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A Review: - Travelling salesman problem solution using Advanced IWD Algorithm

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Abstract— In this review paper, a new approach called "**An Advanced IWD algorithm**" for resolving Travelling Salesman problem is proposed. **Intelligent Water Drops algorithm**, or the IWD algorithm, is a swarm-based nature-inspired optimization algorithm. This algorithm contains a few essential elements of natural water drops and actions and reactions that occur between river's bed and the water drops that flow within. The IWD algorithm may fall into the category of Swarm intelligence and Met heuristic. Intrinsically, the IWD algorithm can be used for combinatorial optimization. However, it may be adapted for continuous optimization too. The IWD was first introduced for the traveling salesman problem in 2007. Since then, multitude of researchers has focused on improving the algorithm for different problems. But as an improvement we will combine the data updation with using the concept of genetic algorithms cross over and mutation. This advanced IWD algorithm hope will find the better tour.

Keywords— Intelligent Water Drops, Swarm-based optimization, Travelling Salesman Problem, Genetic Algorithm, Crossover, Mutation, Water drop, Soil, Velocity.

INTRODUCTION

Travelling salesman problem was first introduced in 1930.It is one of the most intensively studied problems in optimization. Travelling salesman problem follows the three conditions:-

1. Salesman has given N number of cities.
2. Source and destination should remain the same.
3. He has to travel each and every city exactly once and the path followed be of minimum distance.

There are various techniques which have been used to solve Travelling Salesman Problem in a better way.

Applications of Travelling Salesman Problem:-

1. It can be used in planning, logistics and manufacture of microchips.
2. When modification is made to TSP, it appears as a sub –problem in many areas , such as dna sequencing.
3. In these applications ,the concept city can be represented for example,customers, soldering points or dna fragments.
4. TSP is used as a benchmark for optimization.

RESEARCH BACKGROUND AND RELATED WORK

1. **Particle Swarm Optimization**:- Particle Swarm Optimization is a swarm based optimization which was first introduced by Dr.Eberhart and Dr.Kennedy in 1995. Particle Swarm Optimization is inspired by the birds for finding the best path while flying. They don't communicate with each other and they don't have any clear leader to guide them. But they guide each other to find the best solution i.e path. A particle keeps track of the all others particles but follows only that path which is best so far. It has some similarities with genetic algorithm. Similar to genetic algorithm it produces random solutions and finds the optimal solution but unlike genetic algorithm it has no evolution operators . Particle Swarm Optimization does not provide optimal solution always.
2. **Ant Colony Optimization**:- Ant Colony Optimization was introduced by Marco Dorigo which falls in the class of optimization algorithms which is based on the actions of ant colony. Ant Colony Optimization is a tachnique which helps in finding better paths through graphs. The ants while moving towards the food source, record their positions and the solution quality which they have achieved. So that it can help other ants to locate and find better solutions. This whole phneomeon is performed with the help of a substance called pheromone which shows the trace of an ant. Ant uses heuristic information while searching the food source. Heuristic information can be define as the ant's knowledge of where the smell of food comes from.
3. **Bacteria Foraging Optimization**:- Bacteria Foraging Optimization was proposed by Passino in the year 2002. This is based on the criteria of elimination the animals with poor foraging and select only individuals which have good foraging strategy

that falls in the survival of fittest. Bacteria Foraging Optimization algorithm is a global search technique which is based on mimicking the foraging behaviour of E.coli. this method is used for locating, handling and ingesting the food. A bacterium can perform two different actions :-Tumbling and Swimming,

i. During foraging,Tumble actions modifies the orientation of the bacterium.
ii. In swimming, chemotaxis step takes place in which the bacterium will move in its current direction. The chemotaxis movement will goes in the direction of positive nutrient gradient.
iii. After the certain no. of complete swims, the best half of the population will perform reproduction process and the rest of the population will got eliminated.
iv. In order to escape local optima, an elimination dispersion event is carried out where some in which some the bacterias are liquidated at random with very small probability and the new replacements are initialized at random locations of the search space.

4. **Bee Colony Optimization**:- Similar to other nature inspired based algorithms such as Particle Swarm Optimization, Bacteria Foraging Optimization, Ant Colony Optimization; "Bee Colony Optimization"
Also falls in this category. In this first, the group of bees or bee colony looks fir the feed individually. When the bee finds the feed ,it informs other bees by dancing so that other bees can collect and carry the feed to the hive.
5. **Natural Water Drops**:- Rivers are one of the natural resources. Waterdrops flowing in river has two main properties:-
   - **Soil**
   - **Velocity**

When waterdrops flowsv in the river it carries some soil with it which leads to increase in the velocity as the part from which the soil get removed will become deeper and can hold more volume of water and as the result may flow more water.

6. Intelligent water drop

Intelligent Water Drop Algorithm is nature inspired algorithm which follows the criteria of Natural Water Drop. It was first developed by Hammed Shah Hosseini in the year 2007 for solving travelling salesman problem. This algorithm contains a few essential elements of natural water drop which is the action and reaction that occur between river's bed and waterdrops that flow within.

It follows the two main properties of Natural Water Drop.

- Soil
- Velocity

When waterdrops flows in the river it carries some soil with it. More the soil it carries with itself higher will be the velocity. This means that the soil and velocity are inversaly proportional to each other. River flows from a particular source but the desired destination may be known or unknown. And there are many paths in the environment which may be followed in order to reach the desired destination but criteria that Intelligent Water Drop Algorithm follows is the velocity. It follows only that path which has highest velocity than others. By following this criteria at each step ,it reaches to its destination. The goal of this algorithm is to find the best path or shortest path from source to the destination, in the case when destination is known. In case when the destination is unknown, the goal is to find the optimum destination in terms of cost or any suitable measure for the problem.

Algorithm:-

1. Initialization of static parameters.
2. Initialization of dynamic parameters.
3. Spread the IWDs randomly on the nodes of the graph.
4. Update the visited node list of each IWD.
5. Repeat Steps a to d for those IWDs with partial solutions.
   - For the IWD residing in node i, choose the next node j, which does not violate any constraints of the problem and is not in the visited node list of the IWD.
   - For each IWD moving from node i to node j, update its velocity.
   - Compute the soil.
   - Update the soil
6. Find the iteration-best solution from all the solutions found by the IWDs.
7. Update the soils on t he paths that form the current iteration best solution.
8. Update the total best solution by the current iteration - best solution.
9. Increment the iteration number.
10. Stops with the total best solution.

GENETIC ALGORITHM

Genetic Algorithm is inspired by Darwin's theory. According to which if there are two or more parents and the child evolved from parents contains the properties of both parents. In Genetic Algorithm, algorithm is started with the set of solutions called population. Solutions obtainedfrom population are taken and used to form a new population. This new population will be better than the old one because they are selected according to their fitness.

Genetic Algorithm has two operators which helps in evolution of candidate solution:-

- **Crossover**:- The both chromosomes which are selected can be combined together by using crossover operator, the result of which will be replaced by the lowest fitness chromosomes in the population. Each chromosomewhich is selected will be check through an algorithm which will ensure that the selected probability is proportional to the fitness of chromosome. The new chromosome has the chance to be better than the replaced one. By using this operator optimal solution is supposed to be exist.
- **Mutation**:- In Mutation, a gene which is selected from a chromosome is ramdomly chamnged. By performing this process, there is increase in the chance of exploring unreached sub-regions.

ADVANCED IWD

As per study many algorithms have been develop for solving TSP. In this thesis we are going to develop a new approach which is "**an advanced IWD algorithm**" for resolving Travelling Salesman problem. **Intelligent Water Drops algorithm**, or the IWD algorithm, is a swarm-based nature-inspired optimization algorithm. This algorithm contains a few essential elements of natural water drops and actions and reactions that occur between river's bed and the water drops that flow within. The IWD algorithm may fall into the category of Swarm intelligence and Met heuristic. Intrinsically, the IWD algorithm can be used for combinatorial optimization. However, it may be adapted for continuous optimization too. The IWD was first introduced for the travelling salesman problem in 2007. Since then, multitude of researchers has focused on improving the algorithm for different problems. But as an improvement we will combine the data updation with using the concept of genetic algorithms cross over and mutation.

It was mentioned above that a water drop has also a velocity. This velocity plays an important role in removing soil from the beds of rivers. The following properties are assumed for a flowing water drop:

1) A high speed water drop gathers more soil than a slower water drop.

2) The velocity of a water drop increases more on a path with low soil than a path with high soil.

3) A water drop prefers a path with less soil than a path with more soil.

The IWD algorithm represents the TSP in the form of a graph (N, E). N represents the node set, namely cities. E represents the edge set, namely distances between cities. Then, each IWD begins creating its solution stepwise by travelling between the cities until the IWD finally completes its solution. One iteration of the algorithm is complete when all IWDs have completed their solutions.

Algorithm:-

The procedure of the IWD for the TSP can be described as follows: The graph (N, E) of the problem is given to the algorithm.

1. First we need to know about the working area or can say coverage area of travelling by salesman.
2. Then we need to know about the number of cities in area, thus we need to determine the total numbers of cities it has to cover.
3. Initialize the location and rest of the parameters as numbers of iteration which has to be repeated while travelling to different cities.
4. As there are number of cities where salesman has to visit, it means large distance has to be covered, so now we calculate the total distance from one city to other.
5. Then calculate the fitness function on the basis of the data collected.
6. As the visited nodes have its own velocity and other features. Now this solution is updated by our proposed approach that is with IWD and Genetic Algorithm.
7. Now recheck the solution of the system as if minimum fitness is achieved or not.
8. If it does save the results and move to next iteration.

CONCLUSION

The "Advanced IWD Algorithm", will combine the data updation with using the concept of genetic algorithms cross over and mutation which will increase the possibility of traversing unreached nodes and will provide better result.

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