2013 IEEE Congress on Evolutionary Computation Competition on: Large Scale Global Optimization

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Introduction

- Numerous meta-heuristic algorithms have been developed;
- Performance deteriorates rapidly as the dimensionality of a problem increases, i.e., curse of dimensionality;
- Many real-world problems exhibit such large-scale property;
- **What makes large scale optimization problems hard**?
  - Search space grows exponentially as the number of decision variables increases;
  - Properties of the search space may change;
  - Evaluations are usually expensive;
  - Interaction between variables;

Large Scale Global Optimization Benchmarks

- IEEE CEC 2008: simple test functions.
- IEEE CEC 2010 and CEC 2012: aim to provide a suitable evaluation platform for testing and comparing large-scale global optimization (LSGO) algorithms.
- IEEE CEC 2013: extend upon the CEC 2010 LSGO benchmark functions to better represent the real-world problems; and to pose some new challenges to the decomposition based algorithms.
- **Changes to the CEC'2010 Benchmark Suite:**
  - Non-uniform subcomponent sizes;
  - Imbalance in the contribution of subcomponents;
  - Functions with overlapping subcomponents;
  - New transformations to the base functions: Ill-conditioning; Symmetry breaking; and Irregularities.

Large Scale Global Optimization Challenge

- **Category 1**: Fully-separable functions;
- **Category 2**: Two types of partially separable functions:
  - (a) Partially separable functions with a set of non-separable subcomponents and one fully-separable subcomponents;
  - (b) Partially separable functions with only a set of non-separable subcomponents and no fully separable subcomponent.
- **Category 3**: Functions with overlapping subcomponents: the subcomponents of these functions have some degree of overlap with its neighboring subcomponents. There are two types of overlapping functions:
  - (a) Overlapping functions with conforming subcomponents;
  - (b) Overlapping functions with conflicting subcomponents: 4. Fully-nonseparable functions.
- **Category 4**: Fully-nonseparable functions.

15 test functions (1000D) in total.

Experimental settings

- **Problems:** 15 minimization problems;
- **Dimensions:** D = 1000;
- **Number of runs:** 25 runs per function;
- **Maximum number of fitness evaluations:** Max FE = 3 × 106;
- **Termination criteria:** when Max FE is reached.
- **Boundary Handling:** All problems have the global optimum within the given bounds.
- **Solution quality** for each function when the FEs counter reaches:
  - FEs1 = 1.2e+5
  - FEs2 = 6.0e+5
  - FEs3 = 3.0e+6
- The best, median, worst, mean, and standard deviation of the 25 runs should be recorded

Experimental results

1000D		f_1	f_2	f_3	f_4	f_5	f_6	f_7	f_8
1.2e5	Best	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx
	Median								
	Worst								
	Mean								
	StDev								
6.0e5	Best								
	Median								
	Worst								
	Mean								
	StDev								
3.0e6	Best								
	Median								
	Worst								
	Mean								
	StDev								

1000D		f_9	f_{10}	f_{11}	f_{12}	f_{13}	f_{14}	f_{15}	–
1.2e5	Best	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx	x.xxe+xx
	Median								
	Worst								
	Mean								
	StDev								
6.0e5	Best								
	Median								
	Worst								
	Mean								
	StDev								
3.0e6	Best								
	Median								
	Worst								
	Mean								
	StDev								

Median is used to assign points for ranking all comparing algorithms, according to the Formula 1 point system[1]:

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

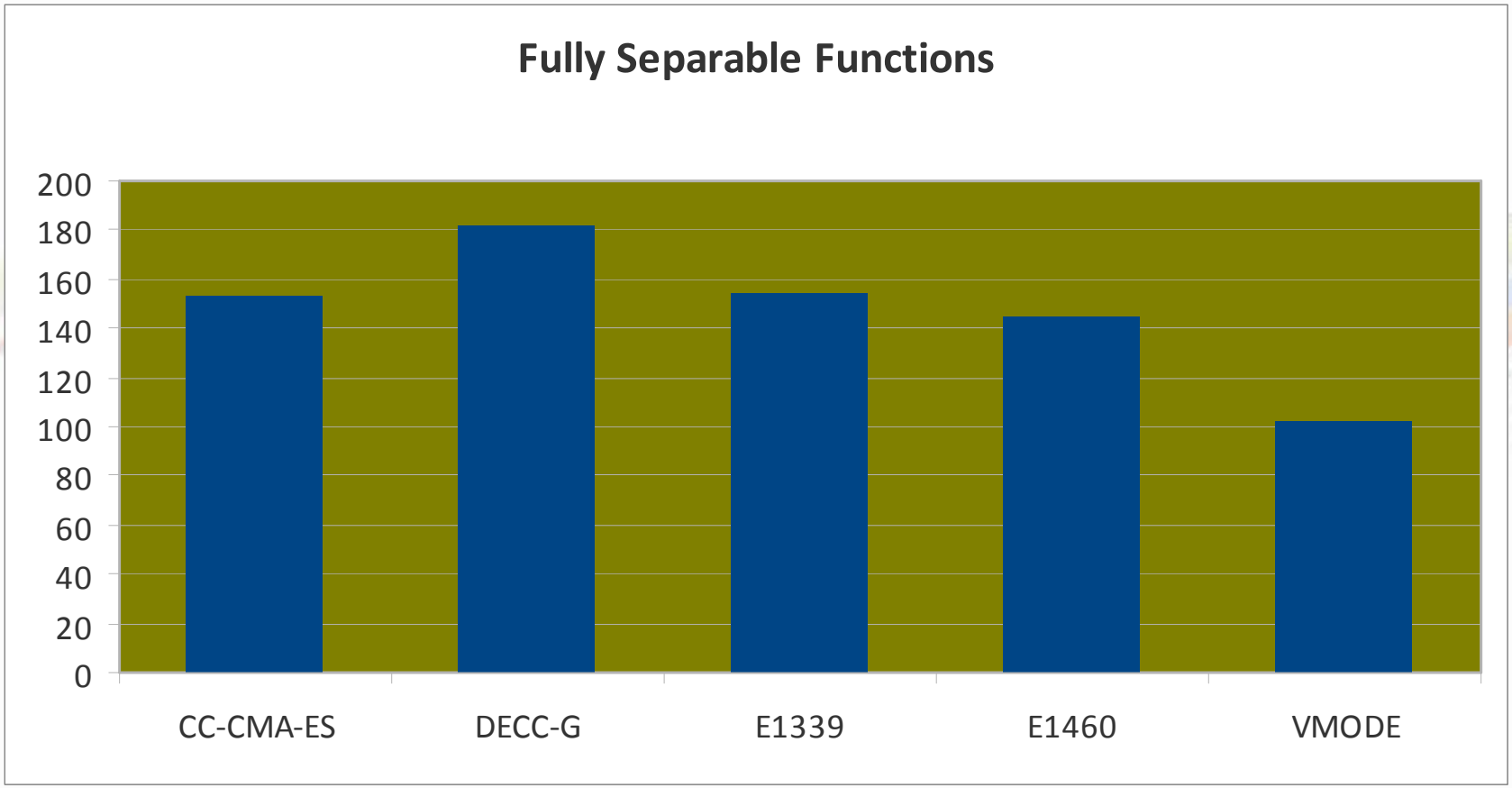
[1] URL: http://en.wikipedia.org/wiki/Formula_One_regulations

Participants

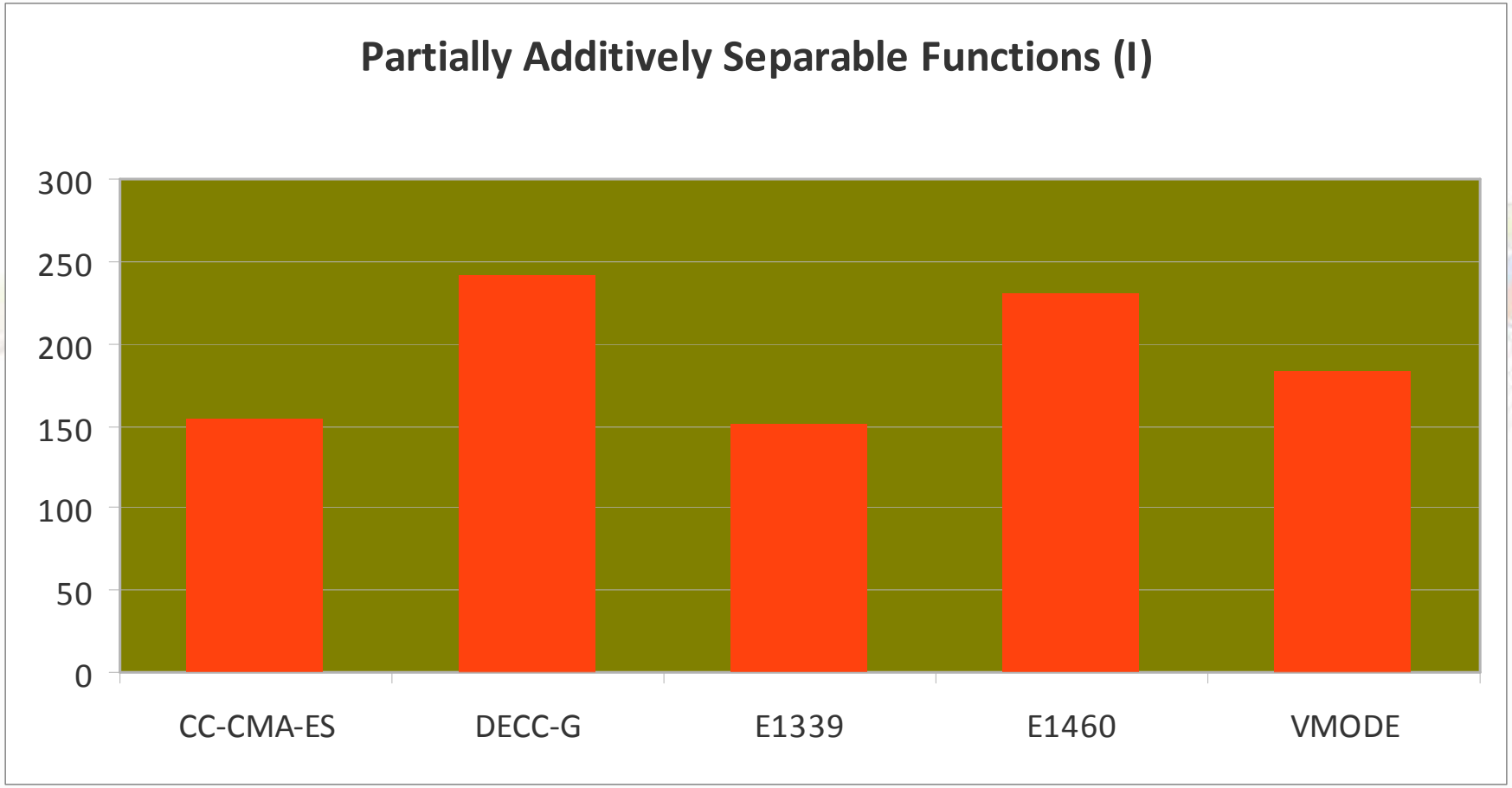
- DECC-G: baseline model, by Zhenyu Yang, Ke Tang and Xin Yao
- E1339: Fei Wei, Yuping Wang, Yuanliang Huo
- E1460: Antonio LaTorre, Santiago Muelas, Jose-Maria Pena
- VMODE: Ernesto Díaz López
- CC-CMA-ES: Jinpeng Liu and Ke Tang

Five entries to the competition, including 2 CEC papers, plus 3 entries without papers.

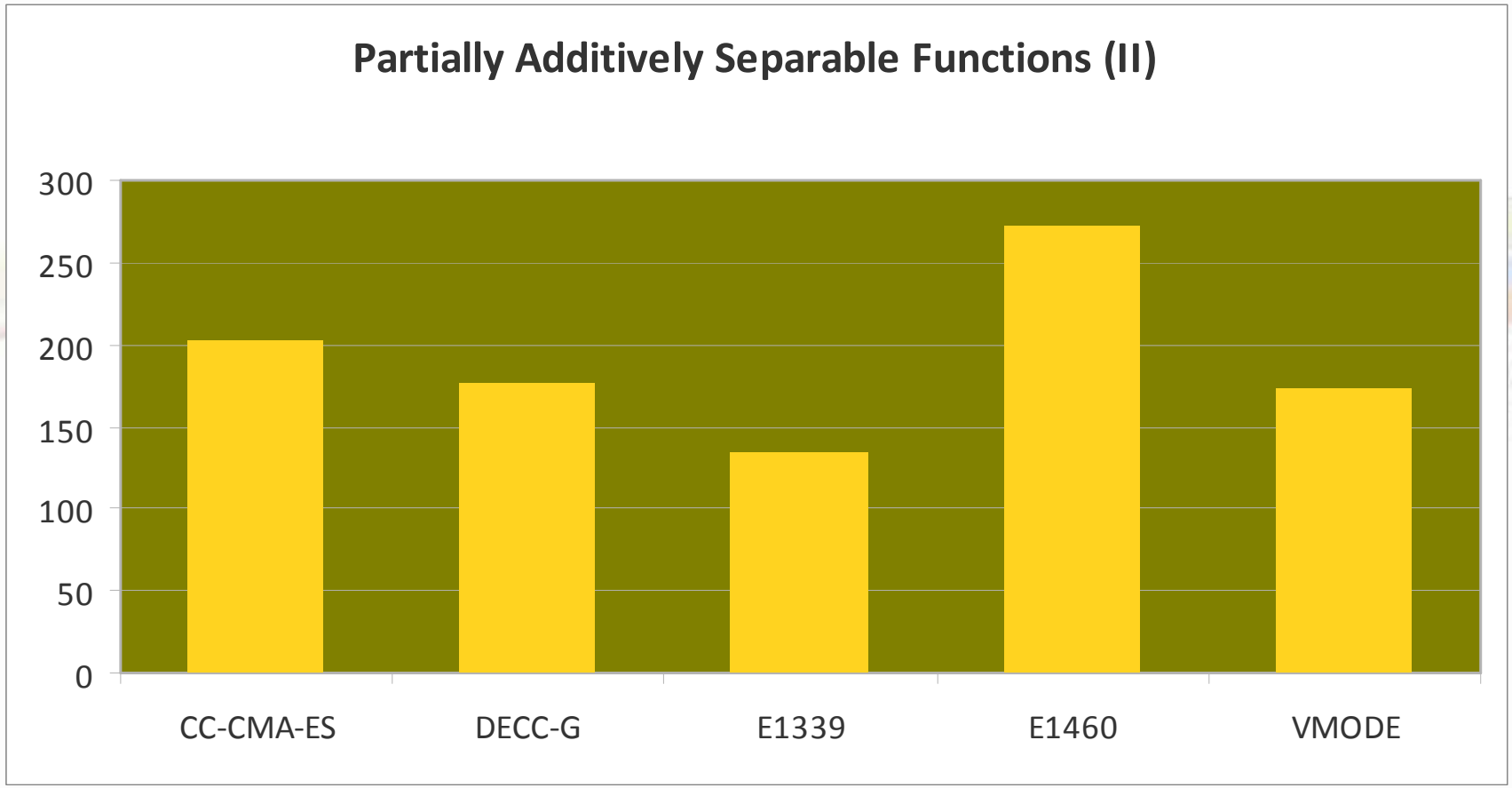
Category 1


Fully Separable Functions
200
180
160
140
120
100
80
60
40
20
0
CC-CMA-ES
DECC-G
E1339
E1460
VMODE

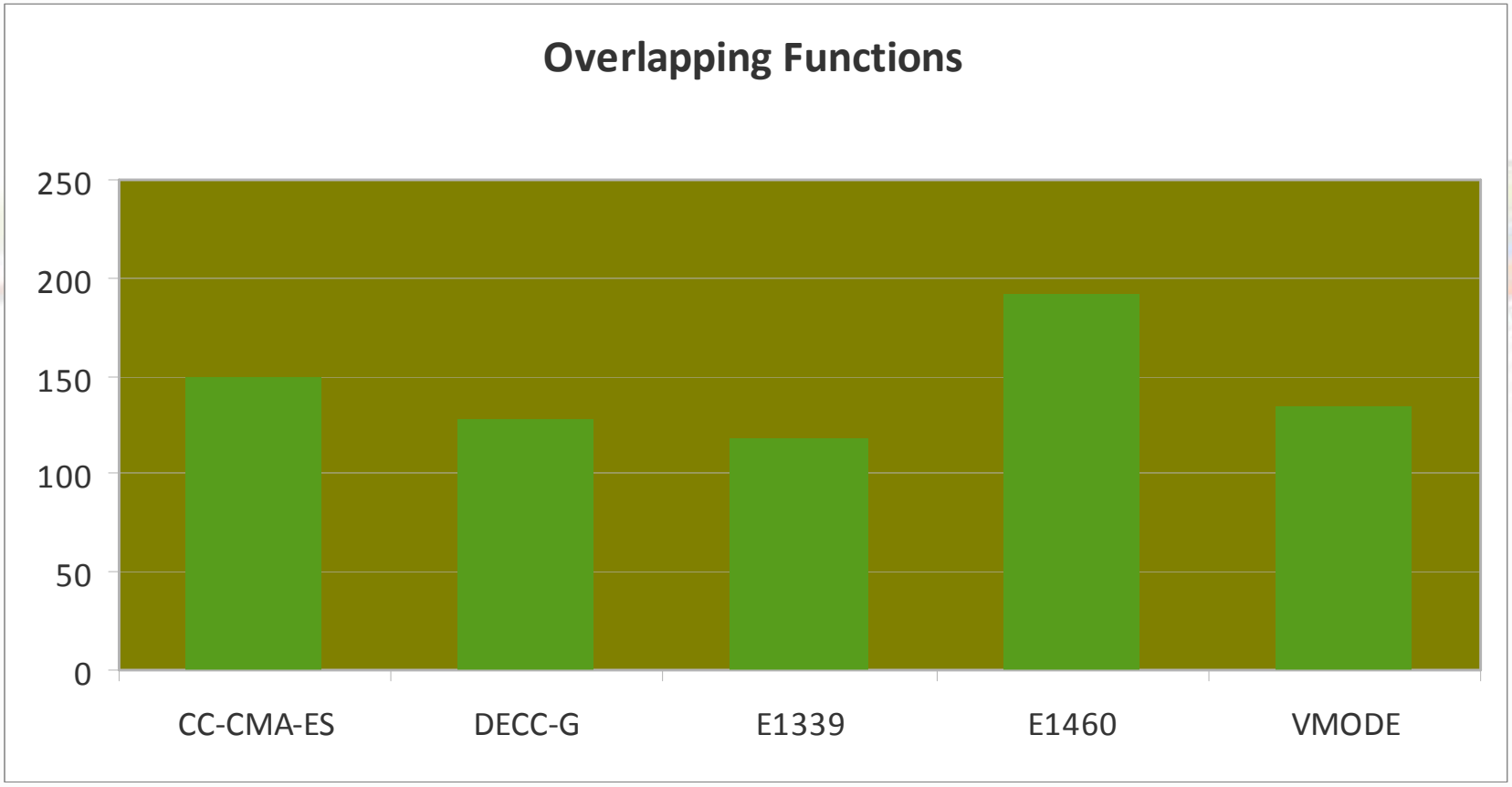
Category 2 (a)


Partially Additively Separable Functions (I)
300
250
200
150
100
50
0
CC-CMA-ES
DECC-G
E1339
E1460
VMODE

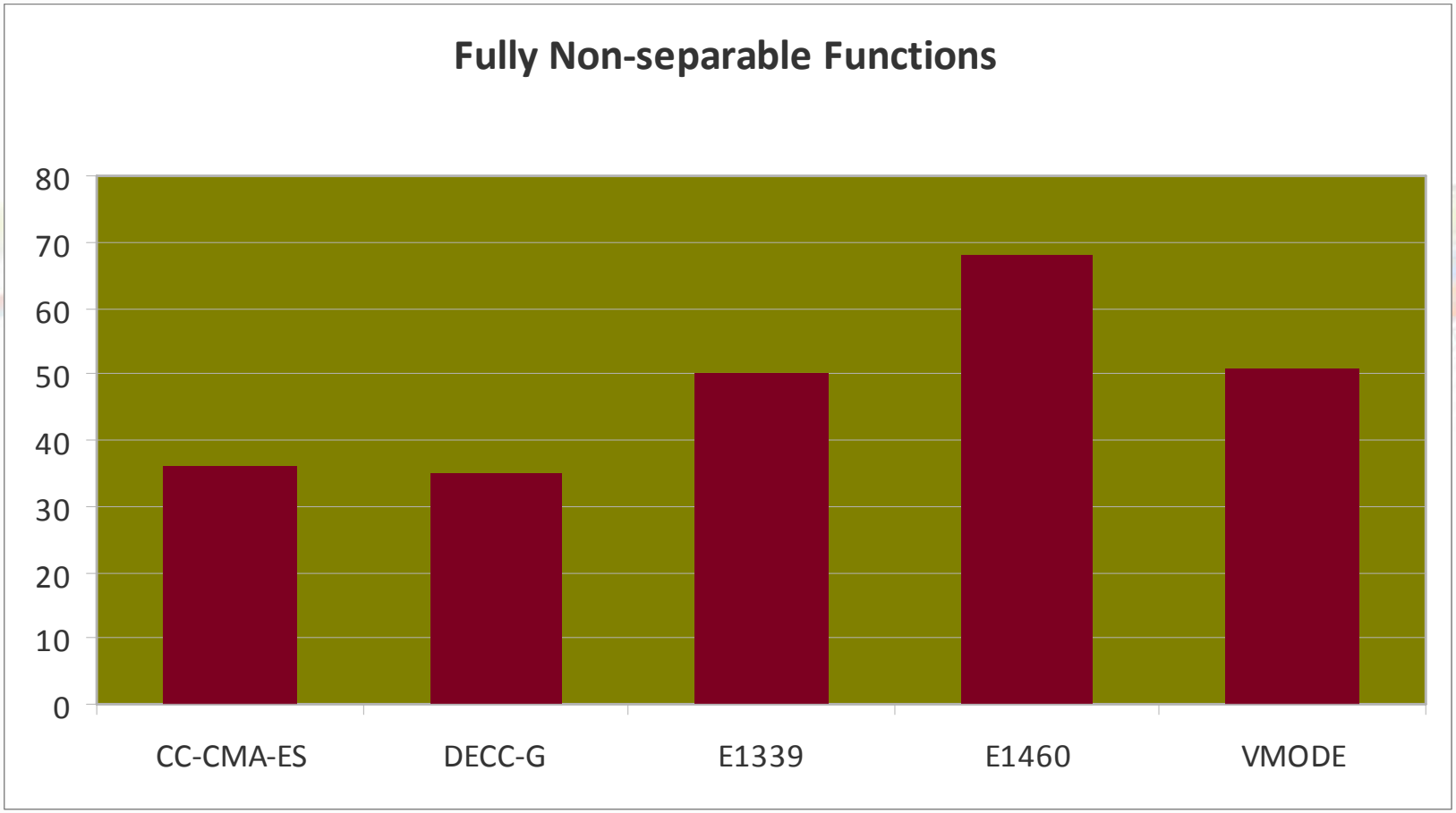
Category 2 (b)


Partially Additively Separable Functions (II)
300
250
200
150
100
50
0
CC-CMA-ES
DECC-G
E1339
E1460
VMODE

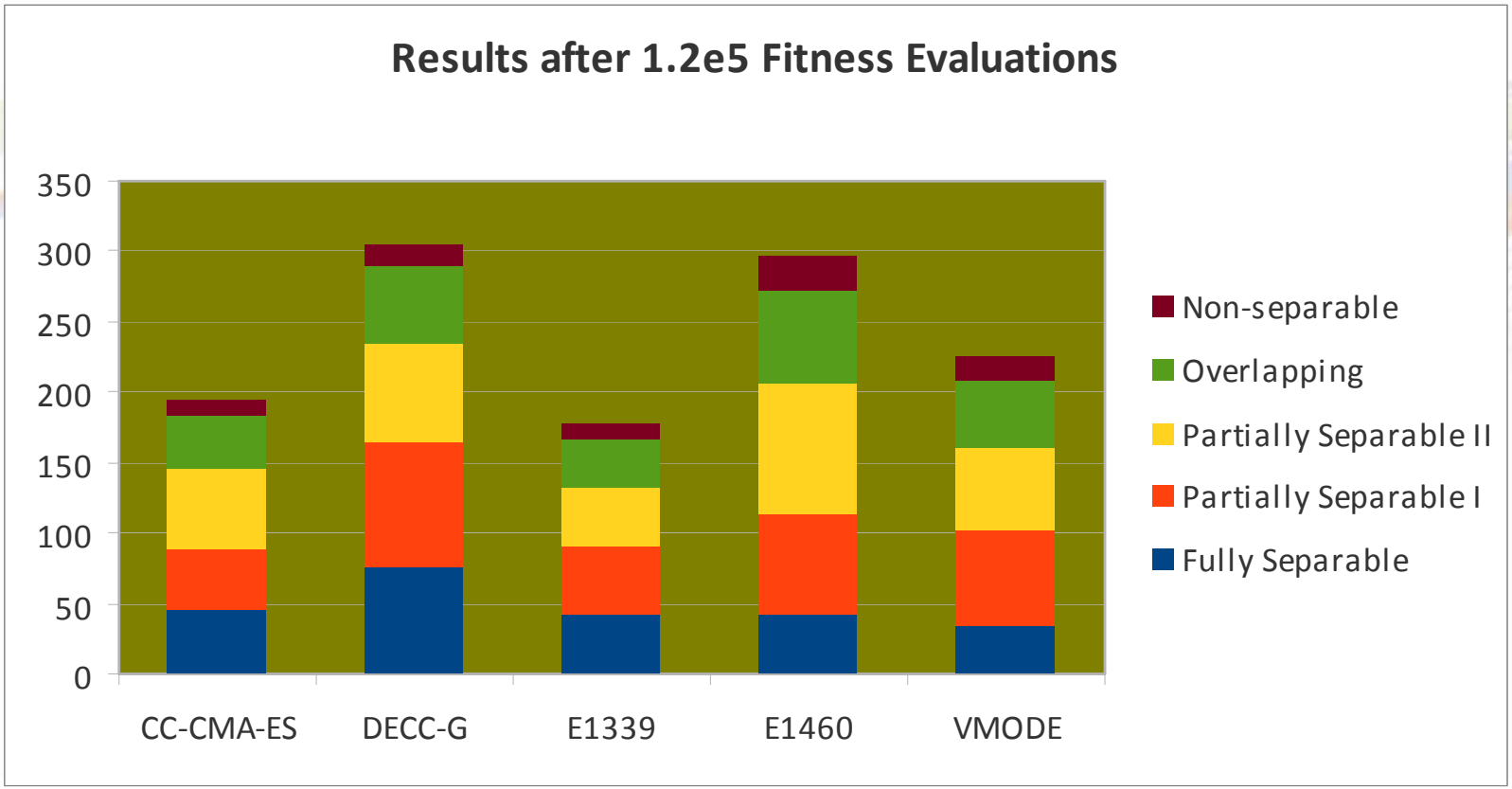
Category 3


Overlapping Functions
250
200
150
100
50
0
CC-CMA-ES
DECC-G
E1339
E1460
VMODE

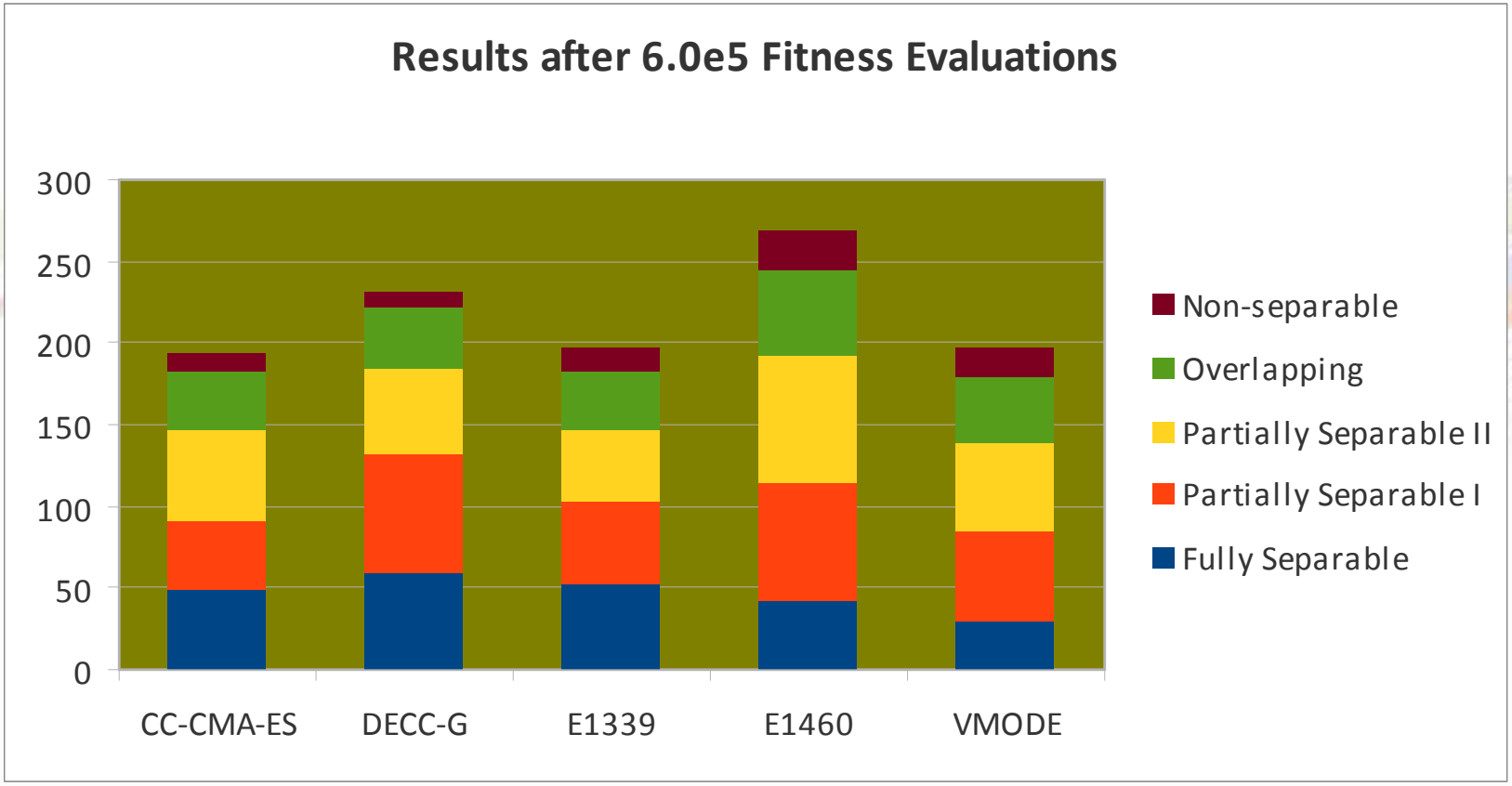
Category 4


Fully Non-separable Functions
80
70
60
50
40
30
20
10
0
CC-CMA-ES
DECC-G
E1339
E1460
VMODE

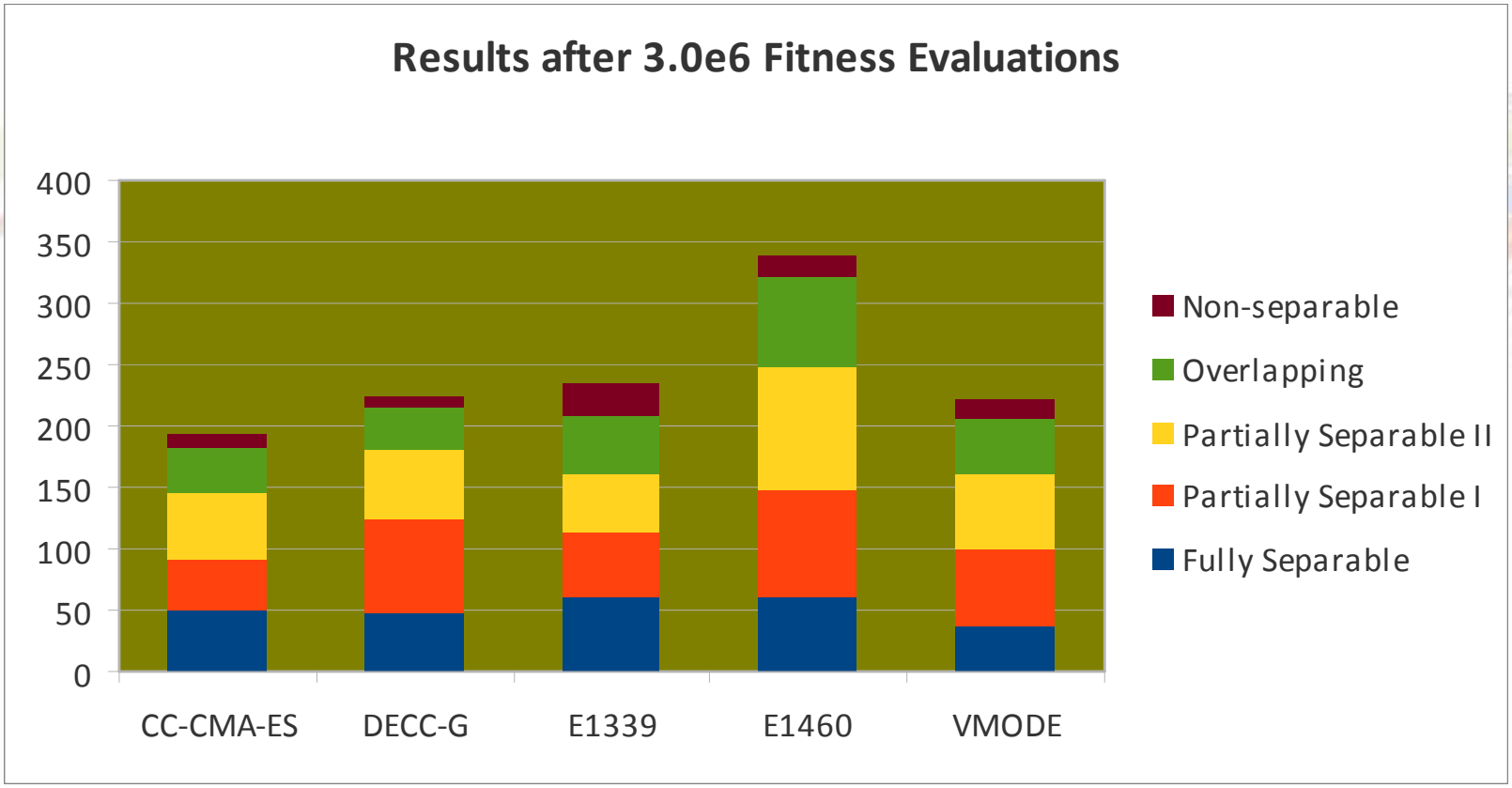
Results at 1.2e5 FEs



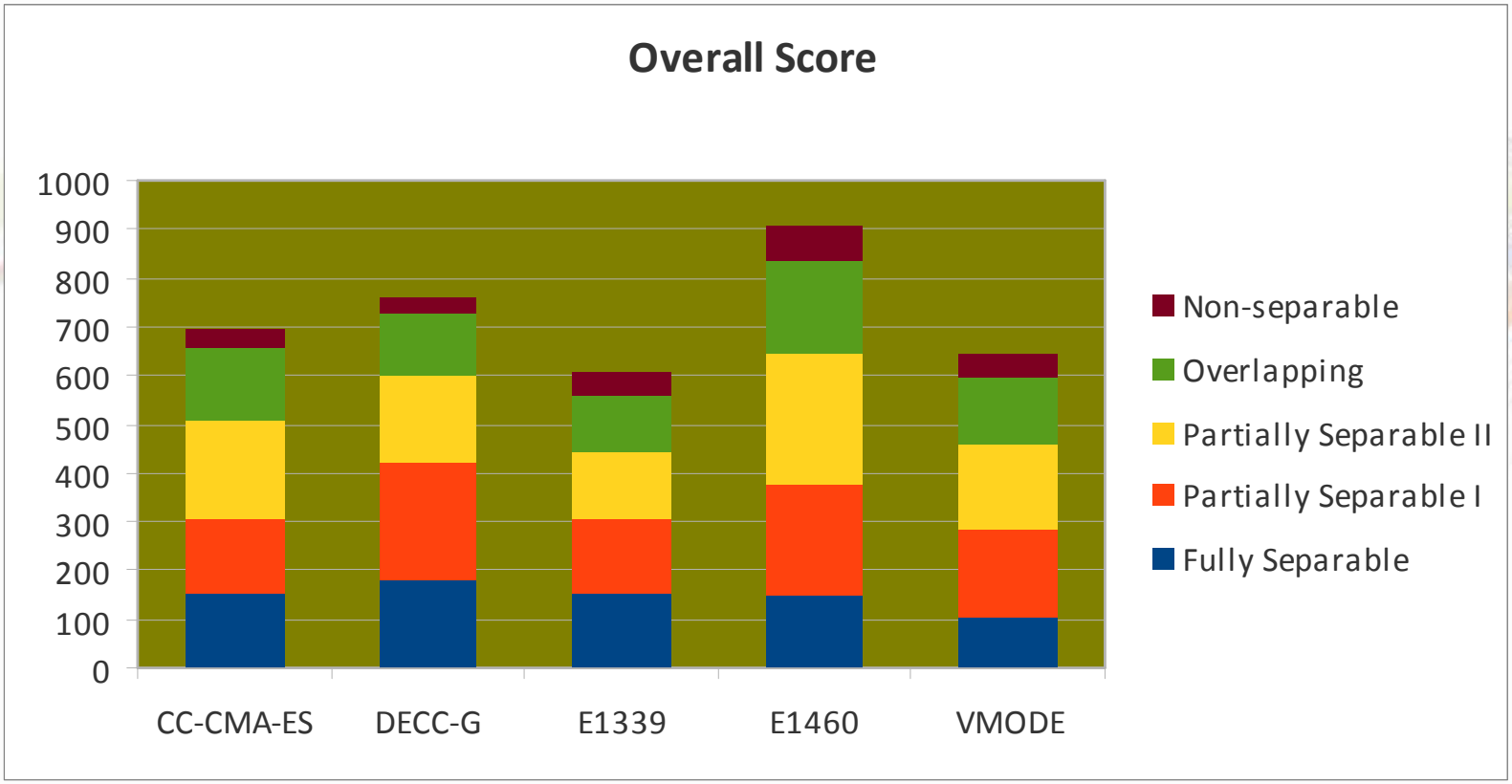
Results at 6.0e5 FEs



Results at 3.0e6 FEs



Overall Scores



Winners

- **First place: E1460 (906 points)**
- **Second: DECC-G (762 points)**
- **Third: CC-CMA-ES (694 points)**
- **Fourth: VMODE (645 points)**

Summary

- Five entries including 2 CEC papers, and 3 results only;
- Combining different meta-heuristics;
- Strong local search;
- Decomposition has a cost; Some trade-offs between decomposition cost and optimization.
- Clear winner: **E1460** - (Multiple Offspring Sampling) MOS-based Hybrid Algorithms.

Questions?