A Survey On Swarm Intelligence

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ABSTRACT

Swarm Intelligence is a branch of Artificial Intelligence which deals with a consolidated measure of different groups that act upon a complex problem. Swarm here refers to groups of (insects) bees, ants, termites and flock of birds etc. This intelligence has been inspired by the behaviour of these swarms i.e. how efficiently and effectively they can do tasks as a group which are difficult for an individual insect to perform. It has been used in various fields of computer science for obtaining an optimized solution of a complex problem. In this paper, we are giving a brief on swarm intelligence concept followed by various algorithms that are based on this concept.

Keyword: - *Swarm intelligence, PSO: particle swarm optimization, ACO: ant colony optimization.*

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1. INTRODUCTION

A swarm is a group of identical insects or animals that interact with each other and their environments to perform a complex task. These swarms do not have a central control and communicate through their surroundings. Each individual system (insects) has limited intellectual capabilities, so they interact in a well organized manner to perform a complicated task. They communicate in two ways –indirect and direct. In direct communication they interact through audio or visual modes and in indirect communication they interact by changing their environments i.e., an individual system change its environment and accordingly other individuals respond to it [1]. Many insects like ants, bees and termites search their food but uses different approaches for the same .As in ant's swarm, the ants search for the shortest distance to reach to its food with the help of a chemical substance called pheromones. This is an example of indirect communication in such systems. Also, in bees swarm, there are scout bees which searches for rich food sources by performing a dance that directs other bees towards the rich food source. This is an example of direct communication in swarm intelligence. As a whole, swarm intelligence(SI) is a concept that is used to design a system that is intelligent enough to perform complicated tasks by using numerous self-coordinated agents which do not have a centralized control. They provide systems that are powerful and malleable. The expression was introduced by Gerardo Beniand Jing Wang in 1989, in the context of cellular robotic systems.

SI has been successfully implemented in various disciplines of computer science like in solving problems to obtain optimized results, in domains of data analysis, in forming 3D images etc.The further sections of this research paper deals with different algorithms that are inspired by the natural behavior of swarms. We are going to summarize only two of the algorithms, the ANT COLONYOPTIMIZATION (ants swarm) and PARTICLE SWARM OPTIMIZATION (flocks of birds).There are several other algorithms as well like Artificial bee colony, Bacterial colony optimization, Bat algorithm etc. but our research comprise of only two algorithms. Section 2, 3 provides an analysis of ACO and PSO algorithms respectively. Furthermore section 4 discusses the conclusion and future scope of swarm intelligence [2].

2. ANT COLONY OPTIMIZATION (ACO)

ACO algorithm was introduced by M. Dorigo et al. He was highly inspired by the collective behaviour of ants in finding a shortest route to reach to their food source. Intellectual capabilities of ants are finite as they are simple creatures. Day to day chore of finding food sources of good quality and shortest route for such food resource is a challenging task for individual ants. They are not clever enough to manage it efficiently. On the other hand ant colonies can act intelligently to perform these tasks in more efficient, better and in an effective manner. Ants are simple and tiny creatures when seen individually but when we consider ant as colonies they are brilliant enough to respond quickly to the environmental changes.

Foraging can be used to describe the potential of ant colonies in the following manner:-

1) Individual small ant wanders to find best supply of food. They act as tiny agents to move around colonies.

2) When an agent ant is successful in finding the food supply, it returns to the nest through the path leaving behind a chemical substance known as pheromone. The direction and the depth of the pheromone can be anticipated by the ant’s long and motile antennae.

3) Otherants sense the pheromone as it is alluring and volatile in nature and hence they are forced to follow the track with pheromone.

4)This process if repeated by all the ants leave pheromone on the track and follow the same track, this will increase the strength of route.

5)Different agents can find different paths to reach to a common food source .In this case, more number of ants will travel on the shorter path in same amount of time. Due to shorter length and

increase in the number of ants the shorter path will become more fascinating as the concentration of pheromone will increase.

6) Due to volatile nature of pheromone, the longer routes will disappear after some time.

7)Thus in this manner ants will be successful in finding smaller path to obtain food source.

A -Routing algorithm for MANETS based on foraging in ant colony

Algorithm for routing in MANETS has been described by carefully imitating the foraging in ants.

Different phases of algorithm are:

1) Route discovery phase

Two agents' forward ant(FANT) and backward ant (BANT) are used to discover new routes. Pheromone track to source and destination node is established by FANT and BANT respectively. ANT holds unique sequence number and is tiny in size. Unique sequence number and source address of FANT helps in identifying the packet received by node is duplicate or not. ANT is firstly broadcasted by sources and the neighbour of sender further forwards it [3].

New entry in routing table is created after FANT is received for the first time. Each record consist of three fields and is referred to as triplet .These three field are destination address(V1), next hop (V2),and pheromone value().

2) Route Maintenance Phase

Route maintenance phase improves the node from source to destination after establishing pheromone track.In Ant routing this phase do not require any packet, over the established routes data packets are transmitted. Pheromone value on established path do not remain same, it get keeps on changing as pheromone keeps on evaporating or its concentration can increase. When V1 forwards a packet to V2, the pheromone value in the entry is increased. As the number of packets increases, there is an increase in the entry of pheromone .Thus, strengthening the route.

3) Route failure handling

Mobile and hoc networks are talked here in which nodes cause frequent route failure as they are motile in nature. Missing acknowledgement identify route failure. Once the route error message is obtained for a link,then firstly that link is deactivated by that node by setting its pheromone

value to zero. Routing table is then searched by the node to find alternate link to send the packet if it is found else inform neighbor for the error message.

3. PARTICLE SWARM OPTIMIZATION

Russell Eberhart, an electrical engineer and James Kennedy, a social psychologist introduced particle swarm optimization. PSO deals with the method in which swarms of birds search for their food or the foraging behaviour of flock of birds. PSO is considered as natural observation for three reasons. Firstly, birds can fly without collision in large groups by maintaining optimum distance between them and neighbours even if they change direction suddenly. Secondly, when they feel external threats they scatter and quickly regrouping. Thirdly, it also helps in avoiding predators.

Flocking behaviour of birds can be implemented using three simple flocking rules

1) Flocking centring

Flocking members try to fly closer to the centroid of the nearby flock mate.

2) Collision avoidance

Based on relative position flock members avoid collisions with nearby flock mates.It attempt to establish the minimum required separation distance.

3) Velocity matching

Velocity is matched with nearby flock mates.It helps to maintain such separation during flocking.

Suppose flock of birds search for a single piece of food in a particular area.Each bird follows the bird in flock which is considered to be nearest to food.Virtual birds' best position Xpbest, global best position Xgbest. For every iteration, the velocity and position of the birds is modified using the following equations:-

$V'=V+C1\text{-}R1\ (pbest\ -X)\ +C2.R2\ (gbest-X)$

$X'=X+V$

Where V and V' are current and new velocities, X and X' are current and new positions, C1 and C2 are acceleration coefficient, R1 and R2 are distributed random variables.

Considering behaviour of birds,considering particle at random position and taking particle as a solution in the search space for the problem.

Algorithm is as follows:-

1)Random velocities and positions is initialise to each particle.

2)Each particle cost is computed and if current cost is less than the best value it is termed as Pbest.

3) Position of particle that has lowest cost is termed as gbest

4)For each particle find new velocity and position.

Steps 3, 4 are repeated to get maximum iteration and minimum error criteria..

4. CONCLUSION

In this paper we have briefed about swarm intelligence concept and its two most popular optimization algorithms, ACO and PSO. These algorithms provide a beautiful idea that how the nature of swarms can be used to solve our real –life problems by providing us with optimized results. They are the most appropriate variants of swarm intelligence. Firstly, we found this topic both new and exciting. It was a bit demanding and an elaborate concept which we have tried to concise in this research paper. Secondly, it was so engaging to learn about the collective social behaviour of swarms.
The various conclusions that we have made are as follows:

- Nature has proved to be an inspirational source for the field of computer science as it is rich in various resources.
- SI is an intelligent subfield of Artificial intelligence that has been spread in various disciplines of computing.

10. REFERENCES

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