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Study on Selection of Intelligent Waterdrop Algorithm for Solving Multiple Problems: A Review

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Abstract

IWD is a swarm-based nature-inspired optimization algorithm, which has been inspired from natural rivers and how they find almost optimal paths to their destination. These near optimal or optimal paths follow from actions and reactions occurring among the water drops and the water drops with their riverbeds. In the IWD algorithm, several artificial water drops cooperate to change their environment in such a way that the optimal path is revealed as the one with the lowest soil on its links. Almost every IWD algorithm is composed of two parts: a graph that plays the role of distributed memory on which soils of different edges are preserved, and the moving part of the IWD algorithm, which is a few number of Intelligent water drops. These Intelligent Water Drops both compete and cooperate to find better solutions and by changing soils of the graph, the paths to better solutions become more reachable. And now we have using IWD algorithm for early detection of nasal dermoid cyst during pregnancy scanning.

Keywords

Swarm Intelligence; Intelligent Water Drops(IWD); Travelling Salesman Problem(TSP); Multiple Knapsack Problem(MKP); n-queen Puzzle

I. Introduction

The natural systems that have developed for so long are one of the rich sources of inspiration for inventing new intelligent systems. Swarm intelligence is one of the scientific fields that are closely related to natural swarms existing in nature, such as ant colonies, bee colonies, brain and rivers. Among the problem solving techniques inspired from nature are evolutionary computation, neural networks, time adaptive self-organizing maps, ant colony optimization, bee colony optimization, particle swarm optimization, DNA computing , electromagnetism-like optimization and intelligent water drops. One of the recently proposed algorithms in the field of the swarm intelligence is the intelligent water drops algorithm. The IWD algorithm is based on the dynamic of river systems, actions and reactions that happen among the water drops in rivers. The natural water drops are used to develop IWD and the IWDs cooperate together to reach a better solution for a given problem. The IWD algorithm may be used for maximization or minimization problems. The solutions are incrementally constructed by the IWD algorithm. Therefore, the IWD algorithm is a population-based constructive optimization algorithm. The IWD algorithm has been used for the travelling salesman's problem and multiple knapsack problem with promising results. Both the TSP and the MKP are NP-hard combinatorial optimization problems. In the TSP, a map of cities is given to the salesman and he has to visit all the cities only once to complete a tour such that the length of the tour is the shortest among all possible tours for this map. iwd algorithm is used to solve many complex problem now we used this algorithms for detection of nasal dermoid cyst during pregnancy scanning. so no need of surgery because its surgery is very complicated. In nature, flowing water drops are observed mostly in rivers, which form huge moving swarms. The paths that a natural river follows have been created by a swarm of water drops. For a swarm of water drops, the river in which they flow is the part of the environment that has been dramatically changed by the swarm and will also be changed in the future. Moreover, the environment itself has substantial effects on the paths that the water drops follow. For example, against a swarm of water drops, those parts of the environment having hard soils resist more than the parts with soft soils.

II. Basics of the IWD

By looking at rivers in nature, we are surprised to see lots of twists and turns along their paths. One thing that makes us think is that why these twists have been created and is there any logic or intelligence behind them. The IWD algorithm is a step in the direction to model a few actions that happen in natural rivers and then to implement them in a form of an algorithm.

In the IWD algorithm, IWDs are created with two main properties:

1. Velocity
2. Soil

Both of the two properties may change during the lifetime of an IWD. An IWD flows from a source to a destination. The IWD begins its trip with an initial velocity and zero soil. During its trip, it travels in the environment from which it removes some soil and it may gain some speed. An IWD is supposed to flow in discrete steps. From its current location to its next location, the IWD velocity is increased by the amount non-linearly proportional to the inverse of the soil between the two locations. Therefore, a path with less soil lets the IWD become faster than a path with more soil. Almost every IWD algorithm is composed of two parts: a graph that plays the role of distributed memory on which soils of different edges are preserved, and the moving part of the IWD algorithm, which is a few number of Intelligent water drops. These Intelligent Water Drops (IWDs) both compete and cooperate to find better solutions and by changing soils of the graph, the paths to better solutions become more reachable. It is mentioned that the IWD-based algorithms need at least two IWDs to work.

III. Application of IWD Algorithm

A. Travelling Salesman Problem (TSP)

The Travelling Salesman problem which belongs to the class of NP-hard problems. It is one of the most intensively studied problems in optimization. TSP has been solved using IWD. In IWD natural river often finds good paths among lots of possible paths in its ways from the source to destination. These near optimal paths follow from actions and reactions occurring among the water drops.

B. Multidimensional Knapsack Problem (MKP)

The multidimensional knapsack problem, MKP, is a generalization of the KP. MKP is a standard NP-hard problem. In the MKP, the aim is to include some of the items in the knapsacks to achieve maximum profit with the constraint that none of knapsacks becomes overflowed. To solve the MKP using the IWD algorithm, the search space of the problem is viewed as a graph (N, E) where the node set N denotes the items of the MKP and the edge set E denotes the arcs (paths) between the items. The IWD-MKP algorithm (Shah-Hosseini, 2008) is used for some other MKPs to observe its power for getting optimal or near-optimal solutions.

C. N-Queen Puzzle

The 8- queen puzzle was originally proposed in 1848 by the chess player. The 8-queen puzzle is the problem of putting eight chess queens on an 8 × 8 chessboard such that no two queens are able to attack each other. Thus, a solution requires that no two queens occupy the same row, column, or diagonal. Nauck also extended the puzzle to n-queens problem. N-queens problem is based on placing n queens on an n×n chessboard. The IWD algorithm for the n-queen problem is called 'IWD-NQ' algorithm. The IWD algorithm uses local heuristic which is trapped in the local optima in which only two queens attack each other. Sometimes, coming out of such local optima takes considerable iterations of the algorithm. For this purpose, a local search algorithm called "N-Queen Local Search" or NQLS has been proposed in (Shah-Hosseini, 2008(b)

D. Automatic Multi-level Thresholding (AMT) Of Gray-Level Images

Image segmentation is often one of the main tasks in any Computer Vision application. Image segmentation is process in which the whole image is segmented into several regions. By doing segmentation, the image is divided into several sub-images such that each sub-image represents an object of the scene. There are several approaches to perform image segmentation (Sezgin & Sankur, 2004). One of the widely used techniques for image segmentation is multilevel thresholding. In multilevel thresholding, it is assumed that each object has a distinct continuous area of the image histogram. The IWD algorithm is used for the AMT.

E. Robot Path Planning

Path planning of robot is a global optimum problem. Intelligent water drops (IWD) algorithm is newly presented under the inspiration of the dynamic of river systems and the actions that water drops do in the rivers, and it is easy to combine with other methods in optimization. IWD problem is used for solving the robot path planning problems in various environments. The water drops can act as an agent in searching the optimal path.

F. Vehicle Routing

Vehicle routing problem (VRP) is an problem which is proposed by Dantzig and Ramser in 1959. VRP is an important problem in the fields of transportation, distribution. We apply a population based algorithm to VRP by imitating the natural flow of water drops. The "Intelligent Water Drops" or IWD algorithm solves the VRP by modeling how water drops collectively modify their environment by soil from river bottoms during moving

G. Trajectory Planning

Trajectory planning is referred to as motion planning. Trajectory planning is moving from point A to point B while avoiding collisions over time. It is a rather complicated global optimum problem in UCAV (Unmanned combat aerial vehicle) mission planning. Intelligent water drops (IWD) algorithm is newly presented under the inspiration of the dynamic of river systems and the actions that water drops takes in the rivers, and it is easy to combine with other methods in optimization. An improved IWD optimization algorithm is used for solving the smooth trajectory planning problems in various combating environments. The water drops can act as an agent in searching the optimal UCAV trajectory. Series experimental comparison results show the proposed IWD optimization algorithm is more effective and feasible in the single UCAV smooth trajectory planning than the basic IWD model.

H. Function Optimization

It is also possible to solve continuous optimization problems by the IWD algorithm. In a continuous optimization problem, a number of continuous variables (parameters) are needed to be obtained such that a function is minimized or maximized. The IWD tries to optimize the given function in the binary representation. Finally, the best solution is reported as the final solution. One attempt is the IWD-CO (IWD for Continuous Optimization).

I. Data Clustering

Clustering is the task of assigning a set of objects into groups (called clusters) so that the objects in the same cluster are more similar to each other than to those in other clusters. K-means Clustering Algorithm can be solved with the Intelligent Water Drops (IWD) Algorithm.

IV. Flow Chart of Intelligent Waterdrop Algorithm

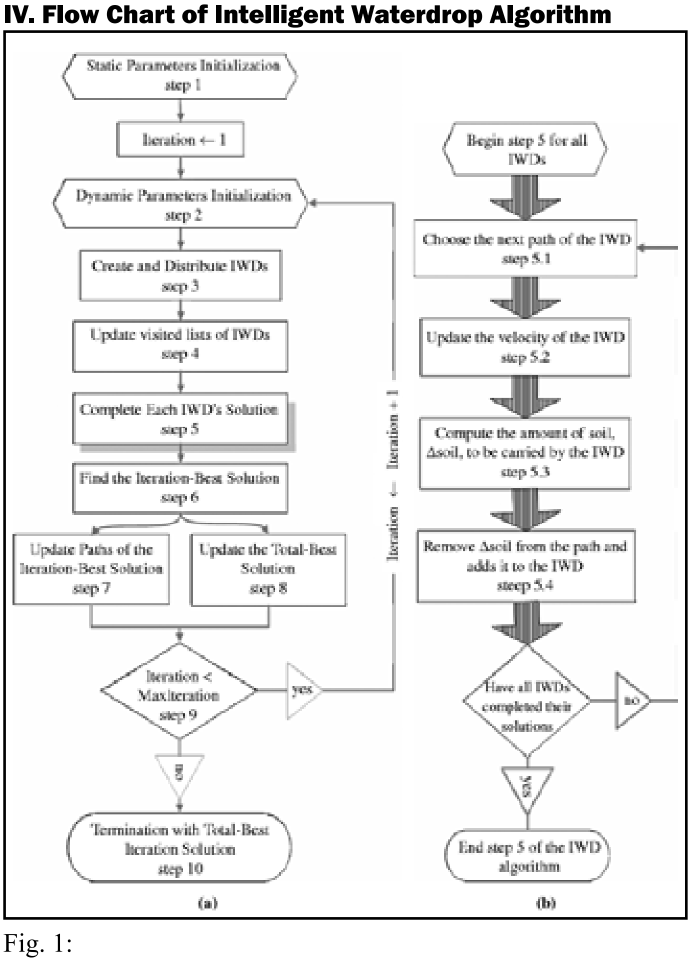

Fig. 1:

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Explaination The IWD algorithm:

The IWD algorithm gets a representation of the problem in the form of a graph (N, E) with the node set N and edge set E. Then, each IWD begins constructing its solution gradually by travelling on the nodes of the graph along the edges of the graph until the IWD finally completes its solution. One iteration of the algorithm is complete when all IWDs have completed their solutions. After each iteration, the iteration-best solution T^{IB} is found and it is used to update the total-best solution. The amount of soil on the edges of the iteration-best solution T^{IB} is reduced based on the goodness (quality) of the solution. Then, the algorithm begins another iteration with new IWDs but with the same soils on the paths of the graph and the whole process is repeated. The algorithm stops when it reaches the maximum number of iterations $iter_{max}$ or the total-best solution T^{TB} reaches the expected quality.

The IWD algorithm has two kinds of parameters. One kind is those that remain constant during the lifetime of the algorithm and they are called 'static parameters'.

The IWD algorithm is specified in the following steps:

1. Initialisation of static parameters. The graph (N, E) of the problem is given to the algorithm. The quality of the total-best solution T^{TB} is initially set to the worst value: $q(T^{TB}) = -\infty$. The maximum number of iterations $iter_{max}$ is specified by the user. The iteration count $iter_{count}$ is set to zero.
2. The number of water drops N_{IWD} is set to a positive integer value, which is usually set to the number of nodes N_c of the graph
3. Which is chosen from [0, 1], is set as $\rho_{IWD} = 0.9$. Moreover, the initial soil on each path (edge) is denoted by the constant InitSoil such that the soil of the path between every two nodes i and j is set by soil (i , j) = InitSoil .
4. Set to InitVel. Both parameters InitSoil and InitVel are user selected and they should be tuned experimentally for the application. Here, InitSoil = 10000 and InitVel = 200. For the IWD-MKP, InitVel = 4 is used,which is the same value used in Shah-Hosseini (2008).
5. Initialisation of dynamic parameters. Every IWD has a visited node list V_c (IWD) , which is initially empty: V_c (IWD) ={ }. Each IWD's velocity is set to InitVel. All IWDs are set to have zero amount of soil.

Find the iteration-best solution TIB from all the solutions TIWD found by the IWDs using

$$T^{IB} = \arg\max_{\forall T^{IWD}} q(T^{IWD}) \qquad (5)$$

where function q(.) gives the quality of the solution.

Update the soils on the paths that form the current iteration-best solution TIB by

soil(i, j) = (1+ ρ_{IWD}) . soil(i, j)

$$- \rho_{IWD} \cdot \frac{1}{(N_{IB} - 1)} \cdot soil_{IB}^{IWD} \qquad \forall (i, j) \in T^{IB} \qquad (6)$$

Where N_{IB} is the number of nodes in the solution T^{IB}.

Update the total best solution T^{TB} by the current iteration-best solution T^{IB} using

$$T^{TB} = \begin{cases} T^{TB} & \text{if } q(T^{TB}) \geq q(T^{IB}) \\ T^{IB} & \text{Otherwise} \end{cases} \qquad (7)$$

9 Increment the iteration number by $Iter_{count} = Iter_{count} + 1$. Then, go to Step 2 if $Iter_{count} < Iter_{max}$.

The algorithm stops here with the total-best solution

It is reminded that the IWD has been shown to have the property of convergence in value (Shah-Hosseini, 2008). It means that the IWD algorithm is able to find the optimal solution if the number of iterations be sufficiently large.

V. Experimental Result of IWD on Traveling Salesman Problems

It is reminded that the IWD-TSP in Shah-Hosseini (2007) gets stuck in some hard local optimums for the cities on a circle. For example, in one of the runs of the IWD-TSP for the 10-city problem, the large iteration number 22275 is observed whereas the largest iteration number of the MIWD-TSP in ten runs is 33. Moreover, for the 20-city problem, the average number of iterations 2046 is obtained whereas for the MIWD-TSP, the average number 387 is obtained. For the circle TSP with more cities, the average numbers of iterations to get to the global optimums become

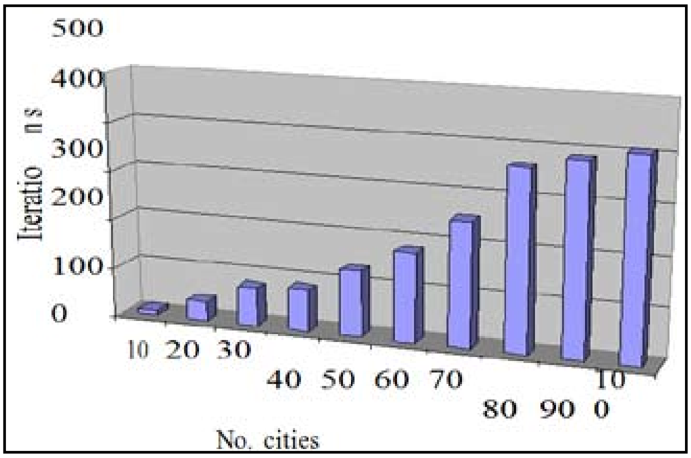

Fig. 2:

Four TSPs are chosen from the TSPLIB95 (the TSP library in the internet) to test the capability of the MIWD-TSP algorithm. The lengths of average and best tours in five runs of the MIWD-TSP algorithm are reported in Table 1. For comparison, the lengths of best tours of some other metaheuristics are also mentioned in Table 1. The table shows that the tours obtained by the MIWD-TSP algorithm are satisfactorily close to the known optimum solutions and are comparable to the other metaheuristics.

So at last mant problems solved by iwd algorithm and it will give betterresults than other algorithm.

VI. Conclusion

The IWD algorithm is an optimisation algorithm that uses a swarm of water drops to collectively search for optimal solutions in the environment of the given problem. In fact, each IWD constructs incrementally a solution to the problem by moving on the graph representation of the problem. Then, among the obtained solutions, the best one in terms of quality is chosen and its total path is reinforced by soil removal. During each iteration of the IWD algorithm, an IWD gains some velocity and removes some soil from the path it flows on. After enough iterations of the IWD algorithm, the IWDs find the good paths that are decoded to good solutions of the problem.so at last iwd algorithm gives better results to solving all problems .and now we have using iwd algorithm be used for detection of nasal dermoid cyst disease during pregnancy scaning.so no need of surgery because its very complicated

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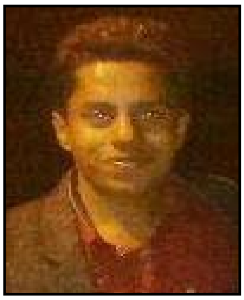

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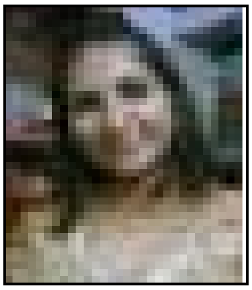

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