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ORIGINAL ARTICLE

SOLVING SHORTEST PATH PROBLEM BY SIMULATING EURYGASTER LIFE

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ABSTRACT: shortest path problem is mainly used in computer network, communication and transportation. The primary goal of this problem is finding minimum value between two nodes of graph in term of time, cost or distance. In this paper a new method based on the behavior of eurygaster is used to solve shortest path problem. In this method the search space of problem is divided into several partitions and each partition is investigated separately. Also, several eurygasters settle on each partition and after searching whole of partition space migrate to another partition or section. Each eurygaster is a solution for the problem and the best eurygaster is absolute solution. The evaluation results of applying this method over shortest path problem indicate our proposed approach is not only faster than genetic algorithm but also has more accurate solution.
Keywords: evolutionary computation, genetic algorithm, particle swarm optimization, shortest path problem.

INTRODUCTION

The shortest path problem is well-known problem that was focused by researchers to solve [2,4,5]. The main goal of this problem is finding the minimum value between two nodes in graph in terms of time, cost, distance and … . consider a graph with some edges that connect nodes to each other. All edges have a value that defines time, cost, fuel consuming and so on. The purpose of this problem is to obtain minimum value between every arbitrary pair of nodes, namely the minimum value or cost from source to destination [1]. This problem is completely different from traveling saleman person because in TSP all nodes or cities must be in tour or solution while in the shortest path problem the solution involves only the necessary nodes that make the best answer [1, 3, 6].

In the other hand, eurygaster algorithm is an algorithm developed to solve NP-Hard problems. In this algorithm, each eurygaster shows one solution and the best solution is the answer of problem. In this algorithm a set of eurygasters distributed over wheat farms and ruin them. After ruining one farm, they migrate to adjacent farm to disturb it. This routing is continued until either all of the farms are ruined or the best farm is reached.

EURYGASTER BEHAVIORS

Eurygaster integricep is an insect pest that predominantly attacks grains, feeding on the leaves, stems and grains, reducing yield and injecting a toxin into the grains which adds a foul smell to the resulting flour, and substantially reduces the baking quality of the dough.

In winters eurygasters live under the plants and bushes in hillside, in several numbers and make a group. At the end of winter and at the beginning of spring when it gets warmer, these insects end their winter sleeps and get ready to move and fly to grain fields by moving over the high mountains and leaving the nests in groups. The first group by the use of its instinct finds the best and the nearest grain fields and stays there. Getting there, this group of insect sends signals to the air to show the other groups their being there. Based on the number of eurygasters in a place, the strength of signals will be different. If the number of eurygasters in a grain field is not great, the rate of diffused signals will be little and if the number of eurygasters in a grain fields is greater, the rate of diffused signals will be increased. They diffuse these signals to show the others that reside there. So that the other groups of eurygasters understand that they should not close to the grain field which contains the first group. Of course the other groups based on diffused signals by the first group and the strength of these signals they decide if they can land and stay there or not. If the power of diffused signals is low, it means that some of the other groups of eurygasters can land and stay by the other groups which are resident there and began to eat. While the strength of the signals in the sky is high, it means that the other groups cannot land on the field(s) containing eurygasters, and they must fly to other fields in which there are no eurygasters, to live and eat.

According to the passage mentioned above, the next group of eurygasters while flying from their nests to other fields to find the best grain fields searches the best and closest ones to land and eat based on the broadcasted signals by landed group(s). This process will continue until they will find a suitable and useful grain field to eat.

We conclude that all the grain fields in a wide area will be attacked by eurygasters, because they do not gather in a one place.so, when there is not enough food in a grain field in which the eurygasters have stayed for a time, they will fly to a new field with no eurygasters according to the process mentioned above.

EURYGASTER ALGORITHM

In this section, eurygaster algorithm is described. Solving non-linear functions are so necessary in real life today and recently researchers interested in inventing methods to solve them. Thus, our approach contributes to solve NP-class problems. The great advantage of this algorithm is that it's so easy to implement and is also inexpensive in term of memory and speed. The second advantage of this algorithm is its convergence speed compared to other methods like GA and PSO.

The related semi-code of the proposed algorithm is as algorithm1. This algorithm is formed by combining of 3 sub-algorithms. In each phase, we described how to apply this algorithm to shortest path problem in a way it can be solved.

INITIALIZATION

In this phase the shortest path problem is divided into some partition and each partition is investigated separately. Also the structure of eurygaster is constituted. Suppose we have one graph like figure1.

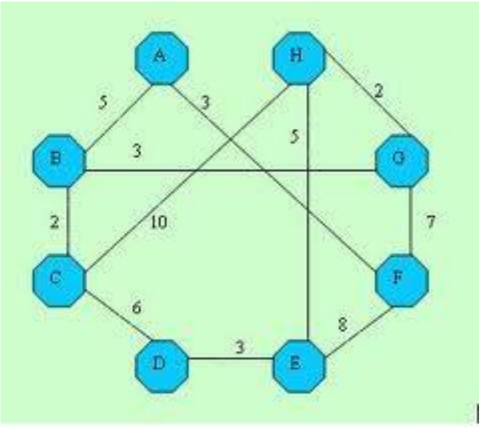

Figure1. a sample of graph

of nodes that is 8 in this figure1. The structure of eurygaster is variable depending on its partition. For example, if eurygaster is in partition with two nodes between source and destination, the structure will be like figure2.

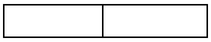
Figure2. eurygaster structure

In this figure, eurygaster has two fields because of two nodes between source and destination. Also, in this problem the area of problem is divided into N-2 partitions as follows. The first partition has 1 intermediate node. The second partition has 2 nodes between source and destination like figure 2. So each next partition has 1 extra node in comparison to its previous partition. The final partition has N-2 nodes where N is the number of graph nodes. It is mentioned that eurygaster doesn't involve source and destination nodes. Another important topic that is necessary to mention is that according to graph size the probability of removing some nodes is existed. For example, consider the sample graph in figure1. Also, suppose we want to find the shortest path from B-node to E-node. Because there is not any path from B to E with 1 node in between, the first partition is removed. Therefore the speed of algorithm to obtain the answer is increased. Also, according to distance from source to destination the approximated best partition is selected to investigate firstly. For example, if distance between source and destination is 10, the partition with 10 field is loaded at first. After that, if the solution of problem is not found the other partitions are investigated.

I← the number of clusters

While I <> 0 do

1. Initialization: produce euragasters or particles according to characteristic of one partition
2. Distribution: distribute eurygasters on the regions of the partition
3. Evaluation: evaluate suitability of each eurygaster or particle depend on the problem

   3.1 If the suitable result of the partition is not obtained

      3.1.1. Change the position of Eurygasters in the partition

      3.1.2. goto 3

   3.2 If the result of the problem is not obtained

      3.2.1. I--

      3.2.2. goto 1

Else

      3.2.3. Stop algorithm or break

End while

Algorithm1. Eurygaster Algorithm

DISTRIBUTION

In this phase, eurygasters according to their structures are produced and spread over the region of first partition. There are three probabilities in each partition. First, the answer is not found and the whole search space of partition is not investigated. In this case, some other eurygasters are produced and distributed to remaining section of partition. Second, the answer is not found and the whole search space of partition is investigated. In this case, some erygasters are created and spread over another partition. Finally, if the answer of problem found in partition, the algorithm is terminated.

SUITABILITY

In order to find the solution of the problem, eurygasters should be evaluated so that the best answer is obtained. In order to reach the best solution, we must have a tool that justifies the solution. In this paper, the following function is used to examine the suitability of solutions.

Suitability (eurygaster) =1/ (total cost of edges)

It is obvious that the best answer is one with highest suitability.

EVALUATION RESULTS

To evaluate results, we use three produced graph with 50, 100 and 200 nodes. The weight of each edge in these graph are produce randomly. Also, Our test was runned on desktop computer with following specifications.

CPU: Xeon L3014
RAM: 8 GB DDR3
OS: windows 8

For better evaluation, we run proposed algorithm and genetic algorithm on each graph 100 times. The average time of 100 runs to reach the best solution in both algorithms is described in figure3. Also, the percents to reach the solution of problem in both algorithms are illustrated in figure4.

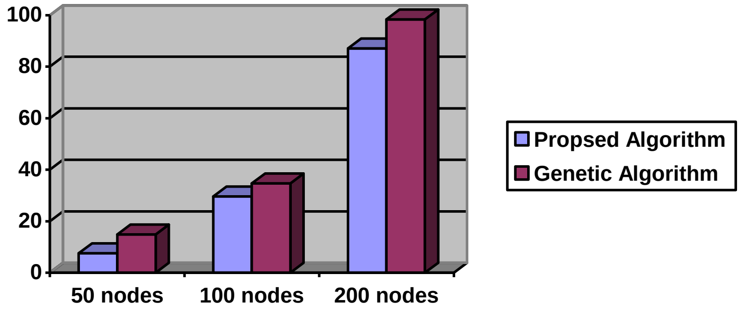

Figure3. Average time of running algorithms in 100 runs in term of second

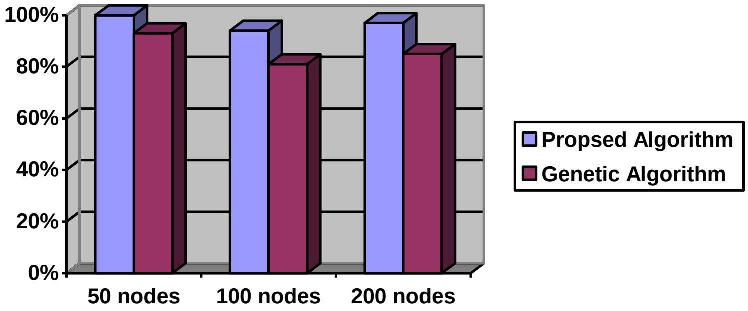

Figure4. Percent of reaching to the best solution in 100 runs

The evaluation results show our approach is faster and more accurate than genetic one. This approach unlike genetic algorithm lacks the local optimum so the probability of getting the more accurate solution in this method is much more than the genetic algorithm. Moreover, in this method every space of the problem is searched for once while in the genetic algorithm every part of the problem space can be searched several times in different generations, so the rate of convergence in this algorithm is much more than the genetic algorithm. Figure 3 shows the convergence speed of proposed approach is faster than genetic ones. Also by figure4, it is concluded that researchers work has accurate solution in comparison to genetic algorithm.

CONCLUSIONS

In this article, one approach based on the behaviors of eurygasters has been presented to solve shortest path problem. This approach unlike genetic algorithm lacks the local optimum so the probability of getting the more accurate solution in this method is much more than the genetic algorithm. Moreover, in this method every space of the problem is searched for once while in the genetic algorithm every part of the problem space can be searched several times in different generations, so the rate of convergence in this algorithm is much more than the genetic algorithm. Also, this algorithm is easy to implement by computer. If takes a few lines to programming and doesn't need a huge memory or CPU speed. Evaluation results on three produced files show that convergence speed by proposed approach is faster and also more accurate. Shortest path problem can be solved by ways of several methods like dynamic programming, greedy algorithm, PSO and genetic algorithm. According to researchers result, one of the best algorithm by which shortest path problem can be solved is genetic algorithm. But our proposed method is more suitable than genetic algorithm not only in convergence speed but also in accuracy of solution. It can be proved that our proposed approach is optimal in used memory in comparison to other heuristics algorithm like genetic and PSO.

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