Firefly Algorithm

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Overview

- What is Optimization
- Introduction to Fireflies
- Firefly Algorithm
- Working Principle
- Flowchart of FA
- Advantages of FA
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What is Optimization?

- Optimization is an important tool in making decisions and in analyzing physical systems.
- Optimization problem is the problem of finding the best solution from among the set of all feasible solutions.
- Mathematicians and engineers developed many mathematical methods for solving the optimization problems.
- Based on behavior of insects or animals, who work together in order to be capable of solving the complex problems.

Formulation of an Optimization Problem

- Objective function value
- Constraint function value

Designing new models

Repeat the process until optimised solution is found

Stop process

Introduction to Fireflies

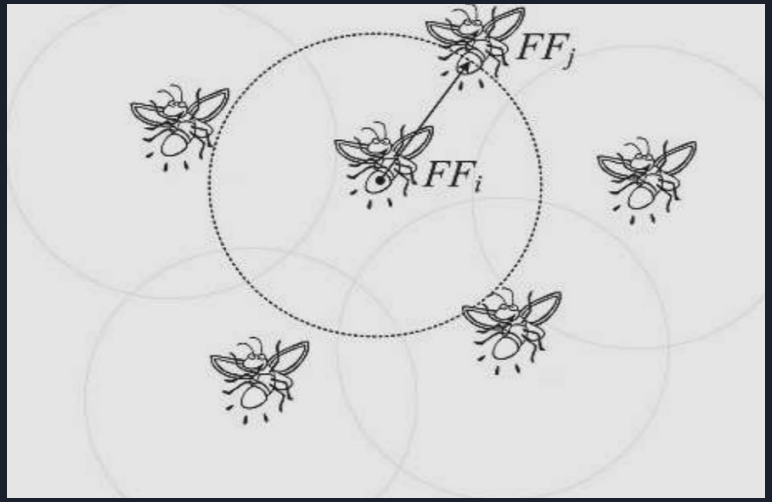
- One of the family of insects.
- Live in tropical environment.
- Produce-cold light-chemically
- Yellow, green, pale-red light
- Based on the flashing patterns and behavior of fireflies.

Behavior of fireflies

- Two fundamental functions of such flashes are:
  - to attract mating partners (communication)
  - to attract potential prey
  - protective warning mechanism
- They have unique flashing pattern.
- Females respond to a male's unique pattern of flashing in the same species.
- As the distance increases, light becomes weaker and weaker because absorption by air.
- In some species, females can mimic to hunt other species by mating pattern.

Firefly Algorithm

- Like Particle Swarm Intelligent.
- developed by Xin-She Yang at Cambridge University in 2007.
- Inspired by behavior of fireflies.



Rules for Firefly Algorithm

- All fireflies are unisex so that one firefly will be attracted to other fireflies regardless of their sex.
- Attractiveness is proportional to the brightness, and they both decrease as their distance increases.
- The brightness of a firefly determined by the objective function.

Pseudo Code

```
Objective function f(x), x = (x_1, ..., x_d)
Generate initial population of fireflies x_i (i = 1, 2, ..., n)
Light intensity I_i at x_i is determined by f(x_i)
Define light absorption coefficient
while (t <MaxGeneration)
 for i = 1 : n all n fireflies
       for j = 1 : i all n fireflies
            if (I_j > I_i), Move firefly i towards j in d-dimension; end if
             Attractiveness varies with distance r via exp[−r]
             Evaluate new solutions and update light intensity
       end for j
end for i
Rank the fireflies and find the current best
end while
Postprocess results and visualization.
```

Working Principle

1. Initialize Objective Function f(xi) :-
   In the simplest form, the light intensity I(r) varies according to the inverse square law.

$$I(r) = \frac{I_s}{r^2}$$

Where, I(r) is the intensity at the source r is the observers distance from source.

$$I = I_0 e^{-\gamma r^2}$$

If we take absorption coefficient γ into account, the light intensity varies with the square of distance r.

2. Generate Initial Population of Fireflies :-

Initialize the Fireflies population (say n) by considering the following equation:-

$$x_{t+1} = x_t + \beta_0 e^{-\gamma r^2} + \alpha\varepsilon$$

Where the second term is due to the attraction and third term is randomization with α being the randomization parameter.

3. Determine the Light Intensity Ii at xi via f(xi) :- Now determine the light intensities of each of the fireflies to find out the brightness of every firefly.

$$I = I_0 e^{-\gamma r^2}$$

4. Calculate the attractiveness of Fireflies :-

Evaluate the attractiveness of Fireflies :

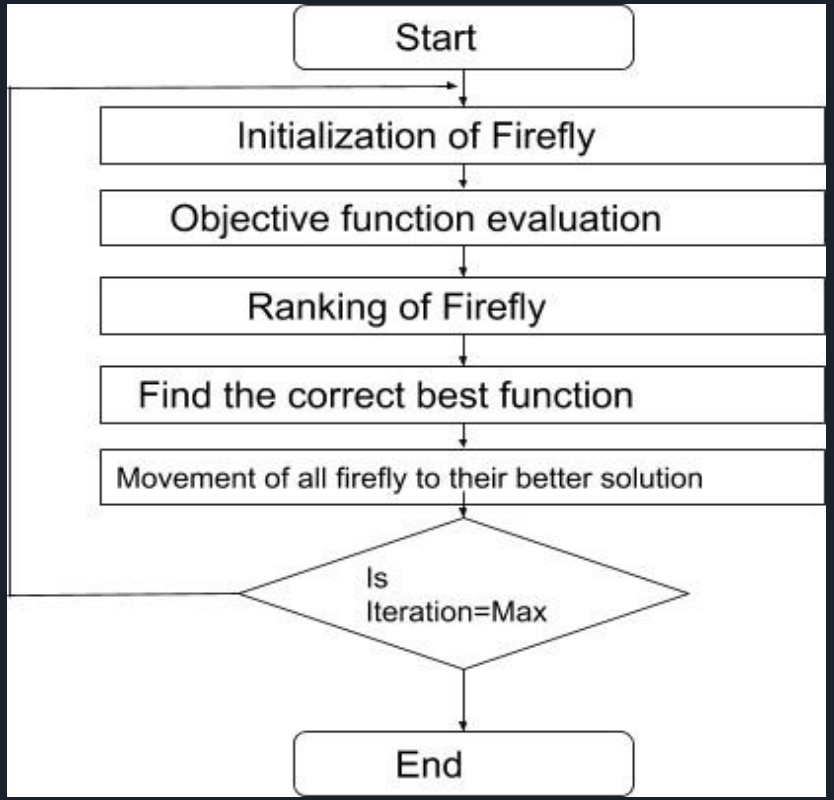
$$\beta = \beta_0 e^{-\gamma r^2}$$

5. Movement of Less Brighter Fireflies towards brighter one The movement of the firefly i is attracted to another more attractive (brighter) firefly j is determined by :-

$$x_i = x_i + \beta_0 e^{-\gamma r_{i,j}} (xj - xi) + \alpha\varepsilon$$

6. Update the Light Intensities, rank the fireflies and find the current best :- Update the Light intensities of the Fireflies and rank the fireflies. After ranking of the fireflies, find the current best solution.

Algorithm


Start
Initialization of Firefly
Objective function evaluation
Ranking of Firefly
Find the correct best function
Movement of all firefly to their better solution
Is
Iteration=Max
End

Advantages of Firefly Algorithm

- FA can deal with highly non- linear, multi-modal optimization problems naturally and efficiently.
- FA does not use velocities, and there is no problem as that associated with velocity in PSO.
- The speed of convergence of FA is very high in probability of finding the global optimized answer.
- It has the flexibility of integration with other optimization techniques to form hybrid tools.
- It does not require a good initial solution to start its iteration process.

Implementation

The data is related with direct marketing campaigns of a Portuguese banking institution. The marketing campaigns were based on phone calls. Often, more than one contact to the same client was required, in order to access if the product (bank term deposit) would be ('yes') or not ('no') subscribed.

Application Area

- For solving Travelling Salesman Problem
- Digital image compression and image processing
- Feature Selection and fault detection
- Antenna design
- Structural design
- Scheduling
- Chemical phase equilibrium
- Dynamic problems

References

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