Introduction to Particle Swarm Optimization

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Particle Swarm Algorithm

Inspired by social behavior of bird flocking and fish schooling

United we stand

Suppose a group of birds is searching food in an area

Only one piece of food is available

Birds do not have any knowledge about the location of the food

But they know how far the food is from their present location

So what is the best strategy to locate the food?

The best strategy is to follow the bird nearest to the food

Particle Swarm Algorithm

Next position

Current position

A flying bird has a position and a velocity at any time t

In search of food, the bird changes his position by adjusting the velocity

The velocity changes based on his past experience and also the feedbacks received from his neighbor

This searching process can be artificially simulated for solving non-linear optimization problem

So this is a population based stochastic optimization technique inspired by social behaviour of bird flocking or fish schooling

Particle Swarm Algorithm

Each solution is considered as bird, called particle

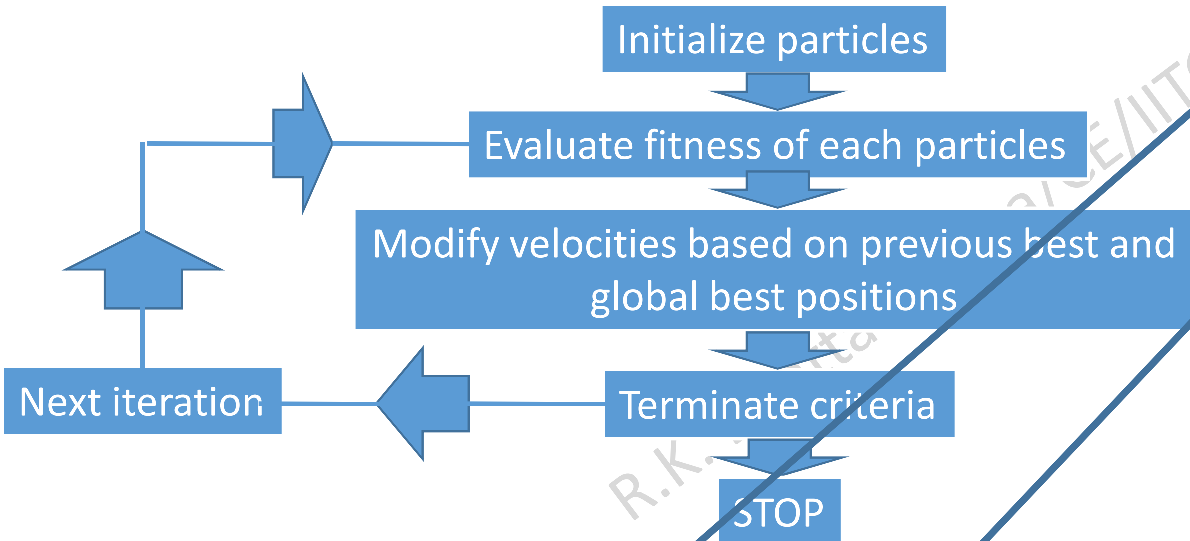
All the particles have a fitness value. The fitness values can be calculated using objective function

All the particles preserve their individual best performance

They also know the best performance of their group

They adjust their velocity considering their best performance and also considering the best performance of the best particle

Particle Swarm Algorithm



Inertia effect

Local search, personal influence

Global search, Social influence

Velocity is updated

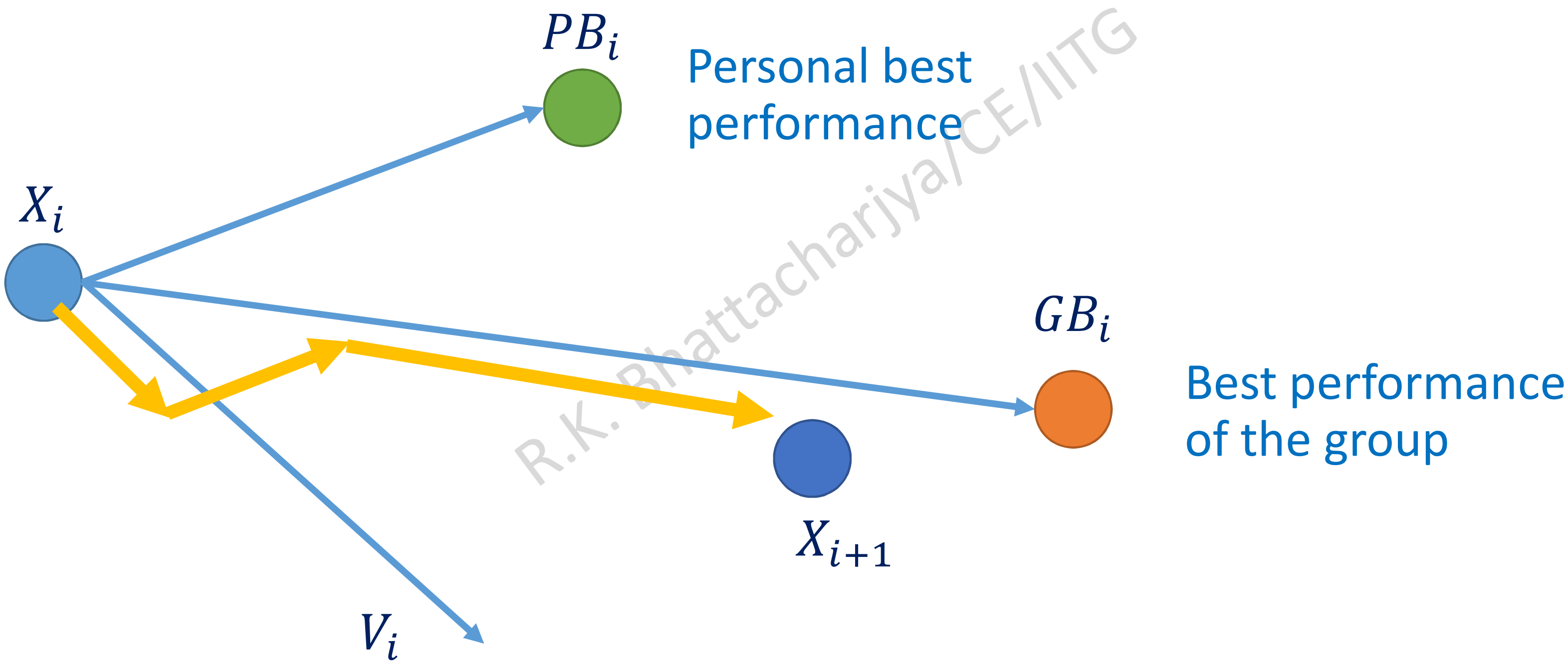
$$V_{i+1} = \omega V_i + C_1 * rand() * (PB_i - X_i) + C_2 * rand() * (GB_i - X_i)$$

Position is updated

$$X_{i+1} = X_i + V_{i+1}$$

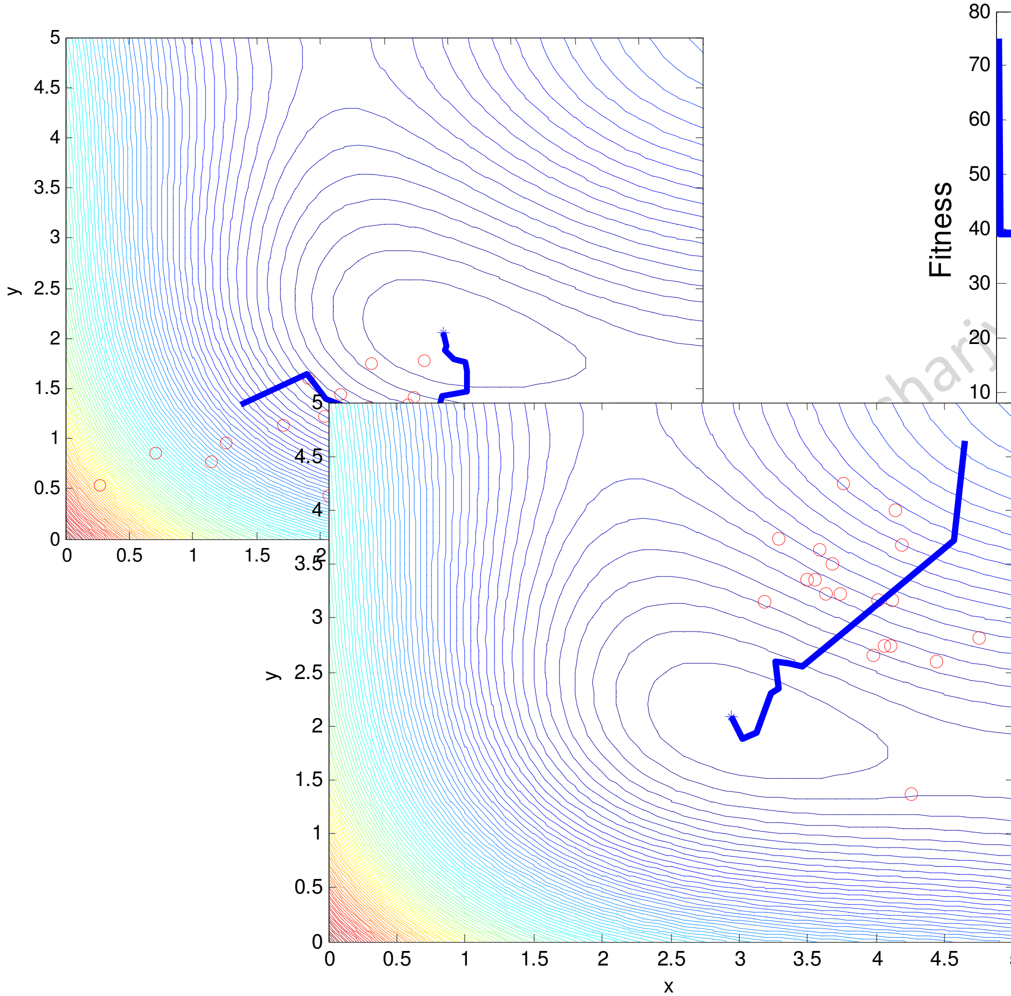
C_1 and C_2 are the learning factor
ω is the inertia weight

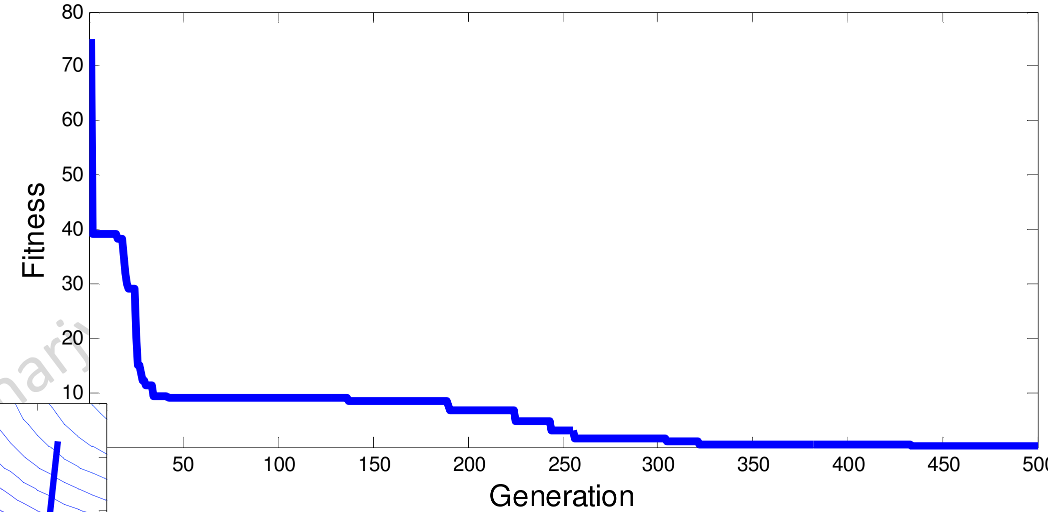
Particle Swarm Algorithm



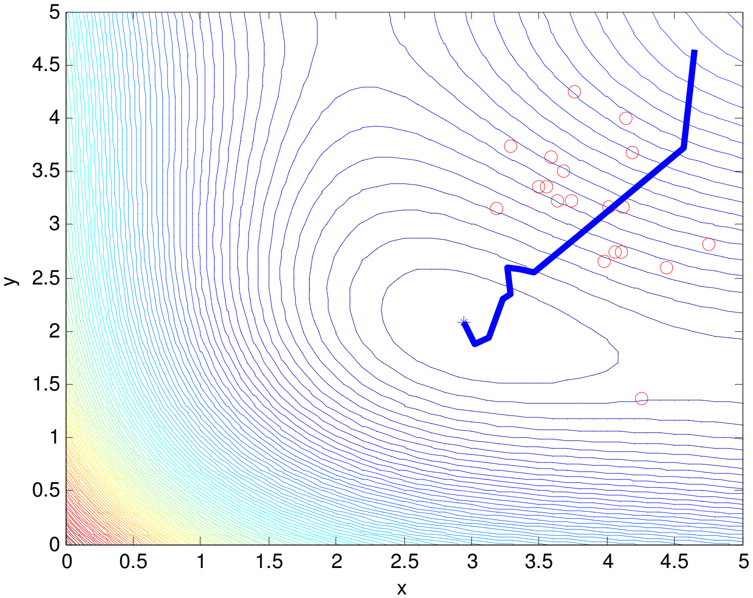
Example problem

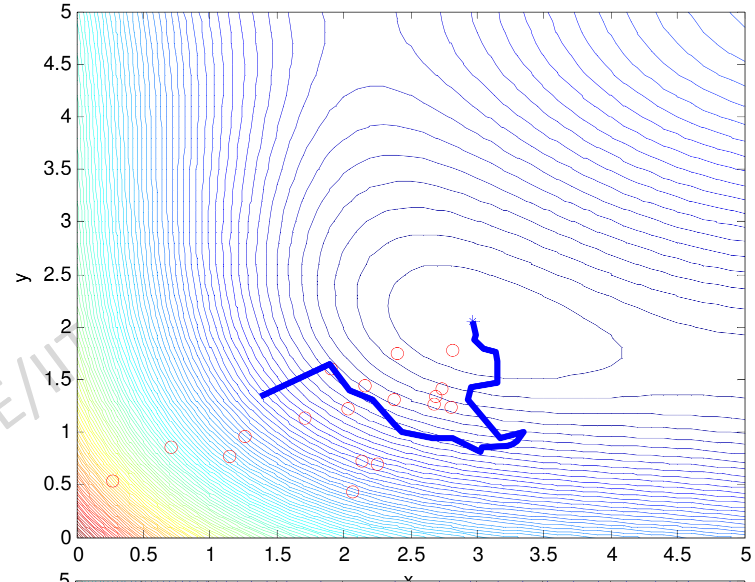
Minimize $f(x,y) = (x^2 + y - 11)^2 + (x + y^2 - 7)^2$



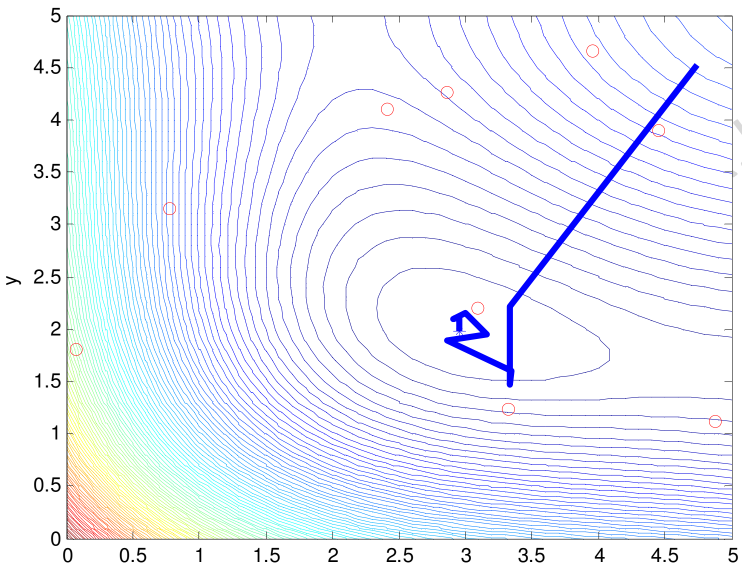


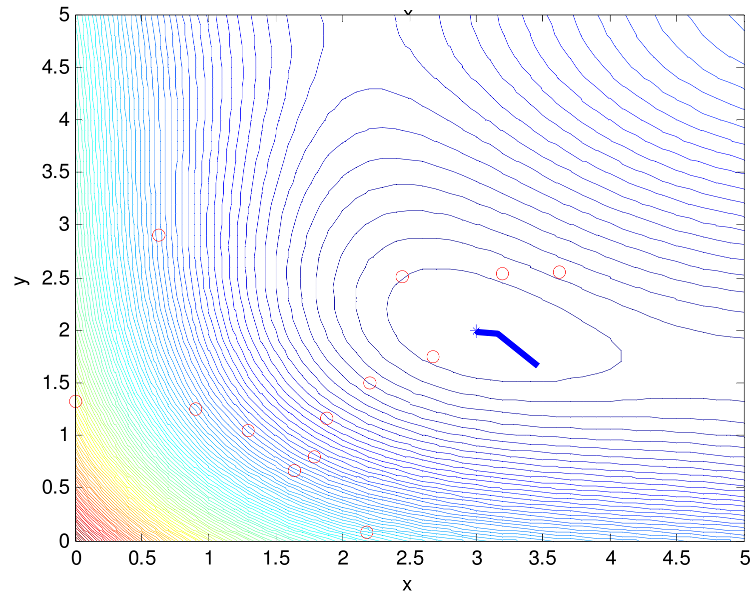
Optimum Solution is $x^* = 3, \quad y^* = 2$





Smaller value of the parameters





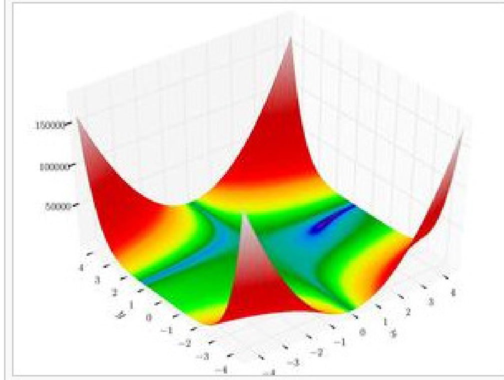
Larger value of the parameters

Examples

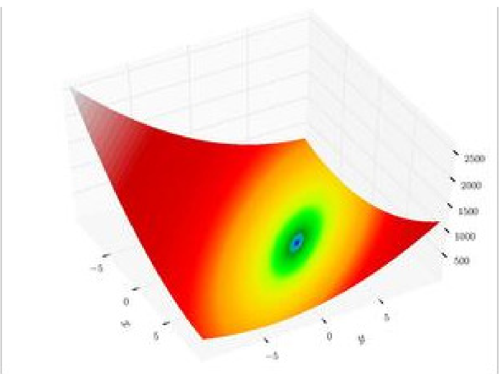
- Beale's function

$$f(x,y) = (1.5 - x + xy)^2 + \left(2.25 - x + xy^2\right)^2 + \left(2.625 - x + xy^3\right)^2$$

Minimum: $f(3, 0.5) = 0$, for $-4.5 \leq x, y \leq 4.5$.



Beale's function.



Booth's function.

- Booth's function:

$$f(x,y) = (x + 2y - 7)^2 + (2x + y - 5)^2$$

Minimum: $f(1, 3) = 0$, for $-10 \leq x, y \leq 10$.

THANKS