Comparison Report of GA, DE and PSO Algorithms

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1 Algorithms Descriptions

1.1 Genetic Algorithm (GA)

An evolutionary algorithm mimicking natural selection. It initializes a random population, evaluates fitness, and generates a new population using crossover and mutation, favoring fitter individuals.

1.2 Differential Evolution (DE)

DE operates through mutation and crossover among candidate solutions. A donor vector is generated and then combined with a target vector. The better one survives to the next generation.

1.3 Particle Swarm Optimization (PSO)

2 Experimental Setup

2.1 Fixed constraints

In order to compare the robustness of different algorithms, 3 experiments will be carried out under identical constraints as shown below:

1. Search Bounds: [-5.12, 5.12]
2. Population/Swarm Size: 30
3. Generation limit: 100
4. Stopping Criteria: Pass_line < 1e-10

2.2 Configurable parameters

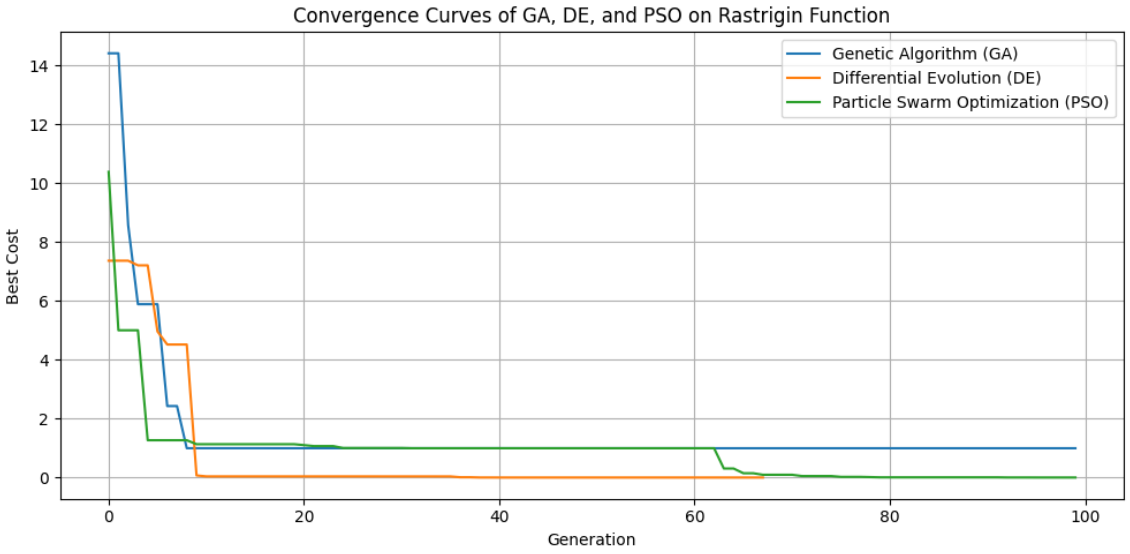
To evaluate the sensitivity of parameter in algorithms, parameters of different category in below table will be used in the experiments.

No.	Category	GA	DE	PSO
1	Conservative	MR=0.05	MF = 0.3, CR = 0.5	w = 0.7, c1 = c2 = 1.0
2	Standard	MR=0.20	MF = 0.5, CR = 0.7	w = 0.5, c1 = c2 = 2.0
3	Aggressive	MR=0.30	MF = 0.9, CR = 1.0	w = 0.3, c1 = c2 = 2.5

(MR: Mutation Rate; MF: Mutation Factor, CR: Crossover Rate; W: Inertial Weight, c1: Personal co-efficient, c2: Global co-efficient.)

3 Experiment Result

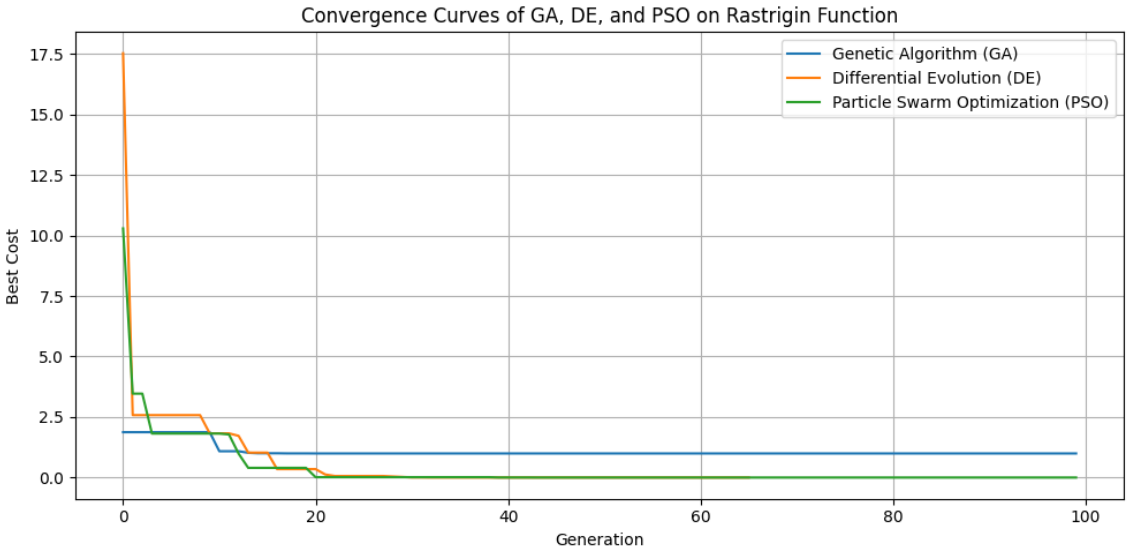
3.1 Conservative experiment



Summary of Fitness – Conservative experiment

Algorithm	Parameters	Pass_line	Result	Generation	time(ms)
GA	MR=0.05	1.00E-10	9.95E-01	100	48.625
DE	MF=0.3, CR=0.5	1.00E-10	7.76E-11	68	104.435
PSO	W=0.7, C1/2=1.0	1.00E-10	7.02E-04	100	45.298

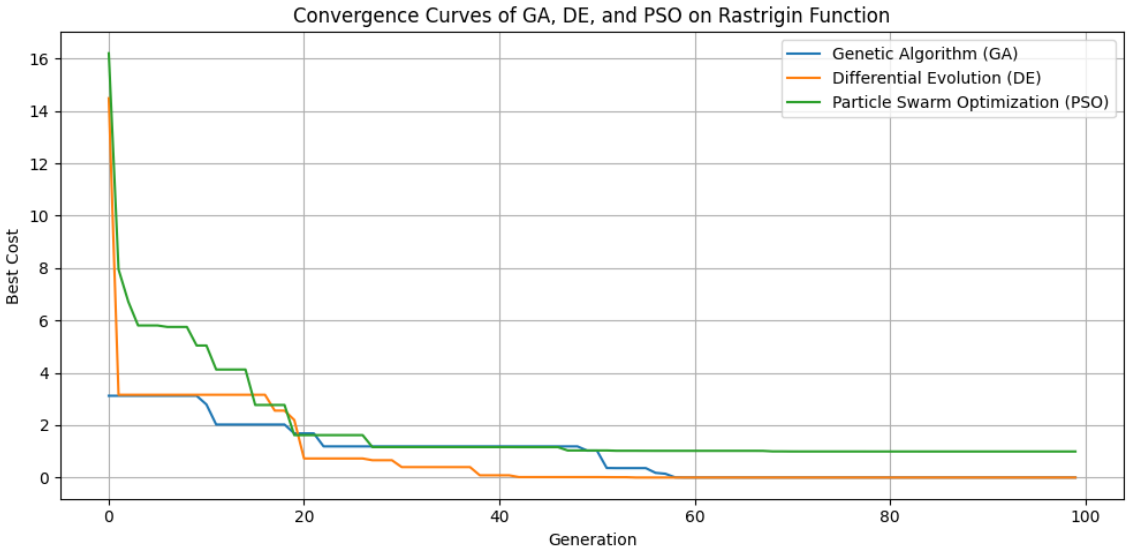
3.2 Standard experiment



Summary of Fitness – Standard experiment

Algorithm	Parameters	Pass_line	Result	Generation	time(ms)
GA	MR=0.2	1.00E-10	9.95E-01	100	48.57
DE	MF=0.5, CR=0.7	1.00E-10	7.59E-11	66	104.292
PSO	W=0.5, C1/2=2.0	1.00E-10	8.51E-09	100	54.7

3.3 Aggressive experiment



Summary of Fitness – Aggressive experiment

Algorithm	Parameters	Pass_line	Result	Generation	time(ms)
GA	MR=0.3	1.00E-10	6.52E-04	100	44.75
DE	MF=0.9, CR=1.0	1.00E-10	2.56E-09	100	138.224
PSO	W=0.3, C1/2=2.5	1.00E-10	9.95E-01	100	49.663

4 Data Analysis

4.1 Overall Performance

Fitness Value: DE < PSO < GA

Convergence time: GA < PSO < DE

(Only DE consistently achieved the target of 1E-10.)

4.2 Genetic Algorithm (GA)

Fitness Value: Aggressive < Standard = Conservative

Convergence time: Conservative < Standard < Aggressive

4.3 Differential Evolution (DE)

Fitness Value:	Conservative $\approx$ Standard < Aggressive
Convergence time:	Conservative = Standard < Aggressive

4.4 Particle Swarm Optimization (PSO)

Fitness Value:	Standard < Conservative < Aggressive
Convergence time:	Standard < Aggressive < Conservative

4.5 Conclusion

If accuracy (hitting the 1E-10 target) is the top priority, “DE with aggressive parameter sets” is clearly superior than the rest combinations.

If speed is more important than precision (e.g., real-time applications), “GA with conservative parameter sets” is faster, but acceptable fitness may fail to reach sometimes.

If you want to draw a balance between accuracy and efficiency, “PSO with standard parameter sets” will be the preferred choice.