A Survey on Artificial Bee Colony Approach from Swarm Intelligence

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Abstract –
Bee System was identified by Sato and Hagiwara in 1997 and the Bee Colony Optimization (BCO) was identified by Lucic and Teodorovic in 2001. Bee colony optimization act as an agent of swarm intelligence. Swarm intelligence is the part of art ificial intelligent based on the study of actions of individuals in various emergent collective intelligence of groups of simple agen ts decentralized systems Swarm intelligence can be defined as the Swarm intelligence is used in wireless sensor network to manipulate various problems of WSN such as optimal deploym ent, node localization, clustering and data-aggregation.

Keywords -
Bee colony, Swarm Intelligence (SI), Bee Colony Optimization (BCO), Artificial Bee Colony Optimization (ABC).

I INTRODUCTION

The BCO is inspired by the bee's behavior of nature. The basic idea behind the BCO is to create multi agent system (colony of artificial bees) capable of successfully solve the complex combinational optimization problems. The Artificial bee colony behaves partially alike and partially different from bee colonies in nature. Bee colony optimization act as an agent of swarm intelligence. Swarm intelligence is the part of artificial intelligent based on the study of actions of individuals in various decentralized systems. Swarm intelligence can be defined as the emergent collective intelligence of groups of simple agents. Swarm behavior is one of the main characteristics of social insects (bees, wasps, ants, termites). Communication between the individual's insects in a colony of social insects has been well known.

II BEE COLONY

Self-organization of bees is based on a few relatively simple rules of individual insect's behavior. In spite of the existence of a large number of different social insect species, and variation in their behavioral patterns, it is possible to describe individual insects' as capable of performing a variety of complex tasks (Camazine and Sneyd [1]).In a real bee colony, some tasks are performed by specialized individuals. These specialized bees try to maximize the nectar amount stored in the hive using efficient division of labor and self-organization. The minimal model of swarm-intelligent forage selection in a honey bee colony which the ABC algorithm simulates consists of three kinds of bees: employed bees, onlooker bees and scout bees. Half of the colony consists of employed bees, and the other half includes onlooker bees. Employed bees are responsible for exploiting the nectar sources explored before and giving information to the waiting bees (onlooker bees) in the hive about the quality of the food source sites which they are exploiting. Onlooker bees wait in the hive and decide on a food source to exploit based on the information shared by the employed bees. Scouts either randomly search the environment in order to find a new food source depending on an internal motivation or based on possible external clues [2]. In a natural honey bee hive there are a variety of bees with specific role(s) to play. There are three types of bees [3]:-

I. Female Queen Bee:-

There is only one Queen of a bee colony. She is responsible for laying eggs which are used to build new colonies.

II. Male drone bees:-

There are many drone bees of a colony. They mate with the Queen to build new colonies.

III. Worker bees:-

There are thousands and thousands of worker bees. These perform all the maintenance and management jobs in the hive. There are two types of worker bees, namely Scout bees and Forager bees, which perform the Scout scenario and Forager scenario respectively, which are collectively responsible for the development of the honey bee colonies.

Fig:-2.1 Bee colony

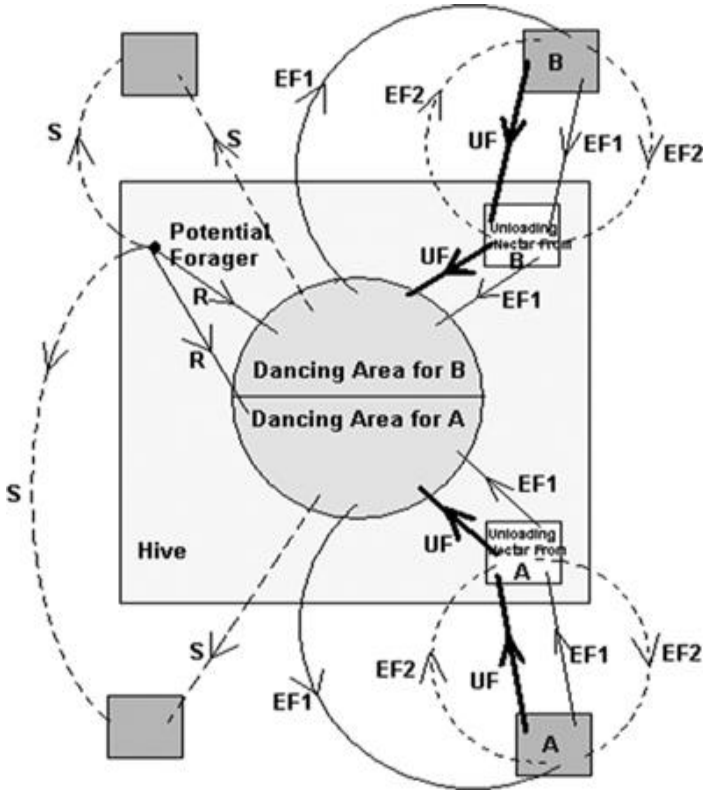

Fig:-2.2 Behaviour of honeybee foraging for nectar.

III SWARM INTELLIGENCE

Swarm intelligence can be defined as the measure introducing the collective behavior of social insect colonies or other animal societies to design algorithms or distributed problem-solving devices [4].
Or
"Swarm intelligence can be defined as the emergent collective intelligence of groups of simple agents.

Why is Swarm Intelligence interesting for IT?

Analogies in IT and social insects

- Distributed system of interacting autonomous agents.
- Goals: performance optimization and robustness.
- Self-organized control and cooperation (decentralized).
- Division of labor and distributed task allocation.
- Indirect interactions.

Two principles in swarm intelligence:

- **Self-organization is based on:**
  - Activity amplification by positive feedback.
  - Activity balancing by negative feedback.
  - Amplification of random fluctuations.
  - Multiple interactions.
- **Stigmergy - stimulation by work - is based on:**
  - Work as behavioral response to the environmental state
  - An environment that serves as a work state memory
  - Work that does not depend on specific agents.

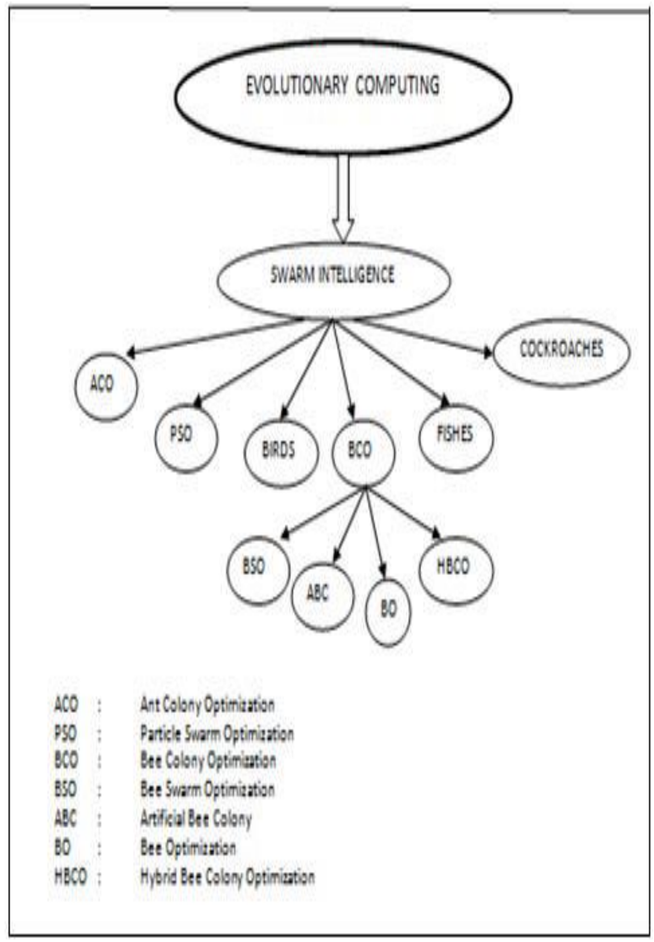

Figure 3.1: Hierarchical representation of Evolutionary Algorithms [5].

IV ARTIFICIAL BEE COLONY

Artificial Bee Colony approach under the category of Swarm Intelligence. The Artificial Bee Colony (ABC) algorithm, proposed by Karaboga in 2005 for real parameter optimization, is a recently introduced optimization algorithm which simulates the foraging behavior of a bee colony [6]. All artificial bees are located in the hive at the beginning of the search process. During the search process, artificial bees communicate directly. Each artificial bee makes a series of local moves, and in this way incrementally constructs a solution of the problem. Bees are adding solution components to the current partial solution until they create one or more feasible solutions. Using the analogy between emergent intelligence in foraging of bees and the ABC algorithm, the units of the basic ABC algorithm can be explained as follows:-

I. Producing Initial Food Source Sites:

If the search space is considered to be the environment of the hive that contains the food source sites, the algorithm starts with randomly producing food source sites that correspond to the solutions in the search space.

II. Sending Employed Bees to the Food Source Sites:

As mentioned earlier, each employed bee is associated with only one food source site. Hence, the number of food source sites is equal to the number of employed bees. An employed bee produces a modification on the position of the food source (solution) in her memory depending on local information (visual information) and finds a neighboring food source, and then evaluates its quality.

III. Calculating Probability Values Involved in probabilist ic selection:

After all employed bees complete their searches, they share their information related to the nectar amounts and the positions of their sources with the onlooker bees on the dance area. This is the multiple interaction feature of the artificial bees of ABC. An onlooker bee evaluates the nectar information taken from all employed bees and chooses a food source site with a probability related to its nectar amount. This probabilistic selection depends on the fitness values of the solutions in the population.

IV. Food Source Site Selection by Onlookers Based on the Information Provided by Employed Bees:

In the ABC algorithm, a random real number within the range [0,1] is generated for each source. If the probability value associated with that source is greater than this random number then the onlooker bee produces a modification on the position of this food source site by using as in the case of the employed bee. After the source is evaluated, greedy selection is applied and the onlooker bee either memorizes the new position by forgetting the old one or keeps the old one. If solution x_i cannot be improved, its counter holding trials is incremented by 1, otherwise, the counter is reset to 0. This process is repeated until all onlookers are distributed onto food source sites.

V ALGORITHM

I: Using scouts to find initial food sources
II: **repeat**
III: Send employed bees to food sources
IV: Calculate food source probabilities for onlookers
V: Send onlooker bees to food sources
VI: Stop exploitation of exhausted food sources
VII: Send scouts to discover new food sources
VIII: Memorize the best food source so far
IX: **until** Requirements are met.

Pseudo-code for Artificial Bee Colonies algorithm [7]

VI SCOPE OF BEE COLONY OPTIMIZATION

Bee Colony Optimization algorithms are widely being used to solve problems belonging to diverse domains [8]. It has been used to solve certain bench mark problems such as:-

I. To Solve Complex Transportation Problem:-

In this application [9] BCO has been used to solve transportation problem using ride-matching problem. This paper presents the BCO concept discussing the social insects' behavior and flexibilities in these colonies. Then it talks about natural bees focusing on their self-organizing behaviors and patterns. Then they have discussed the BCO Meta heuristics in which the agent that is the artificial bees has been introduced. They collaborate with each other to find solution to different combinatorial optimization problems.

II. MANET- Routing Protocol :-

In this a Bee-inspired routing protocol for Mobile Adhoc network (MANET)[10] has been presented. The algorithm developed here is a reactive source routing algorithm which consumes less energy as compared to conventional mobile adhoc routing algorithms. In this work the Bee-Adhoc algorithm has been used to route mobile adhoc network. The Bee-Adhoc algorithm was identified as an algorithm with major savings in energy of consumption packets.

III. Fault Based Test Suite Prioritization:-

In this work [11] the scouts and forager's food foraging scenarios have been mapped to prioritize the test suite. A well organized algorithm has been presented with brief explanation of all its steps. It has been designed in two parts for scouts and foragers. The algorithm has been explained using two examples and the values have been compared using APFD metric.

IV. Solving Sudoku:-

Here in a BCO [12] has been developed to solve Sudoku puzzles which are NP-hard problems. A Sudoku is a logical 2D array in row, column, and diagonal without being repeated. The algorithm mimics the method through which bees forage food. The results obtained have been used to solve Sudoku puzzles more efficiently and effectively.

V. Problem Solving Mechanism:-

In this method [13] the two broad behaviors via the self-organized decision making behavior of bees inside the hive and the problem solving behavior of bees outside the hive have been separated. These separations have been understood, studied and exploited to solve problems in wide variety of domains. The domains solved using the proposed BCO concepts are web searching problems, function optimization problems and hierarchical optimization problems.

VI. Engineering Optimization:-

In the shortcomings of multilevel optimization compared to biology-inspired algorithm has been compared. Here, a Virtual Bee Algorithm (VBA)[14] for solving the engineering problem's function optimization has been presented Etc.

VII. Accident Diagnosis:-

In this research work [15] the BCO has been applied to a new search algorithm capable of locating good solutions efficiently and within a reasonable running time. In the proposed algorithm the food foraging behavior of bees have been mapped to find solution of the problem. It is a population –based search algorithm. Initially the algorithm performs search randomly in synchronization with the neighborhood search. Next a new event classification system step is followed in which the algorithm centroids to the best solution and correctly identifies an accident in a nuclear power plant. Then the comparison and analysis of the proposed algorithm has been performed with other population-based algorithms and the proposed algorithm has been found to be more efficient and with an advantage of having fewer control parameters. The algorithm was implemented in MATLAB.

VII CONCLUSION

Swarm intelligence based approaches are used in the Wireless sensor network and preferred than others. It is used to perform the reliable packet delivery over the network BCO(Bee Colony Optimization) approach is one of the agent of swarm intelligence. BCO is preferred in WSN because of its applications like to solve complex transportation problem , MANET- Routing Protocol , Fault based Test Suite Prioritization , Solving Sudoku , Problem Solving Mechanism , Engineering Optimization etc..

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