Agent Based Improvised Artificial Bee Colony Algorithm for Network Routing

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***Abstract*— The aim of this paper is to implement an algorithm to find the shortest and the most optimal path in network routing, by using one of the Swarm Intelligence algorithms - Artificial Bee Colony(ABC) Algorithm. It discusses the improvisation required for the existing ABC algorithm to obtain best results for network routing. The implemented algorithm overcomes the defects of native ABC algorithm by implementing a prior learning and Information Learning on the native ABC algorithm. The technique of Information learning incorporated here is Multi population strategy, which along with a prior learning on QoS metrics are applied to get the most optimized source to destination paths. This implementation depicts that the improvised ABC algorithm improves the efficiency by finding better and optimized results than the existing ABC algorithm.**

Keywords—Artificial Bee Colony;Information Learning;Multi Population;

I. INTRODUCTION

Routing is the process of selecting paths in a given network along which to send the traffic. It is one of the important aspects of network communication which plays a major role in affecting the performance of any network, because other parameters of the network like reliability, congestion and throughput depend directly on it. With the enormous amount of data flow occurring on the Internet in addition to the conventional routing mechanisms, there are several scenarios for increased bottlenecks in the routing paths[1]. A network bottleneck results in slow communication speeds and limits user efficiency and productivity on a network. In order to improve the network routing there is a need for implementation of optimization techniques for the existing paths. The main challenges faced in obtaining an efficient routing path are various factors like increased operational costs, vessel utilization and reducing transport time have to be considered. Since many engineering and scientific fields involve these optimization issues, researchers pay greater attention to optimization techniques such as Swarm Intelligence.

Swarm intelligence (SI) is defined as the collective behavior of decentralized and self-organized swarms [2]. Some of the well known examples for these swarms are fish schools, bird flocks and the colony of social insects such as ants, bees and termites. The Artificial Bee Colony (ABC) algorithm is a swarm based meta-heuristic algorithm for optimizing numerical problems inspired by the intelligent foraging behavior of honey bees. The comparison results demonstrated that ABC is better than or at least comparable to the other EAs, such as GA, differential evolution (DE), and PSO [3].

Due to its simplest nature and efficiency ,ABC is preferred over EA,GA,DE and PSO.Exploitation and Exploration are the two main characteristics of ABC.One possible limitation with the normal ABC algorithm is that for a given bee colony ,the colony always tends to maximize exploitation and restricting exploration. Since exploration is also one of the important features of ABC algorithm, there exist a need to improvise the existing ABC algorithm to balance between Exploration and Exploitation processes to obtain better performance [4]. There are several learning mechanisms that can be used to improvise the results of ABC algorithm, out of which this paper focuses on Information Learning technique. Basically the whole population is been divided into several sub populations so that it can assign different individuals to different sub regions. So the whole population is divided into different groups and different sub regions and hence every neighbour's information can be improvised [5].Due to this independency there may be chances of inappropriate and inefficient solution to the given problem. Thus this can be solved by hence implementing multi population technique and agent based learning.

The rest of the paper contains the following sections. Section II briefly covers various topics like Network Routing, Learning Mechanisms, Bio Inspired Algorithms, Artificial Bee Colony algorithm .In Section III, the native ABC algorithm is explained. Section IV contains the existing improvisation of Information Learning. Section V depicts our proposed system supported by a flowchart. Section VI gives the implementation details of our proposed algorithm. Sections VII and VIII are the results of our paper and conclusion respectively.

II. LITERATURE REVIEW

A. Network Routing

Network Routing is the process of forwarding data packets from the source to destination. A mobile ad hoc network

(MANET) is a continuously self configurable network of wirelessly connected mobile devices [6]. Routing in mobile ad hoc networks is broadly classified as Reactive (on Demand) and Proactive (Table Driven) Protocols. Reactive protocols set up routes on demand. In the Ad-Hoc On-Demand Distance Vector (AODV) reactive routing protocol, the topology information is sent by the nodes on-demand to only those nodes to which it wants to establish a route. Proactive protocol like the Destination Sequence Distance Vector or DSDV maintains a list of all the destinations and their routes, by sending routing tables throughout the network in a periodic manner. However both the protocols are not highly scalable since they result in traffic overhead due to increased mobility. This drawback can be overcome by Improved Artificial Bee Colony Algorithm as described in the following sections.

B. Learning Mechanisms

Learning is a process of modifying the existing or acquiring new knowledge and behaviors. The ability of learning is acquired by all living creatures including human beings and some machines. There are many types of learning mechanisms out of which they are broadly classified into Supervised and Unsupervised Learning. From their names only it is evident that Supervised learning is a task of inferring outputs from the supervised trained data [7].This supervised trained data is under the supervision of supervisor or trainer. Using this trained data set learning can be easily implemented to any test data to obtain an optimal solution. On the other hand, under Unsupervised learning algorithm, results are inferred from datasets without labeled responses or classes [7].

C. Bio Inspired Algorithms

Optimization plays a significant role in solving complex mathematical problems in engineering. Optimization algorithms can be categorized as deterministic and stochastic in nature. The former method requires an enormous computational effort which tends to fail as the size of the problem increases, which is a motivation to employ bio inspired algorithms[5].These algorithms are a motivational approach for employing computationally efficient alternative models for deterministic approach. Also they are a problem solving methodology derived from the structure, behavior and operation of natural system and remarkably flexible and adaptable nature. The significant beauty in nature inspired algorithms is that it receives its sole inspiration from nature, they describe and resolve complex relationships from intrinsically very simple initial conditions and rules with little or no knowledge of the search space.

Bio inspired computing is efficient in solving problems of almost all areas, including computer networks, data mining, power systems, image processing, security, control systems, robotics and many more.[8]

III. ABC AND RELATED WORK

A. Original ABC

Artificial Bee Colony Optimization is inspired by the behavior of bees in nature [9].This solution search process is a step by step iterative process. The colony of artificial bees contains three groups of bees: onlookers, employed bees and scouts. A bee which is waiting in the dance area, making decision to choose a food source is called Onlooker bee. The one which is going to the food source visited by it before is called a employed bee and the one that carries out random search for new food sources is called a Scout. The food source location corresponds to a possible solution to the optimization problem and the nectar amount corresponds to quality of the solution. For every food source, there is only one employed bee[2]. An employed bee makes modification on the position in her memory depending on the local information and tests the nectar amount of the new source. The employed bee whose food source is exhausted by the employed and onlooker bees becomes a scout. If the nectar amount of the new food source is higher than the previous one, then the employed bee memorizes the new position and forgets the old one[10]. After completing the search process, they share the nectar information of the food sources and their position information with the onlooker bees in the dance area[10]. The search process of ABC has three major steps:

I) Employed bees are sent to a food source and their nectar quality is estimated

II) food sources are selected by Onlooker bees based on information collected from employed bees and estimate their nectar quality

III) scout bees are determined and are employed on possible food sources for exploitation.

The position of the food sources are selected by the bees at the initial stage and their nectar qualities are measured. The employed bees then communicate the nectar information of the sources with the onlooker bees waiting at the dance area within the hive.

The main steps of the algorithm are as below:

1: Initialize Population
2: **repeat**
3: Place the employed bees on their food sources
4: Place the onlooker bees on the food sources depending on their nectar amounts
5: Send the scouts to the search area for discovering new food sources
6: Memorize the best food source found so far
7: **until** requirements are met. [3]

B. Drawbacks of Original ABC

- As from the above working of the Artificial Bee Colony algorithm it is evident that the algorithm provides efficient results in exploration processes at the cost of exploitation process.

- For a given bee colony, best results are obtained only for exploration of food source and exploitation process is not that efficient.
- So there exists a need for an improvisation for this existing system which is the purpose of this paper.[4]

IV. Existing Improvisations

To overcome the drawbacks as mentioned above, many improvisation techniques were applied to the original ABC algorithm. One of the techniques used was Information Learning mechanism on the original ABC algorithm. This mechanism employs the Multipopulation Strategy which is described in detail as follows. [5].

A. Multipopulation Stratergy

Initially the given population is been divided into a number of sub populations, where each of the sub population also known as a region. Each of the sub population will search for source and destination in that given sub region [5]. If a solution is not found, then the search area is expanded to other regions. This eliminates the effort of searching through a larger space when the network route is local to the region.

V. Proposed System

From the above seen Literature Review and ABC related works, it was evident that there is a need for an improvisation for the existing algorithm. When ABC algorithm with Information Learning (ILABC) is implemented on network Routing to obtain optimized results, it will be inefficient to apply it on all paths becomes its time consuming and also waste of resources allotted. Therefore the proposed system implements a prior learning before implementing ABC to improve the efficiency. This prior learning includes selecting all possible paths based on the QoS constraints set by the user. The QoS metric used for this system is bandwidth. Higher bandwidth is preferred for optimized results since more data can be sent on such paths. Thus this proposed system improves efficiency according to the user requirements.

VI. IMPLEMENTATION

Our application which uses artificial bee colony algorithm for routing is region based, where the employee bees are the nodes, the food sources are the routing paths, the onlooker bees find the paths from the specified source to destination from the information collected from the employee bees. The neighbouring nodes are determined and if the paths from the neighbouring nodes are exhausted scout bees perform the

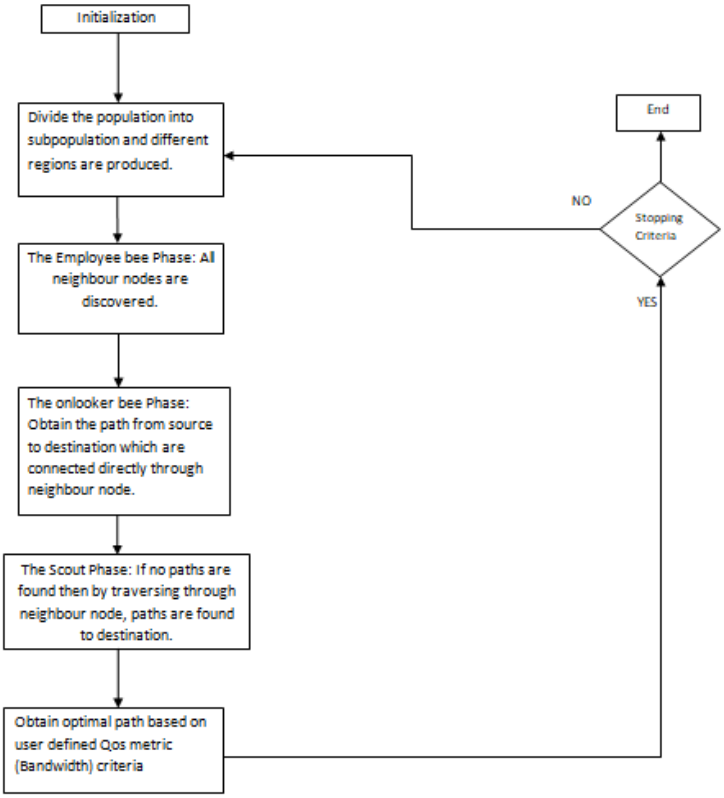

Fig. 1. Flowchart of the working of the proposed system.

random search for the destination nodes by determining its neighbouring nodes. Hence, the initial step in our application is creation of the nodes by specifying the distance and the range. JavaFx which is used for creating the user interface for desktop applications is used to create the graphical user interface for our application. Each node has a specific node name, port number, system name, user specified distance and range, the destination port number to be specified by the user and the list of neighbouring nodes. Each node will determine its neighbouring nodes using the Euclidean's distance and groups the neighbouring nodes into regions. Depending on the distance and the range given by the user, it determines the neighbouring nodes and a list of all its neighbouring nodes will be displayed in each node. We are using multicast ip routing protocol to distribute the data to multiple recipients.

Shortest and best path is discovered for routing the information. The path has to be found to send the data from source to destination. In Onlooker phase, source node will discover if its neighbour node has destination node as its neighbour to find path. If it is present then direct path is found. If no path is found then scout phase is initialized and path discovery is done by checking if each neighbour node has destination node and bandwidth of each node is added. All paths are discovered which connects source to destination

node. Best and optimized path is selected from all paths based on QoS metric Bandwidth. The path with highest bandwidth is selected to send data. User will select the data which needs to be sent from the source to destination following which the data will be sent using the best path. Data will bind to the destination node when size of hop count is equal to zero. Based on bandwidth the optimized path is found.

Following are the snapshots of the implementation of Improvised Agent Based ABC.

Fig. 2. Node initialisation screen.

Fig. 3. Route request module.

VII. Results

The implementation of our proposed algorithm, Improvised ABC using agent based learning involves two main concepts : Multipopulation Strategy and QoS metric learning. The multipopulation strategy aids in dividing the network into regions so that local routing can be performed faster. Routing between regions is the next level of search that is executed. This eliminates a global search that may be performed even if the routing needed is local. The QoS metrics taken under consideration here are bandwidth and delay. The total available bandwidth for a path is calculated simply by summation. The path with the maximum available bandwidth or less overall delay is chosen as the preferred path and the data packets are sent along that route. This is how native ABC is improvised by our proposed algorithm.

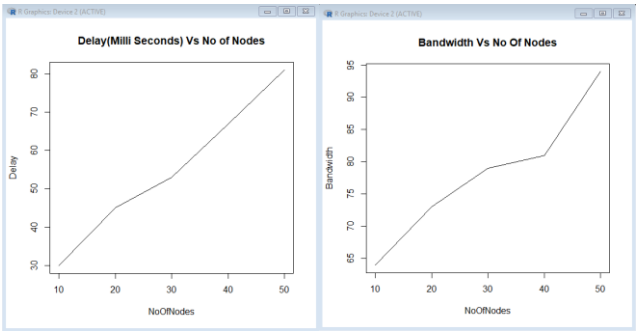

Fig. 4. Performance analysis with delay and bandwidth respectively.

The above line graphs depict the linear dependency of Delay and Bandwidth on the number of nodes in the routing network.

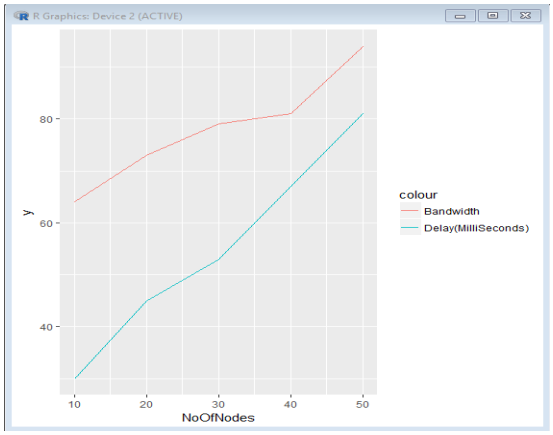

Fig. 5. Performance analysis with delay and bandwidth on the same scale.

From the observation, we can say that both the parameters are directly proportional to the number of nodes. So in selection of an optimal path, higher bandwidth and lesser delay is preferred.

VIII. Conclusion

The original ABC Algorithm performs the exploration process well, but is not so efficient in the exploitation of the resources. This is handled by the Artificial Bee Colony Algorithm with Information Learning. Information Learning on Artificial Bee Colony implements the multipopulation strategy by dividing the population into many subpopulations or regions. The learning within a subpopulation and between subpopulations is based on the QoS metrics of choice. This optimal solution can be obtained by implementing the learning prior to ABC algorithm where all the paths satisfying the threshold value defined by the user based on the QoS constraints are satisfied. This reduces the load on the ABC algorithm as few routes have already been eliminated based on the QoS constraint. So ABC algorithm is then run on fewer nodes to find the optimal paths in a lesser duration and in a more efficient manner.

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