

1 Experiments

1.1 Pseudo-code of PGOA

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1 Require: Parameters: N, D, lb, ub, G, St, Mg, Cp, Co.
2 Ensure: Global optimum global_best and its fitness value global_min.
3 Set the group number G, then each group presents G[i](i ≤ G).
4 Initialize G[i], G[i].best, G[i].min, G[i].pop_fit of each group.
5 Initialize Np = N / G, T = max_iter / Co, n = log(G), m = 0.
6
7 for iter in 1 to max_iter:
8     for g in G:
9         if rand > 0.5:
10            do Exploration
11        else:
12            do Exploitation
13    for i in Np:
14        Update G[g].pop_fit[i], G[g].best, G[g].min, global_best, global_min
15    if communication:
16        while select groups randomly:
17            q = g ^ (2**m)
18            sorted_pop_fit = reverse(sort(pop_fit[q]))
19            expected_pop_fit = sorted_pop_fit[Np * migration]
20            Update(where fitness_func(X[q]) >= expected_pop_fit) = group_best[g]
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1.2 Uni-modal Test Functions

ID	Function	LB	UB	Dim
F1	$f(x) = \sum_{i=1}^D x_i^2$	-100	100	50
F2	$f(x) = \sum_{i=1}^D x_i + \prod_{i=1}^D x_i $	5	10	50
F3	$f(x) = \sum_{i=1}^D (\sum_{j=1}^i x_j)$	-100	100	30
F4	$f(x) = \max\{ x_i , 1 \leq i \leq n\}$	-100	100	50
F5	$f(x) = \sum_{i=1}^{D-1} [100(x_{i+1} - x_i^2)^2 + (x_i - 1)^2]$	-5	10	50
F6	$f(x) = \sum_{i=1}^D (x_i + 0.5)^2$	-100	100	50
F7	$f(x) = \sum_{i=0}^D i \cdot x_i^4 + rand(0, 1)$	-1.28	1.28	30

1.3 Multi-modal Test Functions

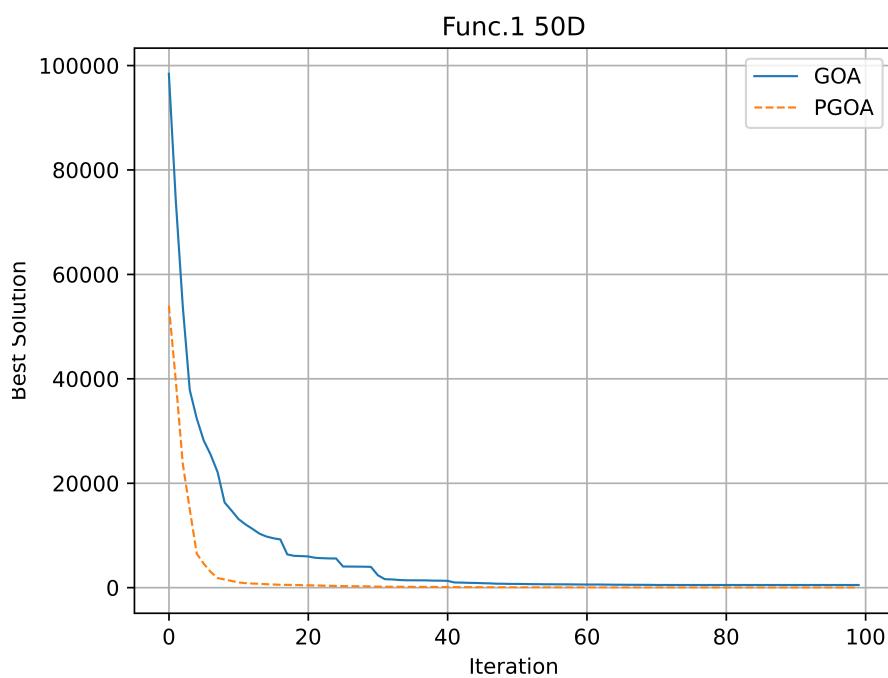
ID	Function	LB	UB	Dim
F8	$f(x) = \sum_{i=1}^D (-x \cdot \sin(\sqrt{ x_i }))$	-500	500	50
F9	$f(x) = 10D + \sum_{i=1}^D [x_i^2 - 10 \cos(2\pi x_i)]$	2.56	5.12	50
F10	$f(x) = -20 \exp\left(-0.2 \sqrt{\frac{1}{n} \sum_{i=1}^D x_i^2}\right) - \exp\left(\frac{1}{n} \sum_{i=1}^D \cos(2\pi x_i)\right) + 20 + e$	-32	32	50
F11	$f(x) = \frac{1}{4000} \sum_{i=1}^D x_i^2 - \prod_{i=1}^D \cos\left(\frac{x_i}{\sqrt{i}}\right) + 1$	300	600	50
F12	$f(x) = \frac{\pi}{D} \{10 \cdot \sin(\pi y_1)\} + \sum_{i=1}^{D-1} (y_i - 1)^2 [1 + 10 \sin^2(\pi y_i + 1) + \sum_{i=1}^D u(x_i, 10, 100, 4)], \text{ where } y_i = 1 + \frac{x_i + 1}{4}$	-50	50	30
F13	$f(x) = 0.1 (\sin^2(3\pi x_1) + \sum_{i=1}^D (x_i - 1)^2 [1 + \sin^2(3\pi x_i + 1)] + (x_n - 1)^2 + \sin^2(2\pi x_n)) + \sum_{i=1}^D u(x_i, 5, 100, 4)$	-50	50	30

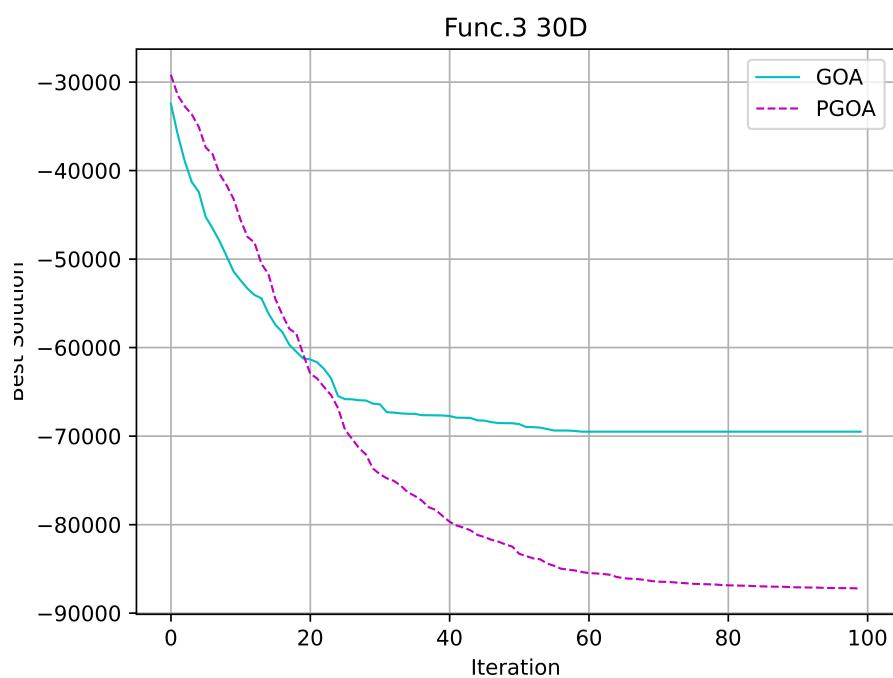
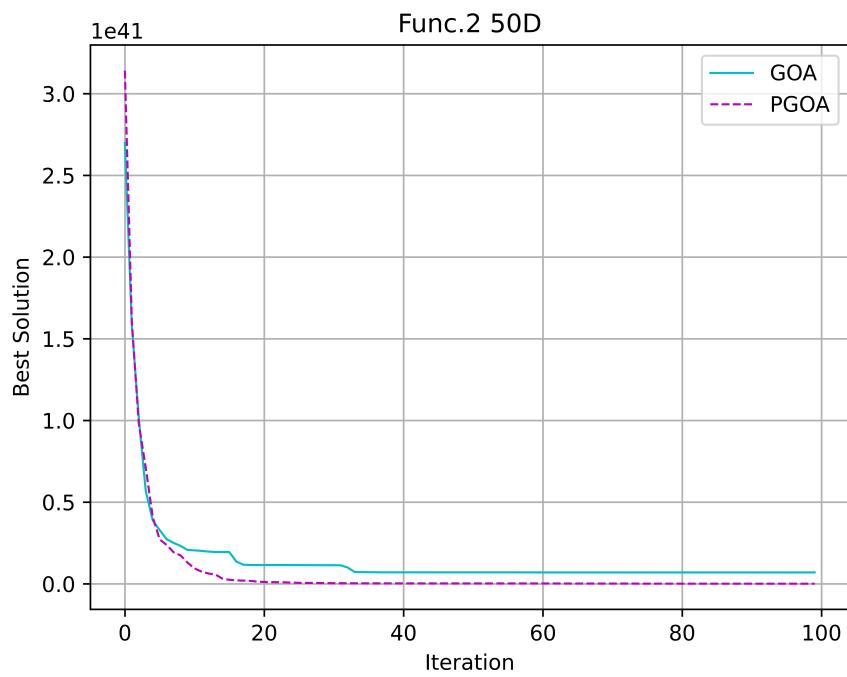
1.4 Discussions

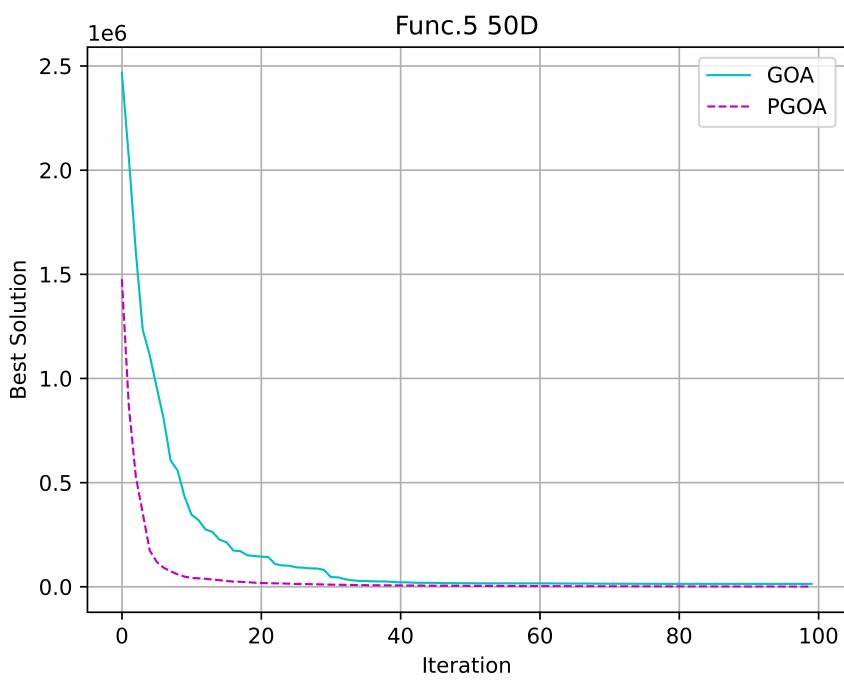
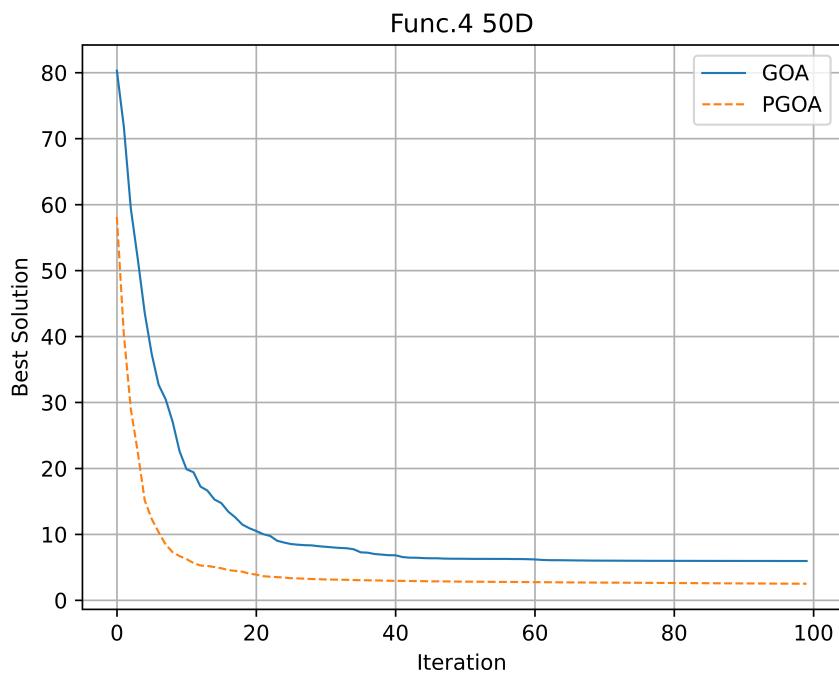
	Average	Best	Value	GOA	PGOA
F1			504.58	17.04	
F2			6.97e+39	7.03e+37	
F3			-69503.89	-87230.38	
F4			5.96	2.52	
F5			13891.70	971.43	
F6			260.01	18.73	
F7			14.38	3.07	
F8			-9863.94	-14078.60	
F9			992.35	765.23	
F10			5.46	1.64	
F11			1546.77	1345.37	
F12			32.52	5.58	
F13			12.87	2.55	

	Average Running Time	GOA	PGOA
F1	49.61s	13.05s	
F2	77.01s	24.07s	
F3	114.15s	24.64s	
F4	48.91s	13.17s	
F5	98.13s	23.28s	
F6	55.33s	14.83s	
F7	71.90s	18.95s	
F8	58.54s	15.53s	
F9	68.80s	18.05s	
F10	109.09s	28.36s	
F11	87.49s	22.75s	
F12	187.64 s	47.70 s	
F13	178.30 s	45.38 s	

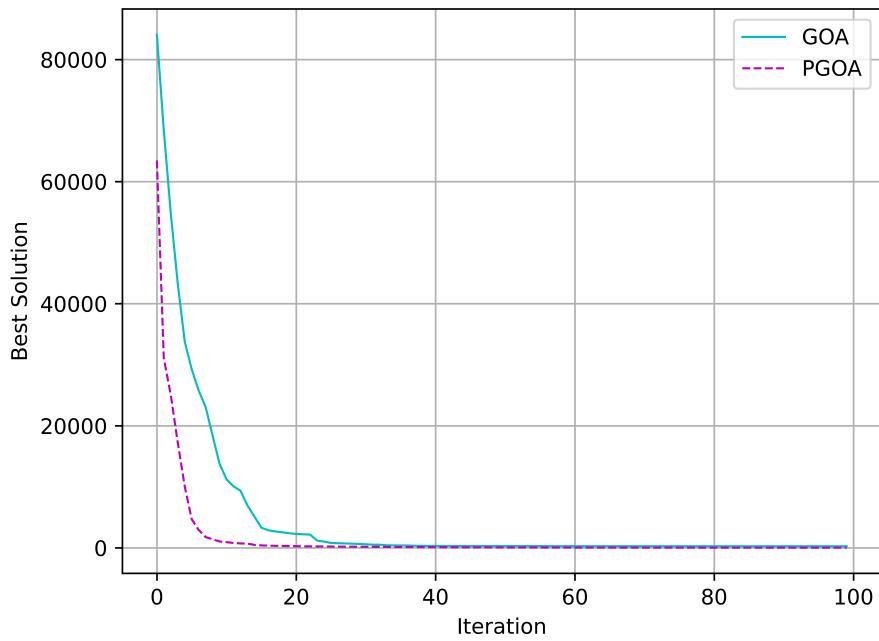
1.5 Figures



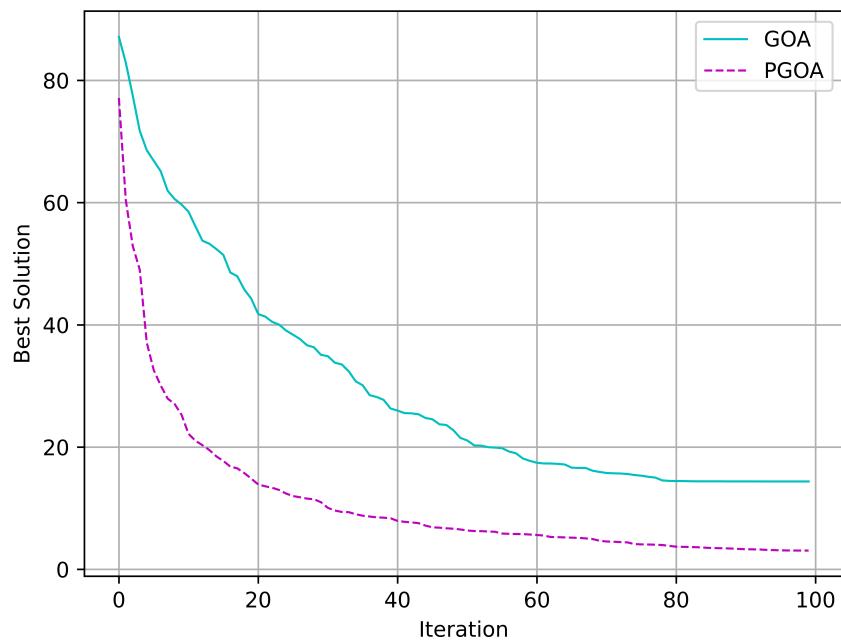




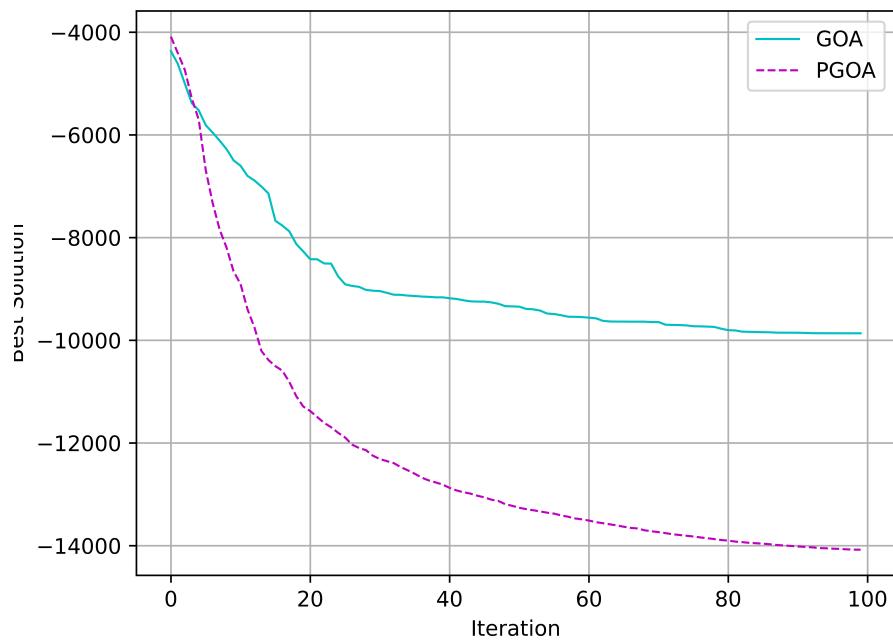
Func.6 50D



Func.7 30D



Func.8 50D



Func.9 50D

