Semester Project Report

On

Bat Algorithm

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Chapter 1

Introduction

Bat algorithm (BA) is a swarm based meta-heuristic algorithm which is mainly used for global optimization. The BA is inspired by the echolocation phenomenon of a particular species of bats known as microbats. This algorithm was developed in 2010 by Xin-She Yang and has been used in various fields that require optimization like image processing, transport designing, feature selection, scheduling, data mining, etc [1]. Echolocation [2] is a phenomenon which is used by microbats to sense different things around them by sending a loud and short pulse of sound in the environment and receiving echo-returns with the help of which they figure out the distances of the object.

1.1 Working

Let Z_i be the random velocity of bats, f_{min} be its frequency, λ be its wavelength, p_i be its position and A_o be its loudness which varies from A_{min} (lowest) to A_o(highest) [3].
This parameters are related to each other by following relation.

$$f_i = f_{min} + (f_{max} - f_{min})\beta$$

$$z_i^t = z_i^{t-1} + (p_i^t - p_*)f_i$$

$$p_i^t = p_i^{t-1} + z_i^t$$

where β lies in the range of [0-1] and p_* is the best solution among bats.
The loudness can be calculated by the following equation.

$$A_i^{t+1} = \alpha A_i^t$$

. Also the rate of pulse emission(R_i) can be calculated as

$$R_i^{t+1} = R_i^o[1 - e^{(-\gamma t)}]$$

where α and γ are constants such that $\alpha\epsilon[0, 1]$ and $\gamma > 0$
The steps of the BAT Algorithm is as follows:

1. First we have to initialize the parameters such as population of bats, position, frequency and velocity.
2. Then initialize echolocation parameters for all bats.
3. After that calculate fitness values for each individuals and note the best position of bat.
4. Adjust the frequency values in order to generate new solutions.
5. Update position and velocity of bat.
6. If a random number is grater than pulse emission rate, then select a bat from the list of best bats which are currently available.Then perform local search operation around that bat.
7. Generate solution by flying the bat randomly.

8. if the fitness is greater than that of best solution and loudness is greater than the random number, then randomly generated solution gets accepted.
9. Update pulse emission rates and also the loudness.
10. Sort the bats in decreasing order and determine the position of best bat.
11. Keep on repeating the steps from 4 - 10 until the terminating condition is satisfied.

1.2 Travelling Salesman Problem

In Travelling Salesman Problem (TSP) we have a set of cities and cost between every pair of cities is given. Our goal to find out the minimum cost route that visits every city exactly once and returns to the starting point.

1.3 Application of Bat Algorithm on TSP

We have used BAT algorithm in order to solve the TSP problem. First of all the original bat algorithm is used for continuous optimization problems but for TSP we have changed bat algorithm in order to solve discrete problems.

In our proposed model each bat represents a solution for TSP.At the start we have also initialized parameters like rate, loudness and solution for each bats.In adition the parameter of frequency and velocity has not been taken into consideration.For the generation of new solution of each bat we have used the 2-OPT function.

Algortihm:

1. Choose the value of number of iteration and the population of bats.
2. Initialize the values of r , A and X(solution).
3. Generate new solutions for each bat.
4. Generate a random number r and if r $> r_i$ select the solution.
5. Now generate another random number r and if r $< A_i$ and cost of current best is less than the global best i.e $f(x_i) > f(x_{best})$ .Then replace the global best with the current best.
6. Repeat the steps from 3-5 till the required number of iteration.

Bibliography

[1] Yahya Zebari, A., M. Almufti, S., Mohammed Abdulrahman, C. (2020). Bat algorithm (BA): review, applications and modifications. International Journal of Scientific World, 8(1), 1-7. doi:http://dx.doi.org/10.14419/ijsw.v8i1.30120

[2] Fraser, Erin Silvis, Alexander Brigham, R. Czenze, Zenon Adams, Amanda Bas, Yves Blakey, Rachel Briones-Salas, Miguel Britzke, Eric Chaverri, Gloriana Clement, Matthew Coleman, Laci Dobony, Christopher Dzal, Yvonne B.M., Fenton Flanders, Jon Ford, W. Frick, Winifred Friedrich, Meryl Gutierrez, Veronica. (2020). Bat Echolocation Research: A handbook for planning and conducting acoustic studies.

[3] Agrawal, Tarun Chahar, Vijay. (2021). A Systematic Review on Bat Algorithm: Theoretical Foundation, Variants, and Applications. Archives of Computational Methods in Engineering.

[4] Osaba, Eneko Yang, Xin-She Diaz, Fernando López García, Pedro Carballedo, Roberto. (2016). An Improved Discrete Bat Algorithm for Symmetric and Asymmetric Traveling Salesman Problems. Engineering Applications of Artificial Intelligence. 48. 59-71. 10.1016/j.engappai.2015.10.006.