

Special Topics on Intelligent Control: Program Report I

Deadline: May 2, 2022

Please apply at least three of the following algorithms, GA, PSO, GSA, DNA, AIM, ABC, Queen-Bee GA or any intelligent heuristic algorithms to determine the optimum values X^* and F^* of the following benchmark functions and make comparisons. Where the initial population size is 50, the maximum iteration cycle (generation) is 500 or 2500, and total 50 runs.

Unimodal benchmark functions.

Benchmark function	Dim.	Search Range	Optima
$F_2(X) = \sum_{i=1}^n x_i + \prod_{i=1}^n x_i $	30	[-10, 10]	0
$F_3(X) = \sum_{i=1}^n \left(\sum_{j=1}^i x_j \right)^2$	30	[-100, 100]	0

Multimodal benchmark functions.

Benchmark function	Dim.	Search Range	Optima
$F_{11}(X) = \frac{1}{4000} \sum_{i=1}^n x_i^2 - \prod_{i=1}^n \cos\left(\frac{x_i}{\sqrt{i}}\right) + 1$	30	[-600, 600]	0
$F_{12}(X) = \frac{\pi}{n} \left\{ 10 \sin^2(\pi y_1) \right. \\ + \sum_{i=1}^{n-1} (y_i - 1)^2 \left[1 + 10 \sin^2(\pi y_{i+1}) \right] + (y_n - 1)^2 \Big\} \\ + \sum_{i=1}^n u(x_i, 10, 100, 4) \\ y_i = 1 + \frac{x_i + 1}{4}, u(x_i, a, k, m) = \begin{cases} k(x_i - a)^m & x_i > a \\ 0 & -a \leq x_i \leq a \\ k(-x_i - a)^m & x_i < -a \end{cases}$	30	[-50, 50]	0
$F_{13}(X) = 0.1 \left\{ \sin^2(3\pi x_1) + \sum_{i=1}^{n-1} (x_i - 1)^2 \left[1 + \sin^2(3\pi x_{i+1}) \right] \right. \\ + \left. (x_n - 1)^2 \left[1 + \sin^2(2\pi x_n) \right] \right\} + \sum_{i=1}^n u(x_i, 5, 100, 4) \\ u(x_i, a, k, m) = \begin{cases} k(x_i - a)^m & x_i > a \\ 0 & -a \leq x_i \leq a \\ k(-x_i - a)^m & x_i < -a \end{cases}$	30	[-50, 50]	0

Multimodal benchmark functions with fixed dimension.

Benchmark function	Dim.	Search Range	Optima
$F_{14}(X) = \left(\frac{1}{500} + \sum_{j=1}^{25} \frac{1}{j + \sum_{i=1}^2 (x_i - a_{ij})^6} \right)^{-1}$	2	[-65, 65]	1
$F_{15}(X) = \sum_{i=1}^{11} \left[a_i - \frac{x_1(b_i^2 + b_i x_2)}{b_i^2 + b_i x_3 + x_4} \right]^2$	4	[-5, 5]	0.0003

Table A.1
 a_{ij} in F_{14} .

$$(a_{ij}) = \begin{pmatrix} -32, -16, 0, 16, 32, -32, \dots, 0, 16, 32 \\ -32, -32, -32, -32, -16, \dots, 32, 32, 32 \end{pmatrix}$$

Table A.2
 a_i and b_i in F_{15} .

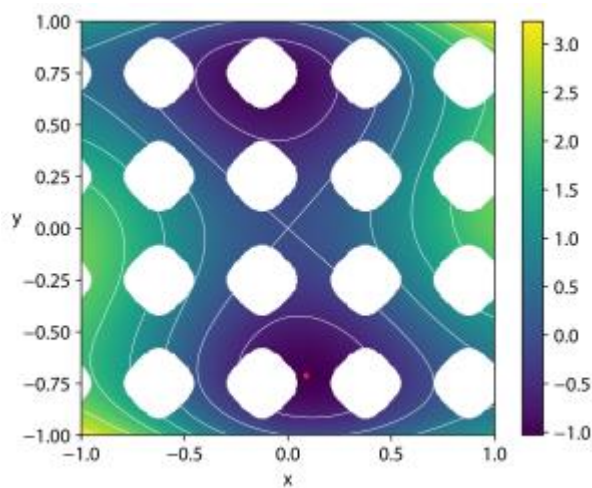
i	1	2	3	4	5	6	7	8	9	10	11
a_i	0.1957	0.1947	0.1735	0.1600	0.0844	0.0627	0.0456	0.0342	0.0342	0.0235	0.0246
b_i^{-1}	0.25	0.5	1	2	4	6	8	10	12	14	16

This program report should include “programs” and “discussions”. For discussion part, the following results should be investigated.

1. Plot the progress of the average best-so-far solution vs. iteration over 50 runs with 500 and 2500 iterations for these functions and make some comments or interpretations.
2. List a table of the averaged results over 50 runs with 500 and 2500 iterations for solutions of average best-so-far, average mean fitness, and the median best-so-far solution in the last iteration.
3. List a table of the averaged results (including mean and standard deviation) over 50 runs with 500 and 2500 iterations for the best solution in the last iteration.
4. Please also give all parameters setting in your simulations.

Extra — Test functions for multi-objective optimization

Gomez and Levy function (modified)



$$f(x, y) = 4x^2 - 2.1x^4 + \frac{1}{3}x^6 + xy - 4y^2 + 4y^4$$

Subjected to :

$$-\sin(4\pi x) + 2\sin^2(2\pi y) \leq 1.5$$

$$-1 \leq x \leq 0.75, \quad -1 \leq y \leq 1$$

$$f(0.08984201, -0.7126564) = -1.031628453$$