Cat and Mouse Based Modified Optimizer

Navya Newatia 190905046

Table of Contents

Abstract....3
Introduction....4
Literature View....4
Research Gap and Question....4
Paper Organization....4
Cat and Mouse Modified Optimization Algorithm....5
Theory and Math....5
Simulations....8
Sphere Cost Function....8
Ackley Cost Function....8
Eggholder Function....9
References....10

Abstract

Based on the Cat and Mouse Optimizer: A New Nature Inspired Optimization Algorithm. In the original CMBO, the movement of cats towards In the proposed CMBO, the movement of cats towards mice as well as the escape of mice towards havens is simulatedmice as well as the escape of mice towards havens is simulated. This paper attempts to modify the behaviour in order to achieve better optimization results.

Introduction

Literature View

It is based on the original paper. Thus, it is also a population based genetic algoritm. It also draws inspiration from particle swarm optimization algorithm.

Particle Swarm Optimzation (PSO) algorithm simulates the movement of a flock of birds. It keeps track of each particle, or bird's personal best and a global best for the entire flock. It works based on the tracked values. It is mathematically simple and easy to implement. It is hard to optimize functions with multiple minima with this algorithm.

Research Gap and Question

The goal is to find a more efficient and accurate global optima.

Paper Organization

The modified CMBO is proposed in Section 2. Simulations are in Section 3.

Cat and Mouse Modified Optimization Algorithm

Theory and Math

The CMBO is a population-based algorithm which is designed by inspiration from the natural behaviors of a cat attacks on mouse and mouse escape to the haven.

As in any population-based algorithm, each member of the population is a proposed solution to the problem. Thus each member can be expressed in the form of a vector of n dimensions, n being the number of paramers we wish to conisder. Each member will occupy one row of m, m being the population size we wish to consider.

$$X_{m \times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

First, we initialize the population. We calculate the cost according to the given cost function and sort. The upper half is considered the mice while the lower half are the cats. The velocities for the cats and mice is randomly initialized. All members of the population have a personal best. There is also a global best.

We then enter the chase phase. Here, the velocity of the cats is updated according to the equation:

$$V_c(t+1) = w \times V_c(t) + cr \times X_m(t)$$

where V_c=Velocity of cats at time t,

X_m=Position of mice at time t

r = Random number between 0 and 1

w, c = parameters of the algorithm

Next, we start the flee phase. Here the velocity of the mice is updated according to the equations:

$$V_m(t+1) = f_c \times (V_c + V_m(t)) + f_p r_1 \times (p_best - X_m) + f_g r_2 \times (g_best - X_m)$$

where $$f_c = \frac{d_c}{(d_c + d_p + d_g)}, f_p = \frac{d_p}{(d_c + d_p + d_g)}, f_g = \frac{d_g}{(d_c + d_p + d_g)}$$

d_c = euclidean distance between cat and mouse current position

d_p = euclidean distance between mouse current and pbest position

d_g = euclidean distance between mouse current and gbest position

V_c = Current velocity of cat

V_m= Current velocity of mouse

X_m= Current position of mouse

r_1, r_2 = random values between 0 and 1

Next we start the approach phase where we update the positions.

$$X_c(t+1) = X_c(t) + V_c(t)$$

where $X_c(t)$ = position of cat at time t

$V_c(t)$ = velocity of cat at time t

$$X_m(t+1) = X_m(t) + V_m(t)$$

where $X_m(t)$ = position of mouse at time t

$V_m(t)$ = velocity of mouse at time t

Finally, we start the catch phase. A random parameter of all mice is changed. We calculate the new costs. If the cost of the mouse is lower, a cat has caught it.

The cat consumes the position of the mouse and a new random set is generated for the mouse.

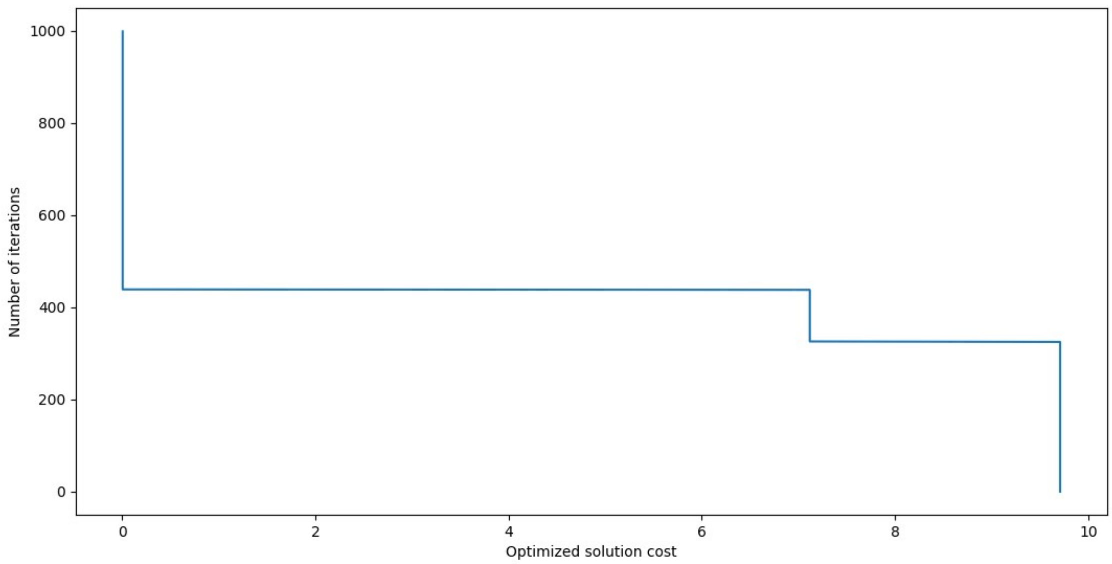
If the cat doesn’t catch it, its velocity is randomized.

Pbest and Gbest are tracked. Changes from mutation only accepted if cost is lower.

Simulations

Sphere Cost Function

$$f(x) = x^2$$

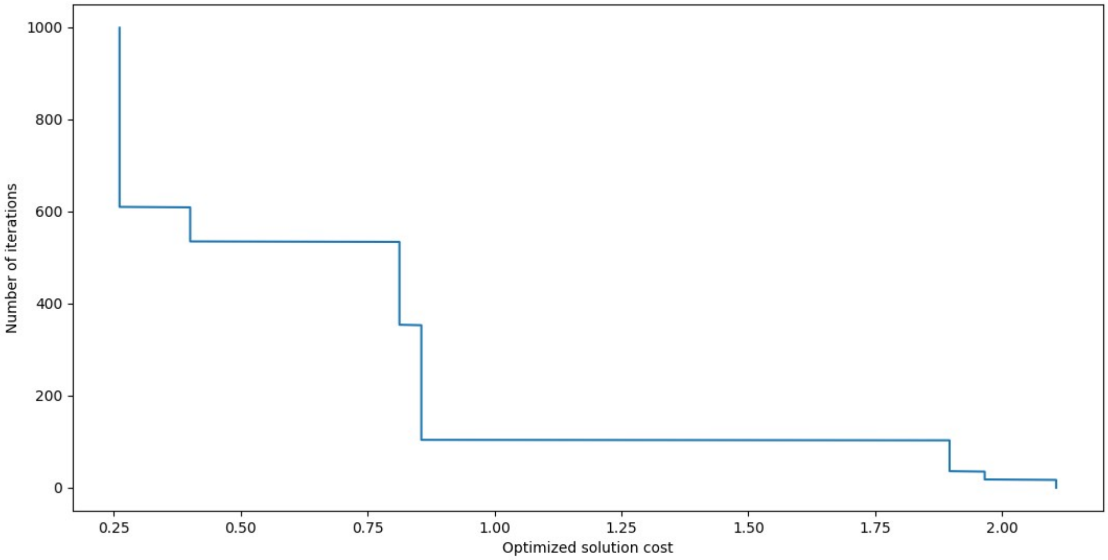


Ackley Cost Function

$$f(x_0 \cdots x_n) = -20$$

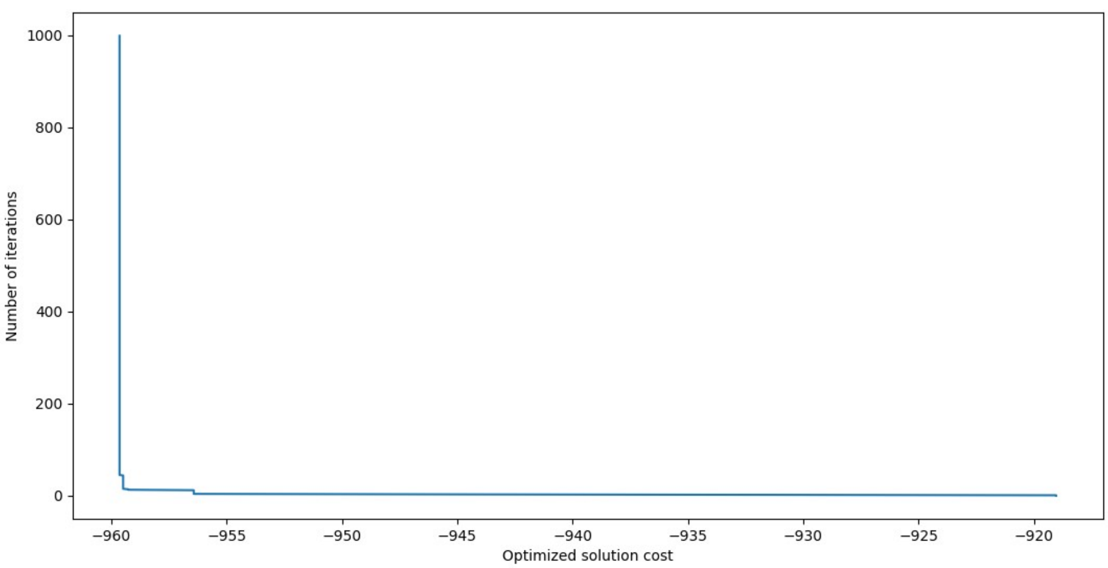
$$exp(-0.2\sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2}) - exp(\frac{1}{n}\sum_{i=1}^{n} cos(2\pi x_i)) + 20 + e\text{-}32 \leq x_i \leq 32$$

$$\text{minimum at } f(0, \cdots, 0) = 0$$



Eggholder Function

$$f(x,y) = -(y+47)\sin\sqrt{\left|\frac{x}{2}+(y+47)\right|} - x\sin\sqrt{|x-(y+47)|}$$



References

Care, I. C. (2019, February 4). *International Cat Care*. Understanding the hunting behaviour of cats | International Cat Care. Retrieved November 7, 2022, from https://icatcare.org/understanding-the-hunting-behaviour-of-pet-cats-an-introduction/#:~:text=The%20domestic%20cat%20is%20a,cats%20are%20specialised%20solitary%20hunters.

Claudi, F., Campagner, D., & Branco, T. (2022). Innate heuristics and fast learning support escape route selection in mice. *Current Biology*, *32*(13). https://doi.org/10.1016/j.cub.2022.05.020

Deer hunting optimization algorithm: A new nature-inspired Meta ... (n.d.). Retrieved November 7, 2022, from https://www.researchgate.net/publication/344771686_Deer_Hunting_Optimization_Algorithm_A_New_Nature-Inspired_Meta-heuristic_Paradigm

Dehghani, M., Hubálovský, Š., & Trojovský, P. (2021, July 31). *Cat and mouse based optimizer: A new nature-inspired optimization algorithm*. MDPI. Retrieved November 7, 2022, from https://www.mdpi.com/1424-8220/21/15/5214/htm

https://www.terminix.com/. (2022, November 4). *Mouse habitat: Where do mice live?* Terminix. Retrieved November 7, 2022, from https://www.terminix.com/rodents/mice/habitat/