Comparison of optimization results submitted for the CEC 2017 Competition of Single Objective Numerical Optimization methods based on empirical runtime distributions

Dariusz Jagodzinski and Jaroslaw Arabas
d.jagodzinski@elka.pw.edu.pl
jarabas@elka.pw.edu.pl

January 8, 2018

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CEC'2017 Competition conditions at a glance

Test functions are minimization problems defined as following:

$$min\ F_P(x),\ \ x = [x_1, x_2, ..., x_D]^D$$

D: Dimension = 10,30,50,100 **P:** Problem Number = 1,..,30
Search range = $[-100, 100]^D$ **Budget:** f-evals = $10000 \cdot D$
Initialization: Uniform random initialization within the search range. Random seed is based on time.
Global Optimum: $F_P(x^*) = 100 \cdot P$

Full specification of CEC'2017 competition conditions: Link

Recording results for CEC'2017

Function error value is defined as:

$$ERR_P = F_P(x^{best}) - F_P(x^*)$$

The accuracy of finding the optimum is 10^{-8}:

$$ERR_P \leq 10^{-8} \implies ERR_P = 0$$

Tuning search method parameters for each problem or dimension is **not allowed.**

Number of runs: For each problem and each dimension, 51 independent runs of the method.

Progress reporting: For each run, record the smallest-so-far error after exceeding (0.01, 0.02, 0.03, 0.05, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0)$\cdot Budget_D$.

ECDF empirical runtime distributions

Runlength-based target quality indicator corresponds to the function P value to be reached, and is defined as:

$$I_P^t = F_P(x^*) + \Delta I_P^t$$

$$F_P(x^{best}) \leq \Delta I_P^t \leq F_P(x^{worst})$$

$$\frac{\Delta I_P^{t+1}}{\Delta I_P^t} = 10^{0.2} \ , \ t \in T_P$$

The ratio between two neighboring ΔI_P target precision values is $10^{0.2}$. The largest ΔI_P value is the error value chosen such that the worst algorithm reaches the first budget step. Smallest ΔI_P value is related to the best algorithm error value on the last budget step.

Budget steps: 14 moments on which error values are reported

ECDF performance assessment: Link

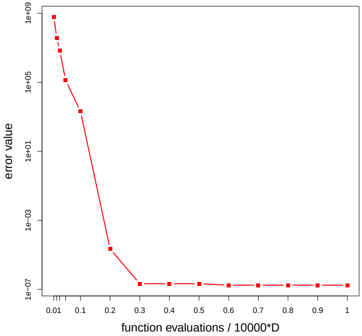
ECDF empirical runtime distributions

ECDF plot displays the proportion of problems solved within a specified budget, where the budget is given on the x-axis. The y-axis shows the fraction of target quality indicators which have been reached. The fraction is defined as:

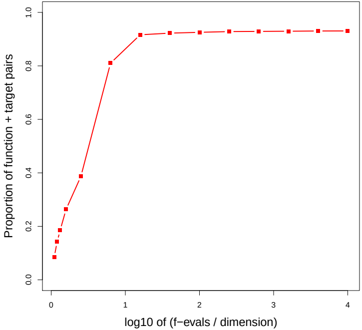
$$P_P(b) = \frac{\sum_{t=1}^{|T_P|}[ERR_P(b) \leq I_P^t]}{|T_P|}\ ,\ \ b \in \{1,..,14\}$$

The $P_P(b)$ ratio can be considered as **probability of achieving success** for a given budget b.

ECDF plot example



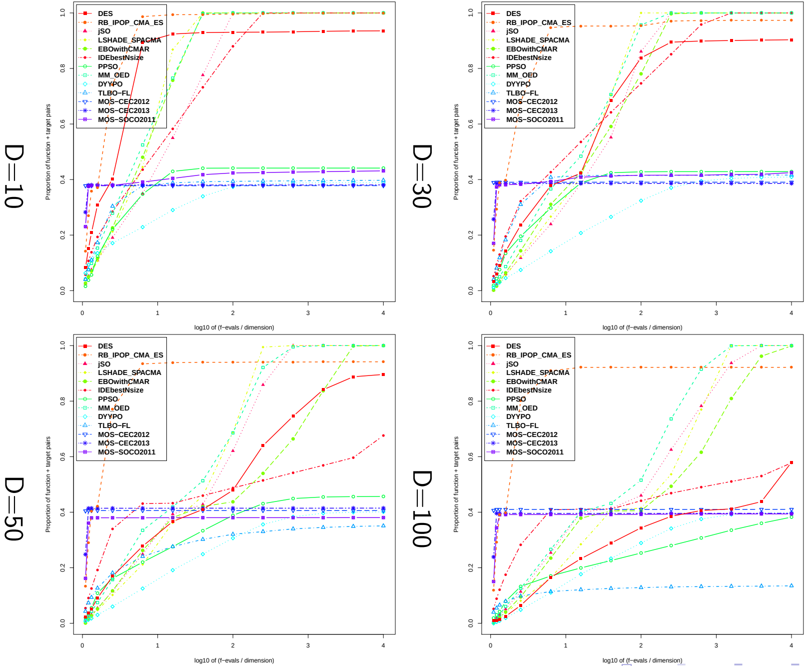
Convergence curve for a single run, with 14 budget steps on which error values have been reported.



ECDF plot aggregated for 51 runs, for a single problem.

Interpretation of the ECDF curve: About 90 percent of the error levels were achieved within budget of $10^2 \cdot D$ function evaluations.

CEC2017 Function 1



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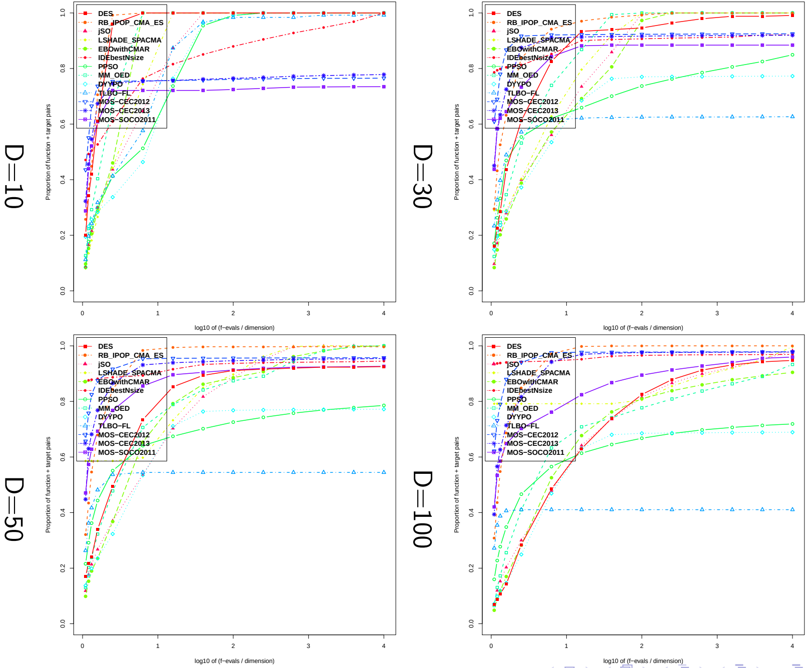

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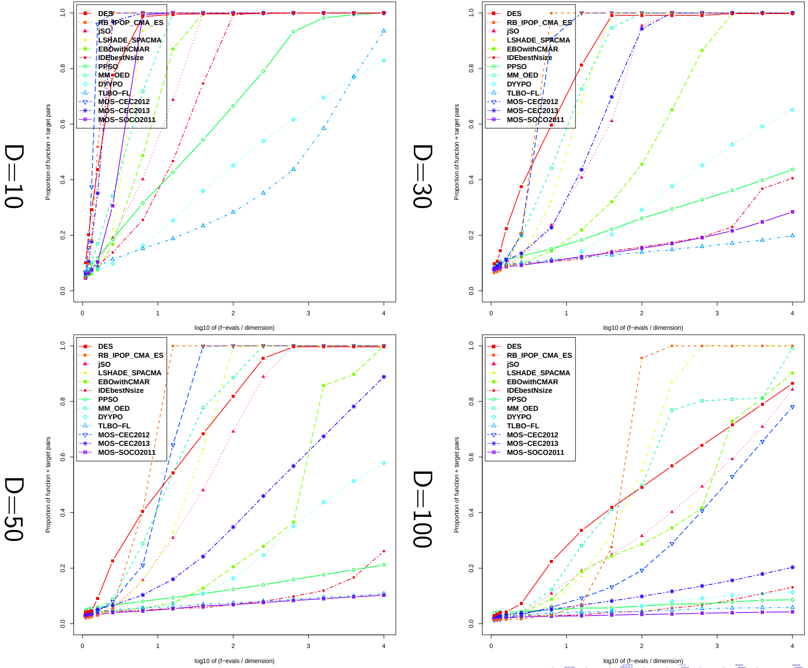

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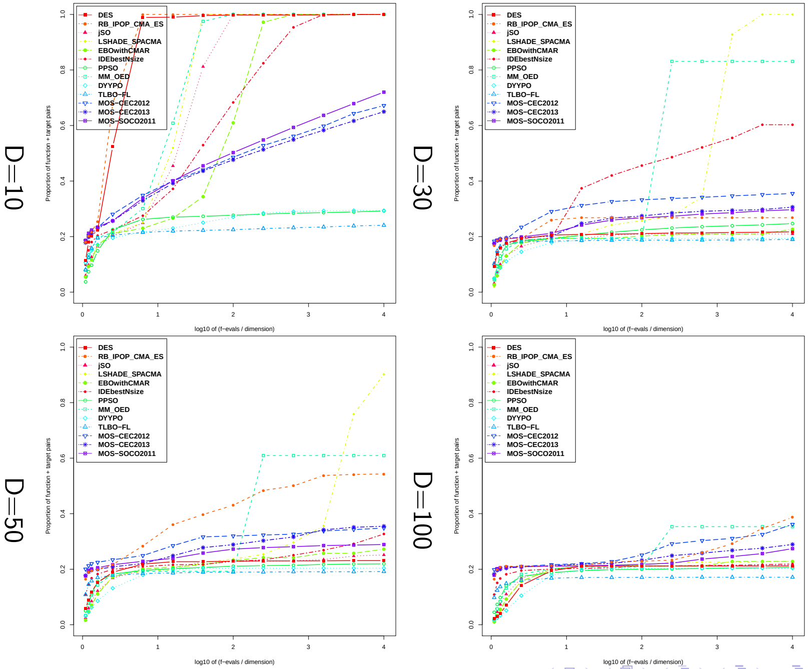

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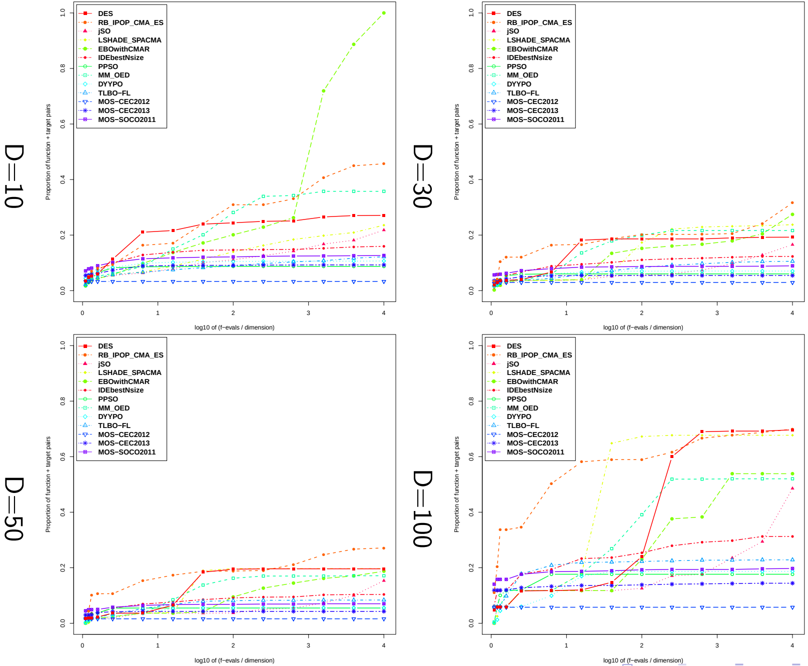

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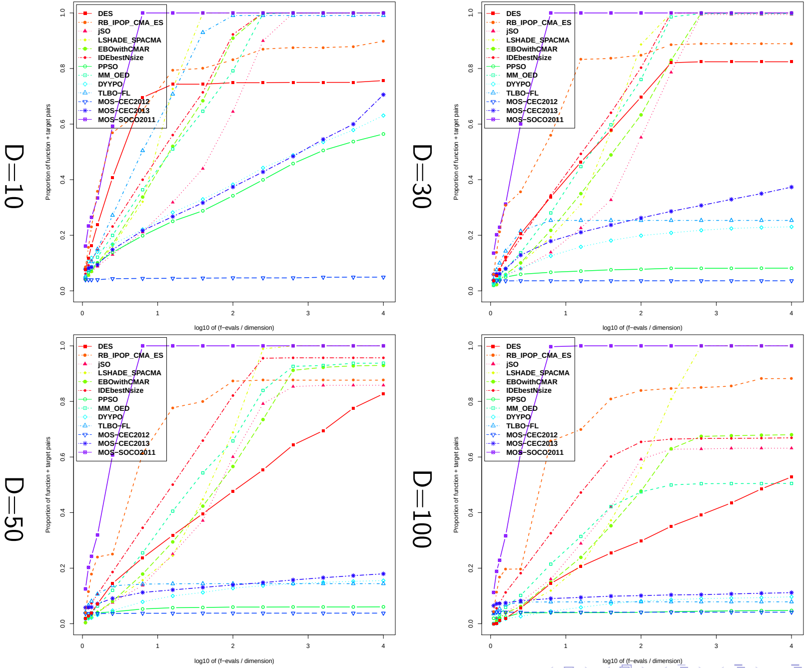

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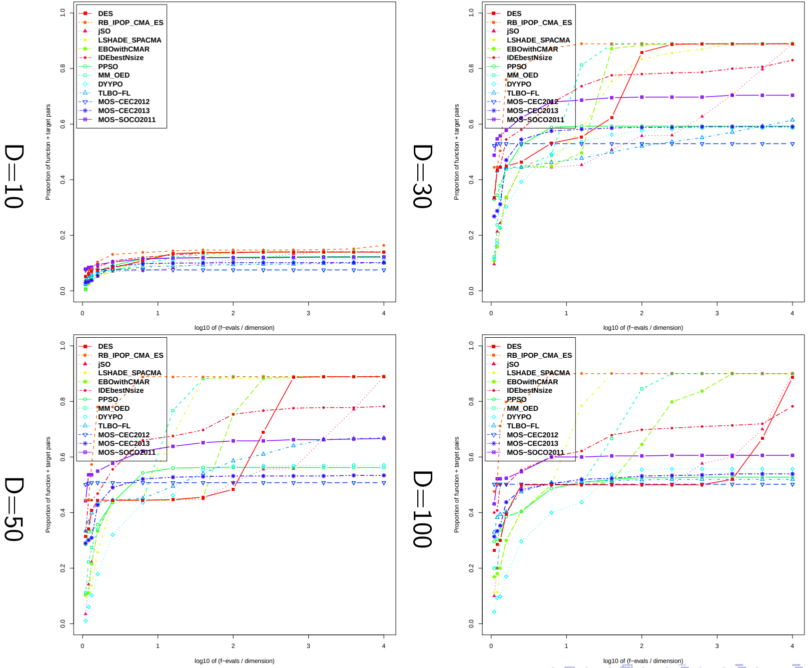

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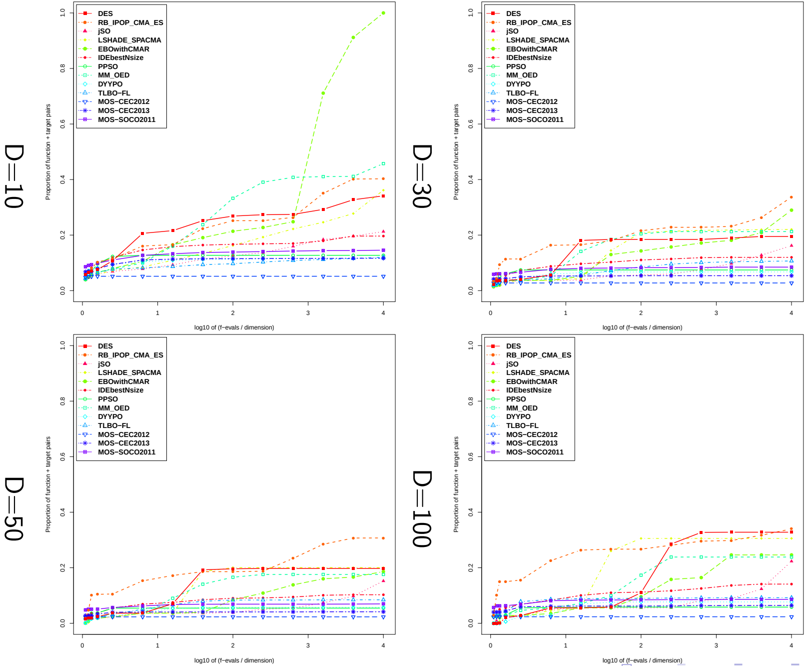

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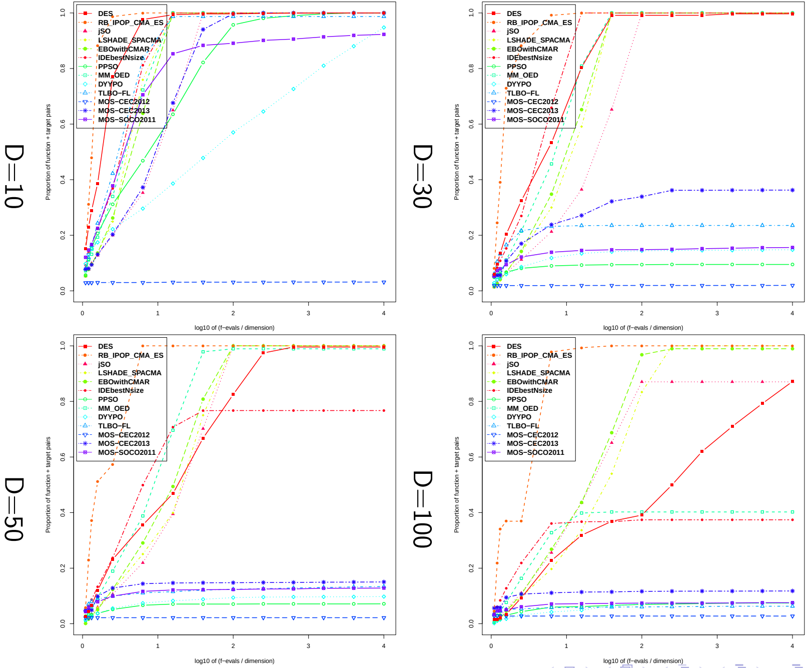

CEC2017 Function 10

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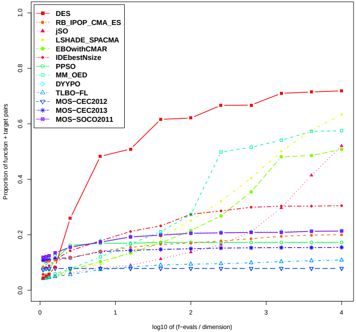

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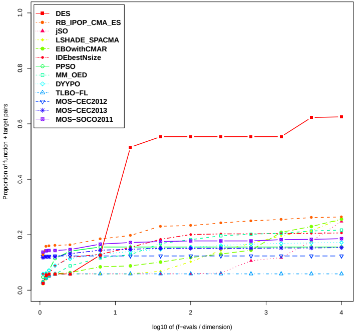

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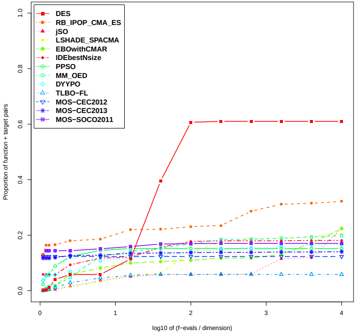

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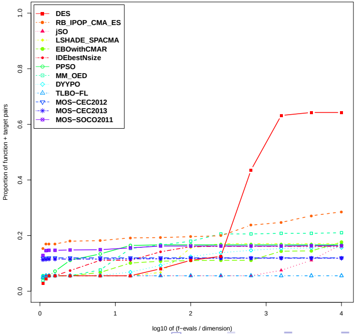

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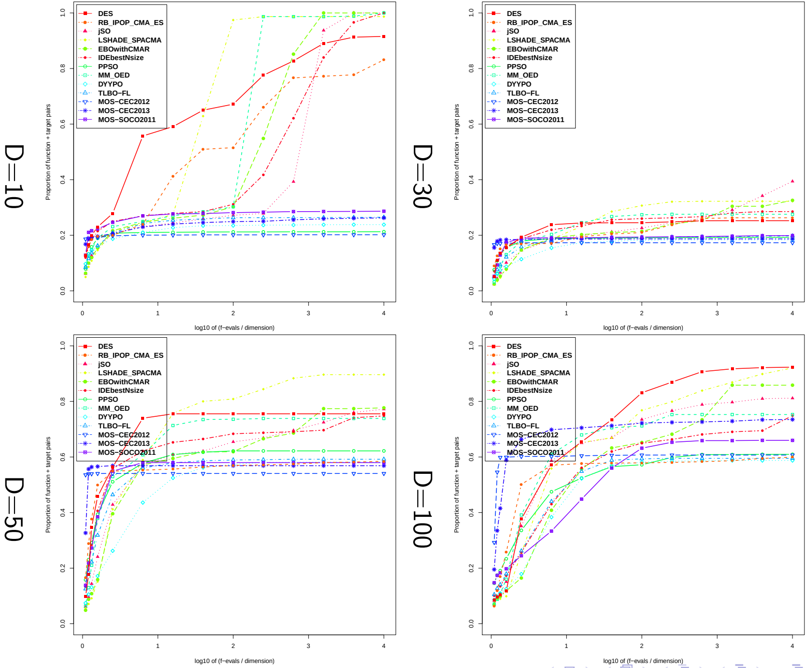

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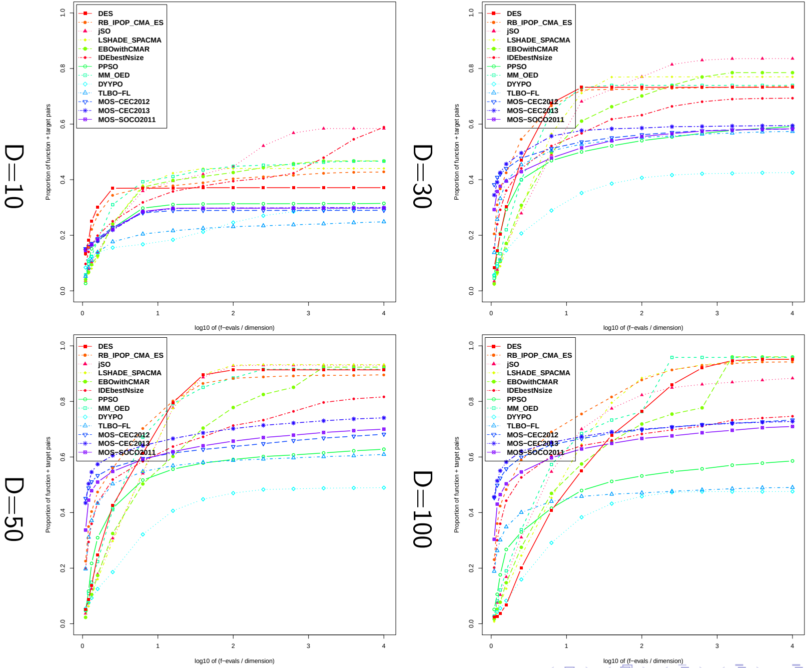

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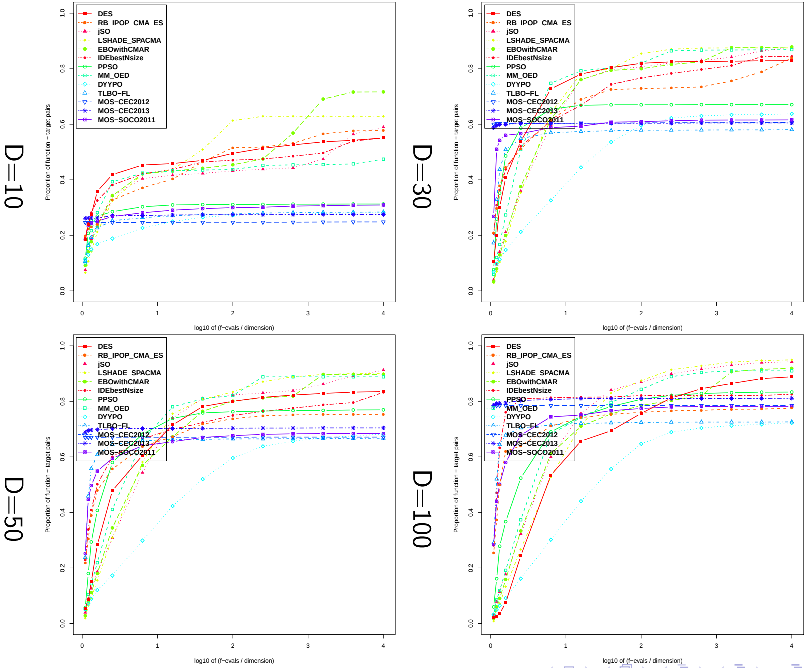

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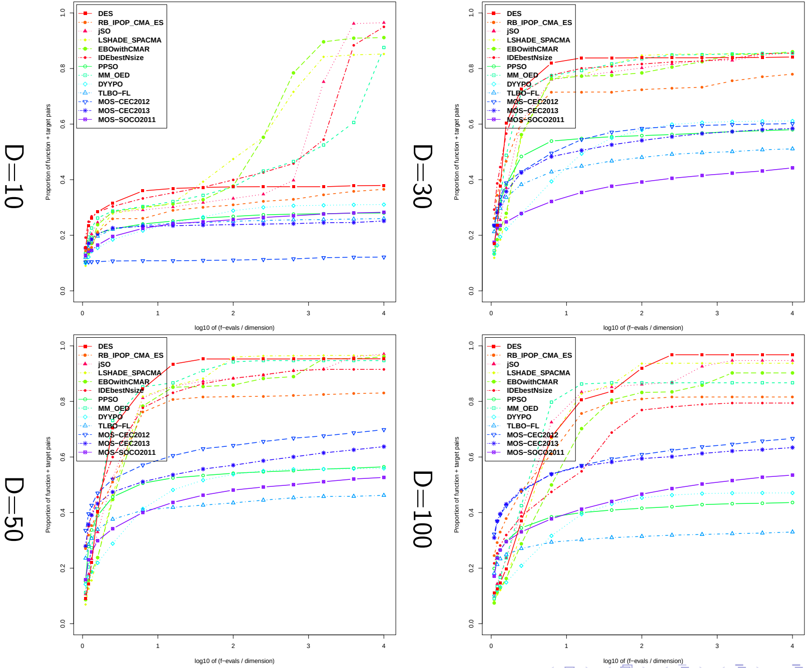

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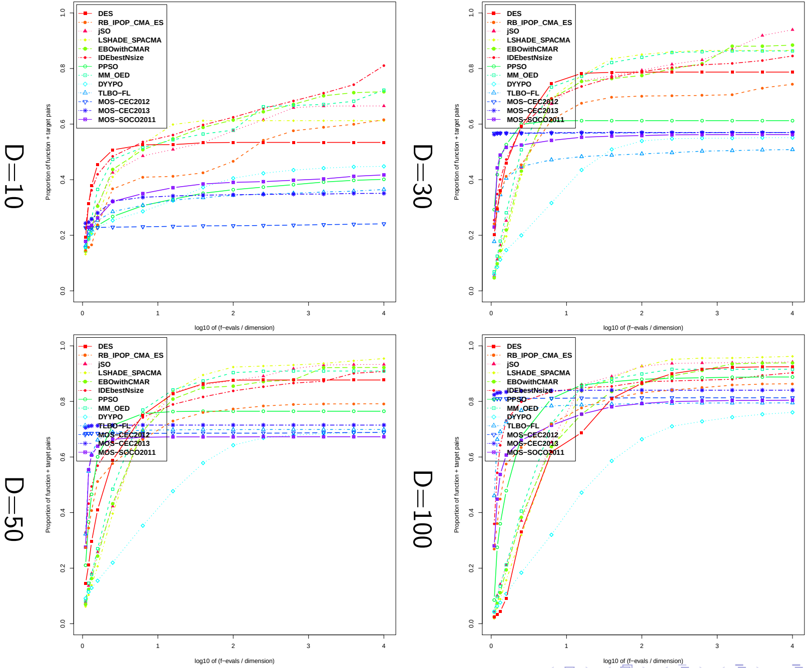

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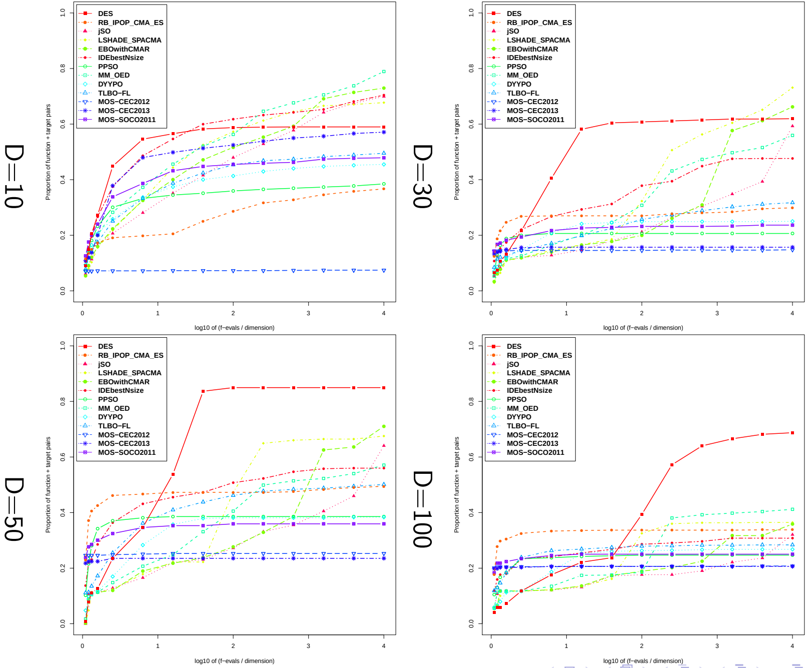

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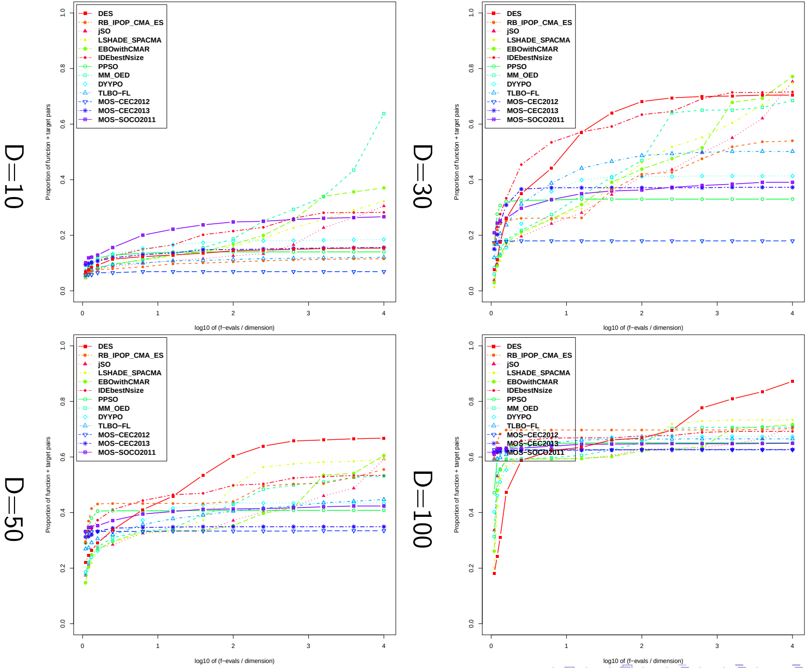

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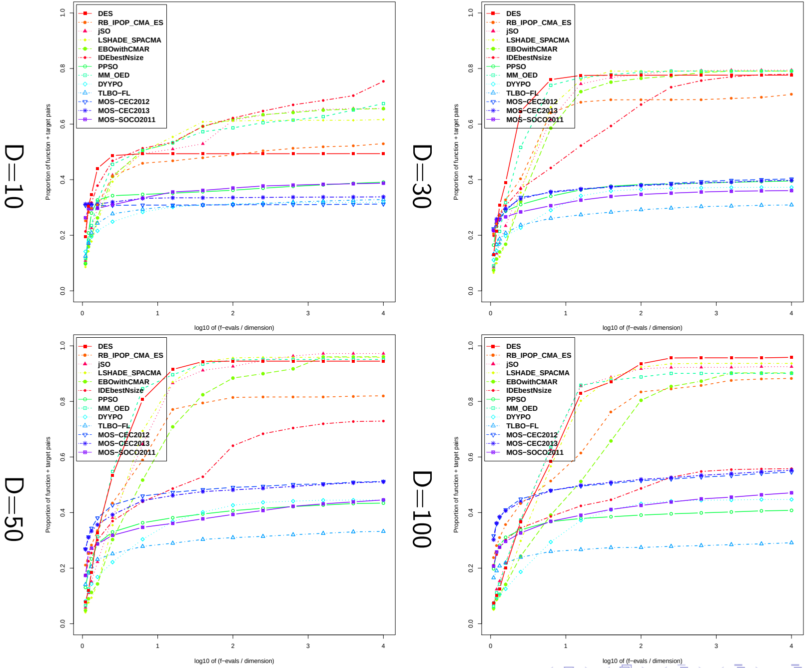

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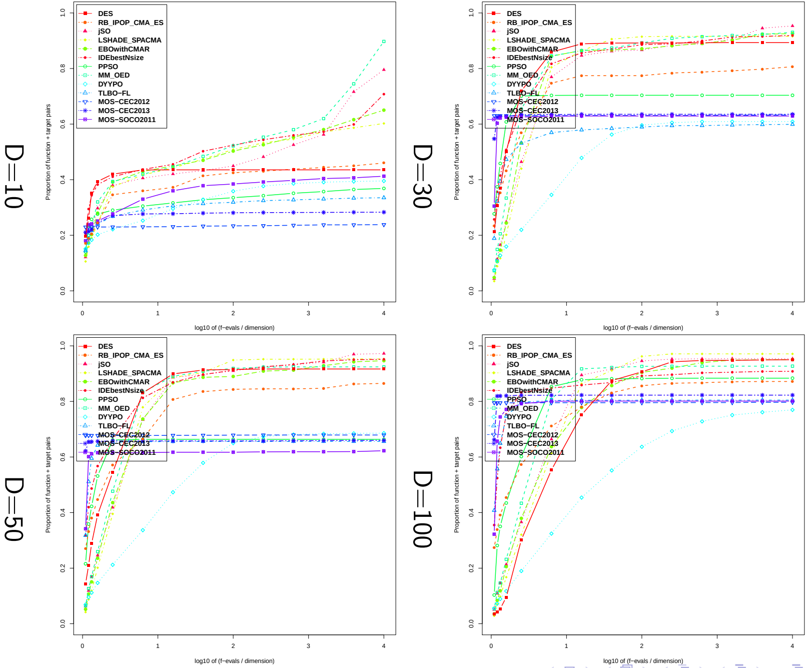

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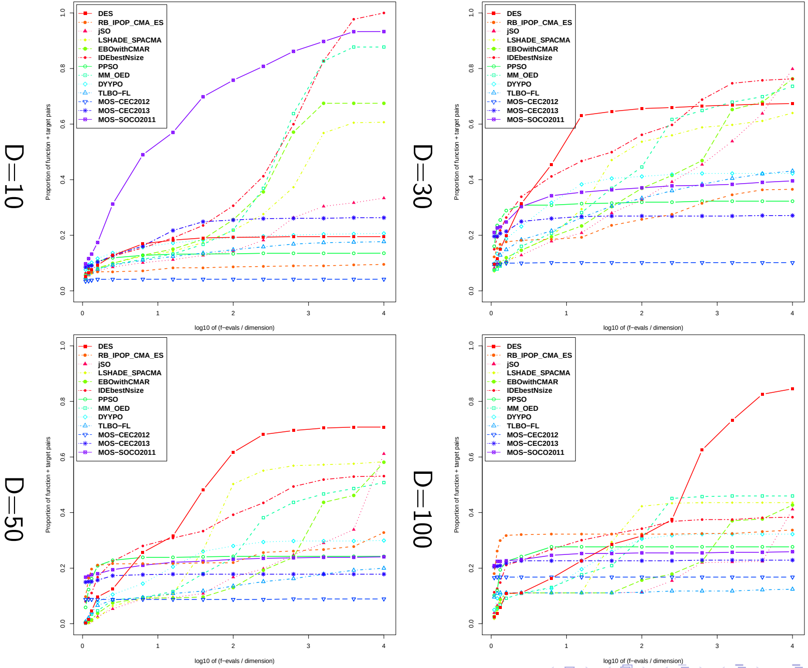

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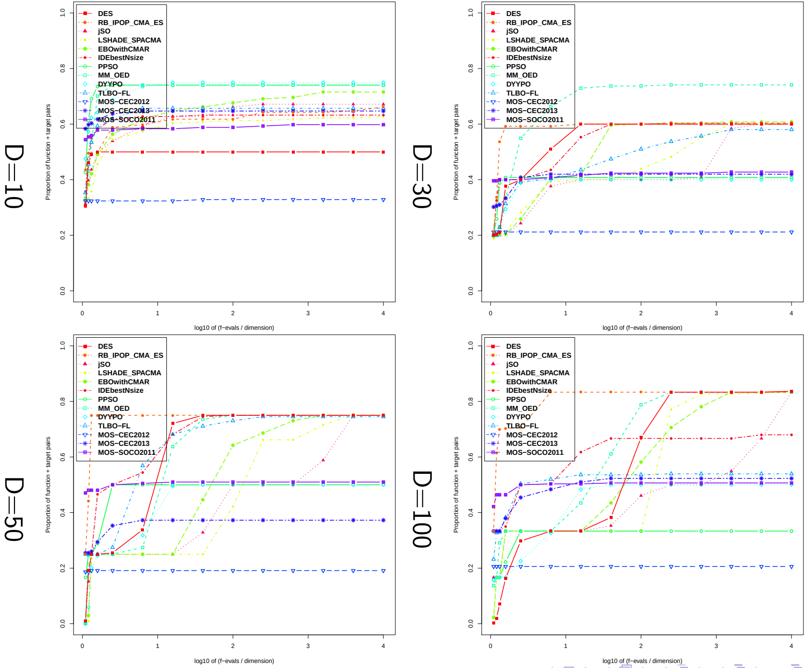

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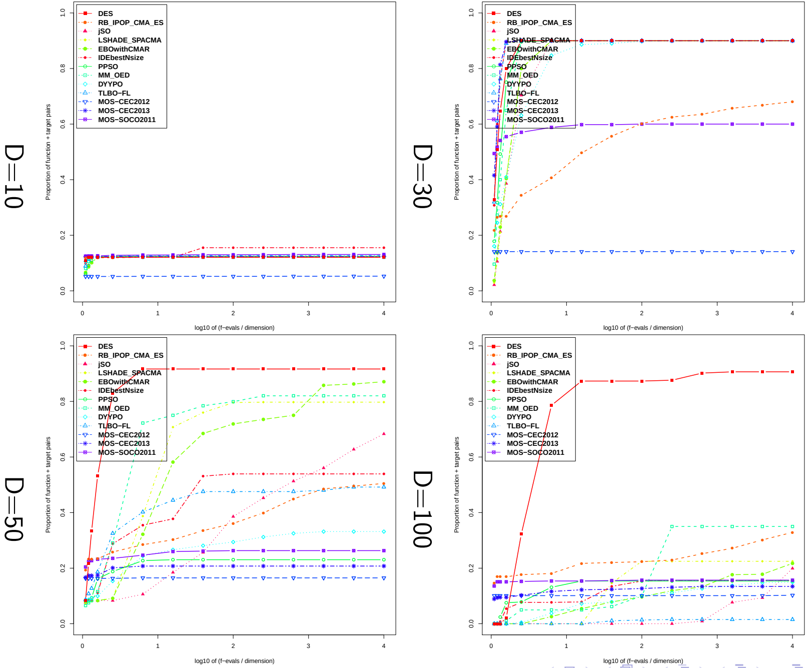

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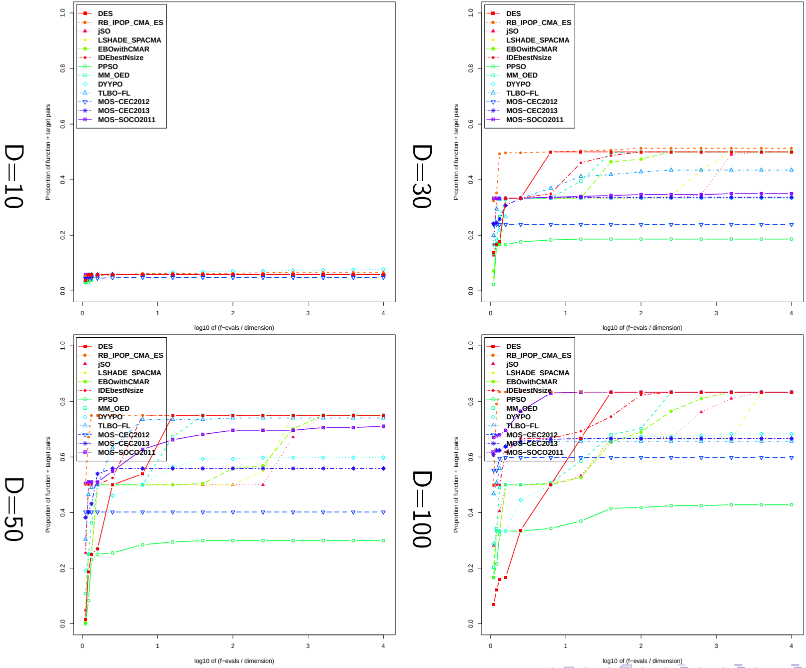

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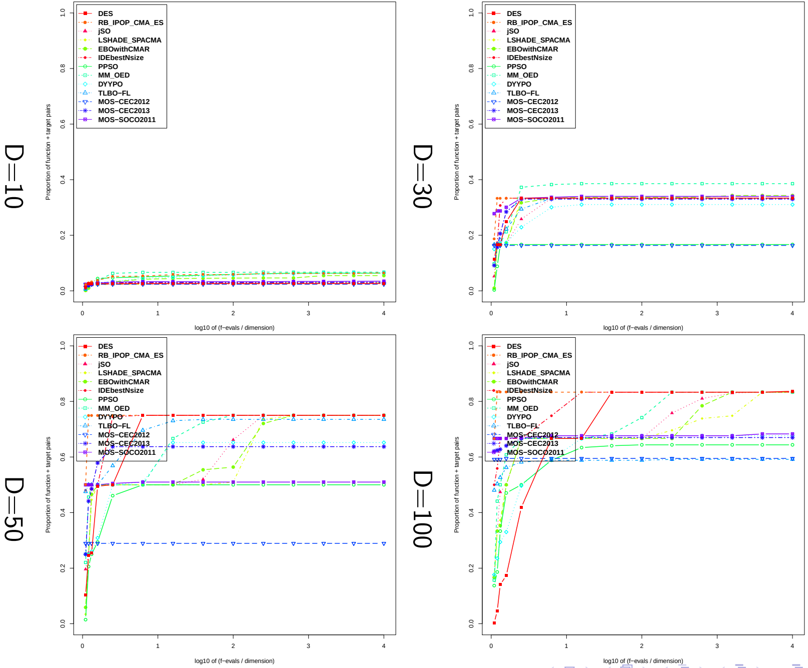

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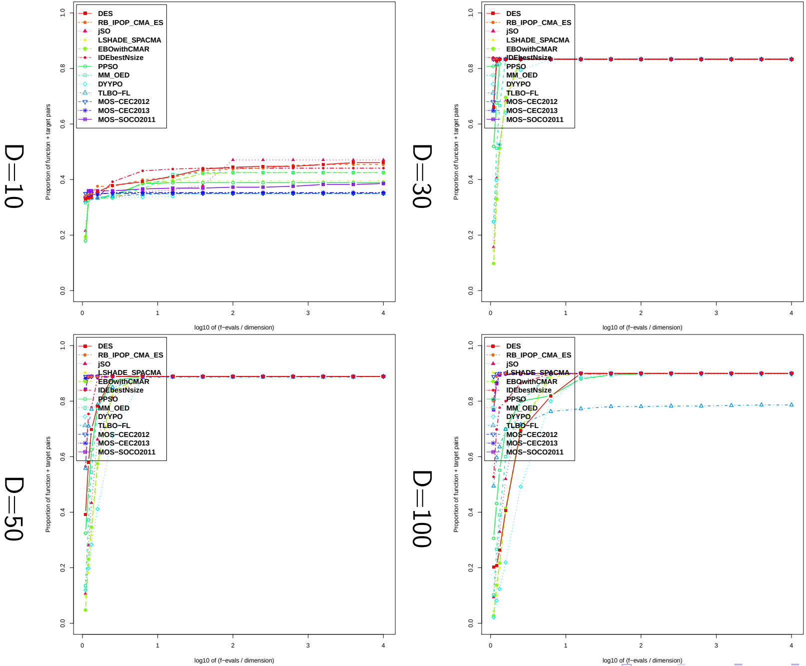

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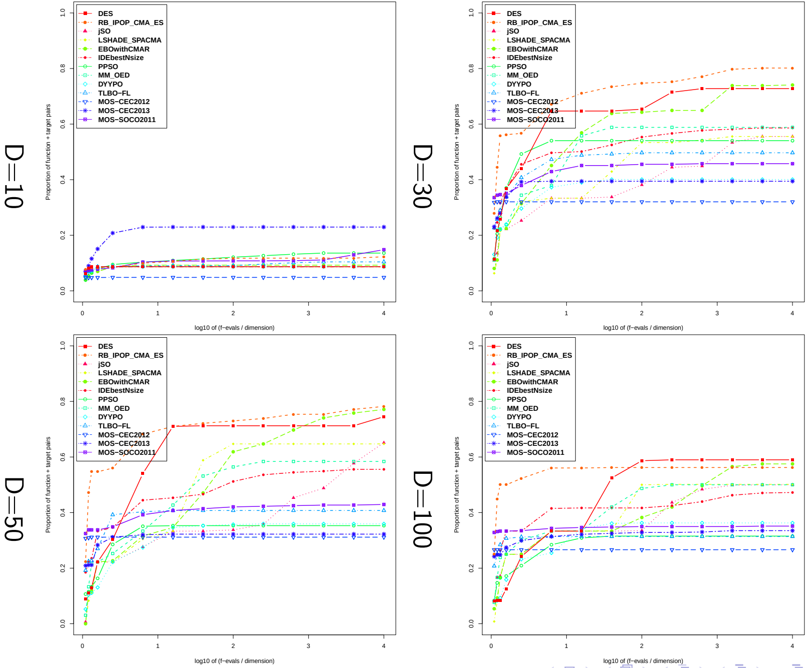

CEC2017 Function 27

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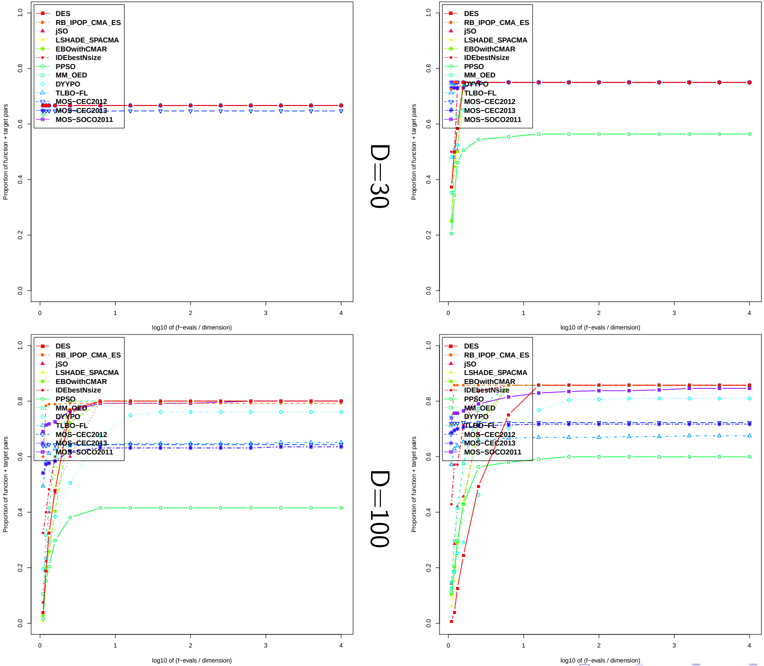
D=30



D=50

D=100

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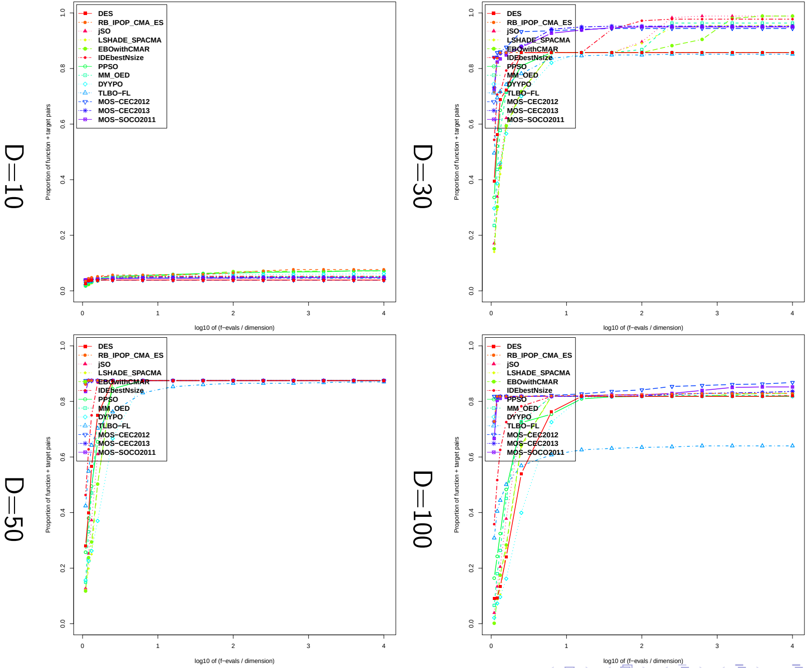

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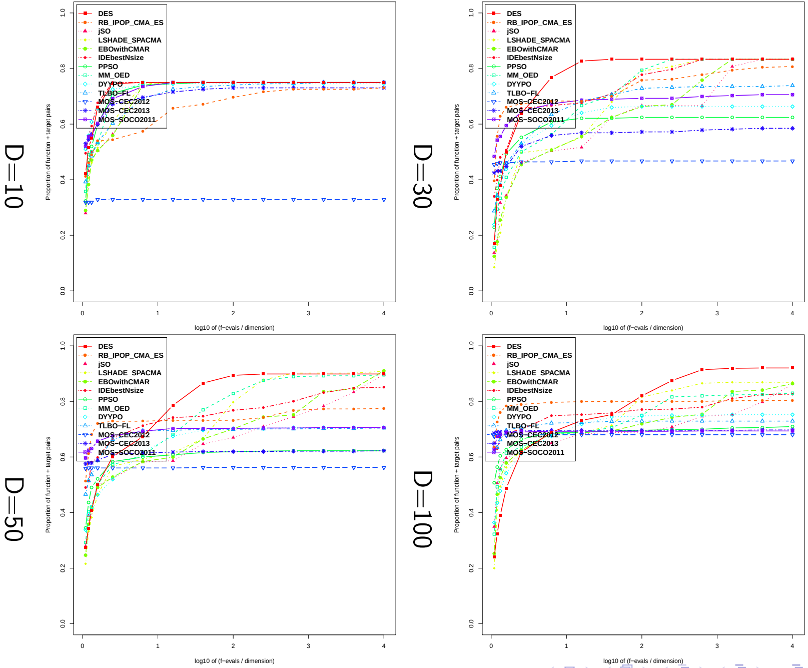

CEC2017 Function 30