing the resulting density and also the distance between krill individual and food source will be reduced significantly. The fitness function is calculated using the distance between krill herd and food. The time-dependent position of an individual krill in 2D surface based on following reason [10]:

- Movement induced by other krill individual.
- Forging activity.
- Random diffusion.

Movement induced by other krill individual
According to the habits of krill, always maintain the high density. The movement is based on the mutual effect [10].
Forging activity
The forging behavior of the krill based on following character:

- Food location.
- Previous experience about food location.

The motion of the krill can be calculated as:

KH Algorithm:
The following steps have been developed for KH Algorithm.

1. Data Structure – used to determine the parameter of the algorithm.
2. Initialization – create the population in the search space.
3. Fitness evaluation – calculate the fitness of the each individual krill based on the place.
4. Motion calculation:
    a. Induced motion
    b. Forging motion
    c. Physical diffusion.
5. Implement the operator (genetic).
6. Update the individual krill position.
7. Check the criteria
8. Update the best solution.
9. Finish.

The Lion's Algorithm: A New Nature-Inspired Search Algorithm

The natural computing is a challenging area for researchers to find the solution for complex problem using inspirations of natural behavior. The new optimization algorithm The Lion's Algorithm (LA): A New Nature-Inspired Search Algorithm originally developed by B. R. Rajkumar in 2012 [11]. The algorithm was inspired by the lion's social behavior. The LA was developed using lion two important behaviors, namely territorial defense and territorial takeover. The territorial defense between resident males and nomadic males. The territorial takeover between old and new territorial male.

The following working procedures have been followed in proposed lion's algorithm [11].

- Pride Generation - generate territorial male and female.
- Mating – the following process has been carried out at the time of mating
    Crossover
    Mutation
    Gender grouping
    Kill sick/weak cubs
    Update Pride
- Territorial Defense – to protect the territorial from nomadic lion.
- Territorial Takeover –process of keeping only derived best male and female solution [11].

Mating process is used to derive the new best solution from existing solution that includes the following operations, namely crossover and mutation. The crossover and mutation is genetic operator. The gender grouping is a clustering process. The cluster has two groups, one for male cubs another for female cubs. To generate the pool cubs the lion's algorithm using K-means clustering algorithm [12].

Intelligent water drops algorithms

Intelligent water drops algorithms IWD algorithm was originally proposed by shah-Hosseini in 2009 [13]. IWD is naturally inspired population based optimization algorithm. The core of the algorithm derived from behaviour of the river flow. IWD derived based on the changes happen because of water drops in river. The IWD effectively produce the good solution for maximization

or minimization problems. The iterative process is used to find the solution. The IWD algorithm is successfully implemented in Travelling Salesman Problem (TSP) and Knapsack problem. The IWD algorithm developed using two properties

- Velocity
- Soil

The IWD algorithm starts with a specified velocity and zero soil initially. Based on the environment this two properties will be changed from source to destination of the river. While travelling the environment, the soil will be removed and speed of the river is increased. The time taking to travel one location to next location is proportional to soil added to water and velocity. The IWD of the path selection is based on soil quantity, the IWD prefer low soil quantity path. The representation of the algorithm in the form of graph (N,E), where N – nodes and E – set of edges. The IWD start with initial node and travelling through the entire nodes only once. The IWD refer two parameters while visiting entire nodes.

- Static parameters – no change in parameters while visiting the nodes.
- Dynamic parameters – change the parameters value.

Multi-Objective Flower Algorithm for Optimization

The Bio-Inspired algorithm derives the future from nature. The multi-objective flower algorithm for optimization (MOFPA) is a naturally inspired algorithm is derived from the basic flower pollination process originally developed by xin-she yang et all [14]. Generally 90%of the plant species are flowering plants. Pollination is the process of transferring the pollen grains from one flower to another flower by any external medium. The flower pollination process is categorized into two types

- Biotic- It requires a medium such as insects, animals or external source
- Abiotic -It does not require any medium to transfer the pollen grains.

The Multi-Objective Flower Pollination Algorithm is derived from the Flower pollination Algorithm which maps the pollination process from the flower to the Pareto fronts test function. The MOFPA uses a simple weighted sum method which combines all the objectives in the function into a single objective function. The general flower pollination algorithm uses four basic rules as given below:

Rule1: The pollinators carrying or transferring the pollen grains obeys Levy Flights which is categorized as a biotic or cross over pollination globally.
Rule2: Abiotic and local pollination can be carried out locally
Rule3: insects which are cause for the pollination develops similar flower consistency
Rule4: switch probability method is used to control the interaction or switching of local pollination.

Multi-Objective Flower Pollination Algorithm (MOFPA)

It uses a weighted sum method to combine all the above four rule multiple objectives into a single objective.

The algorithm uses four test functions:

- ZDT1-fuction to find the convex front
- ZDT2-function used with non-convex front

- ZDT3-function used with a discontinuous front
- LZ -function with Pareto front to analyze Pareto set

The MOFPA is used in the disc brake design which minimizes the braking time and mass by choosing the optimal design variables of the system like the inner radius of the disc, outer radius and the friction surface. The MOFPA is very efficient algorithm which has a exponential convergence rate.

A Novel Bio-Inspired approach based on the behavior of Mosquitoes

Swarm Intelligence provides the best solution for evaluating complex problems. It is best suited for optimization problem where the behavior of animals can be mapped to solve a real time problem. The mosquito host –seeking algorithm (MHSA) was developed by Xiang Feng et al in 2008[15].The algorithm aims to solve the optimization problem Travelling Sales man Problem(TSP) by mapping the naturally inspired host seeking behavior of mosquitoes with each nodes.

The TSP optimization problem is solved by considering each vertex as an artificial mosquito Consider a graph where G= (v, e) where V is the Set of vertices and e is the set of edges. Consider an edge (i,j).if there is an edge between the nodes then it is represented as value 1 and if there is no edge between the pair of vertices then is represented as value 0.Each computing cell in the TSP is considered as an artificial mosquito which is denoted as m_{ij} .the seeking of the host in mosquitoes is attracted by odours,carbon dioxide and radiated heat by the host. When the hosts accumulate a large amount of carbon dioxide, odours they are attracted at a faster rate towards their host.

Each artificial mosquito in TSP has a grayscale value as r_{ij} which tracks the movement of the artificial mosquitoes. When all the mosquito process in equilibrium states the grayscale factor r_{ij} value will be one or zero. The path in TSP is denoted by p_{ij}.

The sex attribute of the artificial mosquito m_{ij} is identified with respect to x_{ij} as male and female If m_{ij} is female then x_{ij}=1 else m_{ij} is male mosquito. The movement of the host from one m_{ij} to another artificial mosquito is tracked by the grayscale factor. In TSP the route between each city is mapped by the host behavior if there is no path between any city then the computing cell will be dead and mark its path as white.

The host seeking behaviors of mosquito has properties of self-organization, openness and parallelism which stimulate a new intelligent computing model. The main advantage is its adaptiviness in a dynamic environment which can be described with high-dimensional behavior.

A New Fruit Fly Algorithm: Taking the Financial distress model as an Example

Swarm intelligence is a naturally inspired algorithm from the behavior of animals. The new fruit fly optimization algorithm was founded by Wen-Tsao Pan in 2011[16].The properties of fruit fly such as its sensitivity vision and perception in capturing its source food is compared with a real time application with a financial distress model.

There are many optimization problem which are solved with genetic algorithm, ant colony optimization and many more algorithms but all these algorithms fails by tracking with complicated a computation process which increases the learning complexity of beginners. A new fruit fly optimization algorithm (FOA) is used for easy understanding and for the transformation from one

value to another. The FOA algorithm is used to find the maximum and minimum value in functions which repeatedly test the functions for optimization.

The FOA algorithm maps the behavior of the fruit fly for finding its food and perception. The osphresis organ in the fruit fly is used to as an sensor to detect its food it has a pungent odour from 40km away for finding its food.
The steps for finding food by fruit fly is given as below

- Step1: intiliaze the fruit fly location with respect to X axis and Y axis
- Step2: To detect the food with osphresis by a fruit fly a random value is declared.
- Step3: The origin value is declared as source since the location of food cannot be identified initially
- Step4: The odour value of the fruit fly is calculated as the fitness function
- Step5: the maximum odour concentration of the fruit fly is found
- Step6: From the best concentration odour and the position of x and y coordinate the vision of the fruit fly is used to fly towards that location.
- Step7: Repeat the steps under iteration until a superior concentration of odour is founded.

The FOA algorithm finds the food searching efficiency of the fruit fly with 10 iterative searches to find the maximum and minimum value. The disadvantage of FOA algorithm is that it has a slow performance in program execution .The advantage is it has a high convergence speed.the FOA algorithm is used in the financial distress model with the historical data of 100 companies and it is optimized by a general regression neural network.

Table 1: Comparison Table

S.No	Name of the Algorithm	Representation of the Algorithm	Operators	Applications	Merits	Demerits
1	Firefly algorithm with chaos	Chaotic Variables	Distance, attractiveness	Chaotic Map	Increase the Speed, Brightness	One Dimensional Random Variable
2	Krill Herd: A new bio-inspired optimization algorithm	Fitness Evaluation	Induced Motion, Foraging Motion, Physical Diffusion	Travelling Salesman optimization problem	Outperformance and less time interval	Random searching is not available
3	The Lion's Algorithm: A New Nature-Inspired Search Algorithm	Territorial	Crossover, Mutation, Gender Grouping	Unimodel, Multimodel and real time search problem.	Minimize the cost function, very less time consuming and reliable.	Solution space is highly varied.

Table 1: Comparison Table

S.No	Name of the Algorithm	Representation of the Algorithm	Operators	Applications	Merits	Demerits
4	Intelligent water drops algorithms	Dynamic of River Systems	Velocity, soil	Travelling Salesman Problem, Knapsack, N-Queen, NP Hard	Open source for modification.	Difficult to implement
5	Multi-Objective Flower Algorithm for Optimization	Population of flower	Weighted sum method with random weight	Solving multi-objective design problem	Very efficient with an exponential convergence rate.	Experiment done only on preliminary parametric.
6	A Novel Bio-Inspired approach based on the behavior of Mosquitoes	Artificial mosquitoes	Microcosmic and macroscopic action.	Travelling salesman problem,	Powerful processing ability, flexibility	Suitable for few application only
7	A New Fruit Fly Algorithm	Food finding	Osphresis and vision	Neural Network	Efficient to find the maximal and minimal value, easy to understand and easy to program	Not implemented in all application

CONCLUSION

This paper presented the investigation report on algorithms for Swarm Intelligence bio-inspired algorithms. Recently developed swarm intelligent algorithms are detailed in this paper to suggest optimized solution to solve every critical proplems at less cost and less complexity with high performance. Available swarm intelligent algorithms are tabulated in this paper.

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