PARTICLE SWARM OPTIMISATION

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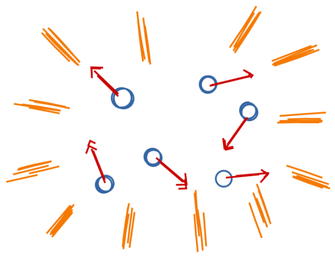
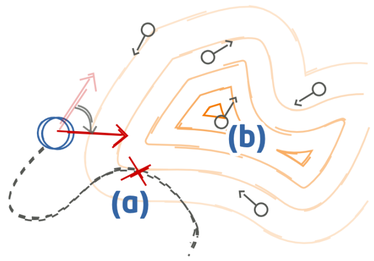
The Algorithm:

1



Generate particles with random positions in the target function space traveling at random velocities.

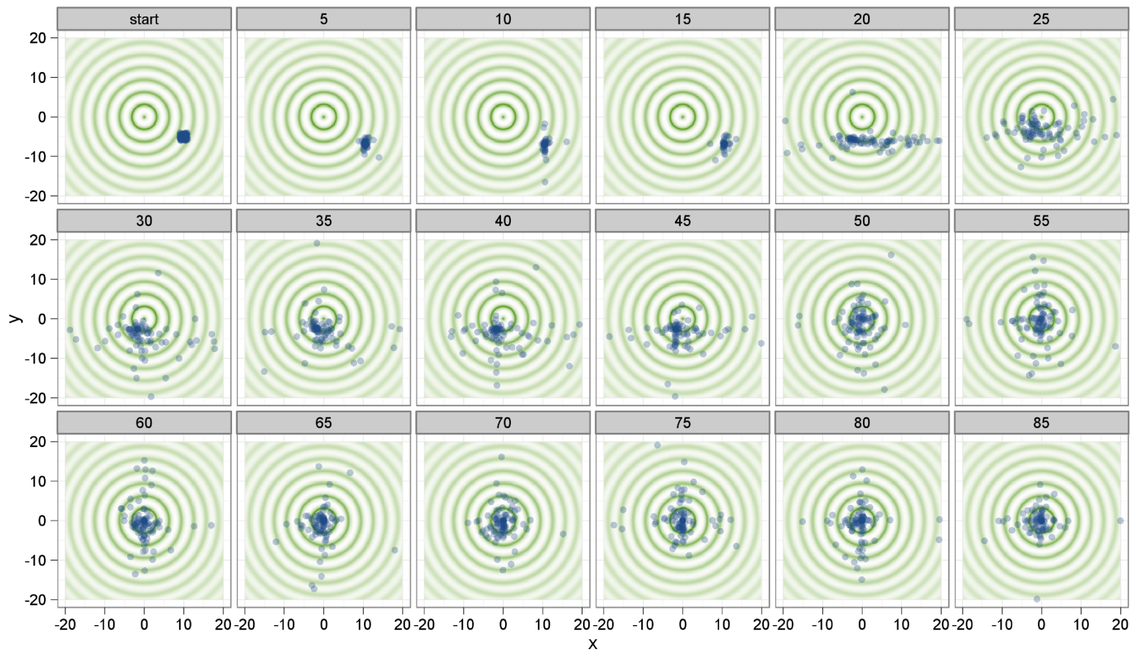
2

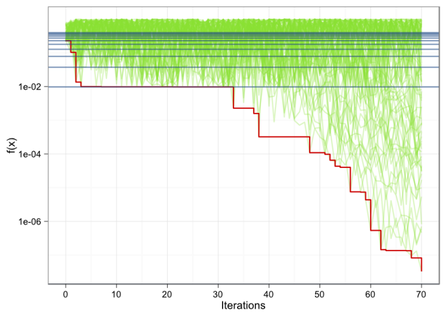


Update each particle's velocity using the best position that particle has been in **(a)** and the best particle in the swarm **(b)** with random weights.

3

Repeat step 2. Return best position found after a fixed number of iterations or when some termination criterion is met.





A run of Particle Swarm Optimisation on the 'F6' Function.

Above: Position of the particles during the run.

Left: Value of particles during the run. Best solution found so far (red). Local minima of the function (blue).

How Good Is It?

Advantages

- Function need not be differentiable
- Works on irregular and noisy data
- Relatively efficient (compared to gradient descent)

Disadvantages

- Can get trapped in local minima
- Naïve versions more easily trapped

Vs. Local Optimum Search

Upon arriving at a minimum, PSO algorithms are able to explore other minima whereas local minima search methods 'get stuck' once they converge to an optimum.

PSO is not as sensitive to the selection of initial starting point(s) as local minima algorithms.

Parameters & Variations

Velocity Update Function

$$v' \leftarrow \omega v + \varphi_p r_1 (p - x) + \varphi_g r_2 (g - x)$$

ω & φ_p & φ_g = algorithm parameters
p & g = best seen position for this particle and the entire swarm
v = particle velocity vector
x = particle position vector
r_1 & r_2 = random numbers in [0, 1]

Sub-Swarms

- Particles are split into groups.
- Particles only affect others in their group.
- Variations exist with adaptive or static groupings.

References

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Salehizadeh, S.M.A.; Yadmellat, P.; Menhaj, M.B.; , "**Local Optima Avoidable Particle Swarm Optimization**," Swarm Intelligence Symposium, 2009. SIS '09. IEEE , vol., no., pp.16-21, March 30 2009-April 2 2009

T. Hendtlass, "**WoSP: A Multi-Optima Particle Swarm Algorithm**," in Proceedings IEEE Congress on Evolutionary Computation, 2005