

Particle Swarm Optimization Algorithm

Visualization in 2D space

Ramkumar

February 10, 2024

PSO Algorithm introduction

- ▶ A non-gradient, population-based algorithm for optimization
- ▶ Inspired from the nature: flock of birds in search of food etc...
- ▶ It uses a number of particles whose position and velocity will depend on the personal and global optimum locations
- ▶ Velocity of each particle is calculated/updated on each iteration with below equation

$$\bar{v}^{(k+1)} = w\bar{v}^{(k)} + C_1r_1^{(k)} \left(\bar{p}_{best} - \bar{x}^{(k)} \right) + C_2r_2^{(k)} \left(\bar{g}_{best} - \bar{x}^{(k)} \right)$$

w, C_1, C_2 are constants, and r_1, r_2 are random values between 0 to 1 for each iteration

- ▶ The position of each particle is updated using below equation

$$\bar{x}^{(k+1)} = \bar{x}^{(k)} + \bar{v}^{(k+1)}$$

Program key points

- ▶ Code was developed using Python programming language
- ▶ Each particle was treated as an object instance from the main Particle class definition
- ▶ Main script file and a separate inputFile.py were developed to induce undisturbance to the main file
- ▶ Objective function and its sampling ranges, along with other inputs like number of particles, can be defined in the inputFile.py file
- ▶ Program will output a final_output.csv file that will contain the final position and velocity information of all particles at the end of iteration
- ▶ As optional output features, the history of each particle and the contour outputs can also be obtained from the program

Test Optimization functions

The following test functions were used for demonstration

- ▶ Deformed egg carton function

$$f(x, y) = (x - 3.14)^2 + (y - 2.2)^2 + \sin(3x + 1.41) + \sin(4y - 1.73)$$
$$0 \leq x, y \leq 5$$

- ▶ Beale function

$$f(x, y) = (1.5 - x + xy)^2 + (2.25 - x + xy^2)^2 + (2.625 - x + xy^3)^2$$
$$-4.5 \leq x, y \leq 4.5$$

- ▶ Himmelblau function

$$f(x, y) = (x^2 + y - 11)^2 + (x + y^2 - 7)^2$$
$$-5 \leq x, y \leq 5$$

- ▶ Three hump camel function

$$f(x, y) = 2x^2 - 1.05x^4 + \frac{x^6}{6} + xy + y^2$$
$$-5 \leq x, y \leq 5$$

Test Optimization functions Contd.

- ▶ Egg holder function

$$f(x, y) = -(y + 47) \sin \sqrt{\left| \frac{x}{2} + (y + 47) \right|} - x \sin \sqrt{|x - (y + 47)|}$$
$$-512 \leq x, y \leq 512$$

- ▶ McCormick function

$$f(x, y) = \sin(x + y) + (x - y)^2 - 1.5x + 2.5y + 1$$
$$-1.5 \leq x \leq 4, -3 \leq y \leq 4$$

Output from program

The following items were output from program for each test function and are present in its own directories

- ▶ final particle data such as velocity and position *final_data.csv*
- ▶ Animated video output *output.mp4*