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AI Revolution and Swarm Intelligence

Shafiqul Abidin
HMR Institute of Technology & Management, GGSIP University, Delhi, India

***Abstract*—** In the modern era of information technology, artificial intelligence is spreading its scope merely in various area . So swarm intelligence is prominent concept comes under the category of artificial intelligence [1]. The term Swarm intelligence was first given by Gerardo Beni and Jing Wang in 1989. It was developed from Cellular Robotic System point of view. It is a concept of collective behavior of Self- Organised, Decentralised system , natural or artificial. So basically this paper deals with the way in which various natural organisms behave whenever they are in group and their, this behavior provides us with the inspiration of solving many computational problems. So this paper on SI briefly describes the various algorithms, fall under the category of SI and various applications in which these algorithms can be fruitful. Also it clearly tells about the various future related works that can lead to a new revolution in the field of AI.

Keywords— ACO - Ant Colony Optimization, AI, Artificial Intelligence, BCO – Bee Colony Optimization, Cellular Robotic System, EC- Evolutionary Computing, SI- Swarm Intelligence.

I. INTRODUCTION

As we know that nature has provided every organism with some sort of intelligence. So from the very starting, nature is providing inspiration to computer scientist and researchers in enormous way. Out of these, behavior of natural organism whenever they are in group can be treated as a magnificiant way to solve many existing computational problems, and this is what we understand from the concept of SI [2].

So basically swarm can be considered as a group of large number of homogenous, simple agents. These agents are interacted locally and with surrounding environment. By this way there is no scope for allowing emerging of global behavior. Due to this reason SI is classified as new and modified branch of AI which is used for monitoring the collective behaviour of various social swarms in nature. For example:- ant colonies, bird flocks, glow worms, bats and honeybees.

However, these social interactions among the swarm agents can be further treated as direct and indirect [3]. For example:- if we talk about direct interaction that it can be a waggle dance of honeybees and on the other hand pheromone trails of ants can best explain the indirect interaction. After carrying out various researches on the behaviour of social swarms , G. Beni and J. Wang in the year of 1980 proposed the concept of SI. They took under the consideration of their interaction among themselves and their coordination for carrying out some important task that are vital for their daily life.

Further with the more researches in the field of AI several algorithms comes under the existence although we have EC which in actual a class of various algorithm which are based on the biological behavior of the organisms in the particular population. So SI is treated as an offspring of EC where the soul reason was to action of group. Further in this all the algorithms are generated with many researches which proves really fruitful and efficient in solving many computational problems in a quick and efficient manner.

II. SWARM INTELLIGENCE ALGORITHM

A. Particle Swarm Intelligence

It is an algorithm in which an optimal solution of a problem is found . This algorithm deals with creating initial particles and allotting initial velocities to them . It determines the heuristic function at each location of the particle and then evaluates the best that is lowest or optimal function value and the optimal location. It then selects new velocities according to current velocity, location of the particle and its neighbours.

It recursively finds and updates the particle location ,velocities and neighbours until it reaches end.

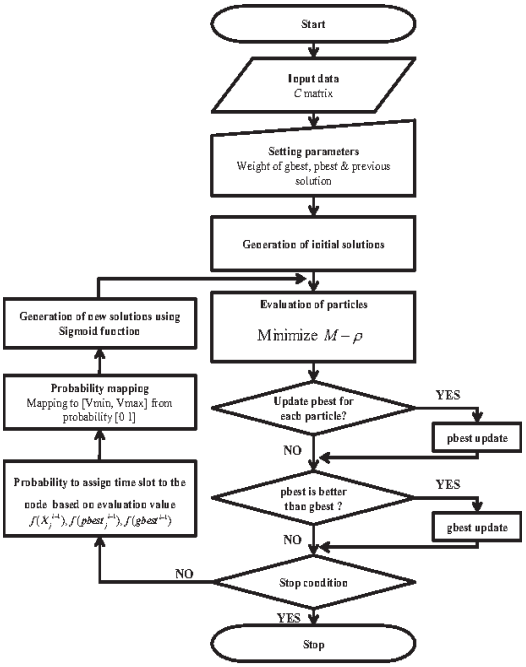

Fig. 1. Flow Chart of Particle Swarm Optimization

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B. *Ant Colony Intelligence*

This algorithm is modeled on the concept of nature of ants looking for food. Optimal locations is achieved by wondering arbitrarily by artificial ants. When an ant finds a source of food it get back to the colony leaving "markers" (pheromones) that represents the root of the food.

These markers are followed by fellow ants. They form a colony until ants' stream looking for sources of food nearby their colonies.

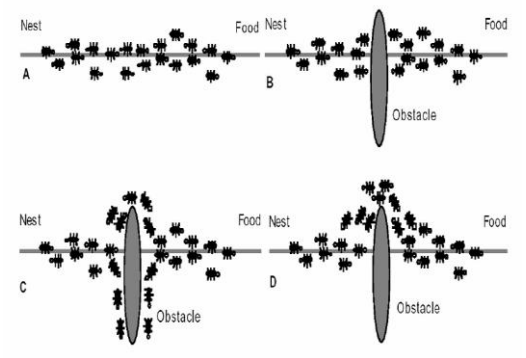

Fig. 2. Foraging Behaviour of Ants

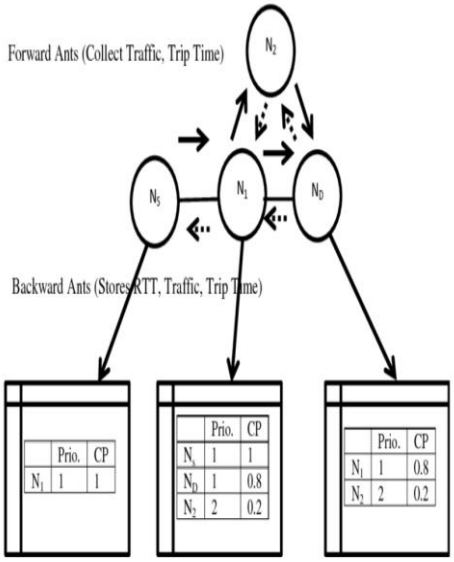

Fig. 3. Flow Diagram of Ants Movements and Functionality [11]

C. *Artificial Bee Colony Optimization*

BCO is based on the behavior of the bees searching for food. It consists of three phases – employed bee, onlooker bee and scout bee [4].

A group of honeybees is known as swarm which can complete tasks through mutual understanding. The employed bees roam around the food source and searc hes for the food in their memory. At the same time they also share information of these food sources to the onlooker bees. The onlooker bee finds and selects the optimal food sources from all the available sources. The onlooker bee selects that source which has a higher fitness rather than one having low fitness.

The scout bees are made from the employed bees, which surrender their food sources and go for the new ones.

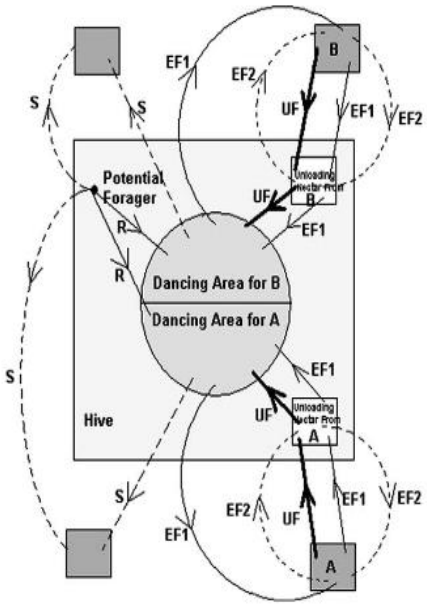

Fig. 4. Behaviour of Honey Bee Foraging for Nectar [12]

D. *Artificial Immune System*

Basically artificial immune system uses the abstract structure. The main function is to computational system and investigating the application in order to solve through engineering mathematics and IT [4].

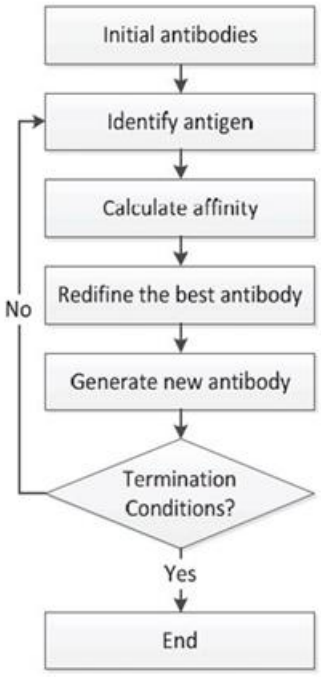

Fig. 5. Artificial Immune System

E. *Bat Algorithm*

This algorithm is inspired and created from the behavior of microbats in which they use echoes or reflected sounds to detect objects by different rates of pulses that include loudness and emission.

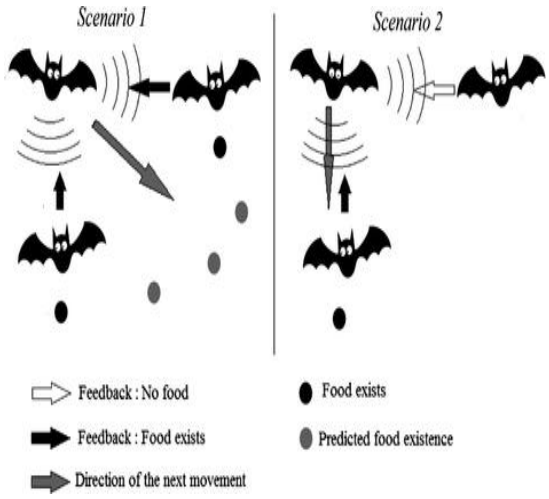

Fig. 6. Bat Algorithm and Directional Bat Algorithm [13]

F. *Differential Evolution*

It is a method which finds an optimal solution of a problem by recursively trying to modify and improve the candidate solution to a given measure of quality. This algorithm can make only few or no assumptions about a problem that is why this algorithm is a meta-heuristic algorithm [5]. This algorithm uses multiple agents to carry out the search.

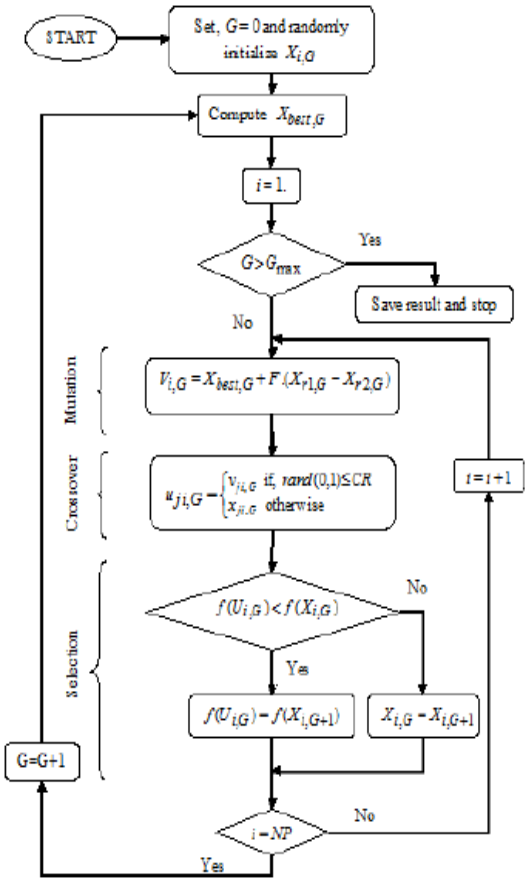

Fig. 7. Flow Chart Differential Evolution

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G. Glow worm Swarm Optimizationn

This algorithm uses glowworm as agent to carry out the search. This glowworm algorithm carry a light that cannot be attributed merely to the temperature of the emitting body (luminescence quantity) called luciferin. The glowworms calculate and encode their present position evaluated with help of objective function. It then identifies the position and movement of its neighbours using a probabilistic mechanism [4].

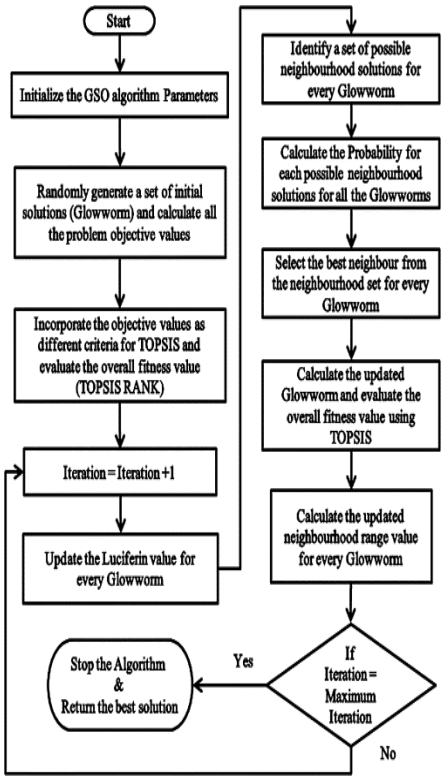

Fig. 7. Flow Chart Glow Worm Swarm Optimization

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H. Multi-Swarm Optimizationn

It uses many sub-swarm rather than one single standard swarm. Each and every sub-swarm is allotted a region and it focuses only on that region whereas this specific variety (diversifying) method decides where and when to launch the sub-swarms.

It is a self-adaptive and cooperative optimization problem [6]. Here multiple (local) optima exist in which multi-swarm framework is fitted for the optimization on multi-modal problems.

III. APPLICATIONS

With the computer revolution, the concepts are drastically being changed particularly - communication, transportation, industrial production , administration, writing and book keeping , technological development, amusement whereas existing system including hardware and software cannot tackle some problems as computing task which have to be well understood, reasonably expectable and quantifiable within time frame.

There are some alternatives to this:

- Chemical Computation (DNA based)

- Quantum computing (quantum physical computation).
- Bio-computing (simulation of biological mechanism) [7].

There are various fields of application of SI. In each and every corner of the world, there is a need of a system which is artificially intelligent enough to tackle any type of problem depending upon the type of inputs. In this paper, we have mentioned various applications which are listed below [8]:

- Combinatorial Optimization Problems.
- Scheduling Problems.
- Image Analysis.
- Data Mining.
- Bio Informatics.
- Medical Information.
- Industrial Problems.
- Travelling Salesman Problem.
- Functional Optimization.
- Finding Optimal Routes.
- Machine Learning.
- Dynamical Systems.
- Operational Research.
- Sequential Ordering Problem.
- Assignment Problem.
- IRIS Recognition.

These applications are implemented with the help of various algorithms like ACO(Ant Colony Optimization), PSO(Particle Swarm Optimization) and many more.

IV. Future Scope

As discussed in the paper, various algorithms have various implementations and applications so it can have variety of more applications by overcoming with its limitations to get the desired and quick output as the changing era of computer revolution due to the human societies. SI, if combined with the field of robotics, can perform much better and provide us more beneficial output by overcoming few drawbacks. Here are some examples:

- For controlling unmanned vehicles, US Military is searching a swarm technique.
- Use of swarm technology for planetary mapping by NASA.
- Possibility of using SI to control nanobots for killing cancer.
- Use of stochastic diffuse to locate tumors.
- ESD investigating about orbital swarm interferometer and self-assembly.

V. Conclusion

At the end, we came at a conclusion that Swarm Intelligence is far better than Natural Sciences, Complexity Theory, Adaptive Algorithms, Artificial Life in the field of Inspiration, Identification, Application and Verification. Due to the existence of various additional algorithms

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