Results of the Competition on High-dimensional Global Optimization at WCCI2010

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Introduction

- Numerical optimization one of the most important disciplines in optimization
- Number of decision variables = scale of a problem
- Large-Scale problems are challenging for optimization algorithms
- Runtime often quickly increases with scale
- Solution quality (objective value) often quickly decreases with scale
- Variable interactions (non-separability) makes problems hard
- Challenge: Find efficient optimization algorithm for large-scale problems under realistic separability assumptions
Large-Scale Global Optimization Challenge

- Scale: \( D = 1000 \) dimensions
- 20 benchmark functions:
  1. 3 separable functions
  2. 5 single-group \( m \)-non-separable functions (\( m = 50 \))
  3. 5 \( \frac{D}{2m} \)-group \( m \)-non-separable functions (\( m = 50 \))
  4. 5 \( \frac{D}{m} \)-group \( m \)-non-separable functions (\( m = 50 \))
  5. 2 fully non-separable functions

- Separable functions rotated by random rotation matrix ⇒ non-separable
- Functions shifted by random vector ⇒ optima ≠ center of search space
- Groups are not continuous fractions of solution vectors: instead random elements are grouped together
## Large-Scale Global Optimization Challenge

<table>
<thead>
<tr>
<th>FEs</th>
<th>Problem</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
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<tbody>
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<td>Mean</td>
<td>Std</td>
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</table>

### Competition Categories

- **20 **3 **5 = 300**

### FE Limits

- A. 1.2e5
- B. 6.0e5
- C. 3.0e6
Large-Scale Global Optimization Challenge

• For each of the 300 categories, we apply the Formula 1 point system\(^1\)

• The participant with the highest score sum wins

• In all categories holds: the smaller the measured value, the better (small standard deviations, e.g., mean more reliable performance)

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\(^1\) http://en.wikipedia.org/wiki/Formula_One_regulations [2010-06-23]

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Table 1: Formula 1 point system
Participants

- C-7136 Differential Ant-Stigmergy Algorithm
- C-7273 Sequential DE Enhanced by Neighborhood Search
- C-7306 Two-stage based Ensemble Optimization
- C-7330 MA-SW-Chains: Memetic Algorithm Based on Local Search Chains
- C-7392 Self-adaptive Differential Evolution Algorithm
- C-7597 Cooperative Co-evolution with Delta Grouping
- C-7938 Dynamic Multi-Swarm Particle Swarm Optimizer with Subregional Harmony Search
- C-7406 Locust Swarms for Large Scale Global Optimization
- C-7939-A Classic Differential Evolution Algorithm ($CR = 0.0$)
- C-7939-B Classic Differential Evolution Algorithm ($CR = 0.9$)
Results: Scores per Problem Class

① in the 3 separable functions
Results: Scores per Problem Class

in the 5 single-group $m$-non-separable functions ($m = 50$)
Results: Scores per Problem Class

in the $\frac{D}{2m}$-group $m$-non-separable functions ($m = 50$)
Results: Scores per Problem Class

4 in the $\frac{D}{m}$-group $m$-non-separable functions ($m = 50$)
Results: Scores per Problem Class

5 in the 2 fully non-separable functions
Results: Scores per FE Limit

for 1.2e5 function evaluations

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<th>Score</th>
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<th>D/2m group</th>
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</table>
Results: Scores per FE Limit

for 6.0e5 function evaluations
Results: Scores per FE Limit

© for 3e6 function evaluations
Results: Overall Scores

- fully non-separable
- D/m group
- D/2m group
- single-group
- fully separable
Winners

1. C-7330
   5293 Points
   MA-SW Chains

2. C-7306
   4323 Points
   2-Stage Ensemble

3. C-7938
   4085 Points
   Multi-PSO+ Harmony

4. C-7135
   4048 Points
   Differential Ants
Summary

• Nine teams from nine countries (four continents)

• Most results are excellent and far superior to previous/traditional methods (such as C-7939)

• Clear winner: Memetic Algorithm based on Local Search Chains
  - Strong especially in the early stage of the optimization process

• Places 2 to 4 very close:
  - Two-stage based Ensemble Optimization
  - Dynamic Multi-Swarm Particle Swarm Optimizer with Subregional Harmony Search
  - Differential Ant-Stigmergy Algorithm
Thank you very much for your attention!

Any questions?

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