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)

Inspired by the social behavior of birds, PSO maintains a swarm of particles that explore the search space, guided by their personal best and the global best positions found so far.

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

图表, 折线图

AI 生成的内容可能不正确。

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

图形用户界面, 表格

AI 生成的内容可能不正确。

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

图表, 折线图

AI 生成的内容可能不正确。

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 ≈ 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.