Cuckoo search based approaches

Cuckoo search based approaches

- Cuckoo search was employed to optimize the Objective function. Xin-she Yang and Suash Deb in 2009
  - Inspired from the process of adaptive survival nature of cuckoo birds.
    - Cuckoo birds are a family of birds, which lay eggs in the nests of other birds for the reproduction.
    - If the host bird identifies the cuckoo egg, it destroys that egg or just leaves that nest.
    - In order to avoid such situation cuckoo bird makes eggs in such a way that they appear exactly like the host eggs.
    - This process is accomplished through a repeated process of optimization.
  - Cuckoo search algorithm uses levy flight for the optimization of the individual solutions.

Cuckoo finch eggs adapted to different hosts.

http://phys.org/news/2013-09-bird-world-cuckoo-finches-host.html

Cuckoo search

Input:

Maximum Number of Generations, G

Error tolerance, ε

Duration of unchanged error, δ

Population Size, P

Initial Step size, α_0

Number of random solutions introduced for each generations, N

Convergence criterion: (*generation* $> =$ *G*) or (*Error* $<=$ ε) or (*error unchanged for* δ *continuous generations*)

Output: Solution X

Cuckoo search

//Initialization

1. Initialize G, ε,δ,P and α_0

2. Generate *P* feasible solutions randomly and assign to *Population*

// Repeat until convergence criteria met

3. While *convergence criteria* not met **do**

// Update Population using a new Cuckoo by using Levy flight

a. Generate an individual *Cuckoo* by Levy flight with step size $\boldsymbol{\alpha} = \alpha_0/\sqrt{generation}$

b. Select an individual, *Cuckoo1* randomly from *population*

c. If fitness of *Cuckoo* **is better than** fitness of *Cuckoo1* **then**

Replace *Cuckoo1 from the population* with *Cuckoo*

d. End if

// Abandoned process and Rank based selection

g. Generate *N* feasible solutions randomly and add to *population*

h. Select the best *P* number of individuals from the *population* and abandon others

4. End while

5. end

Cuckoo search based approaches

- Modified Cuckoo search is employed to further enhance the performance S.Walton, O.Hassan, K.Morgan, M.R.Brown in 2011
  - Information exchange from the previous population
  - Found to provide better performance than the normal Cuckoo search.

Modified cuckoo search

Algorithm 2. Modified cuckoo search (MCS)

$A \leftarrow MaxLévyStepSize$
$\varphi \leftarrow GoldenRatio$
Initialise a population of n nests $\mathbf{x}_i (i = 1, 2, \ldots, n)$
for all $\mathbf{x}_i$ **do**
  Calculate fitness $F_i = f(\mathbf{x}_i)$
end for
Generation number $G \leftarrow 1$
while $NumberObjectiveEvaluations$
  $< MaxNumberEvaluations$ **do**
  $G \leftarrow G + 1$
  Sort nests by order of fitness
  for all nests to be abandoned **do**
    Current position $\mathbf{x}_i$
    Calculate Lévy flight step size $\alpha \leftarrow A/\sqrt{G}$
    Perform Lévy flight from $\mathbf{x}_i$ to generate new
    $\mathbf{x}_i \leftarrow \mathbf{x}_k$
    $F_i \leftarrow f(\mathbf{x}_i)$
  end for
  for all of the top nests **do**
    Current position $\mathbf{x}_i$
    Pick another nest from the top nests at random $\mathbf{x}_j$
    if $\mathbf{x}_i = \mathbf{x}_j$ **then**
      Calculate Lévy flight step size $\alpha \leftarrow A/G^2$
      Perform Lévy flight from $\mathbf{x}_i$ to generate new
  egg $\mathbf{x}_k$
      $F_k = f(\mathbf{x}_k)$
      Choose a random nest l from all nests
      if $(F_k > F_l)$ **do**
        $\mathbf{x}_l \leftarrow \mathbf{x}_k$
        $F_l \leftarrow F_k$
      end if
    else
      $dx = |\mathbf{x}_i - \mathbf{x}_j|/\varphi$
      Move distance dx from the worst nest to the
  best nest to find $\mathbf{x}_k$
      $F_k = f(\mathbf{x}_k)$
      Choose a random nest l from all nests
      if $(F_k > F_l)$ **then**
        $\mathbf{x}_l \leftarrow \mathbf{x}_k$
        $F_l \leftarrow F_k$
      end if
    end if
  end for
end while

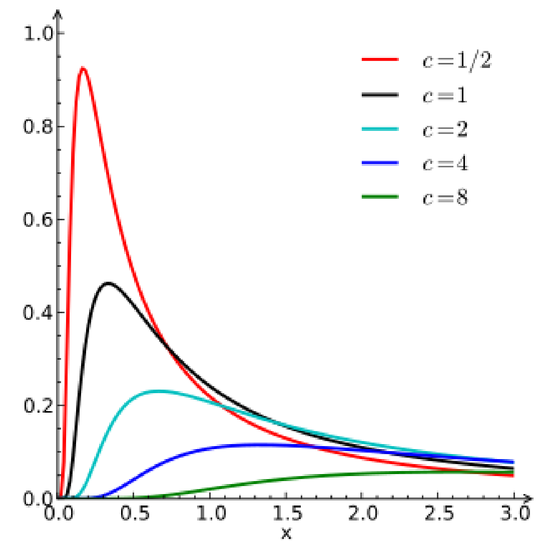
Cuckoo search and modified cuckoo search

- The L´evy flight essentially provides a random walk while the random step length is drawn from a L´evy distribution
- L´evy $u = t^{-\lambda}$, $(1 < \boldsymbol{\lambda} <= 3)$, where t is the generation number.
- $x(t+1)_i = x(t)_i + \boldsymbol{\alpha}$*L´evy() where $\boldsymbol{\alpha} = 1$.

In probability theory and statistics, the **Lévy distribution**, named after Paul Lévy, is a continuous probability distribution for a non-negative random variable.

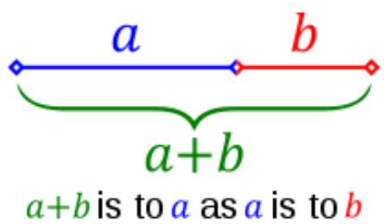
The probability density function of the Lévy distribution over the domain $x \geq \mu$ is

$$f(x;\mu,c) = \sqrt{\frac{c}{2\pi}}\;\frac{e^{-\frac{c}{2(x-\mu)}}}{(x-\mu)^{3/2}}$$



Cuckoo search and modified cuckoo search

In mathematics, two quantities are in the **golden ratio** if their ratio is the same as the ratio of their sum to the larger of the two quantities.



$$\frac{a+b}{a} = \frac{a}{b} \stackrel{\text{def}}{=} \varphi.$$

Greek letter phi (*ϕ* or *φ*) represents the golden ratio. It is an irrational number that is a solution to the quadratic equation $x^2 - x + 1 = 0$, with a value of:

$$\varphi = \frac{1+\sqrt{5}}{2} = 1.6180339887\ldots$$

The golden ratio appears in some patterns in nature, including the spiral arrangement of leaves and other plant parts.

Thank you