Implementation of:

INTELLIGENT WATER DROPS ALGORITHM

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Intelligent Water Drops (IWD) Algorithm is a Swarm- based optimization algorithm which is proposed by Shah Hosseini in 2007 proceedings of CEC i.e. Congress on Evolutionary Computation (Camacho-Villalón, Dorigo , & Stützle , 2019).

Algorithm Description:

IWD Algorithm is inspired by the flow of Natural River. A natural river often finds good paths among lots of possible paths in its ways from the source to destination. These near optimal or optimal paths are obtained by the actions and reactions that occur among the water drops and the water drops with the riverbeds (Shah-Hosseini).

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:

- Velocity
- Soil

A path with less soil lets the IWD become faster than a path with more soil in its route from source to destination. Therefore, paths with lower soils have higher chance to be selected by the IWD. (Shah-Hosseini)

The problem is expressed in the form of a graph (N, E) where N is the nodes and E is the edges. The graph represent the environment for every IWD and they are spread randomly on the nodes of the graph.

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 TIB is found and it is used to update the total-best solution TTB.

The amount of soil on the edges of the iteration-best solution TIB 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 or the total-best solution TTB reaches the expected quality (Shah-Hosseini).

Algorithm Applications:

IWD algorithm has been successfully to perform combinatorial and function optimization problems (O Alijla, Wong, Lim, Khader, & Betar, 2014).

For example:

- Travelling Salesman problem
- Multiple knapsack

- Rough set feature subset selection
- Optimum Reservoir operation (Sarani & Dariane, 2013)
- Workflow scheduling problem in Cloud Computing (Kalra & Singh, 2017)

Implementation Idea/Project Outcome:

We have planned to implement the IWD algorithm using python and analyze its complexity. The data structures that are planned to use are list and integer. This implementation will take initial soil value, initial velocity value and number of IWDs as input and provide the best solution i.e. the best route for water flow.

We have also planned to solve the travelling salesman problem (TSP) using IWD algorithm. TSP is one of the classic algorithmic problem in computer science.

In our implementation, the problem will be represented on a graph (N, E) where N represent the nodes (cities) that the travelling salesman has to visit and E is the path between each node having some soil. The paths are considered undirected as in IWD. The tour of the travelling salesman is T = (c1, c2,…cn) i.e. he travels from city c1 to c2, then from c2 to c3 and he continues this way until he gets to city cn. He then returns to the first city c1. The tour length, TL is calculated by,

$$TL(\mathrm{c1}, \mathrm{c2}, \ldots, \mathrm{cn}) = \sum_{k=1}^{n} \mathrm{d}(\mathrm{c}\ (\mathrm{i}), \mathrm{c}(\ \mathrm{i}+1))$$

Such that, c (n+1) = 1 and the distance function d (. , .) which computes the distance between two cities is often selected as the Euclidean distance. (Shah-Hosseini) As a result of this implementation, travelling salesman prefer to choose paths of TTB because less soil on its paths is deposited.

The experimental results will be provided in order to analyze the efficiency of IWD algorithm in solving optimization problems like TSP.

Libraries that we intend to use are:

- Numpy
- Math
- SciPy

Note: Certain details of the project may be subject to change when work on project will continue

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