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

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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

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Large-Scale Global Optimization Challenge

		F_1	F_2	F_3	F_4	F_5	F_6	F_7
FEs= 12e5	Best	0.00e+00	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx
	Median							
	Worst							
	Mean							
	Std							
FEs= 60e5	Best							
	Median							
	Worst							
	Mean							
	Std							
FEs= 30e6	Best							
	Median							
	Worst							
	Mean							
	Std							

		F_8	F_9	F_{10}	F_{11}	F_{12}	F_{13}	F_{14}
FEs= 12e5	Best							
	Median							
	Worst							
	Mean							
	Std							
FEs= 60e5	Best							
	Median							
	Worst							
	Mean							
	Std							
FEs= 30e6	Best							
	Median							
	Worst							
	Mean							
	Std							

		F_{15}	F_{16}	F_{17}	F_{18}	F_{19}	F_{20}	
FEs= 12e5	Best							
	Median							
	Worst							
	Mean							
	Std							
FEs= 60e5	Best							
	Median							
	Worst							
	Mean							
	Std							
FEs= 30e6	Best							
	Median							
	Worst							
	Mean							
	Std							

20 * 3 * 5 = 300 competition categories

The 3 FE limits are:

Ⓐ 1.2e5

Ⓑ 6.0e5

Ⓒ 3.0e6

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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)

Place	Points
1	25
2	18
3	15
4	12
5	10
6	8
7	6
8	4
9	2
10	1

Table 1: Formula 1 point system

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

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 $(CR = 0.9)$

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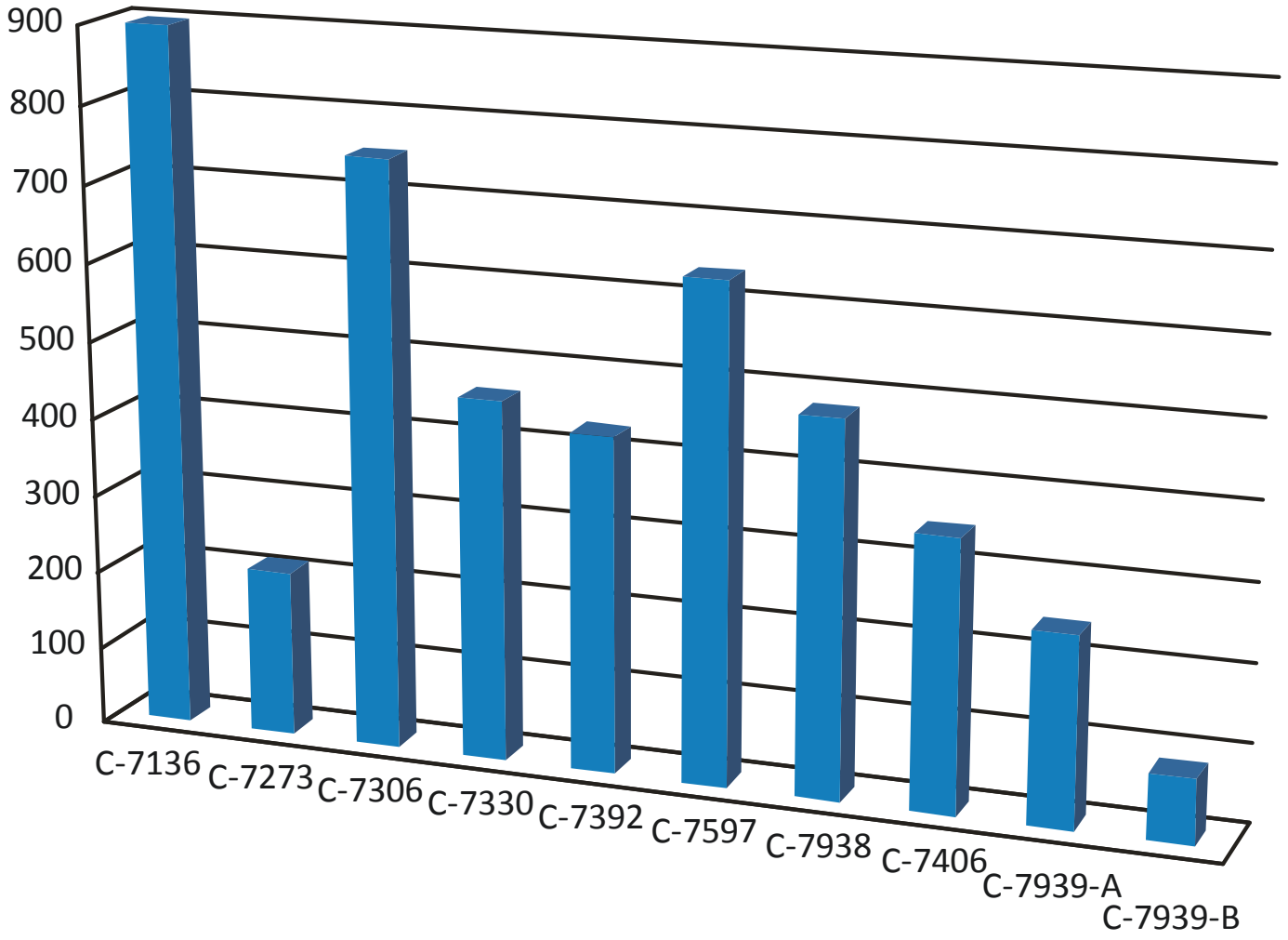
Results: Scores per Problem Class

① in the 3 separable functions



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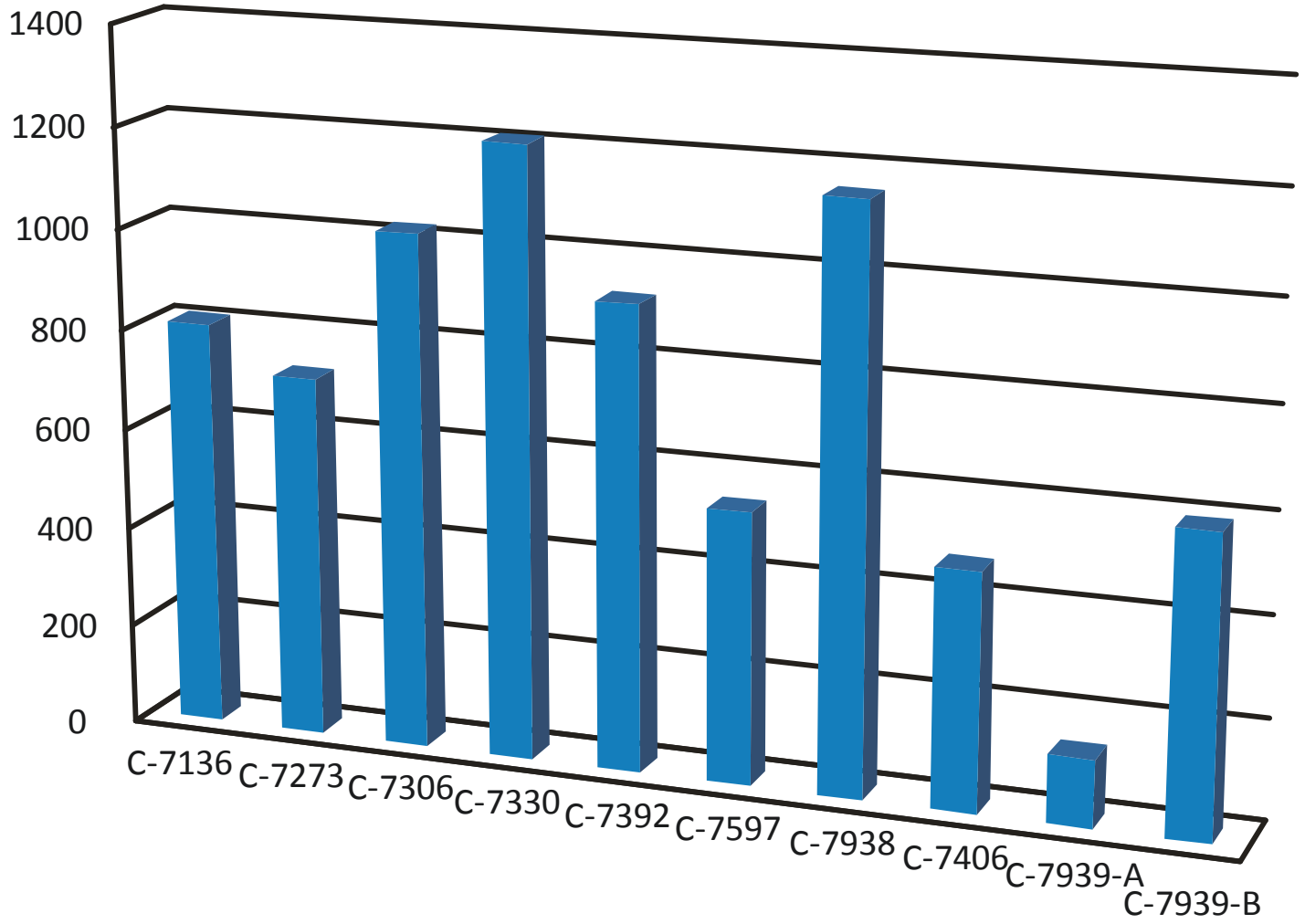
Results: Scores per Problem Class

② in the 5 single-group m-non-separable functions $(m = 50)$



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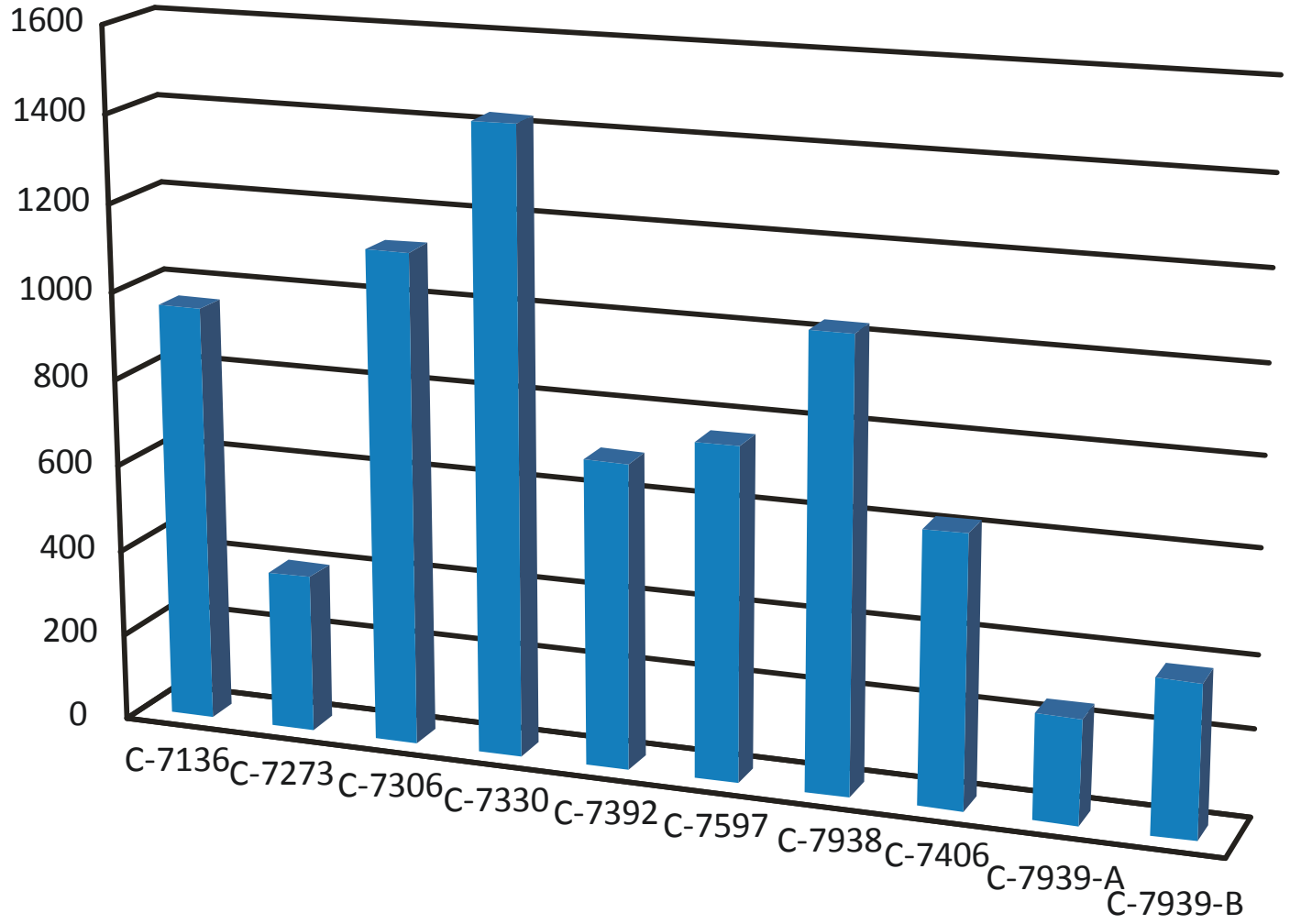
Results: Scores per Problem Class

③ in the 5 $\frac{D}{2m}$-group m-non-separable functions $(m = 50)$



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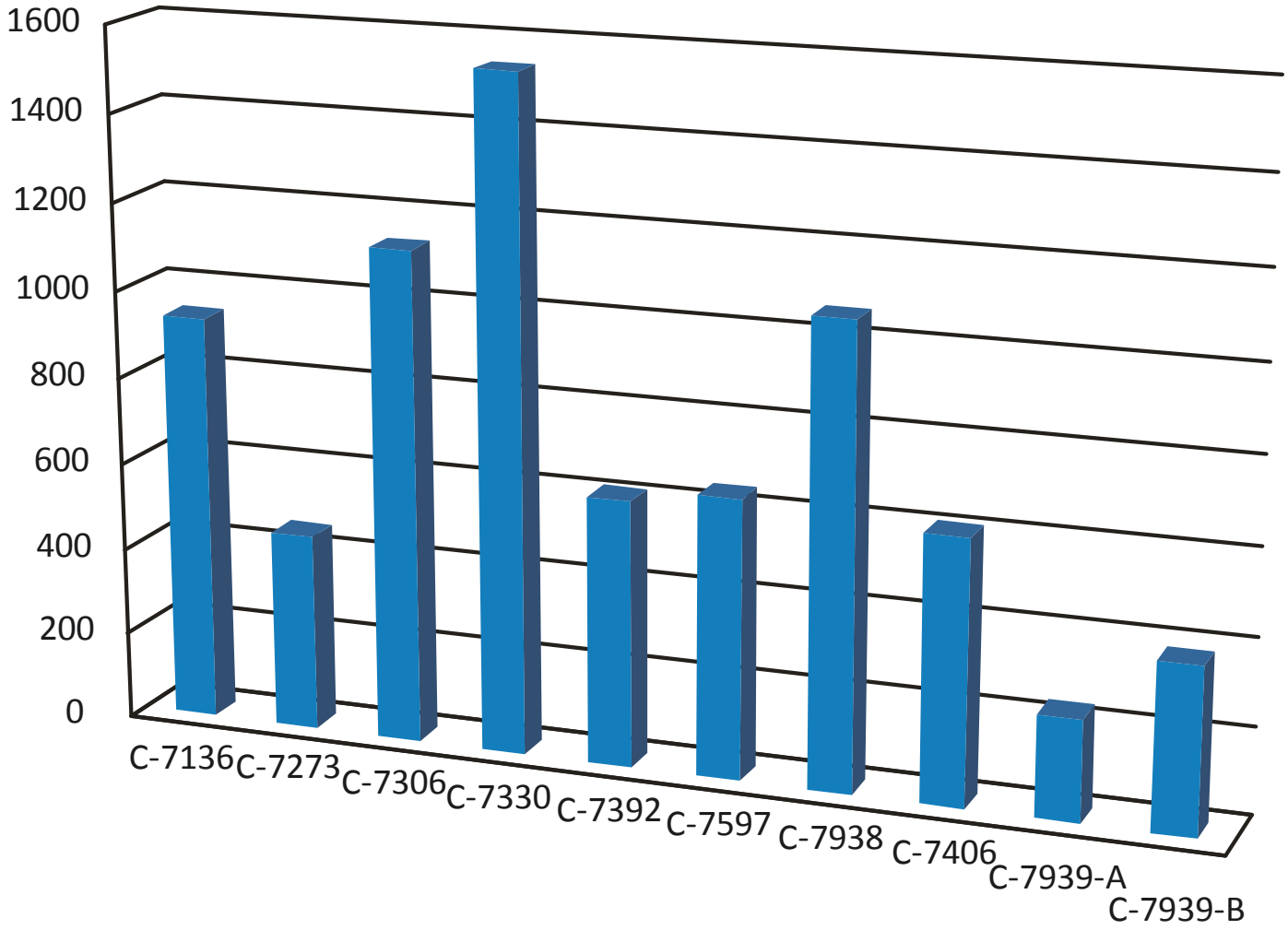
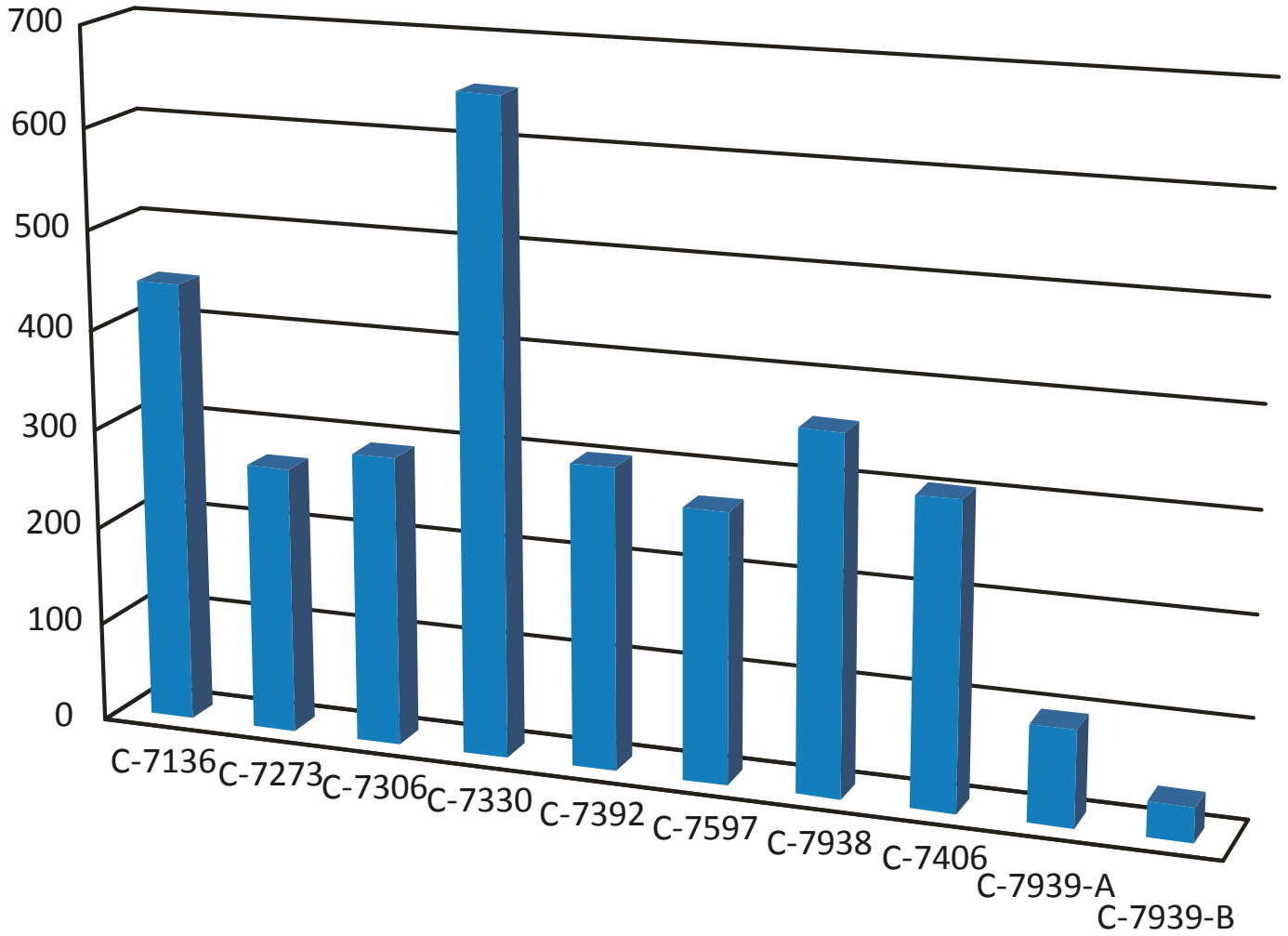
Results: Scores per Problem Class

④ in the 5 $\frac{D}{m}$-group m-non-separable functions $(m = 50)$



Results: Scores per Problem Class

⑤ in the 2 fully non-separable functions



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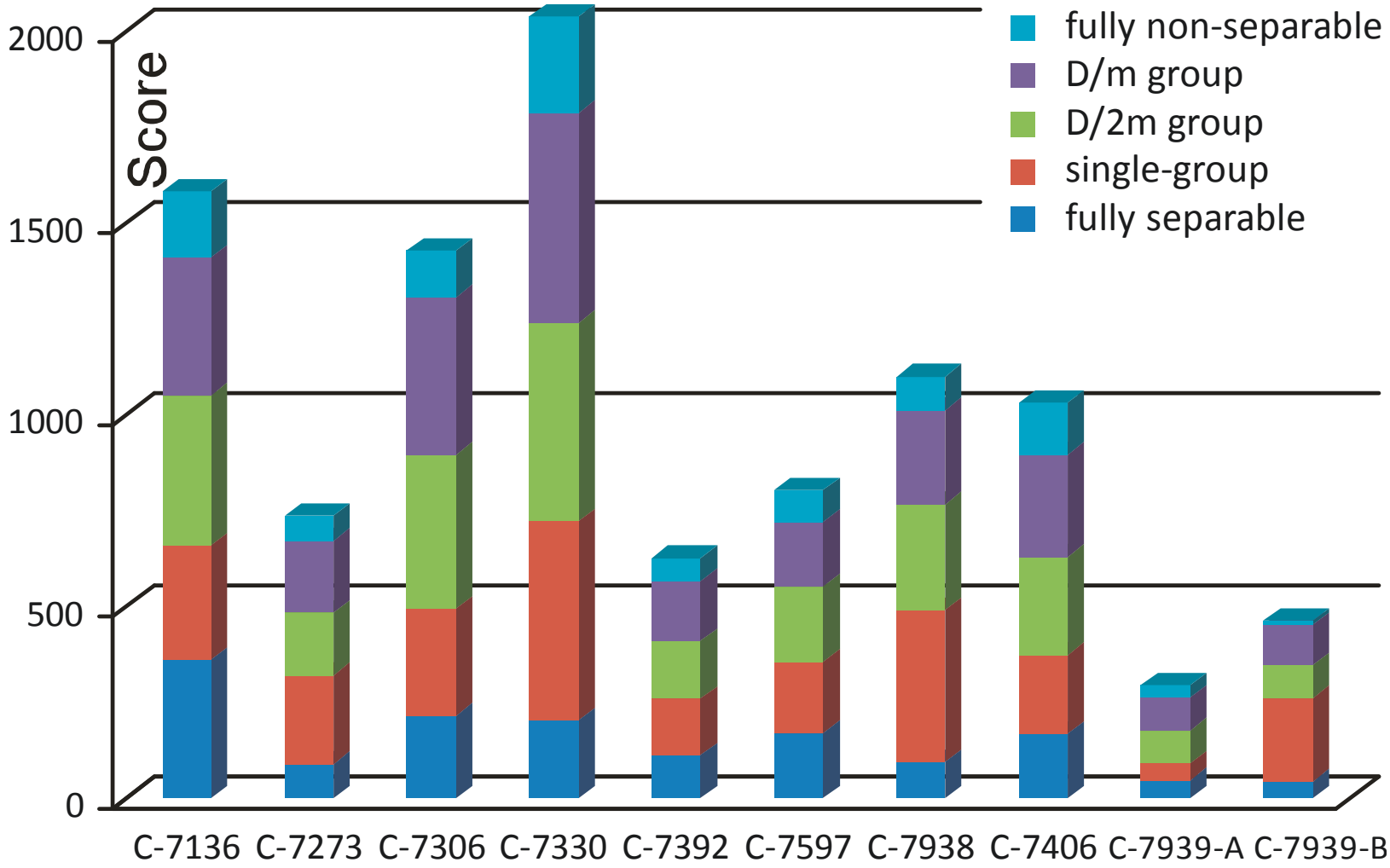
Results: Scores per FE Limit

Ⓐ for 1.2e5 function evaluations



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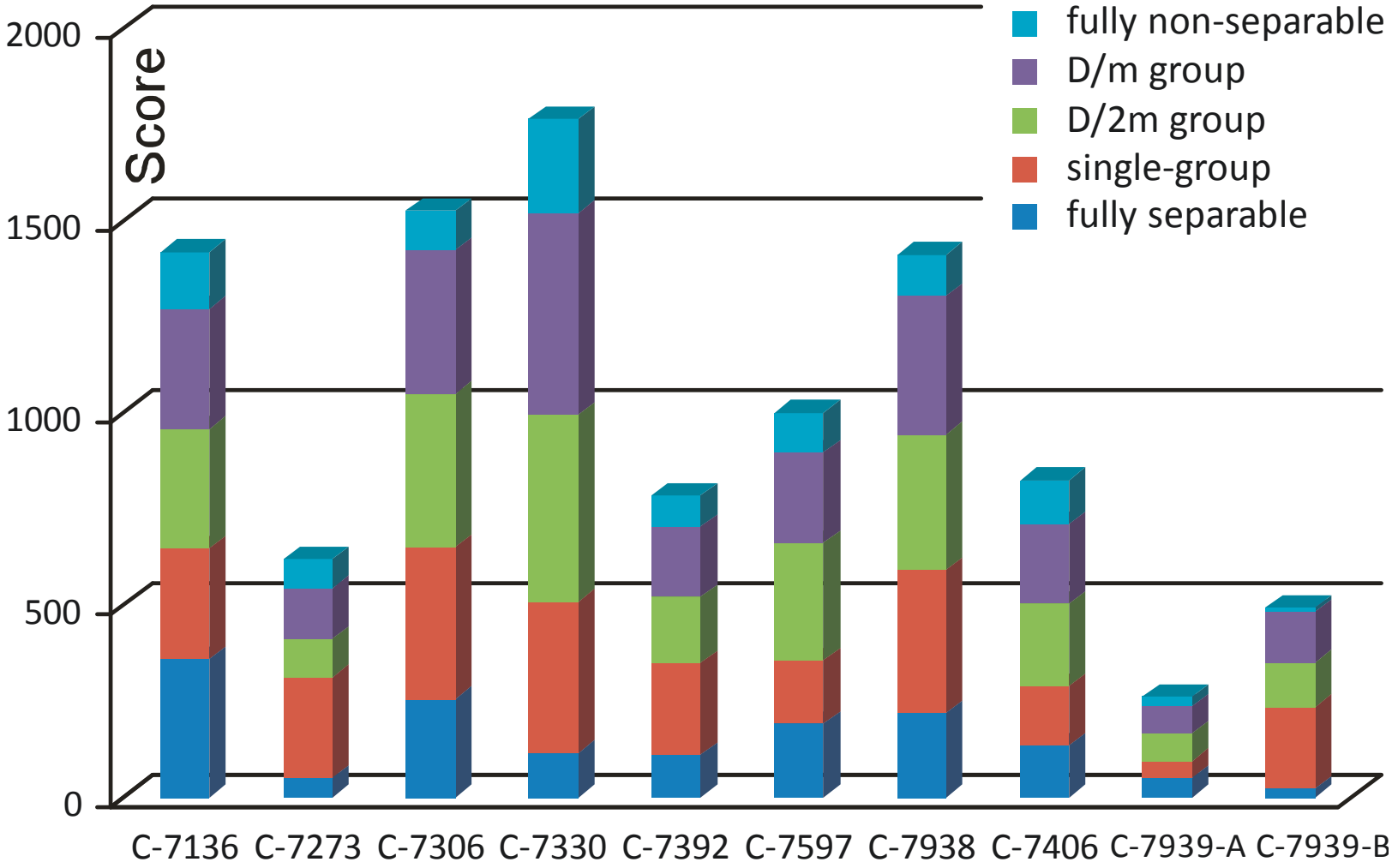
Results: Scores per FE Limit

- for 6.0e5 function evaluations



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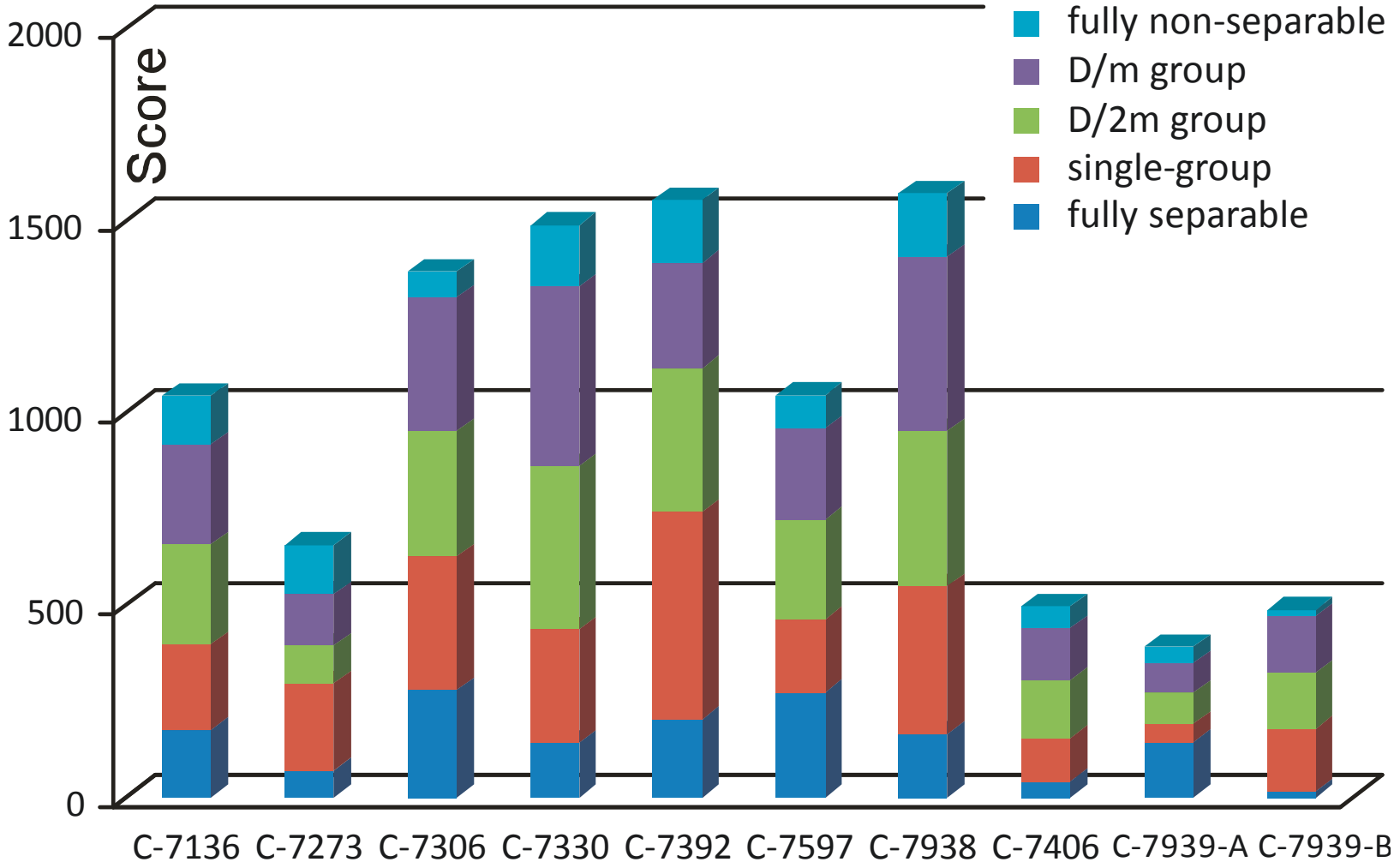
Results: Scores per FE Limit

© for 3e6 function evaluations



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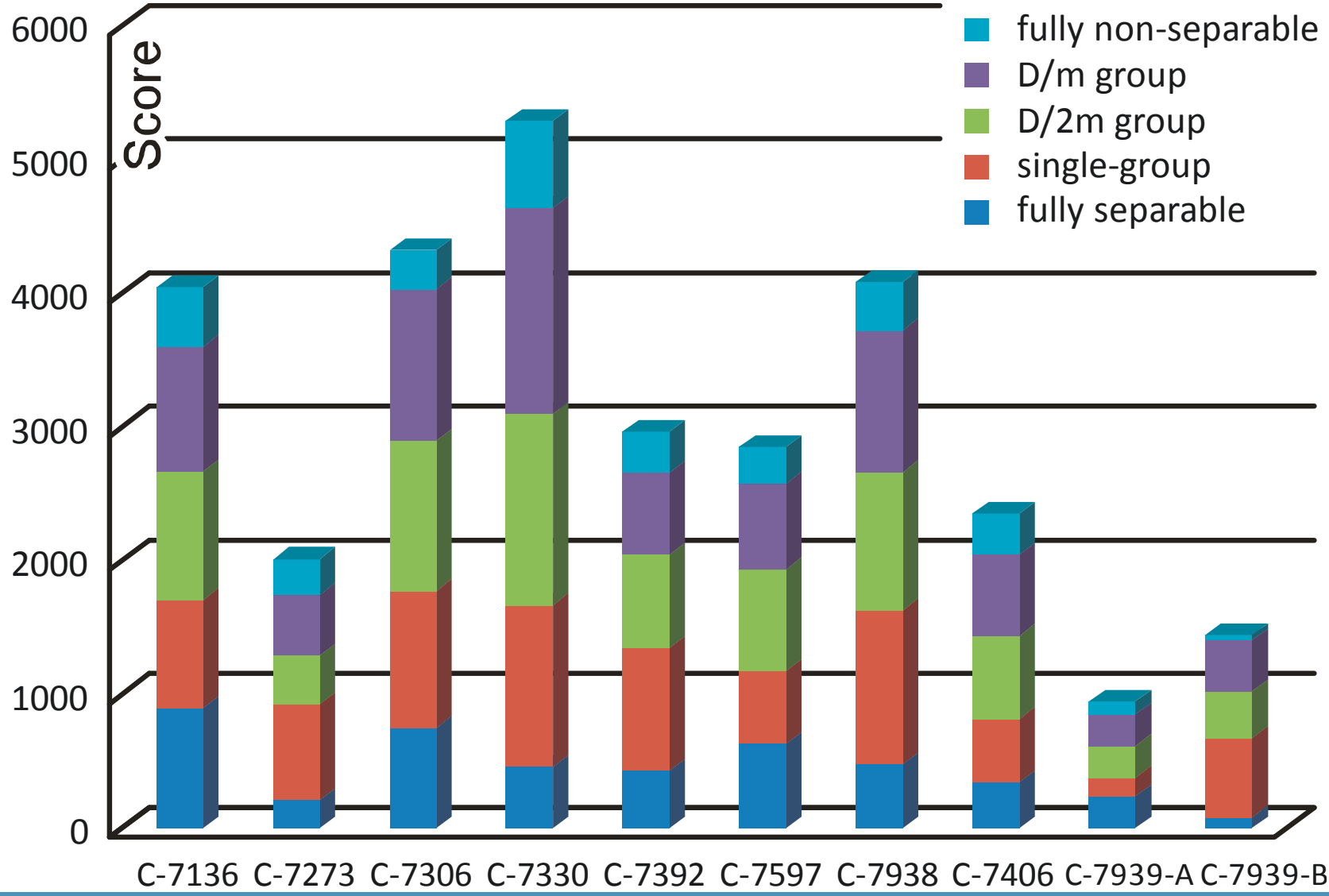
Results: Overall Scores



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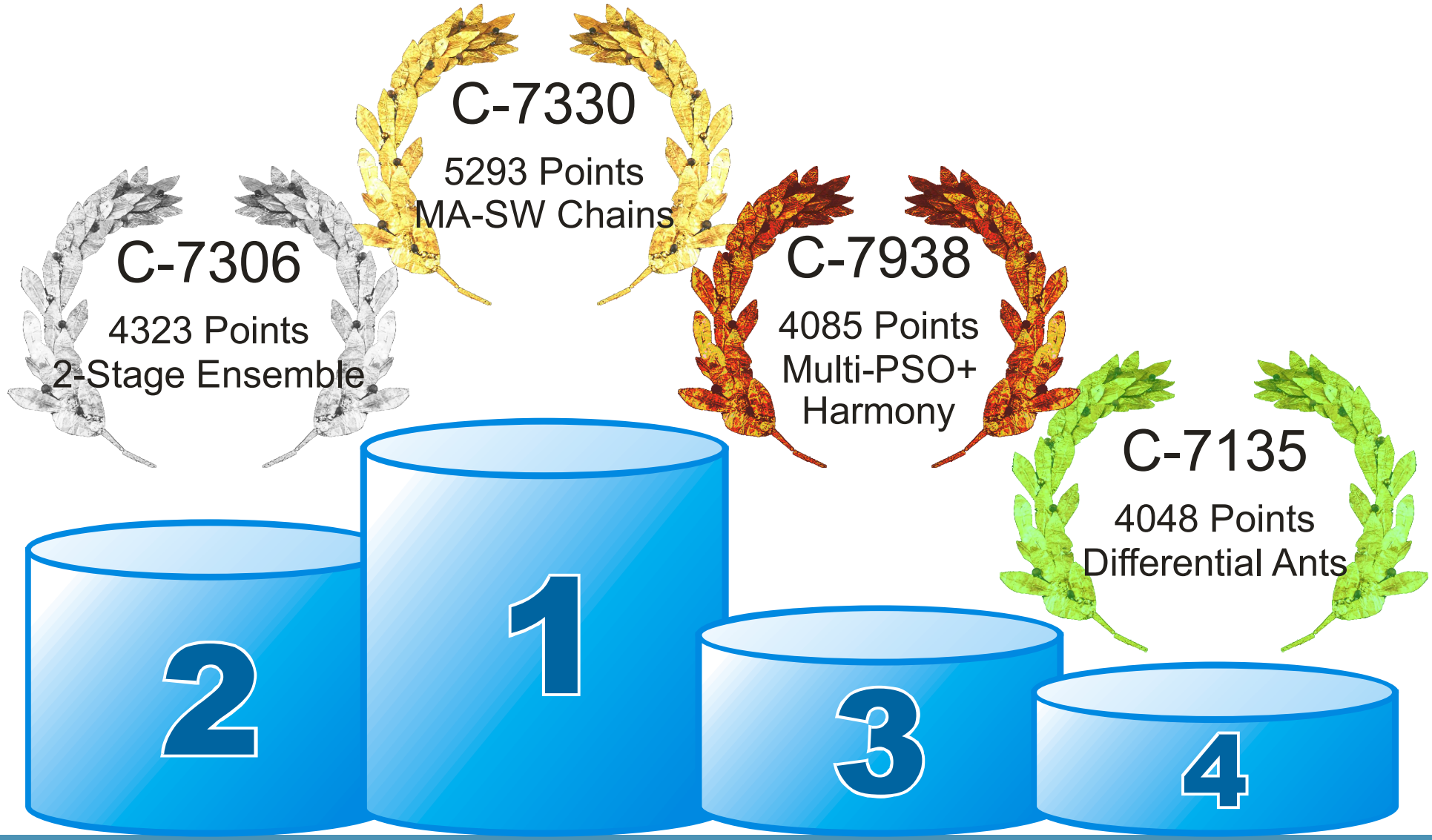
Winners



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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

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Thank you very much for your attention!

Any questions?

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