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DXMODE: A dynamic explorative multi-operator differential evolution algorithm for engineering optimization problems

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ABSTRACT

Traditional methods often struggle with complex, real-world problems, while Differential Evolution (DE) offers more robust and adaptable solutions. However, many DE variants intertwine exploration and exploitation within mutation operators and rely on static or blind population reduction, leading to premature diversity loss. This paper proposes Dynamic Explorative Multi-Operator Differential Evolution (DXMODE), a novel DE variant featuring Error-based Linear Population Decay (ELPD) for adaptive sizing, considering both the error improvement and the iteration count. A decoupled exploration phase is also introduced with two new operators, Aggressive Gaussian Exploration (AGE) and Multiple Nested Chaotic Exploration (MNCE), enhancing diversity and search efficiency. DXMODE is validated on CEC2020/2021 and CEC2022 benchmarks against 30 state-of-the-art algorithms, including advanced DE variants and CEC winners. Statistical analyses indicate that DXMODE consistently outperforms competing methods, securing first place across all tests with statistically significant p-values; it surpasses IMODE with a confidence of 99.29%. DXMODE is also validated on 13 Engineering optimization problems, outperforming all algorithms with significant p-values, proving its superiority across real-world problems. The source code of DXMODE is publicly available on GitHub and MATLAB File Exchange: https://github.com/MohamedRedaMu/DXMODE-Algorithm, https://uk.mathworks.com/matlabcentral/fileexchange/181143-dxmode-algorithm.

1. Introduction

Numerical optimization plays a vital role in solving real-world problems across various domains, including economics, medical science, engineering problems, and artificial intelligence. These problems often involve complex, non-linear, and high-dimensional objective functions that traditional optimization techniques cannot solve and fail to provide robust solutions under such constraints [1]. In contrast, meta-heuristic algorithms proved their success as general problem solvers. They have shown notable success in efficiently navigating complex landscapes and offering approximate but effective solutions with lower computational cost [2].

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1.1. Research gap in the literature and motivation

Meta-heuristic algorithms are broadly categorized into four main groups: evolutionary-based, swarm-based, nature-inspired, and trajectory-based methods. Evolutionary-based algorithms simulate natural selection and survival of the fittest, such as Genetic Algorithm (GA) and Differential Evolution (DE). Swarm-based methods like Particle Swarm Optimization (PSO) and Grey Wolf Optimizer (GWO) mimic collective animal behavior [3]. Nature-inspired techniques such as Firefly Algorithm (FA) and Moth-Flame Optimization (MFO) emulate biological or ecological phenomena [4]. Trajectory-based algorithms like Simulated Annealing (SA) explore neighboring solutions using thermodynamic analogies [5]. Despite their diversity, a persistent challenge across these categories is achieving a proper balance between exploration and exploitation. Static control parameters and insufficient population diversity often result in poor convergence or premature stagnation [6].

Among these methods, DE has remained one of the most reliable and widely adopted algorithms for global optimization. Its simplicity and effectiveness have positioned it at the top of many benchmarking competitions [7]. Over the years, many variants have been proposed to enhance its performance. Examples include JADE [8], which introduces adaptive parameter tuning and an archive mechanism, and IMODE [9], which incorporates a success-based multi-operator framework. Recent DE variants include EODE [10], BeSD [11], QRDE [12], and EA4eig [13].

A critical limitation in existing DE variants is the lack of explicit separation between mutation and exploration phases. Most rely on directional step differences between individuals for diversity [14], which becomes insufficient when the population converges prematurely, limiting escape from local optima. Additionally, population size in many DE variants is either fixed or blindly reduced over time without accounting for actual performance improvements during the search [15]. These decay methods can hinder exploitation in late stages or reduce necessary diversity too early, both of which compromise solution quality.

1.2. Proposed methodology and contributions

This paper introduces the Dynamic eXplorative Multi-Operator Differential Evolution (DXMODE) algorithm to address the limitations identified in existing DE variants. DXMODE proposes a dual-phase optimization framework: a traditional DE mutation phase with four strategies and a decoupled exploration phase. While traditional DE variants mix exploration and exploitation via mutation strategies alone, DXMODE introduces a dedicated exploration stage executed based on a dynamic switching probability. This stage includes two new operators to inject non-directional diversity into the population: Aggressive Gaussian Exploration (AGE) and Multiple Nested Chaotic Exploration (MNCE). Additionally, DXMODE introduces Error-based Linear Population Decay (ELPD), which dynamically adjusts the population size using iteration progress and error improvement metrics. ELPD ensures that population reduction is guided by actual optimization progress, maintaining an effective balance between convergence pressure and search diversity.

The key contributions of this work are:

- A novel algorithm named Dynamic Explorative Multi-Operator Differential Evolution (DXMODE) is proposed, introducing a dual-phase framework for improved exploration and convergence.
- The Error-based Linear Population Decay (ELPD), a dynamic population reduction strategy that reacts to error improvement rather than iteration count alone.
- A decoupled exploration phase governed by an adaptive switching probability, enabling non-directional search behavior.
- Aggressive Gaussian Exploration (AGE): Applies Gaussian perturbation with adaptive variance for intensified search.
- Multiple Nested Chaotic Exploration (MNCE): Generates diverse candidate points using recursive chaotic mapping.

Highlights of the Experimental Evaluation:

- DXMODE achieved top performance on all 22 CEC2020–2022 benchmark functions (10D and 20D), outperforming 30 competitive algorithms, including 16 classical meta-heuristics and 14 advanced DE variants.
- DXMODE ranked first on 13 engineering design problems, exhibiting statistically significant superiority validated by Wilcoxon, Friedman, Sign test, and Cohen's d analysis.
- Extensive ablation and sensitivity analyses were conducted, including 8 DXMODE variants and 20 decay combinations, confirming the benefits of ELPD, MNCE, and AGE components.
- Convergence behavior, diversity metrics (span and SD), and Page trend testing confirmed DXMODE's superior search stability without compromising computational efficiency.

1.3. Paper organization

The rest of the paper is organized as follows: Section 2 reviews recent developments in DE and other meta-heuristic optimization algorithms. Section 3 presents the proposed DXMODE algorithm in detail, highlighting its novel design components. Section 4 provides an ablation and sensitivity analysis of DXMODE's core components. Section 5 outlines the experimental configuration, including the benchmark functions and algorithm parameter settings. The subsequent sections report the empirical results: Section 6 benchmarks DXMODE against classical meta-heuristic algorithms; Section 7 investigates the effect of memory mechanisms using DXMODEv2; Section 8 compares DXMODE with advanced DE variants; Section 9 validates DXMODE on real-world engineering design problems

against classical meta-heuristic algorithms; and Section 10 extends the engineering problems validation against advanced DE variants. Finally, Section 11 concludes the paper and outlines future directions.

2. Literature review

This literature review is divided into two parts: the first surveys recent meta-heuristic and advanced DE algorithms, while the second outlines the mathematical foundations and core operators used in DE.

2.1. State-of-the-art meta-heuristic and DE algorithms

This section reviews the recent advances in meta-heuristic optimization algorithms and their top-performing Differential Evolution (DE) variants.

2.1.1. Meta-heuristic optimization algorithms

Meta-heuristic optimization algorithms have been widely applied across various real-world domains. These algorithms are typically classified into four categories based on their design inspiration and search mechanisms. Evolutionary-based algorithms rely on principles of survival of the fittest, where a population evolves over generations using variation and selection. Notable examples include Genetic Algorithm (GA), Differential Evolution (DE), and Covariance Matrix Adaptation Evolution Strategy (CMA-ES) [16]. Trajectory-based algorithms, such as Simulated Annealing (SA), explore the solution space via localized movements inspired by thermodynamic principles [17].

Swarm-based algorithms mimic the collective behavior and communication of animal groups, including Particle Swarm Optimization (PSO), Grey Wolf Optimization (GWO) [3], Cat Swarm Optimization Algorithm (CSOA) [18], Harris Hawks Optimization (HHO) [19], Artificial Bee Colony (ABC), and Chicken Swarm Optimization (CSO) [20]. Nature-inspired algorithms simulate ecological or biological behaviors, as seen in Firefly Algorithm (FA), Beetle Antennae Search (BAS) [21], Teaching-Learning-Based Optimization (TLBO) [22], and Moth-Flame Optimization (MFO) [4]. Despite these algorithms' variety and success, common limitations persist across categories. In particular, many suffer from static or non-adaptive control parameters, which restrict their ability to balance exploration and exploitation, leading to performance degradation in complex landscapes and increasing the risk of premature convergence [6].

2.1.2. Advanced DE variants

Differential Evolution (DE) and its variants have consistently ranked among the top performers in CEC benchmark competitions, owing to their robustness, simplicity, and effectiveness [23]. Over the years, numerous DE variants have been introduced to address limitations such as premature convergence, restricted population diversity, and rigid parameter tuning. These enhancements have demonstrated dominant performance in a variety of optimization problems.

Sallam et al. introduced the Improved Multi-Operator Differential Evolution (IMODE), one of the most significant variants. IMODE employs a multi-operator framework that adaptively selects mutation strategies based on their success rates. It outperformed all competing DE variants in the CEC2020 competition, including EBOwithCMAR, LSHADE-cnEpSin, and LSHADE-SPACMA [9], achieving a perfect score of 100/100 [7]. Other top performers from recent CEC competitions include the Adaptive Gaining-Sharing Knowledge-Based Algorithm (AGSK) (2nd place, CEC2020) [24], Evolutionary Algorithms with Eigen crossover (EA4eig) (CEC2022 winner) [13], and Hybrid Sampling-Evolution Strategy (HSES) (CEC2018 winner) [25].

Several enhanced variants have been proposed to advance DE's performance further. Moharam et al. introduced the hybrid Equilibrium Optimizer Differential Evolution (EODE), combining EO and DE strategies to improve convergence and solution quality [10]. Karkinli proposed the Multi-Population-Based Differential Evolution (MDE), which incorporates partial-elitist mutation and parameter-free crossover operators [26]. Nadimi-Shahraki et al. presented the Multi-Trial Vector-Based Differential Evolution (MTDE), which applies diverse trial vector producers across subpopulations with a winner-based distribution and lifetime archive to boost exploration [27].

Civicioglu and Besdok proposed several parameter-free DE variants. The Bernstein-Search Differential Evolution (BSD) features simplified mutation and crossover operators [28], while the Bernstein-Levy Differential Evolution (BDE) incorporates elitist mutation and Bernstein polynomial-based crossover [29]. They also introduced Bezier Search Differential Evolution (BeSD), a universal DE variant that deploys Bezier-based operators for efficient search [11]. Layeb proposed the mean Differential Evolution (meanDE), which integrates novel mutation strategies with adaptive control parameters to enhance both exploration and robustness [30].

Haro et al. developed Quartile-Based Ranked Differential Evolution (QRDE), which improves selection by partitioning the population into quartiles and guiding exploitation accordingly [12]. Zhang and Sanderson introduced the Adaptive Differential Evolution with Optional External Archive (JADE) with self-adaptive parameters and a novel mutation strategy enriched by historical data [8]. More recently, Al Hwaitat and Fakhouri proposed JADE-GMO, a hybrid algorithm combining JADE's adaptive strategies with the elite-guided velocity updates of the Geometric Mean Optimizer [31].

These advanced DE variants integrate hybrid operators, adaptive mutation mechanisms, memory-based learning, and self-adjusting parameters to enhance convergence behavior. However, most still rely on coupled mutation-exploration mechanisms using directional step differences between individuals, which leads to diversity loss when the population converges prematurely [14]. Additionally, these variants incorporate static or blind population reduction schedules [15], which can prematurely reduce diversity, hindering performance in later stages. These challenges motivate the development of the proposed DXMODE algorithm, which introduces a decoupled exploration phase and a dynamic, error-aware population control strategy.

2.2. Mathematical foundations of DE algorithms

This section presents the mathematical foundations of key DE operators, including population sizing, mutation, crossover, selection, and local search, as established in the literature.

2.2.1. Population size

Most meta-heuristic optimization algorithms begin by initializing a fixed population size. However, recent studies have shown that dynamic population sizing can enhance performance, particularly in DE. One of the earliest adaptive strategies is the Linear Population Size Reduction (LPSR) approach [32]. In LPSR, the population size starts from an initial value NP_{init} and decreases linearly over time until reaching a lower bound $NP_{\min}$. The LPSR strategy is formulated in Eq. (1), where g is the current generation and $g_{\max}$ is the maximum number of generations. This method has been widely adopted in several successful DE variants such as MODE-ILNS [33], IMODE [9], and FLDE [15].

$$NP = NP_{\text{init}} + (NP_{\min} - NP_{\text{init}}) \cdot \frac{g}{g_{\max}} \tag{1}$$

A refinement of this approach, the Parabolic Population Size Reduction (PPSR), was introduced in the PaDE algorithm [34]. PPSR uses a slower, non-linear decay curve to prevent premature population shrinking, which is particularly useful in problems requiring extended exploration in the early stages. The PPSR strategy is defined in Eq. (2). LPSR and PPSR serve as baseline strategies in our comparative sensitivity analysis, where we evaluate the proposed Error-based Linear Population Decay (ELPD) against these and the fixed-size approach.

$$NP = NP_{\min} + (NP_{\text{init}} - NP_{\min}) \cdot \left(1 - \left(\frac{g}{g_{\max}}\right)^2\right) \tag{2}$$

2.2.2. Mutation operators

The mutation operation is the core update mechanism in the DE algorithm, responsible for generating new candidate solutions, called mutants v_i^g. The following equations represent commonly used mutation rules in DE: DE/rand/1 in Eq. (3), DE/current-to-best in Eq. (4), DE/current-to-ϕbest/1 in Eq. (6), DE/current-to-ϕbest/1/archive in Eq. (7) [8], DE/rand-to-best/1 in Eq. (5), and DE/weighted-rand-to-ϕbest/1 in Eq. (8) [9]. Here, $F \in [0,1]$ is the mutation factor, x_{r1}^g, x_{r2}^g, and x_{r3}^g are three random individuals from the population; x_{best}^g is the best individual in generation g; x_i^g is the current target individual; $x_{\phi\text{best}}^g$ is a randomly selected individual from the top $100\phi\%$ of the population (with $\phi = 25\%$); and $\hat{x}_{r2}^g$ is a randomly selected individual from the archive, which stores past solutions up to a size of $2.6 \times \text{NP}$.

$$v_i^g = x_{r1}^g + F \cdot (x_{r2}^g - x_{r3}^g) \tag{3}$$

$$v_i^g = x_i^g + F \cdot (x_{\text{best}}^g - x_i^g) \tag{4}$$

$$v_i^g = x_{r1}^g + F \cdot (x_{\text{best}}^g - x_{r1}^g) + F \cdot (x_{r2}^g - x_{r3}^g) \tag{5}$$

$$v_i^g = x_i^g + F \cdot (x_{\phi\text{best}}^g - x_i^g) + F \cdot (x_{r1}^g - x_{r2}^g) \tag{6}$$

$$v_i^g = x_i^g + F \cdot (x_{\phi\text{best}}^g - x_i^g) + F \cdot (x_{r1}^g - \hat{x}_{r2}^g) \tag{7}$$

$$v_i^g = F \cdot x_{r1}^g + F \cdot (x_{\phi\text{best}}^g - x_{r2}^g) \tag{8}$$

2.2.3. Crossover, selection, and local search operators

Following mutation, the DE algorithm applies a crossover operation to generate trial vectors. The most common approach is the binomial crossover, where each dimension j of the child $u_{i,j}^g$ is inherited either from the mutant $v_{i,j}^g$ or the original individual $x_{i,j}^g$ based on a crossover probability CR_i, as defined in Eq. (9).

$$u_{i,j}^g = \begin{cases} v_{i,j}^g, & \text{if } \text{rand}_{i,j} \le CR_i \\ x_{i,j}^g, & \text{otherwise} \end{cases} \tag{9}$$

Next, the selection process compares the fitness of the trial vector u_i^g with its parent x_i^g. The better solution proceeds to the next generation, as shown in Eq. (10). To accelerate convergence, DE can incorporate a local search mechanism. One common method is Sequential Quadratic Programming (SQP), which is applied with a probability $P_{ls} = 0.1$ and a limited number of function evaluations [9], particularly during the final stages of the algorithm.

$$x_i^{g+1} = \begin{cases} u_i^g, & \text{if } f(u_i^g) \le f(x_i^g) \\ x_i^g, & \text{otherwise} \end{cases} \tag{10}$$

3. The proposed DXMODE algorithm

The proposed Dynamic eXplorative Multi-Operator Differential Evolution (DXMODE) algorithm introduces a dual-phase optimization framework designed to address the limitations of traditional DE methods, particularly the balance between exploration and exploitation. Unlike conventional DE algorithms that rely solely on population-based mutation, DXMODE incorporates an independent exploration phase that injects diversity into the population's search trajectory, enhancing its ability to escape local optima.

The term "Explorative" refers to this decoupled exploration phase, executed conditionally based on a dynamic probability PX and built upon three custom-designed operators: Aggressive Gaussian Exploration (AGE), Multiple Nested Chaotic Exploration (MNCE), and Biased Selective Random Walk (BSRW). The term "Multi-Operator" reflects the integration of both the three exploration operators and four complementary mutation strategies used in the main DE loop: DE/rand/1 (Eq. (3)), DE/weighted-rand-to-ϕbest/1 (Eq. (8)), DE/current-to-ϕbest/1 (Eq. (6)), and DE/current-to-ϕbest/1 with archive (Eq. (7)). The DE mutation is followed by binomial crossover (Eq. (9)) and selection (Eq. (10)).

The term "Dynamic" captures two adaptive mechanisms at the core of DXMODE: the Error-based Linear Population Decay (ELPD), which adjusts population size based on both error improvement and iteration progress; and a decaying exploration probability PX, which regulates the use of the exploration phase throughout the run. Operator selection in both phases is guided by a success-based learning mechanism inspired by IMODE [9]. The crossover probability CR and mutation factor F are updated using the memory-based adaptation strategy from JADE and SHADE [35]. The detailed implementation of the ELPD mechanism and the custom exploration operators is presented in the following subsections.

3.1. The proposed dynamic population size reduction (ELPD)

Traditional reduction methods such as linear or parabolic decay have shown limited performance gains, as they reduce population size without considering the population's fitness improvements [33]. These strategies may work for simple functions but risk compromising diversity in complex or multimodal landscapes with slow fitness improvement. Reducing the population prematurely in such cases leads to fewer search agents and reduces the chance of escaping local optima.

To address this, we propose a dynamic population control strategy called Error-based Linear Population Decay (ELPD), which adjusts the population size based on both iteration progress and error improvement. First, the error improvement ratio (EIR) is calculated from Eq. (11). Here, $f(x^{g}_{\text{best}})$ and $f(x^{0}_{\text{best}})$ are the best fitness values at generation g and at initialization, respectively, and Tol is a small threshold error. At the first generation, EIR starts at zero and increases as the population improves. If Tol is reached, then EIR = 1.

$$\text{EIR} = 1 - \frac{f(x^{g}_{\text{best}}) - \text{Tol}}{f(x^{0}_{\text{best}}) - \text{Tol}} \tag{11}$$

Second, the generation progress rate GR measures how far the algorithm has advanced toward its stopping condition, as defined in Eq. (12). Here, NFE and $MaxFEs$ denote the current and maximum function evaluations, while NI and $maxIter$ represent the current and maximum number of iterations, respectively. GR increases linearly from 0 to 1 as the algorithm progresses.

$$GR = \begin{cases} \frac{\text{NFE}}{\text{MaxFEs}}, & \text{if termination is based on function evaluations,} \\ \frac{\text{NI}}{\text{maxIter}}, & \text{if termination is based on iterations.} \end{cases} \tag{12}$$

Then, the total reduction rate TR is computed by weighting EIR and GR, as shown in Eq. (13). A weight of 0.4 is assigned to EIR and 0.6 to GR, reflecting the fact that generation progress tends to be a more stable convergence indicator in complex landscapes. In contrast, error improvement can fluctuate due to local optima.

$$TR = 0.4 \cdot EIR + 0.6 \cdot GR \tag{13}$$

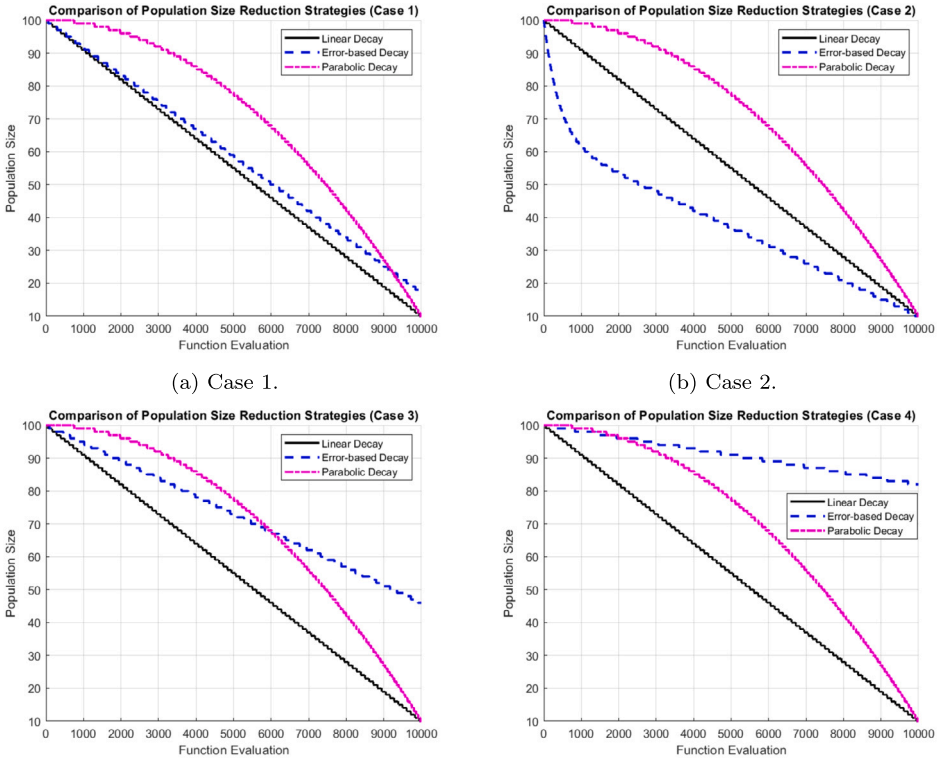
Finally, the population size is updated using Eq. (14). The initial population size is set to $NP_{\text{init}} = 12 \times D$, consistent with empirical guidelines recommending 10–15 individuals per dimension. A lower bound of $NP_{\text{min}} = 6$ ensures sufficient diversity and computational efficiency.

$$NP = \text{round}\left(NP_{\text{min}} + (NP_{\text{init}} - NP_{\text{min}}) \cdot (1 - \text{TR})\right) \tag{14}$$

The population is initialized using Latin Hypercube Sampling (LHS), which ensures uniform coverage over the search space. Each dimension j is initialized within its bounds $x_{\min_j}$ and $x_{\max_j}$ using Eq. (15). Here, $\text{lhd}_{i,j}$ is a Latin Hypercube-sampled value in $[0, 1]$ for individual i and dimension j, ensuring uniform sampling across the dimensions, leading to a diverse initial population [33].

$$x_{i,j} = x_{\min_j} + (x_{\max_j} - x_{\min_j}) \times \text{lhd}_{i,j} \quad \begin{cases} \forall j = 1, 2, \cdots, D \\ \forall i = 1, 2, \cdots, NP_{\text{init}} \end{cases} \tag{15}$$

The ELPD method ensures dynamic decay: if improvement is observed, the population reduces more aggressively to save computational resources; if slow progress is detected, the population remains larger to encourage exploration. Fig. 1 presents four cases



(a) Case 1. (b) Case 2.

(c) Case 3. (d) Case 4.

Fig. 1. Comparison of Population Size Reduction Strategies.

with varying error convergence patterns. In ideal conditions (Fig. 1a), ELPD exhibits near-linear decay. If the error improves early (Fig. 1b), ELPD reduces the population rapidly, conserving resources. If improvement slows later (Fig. 1c) or remains poor (Fig. 1d), ELPD maintains a larger population, offering more search power and diversity.

3.2. Novel exploration operator phase in the proposed algorithm

Traditional DE algorithms often rely on greedy mutation strategies such as DE/current-to-ϕbest/1, encouraging exploitation by pushing the population toward the current best solutions. While effective for convergence, these methods risk premature stagnation due to loss of diversity. Other mutation strategies that use directional steps between randomly selected individuals also offer limited diversity, as new candidates remain within the span of the current population.

Although prior DE variants have introduced implicit exploration mechanisms, such as adaptive parameter tuning or archive-based selection, these strategies remain problem-dependent. For instance, when the control parameter F is forced to be small by the optimization problem, the step size shrinks significantly, reducing the algorithm's ability to escape local optima [8].

Moreover, existing explicit exploration techniques—such as Covariance Matrix Adaptation (CMA-ES), Opposition-Based Learning (OBL), and Orthogonal Learning (OL)—primarily rely on directional or symmetric sampling. CMA-ES demands substantial memory and computational overhead due to its evolving covariance matrix and hyper-parameter tuning. OBL assumes symmetric landscapes and explores mirrored points across a central reference, causing a lack of flexibility in complex search spaces. OL increases diversity via structured vector recombination but still relies on population-driven directions [36].

DXMODE introduces a dedicated and decoupled exploration phase alongside its main evolutionary process to overcome these limitations and ensure balance between exploration and exploitation. This phase includes two new operators, Aggressive Gaussian Exploration (AGE) and Multiple Nested Chaotic Exploration (MNCE), alongside the traditional Biased Selective Random Walk (BSRW). A dynamic exploration probability (PX) adaptively governs the frequency of this phase based on iteration progress.

3.2.1. Aggressive Gaussian exploration (AGE)

AGE introduces a direct perturbation mechanism for each individual using Gaussian-distributed noise with dynamic variance, applied uniformly across all dimensions. Unlike traditional exploration strategies in DE that rely on differences between randomly selected individuals (e.g., DE/rand or Gaussian step sizes based on population spread), AGE eliminates dependency on population structure. These population-based strategies tend to lose effectiveness as the population converges because the difference vectors shrink, leading to vanishing step sizes and halted search progress [37].

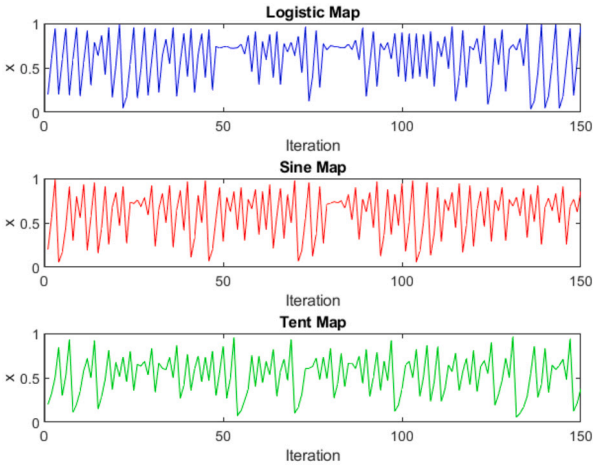


Fig. 2. Chaotic maps: Logistic, Sine and Tent maps.

In contrast, AGE generates new candidate solutions independently of other individuals, ensuring persistent and consistent perturbation. Specifically, the update is performed using Eq. (16) for each individual x_i^g in the g-th generation. Here, a is a scaling factor set to 0.1, and $\mathcal{N}(0,(1-GR)^2)$ denotes a Gaussian-distributed random value with zero mean and a dynamic standard deviation. The term GR represents the normalized generation progress, obtained from Eq. (12). As GR increases, the variance of the Gaussian noise decreases, enabling broader exploration in early stages and more refined perturbations in later stages.

$$u_{i,j}^g = x_{i,j}^g + a \cdot \mathcal{N}_{i,j}(0,(1-GR)^2), \quad \forall j = 1,2,\ldots,D \tag{16}$$

3.2.2. Multiple nested chaotic exploration (MNCE)

MNCE introduces a novel chaotic-map-based exploration rule that perturbs each individual through recursively applied chaotic maps rather than merely tuning algorithmic parameters. Chaotic maps have previously been used to control scalar coefficients, such as mutation factors in DE [38]. On the other hand, MNCE directly manipulates the decision variables of individuals (not just the hyper-parameters), which marks a structural departure from prior approaches by embedding chaotic behavior at the solution level.

Unlike population-based or probabilistic methods, MNCE does not rely on search geometry or directional differences among individuals. Instead, each individual is randomly assigned one of three chaotic maps (logistic, sine, or tent), which is applied iteratively to each dimension for $K = 10$ recursive steps. The process begins with the individual's current value $x_{i,j}^{g,0}$ and applies the chaotic rule defined in Eq. (17) to produce $x_{i,j}^{g,K}$, serving as the updated solution. This mechanism ensures significant perturbation while remaining computationally lightweight and resistant to search stagnation.

$$x_{i,j}^{g,k+1} = \begin{cases} r \cdot x_{i,j}^{g,l} \cdot (1 - x_{i,j}^{g,k}), & \text{if mapType} = \text{'logistic'} \\ r \cdot \sin(\pi \cdot x_{i,j}^{g,k}), & \text{if mapType} = \text{'sine'} \\ r \cdot x_{i,j}^{g,k}, & \text{if mapType} = \text{'tent' and } x_{i,j}^{g,k} < 0.5 \\ r \cdot (1 - x_{i,j}^{g,k}), & \text{if mapType} = \text{'tent' and } x_{i,j}^{g,k} \geq 0.5 \end{cases}, \quad \begin{cases} \forall j = 1,2,\ldots,D \\ \forall k = 1,\ldots,K \end{cases} \tag{17}$$

Fig. 2 illustrates the iterative behaviors of these maps from the same starting point. Each map introduces distinct dynamics: the logistic map is highly sensitive to initial conditions and uses $r \in [3.57,4]$, the sine map generates nonlinearity for $r \in [0.9,1]$, and the tent map exhibits piecewise linear chaos with $r \in [1.5,2]$ [39]. By cycling through these maps and repeatedly applying them across all dimensions, MNCE produces diverse and non-directional transformations, significantly expanding search coverage and enhancing global diversity independently of the population's state.

3.2.3. Biased selective random walk (BSRW)

The final exploration rule employed is the BSRW, originally introduced in [40], and shown to be effective in diverse optimization tasks. BSRW updates each individual based on two randomly selected solutions, as defined in Eq. (18).

$$u_{i,j}^g = \begin{cases} x_{i,j}^g + r \times (x_{r1,j}^g - x_{r2,j}^g), & \text{if } \text{rand}_{i,j} \leq 0.25 \\ x_{i,j}^g, & \text{otherwise} \end{cases}, \quad \forall j = 1,2,\ldots,D \tag{18}$$

Table 1
Summary of Parameter Settings for the proposed DXMODE Algorithm.

Parameter	Value
Initial population size NP_{init}	$12 * D$
Minimum population size $NP_{\min}$	6
Archive size (A)	$2.6 * NP_{\text{init}}$
Memory size (H)	$20 * D$
Initial crossover probability CR_{init}	0.2
Initial mutation factor F_{init}	0.2
Minimum exploration probability PX_{min}	0.05
Maximum exploration probability PX_{max}	0.4
Local search probability P_{ls}	0.1
Min local search probability $P_{ls_{min}}$	0.01
maximum local search function evaluations $MaxFE_{ls}$	$20E-03 * MaxFEs$

Unlike AGE and MNCE, which perturb all dimensions of the individual, BSRW applies changes to approximately 25% of the dimensions based on a discovery probability of 0.25. This ratio makes it a less aggressive operator but a valuable complement to AGE and MNCE by introducing variation in the intensity of exploration.

3.2.4. Dynamic exploration probability PX

A probabilistic switching mechanism is introduced via a parameter PX to regulate the exploratory behavior of DXMODE over time dynamically. PX starts at a high value and linearly decreases throughout the run because broad exploration is more beneficial in the early stages of the search, and finer exploitation is preferred as the algorithm converges. The update rule is expressed in Eq. (19). PX is initialized at $PX_{\max} = 0.4$ and gradually declines to $PX_{\min} = 0.05$ based on the algorithm's progress, measured by a step ratio $GR \in [0, 1]$ defined in Eq. (12).

$$PX = PX_{\max} - (PX_{\max} - PX_{\min}) \times GR \tag{19}$$

This dynamic switching allows DXMODE to prioritize exploration during the early phases and gradually shift toward exploitation as the search progresses. PX introduces a controlled diversity mechanism governing the probability of activating one of the three exploration rules (AGE, BSRW, and MNCE), reducing the likelihood of premature convergence.

3.3. Light version of the algorithm: DXMODEv2

In the proposed algorithm DXMODE, the memory size H is initialized to be scaled with the problem dimension size, $H = memScale * nd$, where the memScale is set to 20. Moreover, the DXMODE algorithm has a no-memory option, where the algorithm does not store the previous CR and F values. The no-memory option helps to accelerate the computation speed and consumes less memory during the execution. The CR and F values are set to values generated from a normal distribution with a mean of 0.5 and a standard deviation of 0.15, as in Equations (20) and (21), where F_i and CR_i are the mutation factor and Crossover probability of the i^{th} individual, respectively.

$$CR_i = \text{randn}(0.5, 0.15) \tag{20}$$

$$F_i = \text{randn}(0.5, 0.15) \tag{21}$$

3.4. The complete DXMODE algorithm

This section summarizes the implementation flow of DXMODE, integrating all previously introduced components. The high-level steps are illustrated in the flowchart (Fig. 3) and the corresponding pseudocode (Algorithm 1). The algorithm begins by initializing parameters (Table 1), generating the initial population via Latin Hypercube Sampling (Eq. (15)), and setting up archives, memories, and operator selection probabilities. The memory size for control parameters is set to $H = 20 \times D$, and the archive size is $2.6 \times NP$.

In each generation, the population size is dynamically reduced using the ELPD strategy using Eq. (14). Based on historical success, the mutation is applied using one of four operators selected via roulette-wheel. The generated mutants are combined with parents using binomial crossover (Eq. (9)) and evaluated via a greedy selection rule (Eq.((10)). Control parameters CR and F are updated from memory as described in [9].

Following the primary DE operations, the exploration phase is executed probabilistically, governed by PX, which decreases over time (Eq. (19)). If triggered, one of three custom exploration operators (AGE, MNCE, or BSRW) is applied to all individuals. Each operator is chosen using adaptive roulette selection based on its past contribution. Finally, a local search phase based on SQP is optionally applied near convergence. If no improvement is observed, the local search probability P_{ls} is reduced for future iterations. The process continues until the termination condition is met.

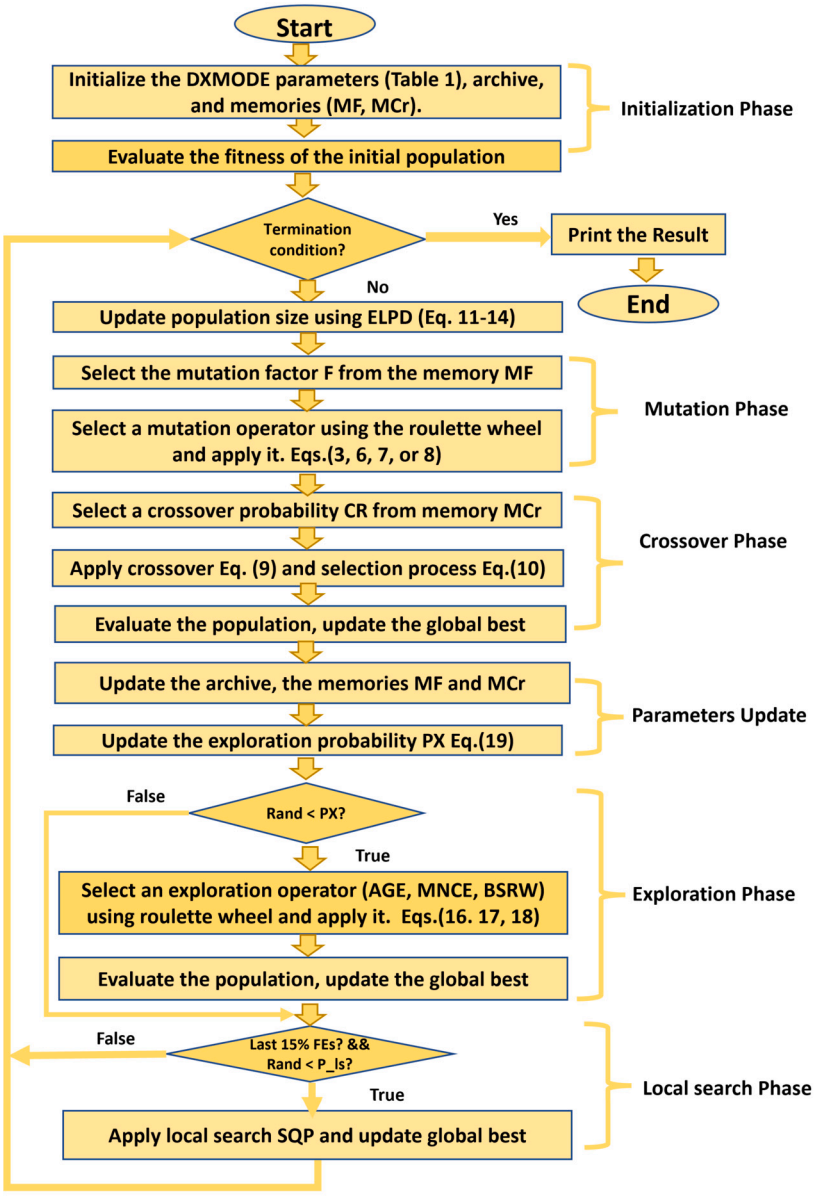


Fig. 3. The proposed DXMODE algorithm flowchart.

4. Ablation and sensitivity analysis of design components

4.1. Effect of PX decay and population decay strategies

4.1.1. Population decay strategies

In Section 3.1, the Error-based Linear Population Decay (ELPD) method is introduced as a dynamic population size reduction strategy that considers both the iterations progress and the rate of error improvement. In this section, we compare ELPD with commonly used population decay strategies in the literature, such as Linear Population Size Reduction (LPSR) [9], Parabolic Population Size Reduction (PPSR) [34], and Fixed Population Size (FPS). These strategies are unified under the formulation in Eq. (22), where GR denotes the normalized generation rate as defined in Eq. (12), and TR is the total weighted rate that combines GR and the Error Improvement Ratio (EIR), as described in Eq. (13).

Algorithm 1 The proposed DXMODE algorithm.

```
Initialize the algorithm parameters as in Table 1.                          ▷ Initialization
Initialize the archive A and the memories M_F and M_CR.
Initialize the population using LHS as in Eq (15).
Evaluate the population fitness and sort the population based on fitness.
while Termination Condition do                                              ▷ Main loop
    Update the population size NP using ELPD method (Eq. (11) to (14)).
    Update the archive size and remove the extra individuals.
    for each individual i = 1 to NP do                                      ▷ Mutation Phase
        Select mutation factor F_i from the memory M_F [9].
        Select mutation rule using roulette wheel selection.
        Apply the selected mutation rule; one of equations: (3), (6), (7), (8).
        Apply the boundary handling.
    end for
    Perform Crossover and selection                                         ▷ Crossover Phase
    Select a crossover probability CR_i from memory M_Cr.
    Perform Crossover and selection operator, as in Eqns. (9) and (10).
    Evaluate and sort the new population and update the global best.
    Update the archive A.
    Update the CR and F memory M_Cr and M_F [9].
    Perform Exploration phase                                               ▷ Exploration Phase
    Update the exploration probability PX Eq. (19).
    if rand < PX then
        Perform Exploration
        for each dimension j = 1 to D do
            Select exploration rule using roulette wheel.
            Apply the selected exploration rule; one of Eq. (16), (17), (18).
            Apply the boundary handling.
        end for
        Evaluate and sort the new population and update the global best.
        Update the archive A.
    end if
    if rand < P_ls then                                                     ▷ Optional Local search
        Perform a local search using SQP, and Update global best solution.
    end if
end while
Return the global best solution.
```

$$NP = \begin{cases} NP_{\text{init}}, & \text{Fixed Pop. Size (FPS)} \\ NP_{\text{init}} + (NP_{\text{min}} - NP_{\text{init}}) \cdot GR, & \text{Linear Pop. Size Reduction (LPSR)} \\ NP_{\text{min}} + (NP_{\text{init}} - NP_{\text{min}}) \cdot (1 - GR^2), & \text{Parabolic Pop. Size Reduction (PPSR)} \\ NP_{\text{min}} + (NP_{\text{init}} - NP_{\text{min}}) \cdot (1 - TR), & \text{Error-based Linear Pop. Decay (ELPD)} \end{cases} \tag{22}$$

4.1.2. PX decay strategies

Similarly, in Section 3.2.4, an adaptive switching probability was introduced using a linear decay formulation, as given in Eq. (19). In this section, we extend the design of the switching probability PX by evaluating five different decay strategies: linear, exponential, logarithmic, sigmoid, and cosine. Each strategy defines a distinct schedule for decreasing the exploration probability PX throughout the optimization process, as summarized in Eq. (23). Here, t_j is the current iteration or function evaluation count, and $T_{\max}$ represents the maximum number of iterations or function evaluations depending on the termination criterion.

$$PX = \begin{cases} PX_{\max} - (PX_{\max} - PX_{\min}) \cdot GR, & \text{Linear (Eq. (19))} \\ PX_{\max} \cdot \exp\left(GR \cdot \ln\left(\dfrac{PX_{\min}}{PX_{\max}}\right)\right), & \text{Exponential} \\ PX_{\max} - \left(\dfrac{\log(1+t_j)}{\log(1+T_{max})}\right) \cdot (PX_{\max} - PX_{\min}), & \text{Logarithmic} \\ PX_{\min} + \dfrac{PX_{\max} - PX_{\min}}{1 + \exp(\gamma \cdot (GR - 0.5))}, & \text{Sigmoid} \\ PX_{\min} + \dfrac{1}{2}(PX_{\max} - PX_{\min})[1 + \cos(\pi \cdot GR)], & \text{Cosine} \end{cases} \tag{23}$$

4.1.3. Sensitivity analysis of different decay strategies

A sensitivity analysis is conducted to assess the performance of different decay strategies by evaluating all 20 combinations of four population decay methods (ELPD, LPSR, PPSR, FPS) and five PX decay strategies (linear, exponential, logarithmic, sigmoid,

Table 2
Sign test results and mean ranks of DXMODE_Decay variants across PX and population decay combinations. Each cell shows +/=/- (mean Friedman rank).

PX \ Pop	ELPD	LPSR	PPSR	FPS
lin	NA (5.825)	+13/=2/-5 (8.85)	+17/=1/-2 (12.075)	+19/=0/-1 (16.0)
exp	+9/=3/-8 (6.7)	+11/=1/-8 (7.525)	+17/=0/-3 (11.5)	+17/=0/-3 (14.4)
log	+11/=2/-7 (7.175)	+13/=1/-6 (9.275)	+16/=1/-3 (10.475)	+19/=0/-1 (16.95)
sig	+12/=2/-6 (8.275)	+15/=1/-4 (8.125)	+15/=1/-4 (10.475)	+17/=0/-3 (15.45)
cos	+11/=2/-7 (7.425)	+11/=1/-8 (6.575)	+14/=1/-5 (11.075)	+17/=0/-3 (15.85)

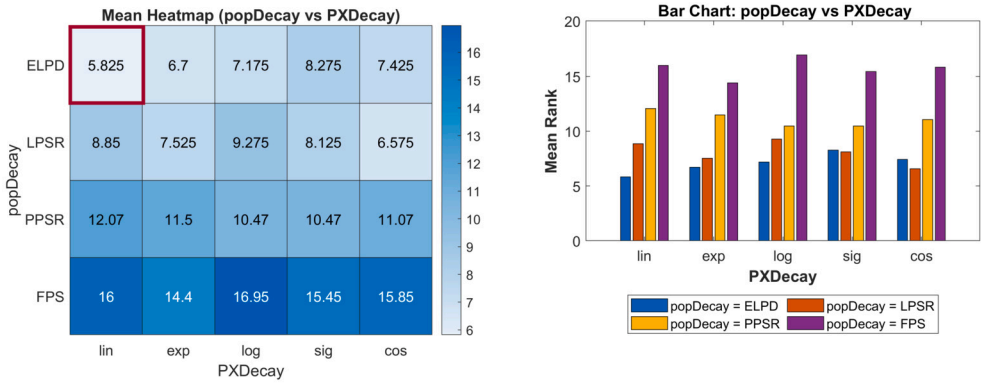


Fig. 4. The heatmap and the bar chart for the mean sensitivity analysis.

and cosine). Each configuration of the DXMODE algorithm is benchmarked on the CEC2020 test functions in 10D and 20D settings, with each run terminated at 50,000 and 100,000 function evaluations, respectively. Each combination was independently executed 8 times.

The Friedman test is applied to each function's average error values across the runs to compute the mean ranks. A pairwise Wilcoxon signed-rank test is then performed between the best-performing configuration and each of the other configurations. The detailed results are presented in Table 2, while the corresponding mean ranks are visualized through a heatmap and bar chart in Fig. 4.

The results reveal that the combination of the proposed ELPD with linear PX decay achieved the lowest mean rank (5.825), outperforming all other configurations. For the linear, exponential, and logarithmic PX decay strategies, ELPD consistently outperformed all other population decay methods. However, for sigmoid and cosine PX decay, the LPSR method slightly outperformed ELPD in terms of mean rank (e.g., 6.575 for LPSR vs. 7.425 for ELPD in the cosine case). Moreover, across all PX strategies, the FPS consistently resulted in the worst performance, with mean ranks reaching 16.95. The PPSR performed moderately but was worse than ELPD and LPSR. Overall, the findings emphasize the effectiveness of adaptive decay mechanisms (ELPD and linear PX decay) in dynamically tuning the population size and the PX hyperparameters.

4.2. Ablation study on ELPD, AGE, and MNCE

A comprehensive ablation study is conducted to quantify the individual contributions of the ELPD, AGE, and MNCE components in DXMODE. Eight variants were implemented: a base version with all enhancements disabled (no ELPD, AGE, or MNCE), three versions with only one component enabled (AGE only, MNCE only, or ELPD only), and three additional configurations that omit one of the proposed components while retaining the others (no AGE, no MNCE, and no ELPD), alongside the full version that includes all three. Each variant was tested on the CEC2020 benchmark suite under 10D and 20D settings, with eight independent runs per function and termination set to 50,000 and 100,000 function evaluations, respectively.

The Friedman test is applied to the mean error across all functions and runs to compute the mean ranks of the eight DXMODE variants. As shown in Fig. 5, the full version of DXMODE achieved the best performance with the lowest mean rank of 3.675. When any of the components (ELPD, AGE, or MNCE) were removed, performance consistently declined. The exclusion of either ELPD or MNCE resulted in a mean rank of 4.275, followed by the absence of AGE with a rank of 4.375. Variants containing only a single enhancement (AGE only, MNCE only, or ELPD only) performed better than the base version (mean rank = 5.025), confirming that each individual component provides measurable improvement. However, none of the isolated variants matched the whole configuration. These results highlight the complementary benefits of ELPD, AGE, and MNCE, confirming that their combined use is essential to achieving the full performance potential of the DXMODE framework.

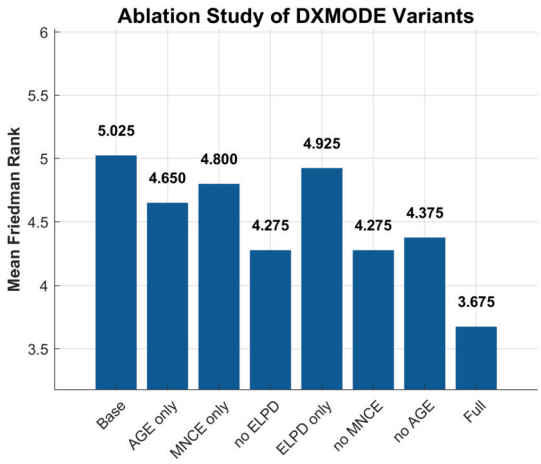


Fig. 5. Mean Friedman ranks of DXMODE variants from the ablation study.

Table 3
Summary of Parameter Settings for CEC2020-2022 Benchmark Functions.

Parameter	Value
Dimensions Size (nd)	10 and 20
Maximum Function	200,000 for $nd = 10$,
Evaluations (MaxFEs)	500,000 for $nd = 20$
Type	all are minimization problems
Fitness Function	$E_i(x) = F_i(X) - F_i(X^*)$
Tolerance of error	$1.0E-08$
Number of runs	30
Dimensions search Space	$[-100, 100]^{nd}$

5. Experimental setup and evaluation framework

This section presents the experimental environment for evaluating the DXMODE algorithm against state-of-the-art meta-heuristic algorithms. The evaluation is conducted using the most recent and challenging single-objective constrained benchmark problems from the CEC2020–2022 test suites and a collection of thirteen engineering optimization problems.

5.1. CEC2020–2022 benchmark suites

The CEC2020 and CEC2021 benchmark suites share a standard set of ten bound-constrained single-objective optimization problems [7], with CEC2021 introducing parameterized transformations such as bias, shift, and rotation. The CEC2022 suite extends the challenge with twelve more functions, constructed as enhanced versions of earlier CEC benchmarks like CEC05, CEC13, CEC14, and CEC17, and intended to better approximate real-world problem complexity [23]. A total of twenty-two functions are used in the evaluation: F1–F10 from CEC2020/2021 and F11–F22 from CEC2022. The complete definitions of these functions are provided in Appendix A (Tables A.1–A.2).

Each function is a minimization problem with a known global optimum $F_i(X^*) = F_i^*$. The fitness function is defined as the error $E_i(X) = F_i(X) - F_i(X^*)$, where $F_i(X)$ is the best obtained optimum solution so far by the algorithm. Algorithms are executed over 30 independent runs per function, and the stopping condition is either reaching $E_i(x^t) \leq 1.0 \times 10^{-8}$ or exhausting the maximum number of function evaluations (200,000 for 10D and 500,000 for 20D). The parameter settings of the benchmark functions are summarized in Table 3.

5.2. Engineering optimization problems

In addition to CEC benchmarks, thirteen real-world engineering optimization problems are employed to evaluate the scalability and applicability of DXMODE in practical scenarios. These include classic mechanical and structural design tasks such as speed reducer, pressure vessel, welded beam, and reinforced concrete beam optimization [41]. Table 4 summarizes the dimensions, decision variable bounds, and known global optima. Each problem is solved over 30 runs with a MaxFEs of 12,000. Full mathematical definitions are provided in Appendix C.

Table 4
Engineering optimization Benchmark problems [41]. LB and UB represent the lower and upper bounds of the variables, respectively.

FNo.	Problem Name	Dim	Bounds	Global Best
F1	Speed Reducer Design	7	LB: [2.6, 0.7, 17, 7.3, 7.3, 2.9, 5] UB: [3.6, 0.8, 28, 8.3, 8.3, 3.9, 5.5]	2994.4245
F2	Tension/Compression Spring Design	3	LB: [0.05, 0.25, 2.0] UB: [2.0, 1.3, 15.0]	0.0127
F3	Pressure Vessel Design	4	LB: [0.51, 0.51, 10, 10] UB: [99.49, 99.49, 200, 200]	6059.7143
F4	Three-Bar Truss Design	2	LB: [0, 0] UB: [1, 1]	263.8958
F5	Gear Train Design	4	LB: [12, 12, 12, 12] UB: [60, 60, 60, 60]	2.701×10^{-12}
F6	Cantilever Beam Design	5	LB: [0.01, 0.01, 0.01, 0.01, 0.01] UB: [100, 100, 100, 100, 100]	1.3400
F7	Minimize I-Beam Deflection	4	LB: [10, 10, 0.9, 0.9] UB: [80, 50, 5.0, 5.0]	0.0131
F8	Tubular Column Design	2	LB: [2, 0.2] UB: [14, 0.8]	26.4864
F9	Piston Lever Design	4	LB: [0.05, 0.05, 0.05, 0.05] UB: [500, 500, 500, 120]	8.4127
F10	Corrugated Bulkhead Design	4	LB: [0, 0, 0, 0] UB: [100, 100, 100, 5]	6.8430
F11	Car Side Impact Design	11	LB: [0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0, 0, -30, -30] UB: [1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1.5, 1, 1, 30, 30]	22.8430
F12	Welded Beam Design	4	LB: [0.1, 0.1, 0.1, 0.1] UB: [2, 10, 10, 2]	1.7249
F13	Reinforced Concrete Beam Design	3	LB: [0, 0, 5] UB: [1, 1, 10]	359.2080

5.3. Optimization algorithms and parameter settings

The DXMODE algorithm is benchmarked against 30 algorithms, including CEC competition winners, recent DE variants, and widely studied meta-heuristic methods. The first group comprises classical meta-heuristic algorithms such as GA [42], DE [43], PSO [19], ABC [42], SA [44], GWO [3], FA [42], BAS [21], TLBO [22], MFO [4], WOA [45], HHO [19], CSO [20], CSOA [18], CMAES [46], and IMODE, with IMODE being the top performer in the CEC2020 competition [9].

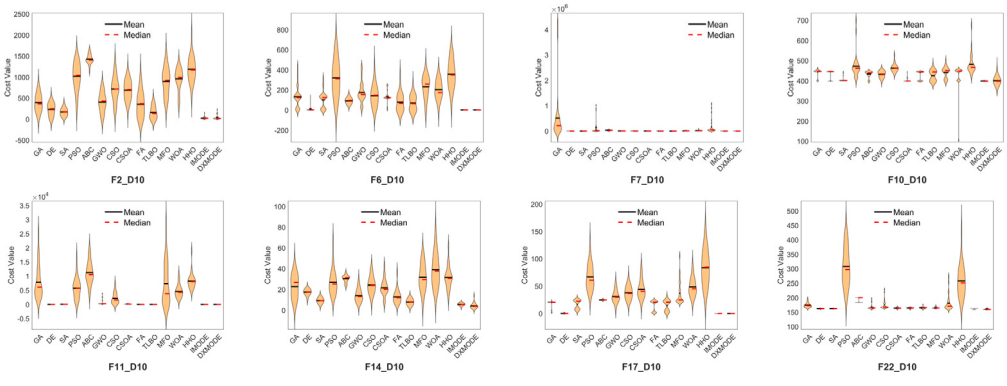
Variants of DXMODE and IMODE, referred to as DXMODEv2 and IMODEv2, are also included, where the archive size (A) and memory size (H) are set to zero to assess memory effects. The second group includes enhanced and recent DE variants, namely EODE [10], MDE [26], MTDE [27], BSD [28], BDE [29], BeSD [11], meanDE [30], QRDE [12], JADE [8], JADEGMO [31], EA4eig [13], AGSK [24], and HSES [25]. The detailed parameter configurations are presented in Appendix B (Table B.3), following standard settings from the literature as recommended by the respective original studies.

5.4. Evaluation criteria and statistical testing

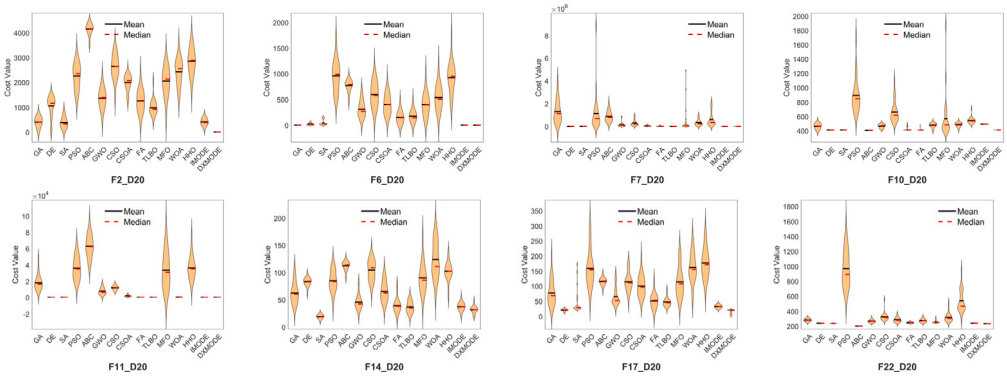
All algorithms are evaluated over 30 independent runs per function using five standard error metrics: best, median, worst, mean, and standard deviation. These metrics are computed across all benchmark functions and all tested dimensions. Evaluation is carried out using a function-evaluation-based ranking strategy, as described in [23], where algorithms are ranked based on either the median error or the number of function evaluations, depending on whether the target error (1.0×10^{-8}) is reached. This method will be referred to as FE-based ranking throughout the paper. Visualization tools such as box plots and violin plots are used to display performance distributions.

Additionally, a comprehensive score-based ranking method is applied following the strategy in [7], where each algorithm receives a total score out of 100 based on the summation of normalized best error values and ranks of the mean error performance across all test problems. This method will be referred to as the SNE-SR-based ranking. Statistical significance testing is performed using Friedman tests to determine overall ranking and Wilcoxon signed-rank tests for pairwise comparisons, with a significance level α between 0.05 and 0.1.

Effect size analysis using Cohen's d is also applied for each function, evaluating every algorithm in a pairwise comparison against the proposed DXMODE algorithm across the 30 independent runs. This method helps assess the practical significance of perfor-



(a) 10 Dim.



(b) 20 Dim.

Fig. 6. Violin plots for best fitness in 30 runs, F2, F6, F7, F10, F11, F14, F17, and F22 (10D and 20D).

mance differences beyond statistical significance. Moreover, a population diversity analysis is introduced based on span and standard deviation metrics computed across all runs and dimensions, as detailed in Appendix D.

Convergence curves show the median error across iterations, providing a visual overview of convergence behavior. To statistically support this, Page's test [47] is employed to detect consistent performance trends. In this test, all the benchmark functions serve as the samples, and selected iteration checkpoints represent the treatments. The input readings represent the median fitness values of each algorithm at the specified cut points for each function. This test determines whether an algorithm converges significantly faster than others, complementing visual analysis with statistical evidence.

6. Benchmarking DXMODE against classical meta-heuristic algorithms on CEC2020–2022

This section presents the performance of DXMODE compared to sixteen classical meta-heuristic algorithms, including GA [42], DE [43], PSO [19], ABC [42], SA [44], GWO [3], FA [42], BAS [21], TLBO [22], MFO [4], WOA [45], HHO [19], CSO [20], CSOA [18], CMAES [46], and IMODE (CEC2020 winner) [9]. All algorithms were executed over 30 independent runs across 22 benchmark functions from CEC2020–2022 in 10D and 20D dimensions.

6.1. Visualizing error distribution

The collected performance metrics include the best, median, mean, worst, and SD of the error, along with the number of function evaluations (FEs). Comprehensive results are summarized in Appendix E ((Tables E.4–E.5)). Violin plots illustrate the error distribution across selected benchmark functions. As shown in Fig. 6, DXMODE demonstrates the most compact and stable results, especially in F2, F6, F7, F11, F17, and F22 for both 10D and 20D. It consistently achieves lower error values with less dispersion than other algorithms. BAS and CMAES are excluded from the plots due to extreme errors but are considered in all statistical evaluations. The complete set of plots is available in Appendix F (Figs. F.1–F.4).

6.2. Ranking and statistical analysis

Fig. 7 illustrates the trade-off between the best-obtained error and the number of function evaluations. DXMODE either achieves the desired error tolerance more efficiently (e.g., F5, F12, F14) or obtains the lowest error when the tolerance is unmet (e.g., F2, F17, F18), highlighting its effectiveness in both accuracy and computational cost.

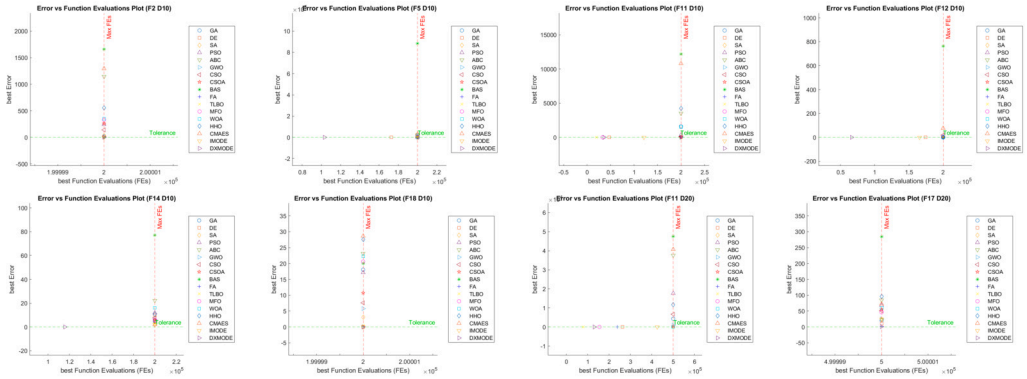


Fig. 7. The relationship between the best function evaluations and the best error for all the algorithms; 10-Dim: F2, F5. F11, F12, F14, F18; 20 Dim: F11, F17.

Table 5
Ranking tables of the DXMODE against meta-heuristic optimization algorithms based on FE-based and SNE-SR ranking methods.

Algorithm	Median FE-based ranking				SNE-SR-based ranking					
	SR 10D	SR 20D	total SR	Place	SNE	Score1	SR	Score2	Total Score	Place
GA	175	226	205.6	9	2.4346	32.9882	195.20	10.7070	43.6952	8
DE	315	301	306.6	3	2.2660	35.4436	93.70	22.3052	57.7488	5
SA	222	271	251.4	6	1.9638	40.8970	127.80	16.3537	57.2507	6
PSO	95	97	96.2	15	4.6153	17.4017	304.20	6.8705	24.2722	14
ABC	181	175	177.4	10	5.0128	16.0219	205.40	10.1753	26.1971	13
GWO	202	211	207.4	8	2.2559	35.6026	195.00	10.7179	46.3206	7
CSO	146	130	136.4	13	3.5121	22.8680	254.20	8.2219	31.0899	12
CSOA	229	213	219.4	7	2.9952	26.8143	179.20	11.6629	38.4772	9
BAS	22	22	22	17	21.8795	3.6708	374.00	5.5882	9.2590	17
FA	270	295	285	4	1.8810	42.6976	111.20	18.7950	61.4926	3
TLBO	288.5	269	276.8	5	1.9616	40.9429	119.00	17.5630	58.5059	4
MFO	176.5	162	167.8	11	3.0447	26.3783	248.60	8.4071	34.7854	10
WOA	142	145	143.8	12	3.5414	22.6787	247.00	8.4615	31.1402	11
HHO	81	101	93	16	4.9295	16.2927	303.20	6.8931	23.1859	15
CMAES	129	93	107.4	14	5.6258	14.2760	301.50	6.9320	21.2080	16
IMODE	337	304	317.2	2	1.6179	49.6400	65.00	32.1538	81.7938	2
DXMODE	355	351	352.6	1	1.6063	50.0000	41.80	50.0000	100.0000	1

The cumulative performance ranks based on FE-based ranking and the SNE-SR method are summarized in Table 5. According to the FE-based ranks, DXMODE ranks first with a score of 352.6, confirming its robustness across all functions and dimensions. IMODE follows with a score of 317.2. DE, FA, and TLBO occupy the following top ranks, while BAS consistently ranks lowest with scores of 22.

The SNE-SR ranking reports the total performance score of each algorithm based on normalized error and rank. DXMODE leads with a perfect score of 100, significantly outperforming IMODE (81.79), FA (61.49), TLBO (58.51), and DE (57.75). The consistency of DXMODE across scoring frameworks underscores its effectiveness as a state-of-the-art optimizer.

Statistical comparisons using the Friedman and Wilcoxon tests further validate the superiority of DXMODE. In the 10D case (Table 6), DXMODE achieved the top rank with an average rank of 1.818182 and a significant Friedman p-value of 1.69×10^{-44}. It was followed by IMODE (2.340909), DE (3.886364), TLBO (4.977273), and FA (5.727273). Wilcoxon tests confirmed that DXMODE significantly outperformed all other algorithms. Compared with IMODE, DXMODE achieved a win/tie/loss count of 11/8/3 with a p-value of 5.74×10^{-2}, indicating a confidence level of 94.26%.

In the 20D case (Table 6), DXMODE again ranked first with an average rank of 2.068182 and a Friedman p-value of 4.02×10^{-43}. The next best performers were IMODE (4.090909), DE (4.340909), FA (4.500000), and SA (5.681818). Against IMODE, DXMODE recorded a win/tie/loss of 19/1/2 with a Wilcoxon p-value of 7.07×10^{-3}, corresponding to a confidence level of 99.29%. These results consistently demonstrate the statistical dominance of DXMODE across both dimensions.

6.3. Cohen's d effect size analysis

Cohen's *d* effect size analysis is applied to each function in the CEC2020–2022 benchmarks to gain deeper insight into the practical relevance of performance differences. Pairwise comparisons are conducted between DXMODE and every meta-heuristic algorithm across 30 independent runs. Positive *d* values indicate superior performance by DXMODE, while negative values favor the competitor.

The effect size is categorized as negligible for $|d| < 0.2$, small for $|d| < 0.5$, moderate for $|d| < 0.8$, large for $0.8 \leq |d| < 1.2$, very large for $1.2 \leq |d| < 2.0$, and huge for $|d| \geq 2.0$ [48]. The results are summarized from three perspectives: per algorithm (Fig. 8), per

Table 6
Statistical Analysis for all 16 meta-heuristic optimization algorithms, for all the 10D and 20D benchmark functions for the median error metric.

Algorithm	10 Dim.						20 Dim.					
	Wilcoxon Test			Friedman Test			Wilcoxon Test			Friedman Test		
	+/=/-	p-value	H	SumR	MeanR	Rank	+/=/-	p-value	H	SumR	MeanR	Rank
GA	+22/=0/-0	4.77E-07	TRUE	221	10.05	11	+21/=0/-1	1.10E-05	TRUE	170	7.7273	7
DE	+12/=8/-2	1.29E-02	TRUE	85.5	3.89	3	+15/=5/-2	2.35E-03	TRUE	95.5	4.3409	3
SA	+22/=0/-0	4.77E-07	TRUE	174	7.91	7	+18/=0/-4	4.34E-03	TRUE	125	5.6818	5
PSO	+22/=0/-0	4.77E-07	TRUE	301	13.68	15	+22/=0/-0	4.77E-07	TRUE	299	13.5909	15
ABC	+21/=0/-1	1.10E-05	TRUE	215	9.77	9	+18/=0/-4	4.34E-03	TRUE	221	10.0455	10
GWO	+22/=0/-0	4.77E-07	TRUE	194	8.82	8	+21/=0/-1	1.10E-05	TRUE	185	8.4091	9
CSO	+22/=0/-0	4.77E-07	TRUE	250	11.36	12	+22/=0/-0	4.77E-07	TRUE	266	12.0909	13
CSOA	+22/=0/-0	4.77E-07	TRUE	167	7.59	6	+21/=0/-1	1.10E-05	TRUE	183	8.3182	8
BAS	+22/=0/-0	4.77E-07	TRUE	374	17.00	17	+22/=0/-0	4.77E-07	TRUE	374	17.0000	17
FA	+22/=0/-0	4.77E-07	TRUE	126	5.73	5	+19/=2/-1	4.01E-05	TRUE	99	4.5000	4
TLBO	+19/=3/-0	3.81E-06	TRUE	109.5	4.98	4	+20/=1/-1	2.10E-05	TRUE	129	5.8636	6
MFO	+22/=0/-0	4.77E-07	TRUE	219.5	9.98	10	+22/=0/-0	4.77E-07	TRUE	234	10.6364	11
WOA	+22/=0/-0	4.77E-07	TRUE	254	11.55	13	+22/=0/-0	4.77E-07	TRUE	251	11.4091	12
HHO	+22/=0/-0	4.77E-07	TRUE	315	14.32	16	+22/=0/-0	4.77E-07	TRUE	295	13.4091	14
CMAES	+18/=3/-1	7.63E-05	TRUE	269	12.23	14	+20/=0/-2	1.21E-04	TRUE	304	13.8182	16
IMODE	+11/=8/-3	5.74E-02	TRUE	51.5	2.34	2	+19/=1/-2	2.21E-04	TRUE	90	4.0909	2
DXMODE	NA	NA	NA	40	1.82	1	NA	NA	NA	45.5	2.0682	1
				p-value = $1.69462E-44$						p-value = $4.01995E-43$		

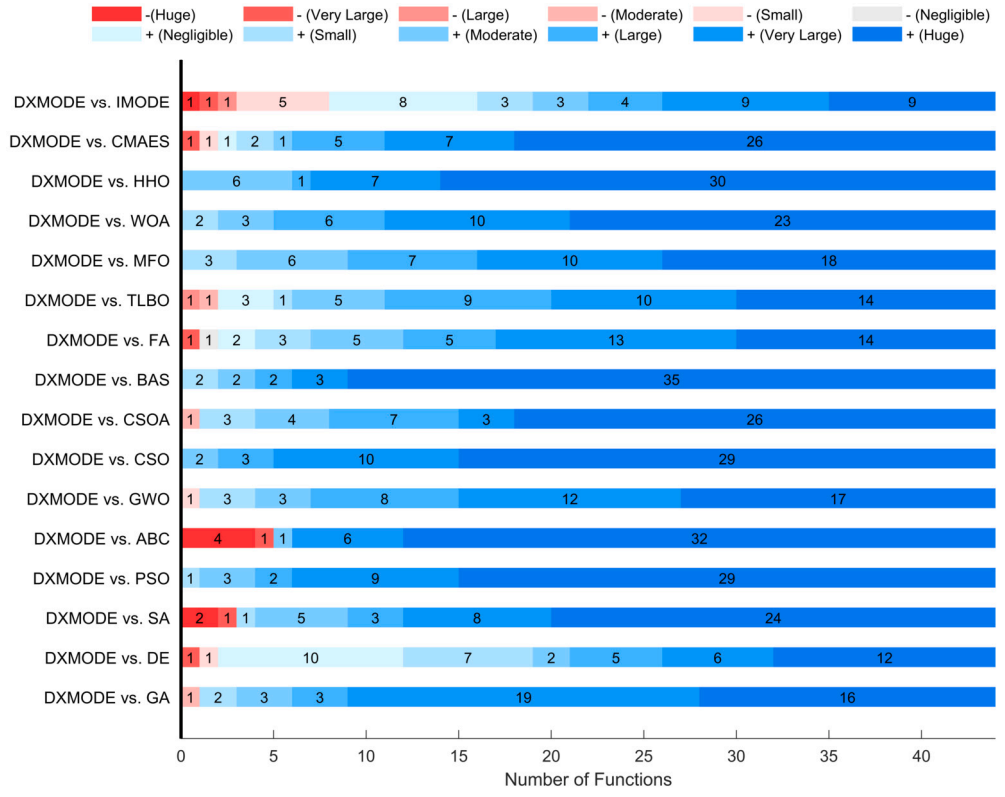


Fig. 8. Cohen's d effect for DXMODE against meta-heuristic optimization algorithms on CEC2020-2022 (Algorithm-Wise).

dimension (Fig. 9), and per function type (Fig. 10), offering a comprehensive view of how meaningful the observed differences are in practical terms. Detailed Cohen's d values can be found in Appendix I (Table I.8).

The overall Cohen's d effect size analysis demonstrates the clear superiority of DXMODE over all the competitors, with only a few isolated instances where competing algorithms perform better. DXMODE consistently exhibits a high number of positive effect sizes, particularly in the "Huge" and "Very Large" categories, indicating strong and consistent performance gains. Notably, the majority of DXMODE's advantages are statistically significant, with Cohen's d values exceeding 0.5, reflecting moderate to huge practical effects.

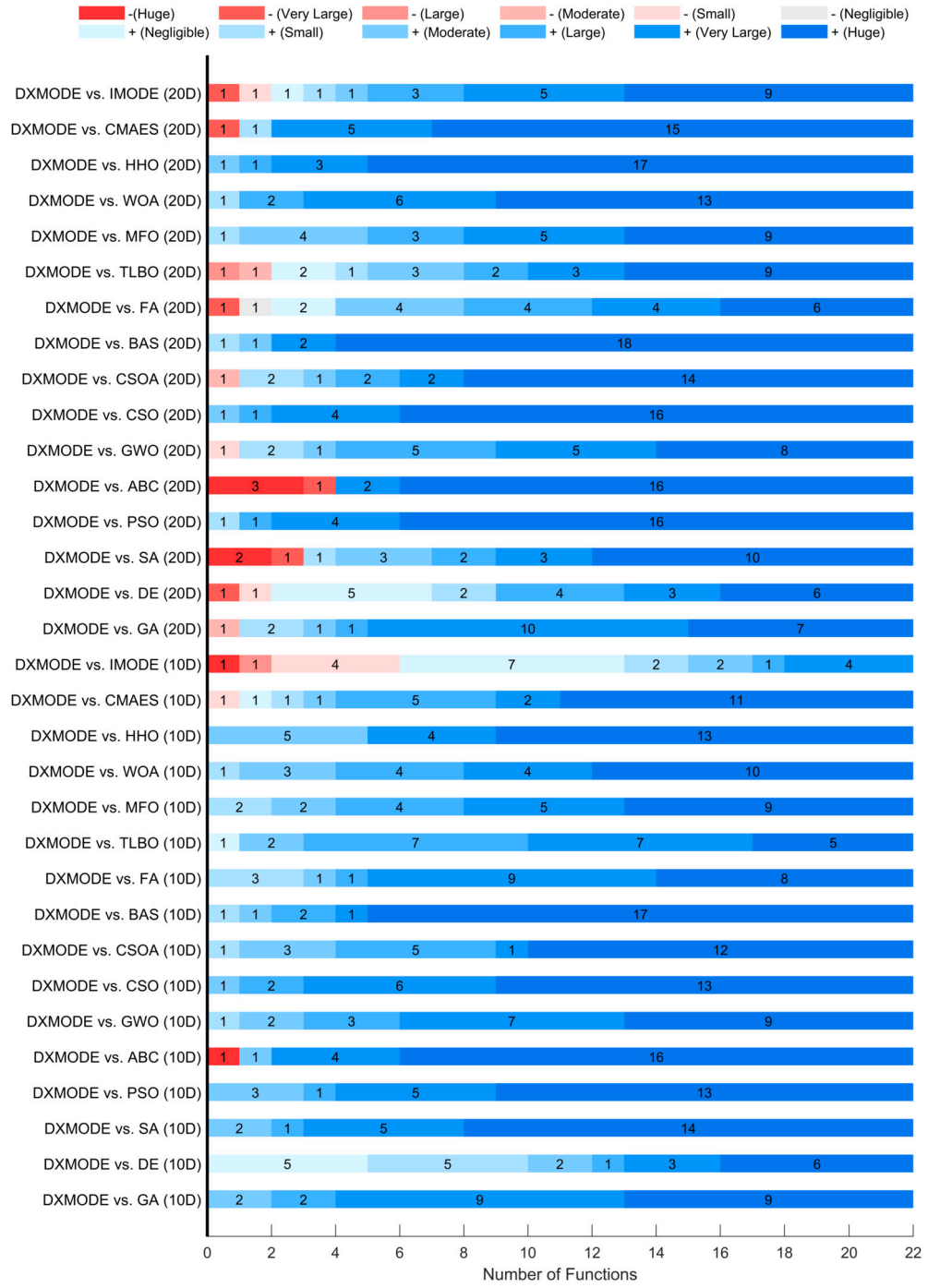


Fig. 9. Cohen's d effect for DXMODE against meta-heuristic optimization algorithms on CEC2020-2022 (Dimension-Wise).

Against IMODE, DXMODE shows 36 positive effects, of which 28 are statistically significant ($d > 0.5$), while IMODE shows only three significant cases in its favor. Similarly, DXMODE achieves 42 positive effect cases compared to DE, with 25 being significant, whereas DE yields only a single significant effect in its favor. Compared with FA, DXMODE records 43 positive cases out of 44, with 37 being significant. Against TLBO, DXMODE secures 42 positive effect cases, 38 of which are significant, further reinforcing its consistent and robust superiority across multiple benchmark scenarios.

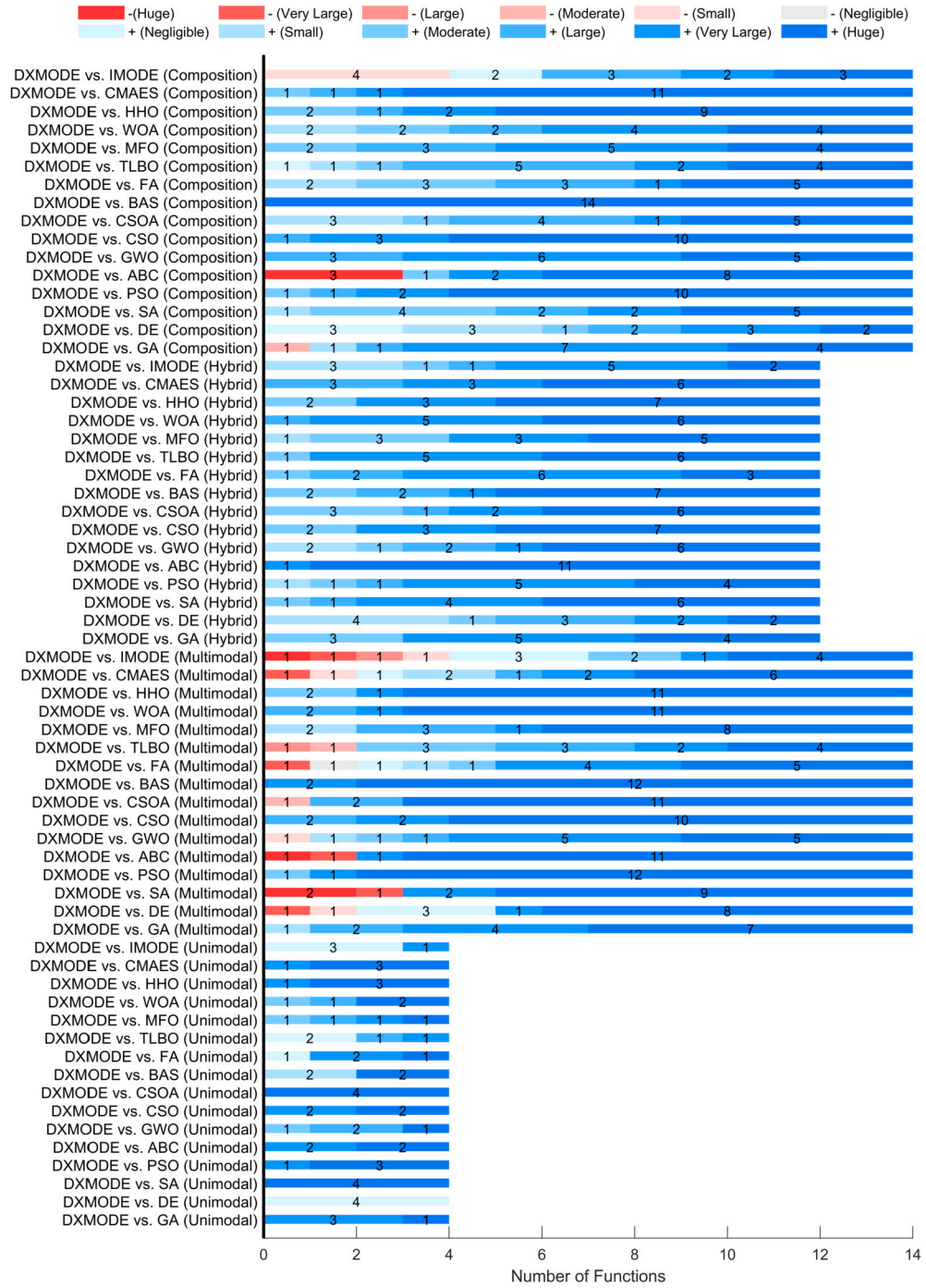


Fig. 10. Cohen's d effect for DXMODE against meta-heuristic optimization algorithms on CEC2020-2022 (Function-Type-Wise).

6.4. Diversity analysis

Population diversity plays a fundamental role in the effectiveness of meta-heuristic optimization algorithms. High diversity enables the algorithm to explore a broader portion of the search space and reduces the risk of premature convergence. In this study, the diversity of the proposed DXMODE algorithm is assessed using the span and standard deviation (SD) metrics defined in Appendix D, computed across all individuals, dimensions, and runs over time.

As a case study, diversity results for benchmark function F17 in 10 dimensions are visualized. Fig. 11 shows the span and SD per dimension across iterations for DXMODE. Median span and median SD values are calculated across dimensions and then across all

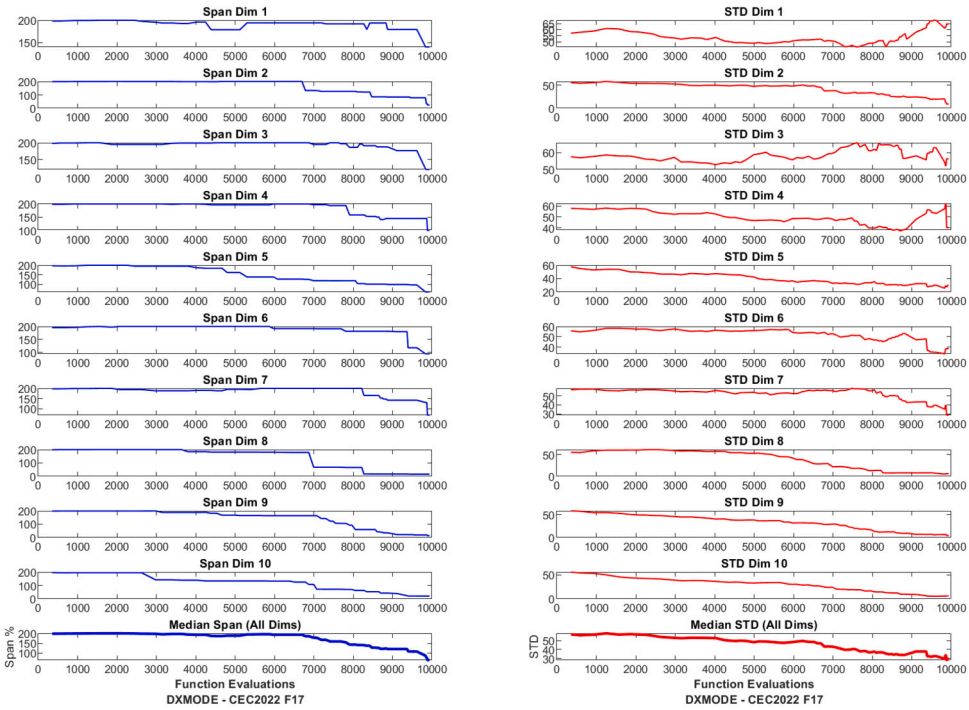


Fig. 11. Span and SD Diversity plots for each dimension in the 10D F17 function for DXMODE algorithm.

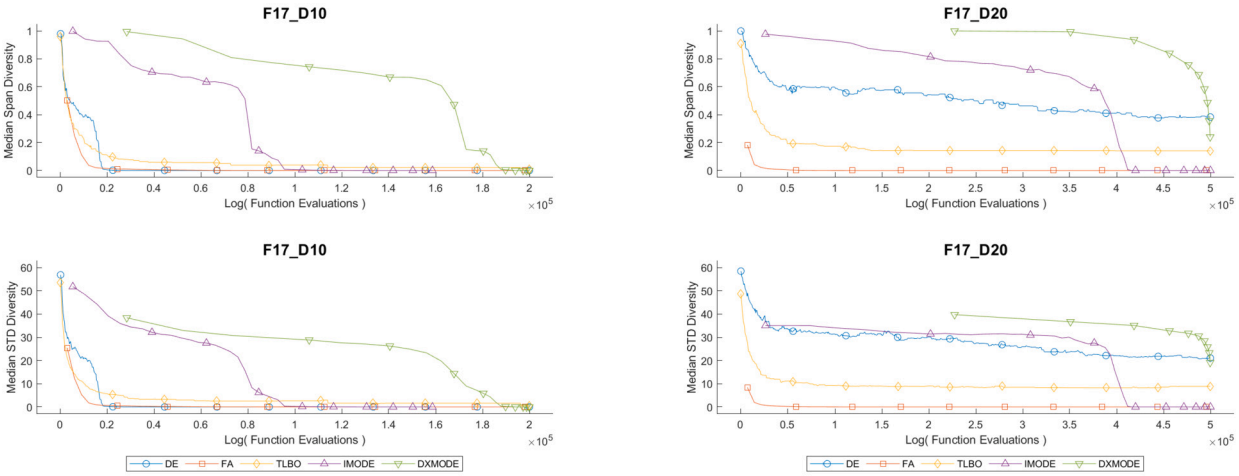


Fig. 12. Median Diversity plots (Span and SD) for the top meta-heuristic optimization algorithms (F17).

30 runs for the top-performing algorithms: DE, FA, TLBO, IMODE, and DXMODE. These summarized results for both 10D and 20D cases are presented in Fig. 12.

The plots indicate that both DXMODE maintain significantly higher population diversity throughout the optimization process, particularly in the early iterations. This behavior supports the algorithm's superior exploration ability. As iterations progress, diversity gradually reduces, enabling effective local exploitation in later stages. Full diversity plots for all benchmark functions and dimensions are provided in Appendix G (Figs. G.9–G.10).

To generalize this observation, the peak median span and SD values are computed for all 22 benchmark functions in both 10D and 20D. These values, presented in Table 7, serve as quantitative indicators of the diversity maintained by each algorithm. The highest SD determines the best algorithm for each function; ties are resolved using the span value.

Overall, the results demonstrate that the proposed DXMODE consistently preserves broader population diversity compared to the top state-of-the-art algorithms, highlighting the DXMODE's exploration mechanisms and resistance to premature convergence across diverse optimization scenarios.

Table 7
The median peak span and median peak SD across all the 30 runs for the top meta-heuristic optimization algorithms for all the 10D and 20D benchmark functions. The best algorithm per function is the one with the maximum Span and SD value.

Fun.	Metric	10-Dim					20-Dim				
No.		FA	TLBO	DE	IMODE	DXMODE	FA	TLBO	DE	IMODE	DXMODE
F1	SD	1.51E-01	7.43E-01	6.53E-01	6.50E-01	9.59E-01	6.83E-02	3.40E-01	4.47E-01	3.75E-01	7.76E-01
	Span	7.52E+00	3.46E+01	2.77E+01	1.98E+01	5.10E+01	3.34E+00	1.50E+01	1.50E+01	1.04E+01	4.24E+01
F2	SD	9.95E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.78E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
	Span	5.76E+01	6.15E+01	5.62E+01	4.75E+01	6.94E+01	3.23E+01	5.82E+01	5.17E+01	4.46E+01	6.54E+01
F3	SD	2.58E-01	6.32E-01	3.18E-01	4.67E-01	8.49E-01	1.68E-01	2.66E-01	2.34E-01	3.44E-01	7.30E-01
	Span	1.33E+01	3.19E+01	9.58E+00	1.31E+01	4.61E+01	7.94E+00	1.26E+01	7.28E+00	8.70E+00	3.70E+01
F4	SD	2.58E-01	8.12E-01	6.52E-01	6.53E-01	9.46E-01	1.57E-01	3.72E-01	5.60E-01	4.66E-01	8.48E-01
	Span	1.28E+01	3.99E+01	2.56E+01	2.16E+01	5.34E+01	7.95E+00	1.85E+01	2.30E+01	1.51E+01	4.96E+01
F5	SD	8.33E-01	1.00E+00	1.00E+00	9.99E-01	1.00E+00	3.69E-01	9.48E-01	9.16E-01	9.97E-01	1.00E+00
	Span	4.95E+01	6.51E+01	4.17E+01	3.83E+01	6.62E+01	1.88E+01	5.07E+01	3.41E+01	3.25E+01	6.56E+01
F6	SD	6.28E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.80E-01	8.78E-01	1.00E+00	9.98E-01	1.00E+00
	Span	3.99E+01	5.98E+01	5.35E+01	3.96E+01	6.68E+01	1.03E+01	4.10E+01	4.65E+01	3.31E+01	6.03E+01
F7	SD	9.38E-01	1.00E+00	1.00E+00	9.99E-01	1.00E+00	6.83E-01	9.78E-01	1.00E+00	1.00E+00	1.00E+00
	Span	4.83E+01	6.08E+01	5.39E+01	3.96E+01	6.73E+01	3.29E+01	5.28E+01	4.79E+01	3.39E+01	6.75E+01
F8	SD	3.04E-01	9.90E-01	1.00E+00	9.93E-01	1.00E+00	1.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
	Span	1.53E+01	5.87E+01	4.38E+01	3.70E+01	6.46E+01	5.42E+00	5.69E+01	4.84E+01	3.30E+01	6.55E+01
F9	SD	6.10E-01	9.50E-01	1.00E+00	9.81E-01	9.76E-01	2.69E-01	7.91E-01	9.58E-01	7.93E-01	7.43E-01
	Span	3.91E+01	5.07E+01	4.60E+01	3.73E+01	5.56E+01	1.30E+01	3.75E+01	3.94E+01	3.91E+01	4.45E+01
F10	SD	2.80E-01	7.39E-01	6.53E-01	6.61E-01	9.41E-01	1.31E-01	4.12E-01	5.63E-01	5.28E-01	8.31E-01
	Span	1.38E+01	3.71E+01	2.44E+01	2.16E+01	5.29E+01	6.39E+00	2.07E+01	1.87E+01	1.39E+01	4.45E+01
F11	SD	7.83E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	7.68E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
	Span	4.34E+01	5.68E+01	5.26E+01	4.32E+01	7.13E+01	4.22E+01	5.86E+01	5.42E+01	4.06E+01	6.74E+01
F12	SD	3.35E-01	7.85E-01	7.93E-01	7.62E-01	9.36E-01	1.07E-01	3.98E-01	4.94E-01	4.82E-01	8.73E-01
	Span	1.78E+01	3.85E+01	3.14E+01	2.50E+01	5.31E+01	5.36E+00	1.86E+01	1.71E+01	1.32E+01	4.65E+01
F13	SD	2.13E-01	9.67E-01	9.30E-01	9.63E-01	9.78E-01	1.08E-01	7.21E-01	9.21E-01	9.68E-01	9.01E-01
	Span	8.84E+00	4.86E+01	3.61E+01	2.98E+01	5.47E+01	4.70E+00	3.39E+01	3.28E+01	2.76E+01	4.70E+01
F14	SD	5.12E-01	8.10E-01	7.98E-01	9.58E-01	9.64E-01	4.93E-01	6.10E-01	8.06E-01	9.74E-01	8.91E-01
	Span	2.75E+01	4.27E+01	2.42E+01	3.21E+01	5.39E+01	2.19E+01	2.85E+01	2.29E+01	2.94E+01	4.86E+01
F15	SD	1.98E-01	9.27E-01	6.96E-01	9.66E-01	9.79E-01	1.44E-01	6.33E-01	7.13E-01	9.09E-01	9.82E-01
	Span	9.71E+00	4.67E+01	2.18E+01	2.99E+01	5.50E+01	6.47E+00	3.12E+01	1.80E+01	2.49E+01	5.40E+01
F16	SD	6.89E-01	9.92E-01	9.91E-01	9.92E-01	1.00E+00	2.75E-01	6.31E-01	9.48E-01	9.24E-01	1.00E+00
	Span	4.32E+01	5.18E+01	4.75E+01	3.63E+01	6.80E+01	1.40E+01	3.23E+01	3.70E+01	2.57E+01	6.33E+01
F17	SD	7.03E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	6.26E-01	1.00E+00	9.97E-01	1.00E+00	1.00E+00
	Span	4.25E+01	5.77E+01	5.53E+01	4.04E+01	6.42E+01	2.77E+01	5.72E+01	3.80E+01	4.05E+01	6.30E+01
F18	SD	9.54E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	5.07E-01	8.26E-01	1.00E+00	1.00E+00	1.00E+00
	Span	4.67E+01	5.49E+01	5.11E+01	4.08E+01	6.53E+01	2.64E+01	4.39E+01	4.62E+01	3.57E+01	6.76E+01
F19	SD	3.64E-01	9.50E-01	9.77E-01	9.66E-01	1.00E+00	1.36E-01	6.79E-01	8.49E-01	7.74E-01	9.79E-01
	Span	1.92E+01	4.85E+01	4.54E+01	3.51E+01	6.26E+01	7.10E+00	2.84E+01	3.39E+01	2.32E+01	5.62E+01
F20	SD	3.32E-01	1.00E+00	1.00E+00	9.99E-01	1.00E+00	1.75E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
	Span	1.70E+01	6.04E+01	5.89E+01	3.97E+01	6.78E+01	8.93E+00	6.39E+01	5.50E+01	4.09E+01	6.74E+01
F21	SD	1.89E-01	8.72E-01	8.38E-01	8.61E-01	1.00E+00	1.24E-01	5.97E-01	7.16E-01	6.31E-01	9.76E-01
	Span	9.85E+00	4.33E+01	3.11E+01	2.53E+01	5.92E+01	6.41E+00	3.35E+01	2.84E+01	1.21E+01	5.42E+01
F22	SD	3.47E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.14E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
	Span	1.76E+01	6.10E+01	5.69E+01	3.92E+01	6.49E+01	6.29E+00	7.62E+01	5.70E+01	3.87E+01	5.75E+01

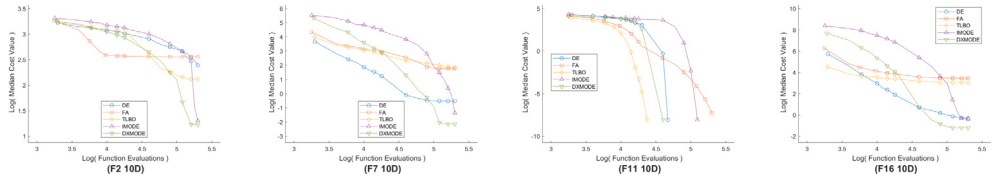
6.5. Convergence analysis

Fig. 13 displays the median convergence profiles for representative benchmark functions (F2, F7, F11, and F16), comparing DXMODE with top-performing meta-heuristic algorithms: DE, IMODE, FA, and TLBO. While DXMODE may initially show a higher median error, it consistently achieves the lowest error values by the end of the optimization process in both 10D and 20D. Full convergence plots for all benchmark functions and dimensions are provided in Appendix H (Figs. H.13–H.14).

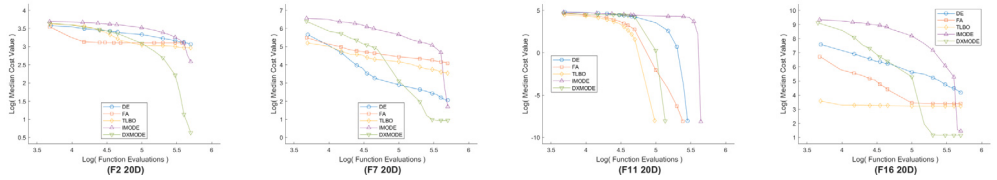
To reinforce these observations, Page's trend test [47] is applied to each comparison, treating functions as samples and selected iterations as treatments. As shown in Fig. 14, significant increasing trends are observed for DXMODE against DE, FA, and TLBO, confirming its superior convergence rate. In the IMODE comparison, an initial decreasing trend indicates slightly faster early-stage convergence by IMODE; however, this is reversed in later stages, where DXMODE demonstrates a significant increasing trend. This dynamic reflects DXMODE's strategic behavior, favoring exploration in early iterations and transitioning to effective exploitation later, achieving a well-balanced convergence trajectory.

7. Evaluating the memory mechanism: DXMODEv2 vs. Classical meta-heuristic algorithms on CEC2020–2022

This section evaluates DXMODEv2, the memory-free variant of the proposed algorithm, against the same sixteen classical meta-heuristic algorithms used in Section 6. IMODEv2, the no-memory version of IMODE, is included to ensure a fair comparison. The

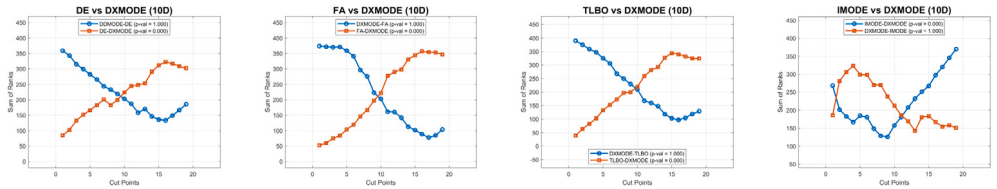


(a) 10 Dim.

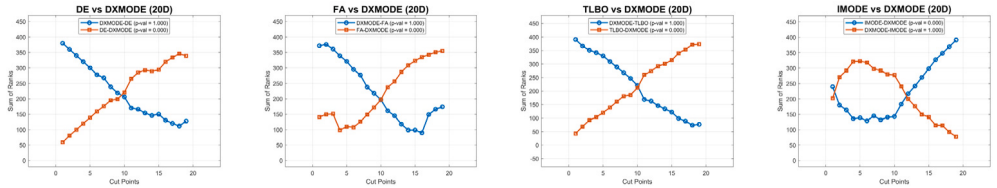


(b) 20 Dim.

Fig. 13. Convergence plots for median fitness in 30 runs for all the top meta-heuristic optimization algorithms, including DXMODE (F2, F7, F11, and F16).



(a) 10 Dim.



(b) 20 Dim.

Fig. 14. Page test and convergence trends between DXMODE and the top meta-heuristic optimization algorithms across all the CEC2020-2022 functions.

purpose is to isolate the impact of the memory mechanism by comparing DXMODEv2's performance across the 22 benchmark functions from CEC2020–2022 in 10D and 20D dimensions.

7.1. Ranking and statistical analysis

Table 8 presents cumulative rank scores using the FE-based and the SNE-SR-based ranking methods. In the FE-based ranking, DXMODEv2 secures the first place with a total score of 352.3, showing outstanding reliability across all functions in both 10D and 20D. It is followed by IMODEv2 with 320.4 and DE with 309.5, confirming their top-tier competitiveness. FA and TLBO also rank in the top five with scores of 284.8 and 276.2, respectively, while BAS again ranked last.

In the SNE-SR-based ranking, DXMODEv2 again ranked first with a perfect score of 100. IMODEv2 ranks second with a total score of 79.76, followed by FA (65.72), TLBO (62.61), and SA (61.59). These results confirm that DXMODEv2 maintains strong accuracy and efficiency across all functions and dimensions, even without memory.

Statistical tests further support DXMODEv2's superiority. In the 10D case (Table 9), DXMODEv2 achieved the top rank (1.909091) with a Friedman p-value of 5.54×10^{-44}. Against IMODEv2, DXMODEv2 recorded a win/tie/loss of 13/8/1 in the Wilcoxon test, with a p-value of 0.0052, indicating 99.48% confidence.

In the 20D case (Table 9), DXMODEv2 also ranked first (1.909091), with a p-value of 2.95×10^{-44}. It achieved a win/tie/loss of 19/2/1 against IMODEv2, with a Wilcoxon p-value of 1.40×10^{-4}, confirming 99.99% confidence. DXMODEv2 also significantly outperformed DE and all other competitors in both dimensions.

7.2. Cohen's d effect size analysis

Fig. 15 illustrates the distribution of Cohen's d statistics for the DXMODEv2 algorithm compared to all meta-heuristic algorithms across all benchmark functions in 10D and 20D. DXMODEv2 consistently demonstrates a high number of significant positive effect sizes ($d \geq 0.5$), indicating moderate to large practical significance. Detailed Cohen's d values can be found in Appendix I (Table I.9).

Table 8
Ranking tables of the DXMODEv2 against meta-heuristic optimization algorithms based on FE-based and SNE-SR ranking methods.

Algorithm	Median FE-based ranking				SNE-SR-based ranking					
	SR 10D	SR 20D	total SR	Place	SNE	Score1	SR	Score2	Total Score	Place
GA	175	226	205.6	9	2.4346	37.3295	195.8000	10.0102	47.3397	8
DE	321.5	301.5	309.5	3	2.2660	40.1080	92.2000	21.2581	61.3661	6
SA	223	268	250	6	1.9638	46.2791	128.0000	15.3125	61.5916	5
PSO	95	97	96.2	15	4.6153	19.6918	304.2000	6.4431	26.1349	14
ABC	181	173	176.2	10	5.0128	18.1304	206.6000	9.4869	27.6173	13
GWO	202	209	206.2	8	2.2559	40.2879	196.2000	9.9898	50.2777	7
CSO	146	130	136.4	13	3.5121	25.8775	254.2000	7.7105	33.5879	11
CSOA	229	212	218.8	7	2.9952	30.3430	179.8000	10.9010	41.2440	9
BAS	22	22	22	17	21.8795	4.1538	374.0000	5.2406	9.3945	17
FA	271	294	284.8	4	1.8810	48.3167	112.6000	17.4067	65.7234	3
TLBO	288.5	268	276.2	5	1.9616	46.3310	120.4000	16.2791	62.6100	4
MFO	176.5	161	167.2	11	3.0447	29.8498	248.6000	7.8842	37.7339	10
WOA	142	144	143.2	12	3.5414	25.6632	247.6000	7.9160	33.5792	12
HHO	81	101	93	16	4.9295	18.4369	303.2000	6.4644	24.9013	15
CMAES	130.5	93	108	14	5.6258	16.1547	302.2000	6.4858	22.6405	16
IMODEv2	330	314	320.4	2	1.9039	47.7355	61.2000	32.0261	79.7616	2
DXMODEv2	352	352.5	352.3	1	1.8177	50.0000	39.2000	50.0000	100.0000	1

Table 9
Statistical Analysis for all 16 meta-heuristic optimization algorithms, for all the 10D and 20D benchmark functions for the median error metric. The versions without memory, IMODEv2 and DXMODEv2, are used.

Algorithm	10 Dim.						20 Dim.					
	Wilcoxon Test			Friedman Test			Wilcoxon Test			Friedman Test		
	+/=/-	p-value	H	SumR	MeanR	Rank	+/=/-	p-value	H	SumR	MeanR	Rank
GA	+22/=0/-0	4.77E-07	TRUE	221	10.0455	11	+21/=0/-1	1.10E-05	TRUE	170	7.7273	7
DE	+11/=7/-4	1.18E-01	FALSE	80	3.6364	3	+14/=7/-1	9.77E-04	TRUE	97	4.4091	3
SA	+21/=0/-1	1.10E-05	TRUE	173	7.8636	7	+19/=0/-3	8.55E-04	TRUE	128	5.8182	5
PSO	+22/=0/-0	4.77E-07	TRUE	301	13.6818	15	+22/=0/-0	4.77E-07	TRUE	299	13.5909	15
ABC	+21/=0/-1	1.10E-05	TRUE	215	9.7727	9	+19/=0/-3	8.55E-04	TRUE	223	10.1364	10
GWO	+22/=0/-0	4.77E-07	TRUE	194	8.8182	8	+22/=0/-0	4.77E-07	TRUE	187	8.5000	9
CSO	+22/=0/-0	4.77E-07	TRUE	250	11.3636	12	+22/=0/-0	4.77E-07	TRUE	266	12.0909	13
CSOA	+22/=0/-0	4.77E-07	TRUE	167	7.5909	6	+21/=0/-1	1.10E-05	TRUE	184	8.3636	8
BAS	+22/=0/-0	4.77E-07	TRUE	374	17.0000	17	+22/=0/-0	4.77E-07	TRUE	374	17.0000	17
FA	+22/=0/-0	4.77E-07	TRUE	125	5.6818	5	+18/=3/-1	7.63E-05	TRUE	101	4.5909	4
TLBO	+19/=3/-0	3.81E-06	TRUE	109.5	4.9773	4	+20/=1/-1	2.10E-05	TRUE	130	5.9091	6
MFO	+22/=0/-0	4.77E-07	TRUE	219.5	9.9773	10	+22/=0/-0	4.77E-07	TRUE	235	10.6818	11
WOA	+22/=0/-0	4.77E-07	TRUE	254	11.5455	13	+22/=0/-0	4.77E-07	TRUE	252	11.4545	12
HHO	+22/=0/-0	4.77E-07	TRUE	315	14.3182	16	+22/=0/-0	4.77E-07	TRUE	295	13.4091	14
CMAES	+17/=2/-3	2.58E-03	TRUE	267.5	12.1591	14	+20/=1/-1	2.10E-05	TRUE	305	13.8636	16
IMODEv2	+13/=8/-1	1.83E-03	TRUE	58.5	2.6591	2	+19/=2/-1	4.01E-05	TRUE	78	3.5455	2
DXMODEv2	NA	NA	NA	42	1.9091	1	NA	NA	NA	42	1.9091	1
				p-value $= 5.5421E-44$						p-value $= 2.9522E-44$		

Specifically, against IMODEv2, DXMODEv2 exhibits 38 positive effects, 26 of which are statistically significant. In contrast, IMODEv2 shows only two significant cases in its favor. Compared to DE, DXMODEv2 achieves 40 positive effect cases, with 22 reaching statistical significance, whereas DE demonstrates only two significant effects. In comparison with FA, DXMODEv2 reports 43 positive outcomes out of 44, with 37 being significant. Against TLBO, DXMODEv2 secures 43 positive effect cases, including 39 that are statistically significant. The statistical results confirm the superiority of the proposed DXMODE algorithm, demonstrating its robust performance regardless of memory usage, dimensions, or problem complexity.

8. Benchmarking DXMODE against advanced differential evolution variants on CEC2020–2022

This section evaluates the performance of DXMODE against fourteen state-of-the-art Differential Evolution (DE) variants and CEC competition winners. The comparative set includes advanced algorithms such as EODE [10], MDE [26], MTDE [27], BSD [28], BDE [29], BeSD [11], meanDE [30], QRDE [12], JADE [8], and JADE-GMO [31]. Also included are top performers from recent CEC competitions: EA4eig (CEC2022 winner) [13], AGSK (2nd place, CEC2020) [24], HSES (CEC2018 winner) [25], and IMODE (CEC2020 winner) [9]. All algorithms are rigorously benchmarked over 30 independent runs on 22 functions from the CEC2020–2022 test suites, evaluated in 10D and 20D problem settings.

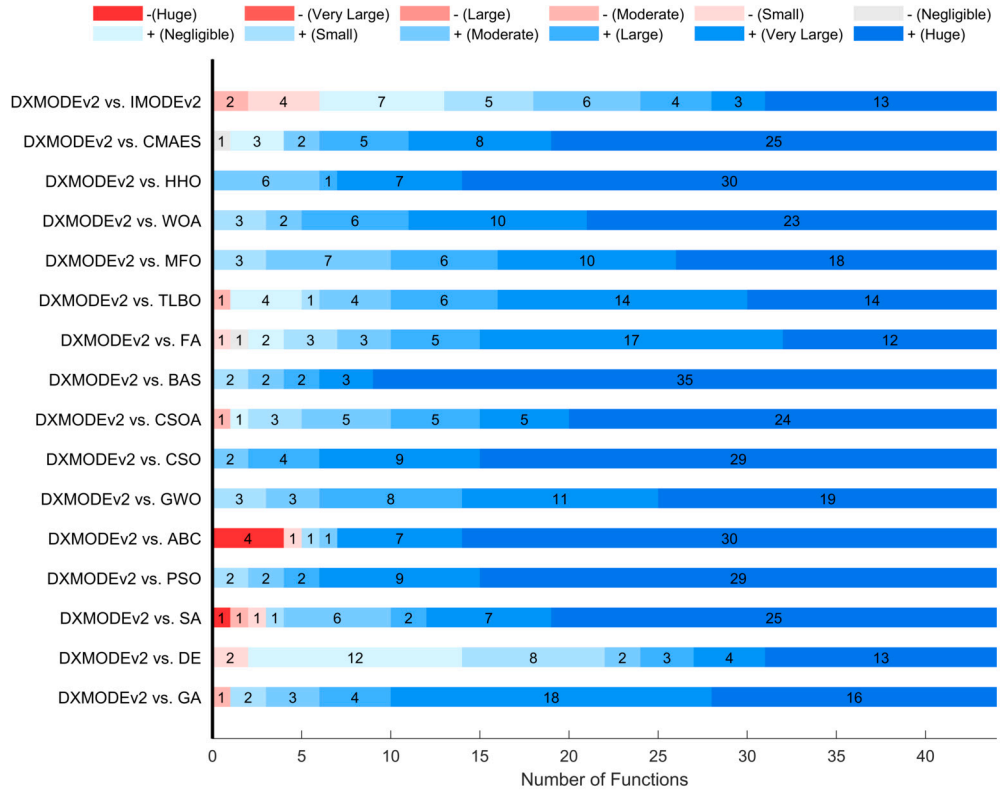
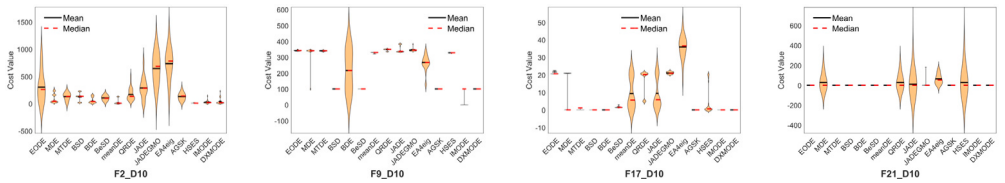
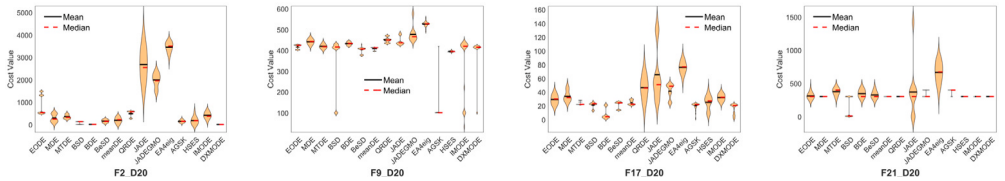


Fig. 15. Cohen's d effect for DXMODEv2 against meta-heuristic optimization algorithms on CEC2020-2022 (Algorithm-Wise).



(a) 10 Dim.



(b) 20 Dim.

Fig. 16. Violin plots for the advanced DE variants on CEC2020-2022 (F2, F9, F17, and F21).

8.1. Results collection and graphical representation

Detailed statistics, including best, worst, mean, median, and SD, of both cost and function evaluations are presented in Appendix E (Tables E.6–E.7). Representative violin plots for selected benchmark functions (F2, F9, F17, and F21) across both 10D and 20D are shown in Fig. 16, highlighting DXMODE's consistently compact and stable performance. Complete sets of box and violin plots for all benchmark functions can be found in Appendix F (Figs. F.5–F.8).

Table 10
Ranking tables of the DXMODE against all advanced DE variants based on FE-based and SNE-SR ranking methods.

Algorithm	Median FE-based ranking				SNE-SR-based ranking					
	SR 10D	SR 20D	total SR	Place	SNE	Score1	SR	Score2	Total Score	Place
EODE	176.5	178	177.4	8	8.1880	36.8682	191.5	21.4099	58.2781	11
MDE	145.5	181.5	167.1	10	8.1188	37.1825	182.5	22.4658	59.6483	10
MTDE	208.5	226	219	4	7.5302	40.0891	135.3	30.3030	70.3921	7
BSD	147	177.5	165.3	11	6.0376	50.0000	170.4	24.0610	74.0610	5
BDE	210	229.5	221.7	3	6.4997	46.4447	129.3	31.7092	78.1540	3
BeSD	186	215.5	203.7	6	6.8136	44.3056	127	32.2835	76.5891	4
meanDE	193.5	179	184.8	7	6.8105	44.3252	168.2	24.3757	68.7010	8
QRDE	122.5	142.5	134.5	13	11.6859	25.8328	225.7	18.1657	43.9985	14
JADE	187	127	151	12	7.8995	38.2147	254	16.1417	54.3565	12
JADEGMO	113.5	87	97.6	14	9.5144	31.7285	256.6	15.9782	47.7066	13
EA4eig	52	30	38.8	15	17.6457	17.1078	306.2	13.3899	30.4977	15
AGSK	217	229.5	224.5	2	6.3237	47.7374	109.3	37.5114	85.2488	2
HSES	195	224	212.4	5	7.4059	40.7620	160.4	25.5611	66.3231	9
IMODE	218.5	146	175	9	6.7904	44.4569	141.6	28.9548	73.4117	6
DXMODE	267.5	267	267.2	1	6.2452	48.3374	82	50.0000	98.3374	1

Table 11
Statistical Analysis for all 15 advanced DE variants, for all the 10D and 20D benchmark functions for the median error metric.

Algorithm	10 Dim.						20 Dim.					
	Wilcoxon Test			Friedman Test			Wilcoxon Test			Friedman Test		
	+/=/-	p-value	H	SumR	MeanR	Rank	+/=/-	p-value	H	SumR	MeanR	Rank
EODE	+15/=6/-1	5.19E-04	TRUE	191	8.6818	10	+15/=5/-2	2.35E-03	TRUE	177	8.0455	10
MDE	+16/=6/-0	3.05E-05	TRUE	207	9.4091	12	+15/=4/-3	7.54E-03	TRUE	170.5	7.7500	9
MTDE	+14/=6/-2	4.18E-03	TRUE	144	6.5455	5	+15/=2/-5	4.14E-02	TRUE	132	6.0000	5
BSD	+15/=5/-2	2.35E-03	TRUE	194.5	8.8409	11	+16/=3/-3	4.43E-03	TRUE	168.5	7.6591	8
BDE	+14/=8/-0	1.22E-04	TRUE	142	6.4545	4	+15/=3/-4	1.92E-02	TRUE	122.5	5.5682	3
BeSD	+14/=6/-2	4.18E-03	TRUE	145	6.5909	6	+14/=4/-4	3.09E-02	TRUE	129.5	5.8864	4
meanDE	+14/=6/-2	4.18E-03	TRUE	182	8.2727	8	+16/=1/-5	2.66E-02	TRUE	167	7.5909	7
QRDE	+16/=5/-1	2.75E-04	TRUE	240	10.9091	14	+19/=2/-1	4.01E-05	TRUE	213.5	9.7045	12
JADE	+16/=5/-1	2.75E-04	TRUE	186	8.4545	9	+18/=3/-1	7.63E-05	TRUE	234	10.6364	13
JADEGMO	+19/=3/-0	3.81E-06	TRUE	237.5	10.7955	13	+20/=0/-2	1.21E-04	TRUE	265	12.0455	14
EA4eig	+21/=0/-1	1.10E-05	TRUE	300	13.6364	15	+21/=0/-1	1.10E-05	TRUE	322	14.6364	15
AGSK	+10/=9/-3	9.23E-02	TRUE	111	5.0455	3	+13/=3/-6	1.67E-01	FALSE	112.5	5.1136	2
HSES	+13/=6/-3	2.13E-02	TRUE	174	7.9091	7	+14/=3/-5	6.36E-02	TRUE	142	6.4545	6
IMODE	+11/=8/-3	5.74E-02	TRUE	103.5	4.7045	2	+19/=1/-2	2.21E-04	TRUE	201	9.1364	11
DXMODE	NA	NA	NA	82.5	3.7500	1	NA	NA	NA	83	3.7727	1
				p-value $= 2.4247E-20$						p-value $= 1.5247E-21$		

8.2. Ranking and statistical analysis

The ranking and statistical analysis results in Tables 10 and 11 clearly confirm the superior performance of DXMODE across both function evaluation-based (FE-based) and score-based normalized error (SNE-SR) ranking methods when compared to fourteen recent advanced DE variants and CEC competition winners.

In the FE-based ranking, DXMODE achieved the highest total sum rank (267.2), ranking first across both 10D and 20D dimensions. Similarly, in the SNE-SR-based evaluation, DXMODE again ranked first with the lowest total score of 98.34, combining a strong SNE component score (48.34) and the best SR component score (82). AGSK and BDE followed in second and third places, with total scores of 85.25 and 78.15, respectively.

Table 11 reinforces this outcome through non-parametric statistical tests. In the Wilcoxon signed-rank and Friedman tests conducted on median error results across 22 benchmark functions, DXMODE again leads with the lowest Friedman mean ranks: 3.75 in 10D and 3.77 in 20D. BDE also performs strongly, consistently placing among the top four in both dimensions, with Friedman ranks of 6.45 in 10D and 5.57 in 20D.

All comparisons involving other algorithms were statistically significant (p-values ≤ 0.05), indicating that the observed performance differences are not due to random variation. Algorithms such as EA4eig, JADEGMO, and QRDE show weaker performance with high Friedman ranks (above 9.7), while some historical CEC winners like IMODE and AGSK display stronger ranks in 10D (4.70 and 5.04, respectively) but more variable results in 20D. Overall, DXMODE maintains top performance across both statistical and rank-based evaluations, confirming its robustness and effectiveness across high-dimensional and diverse problem landscapes.

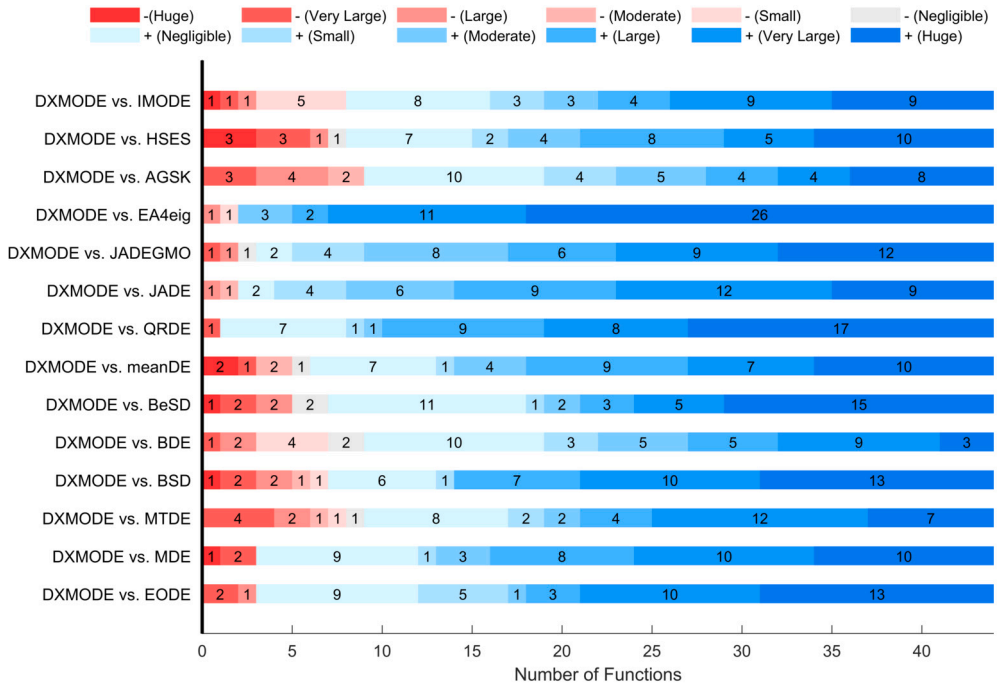


Fig. 17. Cohen's d effect for DXMODEv2 against meta-heuristic optimization algorithms on CEC2020-2022 (Algorithm-Wise).

8.3. Cohen's d effect size analysis

Fig. 17 illustrates the distribution of Cohen's d statistics for the DXMODE algorithm compared to recent advanced DE variants across all benchmark functions in 10D and 20D. As shown, DXMODE consistently yields a high number of significant positive effect sizes ($d \geq 0.5$), reflecting a strong and practically relevant advantage over these advanced methods. The detailed Cohen's d values are provided in Appendix I (Table I.10).

Specifically, DXMODE demonstrates consistent superiority in comparisons against top-ranked recent DE variants. Against AGSK, DXMODE yields 36 positive effects, including 25 statistically significant ones, while AGSK records only three significant outcomes in its favor. In the case of BDE, DXMODE achieves 35 positive effects (22 significant), compared to just three significant cases for BDE. When tested against MTDE, DXMODE secures 35 positive results, with 25 being significant, whereas MTDE shows only seven significant outcomes.

For BeSD, DXMODE records 37 positive effects, 25 of which are significant, while BeSD manages five significant cases. A similar trend appears with HSES, where DXMODE attains 36 positive outcomes (27 significant) versus only six for HSES. The strongest performance is observed against meanDE, where DXMODE achieves 38 positive effects, with 30 reaching statistical significance, while meanDE shows just five significant cases. These results underline DXMODE's robust and practically significant performance advantage over the best-performing DE variants in the field.

8.4. Diversity analysis

Fig. 18 illustrates the diversity behavior of the top-performing DE variants (MTDE, BDE, AGSK, and DXMODE) on the representative function F9, using the median span and standard deviation (SD) across all iterations in both 10D and 20D. DXMODE consistently maintains the highest diversity throughout the search process, reflected in its highest median SD and span values compared to its competitors. The full diversity plots for all benchmark functions are presented in Appendix G (Figs. G.11–G.12).

Table 12 summarizes each function's peak median SD and span values obtained over 30 independent runs. The results clearly show that DXMODE achieves the highest number of maximum values across both metrics, outperforming MTDE, BDE, and AGSK. These results confirm DXMODE's significant advantage in exploration and its ability to maintain population diversity across the optimization process.

8.5. Convergence analysis

Fig. 19 presents the median convergence plots for selected representative functions (F2, F7, F11, and F18) comparing DXMODE with the top-ranked DE variants: AGSK, BDE, MTDE, and BeSD. Although DXMODE often starts with a higher median error, it consistently achieves the lowest final error values across all functions and dimensions. The complete set of convergence plots for all the functions and dimensions are available in Appendix H (Figs. H.15 – H.16).

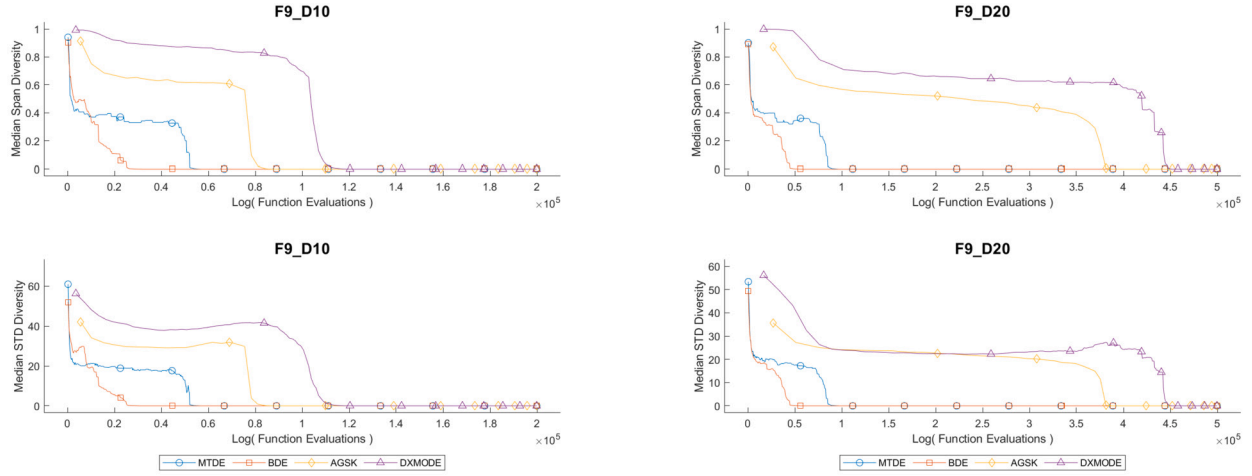
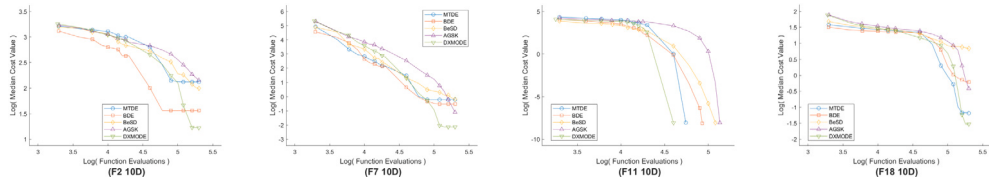
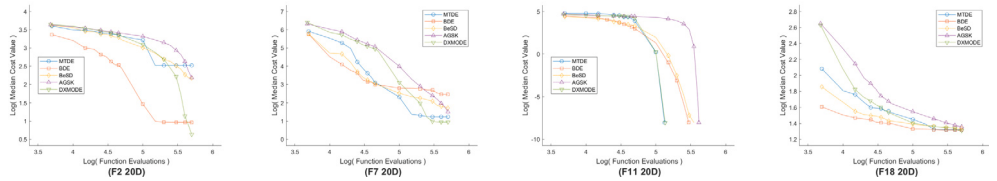


Fig. 18. Median Diversity plots (Span and SD) for the top DE variants algorithms (F9).



(a) 10 Dim.



(b) 20 Dim.

Fig. 19. Convergence plots for median fitness in 30 runs for all the top advanced DE variants, including DXMODE (F2, F7, F11, and F18).

To statistically validate this observation, Page's test [47] is applied between DXMODE and each of the four DE variants, treating the 22 benchmark functions as samples and selected iteration checkpoints as treatments. As shown in Fig. 20, the test reveals a statistically significant increasing trend in all cases (AGSK-DXMODE, BDE-DXMODE, MTDE-DXMODE, and BeSD-DXMODE), in both 10D and 20D settings. These results confirm that DXMODE converges significantly faster than its competitors.

8.6. Algorithm complexity

The computational complexity of classical DE variants is $\mathcal{O}(NP \cdot D \cdot G_{\max})$, where NP is the population size, D is the problem dimension, and $G_{\max}$ is the maximum number of generations [49]. This estimation arises because DE performs mutation and crossover operations in nested loops over NP and D.

Although DXMODE introduces additional mechanisms such as dynamic population reduction (ELPD) and exploration operators (AGE and MNCE), these are probabilistic and conditionally activated within the main DE loop, thus preserving the same asymptotic complexity of $\mathcal{O}(NP \cdot D \cdot G_{\max})$. Furthermore, all additional operations in DXMODE are counted within the MaxFEs limit, ensuring fair termination across all algorithms.

However, due to the probabilistic nature and adaptive behaviors shared among advanced DE variants, including DXMODE, relying solely on Big-O notation does not reflect the true computational complexity. Therefore, the CEC benchmark guidelines [50] recommend evaluating runtime empirically using four standardized timing metrics: T_0, T_1, T_2, and T_3. Algorithms are ranked based on T_3, where lower values indicate higher efficiency.

The time complexity of all advanced DE variants is evaluated on the 10D and 20D CEC2020 benchmark functions using fixed MaxFEs of 1000 in a single run. Experiments were conducted on a machine with 8.00 GB RAM, Intel Core i7-6500U CPU (2.50–2.60 GHz), Windows 11 Pro, and MATLAB R2024a.

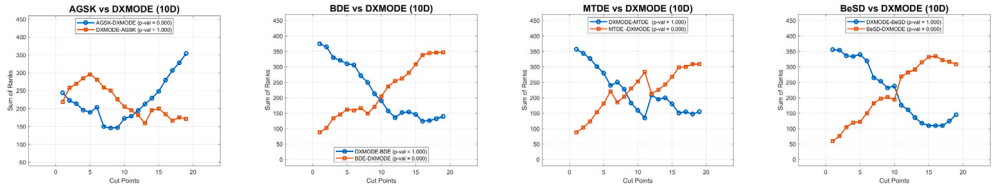
Table 13 reports the average T_3 runtime rankings. In the 10D scenario, AGSK ranked first, followed by meanDE and DXMODE in third. However, AGSK's computational efficiency dropped significantly in the 20D case, falling to 10th place. BSD, which ranked first

Table 12
The median peak span and median peak SD across all the 30 runs for the top DE variants for all the 10D and 20D benchmark functions.

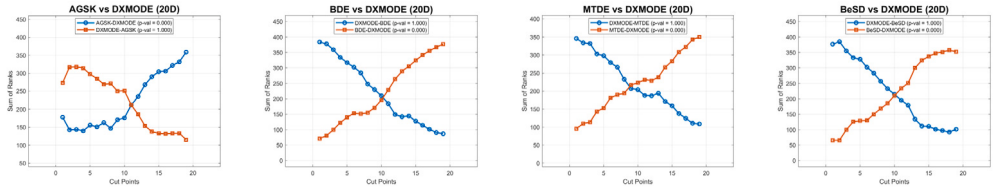
Fun.	Metric	10-Dim				20-Dim			
No.		MTDE	BDE	AGSK	DXMODE	MTDE	BDE	AGSK	DXMODE
F1	SD	9.67E-01	9.36E-01	6.53E-01	9.83E-01	9.38E-01	8.77E-01	4.47E-01	9.62E-01
	Span	5.86E+01	5.06E+01	2.77E+01	4.99E+01	5.67E+01	4.62E+01	1.50E+01	4.11E+01
F2	SD	9.77E-01	9.68E-01	1.00E+00	1.00E+00	9.71E-01	9.48E-01	1.00E+00	9.99E-01
	Span	6.83E+01	5.91E+01	5.62E+01	6.00E+01	6.98E+01	5.79E+01	5.17E+01	5.82E+01
F3	SD	9.21E-01	8.75E-01	3.18E-01	9.73E-01	9.09E-01	8.36E-01	2.34E-01	9.38E-01
	Span	5.49E+01	4.58E+01	9.58E+00	4.65E+01	5.47E+01	4.18E+01	7.28E+00	3.81E+01
F4	SD	9.62E-01	9.22E-01	6.52E-01	9.89E-01	9.35E-01	8.82E-01	5.60E-01	9.70E-01
	Span	5.98E+01	5.33E+01	2.56E+01	5.26E+01	5.89E+01	5.07E+01	2.30E+01	4.76E+01
F5	SD	9.71E-01	9.61E-01	1.00E+00	9.99E-01	9.67E-01	9.37E-01	9.16E-01	9.99E-01
	Span	7.20E+01	5.82E+01	4.17E+01	5.85E+01	6.93E+01	5.59E+01	3.41E+01	5.70E+01
F6	SD	9.69E-01	9.37E-01	1.00E+00	9.98E-01	9.63E-01	9.21E-01	1.00E+00	9.98E-01
	Span	6.64E+01	5.57E+01	5.35E+01	6.01E+01	6.64E+01	5.21E+01	4.65E+01	5.66E+01
F7	SD	9.75E-01	9.36E-01	1.00E+00	9.98E-01	9.73E-01	9.29E-01	1.00E+00	9.99E-01
	Span	6.92E+01	5.79E+01	5.39E+01	5.89E+01	6.96E+01	5.58E+01	4.79E+01	5.71E+01
F8	SD	9.61E-01	9.57E-01	1.00E+00	9.97E-01	9.69E-01	9.44E-01	1.00E+00	9.99E-01
	Span	6.47E+01	5.42E+01	4.38E+01	5.74E+01	6.83E+01	5.73E+01	4.84E+01	5.69E+01
F9	SD	9.54E-01	9.43E-01	1.00E+00	9.97E-01	9.20E-01	9.43E-01	9.58E-01	9.99E-01
	Span	6.48E+01	5.74E+01	4.60E+01	5.81E+01	5.76E+01	5.33E+01	3.94E+01	5.80E+01
F10	SD	9.37E-01	9.12E-01	6.53E-01	9.82E-01	9.43E-01	9.04E-01	5.63E-01	9.78E-01
	Span	5.92E+01	5.02E+01	2.44E+01	4.99E+01	6.03E+01	5.00E+01	1.87E+01	4.47E+01
F11	SD	9.74E-01	9.50E-01	1.00E+00	9.96E-01	9.73E-01	9.38E-01	1.00E+00	9.98E-01
	Span	6.88E+01	5.75E+01	5.26E+01	5.76E+01	6.93E+01	5.55E+01	5.42E+01	5.69E+01
F12	SD	9.55E-01	9.27E-01	7.93E-01	9.94E-01	9.45E-01	8.95E-01	4.94E-01	9.80E-01
	Span	6.02E+01	5.47E+01	3.14E+01	5.26E+01	5.83E+01	4.91E+01	1.71E+01	4.33E+01
F13	SD	9.61E-01	9.35E-01	9.30E-01	9.94E-01	9.64E-01	8.97E-01	9.21E-01	9.98E-01
	Span	6.05E+01	5.45E+01	3.61E+01	5.50E+01	6.02E+01	5.16E+01	3.28E+01	5.40E+01
F14	SD	9.37E-01	9.36E-01	7.98E-01	9.92E-01	9.34E-01	8.80E-01	8.06E-01	9.95E-01
	Span	6.04E+01	5.08E+01	2.42E+01	5.34E+01	5.90E+01	4.84E+01	2.29E+01	5.12E+01
F15	SD	9.46E-01	9.37E-01	6.96E-01	9.95E-01	9.56E-01	9.34E-01	7.13E-01	9.96E-01
	Span	6.25E+01	5.67E+01	2.18E+01	5.52E+01	6.14E+01	5.26E+01	1.80E+01	5.34E+01
F16	SD	9.73E-01	9.43E-01	9.91E-01	9.99E-01	9.51E-01	9.04E-01	9.48E-01	9.99E-01
	Span	6.70E+01	5.61E+01	4.75E+01	5.79E+01	6.58E+01	5.13E+01	3.70E+01	5.35E+01
F17	SD	9.55E-01	9.59E-01	1.00E+00	9.98E-01	9.72E-01	9.51E-01	9.97E-01	9.99E-01
	Span	6.68E+01	5.64E+01	5.53E+01	5.81E+01	6.85E+01	5.73E+01	3.80E+01	5.76E+01
F18	SD	9.77E-01	9.43E-01	1.00E+00	9.98E-01	9.68E-01	9.25E-01	1.00E+00	9.99E-01
	Span	6.90E+01	6.01E+01	5.11E+01	5.85E+01	6.84E+01	5.30E+01	4.62E+01	5.78E+01
F19	SD	9.62E-01	9.31E-01	9.77E-01	9.96E-01	9.57E-01	9.43E-01	8.49E-01	9.98E-01
	Span	6.69E+01	5.66E+01	4.54E+01	5.62E+01	6.63E+01	5.49E+01	3.39E+01	5.33E+01
F20	SD	9.72E-01	9.72E-01	1.00E+00	9.98E-01	9.76E-01	9.50E-01	1.00E+00	9.99E-01
	Span	6.61E+01	5.74E+01	5.89E+01	5.96E+01	7.00E+01	5.57E+01	5.50E+01	5.89E+01
F21	SD	9.52E-01	9.23E-01	8.38E-01	9.91E-01	9.48E-01	9.08E-01	7.16E-01	9.91E-01
	Span	6.40E+01	5.51E+01	3.11E+01	5.16E+01	6.74E+01	5.05E+01	2.84E+01	4.50E+01
F22	SD	9.68E-01	9.60E-01	1.00E+00	9.99E-01	9.65E-01	9.55E-01	1.00E+00	1.00E+00
	Span	6.24E+01	5.68E+01	5.69E+01	6.08E+01	6.35E+01	5.46E+01	5.70E+01	6.23E+01

in 20D, showed poor efficiency in 10D, dropping to 11th place. In contrast, DXMODE exhibited consistent and scalable performance, achieving 3rd place in the 10D and improving to 2nd place in 20D. meanDE also showed consistency, ranking second in 10D and fifth in 20D.

Overall, DXMODE demonstrates balanced performance, achieving top accuracy, statistical dominance, and consistent runtime scalability with dimensionality. Combined with its fast convergence and high diversity, DXMODE achieves superior accuracy with no observable trade-off in computational cost.



(a) 10 Dim.



(b) 20 Dim.

Fig. 20. Page test and convergence trends between DXMODE and the top DE variants across all the CEC2020-2022 functions.

Table 13
Time complexity results for advanced DE variants for the 10D and 20D CEC2020 benchmark functions (MaxFEs = 1000).

Algorithm	10 Dim.					20 Dim.				
Alg.	T0	T1	T2	T3	Rank	T0	T1	T2	T3	Rank
EODE	0.0074	0.0433	0.0937	6.8425	10	0.0074	0.0445	0.0389	0.7533	3
MDE	0.0074	0.0433	0.0641	2.8186	4	0.0074	0.0445	0.0675	3.1227	7
MTDE	0.0074	0.0433	0.0850	5.6573	8	0.0074	0.0445	0.0714	3.6595	8
BSD	0.0074	0.0433	0.1041	8.2570	11	0.0074	0.0445	0.0419	0.3583	1
BDE	0.0074	0.0433	0.1319	12.0288	12	0.0074	0.0445	0.0535	1.2179	4
BeSD	0.0074	0.0433	0.0859	5.7900	9	0.0074	0.0445	0.0590	1.9770	6
meanDE	0.0074	0.0433	0.0567	1.8139	2	0.0074	0.0445	0.0550	1.4264	5
QRDE	0.0074	0.0433	0.1720	17.4829	14	0.0074	0.0445	0.1883	19.5262	13
JADE	0.0074	0.0433	0.0680	3.3505	5	0.0074	0.0445	0.0738	3.9781	9
JADEGMO	0.0074	0.0433	0.0684	3.4148	6	0.0074	0.0445	0.1479	14.0390	12
EA4eig	0.0074	0.0433	0.7074	90.1849	15	0.0074	0.0445	1.9438	257.9117	15
AGSK	0.0074	0.0433	0.0501	0.9288	1	0.0074	0.0445	0.1090	8.7582	10
HSES	0.0074	0.0433	0.0705	3.7007	7	0.0074	0.0445	0.1193	10.1533	11
IMODE	0.0074	0.0433	0.1538	15.0097	13	0.0074	0.0445	0.5712	71.5273	14
DXMODE	0.0074	0.0433	0.0611	2.4189	3	0.0074	0.0445	0.0476	0.4232	2

9. Validation of DXMODE on engineering design optimization problems: part 1

This section validates DXMODE on thirteen real-world engineering design problems introduced in Section 5.2 and detailed in Appendix C[41]. Each algorithm was run independently 30 times with a MaxFEs of 12,000 per run. DXMODE's performance is compared against the classical meta-heuristics optimization algorithms, including GA [42], DE [43], PSO [19], ABC [42], SA [44], GWO [3], FA [42], BAS [21], TLBO [22], MFO [4], WOA [45], HHO [19], CSO [20], CSOA [18], CMA-ES [46], and IMODE [9].

9.1. Results collection and graphical representation

Fig. 21 shows violin plots of the cost distributions for all problems except F5, where all methods perform similarly. BAS and CMAES are excluded from the plots due to their poor performance. DXMODE shows the same stable distribution patterns observed in the CEC benchmarks, confirming its consistent performance across various engineering problems.

Appendix J (Table J.11) summarizes the median results, including position values and success rates, across all thirteen engineering problems. Detailed run-wise statistics (best, worst, mean, median, and SD) of cost and function evaluations are provided in Appendix K (Table K.12). Box plots are available in Appendix L (Fig. L.17).

9.2. Ranking and statistical analysis

Table 14 shows that DXMODE ranks first in both SNE-SR score (100) and FE-based ranking (score = 201). In contrast, competitive algorithms such as TLBO, DE, and IMODE occupy second, third, and fourth place, respectively, while approaches like BAS, HHO, and CMAES reside near the bottom of the table. The Friedman test confirms statistically significant performance differences (p-value = 7.75×10^{-26}), with DXMODE achieving the lowest mean rank (2.076923). TLBO, DE, and IMODE again round out the top four.

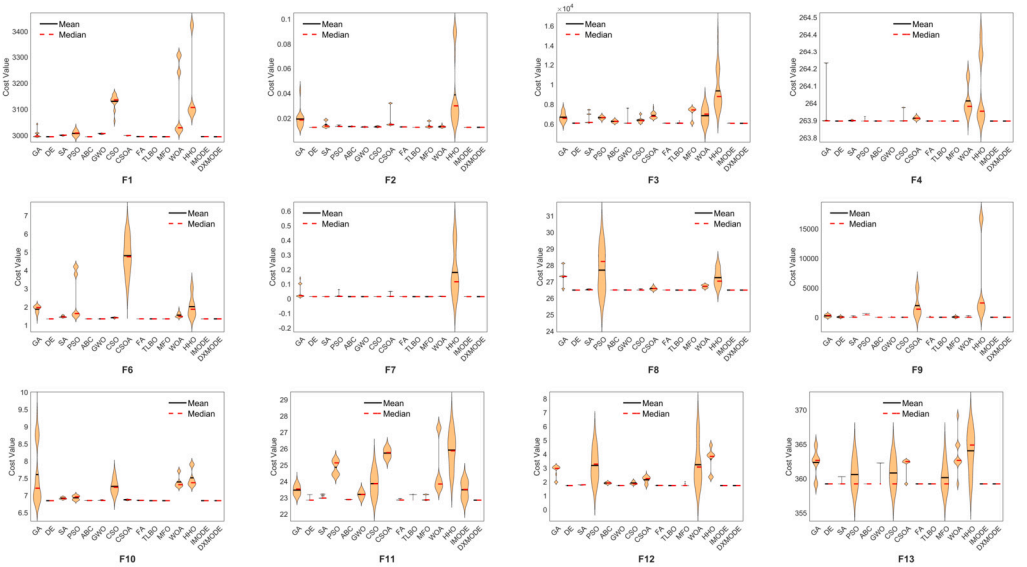


Fig. 21. Violin plots for the Engineering Optimization Problems.

Table 14
Statistical Analysis of the meta-heuristic optimization algorithms for all the engineering optimization problems: SNE-SR ranking, median FE-based ranking, and Friedman test.

Algorithm	SNE-SR Ranking						FE Ranking		Friedman and Wilcoxon Tests			
	SNE	Score1	SR	Score2	Total	Place	FE-SR	Place	SumR	MeanR	Rank	+/=/-
GA	7.98	48.91	163.0	7.21	56.12	12	80	12	160	12.3077	13	+13/=0/-0
DE	7.81	50.00	45.0	26.11	76.11	3	189	3	44	3.3846	3	+7/=5/-1
SA	7.85	49.76	115.0	10.22	59.98	9	110	10	122	9.3846	9.5	+13/=0/-0
PSO	8.72	44.80	165.0	7.12	51.93	14	81	11	153	11.7692	11	+12/=1/-0
ABC	7.86	49.71	88.0	13.35	63.06	6	128	8	102	7.8462	8	+13/=0/-0
GWO	7.82	49.95	94.0	12.50	62.45	7	140	7	94	7.2308	7	+13/=0/-0
CSO	7.88	49.55	127.0	9.25	58.80	10	114	9	122	9.3846	9.5	+12/=1/-0
CSOA	8.70	44.90	162.0	7.25	52.16	13	77	14	161	12.3846	14	+13/=0/-0
BAS	10.39	37.61	202.0	5.82	43.43	17	30	17	204	15.6923	17	+13/=0/-0
FA	7.82	49.96	76.0	15.46	65.42	5	146	6	91	7.0000	6	+13/=0/-0
TLBO	7.81	50.00	40.5	29.01	79.01	2	190	2	40	3.0769	2	+7/=5/-1
MFO	7.84	49.83	99.5	11.81	61.64	8	162.5	5	76.5	5.8846	5	+8/=4/-1
WOA	7.98	48.95	155.0	7.58	56.53	11	79	13	156	12.0000	12	+13/=0/-0
HHO	10.38	37.64	199.0	5.90	43.55	16	34	16	200	15.3846	16	+13/=0/-0
CMAES	9.77	39.99	185.0	6.35	46.35	15	49	15	185	14.2308	15	+13/=0/-0
IMODE	7.81	49.99	49.5	23.74	73.73	4	178.5	4	51.5	3.9615	4	+8/=4/-1
DXMODE	7.81	50.00	23.5	50.00	100.00	1	201	1	27	2.0769	1	NA
									Friedman p-val = $7.74661E-26$			

Paired comparisons using Wilcoxon and sign tests confirm DXMODE's dominance. All competing algorithms yield statistically significant differences in favor of DXMODE, as indicated by p-values < 0.05. These statistical analyses highlight DXMODE's superiority across numerous real-world engineering challenges. DXMODE consistently secures high-quality solutions with fewer FEs, explaining its top score in nearly every aggregated metric.

9.3. Cohen's d effect size analysis

Cohen's d effect size analysis was applied to each engineering optimization problem to compare DXMODE with every meta-heuristic algorithm over 30 independent runs. As shown in Fig. 22, DXMODE consistently demonstrates a dominant performance, with a high number of statistically significant positive effect sizes ($d \geq 0.5$). Detailed Cohen's d values can be found in Appendix M (Table M.14).

Out of a total of 208 comparisons (16 algorithms $\times$ 13 problems), DXMODE showed worse results in only four cases—one each against IMODE, MFO, TLBO, and DE, all occurring in the Corrugated Bulkhead Design problem (F10). However, this anomaly in F10 does not reflect low performance. Both DXMODE and IMODE achieved the same mean result (6.8430E+00), but IMODE had a lower

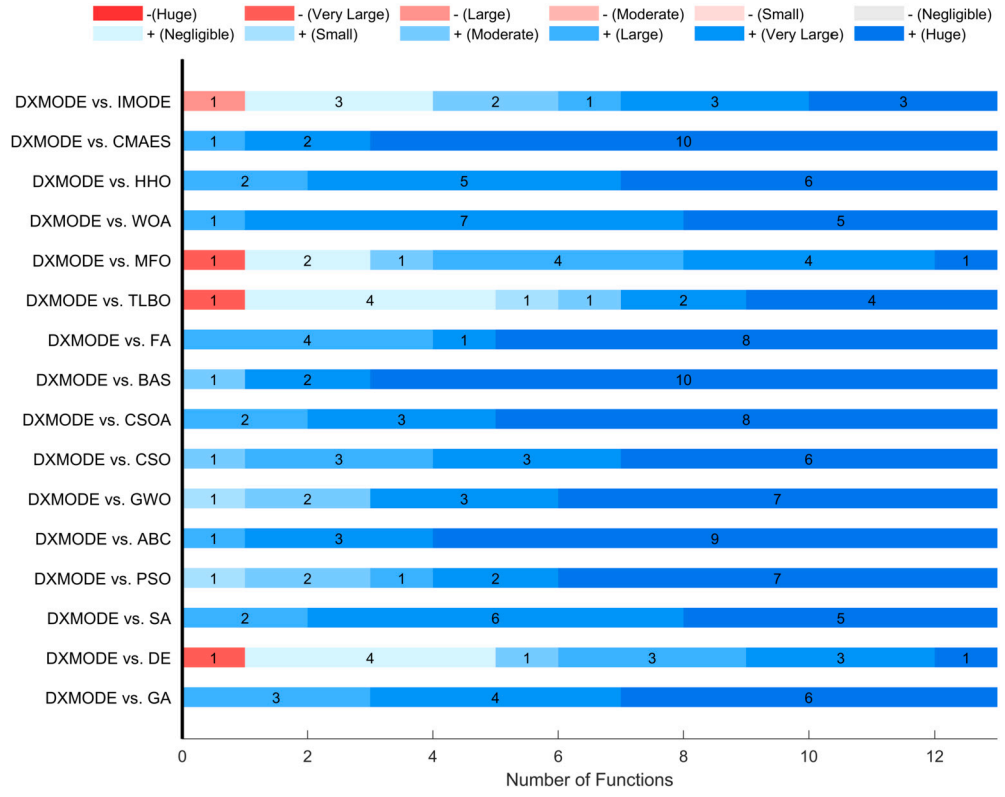


Fig. 22. Cohen's d effect for DXMODE against meta-heuristic optimization algorithms on Engineering Optimization Problems (Algorithm-Wise).

standard deviation (SD) of 9.4784E−09 compared to DXMODE's SD of 3.4812E−08, causing Cohen's d to favor IMODE over DXMODE. Therefore, the nearly identical mean values confirm that DXMODE's performance remains competitive in this case.

Specifically, compared to IMODE, DXMODE achieved 12 positive effects across the 13 problems, with 9 of these being statistically significant. Against DE, DXMODE recorded 12 positive cases, 8 of which were significant. Compared with FA, DXMODE achieved 13 out of 13 positive effects, all statistically significant. Against TLBO, DXMODE recorded 12 positive cases, with 8 showing statistical significance.

10. Validation of DXMODE on engineering design optimization problems: part 2

This section extends the validation of DXMODE on thirteen engineering design problems, comparing its performance against advanced DE variants and recent CEC competition winners, including EODE [10], MDE [26], MTDE [27], BSD [28], BDE [29], BeSD [11], meanDE [30], QRDE [12], JADE [8], JADE-GMO [31], EA4eig [13], AGSK [24], HSES [25], and IMODE [9]. Detailed results of the cost and function evaluations are provided in Appendix K (Table K.13).

10.1. Ranking and statistical analysis

Table 15 confirms DXMODE's clear dominance across all evaluation methods. DXMODE achieves the highest total score of 100 in the SNE-SR ranking, the best FE-based score (SR = 158.5), and the lowest Friedman mean rank of 3.27 with a significant p-value of $5.21208E-09$. EODE, MTDE, and JADE follow with mean ranks of 5.69, 6.42, and 5.81, respectively. The Wilcoxon signed-rank test further reinforces this finding: none of the competing algorithms outperform DXMODE in more than one function. DXMODE maintains robust performance across all engineering problems with no notable weaknesses.

10.2. Cohen's d effect size analysis

Fig. 23 summarizes Cohen's d effect size results across 13 engineering design problems, showing that DXMODE consistently outperforms the 14 advanced DE variants. Full results are available in Appendix M (Table M.15).

Considering 182 comparisons (14 algorithms × 13 problems), DXMODE was outperformed in only four cases, all in the Corrugated Bulkhead Design problem (F10) against IMODE, JADE, meanDE, and EODE. Notably, DXMODE reached the lowest mean value ($6.8430E+00$), but Cohen's d favored the others due to their lower standard deviations, which does not reflect a superior practical distinction over DXMODE.

Table 15
Statistical Analysis of the advanced DE variants for all the engineering optimization problems: SNE-SR ranking, median FE-based ranking, and Friedman test.

Algorithm	SNE-SR Ranking						FE Ranking		Friedman and Wilcoxon Tests			
	SNE	Score1	SR	Score2	Total	Place	FE-SR	Place	SumR	MeanR	Rank	+/=/-
EODE	10.28	49.83	62	27.02	76.85	2	132.5	3	74	5.6923	2	+8/=4/-1
MDE	10.72	47.83	102.5	16.34	64.17	7	106.5	9	104.5	8.0385	10	+8/=5/-0
MTDE	10.25	49.98	67	25.00	74.98	3	120	5	83.5	6.4231	4	+10/=3/-0
BSD	10.53	48.67	157	10.67	59.34	13	45	14	163	12.5385	14	+13/=0/-0
BDE	10.27	49.92	124	13.51	63.42	9	77	12	132	10.1538	12	+12/=1/-0
BeSD	10.55	48.57	159	10.53	59.10	14	40	15	163.5	12.5769	15	+13/=0/-0
meanDE	11.24	45.60	108.5	15.44	61.04	11	97	11	106.5	8.1923	11	+9/=3/-1
QRDE	11.75	43.62	115	14.57	58.19	15	114	8	100	7.6923	9	+8/=4/-1
JADE	10.25	49.98	91.5	18.31	68.29	6	136.5	2	75.5	5.8077	3	+4/=8/-1
JADEGMO	10.43	49.14	150	11.17	60.31	12	66	13	147	11.3077	13	+13/=0/-0
EA4eig	10.40	49.28	119	14.08	63.35	10	127	4	88	6.7692	6	+5/=8/-0
AGSK	10.25	49.98	77	21.75	71.73	4	115	7	95	7.3077	7	+10/=3/-0
HSES	10.41	49.22	113	14.82	64.04	8	105	10	98.5	7.5769	8	+7/=6/-0
IMODE	10.25	49.98	81	20.68	70.65	5	120	6	86.5	6.6538	5	+8/=4/-1
DXMODE	10.25	50.00	33.5	50.00	100.00	1	158.5	1	42.5	3.2692	1	NA
									Friedman p-val = $5.21208E-09$			

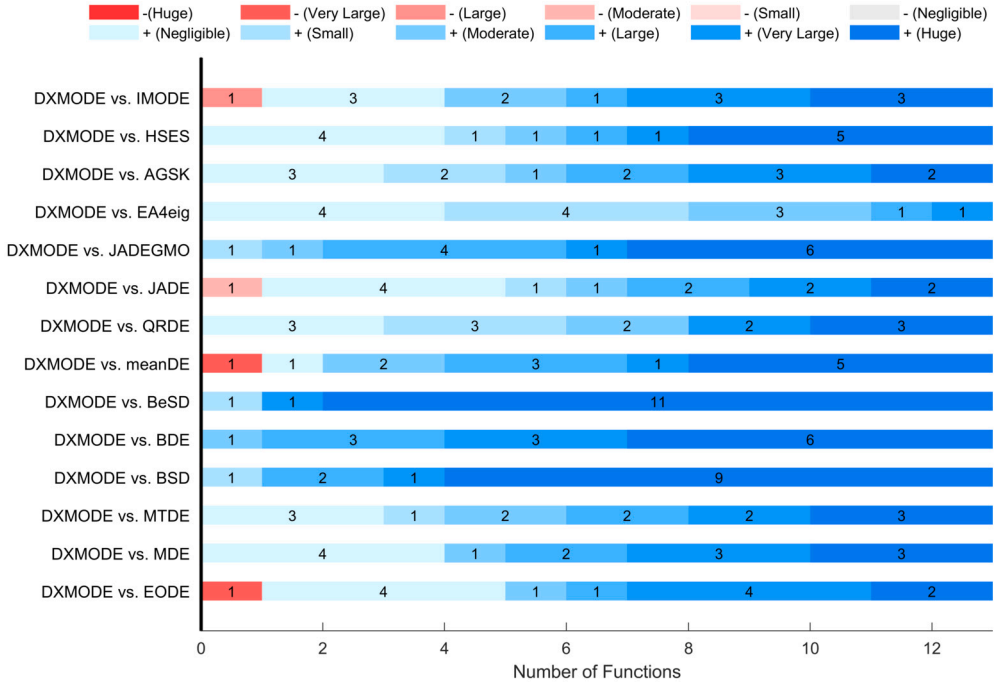


Fig. 23. Cohen's d effect for DXMODE against advanced DE variants on Engineering Optimization Problems (Algorithm-Wise).

In terms of wins, DXMODE achieved 12 positive effects (8 significant) against EODE, 12 (8 significant) against JADE, 13 (9 significant) against MTDE, and 12 (9 significant) against IMODE. These outcomes confirm DXMODE's practical superiority and strong generalization across real-world engineering problems.

11. Conclusion

This paper introduced the Dynamic Explorative Multi-Operator Differential Evolution (DXMODE), a novel DE variant designed to enhance exploration, maintain diversity, and improve convergence in complex optimization tasks. DXMODE incorporates an Error-based Linear Population Decay (ELPD) strategy that adaptively adjusts population size based on both iteration count and error improvement, addressing the limitations of static or blindly decaying population strategies. A decoupled exploration phase was also proposed, featuring two novel operators: Aggressive Gaussian Exploration (AGE) and Multiple Nested Chaotic Exploration (MNCE), each designed to enhance diversity and avoid premature convergence. A sensitivity analysis of 20 configurations showed that ELPD combined with linear exploration decay achieved the best performance.

DXMODE was rigorously benchmarked against 30 algorithms, including classical metaheuristics (GA, PSO, SA, etc.), recent DE variants (EODE, MDE, MTDE, BSD, BDE, BeSD, meanDE, QRDE, JADEGMO), and top CEC winners (IMODE, EA4eig, AGSK, HSES, JADE). Across the CEC2020–2022 benchmark suites, DXMODE consistently ranked first, outperforming all competitors with statistically significant p-values and demonstrating robust convergence and low error across dimensions. Against IMODE, DXMODE achieved confidence of 94.26% (10D) and 99.29% (20D), with 28 significant positive Cohen's d effects. Compared to advanced DE variants, DXMODE achieved the best total ranking (267.2) and the lowest SNE-SR score (98.34), followed by AGSK and BDE.

The algorithm's superiority was further validated on 13 engineering optimization problems, where DXMODE again ranked first across all tests, highlighting DXMODE's robustness and speed across numerous real-world engineering problems. In the future, more mutation operators can be tested in the DXMODE, and their effect can be studied compared to the original DXMODE algorithm. Furthermore, DXMODE can be hybridized with other algorithms to produce a more enhanced variant of the DXMODE.

CRediT authorship contribution statement

Mohamed Reda: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ahmed Onsy:** Supervision, Resources, Project administration, Funding acquisition. **Amira Y. Haikal:** Supervision, Project administration, Funding acquisition. **Ali Ghanbari:** Writing – review & editing, Supervision, Project administration, Funding acquisition.

Ethical approval

Not applicable.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Code availability

The MATLAB source code and corresponding result files for the proposed algorithm, DXMODE, are publicly available on both GitHub and MATLAB File Exchange: https://github.com/MohamedRedaMu/DXMODE-Algorithm, https://uk.mathworks.com/matlabcentral/fileexchange/181143-dxmode-algorithm.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Not applicable.

Appendix A. CEC2020-2022 benchmark functions

This appendix presents the definitions and categories of the CEC2020, CEC2021, and CEC2022 benchmark functions used for evaluating the performance of the proposed DXMODE algorithm.

Table A.1
CEC2020 and CEC2021 benchmark functions Test Suites [7].

Type	No.	Symbol	Functions	F_i^*
Unimodal Functions	1	F1	Shifted and Rotated Bent Cigar Function (CEC 2017 F1)	100
Basic Functions	2	F2	Shifted and Rotated Schwefel's Function (CEC 2014 F11)	1100
	3	F3	Shifted and Rotated Lunacek Bi-Rastrigin Function (CEC 2017 F7)	700
	4	F4	Expanded Rosenbrock's plus Griewank's Function (CEC2017 F9)	1900
Hybrid Functions	5	F5	Hybrid Function 1 (N = 3) (CEC 2014 F17)	1700
	6	F6	Hybrid Function 2 (N = 4) (CEC 2017 F16)	1600
	7	F7	Hybrid Function 3 (N = 5) (CEC 2014 F21)	2100
Composition Functions	8	F8	Composition Function 1 (N = 3) (CEC 2017 F22)	2200
	9	F9	Composition Function 2 (N = 4) (CEC 2017 F24)	2400
	10	F10	Composition Function 3 (N = 5) (CEC 2017 F25)	2500

Table A.2
CEC2022 benchmark functions Test Suite [23].

Type	No.	Symbol	Functions	F_i^*
Unimodal Function	1	F11	Shifted and full Rotated Zakharov Function	300
Basic Functions	2	F12	Shifted and full Rotated Rosenbrock's Function	400
	3	F13	Shifted and full Rotated Expanded Schaffer's f6 Function	600
	4	F14	Shifted and full Rotated Non-Continuous Rastrigin's Function	800
	5	F15	Shifted and full Rotated Levy Function	900
Hybrid Functions	6	F16	Hybrid Function 1 (N = 3)	1800
	7	F17	Hybrid Function 2 (N = 6)	2000
	8	F18	Hybrid Function 3 (N = 5)	2200
Composition Functions	9	F19	Composition Function 1 (N = 5)	2300
	10	F20	Composition Function 2 (N = 4)	2400
	11	F21	Composition Function 3 (N = 5)	2600
	12	F22	Composition Function 4 (N = 6)	2700

Appendix B. Parameter settings of the state-of-the-art algorithms

This appendix summarizes the parameter configurations used for all baseline and advanced algorithms in the benchmarking experiments.

Table B.3
Summary of Parameter Settings for All Algorithms.

Algorithm	Parameters
GA [42]	P_c = 0.8, tournament size = 3 P_m =0.3, μ = 0.02
DE [43]	F = 0.5, CR = 0.5
SA [17]	max No. of sub-iteration = 20, No. of neighbors per individual = 5 , α = 0.99, T_0 = 0.1, mutation rate μ = 0.5
PSO [19]	c_1 = 1, c_2 = 1, w = 0.3
ABC [42]	abandon limit = 0.6 * dimSize * popSize, No. of onlooker bees = popSize, a = 1
CSO [20]	mothers NM = 10%, G = 10% , FL_{min} = 0.5, FL_{max} = 0.9 chicks NC = 20%, hens NH = 60%, roosters NR = 20%
CSOA [18]	SRD = 0.1, CDC = 0.8, initial cat velocity = 25% of problem bounds, c = 2.05, w_{min} = 0.4, w_{max} = 0.9, MR = 0.8, SMP = 15
FA [42]	m = 2, mutation range = 0.05 * (ub - lb), γ = 1, β_0 = 2, α = 0.2, damping ratio = 0.98
BAS [21]	d^1 = 2, η_d = 0.95, d_0 = 0.01 δ^1 = 0.5, η_δ = 0.95, δ_0 = 0.00
TLBO [22]	teacher factor TF = 1 or 2 (randomly chosen)
GWO [3]	a: linearly decreases from 2 to 0
MFO [4]	a: linearly decreases from -2 to -1 , b = 1
WOA [45]	a: linearly decreases from 2 to 0 , b = 1
HHO [19]	escaping energy: randomly varies between [-2,2]
MDE [26]	t = 3, NP = 30
MTDE [27]	H_{gb} = 5, NP = 30, μf = 0.5, $Mu = log(D)$, σ = 0.2 $WinIter$ = 20, $initial$ = 0.0001, $final$ = 2
BSD [28]	NP = 30
BDE [29]	NP = 30
BeSD [11]	K = 5, NP = 30
meanDE [30]	CR = 0.9, F_1 = 0.25, $F_2 = 0.5 * (1 - 2 * rand)$, NP = 30
QRDE [12]	CR = 0.2, F = 0.8, α_0 = 1, NP = 30
EODE [10]	V = 1, NP = 30, a_1 = 2, a_1 =1 GP = 0.5, FD = 0.5, CR = 0.9
CMAES [46]	$C_c = \frac{4}{nd+4}$, $c_{cov} = \frac{2}{(nd+\sqrt{2})^2}$ $\mu = popSize/2$, $d_\sigma = c_\sigma^{-1} + 1$
HSES [25]	$\lambda = round(3 \cdot ln(D) + 80)$, Phase 1: $N = 100$, $M = 200$, $I = 20$, $cc = 0.96$ Phase 4: ($M = 200, N = 160$) for $D \leq 30$, ($M = 450, N = 360$) for $D = 50$, ($M = 600, N = 480$) for $D > 50$
JADE [8]	A = 1, NP = 30, p = 0.05, c = 0.1, F_{init} = 0.5, CR_{init} =0.5
JADEGMO [31]	NP = 30, top = 1, c = 0.1, F_{init} = 0.5, CR_{init} =0.5
AGSK [24]	$NP_{init} = 20 \cdot D$, NP_{min} = 12, $c = 0.05$ $p = 0.05$, $Kw_p = [0.85, 0.05, 0.05, 0.05]$ $Kf = [0.1, 1.0, 0.5, 1.0]$, $Kr = [0.2, 0.1, 0.9, 0.9]$
EA4eig [13]	$NP_{init} = 100$, NP_{min} = 10 $\|A\| = 2.6 \cdot NP$, H = $5 \cdot D$, k = 1, $p^{max} = 0.25$
IMODE [9]	$NP_{\text{init}} = 9 * nd^2$, NP_{min} = 4 CR_{init} = 0.2, F_{init} = 0.2 A = $2.6 * popSize$, H = $20 * nd$, P_{ls} = 0.1
IMODEv2 [9]	A = 0, H = 0, rest of parameters are the same as IMODE
DXMODE	Parameters setting are in Table 1
DXMODEv2	A = , H = 0, Rest of parameters are the same as DXMODE
Population size	nPop = 30, all meta-heuristic alg. except CMAES, IMODE, DXMODE

Appendix C. Engineering optimization benchmark problem definitions

C.1. F1: speed reducer

$$
\begin{aligned}
&\text{Minimize:} \quad f(X) = 0.7854x_1x_2^2(3.3333x_3^2 + 14.9334x_3 - 43.0934) - 1.508x_1(x_6^2 + x_7^2) + \ldots \\
&\quad 7.4777(x_6^3 + x_7^3) + 0.7854(x_4x_6^2 + x_5x_7^2), \\
&\text{Subject to:} \quad g_1(X) = \frac{27}{x_1x_2^2x_3} - 1 \le 0, \\
&g_2(X) = \frac{397.5}{x_1x_2^2x_3^2} - 1 \le 0, \\
&g_3(X) = \frac{1.93x_4^3}{x_2x_3x_6^4} - 1 \le 0, \\
&g_4(X) = \frac{1.93x_5^3}{x_2x_3x_7^4} - 1 \le 0, \\
&g_5(X) = \frac{\sqrt{745x_4/x_2x_3}^2 + 16.9 \times 10^6}{110x_6^3} - 1 \le 0, \\
&g_6(X) = \frac{\sqrt{745x_5/x_2x_3}^2 + 157.5 \times 10^6}{85x_7^3} - 1 \le 0, \\
&g_7(X) = \frac{x_2x_3}{40} - 1 \le 0, \\
&g_8(X) = \frac{5x_2}{x_1} - 1 \le 0, \\
&g_9(X) = \frac{x_1}{12x_2} - 1 \le 0, \\
&g_{10}(X) = \frac{1.5x_6 + 1.9}{x_4} - 1 \le 0, \\
&g_{11}(X) = \frac{1.1x_7 + 1.9}{x_5} - 1 \le 0, \\
&\text{Variable Range:} \quad 2.6 \le x_1 \le 3.6, \\
&0.7 \le x_2 \le 0.8, \\
&x_3 \in \{17, 18, 19, \ldots, 28\}, \\
&7.3 \le x_4, \\
&x_5 \le 8.3, \\
&2.9 \le x_6 \le 3.9, \\
&5 \le x_7 \le 5.5.
\end{aligned}
\tag{C.1}
$$

Where: x_1 : Face width (b),

x_2 : Module of teeth (m),

x_3 : Number of teeth in the pinion (z),

x_4 : Length of the first shaft between bearings (l_1),

x_5 : Length of the second shaft between bearings (l_2),

x_6 : Diameter of the first shaft (d_1),

x_7 : Diameter of the second shaft (d_2).

C.2. F2: design of tension/compression spring

$$
\begin{aligned}
&\text{Minimize:} \quad f(X) = (x_3 + 2)x_2x_1^2, \\
&\text{subject to:}
\end{aligned}
$$

$$g_1(X) = 1 - \frac{x_3 x_2^3}{71785 x_1^4} \le 0,$$

$$g_2(X) = \frac{4x_2^2 - x_1 x_2}{12566(x_3 x_1^3 - x_1^4)} + \frac{1}{5108 x_1^2} - 1 \le 0,$$

$$g_3(X) = 1 - \frac{140.45 x_1}{x_2^2 x_3} \le 0,$$

$$g_4(X) = \frac{x_1 + x_2}{1.5} - 1 \le 0, \tag{C.2}$$

variable range:

$0.05 \le x_1 \le 2,$

$0.25 \le x_2 \le 1.3,$

$2 \le x_3 \le 15,$

where:

x_1 is the mean coil diameter (D),

x_2 is the wire diameter (d),

x_3 is the number of active coils (N).

C.3. F3: design of pressure vessel

Minimize: $f(X) = 0.6224 x_1 x_3 x_4 + 1.7781 x_2 x_3^2 + 3.1661 x_1^2 x_4 + 19.84 x_1 x_3^2,$

subject to:

$g_1(X) = -x_1 + 0.0193 x_3 \le 0,$

$g_2(X) = -x_2 + 0.00954 x_3 \le 0,$

$g_3(X) = -\pi x_3^2 x_4 - \frac{4}{3}\pi x_3^3 + 1,296,000 \le 0,$

$g_4(X) = x_4 - 240 \le 0,$

variable range:

$x_1, x_2 \in \{1 \times 0.0625, 2 \times 0.0625, 3 \times 0.0625, \ldots, 1600 \times 0.0625\},$ (C.3)

$10 \le x_3,$

$x_4 \le 200,$

where:

x_1 is the thickness of the shell (T_s),

x_2 is the thickness of the head (T_h),

x_3 is the inner radius (R),

x_4 is the length of the cylindrical section of the vessel (L).

C.4. F4: three-bar truss design problem

Minimize: $f(X) = (2\sqrt{2}\, x_1 + x_2) \cdot l,$

Subject to:

$$g_1(X) = \frac{\sqrt{2}\, x_1 + x_2}{\sqrt{2}\, x_1^2 + 2 x_1 x_2} P - \sigma \le 0,$$

$$g_2(X) = \frac{x_2}{\sqrt{2}\, x_1^2 + 2 x_1 x_2} P - \sigma \le 0,$$

$$g_3(X) = \frac{1}{\sqrt{2}\, x_2 + x_1} P - \sigma \le 0,$$

Variable range: $0 \le x_1, \quad x_2 \le 1.$ (C.4)

where:

x_1 : Cross-sectional area of the first bar (A_1),

x_2 : Cross-sectional area of the second bar (A_2),

l : Length of the bars (100 cm),

P : Load applied per unit area (2 kN/cm^3),

σ : Allowable stress (2 kN/cm^3)

C.5. F5: design of gear train

$$\text{Minimize:} \quad f(X) = \left(\frac{1}{6.931} - \frac{x_3 x_2}{x_1 x_4}\right)^2,$$

Subject to: (No explicit constraints are provided for this problem.)

Variable range: $x_1, x_2, x_3, x_4 \in \{12, 13, 14, \ldots, 60\}$,

Where: (C.5)

x_1 : Number of teeth of gear n_A,

x_2 : Number of teeth of gear n_B,

x_3 : Number of teeth of gear n_C,

x_4 : Number of teeth of gear n_D.

C.6. F6: cantilever beam problem

$$\text{Minimize:} \quad f(X) = 0.0624(x_1 + x_2 + x_3 + x_4 + x_5),$$
$$\text{subject to:} \quad g(X) = \frac{61}{x_1^3} + \frac{37}{x_2^3} + \frac{19}{x_3^3} + \frac{7}{x_4^3} + \frac{1}{x_5^3} - 1 \le 0, \tag{C.6}$$
$$\text{variable range:} \quad 0.01 \le x_i \le 100, \quad i = 1, \ldots, 5.$$

C.7. F7: optimal design of I-shaped beam

Minimize:

$$f(X) = \frac{5000}{x_3(x_2 - 2x_4)^3/12 + (x_1 x_4^3/6) + 2bx_4(x_2 - x_4/2)^2},$$

Subject to:

$$g_1(X) = 2x_1 x_3 + x_3(x_2 - 2x_4) \le 300,$$
$$g_2(X) = \frac{18x_2 \times 10^4}{x_3(x_2 - 2x_4)^3 + 2x_1 x_3(4x_2 + 3x_2(x_2 - 2x_4))} + \frac{15x_1 \times 10^3}{(x_2 - 2x_4)x_3^2 + 2x_3 x_1} \le 56,$$

Variable range: (C.7)

$$10 \le x_1 \le 50, \quad 10 \le x_2 \le 80, \quad 0.9 \le x_3 \le 5, \quad 0.9 \le x_4 \le 5,$$

where:

x_1: Width of the flange (b),

x_2: Height of the section (h),

x_3: Thickness of the web (t_w),

x_4: Thickness of the flange (t_f).

C.8. F8: tubular column design

Minimize:

$$
\begin{aligned}
&f(X) = 9.8x_1x_2 + 2x_1,\\
&\text{subject to:}\\
&g_1(X) = \frac{P}{\pi x_1 x_2 \sigma_y} - 1 \le 0,\\
&g_2(X) = \frac{8PL^2}{\pi^3 E x_1 x_2 (x_1^2 + x_2^2)} - 1 \le 0,\\
&g_3(X) = \frac{2.0}{x_1} - 1 \le 0,\\
&g_4(X) = \frac{x_1}{14} - 1 \le 0,\\
&g_5(X) = \frac{0.2}{x_2} - 1 \le 0,\\
&g_6(X) = \frac{x_2}{8} - 1 \le 0,\\
&\text{variable range:}\\
&2 \le x_1 \le 14,\\
&0.2 \le x_2 \le 0.8,\\
&\text{where:}\\
&x_1 : \text{Mean diameter of the column } (d),\\
&x_2 : \text{Thickness of the tube } (t).
\end{aligned}
\tag{C.8}
$$

C.9. F9: piston lever

$$
\begin{aligned}
\text{Minimize:}\quad & f(X) = \frac{1}{4}\pi x_3^2 (L_2 - L_1),\\
\text{Subject to:}\quad & g_1(X) = QL\cos\theta - R \times F \le 0,\\
& g_2(X) = Q(L - x_4) - M_{\max} \le 0,\\
& g_3(X) = 1.2(L_2 - L_1) - L_1 \le 0,\\
& g_4(X) = \frac{x_3}{2} - x_2 \le 0,\\
\text{Where:}\quad & R = \left| \frac{-x_4(x_4\sin\theta + x_1) + x_1(x_2 - x_4\cos\theta)}{\sqrt{(x_4 - x_2)^2 + x_1^2}} \right|,\\
& F = \frac{\pi P x_3^2}{4},\\
& L_1 = \sqrt{(x_4 - x_2)^2 + x_1^2},\\
& L_2 = \sqrt{(x_4\sin\theta + x_1)^2 + (x_2 - x_4\cos\theta)^2}.\\
& \theta = 45^\circ,\\
& Q = 10{,}000 \text{ lbs},\\
\text{Constants:}\quad & L = 240 \text{ in},\\
& M_{\max} = 1.8 \times 10^6 \text{ lbs in},\\
& P = 1500 \text{ psi}.\\
\text{Variable range:}\quad & 0.05 \le x_1, x_2, x_4 \le 500,\\
& 0.05 \le x_3 \le 120.
\end{aligned}
\tag{C.9}
$$

x_1 : Horizontal location of the piston component (H),

x_2 : Vertical location of the piston component (B),

Where:

x_3 : Diameter of the piston rod (D),

x_4 : Horizontal displacement of the piston end (X).

C.10. F10: corrugated bulkhead design

$$\text{Minimize:} \quad f(X) = \frac{5.885x_4(x_1 + x_3)}{x_1 + \sqrt{x_3^2 - x_2^2}},$$

subject to:

$$\begin{aligned}
&g_1(X) = -x_4x_2\left(0.4x_1 + \frac{x_3}{6}\right) + 8.94\left(x_1 + \sqrt{x_3^2 - x_2^2}\right) \le 0,\\
&g_2(X) = -x_4x_2\left(0.2x_1 + \frac{x_3}{12}\right) + 2.2\left(8.94\left(x_1 + \sqrt{x_3^2 - x_2^2}\right)\right)^{4/3} \le 0,\\
&g_3(X) = -x_4 + 0.0156x_1 + 0.15 \le 0,\\
&g_4(X) = -x_4 + 0.0156x_3 + 0.15 \le 0,\\
&g_5(X) = -x_4 + 1.05 \le 0,\\
&g_6(X) = -x_3 + x_2 \le 0,
\end{aligned} \tag{C.10}$$

variable range: $0 \le x_1, x_2, x_3 \le 100, \quad 0 \le x_4 \le 5,$

where:

x_1 is the width,

x_2 is the depth,

x_3 is the length,

x_4 is the plate thickness.

C.11. F11: car side impact design

$$\text{Minimize:} \quad f(X) = 1.98 + 4.90x_1 + 6.67x_2 + 6.98x_3 + 4.01x_4 + 1.78x_5 + 2.73x_7,$$

subject to:

$$\begin{aligned}
&g_1(X) = 1.16 - 0.3717x_2x_4 - 0.00931x_3x_{10} - 0.484x_5x_9 + 0.01343x_6x_{10} - 1 \le 0,\\
&g_2(X) = 46.36 - 9.9x_2 - 12.9x_1x_2 + 0.1107x_3x_{10} - 32 \le 0,\\
&g_3(X) = 33.86 + 2.95x_3 + 0.1792x_3 - 5.057x_1x_2 - 11.0x_2x_8 - 0.0215x_5x_{10}\\
&\quad -9.98x_9x_6 + 22.0x_3x_9 - 32 \le 0,\\
&g_4(X) = 28.98 + 3.818x_3 - 4.2x_1x_2 + 0.0207x_3x_{10} + 6.63x_9x_8 - 7.77x_3x_9\\
&\quad +0.32x_6x_9 - 32 \le 0,\\
&g_5(X) = 0.261 - 0.0159x_1 - 0.188x_2 - 0.019x_2x_7 + 0.0144x_3x_5 + 0.000875x_6x_9\\
&\quad +0.00139x_8x_{11} + 0.0000157x_{10}x_{11} - 0.32 \le 0,\\
&g_6(X) = 0.214 + 0.00817x_5 - 0.131x_1x_8 - 0.0704x_1x_9 + 0.03099x_2x_6 - 0.018x_2x_7\\
&\quad +0.0208x_3x_9 + 0.121x_3x_6 - 0.00364x_5x_6 + 0.0007715x_5x_9\\
&\quad -0.000535x_4x_6x_9 + 0.00121x_3x_{11} + 0.00184x_6x_{11} - 0.022x_2 - 0.32 \le 0,\\
&g_7(X) = 0.74 - 0.61x_2 - 0.163x_3x_8 + 0.00123x_3x_{10} - 0.166x_7 + 0.227x_2^2 - 0.32 \le 0,\\
&g_8(X) = 4.72 - 0.5x_4 - 0.19x_2x_3 - 0.0122x_4x_{10} + 0.009325x_6x_{10} + 0.000191x_{11}^2 - 4 \le 0,\\
&g_9(X) = 10.58 - 0.674x_1x_2 - 1.95x_2x_8 + 0.02054x_3x_{10} - 0.0198x_4x_{10} + 0.028x_9 - 9.9 \le 0,\\
&g_{10}(X) = 16.45 - 0.489x_3x_7 - 0.843x_5x_6 + 0.0432x_9x_{10} - 0.0556x_9x_{11} - 0.000786x_{11} - 15.7 \le 0,
\end{aligned} \tag{C.11}$$

variable range:

$0.5 \le x_1, x_2, x_3, x_4, x_5, x_6, x_7 \le 1.5,$

$x_8, x_9 \in \{0.192, 0.345\},$

$-30 \le x_{10},$

$x_{11} \le 30,$

where:

x_1 : Thickness of B-pillar inner,

x_2 : Thickness of B-pillar reinforcement,

x_3 : Thickness of floor side inner,

x_4 : Thickness of cross members,

x_5 : Thickness of door beam,

x_6 : Thickness of door beltline reinforcement,

x_7 : Thickness of roof rail,

x_8 : Material of B-pillar inner,

x_9 : Material of floor side inner,

x_{10} : Barrier height,

x_{11} : Hitting position.

C.12. F12: design of welded beam

Minimize: $f(X) = 1.10471x_1^2x_2 + 0.04811x_3x_4(14.0 + x_2),$

Subject to:

$$
\begin{aligned}
&g_1(X) = \tau(x) - \tau_{\max} \le 0,\\
&g_2(X) = \sigma(x) - \sigma_{\max} \le 0,\\
&g_3(X) = \delta(x) - \delta_{\max} \le 0,\\
&g_4(X) = x_1 - x_4 \le 0,\\
&g_5(X) = P - P_c(x) \le 0,\\
&g_6(X) = 0.125 - x_1 \le 0,\\
&g_7(X) = 1.10471x_1^2x_2 + 0.04811x_3x_4(14.0 + x_2) - 5.0 \le 0,
\end{aligned}
$$

where:

$$
\begin{aligned}
&\tau(x) = \sqrt{(\tau')^2 + 2\tau'\tau''\frac{x_2}{R} + (\tau'')^2}, \quad \tau' = \frac{P}{\sqrt{2}x_1x_2}, \quad \tau'' = \frac{MR}{J},\\
&M = P\left(L + \frac{x_2}{2}\right), \quad R = \sqrt{\frac{x_2^2}{4} + \left(\frac{x_1 + x_3}{2}\right)^2},\\
&J = 2\left[x_1x_2\sqrt{\frac{x_2^2}{4} + \left(\frac{x_1 + x_3}{2}\right)^2}\right],\\
&\sigma(x) = \frac{6PL}{x_4x_3^2}, \quad \delta(x) = \frac{6PL^3}{Ex_3x_4^3},\\
&P_c(x) = \frac{4.013E\sqrt{x_3^2x_4^6/36}}{L^2}\left(1 - \frac{x_3}{2L}\sqrt{\frac{E}{4G}}\right),
\end{aligned}
\tag{C.12}
$$

$$P = 6000\,\text{lb}, \quad L = 14\,\text{in}, \quad \delta_{\max} = 0.25\,\text{in},$$

Constants: $E = 30 \times 10^6\,\text{psi}, \quad G = 12 \times 10^6\,\text{psi},$

$$\tau_{\max} = 13,600\,\text{psi}, \quad \sigma_{\max} = 30,000\,\text{psi}.$$

Variable ranges: $0.1 \le x_1, \quad x_4 \le 2,$

$$0.1 \le x_2, \quad x_3 \le 10.$$

C.13. F13: a reinforced concrete beam design

Minimize: $f(X) = 2.9x_1 + 0.6x_2x_3,$

Subject to:

$$g_1(X) = \frac{x_2}{x_3} - 4 \le 0,$$

$$g_2(X) = 180 + 7.375\frac{x_1^2 x_2}{x_3} - x_1x_2 \le 0,$$

Variable Range:

$$x_1 \in \{6, 6.16, 6.32, 6.6, 7, 7.11, 7.2, 7.8, 7.9, 8, 8.4\}, \tag{C.13}$$

$$x_2 \in \{28, 29, 30, \ldots, 40\},$$

$$5 \le x_3 \le 10.$$

Where:

x_1 : Area of the reinforcement (A_s),

x_2 : Width of the beam (b),

x_3 : Depth of the beam (h).

Appendix D. Diversity evaluation methodology

To evaluate the population diversity during optimization, we introduce a numerical method that computes diversity based on two metrics: the standard deviation (SD) and the span. Both metrics are calculated across all individuals in the population, overall dimensions, and multiple independent runs. This analysis helps characterize the algorithm's ability to maintain population variability throughout the optimization process and avoid premature convergence.

Let the number of individuals in the population be denoted by NP, the number of dimensions by D (set to 10 or 20), and the number of independent runs by $R = 30$. The position of the i-th individual in the r-th run at iteration t in dimension d is denoted by $x^t_{i,r,d}$.

Span Metric: The span measures the range of values for each dimension at every iteration. The span per run and dimension at iteration t is computed as:

$$\text{Span}^t_{r,d} = \max_{i=1,\ldots,NP}(x^t_{i,r,d}) - \min_{i=1,\ldots,NP}(x^t_{i,r,d}) \tag{D.1}$$

The median span across all dimensions per run is:

$$\text{Span}^t_{r,Med} = \text{median}\left(\left\{\text{Span}^t_{r,d}\right\}_{d=1}^{D}\right) \tag{D.2}$$

The median span across all runs is:

$$\text{Span}^t_{Med} = \text{median}\left(\left\{\text{Span}^t_{r,Med}\right\}_{r=1}^{R}\right) \tag{D.3}$$

Standard Deviation (SD) Metric: The standard deviation per dimension is calculated using the following steps. First, the mean value for each dimension is:

$$\bar{x}^t_{r,d} = \frac{1}{NP}\sum_{i=1}^{NP} x^t_{i,r,d} \tag{D.4}$$

The SD for each dimension is then:

$$\text{SD}^t_{r,d} = \sqrt{\frac{1}{NP-1}\sum_{i=1}^{NP}\left(x^t_{i,r,d} - \bar{x}^t_{r,d}\right)^2} \tag{D.5}$$

The median SD per run across all dimensions is:

$$\mathrm{SD}^{t}_{r,Med} = \mathrm{median}\left(\left\{\mathrm{SD}^{t}_{r,d}\right\}_{d=1}^{D}\right) \tag{D.6}$$

The final diversity metric is the median SD across all runs:

$$\mathrm{SD}^{t}_{\mathrm{Med}} = \mathrm{median}\left(\left\{\mathrm{SD}^{t}_{r,Med}\right\}_{r=1}^{R}\right) \tag{D.7}$$

Both the span and SD values are approximated using their median values across dimensions and runs for robustness and consistency. Since all benchmark functions operate within a uniform domain of $[-100, 100]^{D}$, the maximum possible span is 200. Diversity profiles, presented as plots of span and SD against iteration number, provide insight into how well the population maintains variability throughout the optimization process.

Appendix E. CEC2020-2022 benchmark results tables

This appendix presents detailed benchmarking results for CEC2020-2022 functions, including statistical metrics (best, worst, mean, median, SD, and success rate) across 10D and 20D dimensions for all compared algorithms.

Table E.4
The best, worst, mean, median, SD, success rate results for the error and function evaluation metrics for 19 algorithms, functions (F1-F22), (CEC2020-2022, 10D).

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	1.4974E+04	1.7788E+06	3.6617E+05	5.0509E+05	4.3654E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.7740E+04	8.5590E+04	4.0605E+04	4.2637E+04	9.3019E+03	100.00
	SA	1.4496E+06	8.0358E+06	4.0704E+06	4.2385E+06	1.8020E+06	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.4168E+06	2.0380E+09	3.0350E+08	5.8239E+08	6.1165E+08	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.2673E+01	2.6460E+03	3.1767E+02	6.2372E+02	6.7841E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	3.3673E+02	4.8782E+08	1.1451E+04	4.2925E+07	1.2103E+08	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.8636E+07	2.1438E+09	3.9423E+08	5.3372E+08	5.4531E+08	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	3.7122E+02	4.1987E+03	1.0402E+03	1.4392E+03	1.0128E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	8.5458E+09	3.8408E+10	2.0401E+10	2.2467E+10	7.5480E+09	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F1	FA	8.7940E-01	5.8425E+03	1.4874E+03	2.0079E+03	1.9840E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.9762E+01	5.8495E+03	7.7727E+02	1.6923E+03	1.7864E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	1.5474E+00	1.6049E+09	5.5320E+03	1.9685E+08	4.9533E+08	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	3.0989E+03	2.0097E+05	9.2476E+03	1.7982E+04	3.5531E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	1.1640E+07	8.4877E+08	1.0479E+08	1.8747E+08	2.0781E+08	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.6829E+03	8.4241E+09	4.3266E+09	4.0683E+09	1.9841E+09	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7412E+05	1.7668E+05	1.7562E+05	1.7567E+05	6.1766E+02	100.00
	IMODEv2	0.0000E+00	5.8790E-08	0.0000E+00	6.8879E-09	1.6336E-08	1.9508E+05	2.0000E+05	1.9769E+05	1.9783E+05	1.4249E+03	80.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.8318E+04	7.3027E+04	7.0416E+04	7.0464E+04	1.1912E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8.8682E+04	1.0836E+05	9.9718E+04	9.9612E+04	3.9767E+03	100.00
	GA	1.9127E+01	8.2353E+02	3.5663E+02	3.8877E+02	2.0957E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	1.0370E+01	4.6920E+02	2.4575E+02	2.2807E+02	1.4237E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	3.3255E+01	3.5270E+02	1.6893E+02	1.6639E+02	9.1001E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	2.4555E+02	1.4602E+03	1.0420E+03	1.0210E+03	3.2130E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	1.1458E+03	1.6475E+03	1.4025E+03	1.4261E+03	1.1288E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	4.4864E-01	7.9786E+02	4.2419E+02	4.0355E+02	2.3216E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.3988E+02	1.3532E+03	7.1520E+02	7.1547E+02	3.0108E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.6143E+02	1.0788E+03	6.9801E+02	6.8704E+02	2.1666E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	1.6612E+03	2.9002E+03	2.3956E+03	2.3881E+03	2.4614E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F2	FA	3.7194E+00	9.9497E+02	3.6187E+02	3.5041E+02	2.9683E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	7.0173E+00	4.2955E+02	1.3191E+02	1.5391E+02	1.4533E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	3.3181E+02	1.5108E+03	9.2324E+02	8.9678E+02	3.2405E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	3.5198E+02	1.3356E+03	9.9276E+02	9.5997E+02	2.5538E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	5.5573E+02	2.0119E+03	1.1700E+03	1.1842E+03	2.8902E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.2936E+03	2.1447E+03	1.8079E+03	1.7842E+03	1.9028E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.4982E-01	1.4033E+02	2.0205E+01	2.6277E+01	2.5805E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	6.9548E+00	1.2875E+02	3.4324E+01	4.6578E+01	3.6836E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	3.4774E+00	2.2485E+02	1.6858E+01	3.9519E+01	5.3608E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	3.4774E+00	1.2527E+02	1.5064E+01	2.6783E+01	3.4760E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	1.5019E+01	5.2344E+01	3.1609E+01	3.2048E+01	8.5395E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	1.7600E+01	2.4306E+01	2.0917E+01	2.0867E+01	1.8442E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	1.9857E+01	4.0166E+01	3.2383E+01	3.1247E+01	4.8798E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	2.2594E+01	9.7814E+01	4.2976E+01	4.8523E+01	2.0152E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.7640E+01	4.7019E+01	4.1408E+01	4.0345E+01	4.7952E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.3128E+01	4.7748E+01	2.8058E+01	2.7709E+01	8.6992E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	2.6132E+01	6.5052E+01	4.2418E+01	4.2459E+01	1.0341E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.1132E+01	5.0745E+01	3.1557E+01	3.3399E+01	6.9032E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	2.3649E+02	6.6616E+02	4.2734E+02	4.2785E+02	1.1571E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F3	FA	1.2440E+01	2.6835E+01	1.6983E+01	1.7337E+01	3.4682E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.2753E+01	2.5957E+01	1.8200E+01	1.8851E+01	3.7036E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	1.7003E+01	7.9331E+01	3.8552E+01	4.1954E+01	1.4497E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	3.2096E+01	1.2272E+02	7.0940E+01	7.4663E+01	2.7232E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	5.5817E+01	1.3748E+02	1.1057E+02	1.0536E+02	1.9159E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.2007E+01	3.2346E+01	1.4210E+01	1.5142E+01	3.8204E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.2108E+01	1.6519E+01	1.4584E+01	1.4600E+01	1.1074E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	1.1505E+01	1.8330E+01	1.5511E+01	1.5113E+01	1.6277E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.2161E+01	2.0183E+01	1.5806E+01	1.6088E+01	2.2556E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.2067E+01	2.1383E+01	1.4587E+01	1.4770E+01	1.9563E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00

Table E.4 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	1.1889E+00	1.3800E+01	5.5279E+00	6.1676E+00	3.6904E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	9.7477E-01	1.8765E+00	1.5087E+00	1.4914E+00	2.3284E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	1.5240E+00	3.1352E+00	2.3407E+00	2.3371E+00	3.4889E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	2.3776E+01	2.0323E+04	8.2961E+02	2.5839E+03	4.5963E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	1.1653E+00	2.5446E+00	1.8641E+00	1.8896E+00	3.4324E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	5.0434E-01	2.6835E+00	1.8009E+00	1.5908E+00	7.4071E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	7.2876E-01	3.0765E+01	2.1167E+00	4.8072E+00	6.8144E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.0748E+00	2.7907E+00	1.8769E+00	1.9325E+00	5.1183E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	2.8548E+04	1.9816E+07	3.4760E+06	4.7210E+06	5.2016E+06	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F4	FA	3.6599E-01	1.6405E+00	7.6493E-01	8.4064E-01	3.0215E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.2949E-01	2.8668E+00	1.0412E+00	1.0924E+00	6.7855E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	7.7343E-01	3.6148E+02	1.9272E+00	1.6044E+01	6.5697E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.9530E+00	8.7529E+00	4.6540E+00	4.8195E+00	1.6276E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	5.1335E+00	6.0208E+02	1.7543E+01	4.9141E+01	1.1773E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	2.2408E+02	4.6770E+03	1.1301E+03	1.4534E+03	1.1522E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	1.3999E-01	2.0045E-02	3.1208E-02	3.2956E-02	1.8153E+05	2.0000E+05	2.0000E+05	1.9895E+05	3.8034E+03	10.00
	IMODEv2	1.7011E-01	8.3480E-01	4.5176E-01	4.7572E-01	1.4447E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	3.9464E-02	7.2032E-01	3.9019E-01	4.0394E-01	1.6563E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.2855E-01	5.9180E-01	3.9064E-01	3.8916E-01	1.2306E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	1.6195E+04	3.8926E+06	5.6856E+05	1.1642E+06	1.1768E+06	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	5.0181E+01	2.1158E+00	6.4324E+00	1.1096E+01	1.7265E+05	2.0000E+05	2.0000E+05	1.9883E+05	5.1380E+03	6.67
	SA	2.7275E+02	1.8566E+04	3.2823E+03	5.1606E+03	5.0607E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.1785E+03	1.7951E+06	4.0500E+05	5.3711E+05	4.9870E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.3129E+04	2.3669E+05	9.3308E+04	9.8242E+04	5.1338E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	8.7721E+02	3.4512E+05	2.6693E+03	1.5254E+04	6.2362E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	5.5024E+02	5.6285E+05	7.5050E+03	6.0313E+04	1.3710E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.5348E+03	2.4116E+05	1.2676E+04	2.4397E+04	4.3797E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	8.8417E+05	1.2879E+08	9.3323E+06	2.0112E+07	2.9259E+07	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F5	FA	2.8253E+01	7.3105E+03	1.5968E+03	2.5023E+03	2.2652E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	2.5422E+02	1.9275E+03	5.2767E+02	7.1810E+02	4.9377E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	8.0830E+02	2.9387E+06	6.5705E+03	1.1804E+05	5.3402E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.2935E+03	3.6976E+05	2.6262E+04	7.6254E+04	1.0926E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	5.6645E+03	7.3598E+05	1.4105E+05	2.9631E+05	2.8668E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	3.1809E+04	1.6024E+06	1.2477E+05	2.4691E+05	3.2524E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.1895E-04	6.1779E+00	1.4113E+00	1.9057E+00	1.5099E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	2.4069E+00	3.1301E+01	1.3267E+01	1.3896E+01	6.3253E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	1.4112E+00	4.1629E-01	4.6569E-01	3.4456E-01	1.0329E+05	2.0000E+05	2.0000E+05	1.9390E+05	2.3256E+04	6.67
	DXMODEv2	4.1631E-01	1.2584E+01	1.5157E+00	2.4690E+00	2.8196E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	1.7603E+00	4.2228E+02	1.2258E+02	1.3262E+02	1.0718E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	7.7686E-02	1.5030E+02	6.5606E-01	1.1343E+01	3.4144E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	1.2076E+00	3.1210E+02	1.2265E+02	9.9271E+01	8.4382E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	3.2109E+00	6.3954E+02	3.1212E+02	3.1970E+02	1.8124E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	3.5312E+01	1.5261E+02	9.5158E+01	9.1182E+01	3.1313E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.5119E+01	4.1746E+02	1.5320E+02	1.7314E+02	9.9177E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.2949E+00	4.2394E+02	1.4651E+02	1.4230E+02	9.9974E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.8798E+00	2.5110E+02	1.2176E+02	1.3337E+02	5.8997E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	5.2728E+02	3.7166E+03	1.2564E+03	1.3729E+03	6.3254E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F6	FA	8.0615E-01	3.4419E+02	6.6891E+01	7.9175E+01	8.7621E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	7.2932E-01	2.4109E+02	6.1461E+01	6.9402E+01	7.2344E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	2.8237E+00	4.3420E+02	2.5975E+02	2.3228E+02	1.1099E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.5336E+01	3.4440E+02	1.7287E+02	2.0177E+02	8.9057E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	5.4263E+01	6.1259E+02	3.4992E+02	3.5525E+02	1.3995E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	9.2260E+01	6.0883E+02	3.9119E+02	4.0752E+02	1.2131E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.8344E-02	1.2107E+00	3.6776E-01	4.1242E-01	3.7127E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	2.2724E-01	1.2632E+00	5.5377E-01	6.1507E-01	2.6435E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.9627E-02	5.7848E-01	2.0495E-01	2.1411E-01	1.8892E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	2.2961E-02	5.1789E-01	1.5303E-01	2.0930E-01	1.3960E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	4.6341E+02	4.1988E+06	2.1551E+05	5.1481E+05	9.8725E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	5.8594E-04	1.7515E+01	3.1609E-01	8.9054E-01	3.1476E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	2.7657E+01	8.3916E+02	3.2494E+02	3.8422E+02	2.5726E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.2816E+02	1.0100E+06	1.6794E+04	1.3213E+05	2.6765E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	3.7636E+03	6.9115E+04	2.4432E+04	2.6905E+04	1.5003E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	4.8657E+02	1.2061E+04	5.2044E+03	5.6321E+03	4.2771E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	4.2406E+02	2.0155E+04	2.5022E+03	5.1872E+03	5.7935E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.1266E+02	1.9099E+04	2.8776E+03	3.6599E+03	3.8639E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	9.9083E+03	1.3495E+08	5.2464E+06	1.8402E+07	3.2967E+07	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F7	FA	8.3766E-02	6.7825E+02	5.8819E+01	1.1091E+02	1.6102E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.3326E-01	4.1893E+02	6.8146E+01	8.6621E+01	8.8173E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	2.3188E+02	3.0556E+04	6.4689E+03	8.2241E+03	8.1578E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.3769E+03	8.7658E+04	1.2031E+04	1.5549E+04	1.7015E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	4.0539E+03	1.0634E+06	3.9080E+04	1.5265E+05	2.7301E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	3.6593E+03	3.3500E+06	2.9965E+05	5.3895E+05	7.6065E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	5.6937E-03	8.0686E-01	4.5457E-02	2.0264E-01	2.3336E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	6.7712E-02	7.8941E-01	3.6048E-01	3.5695E-01	1.9948E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	7.1866E-06	6.4208E-01	7.5929E-03	1.2575E-01	1.8391E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.1530E-04	5.3785E-02	5.1814E-03	1.1269E-02	1.4419E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00

(*continued on next page*)

Table E.4 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	1.0437E+02	1.2402E+02	1.0871E+02	1.1022E+02	5.4318E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	1.0000E+02	1.0045E+02	1.0000E+02	1.0009E+02	1.4815E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	4.4456E+00	1.1394E+02	1.1247E+02	1.0565E+02	2.6128E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.0563E+02	2.1361E+03	1.3119E+02	2.1340E+02	3.6509E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	1.0733E+02	1.2253E+02	1.1251E+02	1.1345E+02	3.9158E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.0089E+02	1.3127E+02	1.0232E+02	1.0668E+02	7.6409E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	4.4099E+01	2.3258E+02	1.4458E+02	1.4629E+02	3.5718E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.0078E+02	1.1159E+02	1.0271E+02	1.0345E+02	2.5812E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	5.7537E+02	3.0943E+03	2.0540E+03	2.0729E+03	6.4220E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F8	FA	1.8030E+01	1.0211E+02	1.0077E+02	9.2947E+01	2.4466E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	2.1769E+01	1.0860E+02	1.0183E+02	9.9622E+01	1.4821E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	5.0321E+01	1.5372E+02	1.0413E+02	1.0938E+02	1.9726E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	3.9709E+01	7.1169E+02	1.1331E+02	1.3158E+02	1.1057E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	6.0240E+01	1.3648E+03	1.2616E+02	2.0162E+02	2.8202E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.1563E+01	2.2007E+03	1.0000E+02	4.4843E+02	6.9143E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	4.8230E+01	1.0000E+02	1.0000E+02	9.8274E+01	9.4518E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	5.8813E-11	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.5181E+01	1.0000E+02	1.0000E+02	8.0594E+01	2.8541E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	2.2070E+01	1.0029E+02	1.0000E+02	9.7412E+01	1.4230E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	1.0111E+02	4.0487E+02	3.5643E+02	3.5170E+02	4.9507E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	3.3511E+02	3.5074E+02	3.4319E+02	3.4385E+02	3.6245E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	1.0927E+02	3.4788E+02	3.1815E+02	2.8684E+02	9.0912E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.1818E+02	5.2140E+02	4.3292E+02	3.9768E+02	1.2833E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.9864E+02	3.6852E+02	3.5817E+02	3.5229E+02	1.7884E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.1835E+02	3.5935E+02	3.4004E+02	3.3258E+02	4.2761E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.4983E+02	4.1583E+02	3.7022E+02	3.5518E+02	6.0695E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.0004E+02	4.0543E+02	3.3967E+02	2.7146E+02	1.1156E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	5.0507E+02	1.0493E+03	6.2767E+02	6.5683E+02	1.1479E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F9	FA	1.0000E+02	3.6728E+02	3.4367E+02	2.9726E+02	1.0057E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.0000E+02	3.4699E+02	3.3749E+02	3.1483E+02	7.2902E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	3.4263E+02	3.8618E+02	3.6641E+02	3.6554E+02	1.0829E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.0060E+02	4.5427E+02	3.8079E+02	3.6491E+02	7.5662E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	1.6656E+02	5.3000E+02	4.2105E+02	4.1098E+02	7.3871E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	2.9519E+02	4.2983E+02	4.1492E+02	4.0955E+02	2.3408E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	1.0000E+02	1.0000E+02	9.3333E+01	2.5371E+01	1.9662E+05	2.0000E+05	2.0000E+05	1.9984E+05	6.6704E+02	6.67
	IMODEv2	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	5.0762E-07	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	8.3031E-14	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.0000E+02	3.3359E+02	1.0000E+02	1.4631E+02	9.4197E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	3.9862E+02	4.6164E+02	4.4753E+02	4.4113E+02	1.8713E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	3.9774E+02	4.4605E+02	4.4579E+02	4.2963E+02	2.2682E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	3.9939E+02	4.4627E+02	4.0089E+02	4.0568E+02	1.2972E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	4.0123E+02	6.9870E+02	4.6117E+02	4.7092E+02	6.1030E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	3.9774E+02	4.4598E+02	4.3874E+02	4.3309E+02	1.5436E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	3.9816E+02	4.4977E+02	4.3382E+02	4.3120E+02	1.5576E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	4.2924E+02	5.2649E+02	4.6098E+02	4.6234E+02	1.9580E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	3.9777E+02	4.4440E+02	3.9844E+02	4.0335E+02	1.2213E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	8.3299E+02	3.8705E+03	2.0392E+03	1.9937E+03	7.1495E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F10	FA	3.9774E+02	4.4597E+02	4.4342E+02	4.2612E+02	2.3080E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	3.9778E+02	4.7080E+02	4.4344E+02	4.2480E+02	2.5025E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	3.9819E+02	4.9671E+02	4.5013E+02	4.4154E+02	2.7400E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.0433E+02	4.5823E+02	4.4845E+02	4.2442E+02	6.4622E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	4.2191E+02	6.7452E+02	4.6512E+02	4.8132E+02	4.9846E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	4.4336E+02	8.7406E+02	5.9742E+02	6.0663E+02	1.0735E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	3.9774E+02	3.9958E+02	3.9774E+02	3.9836E+02	8.8322E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	3.9774E+02	3.9958E+02	3.9774E+02	3.9824E+02	8.2601E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	3.9774E+02	4.4333E+02	3.9774E+02	3.9957E+02	8.2943E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	3.9774E+02	4.4336E+02	3.9774E+02	3.9964E+02	8.2905E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	1.6058E+03	2.4511E+04	6.0546E+03	7.7889E+03	5.8584E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.6920E+04	6.0600E+04	5.5350E+04	5.5097E+04	3.0349E+03	100.00
	SA	1.0419E+01	5.4732E+01	3.6801E+01	3.5154E+01	1.1780E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	3.3163E+02	1.6488E+04	5.7289E+03	5.6886E+03	3.6414E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	3.5248E+03	1.9726E+04	1.0475E+04	1.1150E+04	3.9840E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	7.4988E-02	3.8458E+03	1.7998E+02	8.3361E+02	1.1831E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	9.8814E+01	7.1941E+03	1.5084E+03	2.1165E+03	1.8969E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.9567E+01	2.6796E+02	6.3774E+01	8.8510E+01	5.7503E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	1.2199E+04	1.0324E+08	4.2077E+04	3.7993E+06	1.8804E+07	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F11	FA	0.0000E+00	7.3310E-08	4.7023E-08	4.7219E-08	1.5475E-08	1.9970E+05	2.0000E+05	2.0000E+05	1.9999E+05	5.5685E+01	3.33
	TLBO	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.9950E+04	2.8650E+04	2.4030E+04	2.4024E+04	2.2442E+03	100.00
	MFO	0.0000E+00	2.7603E+04	3.7371E+03	7.2207E+03	7.4282E+03	3.2970E+04	2.0000E+05	2.0000E+05	1.5167E+05	7.5121E+04	30.00
	WOA	1.5195E+03	1.0373E+04	4.2115E+03	4.5557E+03	2.1727E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	4.2449E+03	1.8819E+04	7.9623E+03	8.1494E+03	2.7374E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.0823E+04	5.2395E+04	2.3861E+04	2.5722E+04	8.4093E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.2104E+05	1.2726E+05	1.2375E+05	1.2377E+05	1.4593E+03	100.00
	IMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7024E+05	1.7350E+05	1.7093E+05	1.7113E+05	8.3770E+02	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.6209E+04	4.8942E+04	3.9463E+04	4.0095E+04	2.7790E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8.5510E+04	1.1326E+05	1.0253E+05	1.0223E+05	6.4940E+03	100.00

Table E.4 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	1.9297E-01	9.1288E+01	5.3724E+00	2.0236E+01	3.1098E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	8.9161E+00	8.9161E+00	7.2834E+00	2.4788E+00	1.7445E+05	2.0000E+05	2.0000E+05	1.9915E+05	4.6648E+03	3.33
	SA	9.8680E-01	9.6607E+00	9.1712E+00	8.0246E+00	2.1876E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	4.4157E+00	2.6352E+02	9.7844E+01	1.0070E+02	6.6650E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.1082E+00	4.6601E+00	2.8803E+00	2.8151E+00	5.0319E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.6960E+00	6.2433E+01	1.0901E+01	1.8480E+01	1.7829E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.9233E+01	8.9605E+01	5.7263E+01	5.5798E+01	1.9539E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.8712E-04	8.9162E+00	1.6273E-01	1.2060E+00	2.1289E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	7.6396E+02	9.0917E+03	3.2437E+03	4.0354E+03	2.4937E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F12	FA	9.8722E-05	8.9161E+00	4.3632E+00	4.8903E+00	3.9073E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.2938E-03	7.0781E+01	1.2858E-01	6.9162E+00	1.7679E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	4.0654E+00	7.0781E+01	8.9161E+00	1.4568E+01	1.6245E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	4.0175E-02	8.8469E+01	7.4574E+00	1.8013E+01	2.7277E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	5.3846E-01	5.0830E+02	9.1270E+01	1.1761E+02	1.1533E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	7.5803E+01	3.9196E+02	2.2716E+02	2.4135E+02	9.0734E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6557E+05	1.6941E+05	1.6760E+05	1.6747E+05	8.7217E+02	100.00
	IMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7041E+05	1.7321E+05	1.7120E+05	1.7125E+05	6.7186E+02	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.6280E+04	8.6650E+04	7.7347E+04	7.6762E+04	5.4126E+03	100.00
	DXMODEv2	0.0000E+00	8.9161E+00	0.0000E+00	4.3009E-01	1.7601E+00	1.3162E+05	2.0000E+05	1.5775E+05	1.5972E+05	1.6705E+04	93.33
	GA	7.5555E-03	8.0135E-01	1.0499E-01	1.9598E-01	2.1790E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.4670E+04	1.6710E+04	1.5690E+04	1.5679E+04	4.5220E+02	100.00
	SA	6.6642E-01	1.9312E+00	1.3807E+00	1.3631E+00	3.1017E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	9.8332E+00	4.5330E+01	3.1336E+01	2.9647E+01	9.4455E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.8901E-03	1.0950E-02	6.3572E-03	6.4224E-03	1.9748E-03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	3.0229E-03	1.3506E+01	1.8479E-01	1.1211E+00	2.8383E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	5.2409E+00	2.3712E+01	1.2980E+01	1.3428E+01	4.8384E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.3991E+00	4.1599E+01	1.7058E+01	1.9895E+01	1.1552E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	5.4727E+01	9.7046E+01	7.8432E+01	7.7186E+01	1.2480E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F13	FA	9.2029E-05	1.5289E-04	1.3278E-04	1.2844E-04	1.6908E-05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	3.5528E-07	4.1358E+00	1.8602E-02	4.2661E-01	1.0482E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	0.0000E+00	1.5199E+01	1.3355E+00	2.9199E+00	3.5886E+00	2.4240E+04	2.0000E+05	2.0000E+05	1.7098E+05	6.5994E+04	16.67
	WOA	8.8554E+00	6.2954E+01	2.5002E+01	2.6859E+01	1.2913E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	2.4165E+01	6.9155E+01	3.9888E+01	4.1729E+01	1.1711E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	0.0000E+00	5.6583E+01	0.0000E+00	1.2685E+01	2.1643E+01	1.6337E+04	2.0000E+05	1.7810E+04	1.0232E+05	9.2938E+04	53.33
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.9149E+05	1.9412E+05	1.9271E+05	1.9273E+05	6.6779E+02	100.00
	IMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.8960E+05	1.9260E+05	1.9131E+05	1.9118E+05	8.0524E+02	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	9.2442E+04	9.8795E+04	9.5271E+04	9.5546E+04	1.5892E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8.5231E+04	9.7900E+04	9.0745E+04	9.1099E+04	2.6979E+03	100.00
	GA	4.9885E+00	4.0811E+01	2.6377E+01	2.2745E+01	1.0481E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	9.6003E+00	2.2052E+01	1.7429E+01	1.7264E+01	3.0817E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	4.0768E+00	1.4040E+01	9.1437E+00	9.1674E+00	2.6383E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.1940E+01	6.5667E+01	2.4875E+01	2.6700E+01	1.1922E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.2277E+01	3.6355E+01	3.0960E+01	2.9980E+01	3.5257E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	5.9782E+00	2.7882E+01	1.3103E+01	1.4015E+01	5.8619E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	7.6861E+00	4.0801E+01	2.3805E+01	2.4047E+01	8.3098E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	5.9703E+00	4.2775E+01	2.0167E+01	2.1563E+01	8.1807E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	7.6974E+01	1.5461E+02	1.1553E+02	1.1488E+02	1.7205E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F14	FA	3.9798E+00	3.6178E+01	1.1939E+01	1.2784E+01	6.4725E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	2.9849E+00	1.2962E+01	7.9597E+00	7.7958E+00	2.9695E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	5.9698E+00	5.2733E+01	2.9353E+01	3.1503E+01	1.2482E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.5986E+01	7.6616E+01	3.7313E+01	3.8652E+01	1.5371E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	1.0875E+01	6.1162E+01	3.0491E+01	3.1165E+01	1.0371E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.9899E+00	2.6578E+01	3.9798E+00	4.9653E+00	4.4780E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.9947E+00	7.9597E+00	5.4033E+00	5.5182E+00	1.3378E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	9.9496E-01	8.9565E+00	4.2567E+00	4.4603E+00	1.7854E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	1.3929E+01	3.4824E+00	4.0462E+00	2.6766E+00	1.1577E+05	2.0000E+05	2.0000E+05	1.9719E+05	1.5379E+04	3.33
	DXMODEv2	2.9849E+00	8.9546E+00	4.9748E+00	5.0411E+00	1.4295E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	1.6034E+01	1.0639E+03	1.3040E+02	2.2291E+02	2.3910E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1280E+04	1.8690E+04	1.2210E+04	1.2496E+04	1.3484E+03	100.00
	SA	6.6496E-01	3.0860E+00	1.9739E+00	1.8810E+00	5.9178E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	5.4427E+01	4.1984E+02	1.7952E+02	2.0480E+02	1.0664E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.4393E-03	1.9074E-01	5.5555E-02	6.6173E-02	5.1981E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.1636E-02	5.4339E+01	1.5396E+00	9.4574E+00	1.5859E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	2.2460E+00	2.7819E+02	2.8833E+01	4.7690E+01	6.1881E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.2261E+01	8.5822E+02	7.2210E+01	1.4957E+02	2.0707E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	6.4813E+02	2.6943E+03	1.4744E+03	1.5557E+03	4.2404E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F15	FA	0.0000E+00	2.0086E-08	1.2849E-08	1.2177E-08	5.4768E-09	1.9361E+05	2.0000E+05	2.0000E+05	1.9974E+05	1.1690E+03	13.33
	TLBO	0.0000E+00	1.3312E+01	6.3338E-01	1.7288E+00	2.6328E+00	2.0130E+04	2.0000E+05	2.0000E+05	1.9400E+05	3.2840E+04	3.33
	MFO	0.0000E+00	1.0936E+03	6.3172E+01	1.3901E+02	2.1783E+02	2.0160E+04	2.0000E+05	2.0000E+05	1.9401E+05	3.2834E+04	3.33
	WOA	2.7840E+01	2.0555E+03	4.0909E+02	4.7079E+02	4.0534E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	1.2806E+02	1.0886E+03	5.1666E+02	5.6177E+02	2.2832E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.3780E+03	8.7730E+03	8.0600E+03	8.0486E+03	3.2252E+02	100.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6589E+05	1.7062E+05	1.6824E+05	1.6811E+05	1.1227E+03	100.00
	IMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.5441E+05	1.6394E+05	1.5938E+05	1.5910E+05	2.2382E+03	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.8854E+04	7.0257E+04	6.5784E+04	6.5544E+04	2.7278E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.8021E+04	6.8802E+04	5.9370E+04	5.9831E+04	4.7219E+03	100.00

(*continued on next page*)

Table E.4 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	8.5036E+00	4.2044E+04	2.0754E+03	4.5533E+03	8.5565E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	3.1265E-01	6.4817E-01	5.0401E-01	4.9602E-01	7.1864E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	5.2812E+02	7.4677E+03	4.1567E+03	4.2190E+03	2.2210E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	3.1852E+01	6.1245E+03	8.7018E+02	1.5305E+03	1.6610E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	3.9653E+04	1.8268E+06	5.3001E+05	5.5292E+05	4.2690E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	7.7275E+01	6.3141E+03	6.2271E+03	4.3304E+03	2.5102E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	4.4742E+01	6.1565E+03	1.8328E+03	1.9585E+03	1.6089E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.8540E+01	2.8907E+03	8.9049E+01	2.0931E+02	5.1499E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	1.5673E+07	4.3086E+09	1.1049E+09	1.3391E+09	8.7835E+08	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F16	FA	3.2507E+01	6.0903E+03	2.7964E+03	2.7426E+03	2.1556E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	7.5742E+01	5.1168E+03	1.1190E+03	1.6900E+03	1.6655E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	1.3965E+01	6.3521E+03	2.1845E+03	2.9229E+03	2.4614E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.0405E+02	6.2160E+03	1.2015E+03	1.8588E+03	2.0237E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	3.5466E+02	1.9869E+05	7.7116E+03	2.7221E+04	5.0211E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	4.8261E+05	1.5787E+08	8.6884E+06	3.2542E+07	4.5274E+07	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.3479E-02	5.0000E-01	4.1501E-01	3.2275E-01	1.8576E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	1.0832E-02	2.1191E+00	5.2593E-01	6.7781E-01	5.4498E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.6443E-03	4.2460E-01	6.5557E-02	1.2437E-01	1.3197E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	8.4933E-03	4.4988E-01	1.0431E-01	1.2215E-01	1.0500E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	6.8932E-01	2.4137E+01	2.0287E+01	1.6517E+01	7.7023E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	9.9496E-01	0.0000E+00	8.7134E-02	2.7175E-01	3.3510E+04	2.0000E+05	5.4150E+04	6.8465E+04	4.5587E+04	90.00
	SA	4.4616E+00	2.5925E+01	2.2139E+01	1.6421E+01	8.2824E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	3.5247E+01	1.2774E+02	6.0281E+01	6.6616E+01	2.2623E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.2356E+01	2.7076E+01	2.4423E+01	2.4427E+01	9.2803E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	8.9882E+00	5.8040E+01	2.9523E+01	3.0913E+01	1.1462E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.8994E+01	6.2988E+01	3.6316E+01	3.7870E+01	1.1467E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.3422E+01	8.6050E+01	4.0371E+01	4.4155E+01	1.7524E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	7.8641E+01	2.6921E+02	1.4567E+02	1.5717E+02	5.3533E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F17	FA	6.2473E-01	2.4605E+01	2.0668E+01	1.4472E+01	1.0041E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	7.9619E-07	3.0287E+01	2.0600E+01	1.4359E+01	9.9299E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	2.0112E+01	1.0488E+02	2.4413E+01	3.6607E+01	2.1026E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	2.1648E+01	8.9254E+01	4.5150E+01	4.8383E+01	1.6664E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	3.1005E+01	1.4493E+02	8.4274E+01	8.3363E+01	3.0607E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	2.4006E+01	2.2626E+02	1.0360E+02	1.0596E+02	6.0912E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	2.1211E-02	8.0000E-08	7.1138E-04	3.8719E-03	1.9757E+05	2.0000E+05	2.0000E+05	1.9969E+05	6.4690E+02	36.67
	IMODEv2	5.0680E-05	5.1762E-02	1.5320E-03	6.8742E-03	1.2020E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3548E+05	1.5878E+05	1.4860E+05	1.4841E+05	5.3428E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7456E+05	1.9093E+05	1.8160E+05	1.8172E+05	4.5000E+03	100.00
	GA	1.8042E+01	2.2003E+01	2.0829E+01	2.0843E+01	7.4471E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	4.0614E-04	2.0068E+01	1.7590E-02	8.7862E-01	3.6382E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	3.0254E+00	2.4608E+01	2.3785E+01	2.1300E+01	6.4349E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.7137E+01	2.5552E+02	2.8423E+01	5.1100E+01	5.6267E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	2.3148E+01	2.9366E+01	2.5591E+01	2.5769E+01	1.4531E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	5.7922E+00	2.8169E+01	2.2816E+01	2.2887E+01	3.7505E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	7.6072E+00	3.0098E+01	2.3941E+01	2.3611E+01	4.9493E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.0746E+01	2.1659E+01	2.0746E+01	2.0279E+01	1.9501E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	2.0012E+01	5.7493E+03	3.8405E+02	6.9679E+02	1.0924E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F18	FA	6.4851E-02	2.2439E+01	2.0239E+01	1.5985E+01	8.5591E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	4.8162E-01	2.6979E+01	2.1081E+01	1.6359E+01	9.2740E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	2.0598E+01	3.4666E+01	2.2649E+01	2.4426E+01	3.9101E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	2.2272E+01	3.9869E+01	3.0206E+01	3.0059E+01	3.9719E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	2.7567E+01	6.6532E+01	3.6233E+01	3.8612E+01	9.6473E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	2.8641E+01	1.7718E+02	5.5523E+01	6.8344E+01	3.4985E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.0161E-02	9.8788E-01	2.7203E-01	3.8595E-01	3.0406E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	7.4011E-02	3.2133E+00	1.3205E+00	1.3396E+00	7.4109E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	8.5727E-05	6.9345E-01	2.9554E-02	8.3120E-02	1.6569E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	7.6648E-03	8.7973E-01	8.6734E-02	1.6198E-01	2.2414E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	2.3515E+02	3.7640E+02	2.4709E+02	2.5205E+02	2.5713E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	2.2942E+02	2.2980E+02	2.2956E+02	2.2958E+02	1.0089E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	2.7444E+02	4.0231E+02	3.3080E+02	3.3128E+02	2.9702E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	1.9043E+02	2.0804E+02	1.9879E+02	1.9851E+02	4.2414E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	2.2928E+02	3.4220E+02	2.5368E+02	2.6046E+02	3.0136E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	2.4947E+02	3.6407E+02	2.8231E+02	2.9585E+02	3.2708E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	2.2928E+02	2.7039E+02	2.2929E+02	2.3714E+02	1.3740E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	5.1144E+02	1.0753E+03	6.7946E+02	7.1378E+02	1.4333E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F19	FA	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	4.0955E-10	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	3.6801E-13	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	2.2928E+02	3.2707E+02	2.2956E+02	2.4123E+02	2.9664E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	2.2929E+02	3.7622E+02	2.2940E+02	2.3644E+02	2.7662E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	2.3213E+02	4.3528E+02	3.8566E+02	3.7458E+02	4.5963E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	2.3138E+02	3.9916E+02	2.3722E+02	2.5545E+02	4.3479E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00

Table E.4 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	1.0049E+02	2.4011E+02	1.0090E+02	1.3898E+02	5.9444E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	1.0016E+02	2.0416E+02	1.0022E+02	1.0704E+02	2.5954E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	1.0033E+02	2.1843E+02	1.0043E+02	1.2730E+02	4.9571E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.0065E+02	1.0291E+03	2.2334E+02	2.4085E+02	1.8475E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	1.0103E+02	1.2232E+02	1.0774E+02	1.0866E+02	4.8523E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.0024E+02	2.1928E+02	2.0974E+02	1.6763E+02	5.5987E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.0053E+02	2.5986E+02	1.0539E+02	1.6336E+02	6.7412E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.0071E+02	7.0123E+02	1.0253E+02	1.7977E+02	1.4026E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	1.2496E+02	2.5803E+03	1.1939E+03	1.2317E+03	6.8980E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F20	FA	1.0017E+02	2.2107E+02	1.0024E+02	1.1184E+02	3.5445E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.0012E+02	2.3086E+02	1.0030E+02	1.3017E+02	5.0563E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	1.0049E+02	2.3870E+02	1.0118E+02	1.3447E+02	5.5927E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.0029E+02	6.4998E+02	1.0111E+02	1.7960E+02	1.1314E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	1.0077E+02	1.0486E+03	1.0217E+02	1.9001E+02	1.7705E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.2209E+02	1.8592E+03	4.1970E+02	7.6397E+02	6.5539E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.0017E+02	1.0030E+02	1.0022E+02	1.0022E+02	3.3925E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	1.0017E+02	1.0033E+02	1.0024E+02	1.0025E+02	3.5645E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.0015E+02	1.0031E+02	1.0023E+02	1.0023E+02	3.9320E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.0014E+02	1.0031E+02	1.0023E+02	1.0023E+02	3.7541E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GA	2.7601E+00	3.1928E+02	1.5112E+02	1.4945E+02	1.1667E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	3.0000E+02	0.0000E+00	4.5640E+01	8.1166E+01	1.4580E+04	2.0000E+05	1.5750E+04	6.4732E+04	8.2967E+04	73.33
	SA	1.3862E+01	3.6347E+01	2.3506E+01	2.4804E+01	5.7771E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	1.1842E+02	7.3910E+02	1.7593E+02	2.7582E+02	1.8475E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	6.2551E-02	9.8853E+00	4.2580E-01	1.0828E+00	1.9820E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.0745E-01	7.5775E+02	1.5005E+02	2.2697E+02	1.8806E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.5105E+02	8.1146E+02	1.7657E+02	2.5393E+02	1.7930E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.4042E-01	4.0009E+02	3.3836E-01	7.1165E+01	1.2895E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	7.8353E+02	4.1116E+03	2.5214E+03	2.5276E+03	9.4128E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F21	FA	1.0303E-03	4.0000E+02	1.7856E-03	3.8406E+01	8.8842E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	0.0000E+00	4.0000E+02	0.0000E+00	8.4273E+01	1.1489E+02	1.8450E+04	2.0000E+05	2.9460E+04	1.0474E+05	9.0678E+04	53.33
	MFO	0.0000E+00	6.6813E+02	1.6665E+02	2.0026E+02	1.5615E+02	2.7540E+04	2.0000E+05	2.0000E+05	1.8290E+05	5.2173E+04	10.00
	WOA	3.9222E-01	6.0355E+02	1.5111E+02	2.0617E+02	1.5304E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	6.1521E+01	6.7015E+02	1.5645E+02	2.4289E+02	1.7541E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	2.1852E+02	1.0186E+03	3.0000E+02	4.2362E+02	2.4771E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7859E+05	1.8097E+05	1.7984E+05	1.7985E+05	6.4423E+02	100.00
	IMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7524E+05	1.7919E+05	1.7737E+05	1.7752E+05	1.0005E+03	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.6934E+04	7.7951E+04	7.3415E+04	7.3285E+04	2.6485E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.0829E+04	7.2081E+04	6.5496E+04	6.5568E+04	2.4730E+03	100.00
	GA	1.6540E+02	1.9387E+02	1.7234E+02	1.7386E+02	7.7740E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DE	1.5939E+02	1.6371E+02	1.6260E+02	1.6239E+02	1.0959E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	SA	1.6082E+02	1.6369E+02	1.6266E+02	1.6246E+02	8.6119E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	PSO	2.0233E+02	4.3287E+02	2.9691E+02	3.0738E+02	6.5823E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	ABC	1.8271E+02	2.0000E+02	2.0000E+02	1.9843E+02	4.5338E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	GWO	1.5955E+02	1.9747E+02	1.6436E+02	1.6762E+02	9.4102E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSO	1.6408E+02	2.2868E+02	1.6741E+02	1.7483E+02	1.5749E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CSOA	1.5897E+02	1.6935E+02	1.6372E+02	1.6405E+02	1.8159E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BAS	2.7692E+02	1.0654E+03	4.9296E+02	5.2550E+02	1.6544E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F22	FA	1.5862E+02	1.6699E+02	1.6440E+02	1.6403E+02	1.8931E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	TLBO	1.5862E+02	1.7581E+02	1.6499E+02	1.6481E+02	2.7940E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MFO	1.6140E+02	1.7380E+02	1.6419E+02	1.6490E+02	2.6938E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	WOA	1.6141E+02	2.7166E+02	1.7005E+02	1.8120E+02	2.6757E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HHO	1.8448E+02	4.2698E+02	2.5024E+02	2.5766E+02	5.2416E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	CMAES	1.7143E+02	1.9212E+02	1.7626E+02	1.7752E+02	6.0018E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.5862E+02	1.6352E+02	1.6270E+02	1.6231E+02	1.2784E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODEv2	1.5937E+02	1.6352E+02	1.6270E+02	1.6259E+02	9.1867E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.5862E+02	1.6454E+02	1.5937E+02	1.6009E+02	1.5494E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.5862E+02	1.6440E+02	1.6270E+02	1.6148E+02	1.8637E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00

Table E.5
The best, worst, mean, median, SD, success rate results for the error and function evaluation metrics for 19 algorithms, functions (F1-F20), (CEC2020-2022, 20D).

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	1.2426E+04	2.6591E+05	5.3753E+04	7.4397E+04	6.4180E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.0380E+04	9.9510E+04	7.6425E+04	7.7975E+04	5.9869E+03	100.00
	SA	6.5182E+05	2.3992E+06	1.6167E+06	1.5951E+06	4.7568E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	2.1809E+09	1.5419E+10	6.5854E+09	7.5710E+09	3.5970E+09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	9.4640E+00	1.1106E+04	2.0601E+03	2.8874E+03	2.7787E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	1.9767E+02	3.0740E+09	4.6268E+08	6.9956E+08	8.5131E+08	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	1.2264E+09	1.1670E+10	4.8365E+09	5.1594E+09	2.3825E+09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	6.6525E+02	7.7335E+03	3.0940E+03	3.2307E+03	2.0461E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	3.8225E+10	8.6432E+10	6.3699E+10	6.4602E+10	1.1161E+10	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F1	FA	4.4123E+00	1.1691E+04	1.8836E+03	3.0924E+03	3.5731E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	8.1326E-01	3.0223E+03	2.9215E+02	5.5634E+02	7.5774E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	1.2092E+04	1.6428E+10	1.7118E+09	2.7251E+09	3.3182E+09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	6.0174E+03	3.3321E+04	1.3617E+04	1.4173E+04	5.2993E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	2.4371E+07	4.9665E+08	1.5918E+08	1.7041E+08	1.0456E+08	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	2.1323E+02	2.1728E+10	9.8212E+09	8.4589E+09	7.6954E+09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	4.1903E-06	1.3191E-04	2.2553E-05	3.0277E-05	2.6881E-05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	6.9885E-06	1.2450E-04	4.2732E-05	5.0656E-05	3.2644E-05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.4468E+05	2.5271E+05	2.4904E+05	2.4878E+05	2.2160E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.5826E+05	2.8953E+05	2.7601E+05	2.7605E+05	7.6086E+03	100.00
	GA	1.1192E+01	7.6484E+02	4.0814E+02	4.1054E+02	2.1424E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	2.6838E+01	1.5918E+03	1.1688E+03	1.0565E+03	4.1834E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	4.8356E+01	8.3909E+02	3.3886E+02	3.8547E+02	2.2554E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	1.3760E+03	3.1143E+03	2.3544E+03	2.2551E+03	5.0741E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	3.5122E+03	4.4878E+03	4.1658E+03	4.1567E+03	2.3736E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	5.1117E+02	2.1611E+03	1.3963E+03	1.3636E+03	3.9201E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	1.4467E+03	3.4008E+03	2.6463E+03	2.6506E+03	4.7128E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	1.2987E+03	2.4627E+03	2.0787E+03	1.9940E+03	3.1202E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	4.6840E+03	6.2094E+03	5.8057E+03	5.7104E+03	3.4316E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F2	FA	3.5576E+02	2.3035E+03	1.2768E+03	1.2564E+03	4.3842E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	4.8940E+02	2.0262E+03	9.2964E+02	9.8477E+02	3.0196E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	5.8718E+02	3.0032E+03	2.1382E+03	2.0504E+03	5.6477E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	1.3531E+03	3.4303E+03	2.5558E+03	2.4240E+03	5.2529E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.6729E+03	3.8250E+03	2.8877E+03	2.8599E+03	5.3056E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	3.9583E+03	5.1006E+03	4.6652E+03	4.6431E+03	2.6692E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.2736E+02	6.7102E+02	3.8421E+02	4.1519E+02	1.4758E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.2052E+02	7.9224E+02	4.6195E+02	4.5285E+02	1.6110E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.5614E-01	1.3475E+01	4.3313E+00	4.8189E+00	3.3809E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.5614E-01	2.5589E+01	6.4507E+00	6.6501E+00	5.0136E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	2.5129E+01	5.2493E+01	3.7674E+01	3.9198E+01	5.7818E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	4.6169E+01	6.5556E+01	5.8769E+01	5.8930E+01	5.2305E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	3.4996E+01	7.4456E+01	5.8414E+01	5.6258E+01	8.6220E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	8.4114E+01	2.2566E+02	1.4498E+02	1.5338E+02	3.3011E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	1.1020E+02	1.4429E+02	1.2951E+02	1.2895E+02	8.0044E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	4.2527E+01	9.6178E+01	6.6196E+01	6.8030E+01	1.3915E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	7.5290E+01	2.2245E+02	1.8346E+02	1.7760E+02	3.3728E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	6.6741E+01	2.1357E+02	1.0802E+02	1.1507E+02	3.0856E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	1.0719E+03	1.8417E+03	1.4114E+03	1.4594E+03	2.0708E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F3	FA	3.2303E+01	7.4941E+01	4.4072E+01	4.5661E+01	1.0390E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	5.2980E+01	1.3217E+02	7.9214E+01	8.0983E+01	1.7242E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	4.8076E+01	2.6684E+02	9.5346E+01	1.2323E+02	6.5378E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	1.4252E+02	3.3626E+02	2.0399E+02	2.1201E+02	4.3209E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	2.0008E+02	3.6010E+02	2.9135E+02	2.8546E+02	3.9099E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	1.3263E+01	4.3109E+01	3.1306E+01	3.2130E+01	5.8292E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	2.6516E+01	4.2771E+01	3.7445E+01	3.6616E+01	4.3631E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	2.6348E+01	3.9931E+01	3.3206E+01	3.3291E+01	3.6824E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	2.0387E+01	2.3150E+01	2.2163E+01	2.2034E+01	6.5911E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	2.1708E+01	2.8148E+01	2.3566E+01	2.3738E+01	1.4913E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	1.0271E+00	4.2028E+01	5.3050E+00	7.5279E+00	8.1102E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	4.1719E+00	6.9222E+00	5.7205E+00	5.7049E+00	6.6065E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	2.7671E+00	5.3034E+00	4.0831E+00	4.0945E+00	6.5655E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	4.6508E+02	6.9316E+04	6.6722E+03	1.3881E+04	1.5279E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	7.8007E+00	1.1807E+01	1.0272E+01	1.0003E+01	1.1339E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	1.7591E+00	1.3262E+03	8.1292E+00	6.1546E+01	2.4002E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	1.4284E+01	2.6176E+03	2.8982E+02	5.9502E+02	6.9867E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	1.8698E+00	7.8264E+00	3.7088E+00	3.8308E+00	1.2020E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	1.4739E+06	4.3505E+07	1.0227E+07	1.2433E+07	9.6398E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F4	FA	8.7802E-01	3.1403E+00	1.7940E+00	1.9511E+00	5.8292E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	2.8392E+00	4.9907E+01	1.2804E+01	1.4673E+01	9.1797E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	7.0343E+00	3.7385E+05	3.0239E+03	2.4214E+04	7.1382E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	5.7883E+00	9.0685E+01	2.3660E+01	2.9163E+01	1.7518E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	2.0719E+01	2.1017E+03	6.6776E+01	1.7745E+02	3.9969E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	3.6721E+03	1.4634E+05	3.2136E+04	4.9423E+04	3.8618E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.2312E+00	3.6983E+00	1.9358E+00	2.0514E+00	5.7513E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	8.6067E-01	3.0069E+00	1.5989E+00	1.7102E+00	4.6972E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	5.9425E-01	1.3109E+00	8.9715E-01	9.1225E-01	2.0528E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	5.7337E-01	1.2787E+00	9.7954E-01	9.3349E-01	1.8896E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

Table E.5 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	3.6842E+05	9.1174E+06	1.4630E+06	2.0008E+06	1.8026E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	1.1190E+03	2.6355E+04	2.1156E+03	3.8958E+03	4.7046E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	4.9847E+03	1.5093E+05	3.1260E+04	4.5571E+04	3.5033E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	2.2468E+05	6.2761E+06	1.5078E+06	1.7969E+06	1.4517E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	5.4337E+05	5.6922E+06	2.4481E+06	2.5917E+06	1.1415E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	3.5390E+04	2.3382E+06	2.4408E+05	5.3121E+05	6.5340E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	1.2731E+05	2.0006E+06	7.2975E+05	7.5101E+05	4.8194E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	3.9028E+04	3.5912E+05	1.1747E+05	1.3905E+05	8.6593E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	9.3991E+06	3.3799E+08	1.5765E+08	1.5858E+08	9.3061E+07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F5	FA	2.1078E+03	2.3953E+05	5.2909E+04	7.4722E+04	6.5999E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	1.0283E+03	7.3920E+04	2.2715E+04	2.5288E+04	1.9118E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	4.5879E+03	1.6116E+07	3.5692E+05	1.5403E+06	3.3947E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	2.8976E+04	2.1280E+06	3.6422E+05	5.5421E+05	5.2556E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.8768E+05	3.4197E+06	1.2303E+06	1.3911E+06	7.7396E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	1.2710E+06	3.8779E+07	1.0471E+07	1.2520E+07	8.9411E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.4604E+02	3.8711E+02	2.0979E+02	2.2875E+02	6.9601E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	4.1004E+02	1.4079E+03	7.9971E+02	8.3636E+02	2.7752E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	4.3500E+01	2.8749E+02	2.5356E+02	2.0759E+02	6.8430E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.2150E+01	4.6088E+02	1.6233E+02	2.0906E+02	1.1800E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	7.3447E-01	7.7369E+00	2.8436E+00	3.2691E+00	1.6755E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	8.0589E-01	7.4191E+01	1.6019E+01	2.2142E+01	1.9314E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	3.2896E+00	1.5637E+02	2.8785E+01	5.2812E+01	5.6180E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	4.7061E+02	1.6814E+03	9.8696E+02	9.5607E+02	3.0090E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	4.5301E+02	9.5763E+02	7.9077E+02	7.7105E+02	1.1356E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	3.2595E+01	6.7678E+02	2.6788E+02	3.1220E+02	1.6732E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	1.0891E+02	1.0671E+03	5.7504E+02	5.9564E+02	2.3789E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	1.2302E+02	8.2452E+02	4.0540E+02	4.0343E+02	1.9003E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	2.0437E+03	5.1105E+03	3.0469E+03	3.2298E+03	7.8191E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F6	FA	3.1100E+00	4.4023E+02	1.4291E+02	1.4911E+02	1.1696E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	1.9419E+00	4.7642E+02	1.4106E+02	1.7381E+02	1.1344E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	5.3418E+01	9.8132E+02	3.9563E+02	3.9918E+02	2.2049E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	7.2164E+01	1.1502E+03	5.0729E+02	5.3820E+02	2.4534E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	3.6168E+02	1.7284E+03	9.5047E+02	9.2383E+02	2.9609E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	9.1419E+02	1.6387E+03	1.2544E+03	1.2378E+03	2.0520E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.6273E+00	3.4986E+00	2.3206E+00	2.3721E+00	3.8336E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.4061E+00	3.3866E+00	2.4174E+00	2.4895E+00	4.1890E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0407E-01	1.2483E+00	4.4035E-01	4.7882E-01	2.6561E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.5954E-01	1.5575E+00	6.5023E-01	7.5642E-01	3.9478E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	7.1314E+04	3.7286E+06	1.1128E+06	1.3044E+06	1.0034E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	1.6428E+01	3.7639E+02	1.1537E+02	1.3208E+02	7.9062E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	2.2933E+03	3.3903E+04	1.4176E+04	1.5180E+04	9.1011E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	9.5587E+04	8.8349E+06	7.0209E+05	1.1388E+06	1.6422E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	3.7987E+05	1.9180E+06	8.0236E+05	8.7096E+05	4.3548E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	5.3803E+03	8.3670E+05	9.1130E+04	1.4848E+05	1.9945E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	5.8904E+04	9.6778E+05	1.9581E+05	2.9217E+05	2.6687E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	2.6056E+03	1.7054E+05	3.4018E+04	4.6083E+04	4.1515E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	5.0555E+06	4.1957E+08	8.1566E+07	9.7923E+07	9.3156E+07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F7	FA	1.6419E+03	1.3073E+05	1.1956E+04	2.3097E+04	2.9849E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	8.9171E+02	1.4146E+04	3.5048E+03	4.2481E+03	2.6818E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	8.0382E+03	4.9036E+06	6.6893E+04	4.1463E+05	1.0523E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	2.3759E+04	9.9478E+05	2.2785E+05	3.3406E+05	2.6439E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.0002E+05	2.1321E+06	3.4751E+05	6.0524E+05	6.0070E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	9.9753E+05	2.1289E+07	4.0429E+06	5.7073E+06	5.3362E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	4.4309E+00	2.2196E+02	5.0555E+01	7.9550E+01	6.1939E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.2524E+02	7.4207E+02	3.7259E+02	4.0525E+02	1.4857E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	2.1975E-01	1.3124E+02	8.8217E+00	1.9491E+01	3.1635E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	4.0942E-01	1.4061E+02	2.7701E+01	3.4689E+01	3.5546E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	1.0129E+02	3.4174E+03	1.0535E+02	1.0876E+03	1.1455E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	1.0000E+02	3.4155E+03	1.0000E+02	2.1052E+02	6.0533E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	1.1203E+02	7.6363E+02	1.1254E+02	1.6090E+02	1.5675E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	3.3041E+02	3.8475E+03	1.3857E+03	1.8319E+03	1.2583E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	1.4194E+03	4.3731E+03	2.8901E+03	2.9592E+03	8.6222E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	1.0921E+02	2.5176E+03	1.8332E+02	6.4869E+02	7.9431E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	3.2704E+02	3.2620E+03	6.8161E+02	8.2581E+02	5.6986E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	1.0018E+02	3.3277E+03	2.2590E+03	1.5515E+03	1.3840E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	4.7962E+03	6.9016E+03	6.0740E+03	5.9888E+03	5.2244E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F8	FA	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	3.4532E-11	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	1.0000E+02	1.9452E+03	1.0159E+02	1.6479E+02	3.3634E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	1.7481E+02	3.8776E+03	1.9898E+03	1.8885E+03	1.3121E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	1.0167E+02	4.0058E+03	2.1484E+03	1.7678E+03	1.6353E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.1990E+02	4.1258E+03	2.3663E+02	1.3083E+03	1.4838E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	1.0000E+02	4.9377E+03	4.6566E+03	3.7316E+03	1.8585E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	1.1975E-07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	3.5167E-09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	1.1539E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	0.0000E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

(*continued on next page*)

Table E.5 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	4.1381E+02	5.8499E+02	5.1269E+02	5.1293E+02	3.7749E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	4.5895E+02	4.8700E+02	4.7669E+02	4.7520E+02	8.0101E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	4.0608E+02	4.1841E+02	4.1140E+02	4.1124E+02	2.8379E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	4.7026E+02	1.1661E+03	9.1225E+02	8.9162E+02	1.2903E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	4.9173E+02	5.2825E+02	5.2057E+02	5.1935E+02	7.1713E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	4.1285E+02	5.2228E+02	4.4573E+02	4.5327E+02	3.1139E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	5.3301E+02	6.2654E+02	5.7180E+02	5.7681E+02	2.6341E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	4.7010E+02	6.3114E+02	5.5264E+02	5.4735E+02	5.1805E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	9.6645E+02	1.7635E+03	1.4211E+03	1.3956E+03	1.7718E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F9	FA	4.1703E+02	4.7759E+02	4.3994E+02	4.4195E+02	1.4388E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	4.1362E+02	4.7360E+02	4.4269E+02	4.4355E+02	1.8090E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	4.4447E+02	5.6033E+02	4.9012E+02	4.9111E+02	2.2538E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	4.4617E+02	7.5594E+02	5.8059E+02	5.8165E+02	7.2808E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	2.4291E+02	8.3904E+02	7.0380E+02	6.6867E+02	1.3192E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	5.5490E+02	6.5130E+02	6.0439E+02	6.0590E+02	2.1128E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	3.2568E+01	4.4094E+02	4.1960E+02	3.4056E+02	1.4586E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	3.9982E+02	4.3172E+02	4.1702E+02	4.1634E+02	7.2081E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0000E+02	4.2244E+02	4.1513E+02	3.9481E+02	8.0238E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	4.0648E+02	4.1955E+02	4.1211E+02	4.1228E+02	3.0547E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	4.0151E+02	5.2422E+02	4.6783E+02	4.6477E+02	3.7463E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	4.1366E+02	4.1375E+02	4.1367E+02	4.1367E+02	2.0380E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	4.1420E+02	4.1436E+02	4.1428E+02	4.1429E+02	4.4626E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	6.0508E+02	1.6972E+03	8.4940E+02	8.9152E+02	2.3580E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	4.0643E+02	4.0666E+02	4.0655E+02	4.0655E+02	5.1604E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	4.1899E+02	5.0838E+02	4.7290E+02	4.6668E+02	2.7952E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	5.0680E+02	1.0873E+03	6.1762E+02	6.6446E+02	1.4239E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	4.0661E+02	5.1176E+02	4.1441E+02	4.3847E+02	3.2479E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	3.0312E+03	2.1876E+04	9.5062E+03	1.0611E+04	4.5566E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F10	FA	4.0289E+02	4.9344E+02	4.1369E+02	4.2613E+02	2.4801E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	4.0175E+02	5.2437E+02	4.8605E+02	4.7758E+02	3.3069E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	4.1068E+02	1.8715E+03	4.8503E+02	5.6976E+02	2.9041E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	4.1565E+02	5.3602E+02	4.9238E+02	4.8660E+02	2.9265E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	4.8930E+02	7.0897E+02	5.3915E+02	5.4414E+02	4.1321E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	4.5383E+02	2.1098E+03	1.1431E+03	1.1043E+03	3.8356E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	4.9209E+02	4.9401E+02	4.9331E+02	4.9327E+02	4.5086E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	4.1366E+02	4.1368E+02	4.1366E+02	4.1366E+02	7.1780E-03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	4.1366E+02	4.1367E+02	4.1366E+02	4.1366E+02	3.1058E-03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	4.1366E+02	4.1366E+02	4.1366E+02	4.1366E+02	2.0065E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	4.3278E+03	4.7156E+04	1.6307E+04	1.8059E+04	9.1889E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.6193E+05	3.1536E+05	2.9114E+05	2.9215E+05	1.2482E+04	100.00
	SA	2.7578E+00	9.2726E+00	6.1771E+00	6.0200E+00	1.6697E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	1.7679E+04	5.9943E+04	3.5032E+04	3.6147E+04	1.3137E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	3.7629E+04	9.2582E+04	6.2375E+04	6.3085E+04	1.3895E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	9.7126E+02	1.6461E+04	6.4049E+03	7.7694E+03	4.1597E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	6.6909E+03	1.7262E+04	1.2277E+04	1.2032E+04	2.7822E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	4.1413E+02	4.7180E+03	1.5591E+03	2.0793E+03	1.1439E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	4.7514E+04	1.3087E+11	8.4712E+05	5.9643E+09	2.3978E+10	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F11	FA	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.3841E+05	2.4711E+05	2.4320E+05	2.4308E+05	2.4312E+03	100.00
	TLBO	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.8570E+04	1.1493E+05	9.4680E+04	9.5150E+04	7.7822E+03	100.00
	MFO	0.0000E+00	8.0715E+04	3.1138E+04	3.3463E+04	2.1890E+04	1.5444E+05	5.0000E+05	5.0000E+05	4.8848E+05	6.3090E+04	3.33
	WOA	1.3078E+01	1.1396E+03	1.4279E+02	1.9932E+02	2.3867E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.1629E+04	7.5893E+04	3.5197E+04	3.6336E+04	1.3984E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	4.0710E+04	1.1475E+05	7.0783E+04	7.5060E+04	2.0605E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.2515E+05	4.3989E+05	4.2712E+05	4.2833E+05	3.4090E+03	100.00
	IMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.2532E+05	4.4496E+05	4.2946E+05	4.3049E+05	4.8754E+03	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3063E+05	1.5134E+05	1.3974E+05	1.4052E+05	4.3166E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.2159E+05	4.3526E+05	4.2548E+05	4.2578E+05	1.9770E+03	100.00
	GA	9.3149E+00	9.4733E+01	4.9256E+01	5.5228E+01	1.8118E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	1.0518E-02	4.9084E+01	4.9084E+01	4.7030E+01	8.9717E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	4.5004E+01	4.5139E+01	4.5087E+01	4.5090E+01	3.0741E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	2.3262E+02	8.6376E+02	4.3132E+02	4.4971E+02	1.5832E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	1.1845E+01	1.4337E+01	1.2321E+01	1.2451E+01	5.3518E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	4.5446E+01	2.8244E+02	8.4091E+01	1.0065E+02	4.9492E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	1.1703E+02	3.5851E+02	2.2719E+02	2.2763E+02	6.1390E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	1.3375E+00	8.0934E+01	4.4897E+01	4.0048E+01	2.1988E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	3.4645E+03	1.6838E+04	8.6414E+03	9.2003E+03	3.2602E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F12	FA	4.4533E+00	7.5489E+01	4.9084E+01	4.8862E+01	1.0788E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	1.7229E-02	6.8337E+01	4.9084E+01	4.1183E+01	2.1252E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	3.9772E+01	6.1868E+02	1.0522E+02	1.4552E+02	1.2713E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	4.9419E-01	1.7026E+02	7.1974E+01	7.2896E+01	3.9203E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.0182E+02	3.1353E+02	1.9883E+02	1.9068E+02	4.9092E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	2.1549E+02	1.5077E+03	6.8121E+02	7.5506E+02	3.5011E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	4.0637E-12	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	1.1769E-11	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	3.6134E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	5.4411E-08	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

Table E.5 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	2.5382E-03	4.2319E-01	5.5338E-02	6.9497E-02	7.6649E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.2400E+04	3.7110E+04	3.4290E+04	3.4466E+04	1.0750E+03	100.00
	SA	4.5544E-01	9.9507E-01	7.2998E-01	7.1071E-01	1.4409E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	4.0020E+01	7.4254E+01	5.4406E+01	5.4037E+01	8.1289E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	1.0077E-05	6.3286E-05	1.7119E-05	2.5623E-05	1.7355E-05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	6.1719E-02	1.7433E+01	2.7446E+00	4.0156E+00	3.9955E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	2.6797E+01	5.1775E+01	4.1302E+01	4.0195E+01	7.0318E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	2.7098E+01	6.3574E+01	4.9769E+01	4.7804E+01	9.9056E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	6.4254E+01	1.3793E+02	1.1584E+02	1.1285E+02	1.7926E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F13	FA	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.1372E+05	4.2807E+05	4.2416E+05	4.2394E+05	2.7624E+03	100.00
	TLBO	6.7424E-01	1.3663E+01	4.8043E+00	5.5269E+00	3.2374E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	9.8258E+00	4.6202E+01	2.0647E+01	2.2176E+01	8.6699E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	3.2405E+01	7.5873E+01	5.6127E+01	5.6892E+01	1.1160E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	3.9434E+01	9.0508E+01	7.0365E+01	6.9223E+01	1.1327E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	7.1928E-07	7.0253E+01	5.6709E+01	5.3232E+01	1.6614E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	3.4080E-04	2.2709E-03	1.0538E-03	1.0755E-03	4.8662E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	8.3605E-06	3.6954E-05	1.8070E-05	1.8258E-05	8.3109E-06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.2336E+05	3.4326E+05	3.3513E+05	3.3507E+05	5.1455E+03	100.00
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.7772E+05	3.0516E+05	2.8874E+05	2.8852E+05	6.2206E+03	100.00
	GA	3.0851E+01	1.0448E+02	6.0370E+01	6.2378E+01	1.9412E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	6.1167E+01	9.7159E+01	8.4072E+01	8.2991E+01	7.6515E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	9.8292E+00	2.6542E+01	1.9474E+01	1.9202E+01	4.0846E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	4.1169E+01	1.1784E+02	8.3491E+01	8.4770E+01	1.9503E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	9.0692E+01	1.2653E+02	1.1400E+02	1.1271E+02	8.3488E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	2.1119E+01	8.1719E+01	4.2349E+01	4.5318E+01	1.3489E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	7.0160E+01	1.3137E+02	1.0871E+02	1.0445E+02	1.7909E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	3.5819E+01	9.8501E+01	6.2404E+01	6.5294E+01	1.7821E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	2.4879E+02	3.7325E+02	3.0320E+02	3.0732E+02	3.2824E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F14	FA	1.3929E+01	7.5239E+01	3.8350E+01	3.9200E+01	1.3737E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	1.8904E+01	5.5718E+01	3.4825E+01	3.6833E+01	1.0185E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	3.6837E+01	1.6523E+02	8.6052E+01	8.9932E+01	2.6604E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	6.6680E+01	1.7810E+02	1.1094E+02	1.2419E+02	3.1563E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	5.5203E+01	1.3686E+02	1.0259E+02	1.0267E+02	1.6454E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	6.9647E+00	1.9102E+02	1.7412E+01	4.7661E+01	5.3068E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	2.0894E+01	5.4499E+01	3.7311E+01	3.7038E+01	7.2504E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.1940E+01	4.1308E+01	2.4874E+01	2.6098E+01	8.2709E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.8904E+01	4.8753E+01	3.1839E+01	3.1805E+01	6.7455E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.1940E+01	3.7808E+01	2.2884E+01	2.3216E+01	6.4815E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	2.4198E+02	4.1992E+03	1.0557E+03	1.1882E+03	8.7935E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.4180E+04	3.2280E+04	2.7690E+04	2.7357E+04	1.9319E+03	100.00
	SA	4.5650E-01	8.2349E-01	6.8077E-01	6.6707E-01	8.5028E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	6.2130E+02	2.3686E+03	1.3773E+03	1.3674E+03	4.0923E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	5.6236E-06	9.2510E-03	5.9073E-05	4.0090E-04	1.6765E-03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	9.7378E+00	8.7271E+02	1.3768E+02	1.9997E+02	1.8139E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	2.4435E+02	1.8178E+03	6.5135E+02	7.1112E+02	3.3742E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	5.6559E+02	3.1391E+03	1.9726E+03	1.9595E+03	6.4858E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	3.5195E+03	9.9486E+03	7.1719E+03	7.0942E+03	1.6778E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F15	FA	0.0000E+00	2.1908E+01	0.0000E+00	7.3027E-01	3.9999E+00	2.2145E+05	5.0000E+05	2.2470E+05	2.3347E+05	5.0362E+04	96.67
	TLBO	1.9068E+00	3.2166E+02	3.1959E+01	5.8077E+01	6.5107E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	6.5663E+02	4.6506E+03	2.0290E+03	2.0867E+03	1.0102E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	1.1251E+03	4.9745E+03	2.3125E+03	2.3545E+03	8.5310E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.5529E+03	3.3126E+03	2.2017E+03	2.3413E+03	5.0206E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.5283E+04	1.7329E+04	1.6337E+04	1.6297E+04	4.6512E+02	100.00
	IMODE	0.0000E+00	4.0121E-03	1.3923E-04	5.3774E-04	1.0278E-03	4.9700E+05	5.0000E+05	5.0000E+05	4.9989E+05	5.4761E+02	10.00
	IMODEv2	0.0000E+00	6.0229E-06	0.0000E+00	2.3518E-07	1.0967E-06	4.2532E+05	5.0000E+05	4.9279E+05	4.6785E+05	3.4247E+04	70.00
	DXMODE	0.0000E+00	7.6475E+02	2.0082E+02	2.6146E+02	2.7338E+02	2.9541E+05	5.0000E+05	5.0000E+05	4.5416E+05	7.0394E+04	33.33
	DXMODEv2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.8288E+05	2.4605E+05	2.1152E+05	2.1501E+05	1.5115E+04	100.00
	GA	3.5487E+02	3.1101E+04	8.6185E+03	9.8137E+03	7.9572E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	2.6831E+03	1.4342E+05	1.5412E+04	2.7198E+04	3.3230E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	1.1811E+04	5.8117E+04	3.0292E+04	3.1272E+04	1.1956E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	1.1052E+02	1.8206E+08	1.9269E+04	7.5181E+06	3.3149E+07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	1.5213E+07	1.7689E+08	5.9771E+07	6.2028E+07	3.5810E+07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	1.9230E+02	5.5225E+06	3.7414E+03	5.0669E+05	1.4766E+06	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	5.2739E+03	8.2026E+07	1.5808E+06	8.9918E+06	1.6893E+07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	8.7807E+01	1.2394E+04	4.5545E+02	1.5258E+03	2.6399E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	3.6738E+09	1.3765E+10	8.7141E+09	8.5310E+09	2.9884E+09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F16	FA	7.9424E+01	1.6954E+04	2.5447E+03	4.5775E+03	5.1803E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	8.4461E+01	1.1416E+04	1.7051E+03	2.8921E+03	3.3215E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	2.9691E+02	4.3178E+07	1.8815E+04	7.4004E+06	1.3290E+07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	2.4206E+02	2.3658E+04	5.7143E+03	6.6391E+03	6.0240E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.7548E+05	2.1676E+06	5.6780E+05	8.1351E+05	5.4732E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	5.2414E+06	1.2901E+09	2.5906E+08	3.8285E+08	3.5631E+08	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	8.3422E+00	4.6107E+01	2.9233E+01	2.8515E+01	7.3731E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.1156E+01	4.1008E+01	2.6894E+01	2.6750E+01	9.5334E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	3.1870E+00	2.8091E+01	1.4596E+01	1.4398E+01	6.8456E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	3.4229E+00	2.1681E+01	1.0327E+01	1.1411E+01	4.3243E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

(*continued on next page*)

Table E.5 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	2.0687E+01	1.9316E+02	6.7809E+01	7.7472E+01	4.1792E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	1.0527E+01	2.8953E+01	2.1332E+01	2.0809E+01	4.3689E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	2.3761E+01	1.7228E+02	2.9392E+01	4.7607E+01	4.0879E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	6.8272E+01	3.0246E+02	1.5487E+02	1.5944E+02	6.0031E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	8.4711E+01	1.4188E+02	1.1689E+02	1.1547E+02	1.2329E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	2.5112E+01	1.4239E+02	5.2590E+01	6.5326E+01	3.0456E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	5.1408E+01	1.7648E+02	1.1126E+02	1.1403E+02	3.1864E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	5.5423E+01	1.8801E+02	9.6331E+01	1.0013E+02	3.2700E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	2.8497E+02	7.0527E+02	4.8734E+02	4.9348E+02	1.1609E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F17	FA	2.3023E+00	1.1684E+02	5.2896E+01	5.0039E+01	2.3406E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	2.6172E+01	8.6949E+01	4.4660E+01	4.7277E+01	1.4688E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	4.6327E+01	2.1089E+02	1.0796E+02	1.1375E+02	4.8875E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	6.0508E+01	2.6014E+02	1.5576E+02	1.6192E+02	4.8982E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	9.6260E+01	2.7712E+02	1.7168E+02	1.7710E+02	4.7846E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	7.2577E+01	3.4597E+02	2.2026E+02	2.2441E+02	6.2186E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	2.4200E+01	4.1462E+01	3.2590E+01	3.2276E+01	4.9838E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	2.2867E+01	3.5099E+01	2.9766E+01	2.9250E+01	2.6644E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0007E+00	2.2985E+01	2.0312E+01	1.4897E+01	7.8702E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	4.5307E+00	2.3296E+01	2.1045E+01	2.0215E+01	3.4815E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	2.0575E+01	1.4268E+02	2.2099E+01	3.1583E+01	3.0531E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	1.8346E+01	2.8911E+01	2.7310E+01	2.6915E+01	1.8365E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	2.3111E+01	1.4453E+02	2.4506E+01	2.8687E+01	2.1900E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	2.6155E+01	7.0421E+02	7.7160E+01	1.6823E+02	1.6004E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	5.9702E+01	1.7310E+02	1.0547E+02	1.1123E+02	2.7674E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	2.2518E+01	1.4483E+02	2.5385E+01	3.8530E+01	3.6167E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	2.5841E+01	5.5222E+01	3.2897E+01	3.4739E+01	5.8652E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	2.1033E+01	1.5815E+02	2.2423E+01	4.7155E+01	4.9299E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	3.9568E+02	1.5677E+05	5.7894E+03	1.8583E+04	3.2840E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F18	FA	2.0233E+01	3.8170E+01	2.1139E+01	2.1699E+01	3.1638E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	2.1190E+01	1.4094E+02	2.4091E+01	2.8991E+01	2.1479E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	2.1606E+01	2.4362E+02	4.4977E+01	6.9638E+01	5.7470E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	3.0793E+01	9.7909E+01	4.5166E+01	4.7389E+01	1.3312E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	3.0952E+01	2.6874E+02	4.6392E+01	8.0042E+01	6.2427E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	4.7524E+01	5.8919E+02	1.9227E+02	2.0544E+02	1.1542E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.6888E+01	2.3077E+01	2.1388E+01	2.1351E+01	1.0763E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.0697E+01	2.4187E+01	2.1646E+01	2.1385E+01	2.2240E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.2030E+01	2.0906E+01	2.0467E+01	1.9778E+01	1.8657E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.8415E+01	2.1430E+01	2.0774E+01	2.0662E+01	6.4315E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	1.8082E+02	2.0281E+02	1.8451E+02	1.8647E+02	5.9303E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	8.6723E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	1.8081E+02	1.8087E+02	1.8084E+02	1.8084E+02	1.3917E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	2.7086E+02	6.2546E+02	3.8079E+02	3.9822E+02	8.6167E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	1.8507E+02	2.1814E+02	1.9980E+02	2.0036E+02	7.9934E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	1.8099E+02	2.7784E+02	1.9806E+02	2.0570E+02	2.7004E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	2.2060E+02	3.7339E+02	2.8859E+02	2.8866E+02	4.1818E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	1.8078E+02	2.2362E+02	1.8079E+02	1.8395E+02	9.8921E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	8.1420E+02	3.1277E+03	1.8823E+03	2.0209E+03	6.2637E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F19	FA	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.2834E-11	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.5669E-12	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	1.8080E+02	3.4112E+02	1.8794E+02	2.0488E+02	3.7690E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	1.8084E+02	1.9392E+02	1.8285E+02	1.8310E+02	2.5350E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	2.1602E+02	3.8196E+02	2.7888E+02	2.8230E+02	4.8170E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	2.4074E+02	7.2682E+02	4.4766E+02	4.3016E+02	1.2506E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	6.2438E-09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.1967E-08	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	8.6723E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	8.6723E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GA	1.0798E-01	2.7658E+02	5.0576E+01	6.7650E+01	8.4320E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DE	4.2663E+01	1.9817E+02	1.0035E+02	1.0402E+02	3.5837E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	SA	8.5518E+01	8.5452E+02	1.9631E+02	2.4341E+02	1.8352E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	PSO	1.1597E+02	3.1800E+03	2.2046E+03	2.0141E+03	7.9663E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	ABC	1.8668E+02	4.1351E+03	9.3427E+02	1.5157E+03	1.3924E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	GWO	1.0037E+02	1.7850E+03	9.2884E+02	8.6479E+02	5.6531E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSO	1.1402E+02	2.8932E+03	2.1918E+02	1.0469E+03	1.1804E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CSOA	1.0844E+02	2.6948E+03	1.8826E+03	1.7085E+03	6.8714E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BAS	2.3918E+03	6.2776E+03	5.5226E+03	5.3559E+03	8.0063E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F20	FA	1.0024E+02	1.7481E+03	1.0038E+02	3.0851E+02	4.7170E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	TLBO	1.0033E+02	1.1819E+03	1.0048E+02	2.3659E+02	3.0436E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MFO	1.0122E+02	3.3707E+03	1.7527E+03	1.5721E+03	1.0466E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	WOA	1.0086E+02	3.9830E+03	1.8727E+03	1.5342E+03	1.3445E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HHO	1.0226E+02	3.9852E+03	2.5522E+03	2.4778E+03	1.0281E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	CMAES	1.7842E+02	4.6333E+03	4.3423E+03	3.7480E+03	1.3952E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.0036E+02	1.0065E+02	1.0048E+02	1.0049E+02	6.5350E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODEv2	1.0029E+02	1.0053E+02	1.0041E+02	1.0041E+02	5.7573E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0028E+02	1.0050E+02	1.0037E+02	1.0037E+02	4.8975E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODEv2	1.0027E+02	1.0045E+02	1.0034E+02	1.0035E+02	4.8539E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

Table E.6
The best, worst, mean, median, SD, success rate results for the error and function evaluation metrics for 15 advanced algorithms, functions (F1-F22), (CEC2020-2022, 10D).

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0104E+05	1.1343E+05	1.0854E+05	1.0914E+05	3.5226E+03	100.00
	MDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0206E+05	1.3920E+05	1.3569E+05	1.2834E+05	1.6181E+04	100.00
	MTDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.0030E+04	6.5040E+04	6.1620E+04	6.2118E+04	1.7234E+03	100.00
	BSD	8.0843E-05	2.6958E+01	2.4625E-02	6.6645E+00	1.1521E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8.3790E+04	9.0720E+04	8.5560E+04	8.7229E+04	2.5839E+03	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.4247E+05	1.5588E+05	1.5153E+05	1.5120E+05	4.7168E+03	100.00
	meanDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.2369E+05	1.2705E+05	1.2633E+05	1.2639E+05	8.0698E+02	100.00
F1	QRDE	1.5822E+03	5.5320E+03	1.9265E+03	2.8289E+03	1.4728E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0050E+04	2.4030E+04	1.1790E+04	1.5115E+04	5.5817E+03	100.00
	JADEGMO	0.0000E+00	7.1191E-06	1.7686E-07	5.8567E-07	1.7778E-06	1.6704E+05	2.0000E+05	2.0000E+05	1.9451E+05	1.2493E+04	16.67
	EA4eig	5.7173E+03	1.9832E+08	1.8770E+07	3.6599E+07	4.5546E+07	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3642E+05	1.4261E+05	1.3831E+05	1.3870E+05	1.5455E+03	100.00
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.3414E+04	5.0184E+04	3.5220E+04	3.5664E+04	2.8505E+03	100.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7412E+05	1.7668E+05	1.7562E+05	1.7567E+05	6.1766E+02	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.8318E+04	7.3027E+04	7.0416E+04	7.0464E+04	1.1912E+03	100.00
	EODE	1.0362E+01	8.6305E+02	2.6124E+02	3.0594E+02	2.7892E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	2.7012E+01	2.6602E+02	4.4321E+01	1.0335E+02	8.7602E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	2.1887E+01	1.9665E+02	1.3204E+02	1.2792E+02	6.5402E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	1.3536E+01	2.2404E+02	1.3357E+02	1.2403E+02	7.0682E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	1.0307E+01	1.5184E+02	3.6757E+01	6.1891E+01	5.7417E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	4.6612E+01	1.5692E+02	9.8880E+01	1.0323E+02	4.3120E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	3.7473E-01	1.2697E+02	6.9548E+00	3.0198E+01	4.9489E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F2	QRDE	6.5143E+01	4.9585E+02	1.3173E+02	1.6896E+02	1.0683E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	1.7980E+01	7.5891E+02	2.8473E+02	2.8828E+02	1.9391E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.7648E+02	9.6289E+02	6.8804E+02	6.4536E+02	2.5810E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.1042E+01	1.3548E+03	7.8000E+02	7.3621E+02	3.0357E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	2.9631E+01	2.6326E+02	1.4270E+02	1.2858E+02	6.6087E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	3.6023E+00	1.8535E+01	6.9236E+00	8.8281E+00	4.4462E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.4982E-01	1.4033E+02	2.0205E+01	2.6277E+01	2.5805E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	3.4774E+00	2.2485E+02	1.6858E+01	3.9519E+01	5.3608E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	1.4852E+01	1.9707E+01	1.6937E+01	1.6896E+01	2.0448E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.3441E+01	2.2384E+01	1.7266E+01	1.8276E+01	3.8512E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	6.5873E+00	2.4285E+01	9.5637E+00	1.2231E+01	6.9558E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	1.4091E+01	1.9625E+01	1.7800E+01	1.6958E+01	2.2570E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	1.3694E+01	1.6778E+01	1.6306E+01	1.5944E+01	9.0626E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	1.2627E+01	1.4793E+01	1.4009E+01	1.3782E+01	8.9691E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	1.2069E+01	1.6050E+01	1.5080E+01	1.4680E+01	1.4080E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F3	QRDE	1.3114E+01	1.8980E+01	1.7594E+01	1.6589E+01	2.1274E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	4.8637E+00	1.9732E+01	1.3877E+01	1.3128E+01	5.5203E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.3893E+01	1.6812E+01	1.6046E+01	1.5731E+01	1.1584E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	2.8063E+01	6.0757E+01	4.2473E+01	4.4152E+01	7.6805E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	1.2272E+01	1.8268E+01	1.4408E+01	1.4897E+01	1.6208E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	1.0436E+01	1.3419E+01	1.1118E+01	1.1402E+01	7.2731E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.2108E+01	1.6519E+01	1.4584E+01	1.4600E+01	1.1074E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.2161E+01	2.0183E+01	1.5806E+01	1.6088E+01	2.2556E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	7.8257E-01	1.0403E+00	1.0123E+00	9.2254E-01	1.1401E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	5.1158E-01	9.6964E-01	6.1431E-01	6.2472E-01	1.2817E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	4.2892E-01	8.3638E-01	5.6561E-01	6.1732E-01	1.6052E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	3.8804E-01	1.8087E+00	1.3159E+00	1.2310E+00	5.8048E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	4.3732E-01	8.6128E-01	6.8761E-01	6.3644E-01	1.3078E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	5.3247E-02	3.6877E-01	2.4784E-01	2.3758E-01	1.2176E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	3.5985E-01	7.0939E-01	5.8583E-01	5.6656E-01	1.2077E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F4	QRDE	5.5015E-01	1.1447E+00	7.8998E-01	7.6780E-01	1.3849E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	4.4849E-01	9.3631E-01	6.9264E-01	6.4733E-01	1.5433E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	7.2148E-01	1.1465E+00	1.0245E+00	9.8833E-01	1.6800E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.9480E+00	8.4434E+00	3.6959E+00	4.0205E+00	1.3611E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	3.3667E-01	7.4142E-01	6.3051E-01	6.0537E-01	9.9217E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	2.2134E-01	1.2579E+00	5.8806E-01	6.4209E-01	2.4053E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	1.3999E-01	2.0045E-02	3.1208E-02	3.2956E-02	1.8153E+05	2.0000E+05	2.0000E+05	1.9895E+05	3.8034E+03	10.00
	DXMODE	3.9464E-02	7.2032E-01	3.9019E-01	4.0394E-01	1.6563E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	5.6398E+00	1.2471E+02	1.3920E+01	4.8666E+01	4.9398E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	4.0803E+01	4.9173E+03	5.2922E+02	1.1147E+03	1.5662E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	2.0814E-01	4.6043E+00	2.4062E+00	2.2998E+00	1.5879E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	7.6226E+01	8.3787E+02	4.7397E+02	4.1906E+02	2.9416E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	2.0814E-01	5.1176E+01	2.6143E+00	1.6542E+01	2.1636E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	1.4148E+01	2.6431E+01	1.8156E+01	2.0025E+01	5.8181E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	2.1981E+00	1.7438E+02	4.8958E+01	7.1991E+01	6.5174E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F5	QRDE	2.6071E+04	5.8719E+05	3.2134E+04	1.6348E+05	2.2399E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	5.9923E+01	3.3210E+02	1.6593E+02	1.7390E+02	8.4211E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.7351E+01	3.9580E+02	1.1615E+02	1.6334E+02	1.1137E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	3.1178E+02	1.6301E+04	3.9001E+03	5.0239E+03	4.1414E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	5.0118E-02	7.7176E+00	1.5159E+00	2.0490E+00	1.8686E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	1.4366E+01	6.9238E+02	1.6025E+02	2.1210E+02	1.8919E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.1895E-04	6.1779E+00	1.4113E+00	1.9057E+00	1.5099E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	1.4112E+00	4.1629E-01	4.6569E-01	3.4456E-01	1.0329E+05	2.0000E+05	2.0000E+05	1.9390E+05	2.3256E+04	6.67

(*continued on next page*)

Table E.6 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	6.1606E-01	1.2592E+01	1.4287E+00	6.1073E+00	5.5520E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.6150E+00	1.3522E+02	1.2987E+01	5.5902E+01	6.1491E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	5.2214E-02	1.1360E+00	6.5777E-01	5.4387E-01	4.2881E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	5.8566E-01	7.7020E-01	7.4469E-01	7.0089E-01	7.4292E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	7.4545E-02	1.4108E+00	2.5773E-01	5.5188E-01	5.3624E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	5.2838E-01	1.4597E+00	6.8042E-01	9.0344E-01	3.1900E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	9.0891E-01	2.8047E+00	1.7873E+00	1.7407E+00	7.5367E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F6	QRDE	7.7045E-01	2.5951E+02	6.0179E+01	6.9063E+01	7.6362E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	7.4996E-01	1.0936E+02	1.6500E+00	1.6331E+01	3.7142E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.4958E+00	3.7272E+02	6.3520E+00	1.1695E+02	1.5067E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	5.6771E+00	1.4746E+02	3.7927E+01	5.1457E+01	4.0445E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	2.0858E-02	1.2207E+00	4.1414E-01	4.6303E-01	3.6011E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	2.0355E-02	1.2000E+02	8.1135E-01	8.7317E+00	3.0133E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.8344E-02	1.2107E+00	3.6776E-01	4.1242E-01	3.7127E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.9627E-02	5.7848E-01	2.0495E-01	2.1411E-01	1.8892E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	3.2467E-01	1.9060E+02	6.2970E-01	3.8509E+01	7.7346E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.6758E+01	1.3715E+02	1.1846E+02	8.0452E+01	5.2273E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	3.0562E-03	9.9472E-01	6.3206E-01	5.3649E-01	2.7740E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	1.4976E+00	5.9937E+01	2.0392E+01	2.4793E+01	2.0709E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	4.9854E-04	6.2833E-01	3.1228E-01	2.0391E-01	2.0492E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	3.3356E-01	1.0410E+00	6.7228E-01	6.2494E-01	2.8717E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	6.2021E-04	5.9108E+01	1.1803E+00	1.3162E+01	2.1769E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F7	QRDE	1.1957E+03	7.4421E+04	1.6296E+03	1.7838E+04	2.8925E+04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	3.1959E-01	1.7082E+01	9.2909E-01	5.4766E+00	7.2081E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	8.2175E+00	2.0408E+03	1.9094E+02	6.4822E+02	7.5339E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.2166E+02	7.2516E+03	1.8136E+03	2.1466E+03	1.8125E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	4.1625E-04	7.8633E-01	8.3410E-02	2.1472E-01	2.3712E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	1.2887E-03	1.1927E+02	1.7162E+01	2.7496E+01	3.6478E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	5.6937E-03	8.0686E-01	4.5457E-02	2.0264E-01	2.3336E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	7.1866E-06	6.4208E-01	7.5929E-03	1.2575E-01	1.8391E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	1.0000E+02	1.0133E+02	1.0029E+02	1.0040E+02	3.6678E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.0000E+02	1.0192E+02	1.0080E+02	1.0087E+02	7.2176E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	0.0000E+00	1.0064E+02	1.0035E+02	8.0263E+01	4.0818E+01	6.5130E+04	2.0000E+05	2.0000E+05	1.7303E+05	5.4870E+04	20.00
	BSD	1.3952E+00	1.0111E+02	4.5726E+00	4.5655E+01	4.9061E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	0.0000E+00	1.0075E+02	1.0000E+02	7.3629E+01	4.5160E+01	7.0620E+04	2.0000E+05	2.0000E+05	1.6550E+05	5.8192E+04	26.67
	BeSD	2.9057E+01	1.0040E+02	1.0006E+02	8.1205E+01	3.1984E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	1.0029E+02	1.0050E+02	1.0034E+02	1.0035E+02	6.6278E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F8	QRDE	1.0000E+02	1.0085E+02	1.0060E+02	1.0058E+02	2.9304E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	2.5442E+01	1.0064E+02	1.0000E+02	8.7687E+01	2.8313E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.0000E+02	1.0169E+02	1.0080E+02	1.0093E+02	5.0227E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	4.9463E+01	1.1846E+02	1.0991E+02	1.0809E+02	1.1719E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	1.0029E+02	2.0407E+01	4.4673E+01	4.7398E+01	1.4614E+05	2.0000E+05	2.0000E+05	1.8188E+05	2.1552E+04	43.33
	HSES	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	3.1563E-10	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	4.8230E+01	1.0000E+02	1.0000E+02	9.8274E+01	9.4518E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.5181E+01	1.0000E+02	1.0000E+02	8.0594E+01	2.8541E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	3.3833E+02	3.4789E+02	3.4279E+02	3.4200E+02	2.7987E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.0000E+02	3.4412E+02	3.4097E+02	3.2486E+02	6.1167E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	3.3704E+02	3.4321E+02	3.4048E+02	3.4006E+02	2.1148E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	7.7851E-04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	1.0000E+02	3.3645E+02	2.1702E+02	2.1766E+02	1.1968E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	1.0000E+02	1.0001E+02	1.0000E+02	1.0000E+02	6.6155E-03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	3.2117E+02	3.3051E+02	3.2954E+02	3.2757E+02	3.9491E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F9	QRDE	3.3583E+02	3.5327E+02	3.5100E+02	3.4803E+02	6.3378E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	3.3432E+02	3.8400E+02	3.3717E+02	3.5084E+02	2.2366E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	3.3913E+02	3.8163E+02	3.4502E+02	3.4489E+02	7.5559E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.2688E+02	3.4045E+02	2.6612E+02	2.6606E+02	4.8979E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	1.6606E-13	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	3.2412E+02	3.3082E+02	3.2859E+02	3.2849E+02	1.0686E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	0.0000E+00	1.0000E+02	1.0000E+02	9.3333E+01	2.5371E+01	1.9662E+05	2.0000E+05	2.0000E+05	1.9984E+05	6.6704E+02	6.67
	DXMODE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	8.3031E-14	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	3.9775E+02	4.4588E+02	4.2154E+02	4.2173E+02	2.3617E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	3.9799E+02	4.4896E+02	4.2212E+02	4.2276E+02	2.4089E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	3.9775E+02	3.9828E+02	3.9808E+02	3.9803E+02	1.7036E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	3.9961E+02	4.4376E+02	4.4361E+02	4.3191E+02	1.9809E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	3.9774E+02	3.9819E+02	3.9810E+02	3.9803E+02	1.8098E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	3.9774E+02	3.9958E+02	3.9958E+02	3.9873E+02	9.3471E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	3.9807E+02	4.4587E+02	4.0083E+02	4.2038E+02	2.3292E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F10	QRDE	3.9804E+02	4.4423E+02	4.4395E+02	4.2261E+02	2.3356E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	3.9801E+02	4.4585E+02	3.9819E+02	4.1879E+02	2.4060E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	3.9774E+02	4.4586E+02	3.9809E+02	4.1170E+02	2.1296E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	3.9784E+02	4.5236E+02	4.4399E+02	4.2995E+02	2.3163E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	1.0000E+02	3.9808E+02	3.9774E+02	3.0847E+02	1.3881E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	4.4446E+02	4.4825E+02	4.4644E+02	4.4643E+02	1.1752E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	3.9774E+02	3.9958E+02	3.9774E+02	3.9836E+02	8.8322E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	3.9774E+02	4.4333E+02	3.9774E+02	3.9957E+02	8.2943E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00

Table E.6 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.5220E+04	3.8700E+04	3.7710E+04	3.7284E+04	1.2282E+03	100.00
	MDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.7040E+04	8.8680E+04	7.9590E+04	8.1524E+04	3.6077E+03	100.00
	MTDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.5350E+04	5.8020E+04	5.6040E+04	5.6588E+04	1.0343E+03	100.00
	BSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3032E+05	1.3947E+05	1.3065E+05	1.3210E+05	2.6708E+03	100.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.4550E+04	9.6690E+04	9.3300E+04	8.8499E+04	8.1865E+03	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1109E+05	1.2357E+05	1.2039E+05	1.1810E+05	4.8443E+03	100.00
	meanDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.4490E+04	1.8360E+04	1.6650E+04	1.6292E+04	1.3604E+03	100.00
F11	QRDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.6690E+04	7.4010E+04	7.2720E+04	7.1458E+04	2.7309E+03	100.00
	JADE	0.0000E+00	4.1535E+03	0.0000E+00	9.6915E+02	1.7868E+03	9.2700E+03	2.0000E+05	1.7070E+04	5.7967E+04	7.9786E+04	76.67
	JADEGMO	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.8500E+04	7.6440E+04	6.9660E+04	6.8812E+04	6.0679E+03	100.00
	EA4eig	1.8244E-06	3.9900E+02	1.2086E+02	1.1107E+02	9.6846E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3283E+05	1.4144E+05	1.3596E+05	1.3668E+05	2.0855E+03	100.00
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.9544E+04	3.9520E+04	3.0404E+04	3.0997E+04	2.3053E+03	100.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.2104E+05	1.2726E+05	1.2375E+05	1.2377E+05	1.4593E+03	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.6209E+04	4.8942E+04	3.9463E+04	4.0095E+04	2.7790E+03	100.00
	EODE	0.0000E+00	8.9161E+00	8.9161E+00	5.5526E+00	3.9057E+00	9.7830E+04	2.0000E+05	2.0000E+05	1.7275E+05	4.5954E+04	26.67
	MDE	8.9161E+00	8.9161E+00	8.9161E+00	8.9161E+00	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	3.9866E+00	3.9866E+00	3.9866E+00	3.9866E+00	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	3.7193E-06	1.3777E-02	3.6976E-03	5.4414E-03	5.9659E-03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	0.0000E+00	3.9866E+00	0.0000E+00	7.9732E-01	1.6219E+00	7.4070E+04	2.0000E+05	9.8160E+04	1.1919E+05	4.2576E+04	80.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1028E+05	1.4490E+05	1.2603E+05	1.2392E+05	1.4379E+04	100.00
	meanDE	0.0000E+00	4.6383E-02	1.1564E-06	1.0823E-02	1.9953E-02	1.5030E+05	2.0000E+05	1.9300E+05	1.8315E+05	2.1166E+04	50.00
F12	QRDE	7.5541E+00	8.9161E+00	8.9161E+00	8.6437E+00	5.5411E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	0.0000E+00	8.9161E+00	8.9161E+00	4.7553E+00	4.5242E+00	1.0590E+04	2.0000E+05	2.0000E+05	1.1182E+05	9.5876E+04	46.67
	JADEGMO	3.9866E+00	9.2579E+02	8.9161E+00	1.6580E+02	3.4693E+02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.7851E+00	6.5560E+01	2.4955E+01	2.5822E+01	1.5223E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	3.9866E+00	0.0000E+00	3.9866E-01	1.2164E+00	1.3852E+05	2.0000E+05	1.4802E+05	1.5299E+05	1.6315E+04	90.00
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.8598E+04	3.0834E+04	2.9931E+04	2.9811E+04	5.9896E+02	100.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6557E+05	1.6941E+05	1.6760E+05	1.6747E+05	8.7217E+02	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.6280E+04	8.6650E+04	7.7347E+04	7.6762E+04	5.4126E+03	100.00
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.2500E+04	2.4420E+04	2.2980E+04	2.3252E+04	7.5579E+02	100.00
	MDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.5770E+04	2.8740E+04	2.7210E+04	2.7344E+04	1.0023E+03	100.00
	MTDE	0.0000E+00	1.1333E-05	0.0000E+00	1.1333E-06	3.4579E-06	6.8940E+04	2.0000E+05	7.0140E+04	8.2846E+04	3.9725E+04	90.00
	BSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.9320E+04	5.1900E+04	5.1180E+04	5.0792E+04	9.8901E+02	100.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.5340E+04	6.8520E+04	6.6840E+04	6.6849E+04	1.0863E+03	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6803E+05	1.7655E+05	1.7036E+05	1.7232E+05	3.8187E+03	100.00
	meanDE	0.0000E+00	3.5528E-07	0.0000E+00	4.7371E-08	1.2284E-07	1.2600E+04	2.0000E+05	1.3410E+04	3.7947E+04	6.4650E+04	86.67
F13	QRDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7040E+04	1.8750E+04	1.8060E+04	1.7936E+04	6.1045E+02	100.00
	JADE	0.0000E+00	5.5602E-01	1.3283E-04	1.4831E-01	2.5006E-01	1.3860E+04	2.0000E+05	2.0000E+05	1.6277E+05	7.5729E+04	20.00
	JADEGMO	1.8163E-05	5.4648E-03	3.5737E-05	4.1458E-04	1.3740E-03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	2.2103E-02	1.0251E+01	1.8636E+00	2.8063E+00	2.4625E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	1.4211E-06	0.0000E+00	1.4211E-07	4.3362E-07	1.5710E+05	2.0000E+05	1.6171E+05	1.6491E+05	1.2009E+04	90.00
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.4360E+04	5.0012E+04	3.5134E+04	3.5570E+04	2.7484E+03	100.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.9149E+05	1.9412E+05	1.9271E+05	1.9273E+05	6.6779E+02	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	9.2442E+04	9.8795E+04	9.5271E+04	9.5546E+04	1.5892E+03	100.00
	EODE	5.9697E+00	1.0945E+01	6.9647E+00	7.4954E+00	1.8052E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	4.9748E+00	1.5919E+01	8.9546E+00	1.0945E+01	4.5856E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	2.9849E+00	1.7909E+01	1.0447E+01	1.0082E+01	5.2566E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	5.9698E+00	1.1939E+01	8.9546E+00	9.0873E+00	1.9331E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	4.9748E+00	1.4924E+01	7.9597E+00	1.0613E+01	4.2401E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	2.4014E+00	5.2175E+00	4.1841E+00	4.0356E+00	1.0139E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	9.9496E-01	6.9647E+00	4.9748E+00	4.2120E+00	1.8417E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F14	QRDE	1.1939E+01	1.8981E+01	1.5137E+01	1.4826E+01	3.0135E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	4.2795E+00	1.1890E+01	5.9910E+00	6.7714E+00	3.2188E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	3.9798E+00	1.1939E+01	6.9647E+00	6.7661E+00	2.6570E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	4.0132E+00	3.5724E+01	2.1888E+01	2.1774E+01	7.2704E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	3.0882E+00	1.0067E+01	6.0471E+00	6.2534E+00	1.5834E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	0.0000E+00	1.9899E+00	4.9748E-01	5.9698E-01	6.7126E-01	2.5588E+04	2.0000E+05	2.0000E+05	1.4774E+05	8.1194E+04	30.00
	IMODE	1.9947E+00	7.9597E+00	5.4033E+00	5.5182E+00	1.3378E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	1.3929E+01	3.4824E+00	4.0462E+00	2.6766E+00	1.1577E+05	2.0000E+05	2.0000E+05	1.9719E+05	1.5379E+04	3.33
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1190E+04	1.3770E+04	1.1220E+04	1.2034E+04	1.0187E+03	100.00
	MDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.8030E+04	5.5590E+04	5.5230E+04	5.3550E+04	2.8774E+03	100.00
	MTDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.3790E+04	5.8710E+04	5.6610E+04	5.6045E+04	1.9283E+03	100.00
	BSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1586E+05	1.6818E+05	1.4310E+05	1.4431E+05	1.7887E+04	100.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.6620E+04	5.8500E+04	5.0820E+04	5.1556E+04	3.6205E+03	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	9.3390E+04	1.0581E+05	9.9750E+04	9.9778E+04	4.6205E+03	100.00
	meanDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.9100E+03	6.3600E+03	6.0000E+03	6.1210E+03	1.8982E+02	100.00
F15	QRDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.5480E+04	1.7940E+04	1.6290E+04	1.6526E+04	9.3550E+02	100.00
	JADE	0.0000E+00	4.0668E+02	0.0000E+00	1.3556E+01	7.4250E+01	7.2000E+03	2.0000E+05	8.0550E+03	1.5253E+04	3.4951E+04	96.67
	JADEGMO	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.8260E+04	8.0640E+04	6.2280E+04	6.7032E+04	8.6668E+03	100.00
	EA4eig	5.1915E-06	1.9705E+01	2.0531E+00	4.1117E+00	5.1819E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.2389E+05	1.3251E+05	1.2795E+05	1.2782E+05	2.2712E+03	100.00
	HSES	0.0000E+00	5.6287E-09	0.0000E+00	8.3369E-10	1.9153E-09	2.5588E+04	2.0000E+05	2.6018E+04	9.5519E+04	8.6767E+04	60.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6589E+05	1.7062E+05	1.6824E+05	1.6811E+05	1.1227E+03	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.8854E+04	7.0257E+04	6.5784E+04	6.5544E+04	2.7278E+03	100.00

(*continued on next page*)

Table E.6 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	5.9733E-01	7.5392E+00	1.6207E+00	3.8039E+00	3.0012E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	3.3058E-01	1.3251E+01	1.2367E+01	7.6088E+00	5.6863E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	4.8623E-02	1.2206E+00	3.2423E-01	4.6056E-01	4.4605E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	1.7705E+00	1.3900E+01	1.3058E+01	9.0116E+00	5.0342E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	3.4690E-01	1.2873E+00	1.1578E+00	1.0784E+00	2.9797E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	9.3838E-02	6.6586E-01	1.1431E-01	2.3587E-01	2.2103E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	1.4044E-01	2.5096E+01	2.6040E+00	7.0929E+00	1.0238E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F16	QRDE	4.0438E+02	7.6398E+03	5.4254E+03	4.8334E+03	2.8410E+03	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	4.2397E-01	9.0325E+00	1.0943E+00	2.9701E+00	2.7486E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.7510E+00	5.4314E+01	2.1356E+01	1.9226E+01	1.6295E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	8.7728E+01	1.5563E+06	3.8097E+04	1.9068E+05	3.6697E+05	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	1.9229E-02	4.8608E-01	2.3098E-01	2.4565E-01	1.2306E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	3.7287E-03	2.0908E+00	3.0172E-01	6.3448E-01	6.1382E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.3479E-02	5.0000E-01	4.1501E-01	3.2275E-01	1.8576E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.6443E-03	4.2460E-01	6.5557E-02	1.2437E-01	1.3197E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	2.0623E+01	2.2403E+01	2.0679E+01	2.1275E+01	7.2348E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	0.0000E+00	2.0995E+01	2.6487E-08	9.5323E+00	1.0370E+01	8.9700E+04	2.0000E+05	2.0000E+05	1.8162E+05	4.1809E+04	16.67
	MTDE	0.0000E+00	9.9496E-01	9.9496E-01	5.3064E-01	5.0486E-01	8.3040E+04	2.0000E+05	2.0000E+05	1.4564E+05	5.9105E+04	46.67
	BSD	3.3639E-04	1.1368E-03	4.2384E-04	6.0175E-04	3.3202E-04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8.6190E+04	1.1769E+05	9.8310E+04	1.0266E+05	1.4116E+04	100.00
	BeSD	1.2287E+00	2.8706E+00	1.4548E+00	1.5976E+00	4.6542E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	5.4428E-04	2.0624E+01	5.5989E+00	9.3909E+00	8.7724E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F17	QRDE	4.9660E+00	2.0948E+01	2.0176E+01	1.6452E+01	7.0514E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	1.4127E+00	2.4959E+01	5.8537E+00	9.4940E+00	8.8811E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	2.0426E+01	2.2096E+01	2.0938E+01	2.1162E+01	5.6981E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.7637E+01	4.9120E+01	3.6500E+01	3.5862E+01	6.4808E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6966E+05	1.8682E+05	1.7721E+05	1.7794E+05	4.3185E+03	100.00
	HSES	0.0000E+00	2.0622E+01	6.2410E-01	4.2888E+00	7.6472E+00	4.9152E+04	2.0000E+05	2.0000E+05	1.6398E+05	6.1614E+04	26.67
	IMODE	0.0000E+00	2.1211E-02	8.0000E-08	7.1138E-04	3.8719E-03	1.9757E+05	2.0000E+05	2.0000E+05	1.9969E+05	6.4690E+02	36.67
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3548E+05	1.5878E+05	1.4860E+05	1.4841E+05	5.3428E+03	100.00
	EODE	3.2828E-01	4.2819E+00	2.1319E+00	2.1963E+00	1.4365E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.7643E-01	2.0796E+01	2.0046E+01	1.2448E+01	9.9197E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	6.0846E-04	6.4849E-01	6.4589E-02	2.2141E-01	2.4264E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	7.2632E-01	2.0197E+01	1.1809E+01	1.2551E+01	7.9847E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	5.1405E-03	2.0049E+01	6.2504E-01	2.3087E+00	6.0220E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	2.2196E+00	7.8259E+00	6.8557E+00	5.2426E+00	2.4212E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	4.8381E-02	2.0655E+01	2.0204E+01	1.1748E+01	9.9752E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F18	QRDE	1.3952E+00	2.4229E+01	1.6160E+01	1.4287E+01	8.6996E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	8.6264E-01	3.3007E+01	2.0557E+01	1.5496E+01	1.3215E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	6.4788E-01	2.1892E+01	1.0564E+01	1.0452E+01	8.0646E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.5701E+01	3.2977E+01	2.7898E+01	2.7078E+01	3.3481E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	1.9837E-02	1.1440E+00	3.8785E-01	4.3271E-01	2.7304E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	2.0025E+01	2.1769E+01	2.0405E+01	2.0482E+01	4.1208E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.0161E-02	9.8788E-01	2.7203E-01	3.8595E-01	3.0406E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	8.5727E-05	6.9345E-01	2.9554E-02	8.3120E-02	1.6569E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	1.1141E-11	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F19	QRDE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	2.2928E+02	2.3293E+02	2.2928E+02	2.2977E+02	1.2601E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	2.0419E+02	2.4697E+02	2.2881E+02	2.2520E+02	1.2705E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	1.1075E-04	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	2.2928E+02	2.2928E+02	2.2928E+02	2.2928E+02	0.0000E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EODE	1.0015E+02	2.0988E+02	1.0020E+02	1.3411E+02	4.8865E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.0022E+02	1.0038E+02	1.0030E+02	1.0027E+02	4.0952E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	1.0013E+02	1.0020E+02	1.0019E+02	1.0018E+02	2.3422E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	1.9248E-01	7.0041E+00	5.4136E-01	2.2351E+00	2.9850E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	1.0027E+02	1.0035E+02	1.0029E+02	1.0030E+02	3.1382E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	1.0021E+02	1.0035E+02	1.0028E+02	1.0029E+02	4.0391E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	1.0008E+02	2.0693E+02	2.0488E+02	1.7764E+02	4.7574E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F20	QRDE	1.0021E+02	1.0029E+02	1.0022E+02	1.0024E+02	3.5483E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	1.0023E+02	1.0030E+02	1.0023E+02	1.0025E+02	2.4093E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.0026E+02	2.1232E+02	1.2373E+02	1.5331E+02	5.5108E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.0038E+02	1.0871E+02	1.0064E+02	1.0090E+02	1.4821E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	1.0017E+02	1.0031E+02	1.0023E+02	1.0023E+02	3.2210E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	1.0025E+02	2.0665E+02	1.3721E+02	1.4810E+02	4.8382E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.0017E+02	1.0030E+02	1.0022E+02	1.0022E+02	3.3925E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.0015E+02	1.0031E+02	1.0023E+02	1.0023E+02	3.9320E-02	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00

Table E.6 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.8180E+04	1.9320E+04	1.8840E+04	1.8692E+04	4.5985E+02	100.00
	MDE	0.0000E+00	1.5043E+02	0.0000E+00	3.0085E+01	6.1200E+01	3.9870E+04	2.0000E+05	4.3530E+04	7.4474E+04	6.3865E+04	80.00
	MTDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.3510E+04	6.5730E+04	6.4200E+04	6.4553E+04	8.5739E+02	100.00
	BSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.7740E+04	1.1139E+05	5.7900E+04	6.6631E+04	2.8251E+04	100.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	5.9130E+04	6.4320E+04	5.9670E+04	6.1198E+04	2.1106E+03	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3242E+05	1.4349E+05	1.3893E+05	1.3735E+05	4.5416E+03	100.00
	meanDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	8.4600E+03	1.2504E+05	9.3750E+03	4.0005E+04	5.2156E+04	100.00
F21	QRDE	0.0000E+00	1.5043E+02	0.0000E+00	3.0085E+01	6.1200E+01	1.9380E+04	2.0000E+05	2.0190E+04	5.5944E+04	7.3260E+04	80.00
	JADE	0.0000E+00	3.0000E+02	0.0000E+00	1.0000E+01	5.4772E+01	9.9300E+03	2.0000E+05	1.0230E+04	1.6714E+04	3.4619E+04	96.67
	JADEGMO	0.0000E+00	1.8172E+02	3.8000E-08	1.1617E+01	4.4254E+01	1.9008E+05	2.0000E+05	2.0000E+05	1.9722E+05	4.4390E+03	30.00
	EA4eig	2.7520E-03	1.5744E+02	5.4391E+01	6.3604E+01	5.0751E+01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.2195E+05	1.2543E+05	1.2344E+05	1.2341E+05	8.7099E+02	100.00
	HSES	0.0000E+00	3.0000E+02	0.0000E+00	3.0000E+01	9.1539E+01	3.3414E+04	2.0000E+05	3.5650E+04	5.1838E+04	5.0239E+04	90.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7859E+05	1.8097E+05	1.7984E+05	1.7985E+05	6.4423E+02	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.6934E+04	7.7951E+04	7.3415E+04	7.3285E+04	2.6485E+03	100.00
	EODE	1.6371E+02	1.6507E+02	1.6493E+02	1.6468E+02	5.1890E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MDE	1.6214E+02	1.6388E+02	1.6285E+02	1.6299E+02	7.3160E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	MTDE	1.5937E+02	1.6492E+02	1.6454E+02	1.6312E+02	2.1010E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BSD	1.6267E+02	1.6599E+02	1.6587E+02	1.6534E+02	8.5704E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BDE	1.6270E+02	1.6493E+02	1.6493E+02	1.6433E+02	1.0021E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	BeSD	1.6270E+02	1.6493E+02	1.6492E+02	1.6470E+02	6.7917E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	meanDE	1.6492E+02	1.6693E+02	1.6507E+02	1.6516E+02	4.9398E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
F22	QRDE	1.5919E+02	1.6521E+02	1.6349E+02	1.6273E+02	2.1131E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADE	1.5937E+02	1.6270E+02	1.6144E+02	1.6135E+02	1.1479E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	JADEGMO	1.6140E+02	1.7687E+02	1.6147E+02	1.6331E+02	4.2550E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	EA4eig	1.5765E+02	1.7219E+02	1.6531E+02	1.6549E+02	3.4698E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	AGSK	1.5862E+02	1.5965E+02	1.5862E+02	1.5885E+02	3.6788E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	HSES	1.6492E+02	1.6770E+02	1.6721E+02	1.6708E+02	6.3862E-01	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	IMODE	1.5862E+02	1.6352E+02	1.6270E+02	1.6231E+02	1.2784E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00
	DXMODE	1.5862E+02	1.6454E+02	1.5937E+02	1.6009E+02	1.5494E+00	2.0000E+05	2.0000E+05	2.0000E+05	2.0000E+05	0.0000E+00	0.00

Table E.7
The best, worst, mean, median, SD, success rate results for the error and function evaluation metrics for 15 advanced algorithms, functions (F1-F22), (CEC2020-2022, 20D).

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.7154E+05	2.2143E+05	1.9383E+05	1.9384E+05	1.6925E+04	100.00
	MDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.0797E+05	2.1078E+05	1.6458E+05	1.5834E+05	4.1611E+04	100.00
	MTDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3080E+05	1.4043E+05	1.3875E+05	1.3567E+05	3.6733E+03	100.00
	BSD	7.3868E-08	2.1990E-04	2.7193E-06	6.4993E-05	9.5573E-05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.5405E+05	1.9575E+05	1.6560E+05	1.6701E+05	1.2003E+04	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.7687E+05	3.0486E+05	2.9730E+05	2.9613E+05	1.0074E+04	100.00
	meanDE	0.0000E+00	1.6404E+03	6.8422E+02	7.2224E+02	5.6581E+02	3.1131E+05	5.0000E+05	5.0000E+05	4.4968E+05	8.4868E+04	26.67
F1	QRDE	1.4460E+02	1.1261E+04	3.9651E+02	3.2954E+03	4.9150E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	0.0000E+00	8.9297E+08	0.0000E+00	1.7859E+08	3.6329E+08	2.5830E+04	5.0000E+05	3.6510E+04	1.2594E+05	1.9029E+05	80.00
	JADEGMO	1.7953E-02	3.4010E+01	1.0693E+00	1.3227E+01	1.5213E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	2.0255E+06	5.3169E+08	1.5010E+08	1.9096E+08	1.5393E+08	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.3583E+05	3.4350E+05	3.3960E+05	3.3974E+05	1.8408E+03	100.00
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.7000E+04	5.0432E+04	4.8584E+04	4.8558E+04	7.7173E+02	100.00
	IMODE	4.1903E-06	1.3191E-04	2.2553E-05	3.0277E-05	2.6881E-05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.4468E+05	2.5271E+05	2.4904E+05	2.4878E+05	2.2160E+03	100.00
	EODE	5.0393E+02	1.4825E+03	5.3893E+02	9.2315E+02	4.4113E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	1.6953E+01	5.1063E+02	2.4962E+02	2.9386E+02	1.7838E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	2.7025E+02	4.7698E+02	3.3281E+02	3.5472E+02	8.4213E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	7.0822E+00	1.3289E+02	1.2792E+02	7.3760E+01	6.2091E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	5.0914E+00	1.1768E+01	9.2676E+00	8.6106E+00	2.5387E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	9.0224E+01	2.2507E+02	1.5074E+02	1.6090E+02	5.9417E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	5.1851E+00	3.6471E+02	2.2245E+02	1.9363E+02	1.2853E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F2	QRDE	2.7818E+02	6.0098E+02	5.7730E+02	5.0075E+02	1.2109E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	1.7666E+03	3.6304E+03	2.5493E+03	2.6855E+03	6.8426E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	1.5056E+03	2.3455E+03	1.9641E+03	1.9912E+03	3.0787E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	2.8624E+03	3.7788E+03	3.4989E+03	3.4550E+03	2.3418E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	4.8910E+01	2.7810E+02	1.5312E+02	1.5343E+02	5.7806E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	3.6337E+00	5.9594E+02	1.7579E+02	1.7885E+02	1.6595E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.2736E+02	6.7102E+02	3.8421E+02	4.1519E+02	1.4758E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.5614E-01	1.3475E+01	4.3313E+00	4.8189E+00	3.3809E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

(*continued on next page*)

Table E.7 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	3.4722E+01	4.8821E+01	4.5727E+01	4.3927E+01	5.7505E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	2.6181E+01	4.4164E+01	3.8649E+01	3.7282E+01	6.6524E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	9.2256E+00	4.1364E+01	3.5491E+01	3.0846E+01	1.2770E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	2.4002E+01	2.7520E+01	2.4365E+01	2.5422E+01	1.4686E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	2.2355E+01	2.7263E+01	2.4214E+01	2.4436E+01	1.8993E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	2.8141E+01	3.1658E+01	2.8166E+01	2.9271E+01	1.4019E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	2.5520E+01	3.4479E+01	2.8974E+01	2.9456E+01	3.1108E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F3	QRDE	2.6269E+01	3.6185E+01	3.5189E+01	3.3319E+01	3.9854E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	4.8785E+01	1.2414E+02	5.1946E+01	7.3497E+01	3.1796E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	4.2779E+01	6.1642E+01	4.6102E+01	4.9136E+01	6.7996E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	1.2020E+02	1.6880E+02	1.4717E+02	1.4504E+02	1.0704E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	2.2023E+01	2.8472E+01	2.5076E+01	2.5350E+01	1.5288E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	2.0498E+01	2.6815E+01	2.3465E+01	2.3377E+01	1.5786E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	2.6516E+01	4.2771E+01	3.7445E+01	3.6616E+01	4.3631E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	2.0387E+01	2.3150E+01	2.2163E+01	2.2034E+01	6.5911E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	1.4367E+00	3.5586E+00	2.4895E+00	2.3124E+00	8.7117E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	9.6128E-01	4.1726E+00	1.1167E+00	1.3036E+00	5.7855E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	1.2870E+00	1.8390E+00	1.4527E+00	1.4975E+00	2.1944E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	1.1140E+00	1.5805E+00	1.2281E+00	1.2973E+00	1.8183E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	6.8147E-01	1.0853E+00	8.4827E-01	8.7477E-01	1.4398E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.5247E+00	1.8287E+00	1.7104E+00	1.7063E+00	1.1938E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	1.3864E+00	2.9433E+00	1.6963E+00	1.8232E+00	4.6627E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F4	QRDE	1.3567E+00	2.1262E+00	1.6554E+00	1.6942E+00	2.8957E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	1.6637E+00	3.3325E+00	2.7190E+00	2.5904E+00	6.1933E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	1.9751E+00	8.6846E+02	4.4218E+00	2.0609E+02	3.7167E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	1.2319E+01	2.2589E+01	1.5120E+01	1.5874E+01	2.9330E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.2938E+00	2.0751E+00	1.6607E+00	1.6410E+00	1.9647E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	1.2302E+00	2.7568E+00	1.8093E+00	1.8739E+00	4.0210E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.2312E+00	3.6983E+00	1.9358E+00	2.0514E+00	5.7513E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	5.9425E-01	1.3109E+00	8.9715E-01	9.1225E-01	2.0528E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	4.4719E+02	1.3731E+03	6.6925E+02	7.5485E+02	3.3100E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	3.4470E+03	2.2130E+05	6.4483E+04	6.2995E+04	6.0522E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	1.7227E+01	3.4008E+02	1.2956E+02	1.2753E+02	1.2103E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	1.8111E+03	5.1035E+04	1.3600E+04	2.0201E+04	1.9348E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	1.7724E+02	2.5720E+03	4.2334E+02	5.5683E+02	4.9082E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.2953E+02	3.3751E+02	2.6826E+02	2.4622E+02	7.9688E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	4.9342E+01	8.8720E+02	4.5776E+02	4.2039E+02	2.7767E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F5	QRDE	3.7497E+04	2.8692E+05	1.2899E+05	1.5214E+05	9.3746E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	4.9599E+02	5.1033E+03	1.8500E+03	2.4361E+03	1.6625E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	7.5663E+02	1.9677E+03	1.2464E+03	1.2166E+03	2.3181E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	2.4491E+03	5.8115E+05	2.5396E+05	2.6115E+05	1.5719E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.2670E+01	4.3297E+02	2.5346E+02	2.3891E+02	1.1660E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	1.5463E+02	1.0317E+03	6.2321E+02	5.9869E+02	2.2737E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.4604E+02	3.8711E+02	2.0979E+02	2.2875E+02	6.9601E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	4.3500E+01	2.8749E+02	2.5356E+02	2.0759E+02	6.8430E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	2.5686E+01	1.9568E+02	2.7098E+01	7.1739E+01	7.6017E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	9.5177E-01	7.7039E+00	2.1890E+00	4.2935E+00	3.0782E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	2.0288E+00	1.2951E+01	7.0622E+00	7.1165E+00	4.8457E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	1.2831E+00	1.9781E+00	1.5356E+00	1.5284E+00	1.9784E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	2.6452E-01	1.2946E+00	6.0247E-01	6.4522E-01	3.9716E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.6740E+00	2.1359E+00	1.7438E+00	1.8722E+00	1.8540E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	2.5671E+00	1.2193E+02	1.2074E+02	6.5930E+01	6.0244E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F6	QRDE	2.9860E+01	2.9946E+02	5.6372E+01	1.1332E+02	1.1042E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	1.8232E+01	3.6492E+02	6.4368E+01	7.8908E+01	7.5343E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	1.3843E+01	3.8162E+02	2.3602E+02	2.2302E+02	9.9108E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	2.6880E+02	9.7531E+02	4.4509E+02	4.6748E+02	1.3897E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	5.5869E-01	1.5276E+00	1.1552E+00	1.1541E+00	2.6770E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	1.9339E+00	2.1918E+02	2.3937E+00	3.7038E+01	6.1099E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.6273E+00	3.4986E+00	2.3206E+00	2.3721E+00	3.8336E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0407E-01	1.2483E+00	4.4035E-01	4.7882E-01	2.6561E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	4.1750E+01	3.4185E+02	2.7304E+02	1.9529E+02	1.2258E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	4.7241E+02	1.4622E+04	7.7855E+03	8.0700E+03	4.5976E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	8.8739E+00	1.1770E+02	1.7301E+01	5.2847E+01	4.5693E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	6.8267E+02	8.2069E+03	2.4433E+03	3.4190E+03	2.6599E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	9.2301E+01	7.8651E+02	2.8893E+02	3.1238E+02	2.5568E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	3.4299E+01	1.3711E+02	5.3611E+01	6.6183E+01	3.7320E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	1.7401E+02	3.4082E+02	2.7606E+02	2.4862E+02	6.3192E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F7	QRDE	3.3140E+03	1.3597E+06	6.0698E+03	3.9031E+05	5.9719E+05	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	1.3906E+02	1.1080E+03	4.5525E+02	5.6108E+02	3.1158E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	4.3671E+01	2.2654E+05	6.1529E+02	3.0766E+04	7.8103E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	2.7347E+03	2.2102E+05	8.8294E+04	9.1590E+04	6.2916E+04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.7178E+00	9.1577E+01	3.2492E+01	3.6624E+01	2.6908E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	1.4778E+00	8.9308E+02	2.9299E+02	3.3269E+02	2.1866E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	4.4309E+00	2.2196E+02	5.0555E+01	7.9550E+01	6.1939E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	2.1975E-01	1.3124E+02	8.8217E+00	1.9491E+01	3.1635E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

Table E.7 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	1.0000E+02	2.4600E+03	1.0000E+02	2.5745E+02	5.9873E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	1.0000E+02	1.0116E+02	1.0000E+02	1.0004E+02	2.1195E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	1.8510E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	2.0343E-02	1.0000E+02	1.0000E+02	7.5949E+01	3.9160E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	1.0000E+02	1.0120E+02	1.0000E+02	1.0032E+02	5.4036E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	0.0000E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	1.0000E+02	1.0120E+02	1.0000E+02	1.0028E+02	5.1639E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F8	QRDE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	3.3778E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	1.0000E+02	1.0201E+02	1.0077E+02	1.0088E+02	9.0805E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	1.0000E+02	2.7413E+03	1.0134E+02	2.4467E+02	5.0118E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	1.1447E+02	1.8749E+02	1.4231E+02	1.4381E+02	1.9553E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	2.2920E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	7.9696E-10	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	1.1975E-07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0000E+02	1.0000E+02	1.0000E+02	1.0000E+02	1.1539E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	4.0260E+02	4.2650E+02	4.2426E+02	4.1718E+02	9.8808E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	4.2606E+02	4.5590E+02	4.4307E+02	4.4204E+02	1.1315E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	4.0733E+02	4.3299E+02	4.1810E+02	4.1938E+02	9.5740E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	1.0000E+02	4.2940E+02	4.1686E+02	3.5509E+02	1.2992E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	4.2167E+02	4.4288E+02	4.3350E+02	4.3240E+02	7.6280E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	3.7659E+02	4.2669E+02	4.0645E+02	4.0037E+02	1.5056E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	3.9538E+02	4.1361E+02	4.1260E+02	4.0820E+02	6.8880E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F9	QRDE	4.3488E+02	4.7024E+02	4.4992E+02	4.5025E+02	1.2391E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	4.2691E+02	4.8374E+02	4.3711E+02	4.4499E+02	2.1199E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	4.4599E+02	5.7632E+02	4.6661E+02	4.7717E+02	3.6389E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	4.9174E+02	5.5594E+02	5.2881E+02	5.2721E+02	1.1672E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.0000E+02	4.1974E+02	1.0000E+02	1.8464E+02	1.3635E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	3.8731E+02	4.0303E+02	3.9437E+02	3.9475E+02	3.0265E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	3.2568E+01	4.4094E+02	4.1960E+02	3.4056E+02	1.4586E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0000E+02	4.2244E+02	4.1513E+02	3.9481E+02	8.0238E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	4.1367E+02	4.9513E+02	4.1377E+02	4.2187E+02	2.4838E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	4.1373E+02	4.9093E+02	4.1400E+02	4.3038E+02	2.7169E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	4.1367E+02	4.1371E+02	4.1370E+02	4.1369E+02	1.4912E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	4.6055E+02	4.9606E+02	4.9337E+02	4.8555E+02	1.5363E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	3.9947E+02	4.1384E+02	4.1369E+02	4.0984E+02	6.3940E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	4.4799E+02	4.9257E+02	4.6032E+02	4.7203E+02	1.9975E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	4.1380E+02	4.8752E+02	4.2688E+02	4.3431E+02	1.9356E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F10	QRDE	4.1367E+02	4.1379E+02	4.1371E+02	4.1372E+02	5.0560E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	4.1052E+02	4.7460E+02	4.1396E+02	4.3703E+02	2.6871E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	4.1025E+02	4.6182E+02	4.1397E+02	4.3535E+02	2.4808E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	4.1749E+02	5.7529E+02	4.8109E+02	4.7895E+02	4.3681E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	4.1366E+02	4.1369E+02	4.1366E+02	4.1366E+02	8.3344E-03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	4.1366E+02	4.8642E+02	4.1367E+02	4.2898E+02	2.8522E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	4.9209E+02	4.9401E+02	4.9331E+02	4.9327E+02	4.5086E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	4.1366E+02	4.1367E+02	4.1366E+02	4.1366E+02	3.1058E-03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.5432E+05	1.7364E+05	1.6566E+05	1.6436E+05	6.8531E+03	100.00
	MDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.9724E+05	3.7236E+05	3.2490E+05	3.3330E+05	2.2599E+04	100.00
	MTDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3329E+05	1.4757E+05	1.3833E+05	1.3842E+05	3.8979E+03	100.00
	BSD	0.0000E+00	1.4549E-06	0.0000E+00	3.9938E-07	6.4775E-07	4.8696E+05	5.0000E+05	4.9446E+05	4.9505E+05	5.4753E+03	53.33
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.6028E+05	3.2448E+05	2.9475E+05	2.9235E+05	2.2527E+04	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.8482E+05	3.5235E+05	3.2403E+05	3.2994E+05	1.6926E+04	100.00
	meanDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.2223E+05	3.3906E+05	3.3876E+05	3.3166E+05	7.9297E+03	100.00
F11	QRDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.9598E+05	3.3192E+05	3.0030E+05	3.0901E+05	1.4873E+04	100.00
	JADE	0.0000E+00	1.1998E+03	0.0000E+00	2.6432E+02	4.5908E+02	3.8790E+04	5.0000E+05	4.5450E+04	1.6584E+05	2.0496E+05	73.33
	JADEGMO	1.3513E-03	5.6979E+02	7.5572E-01	1.6327E+02	2.3952E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	9.8998E+02	4.8119E+03	2.7281E+03	2.8293E+03	9.7727E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.9989E+05	4.2134E+05	4.1470E+05	4.1457E+05	4.0550E+03	100.00
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.0576E+04	4.3040E+04	4.1764E+04	4.1790E+04	5.5915E+02	100.00
	IMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.2515E+05	4.3989E+05	4.2712E+05	4.2833E+05	3.4090E+03	100.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3063E+05	1.5134E+05	1.3974E+05	1.4052E+05	4.3166E+03	100.00
	EODE	1.3777E-02	4.9084E+01	4.9084E+01	3.1099E+01	2.4042E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	4.2836E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	4.4895E+01	4.9084E+01	4.4895E+01	4.6571E+01	2.0873E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	4.9084E+01	7.1611E+01	4.9084E+01	5.5092E+01	1.0132E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	2.0038E-06	4.9084E+01	4.9084E+01	4.4176E+01	1.4977E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	3.3633E-03	4.9084E+01	4.4895E+01	3.3251E+01	2.2188E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	6.9388E-05	4.9084E+01	4.0303E+00	1.5499E+01	2.0733E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F12	QRDE	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	2.4900E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	4.9084E+01	1.1765E+02	1.0024E+02	9.0431E+01	2.6183E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	6.6729E+00	5.3543E+01	4.4895E+01	3.6973E+01	1.8795E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	3.9215E+01	1.5507E+02	1.0056E+02	1.0020E+02	2.8924E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	4.4895E+01	4.9084E+01	4.9084E+01	4.8247E+01	1.7042E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	4.4895E+01	4.9084E+01	4.4895E+01	4.5035E+01	7.6480E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	4.0637E-12	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	4.9084E+01	4.9084E+01	4.9084E+01	4.9084E+01	3.6134E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

(*continued on next page*)

Table E.7 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	2.5428E-06	3.5379E-04	5.9486E-05	1.1306E-04	1.4936E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.3170E+04	1.0956E+05	4.8510E+04	6.2388E+04	2.4139E+04	100.00
	MTDE	5.7213E-06	4.9829E-04	1.9671E-04	1.8516E-04	1.8369E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	7.8180E+04	8.9940E+04	8.1570E+04	8.3672E+04	4.5852E+03	100.00
	BDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.1850E+05	1.2957E+05	1.2360E+05	1.2448E+05	3.6594E+03	100.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.1560E+05	3.4488E+05	3.2705E+05	3.2828E+05	1.2325E+04	100.00
	meanDE	2.8700E-06	8.8162E-04	1.2798E-04	1.6535E-04	2.5214E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F13	QRDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.9270E+04	3.9960E+04	3.9690E+04	3.9578E+04	2.8742E+02	100.00
	JADE	1.1078E-04	9.6802E+00	7.2926E-04	1.1970E+00	3.1353E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	4.6550E-02	1.7772E+01	2.0190E-01	1.5988E+00	3.7600E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	4.6180E+00	1.6127E+01	1.0908E+01	1.0580E+01	2.6812E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	2.5666E-05	1.2755E-06	2.5071E-06	5.1550E-06	4.2688E+05	5.0000E+05	5.0000E+05	4.8157E+05	3.1119E+04	26.67
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	4.2600E+04	7.7096E+04	4.3920E+04	5.0520E+04	1.2894E+04	100.00
	IMODE	3.4080E-04	2.2709E-03	1.0538E-03	1.0755E-03	4.8662E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.2336E+05	3.4326E+05	3.3513E+05	3.3507E+05	5.1455E+03	100.00
	EODE	1.4924E+01	4.1788E+01	1.8904E+01	2.1790E+01	7.5609E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	1.2934E+01	2.1889E+01	1.7909E+01	1.7658E+01	3.2161E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	1.7909E+01	3.7808E+01	2.1392E+01	2.5570E+01	8.3537E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	3.1839E+01	5.7708E+01	4.0793E+01	4.5304E+01	1.0464E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	2.1889E+01	3.5818E+01	2.9849E+01	2.9550E+01	5.1874E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.8524E+01	2.3830E+01	2.2201E+01	2.1678E+01	2.0449E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	7.9597E+00	1.9899E+01	1.6914E+01	1.4526E+01	4.8574E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F14	QRDE	2.3918E+01	6.7252E+01	3.9765E+01	4.1828E+01	1.5780E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	2.4319E+01	7.8342E+01	4.7172E+01	4.7570E+01	1.8674E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	2.3973E+01	5.0528E+01	3.6995E+01	3.6849E+01	1.0185E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	7.9820E+01	1.0969E+02	9.7348E+01	9.6858E+01	7.9312E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.8410E+01	3.7568E+01	2.6854E+01	2.6441E+01	4.7664E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	9.9496E-01	8.9546E+00	3.9798E+00	4.3778E+00	2.0340E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	2.0894E+01	5.4499E+01	3.7311E+01	3.7038E+01	7.2504E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.8904E+01	4.8753E+01	3.1839E+01	3.1805E+01	6.7455E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.9190E+04	4.2210E+04	3.2700E+04	3.4360E+04	5.0513E+03	100.00
	MDE	0.0000E+00	4.2430E+00	1.7906E-01	5.0404E-01	8.1957E-01	9.8550E+04	5.0000E+05	5.0000E+05	4.0633E+05	1.7270E+05	23.33
	MTDE	0.0000E+00	1.4280E+00	0.0000E+00	2.6188E-01	5.3185E-01	1.0623E+05	5.0000E+05	1.1751E+05	2.8008E+05	1.9564E+05	56.67
	BSD	5.8748E+01	2.0961E+02	1.0829E+02	1.1636E+02	5.2323E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	8.9528E-02	6.1528E+00	1.4525E+00	2.5200E+00	2.1915E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.3298E+05	2.6652E+05	2.4579E+05	2.4844E+05	1.2069E+04	100.00
	meanDE	0.0000E+00	5.4385E-01	0.0000E+00	1.4503E-01	2.4461E-01	3.0852E+05	5.0000E+05	3.9858E+05	4.0158E+05	9.2353E+04	73.33
F15	QRDE	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	3.3840E+04	3.9510E+04	3.4200E+04	3.5390E+04	2.0581E+03	100.00
	JADE	6.3338E-01	1.5765E+02	1.7861E+00	3.7053E+01	5.2123E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	1.7906E-01	2.1377E+01	1.8173E+00	4.3216E+00	5.6459E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	1.8365E+01	1.0885E+02	5.7114E+01	5.6015E+01	2.4162E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	0.0000E+00	8.9528E-02	0.0000E+00	5.9686E-03	2.2714E-02	3.5152E+05	5.0000E+05	3.5964E+05	3.6855E+05	3.6052E+04	93.33
	HSES	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	2.8608E+04	3.0104E+04	2.9268E+04	2.9227E+04	3.5312E+02	100.00
	IMODE	0.0000E+00	4.0121E-03	1.3923E-04	5.3774E-04	1.0278E-03	4.9700E+05	5.0000E+05	5.0000E+05	4.9989E+05	5.4761E+02	10.00
	DXMODE	0.0000E+00	7.6475E+02	2.0082E+02	2.6146E+02	2.7338E+02	2.9541E+05	5.0000E+05	5.0000E+05	4.5416E+05	7.0394E+04	33.33
	EODE	1.1762E+02	6.7098E+03	2.9008E+03	3.2736E+03	2.4589E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	1.0018E+02	7.3761E+03	1.6334E+02	3.0673E+03	3.2824E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	3.1161E+00	7.1980E+01	3.0328E+01	3.4704E+01	2.2012E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	7.0325E+01	3.1577E+03	9.1228E+02	1.1455E+03	1.2862E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	3.3581E+01	1.3792E+03	7.7449E+01	4.2200E+02	5.8182E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	9.3452E+00	6.3593E+01	3.0073E+01	3.3598E+01	1.9193E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	2.8168E+01	7.4338E+01	4.4309E+01	4.9564E+01	1.9500E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F16	QRDE	5.6448E+01	2.2969E+04	1.8448E+04	1.1751E+04	9.9223E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	8.9675E+00	2.0131E+04	6.3096E+01	4.8051E+03	7.0123E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	8.9611E+01	4.0984E+02	2.0488E+02	2.1983E+02	1.0433E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	7.7336E+04	3.9866E+07	1.5007E+07	1.5687E+07	1.2497E+07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	5.3071E-01	3.7031E+01	1.2969E+01	1.5656E+01	9.3536E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	1.1875E+00	1.5469E+01	4.7986E+00	5.2300E+00	3.2864E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	8.3422E+00	4.6107E+01	2.9233E+01	2.8515E+01	7.3731E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	3.1870E+00	2.8091E+01	1.4596E+01	1.4398E+01	6.8456E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	2.2614E+01	3.8142E+01	3.0176E+01	2.9186E+01	6.1860E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	2.6284E+01	4.5714E+01	3.2305E+01	3.4031E+01	7.5383E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	2.1098E+01	2.7960E+01	2.2042E+01	2.3785E+01	2.5016E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	1.3333E+01	2.5788E+01	2.3219E+01	2.1280E+01	4.2010E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	2.3029E+00	2.0996E+01	4.2926E+00	8.3526E+00	7.8166E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.3947E+01	2.6054E+01	2.4389E+01	2.2025E+01	5.0002E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	2.0198E+01	2.9464E+01	2.2406E+01	2.4729E+01	3.2696E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F17	QRDE	2.6093E+01	6.4626E+01	4.5975E+01	4.6413E+01	1.4417E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	2.7808E+01	1.3080E+02	5.1155E+01	6.5576E+01	3.8445E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	2.4641E+01	5.4136E+01	4.8935E+01	4.1595E+01	1.0611E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	5.5122E+01	9.4403E+01	7.7164E+01	7.6105E+01	9.2084E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.8964E+00	2.3625E+01	2.1749E+01	2.0039E+01	4.6728E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	5.2870E+00	4.5185E+01	2.7130E+01	2.5166E+01	1.0673E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	2.4200E+01	4.1462E+01	3.2590E+01	3.2276E+01	4.9838E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0007E+00	2.2985E+01	2.0312E+01	1.4897E+01	7.8702E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

Table E.7 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	2.1812E+01	2.5802E+01	2.2554E+01	2.3257E+01	1.5960E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	2.0465E+01	2.1513E+01	2.0992E+01	2.1000E+01	3.8971E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	2.0375E+01	2.1177E+01	2.0982E+01	2.0776E+01	3.5615E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	2.0571E+01	2.1224E+01	2.0865E+01	2.0852E+01	2.5285E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	2.0372E+01	2.0995E+01	2.0797E+01	2.0727E+01	2.3645E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	2.1119E+01	2.1801E+01	2.1708E+01	2.1550E+01	2.6447E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	1.2858E+00	2.1887E+01	2.1501E+01	1.6187E+01	9.1420E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F18	QRDE	2.3183E+01	2.9692E+01	2.4296E+01	2.5136E+01	2.3768E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	2.3054E+01	2.7747E+01	2.6342E+01	2.5539E+01	1.7452E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	2.5011E+01	3.8200E+01	2.6588E+01	2.8761E+01	5.0897E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	3.1614E+01	5.7822E+01	4.0124E+01	4.0196E+01	4.4075E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	2.1092E+01	2.3384E+01	2.2806E+01	2.2670E+01	5.5066E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	2.0354E+01	2.2038E+01	2.0942E+01	2.1005E+01	4.7090E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.6888E+01	2.3077E+01	2.1388E+01	2.1351E+01	1.0763E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.2030E+01	2.0906E+01	2.0467E+01	1.9778E+01	1.8657E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	8.6723E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.2528E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	5.0645E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.3306E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.0194E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.0468E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	1.8078E+02	1.8097E+02	1.8078E+02	1.8083E+02	8.6717E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F19	QRDE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	5.2706E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	1.8078E+02	2.2744E+02	1.8078E+02	2.0097E+02	2.3480E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.2617E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	1.8166E+02	2.2250E+02	2.0093E+02	2.0080E+02	1.0661E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	2.3838E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	1.8078E+02	1.8079E+02	1.8078E+02	1.8078E+02	8.2314E-04	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	6.2438E-09	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.8078E+02	1.8078E+02	1.8078E+02	1.8078E+02	8.6723E-14	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	1.0022E+02	2.8502E+02	2.3441E+02	1.8529E+02	8.3079E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	1.2714E+01	1.0060E+02	1.0034E+02	6.1761E+01	4.2189E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	1.0022E+02	1.0034E+02	1.0031E+02	1.0028E+02	4.9236E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	2.8597E-01	1.0045E+02	1.1087E+01	4.0355E+01	4.6645E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	1.0036E+02	1.0054E+02	1.0038E+02	1.0040E+02	4.7469E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	1.0042E+02	1.0051E+02	1.0048E+02	1.0046E+02	3.9158E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	1.0022E+02	2.2703E+02	1.0026E+02	1.3174E+02	5.3186E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F20	QRDE	1.0062E+02	2.4729E+02	1.2397E+02	1.4802E+02	6.1502E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	1.0034E+02	1.9657E+03	1.0728E+02	5.3884E+02	8.0063E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	1.6089E+02	3.0003E+03	2.9362E+02	1.1771E+03	1.1019E+03	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	1.0074E+02	1.3218E+02	1.0119E+02	1.0306E+02	7.0039E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	1.0022E+02	1.0037E+02	1.0030E+02	1.0030E+02	3.4783E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	5.2804E+00	4.1824E+02	1.0054E+02	1.4411E+02	8.0816E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	1.0036E+02	1.0065E+02	1.0048E+02	1.0049E+02	6.5350E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	1.0028E+02	1.0050E+02	1.0037E+02	1.0037E+02	4.8975E-02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	3.0000E+02	4.0000E+02	3.0000E+02	3.1000E+02	3.0513E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	3.0000E+02	3.0000E+02	3.0000E+02	3.0000E+02	2.8212E-11	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	3.0000E+02	4.0000E+02	4.0000E+02	3.7333E+02	4.4978E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	3.3962E-01	3.0000E+02	1.1023E+01	1.3411E+02	1.4757E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	3.0000E+02	4.0000E+02	3.0000E+02	3.4667E+02	5.0742E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	3.0000E+02	4.0000E+02	3.0000E+02	3.2667E+02	4.4978E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	3.0000E+02	3.0110E+02	3.0000E+02	3.0022E+02	4.4797E-01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F21	QRDE	3.0000E+02	3.0000E+02	3.0000E+02	3.0000E+02	3.4785E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	0.0000E+00	1.4265E+03	3.0000E+02	3.6932E+02	3.9360E+02	2.1450E+04	5.0000E+05	5.0000E+05	3.7239E+05	2.1524E+05	26.67
	JADEGMO	3.0000E+02	4.0000E+02	3.0000E+02	3.2667E+02	4.4978E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	3.3631E+02	9.0454E+02	6.7563E+02	6.6494E+02	1.5621E+02	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	3.0000E+02	4.0000E+02	4.0000E+02	3.7333E+02	4.4978E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	3.0000E+02	3.0000E+02	3.0000E+02	3.0000E+02	2.0650E-10	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	3.0000E+02	3.0000E+02	3.0000E+02	3.0000E+02	2.3084E-07	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	3.0000E+02	3.0000E+02	3.0000E+02	3.0000E+02	1.5727E-13	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EODE	2.3306E+02	2.6502E+02	2.4838E+02	2.4838E+02	1.0043E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MDE	2.3675E+02	2.4460E+02	2.3703E+02	2.3952E+02	3.1396E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	MTDE	2.3413E+02	2.4506E+02	2.4000E+02	2.4019E+02	3.6030E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BSD	2.4559E+02	2.7156E+02	2.5159E+02	2.5521E+02	1.0345E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BDE	2.3469E+02	2.5092E+02	2.3978E+02	2.4110E+02	6.2832E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	BeSD	2.3365E+02	2.4695E+02	2.4352E+02	2.4197E+02	4.6738E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	meanDE	2.3495E+02	2.6285E+02	2.5774E+02	2.5369E+02	1.1042E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
F22	QRDE	2.3685E+02	2.5662E+02	2.4134E+02	2.4437E+02	7.0473E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADE	2.4566E+02	2.8359E+02	2.4812E+02	2.5734E+02	1.6225E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	JADEGMO	2.4500E+02	3.6203E+02	2.4662E+02	2.7402E+02	4.6545E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	EA4eig	2.0005E+02	4.0174E+02	3.1211E+02	2.9776E+02	5.6504E+01	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	AGSK	2.3161E+02	2.3944E+02	2.3398E+02	2.3489E+02	2.4961E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	HSES	2.4481E+02	2.6794E+02	2.5053E+02	2.5164E+02	5.2104E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	IMODE	2.3608E+02	2.4725E+02	2.4202E+02	2.4154E+02	2.7841E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00
	DXMODE	2.3108E+02	2.3683E+02	2.3305E+02	2.3331E+02	1.3116E+00	5.0000E+05	5.0000E+05	5.0000E+05	5.0000E+05	0.0000E+00	0.00

Appendix F. CEC2020-2022 box and violin plots

This appendix includes box and violin plots for the best fitness values across 30 runs on CEC2020-2022 benchmarks. Results are shown for both 10D and 20D dimensions, covering classical and advanced algorithms.

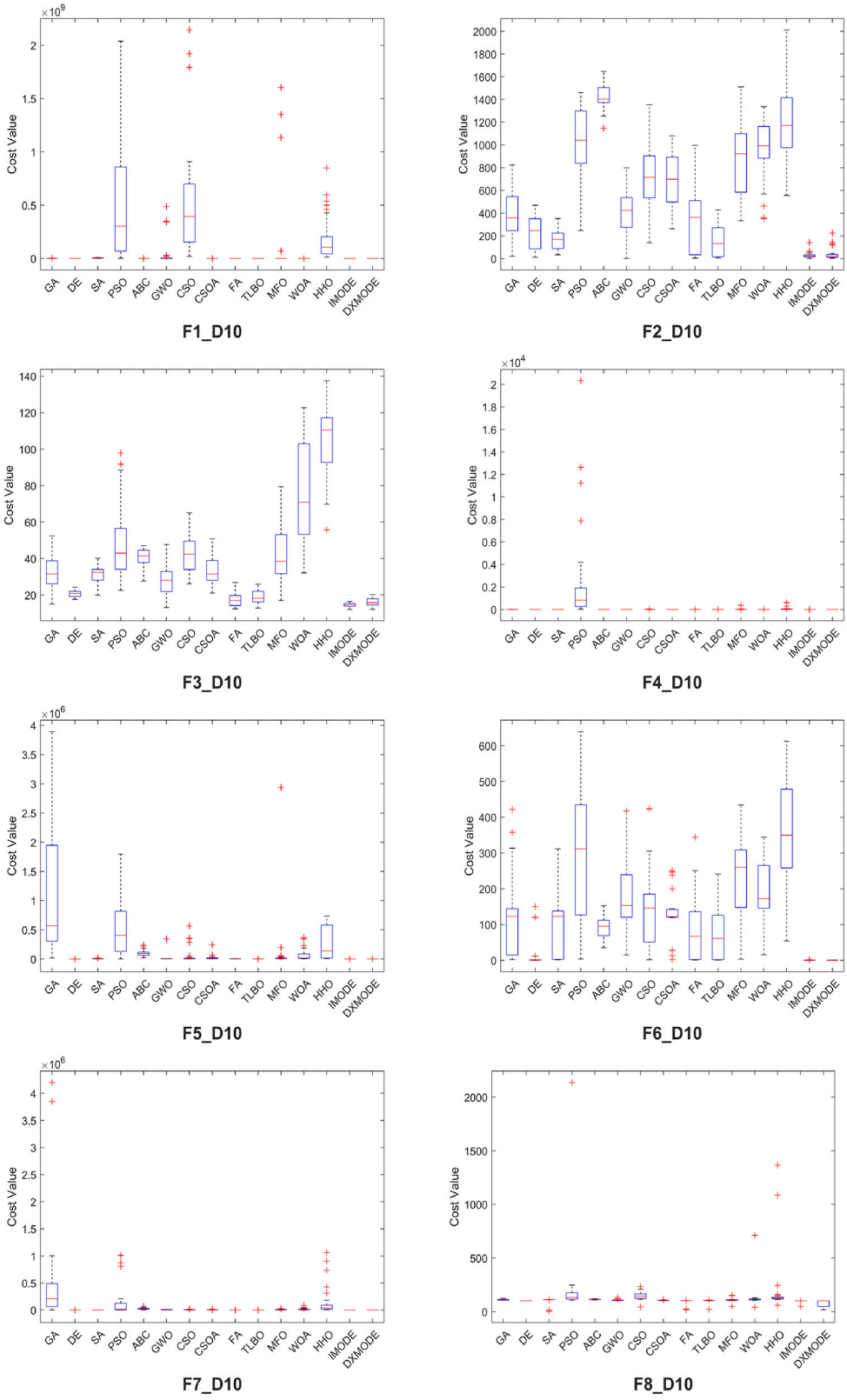


Fig. F.1. Box plots for the best fitness in 30 runs for all the algorithms, F1-F8 (10D).

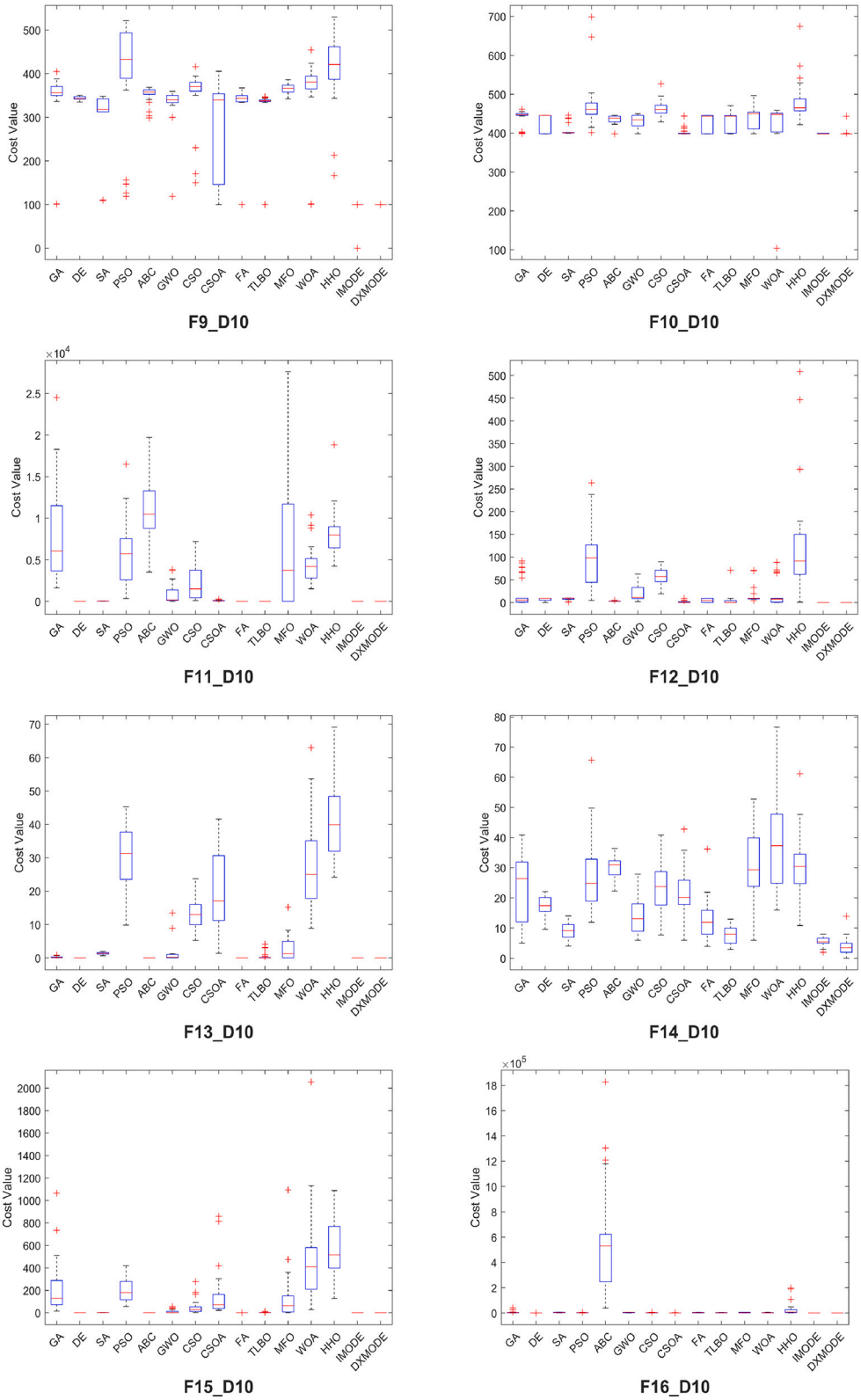


Fig. F.1. (*continued*) Box plots for the best fitness in 30 runs for all algorithms, F9-F16 (10D).

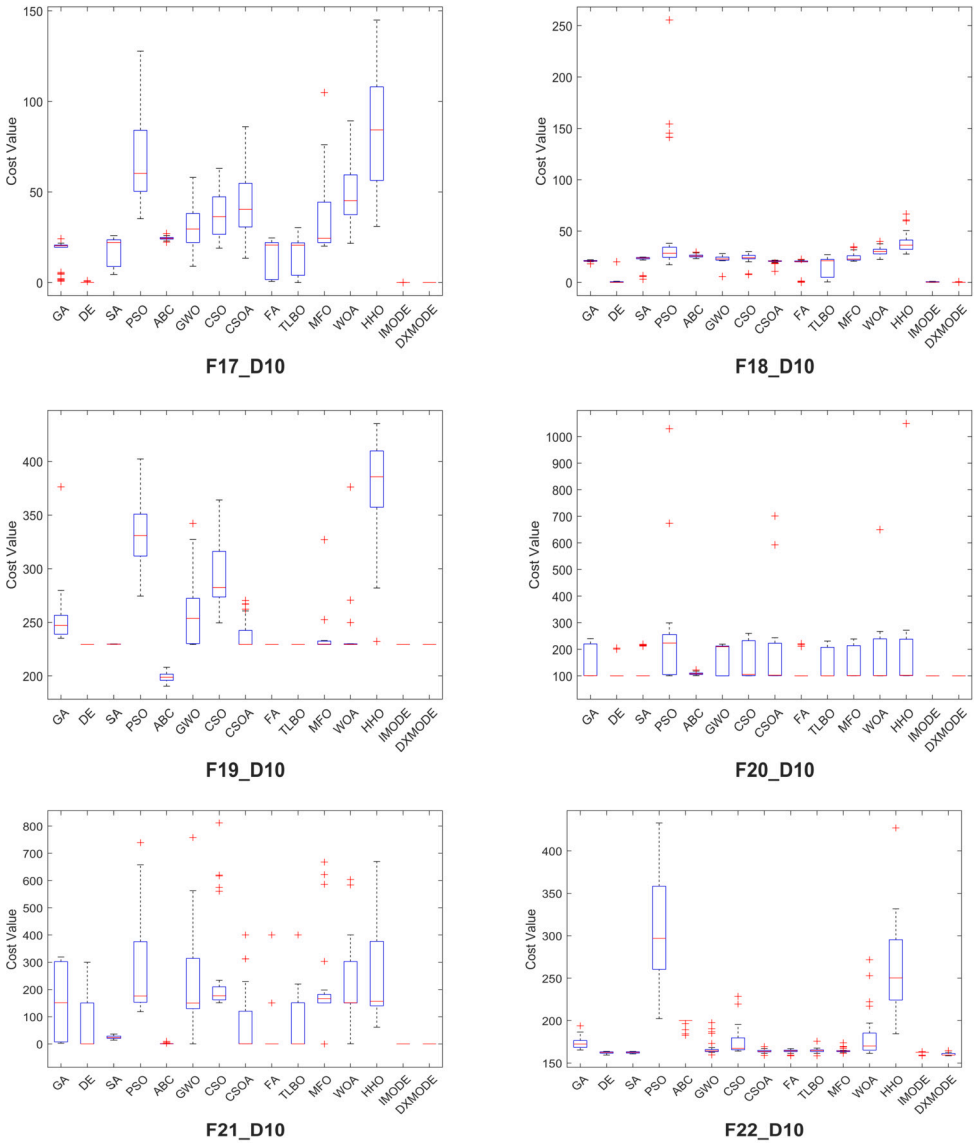


Fig. F.1. (*continued*) Box plots for the best fitness in 30 runs for all algorithms, F17-F22 (10D).

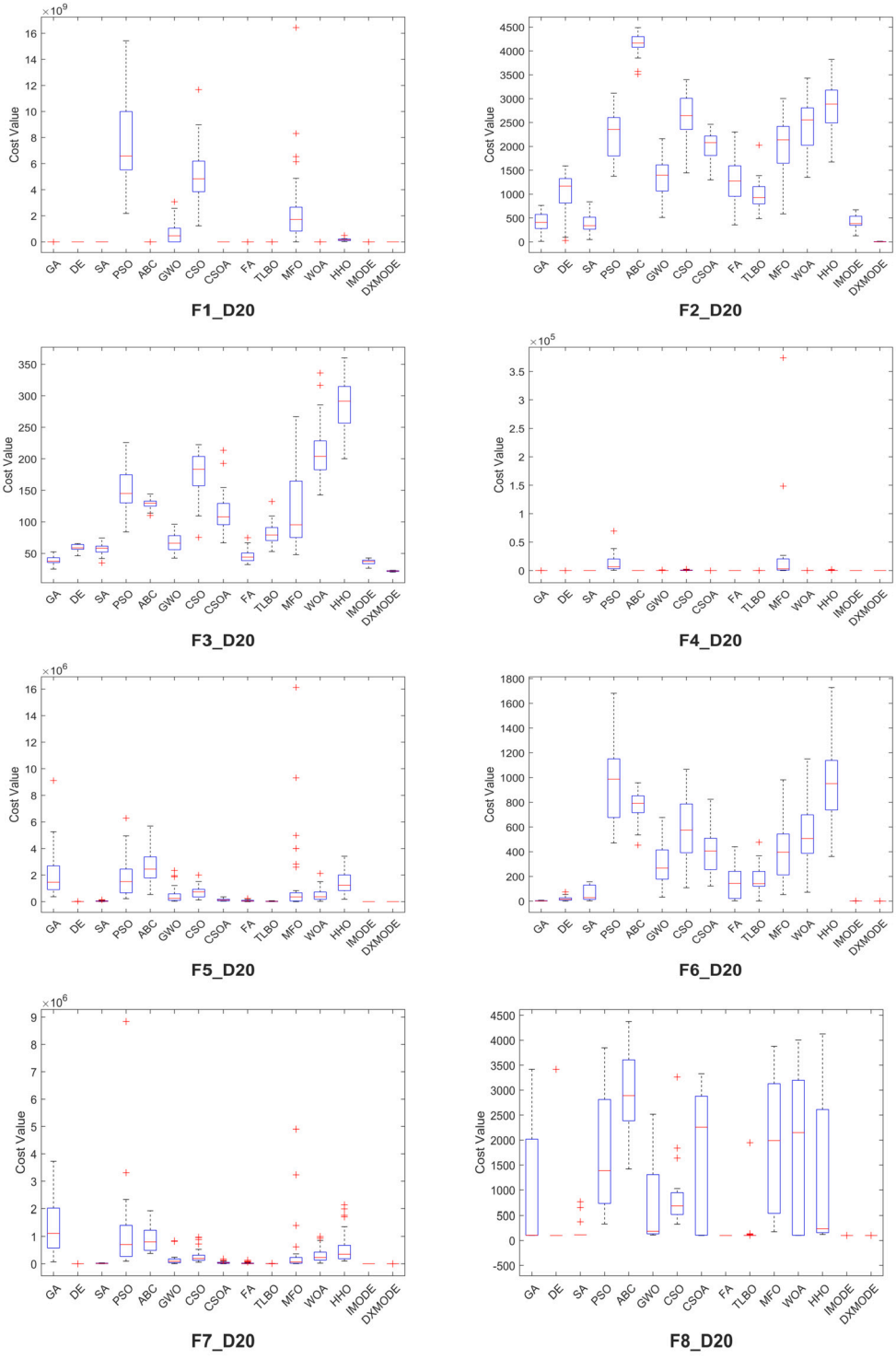
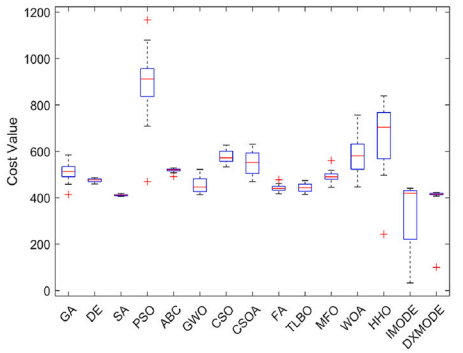
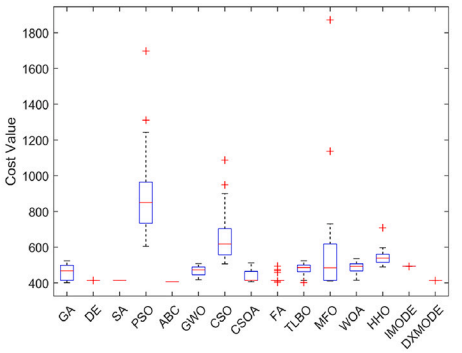


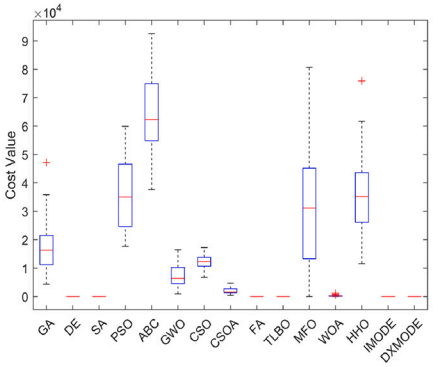
Fig. F.2. Box plots for the best fitness in 30 runs for all the algorithms, F1-F8 (20D).



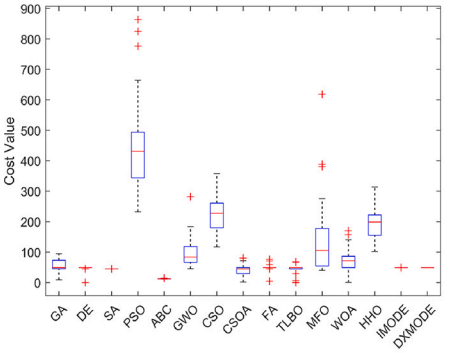
F9_D20



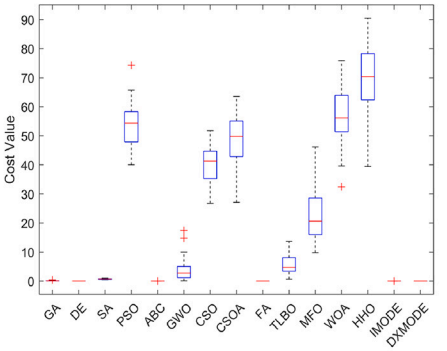
F10_D20



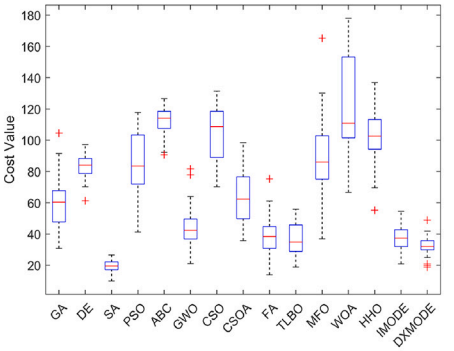
F11_D20



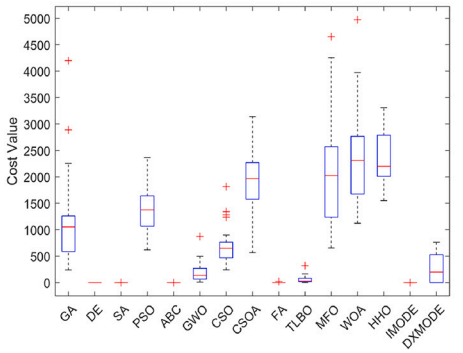
F12_D20



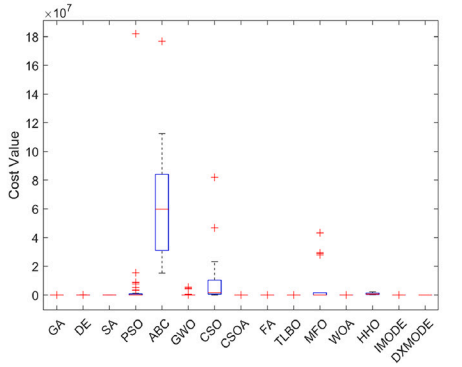
F13_D20



F14_D20



F15_D20



F16_D20

Fig. F.2. (*continued*) Box plots for the best fitness in 30 runs for all algorithms, F9-F16 (20D).

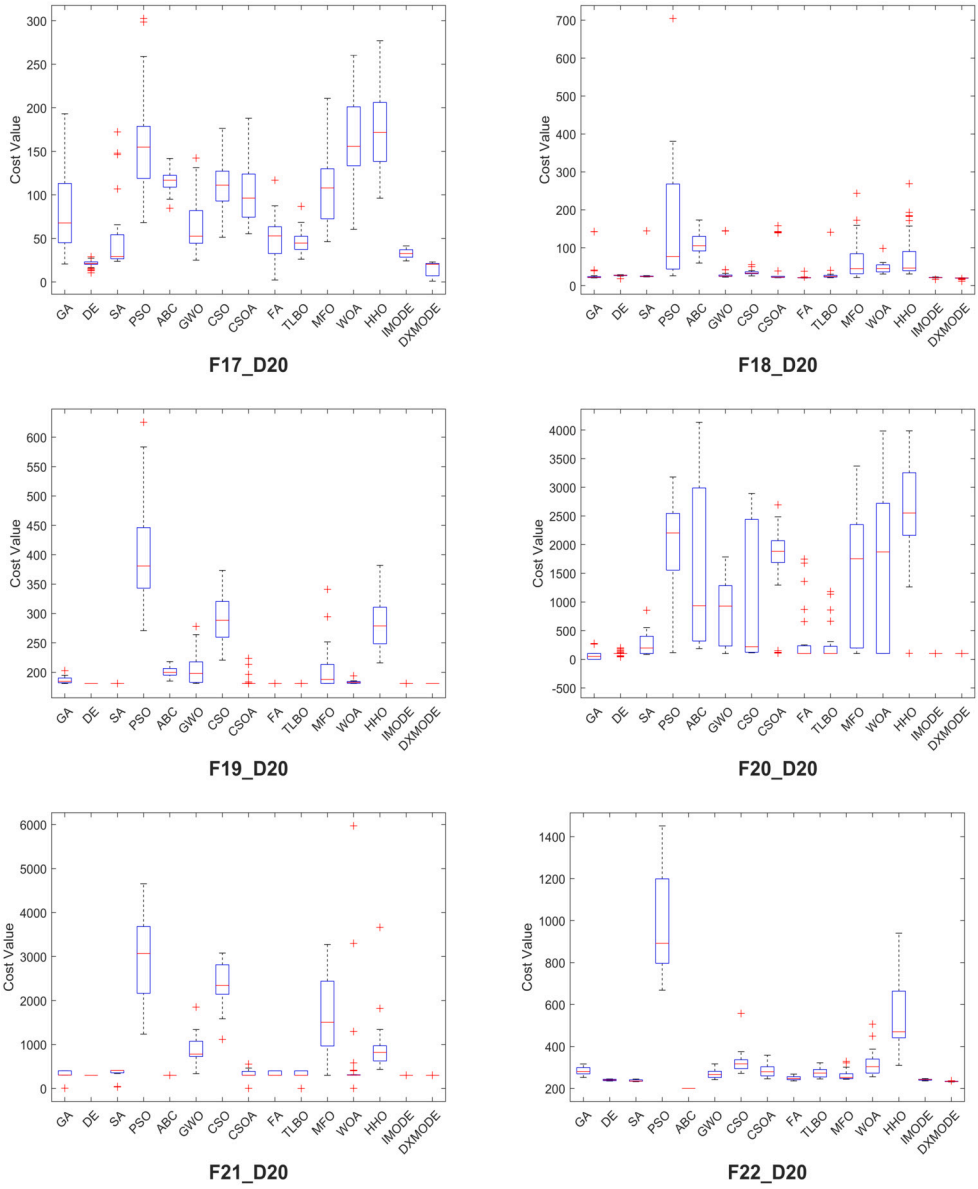


Fig. F.2. (*continued*) Box plots for the best fitness in 30 runs for all algorithms, F17-F22 (20D).

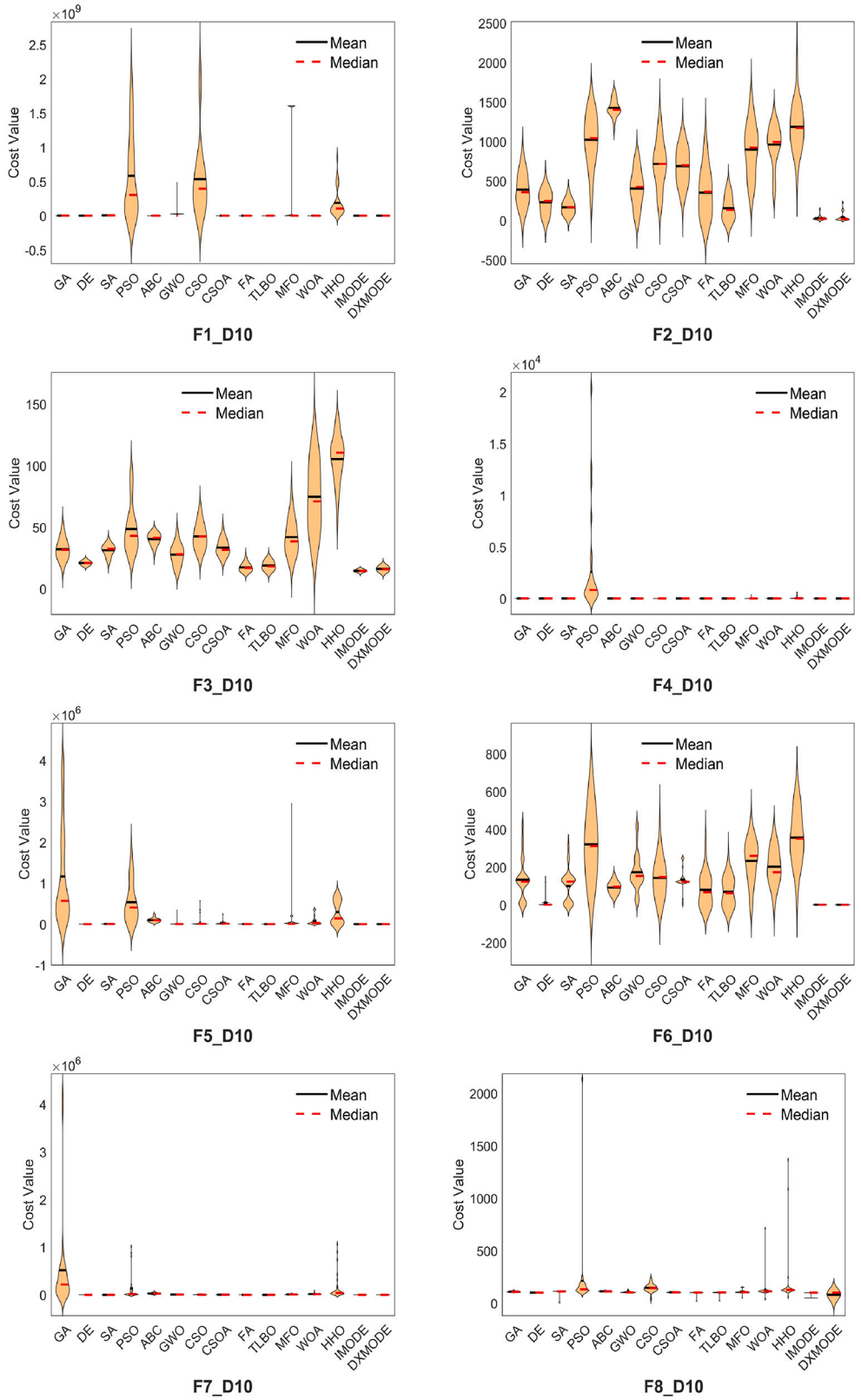


Fig. F.3. Violin plots for the best fitness in 30 runs for all the algorithms, F1-F8 (10D).

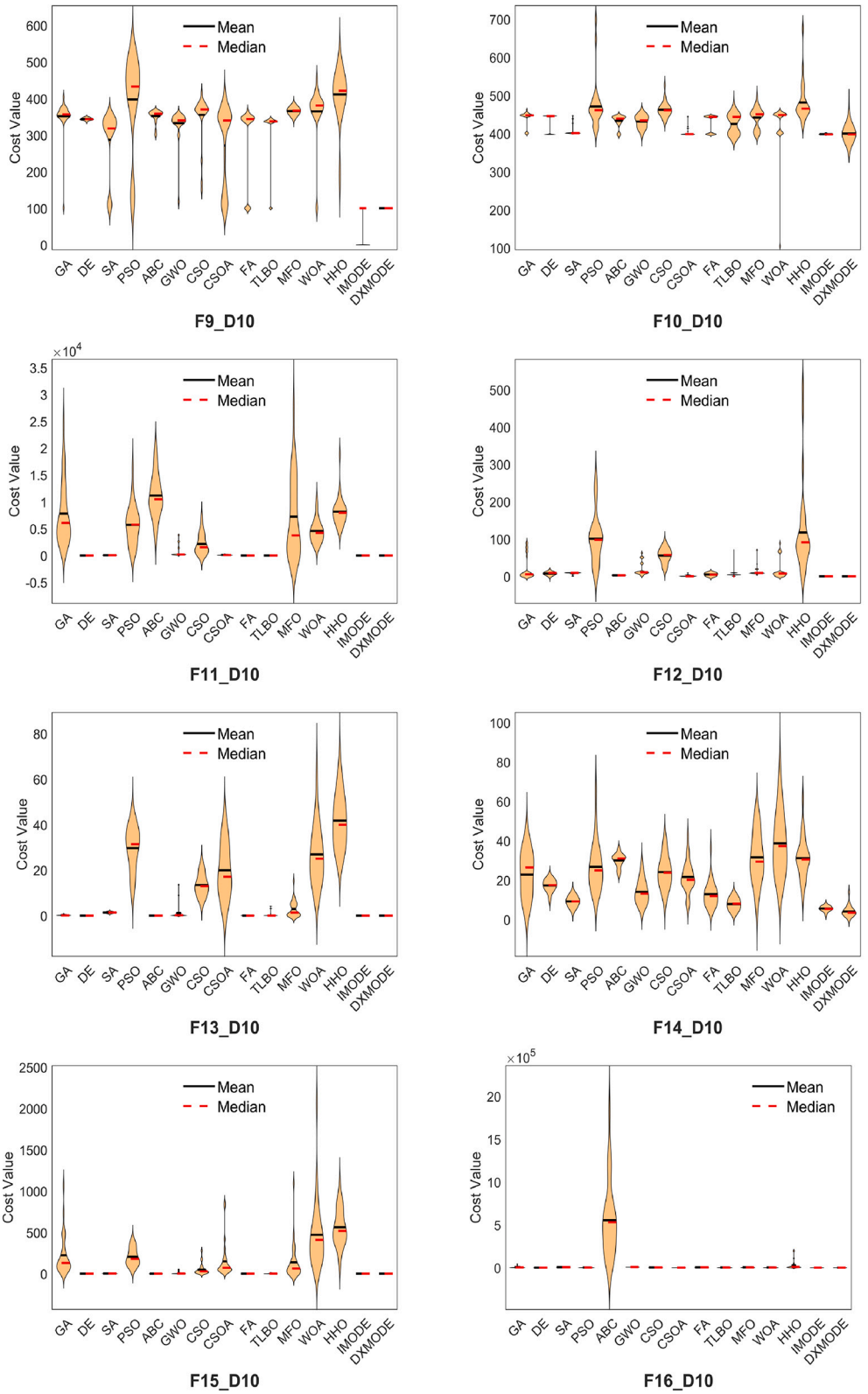


Fig. F.3. (*continued*) Violin plots for best fitness in 30 runs for all algorithms, F9-F16 (10D).

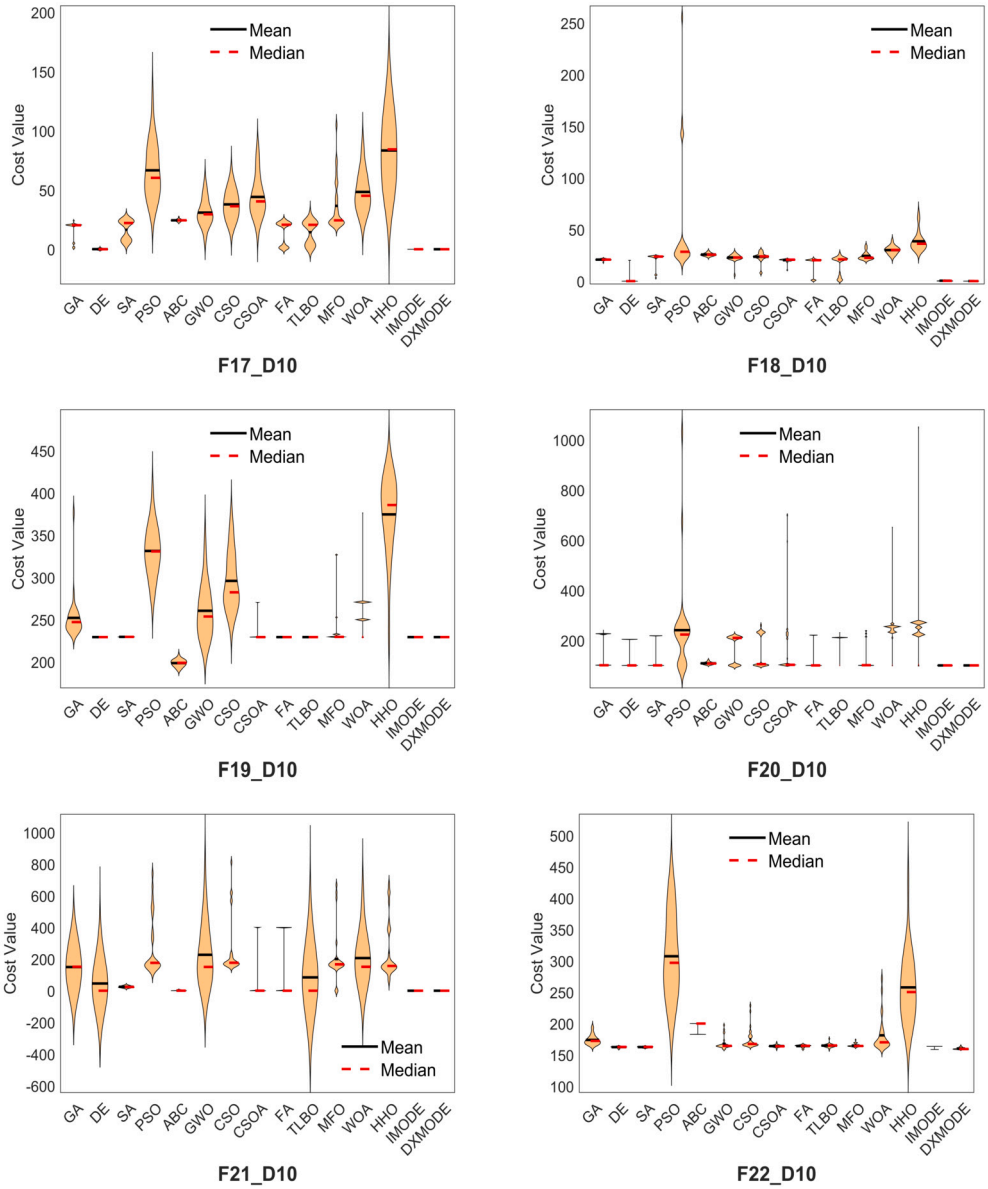


Fig. F.3. (*continued*) Violin plots for best fitness in 30 runs for all algorithms, F17-F22 (10D).

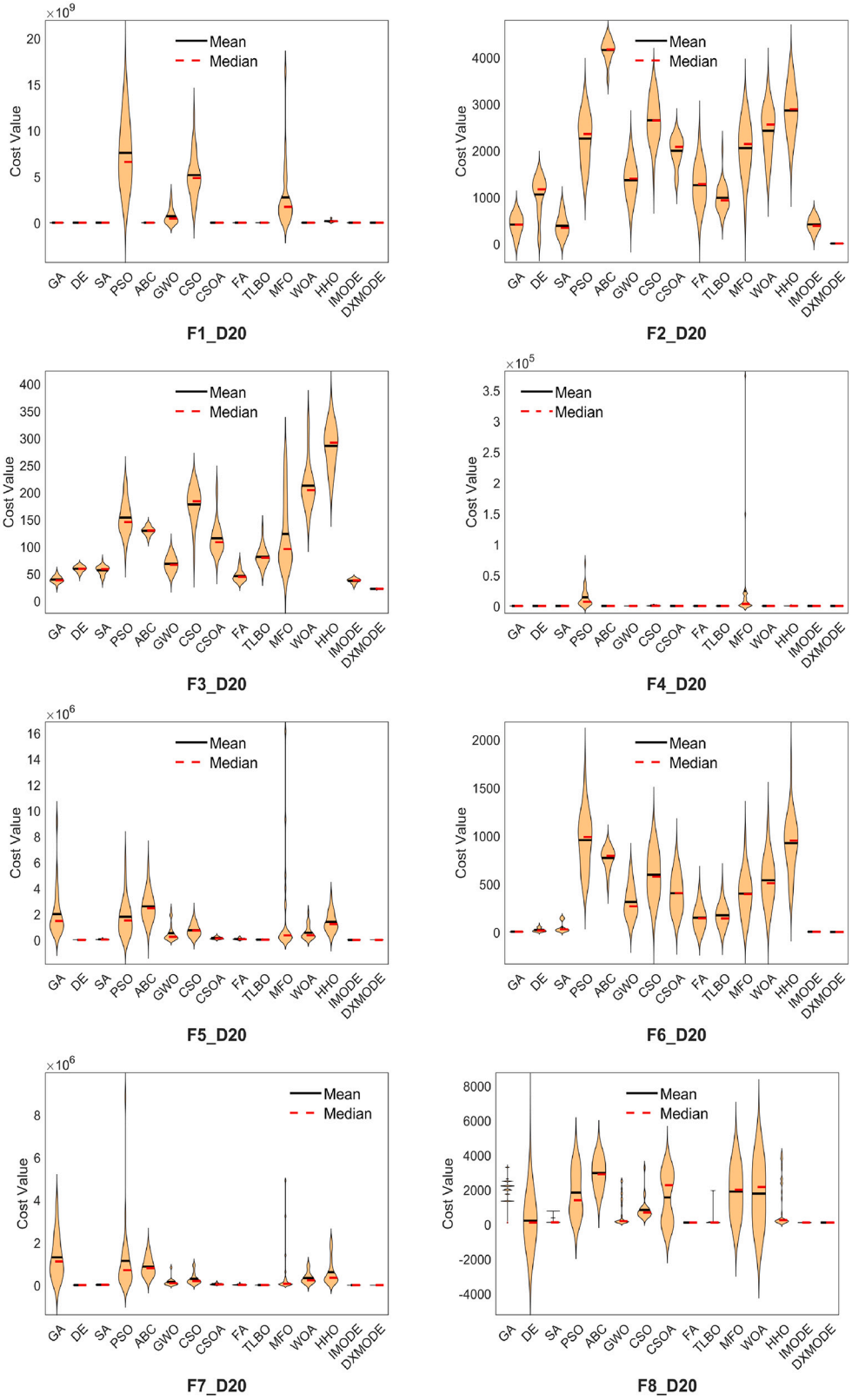


Fig. F.4. Violin plots for the best fitness in 30 runs for all the algorithms, F1-F8 (20D).

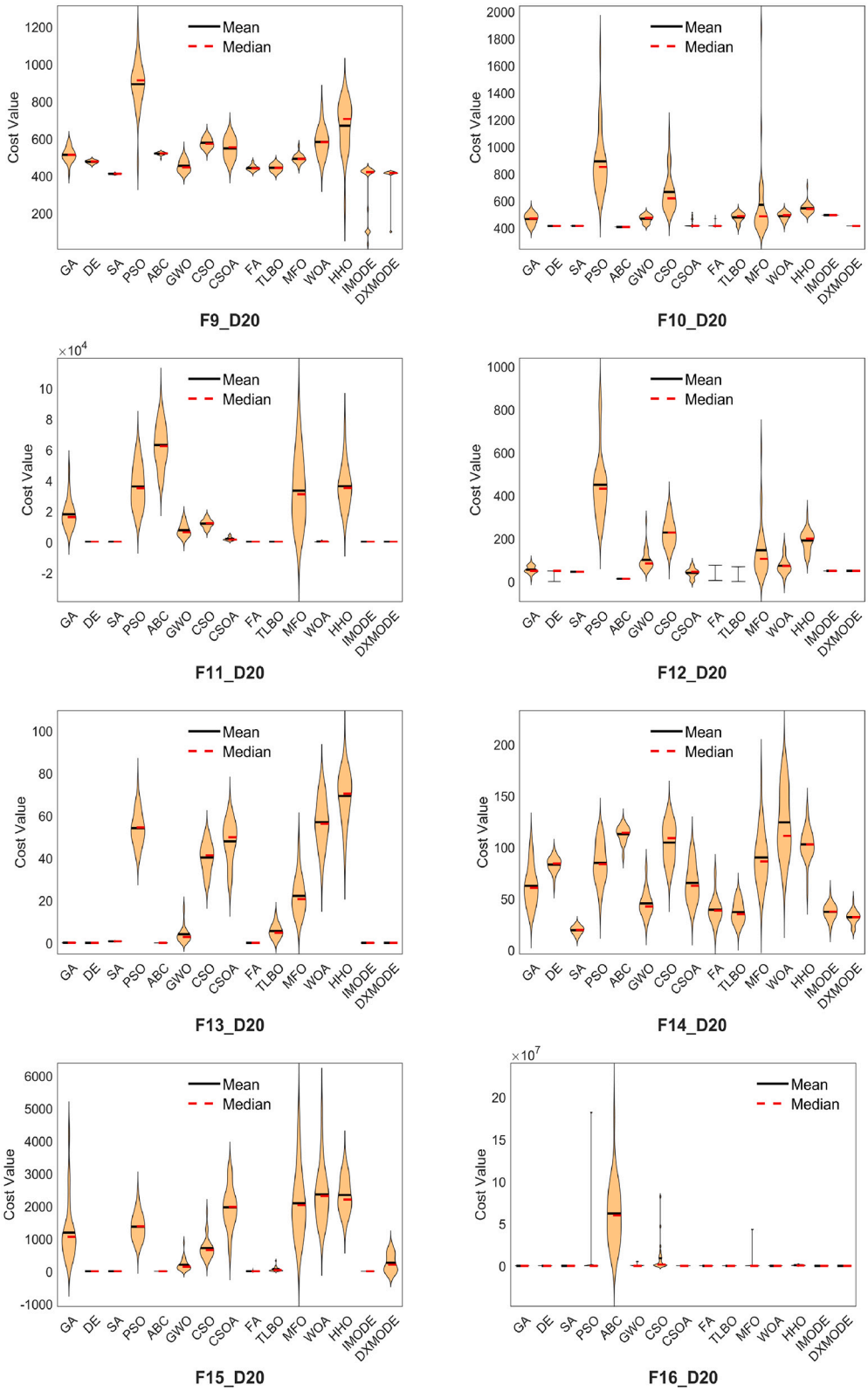


Fig. F.4. (*continued*) Violin plots for best fitness in 30 runs for all algorithms, F9-F16 (20D).

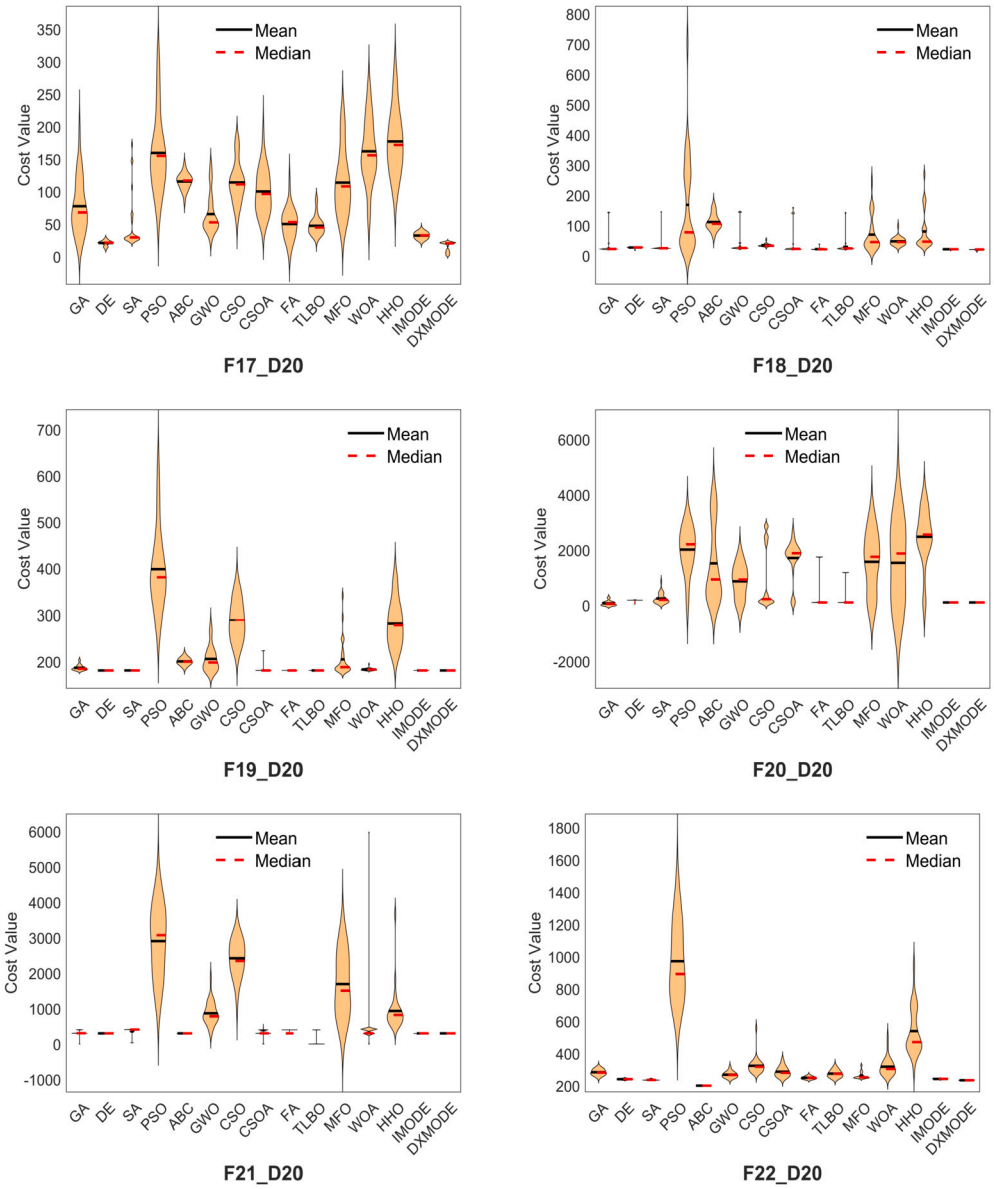


Fig. F.4. (*continued*) Violin plots for best fitness in 30 runs for all algorithms, F17-F22 (20D).

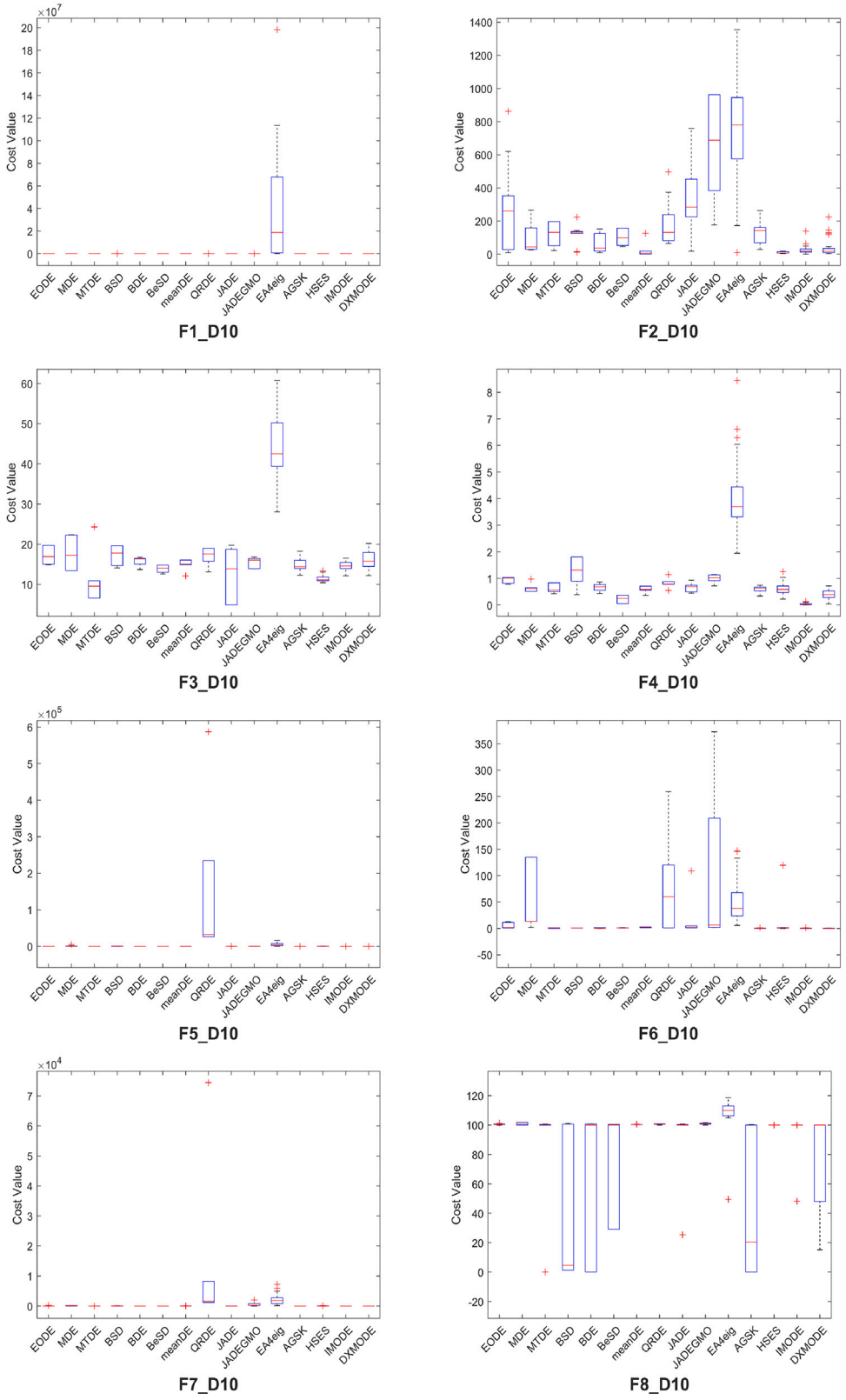


Fig. F.5. Box plots for the best fitness in 30 runs for advanced algorithms, F1-F8 (10D).

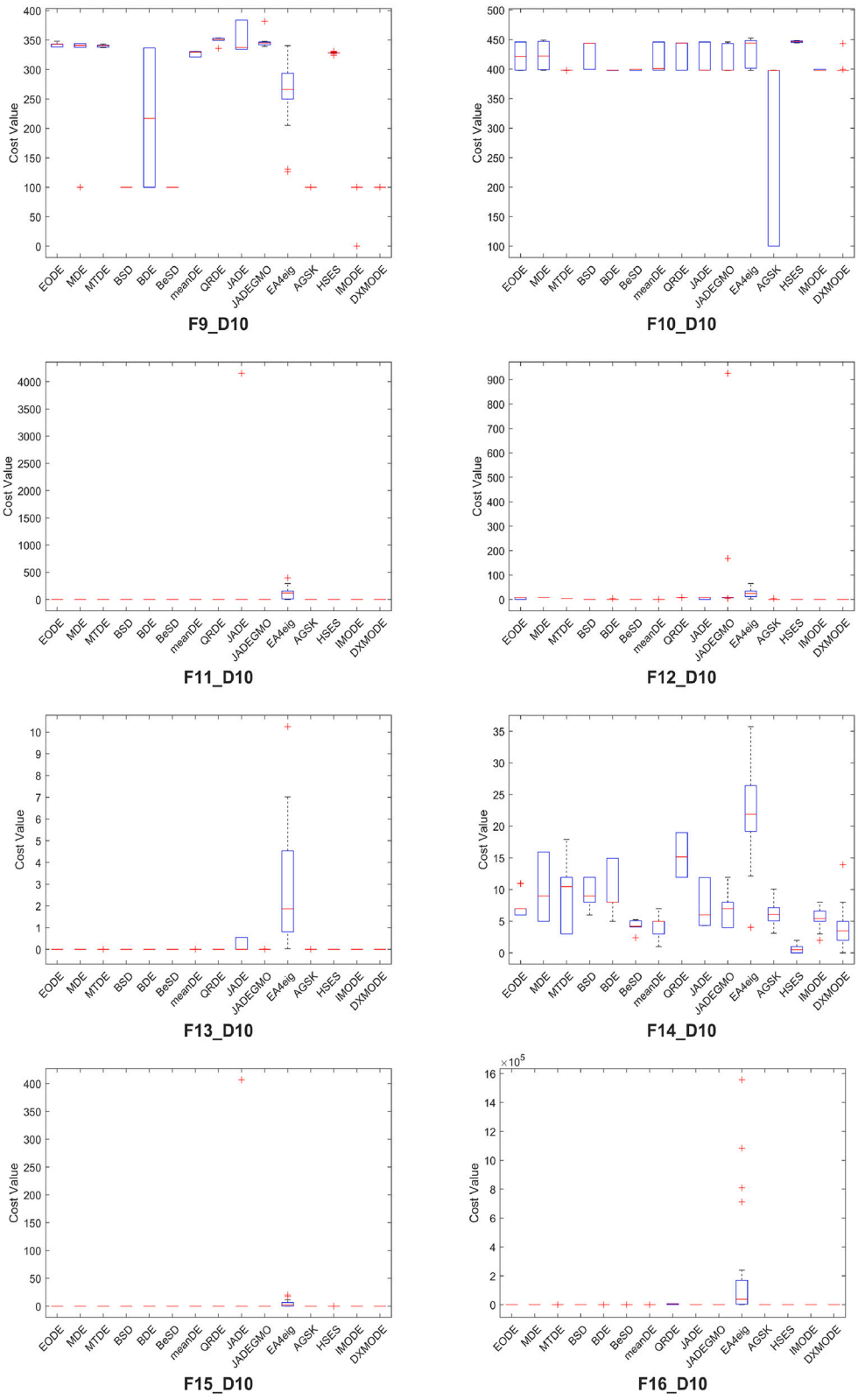


Fig. F.5. (*continued*) Box plots for the best fitness in 30 runs for advanced algorithms, F9-F16 (10D).

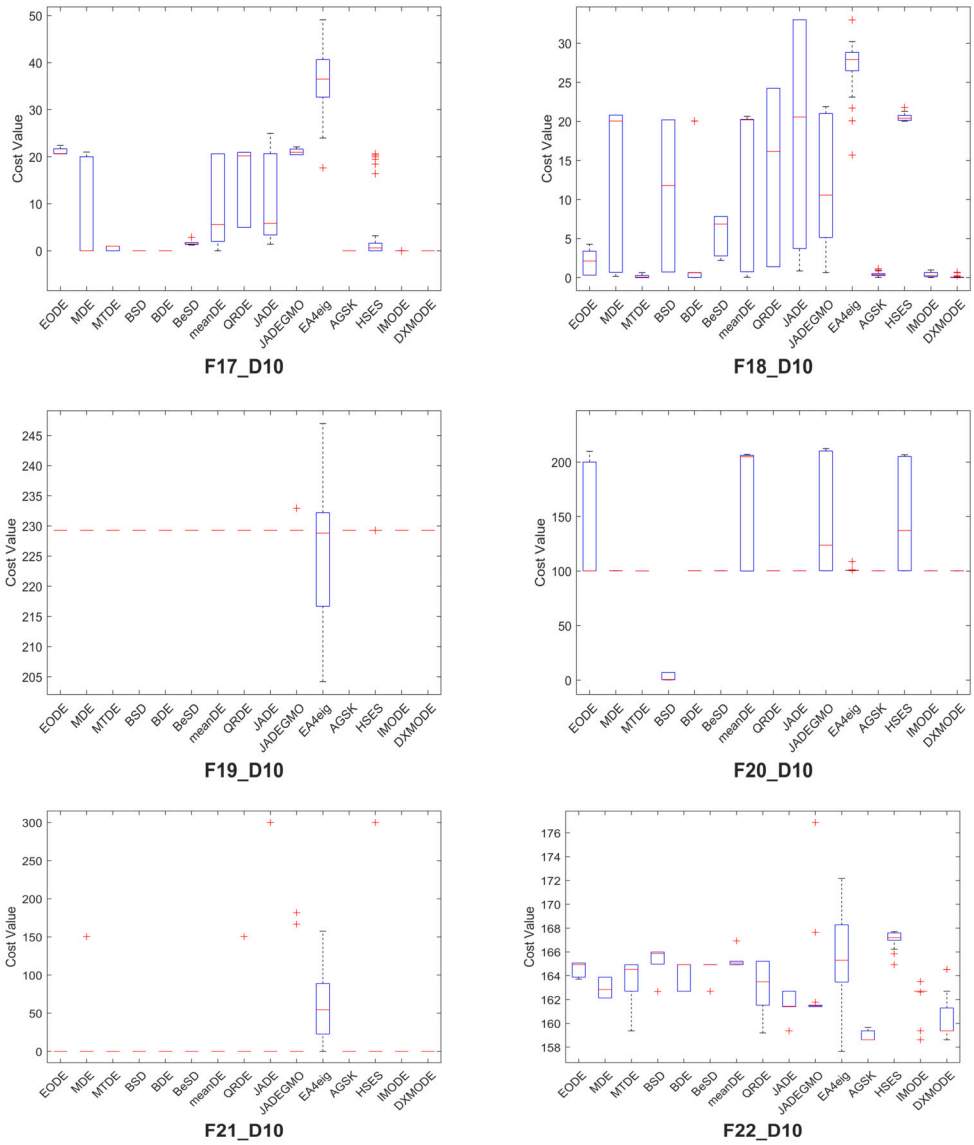


Fig. F.5. (*continued*) Box plots for the best fitness in 30 runs for advanced algorithms, F17-F22 (10D).

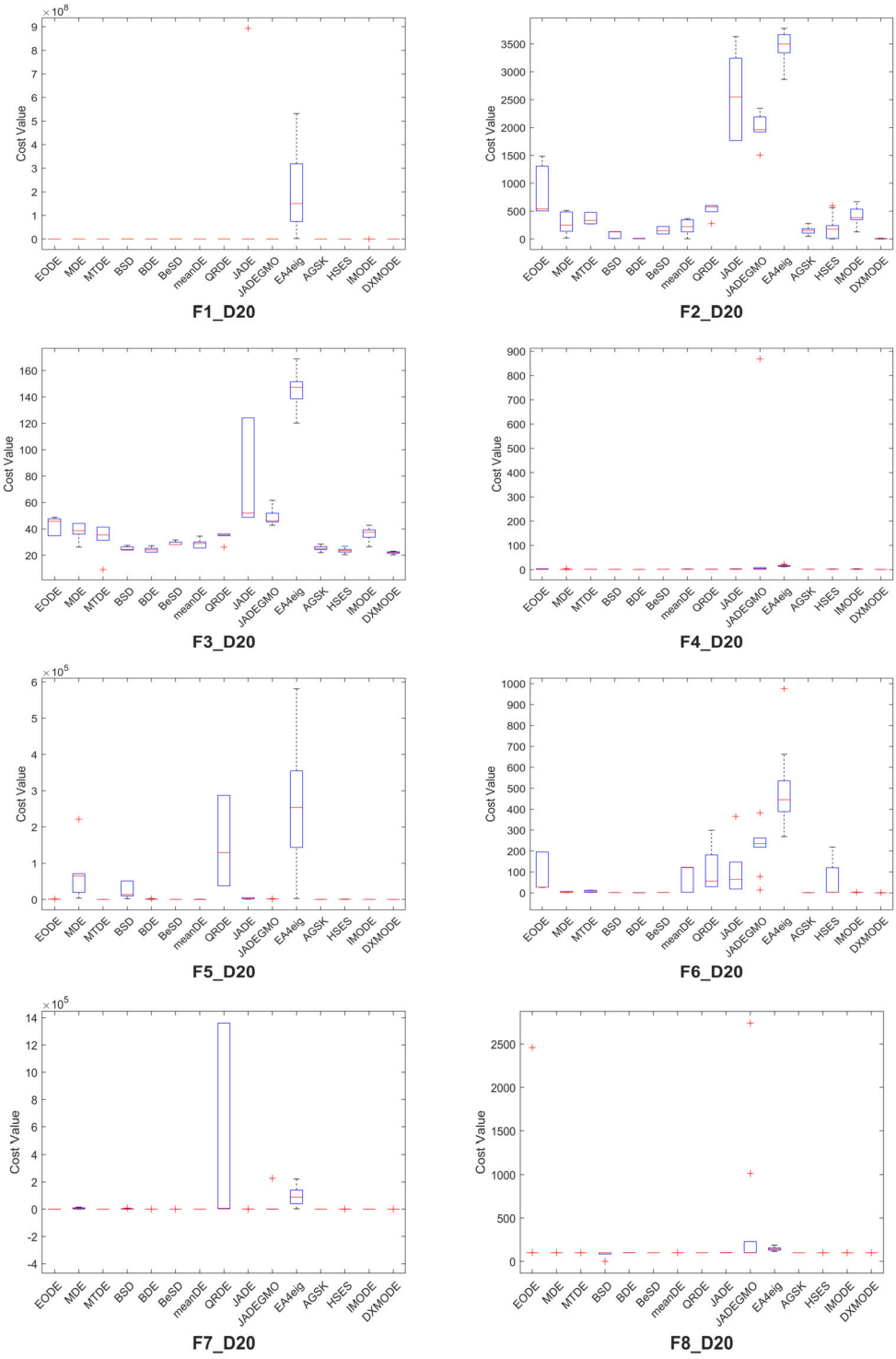


Fig. F.6. Box plots for the best fitness in 30 runs for advanced algorithms, F1-F8 (20D).

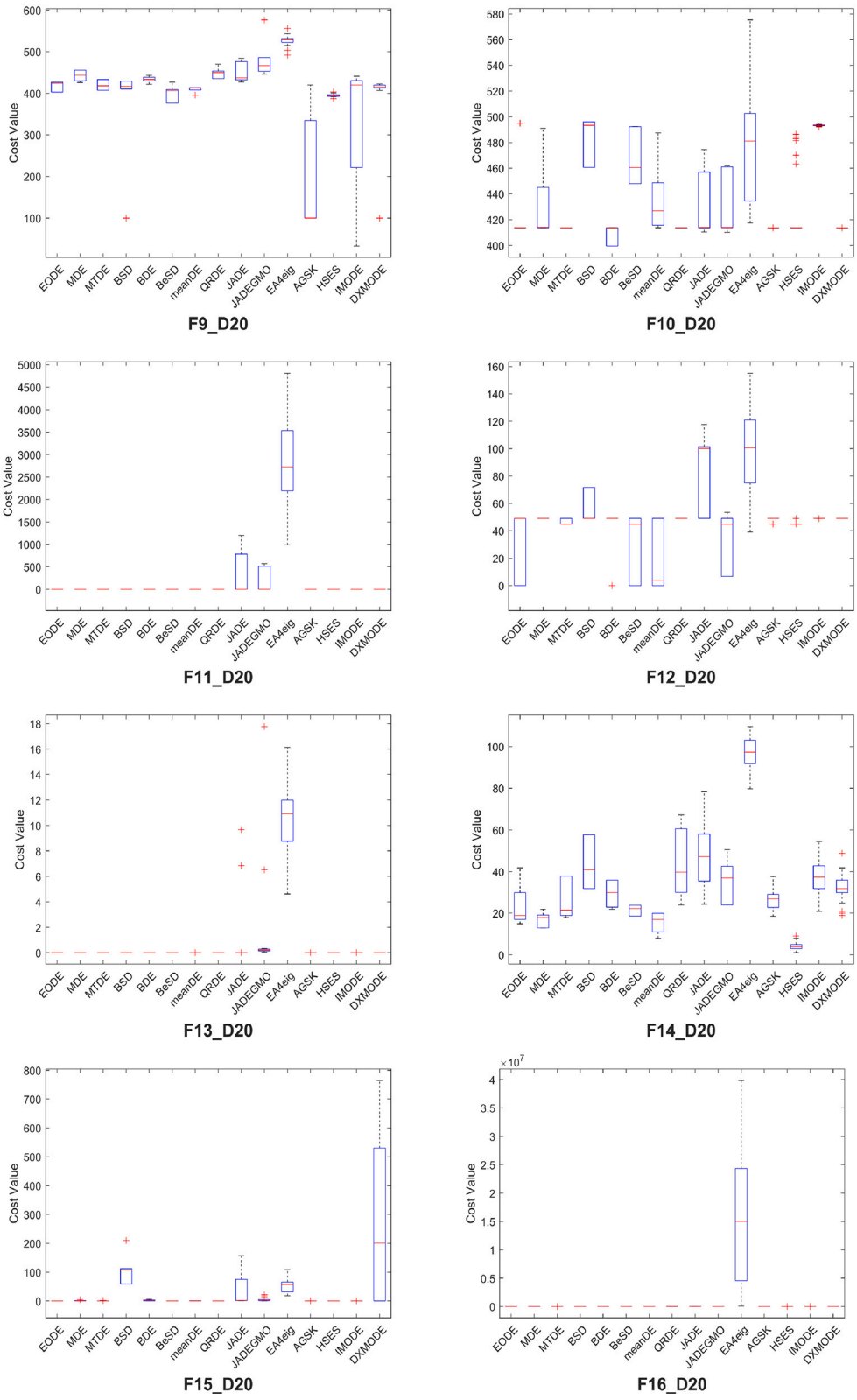


Fig. F.6. (*continued*) Box plots for the best fitness in 30 runs for advanced algorithms, F9-F16 (20D).

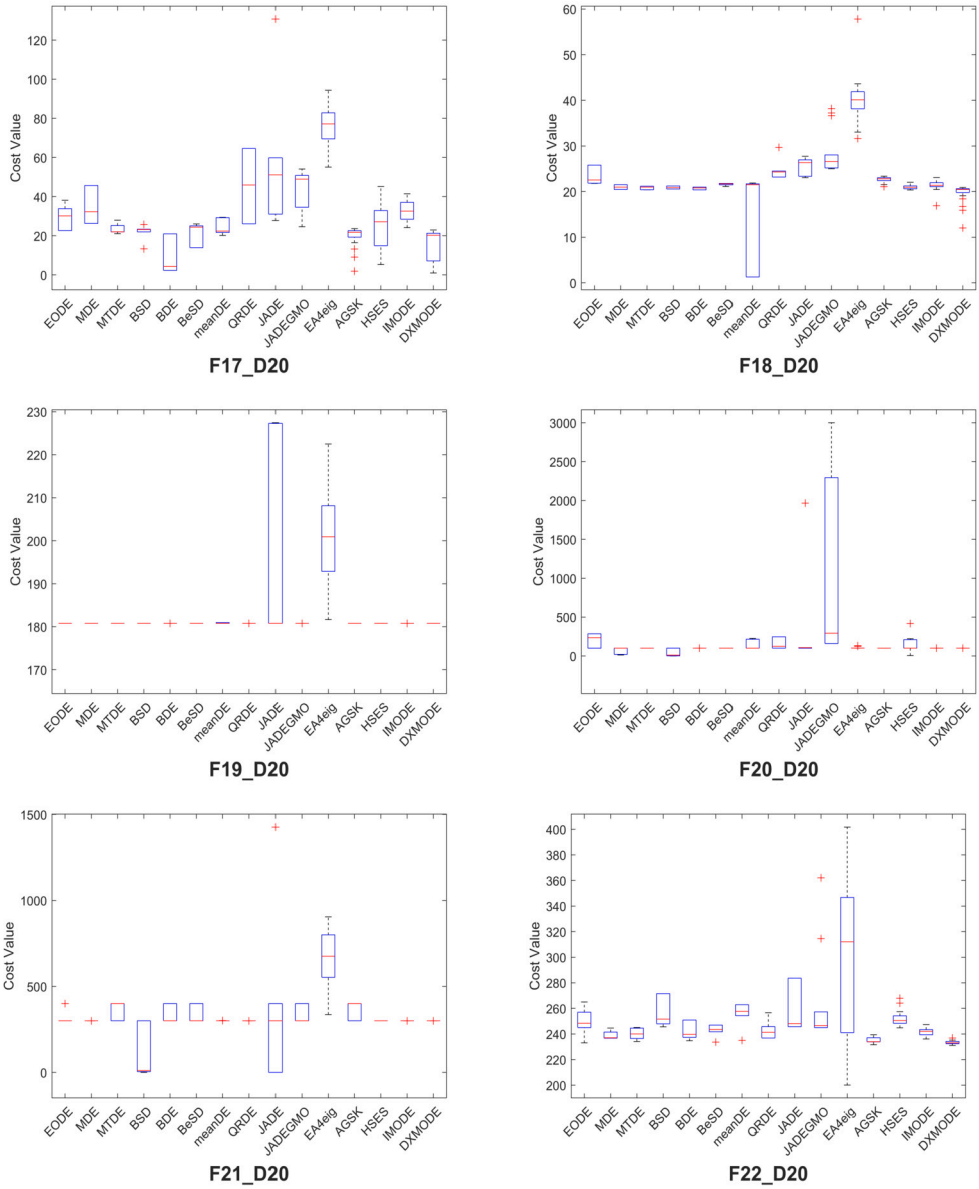


Fig. F.6. (*continued*) Box plots for the best fitness in 30 runs for advanced algorithms, F17-F22 (20D).

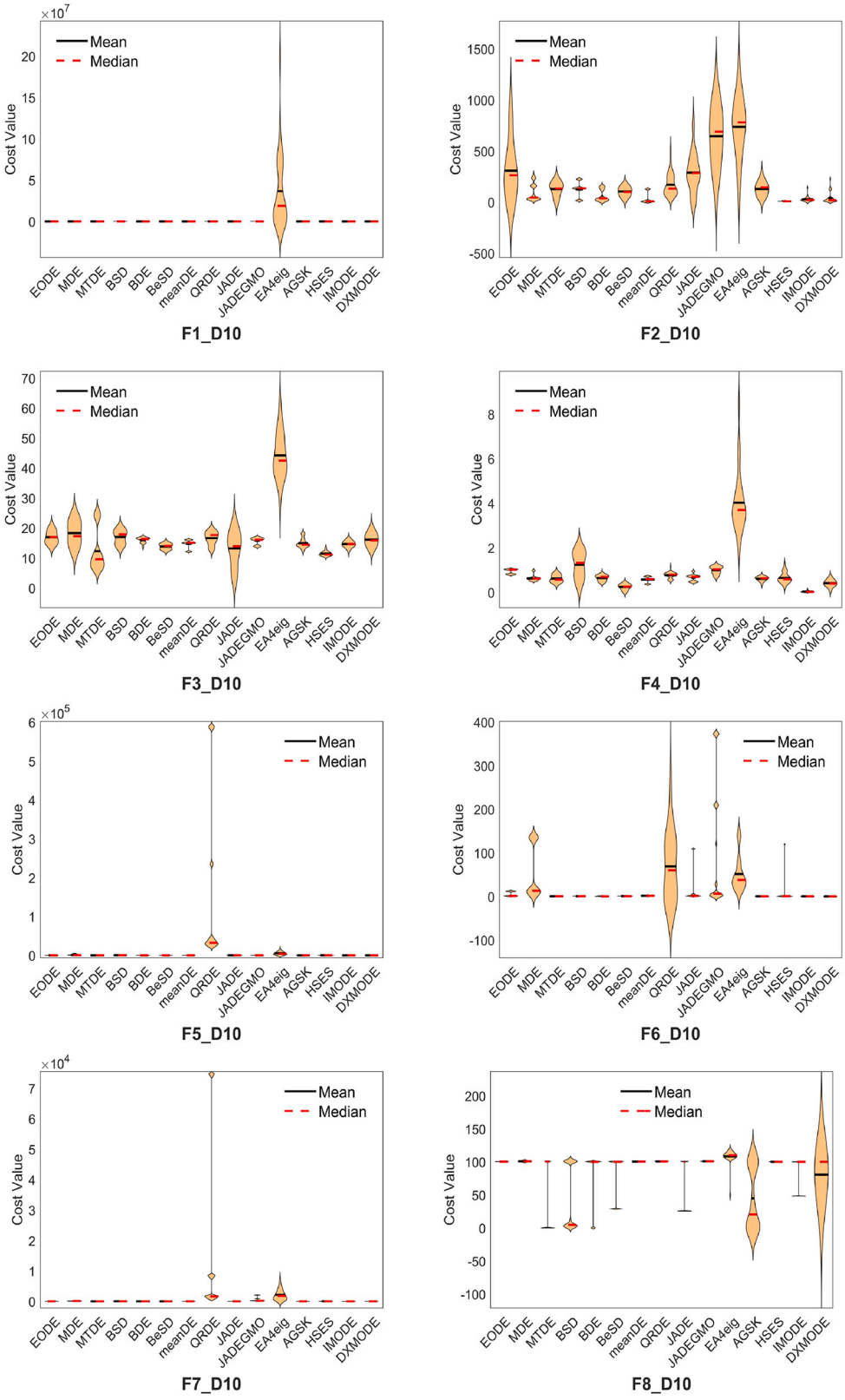
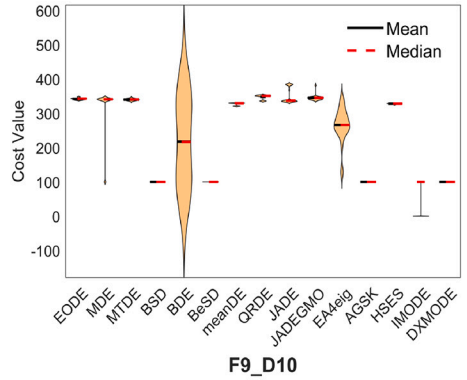
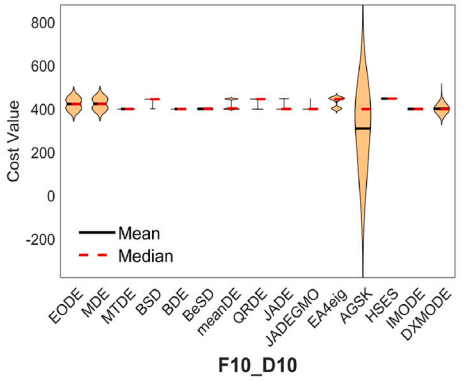
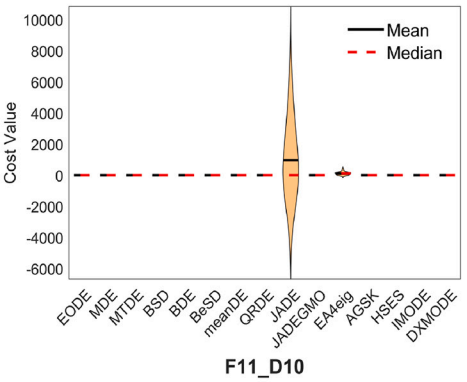
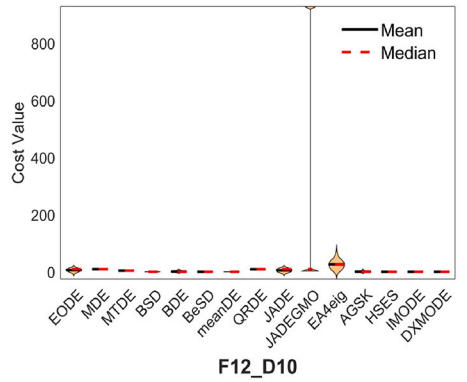


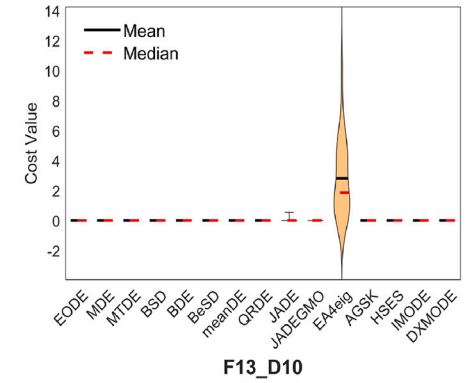
Fig. F.7. Violin plots for the best fitness in 30 runs for advanced algorithms, F1-F8 (10D).

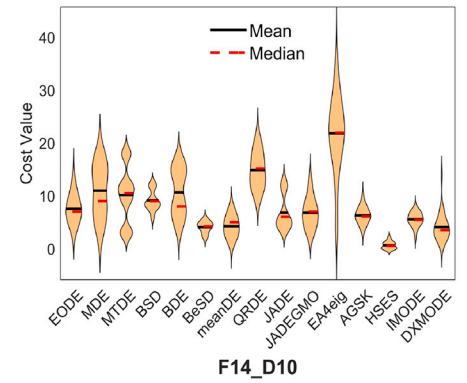


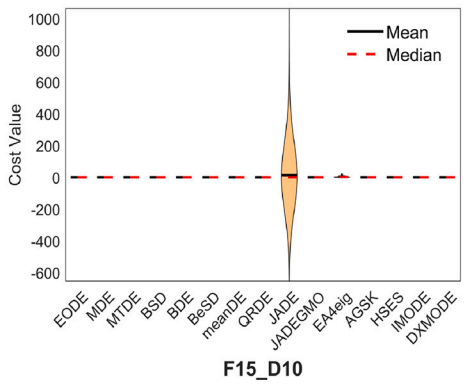












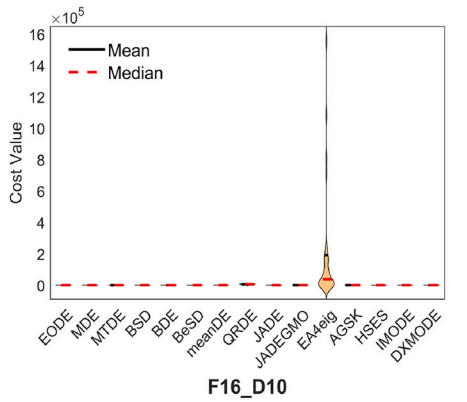


Fig. F.7. (*continued*) Violin plots for best fitness in 30 runs for advanced algorithms, F9-F16 (10D).

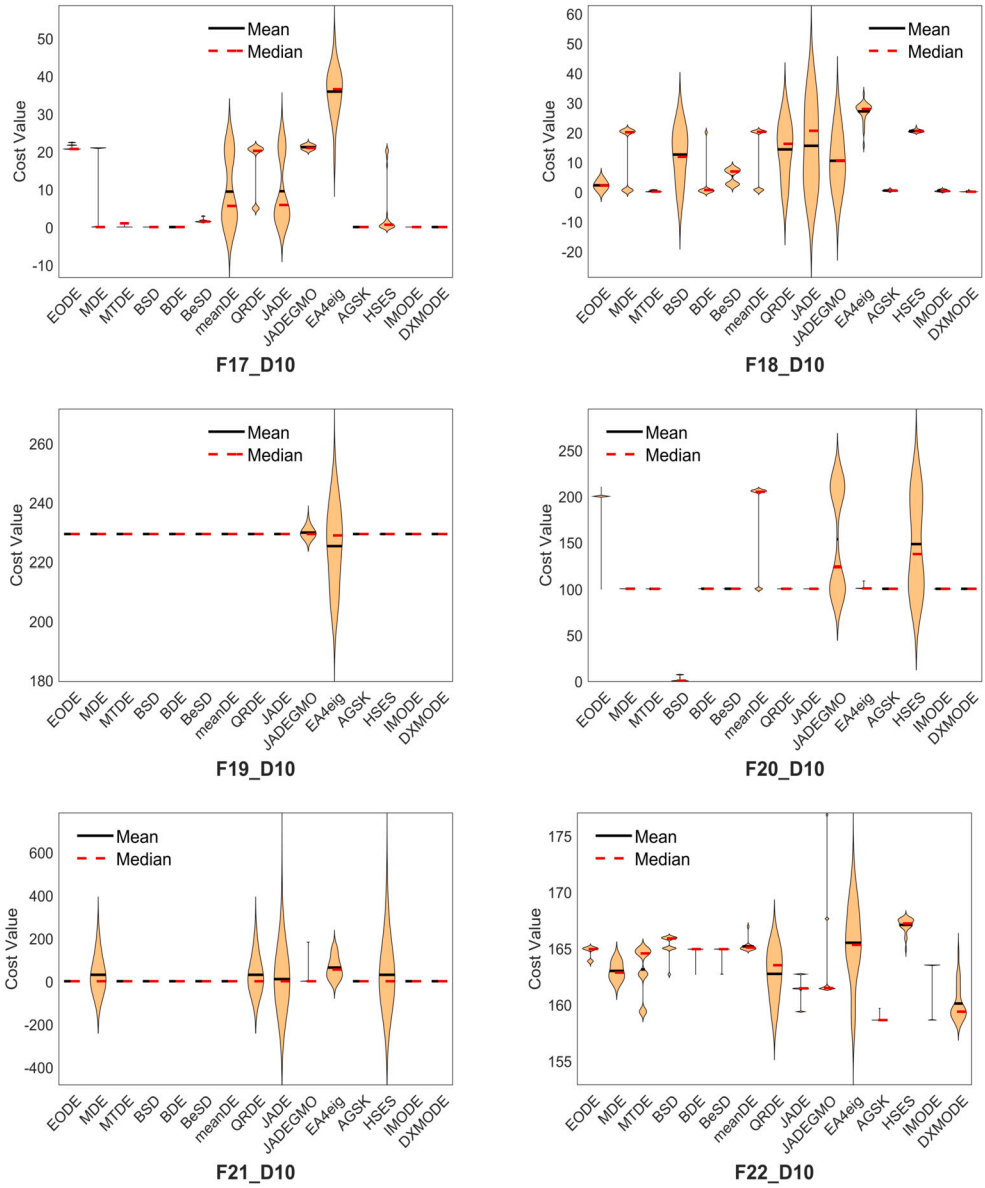


Fig. F.7. (*continued*) Violin plots for best fitness in 30 runs for advanced algorithms, F17-F22 (10D).

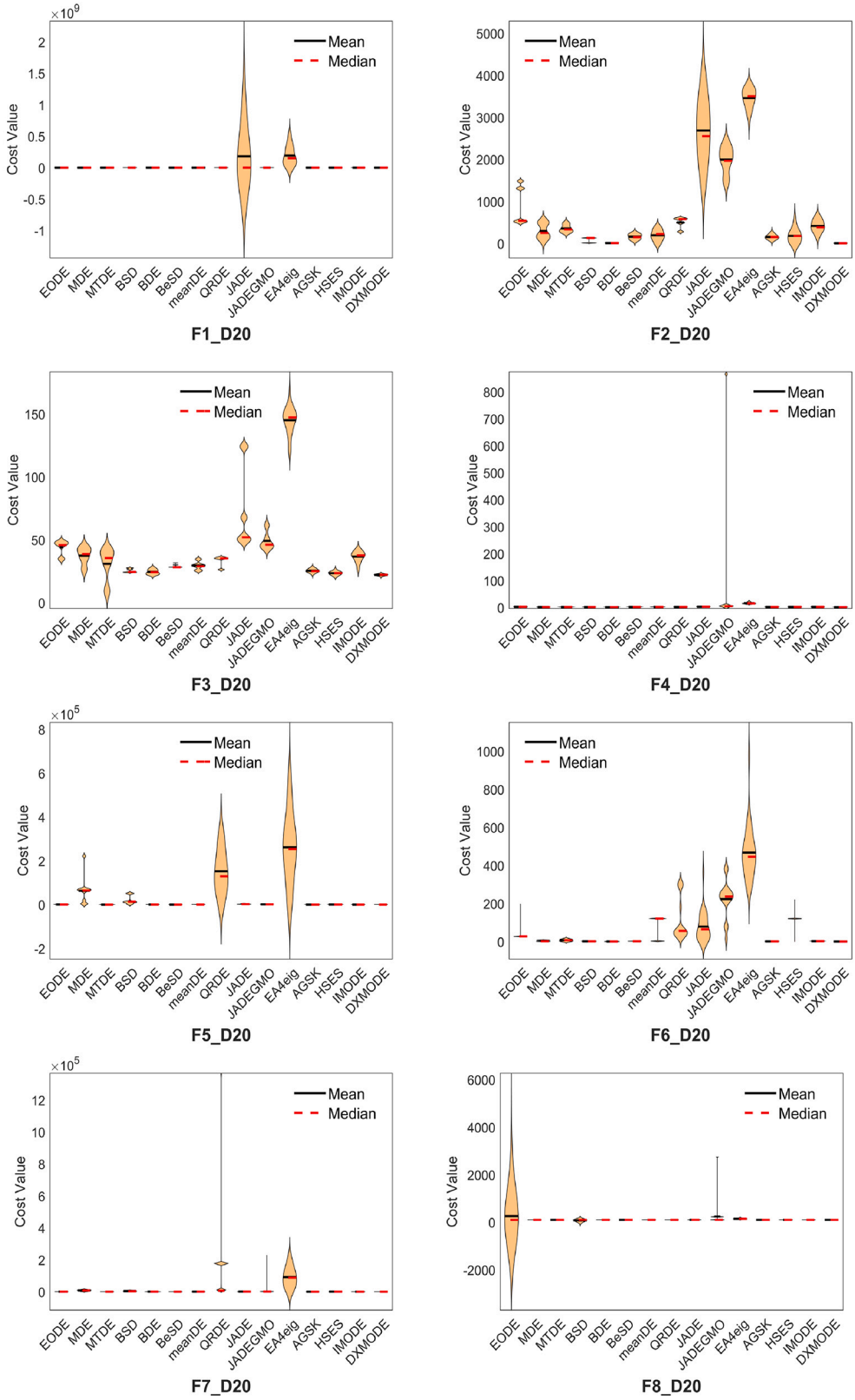


Fig. F.8. Violin plots for the best fitness in 30 runs for advanced algorithms, F1-F8 (20D).

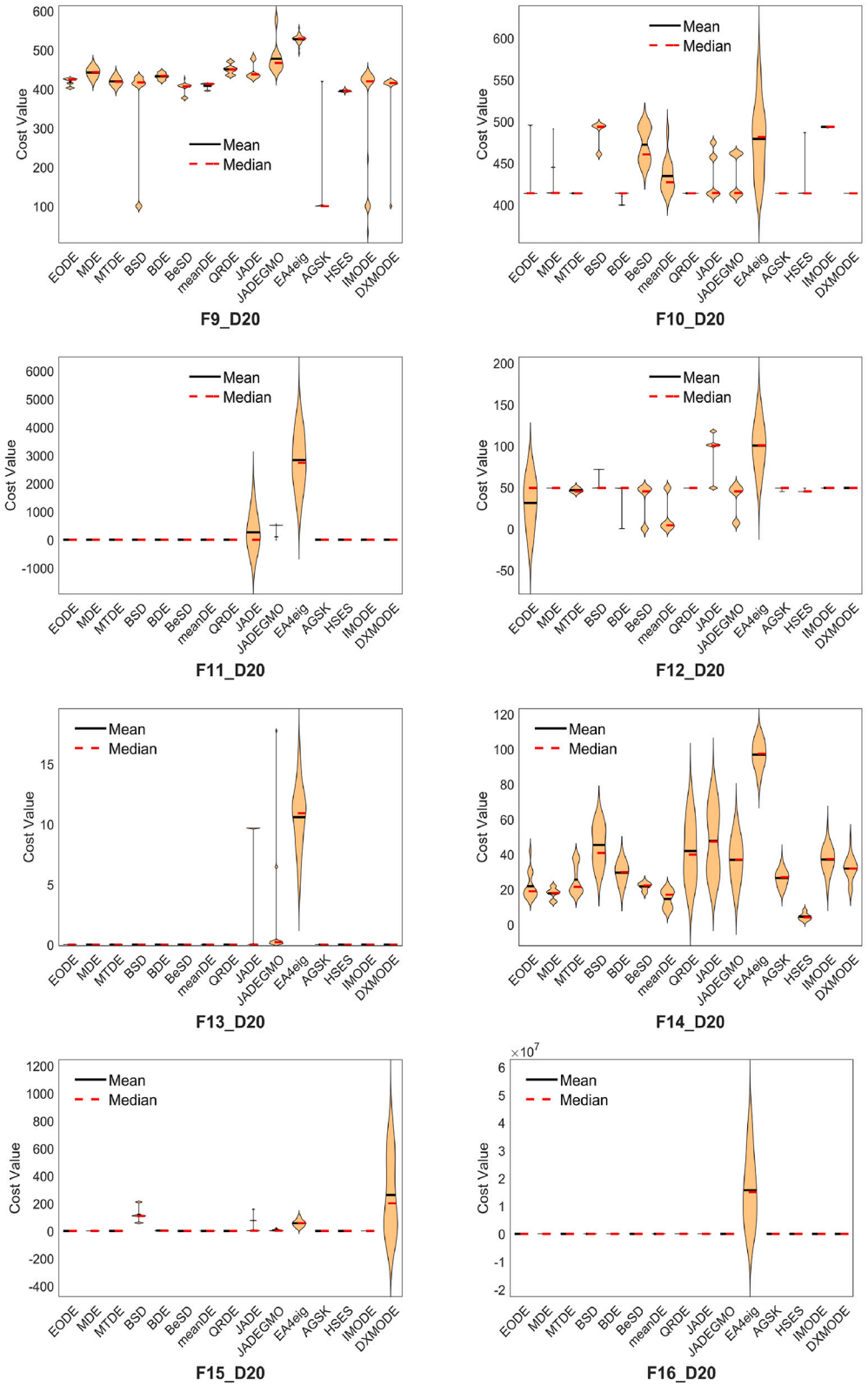


Fig. F.8. (*continued*) Violin plots for best fitness in 30 runs for advanced algorithms, F9-F16 (20D).

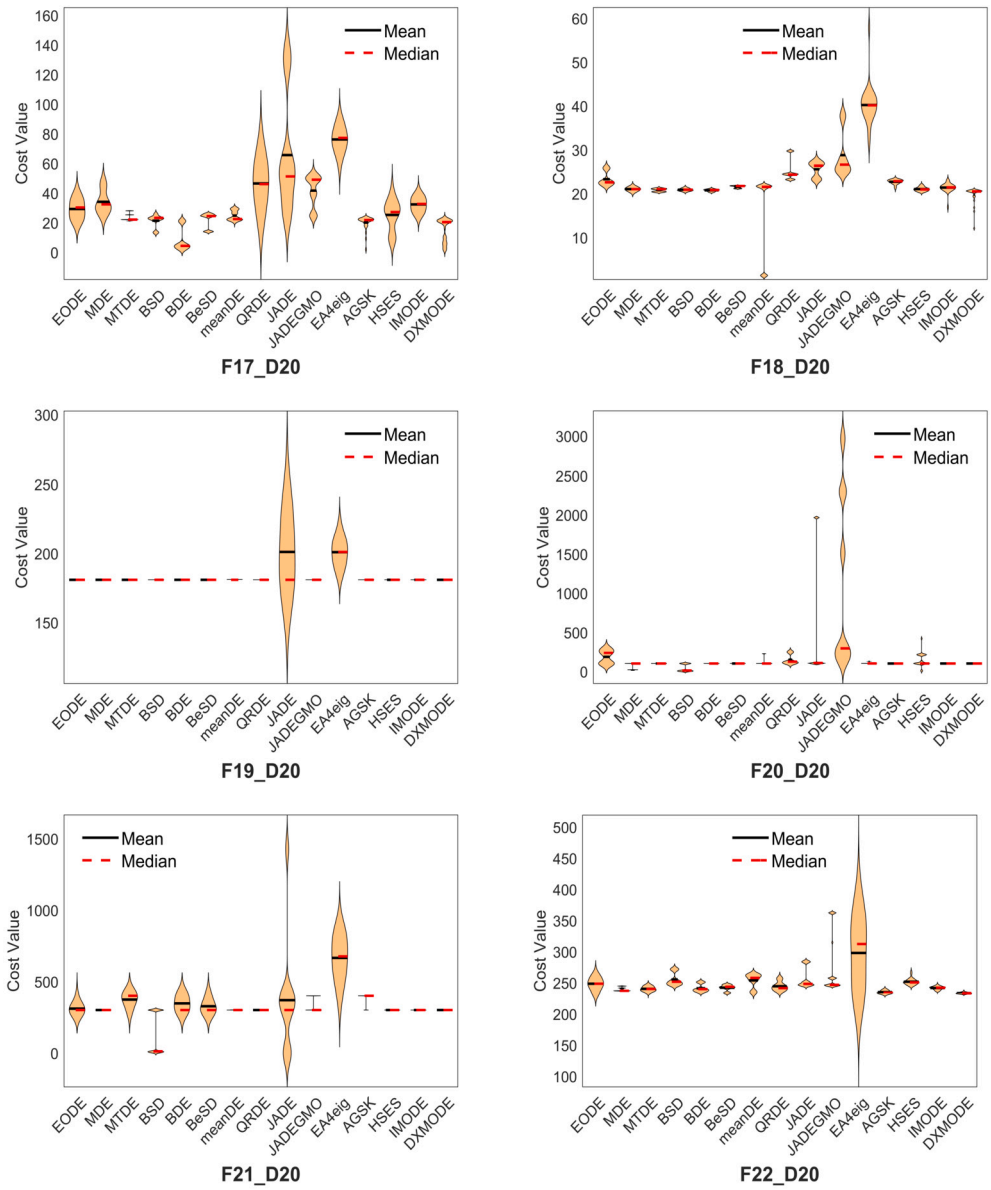


Fig. F.8. (*continued*) Violin plots for best fitness in 30 runs for advanced algorithms, F17-F22 (20D).

Appendix G. CEC2020-2022 diversity plots

This appendix presents median diversity plots across 30 runs for top meta-heuristic and advanced DE algorithms on CEC2020-2022 benchmarks in both 10D and 20D settings.

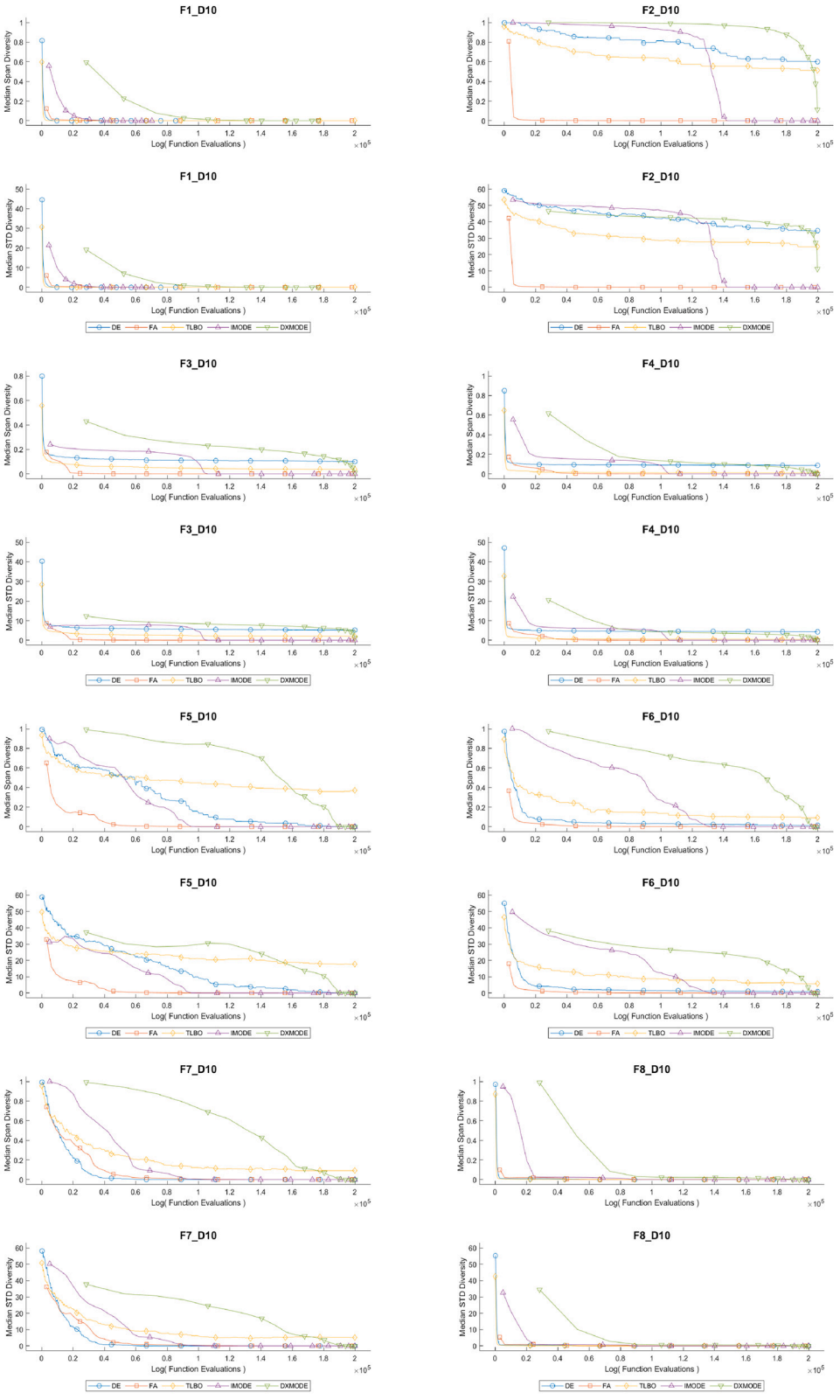


Fig. G.9. Median diversity plots for top meta-heuristic algorithms, F1-F8 (10D).

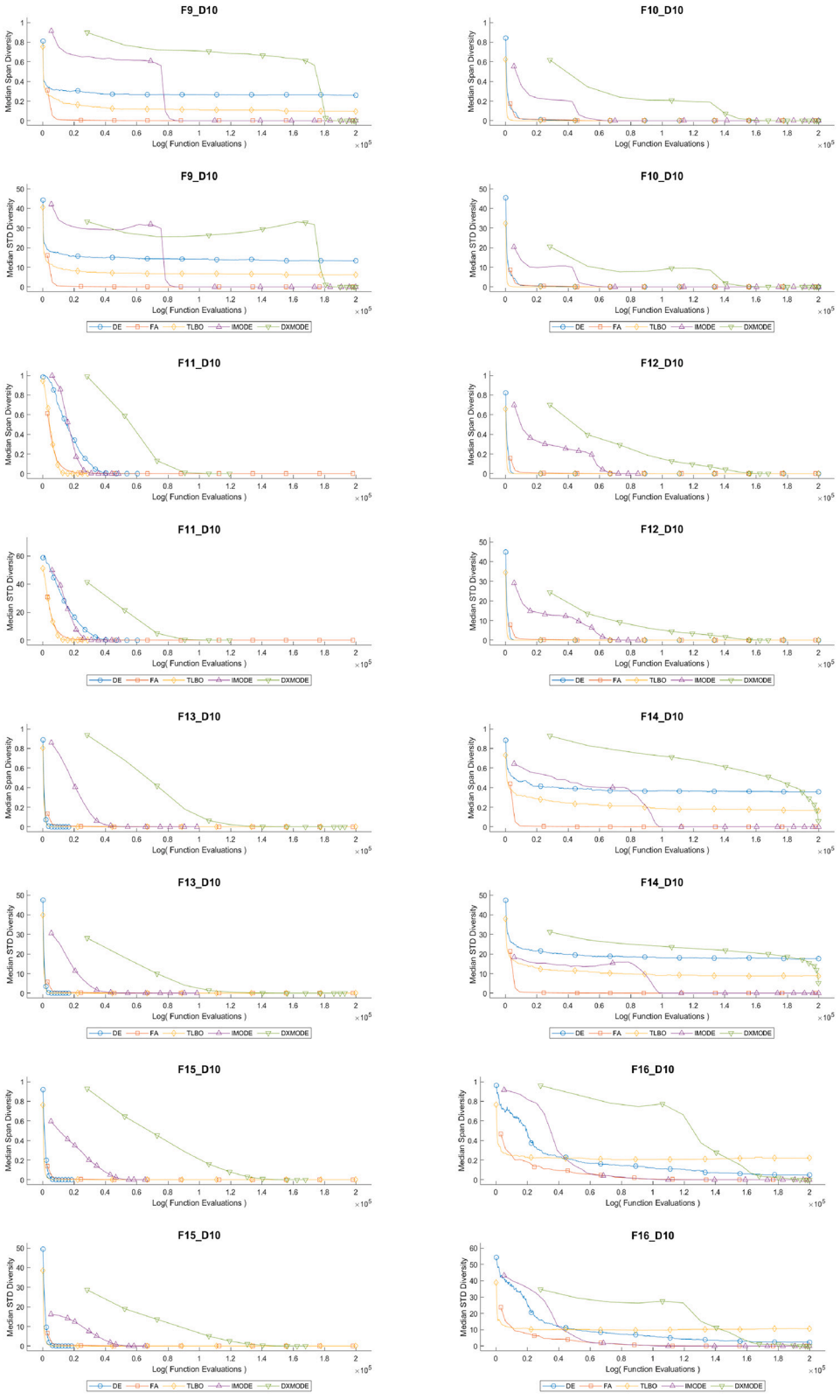


Fig. G.9. (*continued*) Median diversity plots for top meta-heuristic algorithms, F9-F16 (10D).

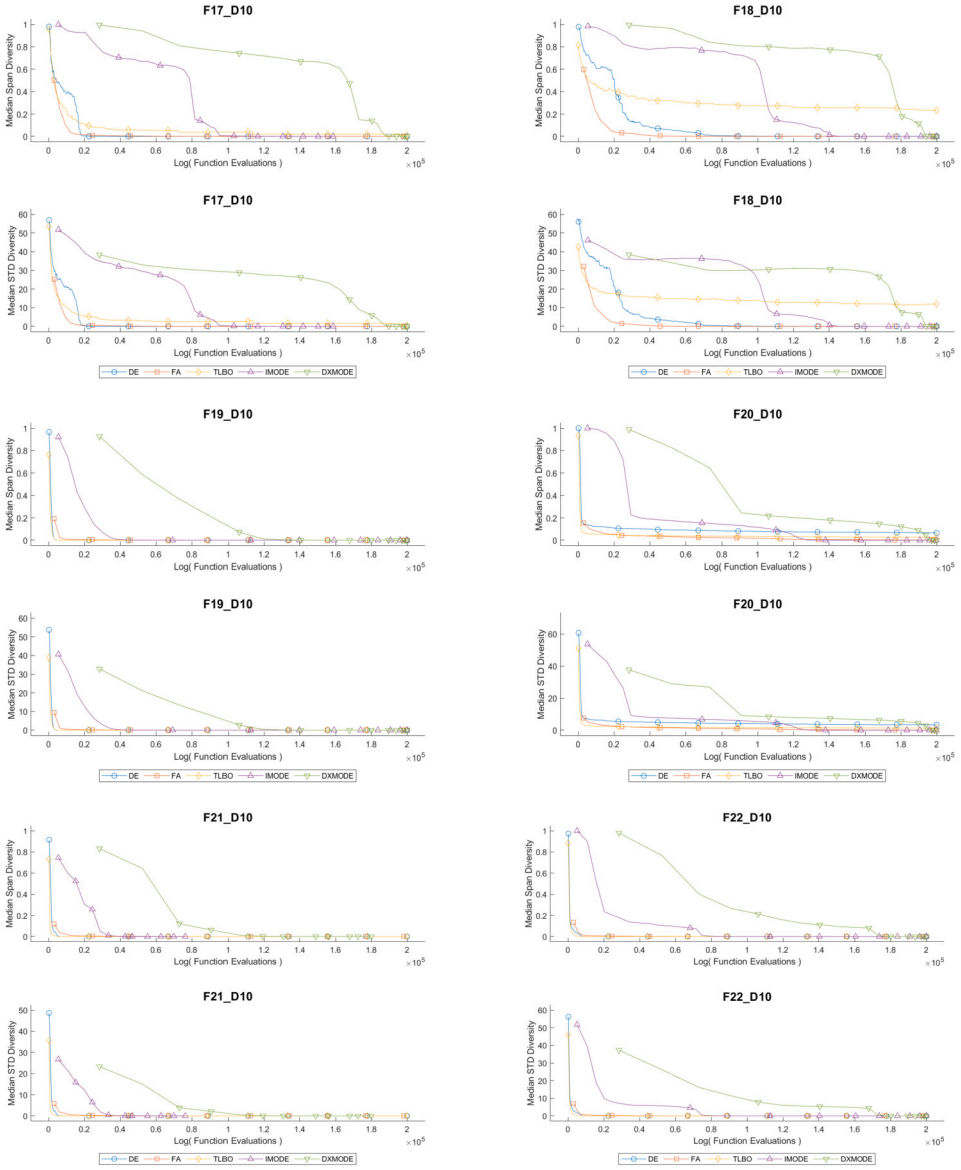


Fig. G.9. (*continued*) Median diversity plots for top meta-heuristic algorithms, F17-F22 (10D).

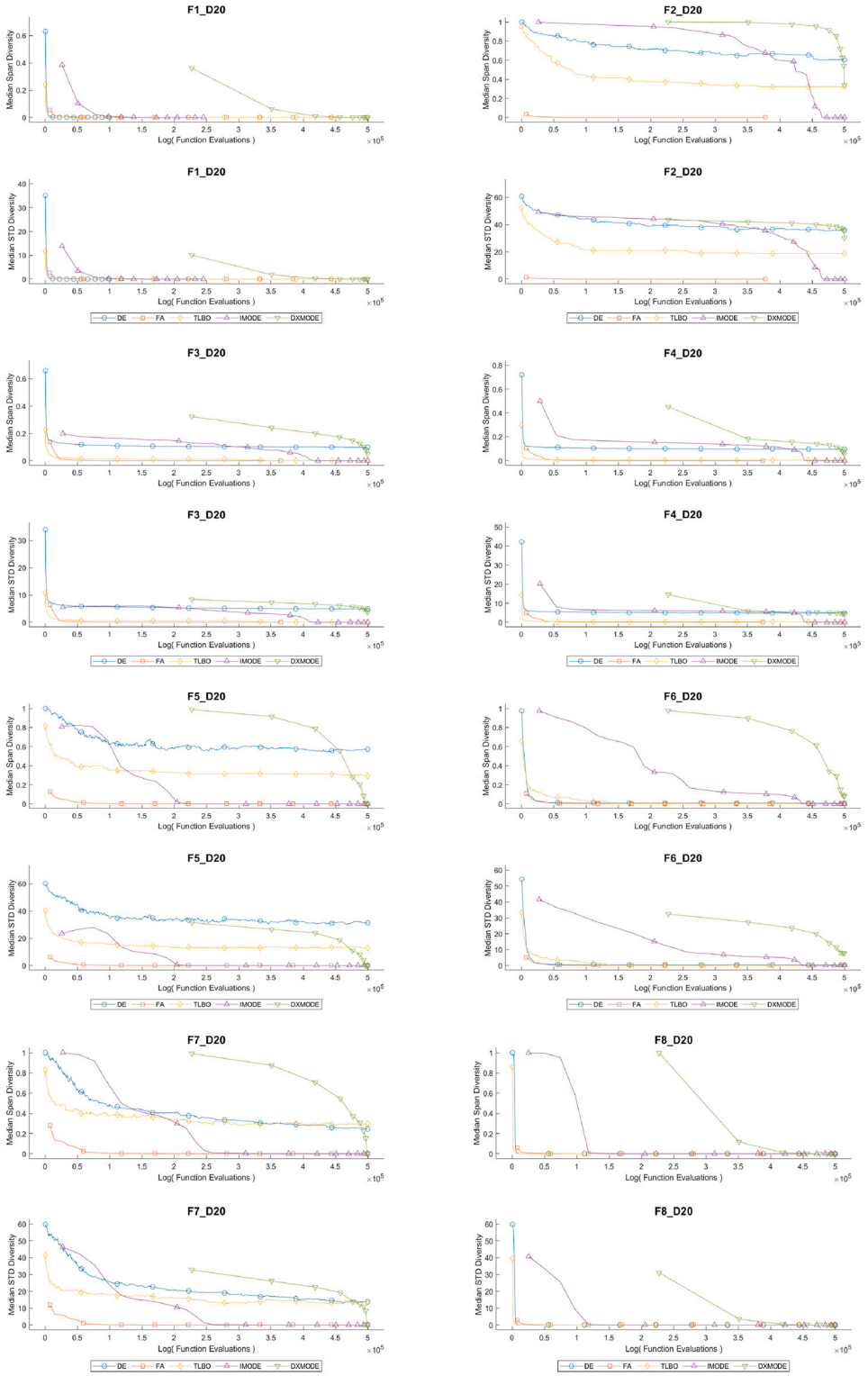


Fig. G.10. Median diversity plots for top meta-heuristic algorithms, F1-F8 (20D).

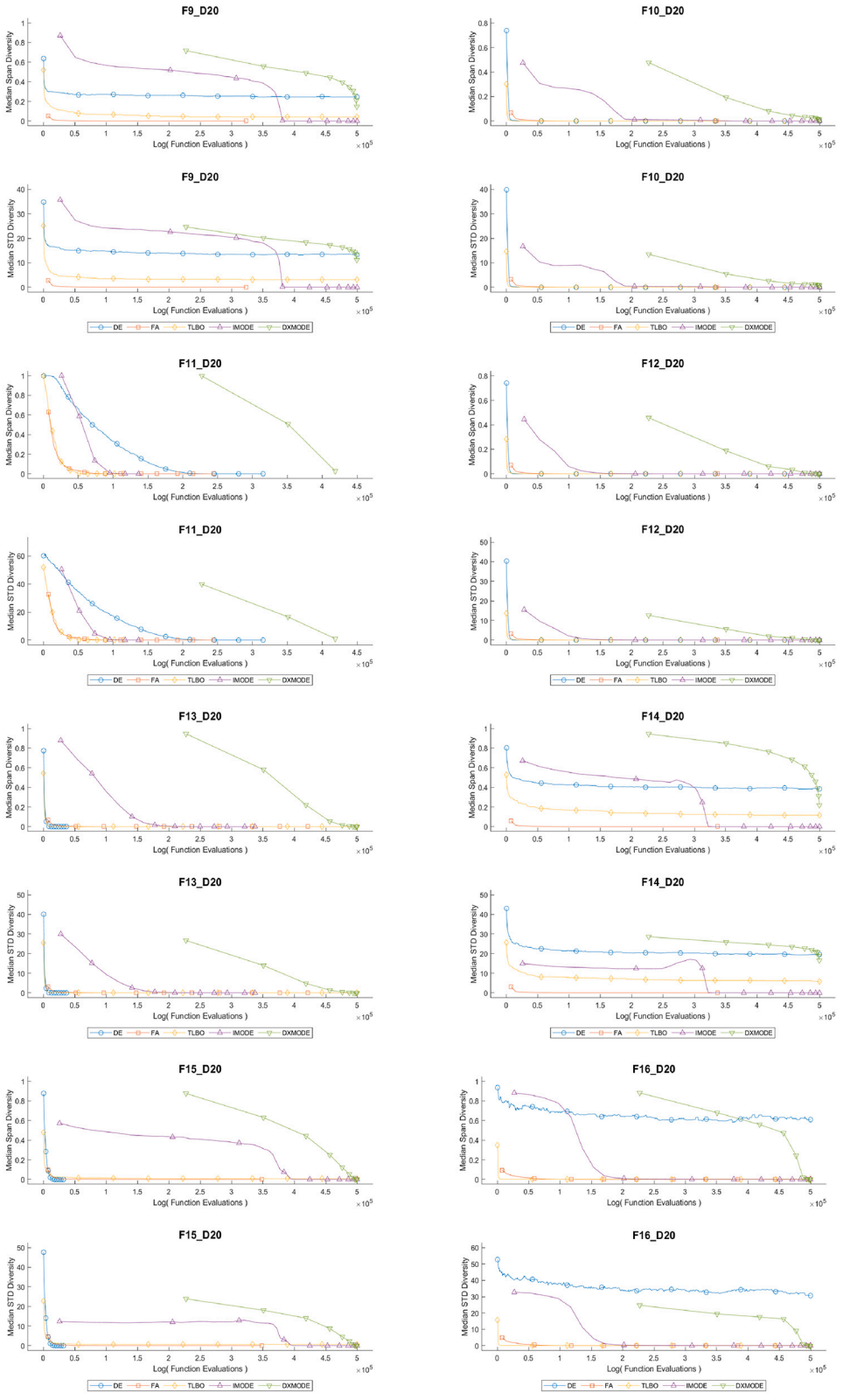


Fig. G.10. (*continued*) Median diversity plots for top meta-heuristic algorithms, F9-F16 (20D).

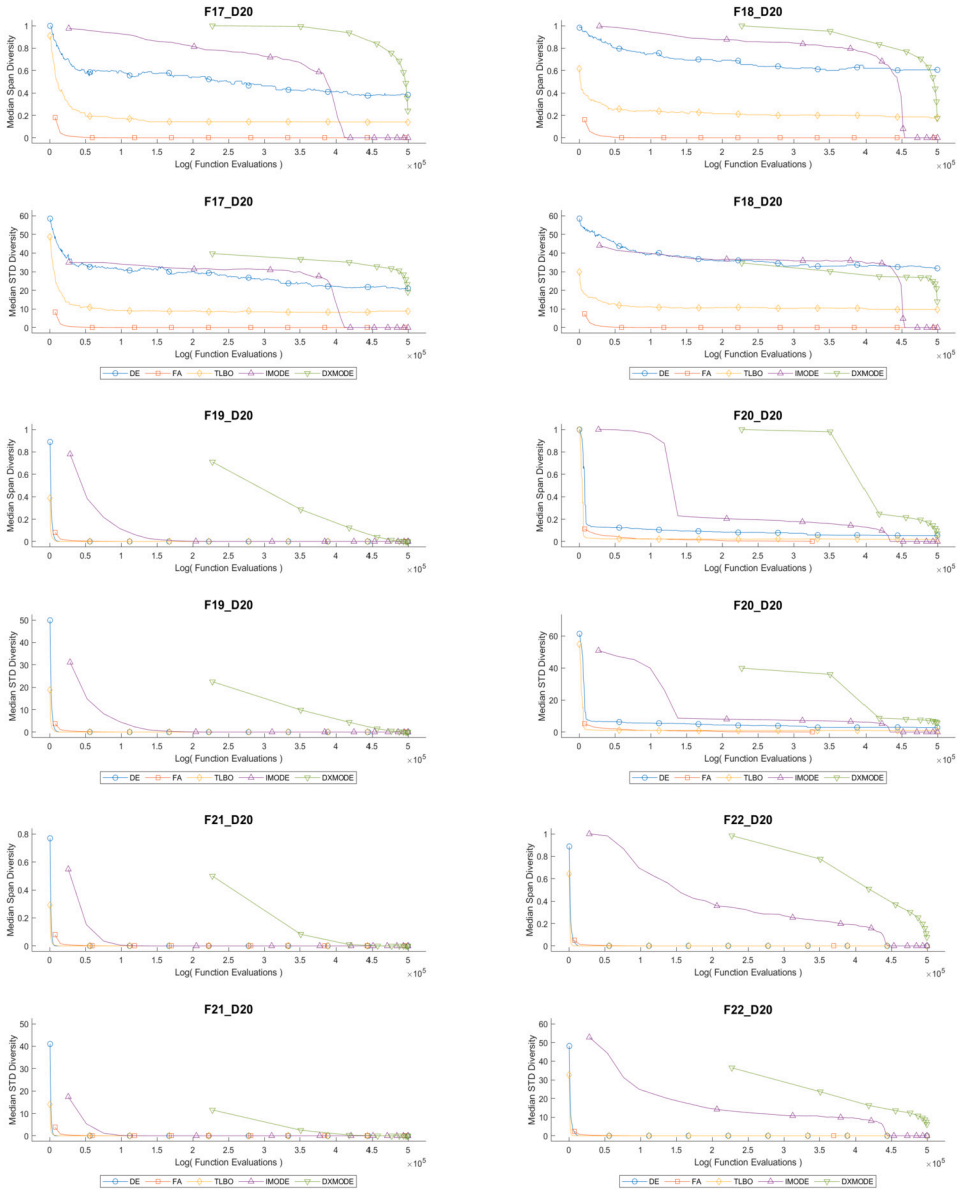


Fig. G.10. (*continued*) Median diversity plots for top meta-heuristic algorithms, F17-F22 (20D).

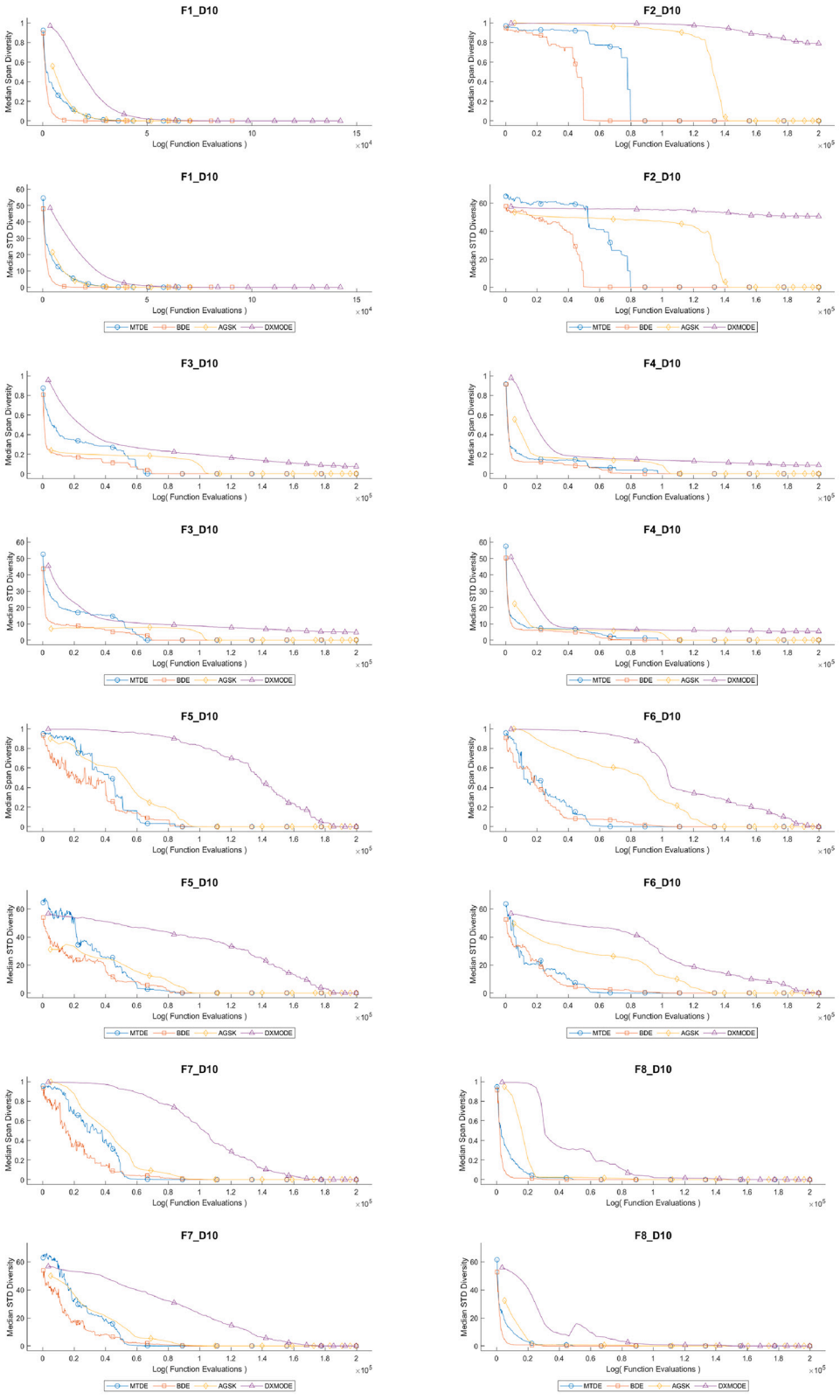


Fig. G.11. Median diversity plots for top DE variants, F1-F8 (10D).

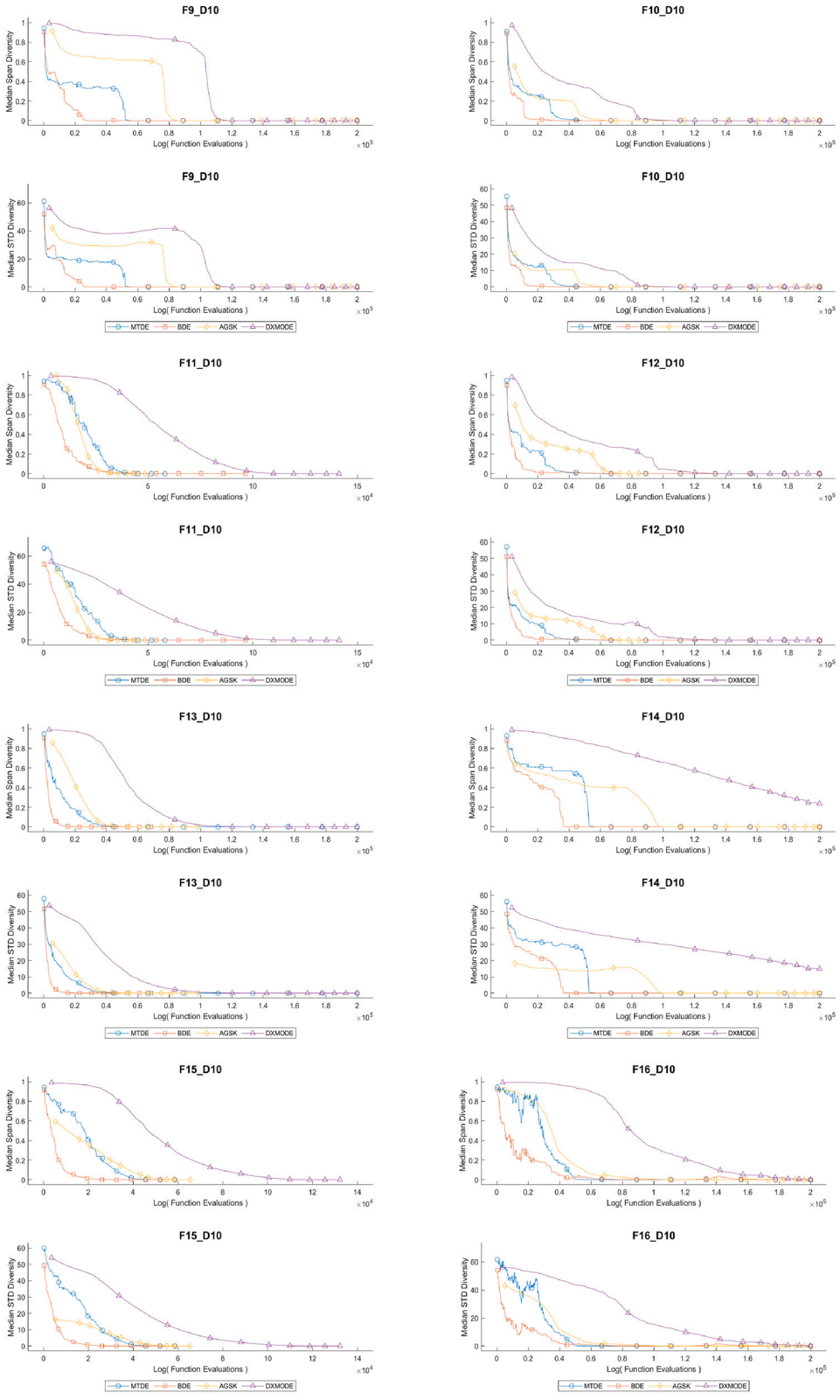


Fig. G.11. (*continued*) Median diversity plots for top DE variants, F9-F16 (10D).

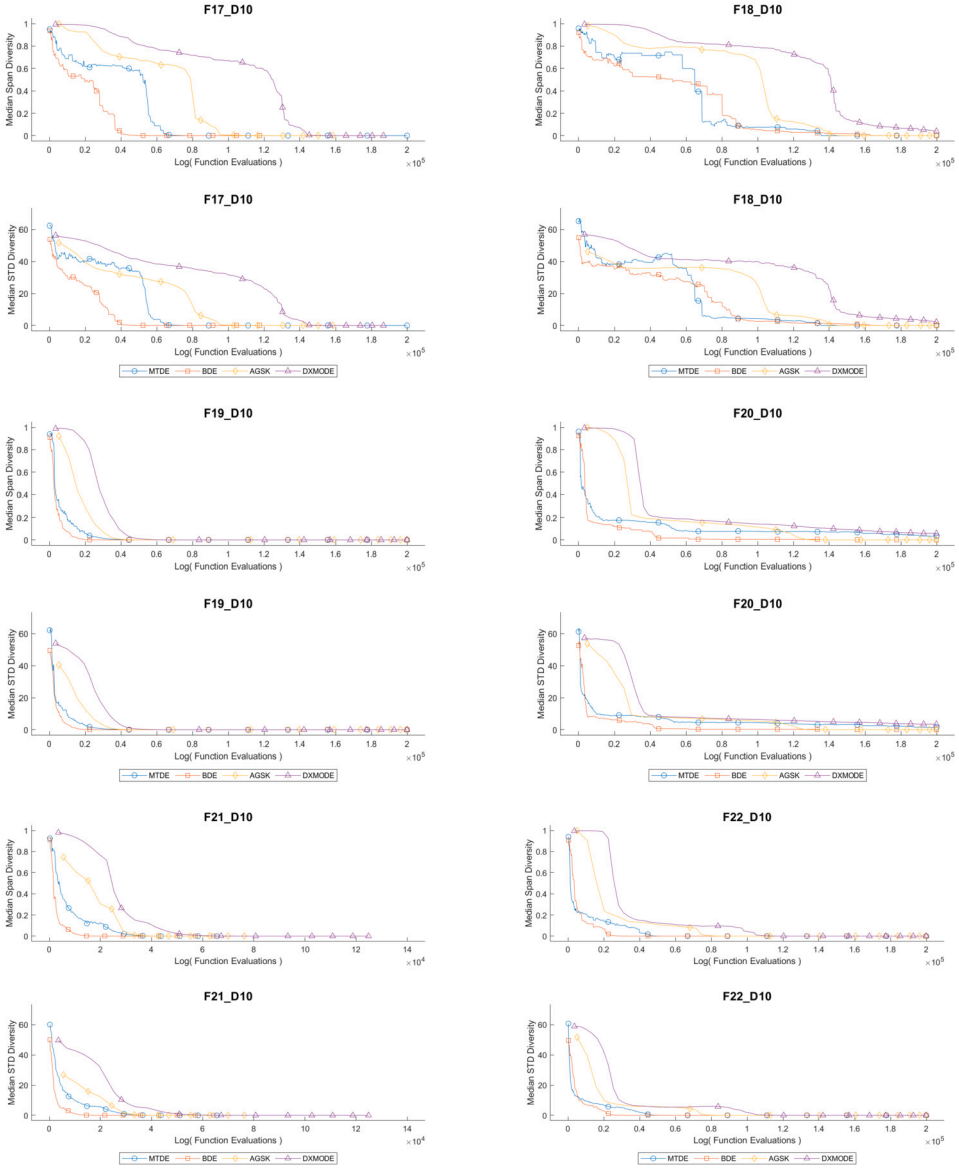


Fig. G.11. (*continued*) Median diversity plots for top DE variants, F17-F22 (10D).

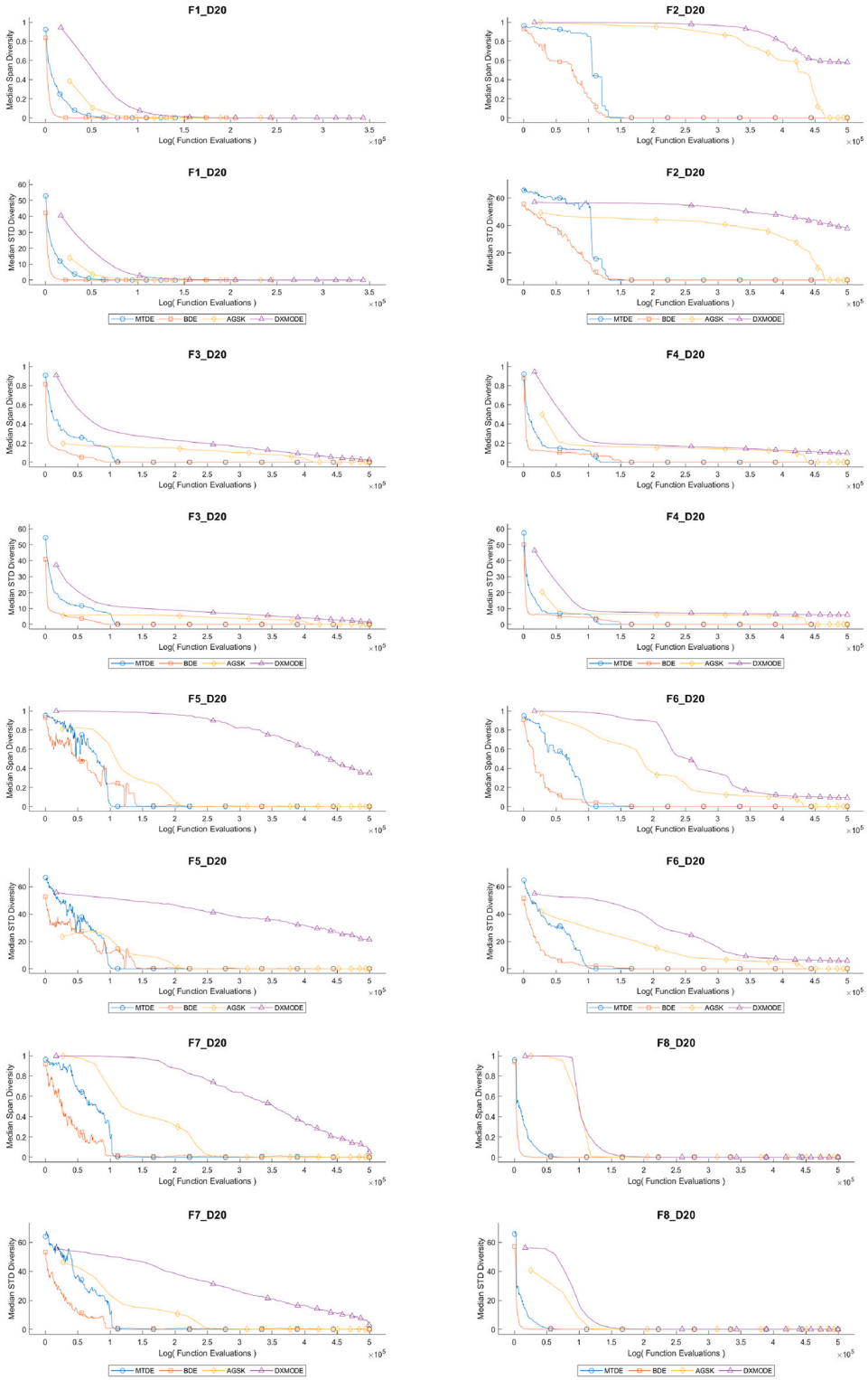


Fig. G.12. Median diversity plots for top DE variants, F1-F8 (20D).

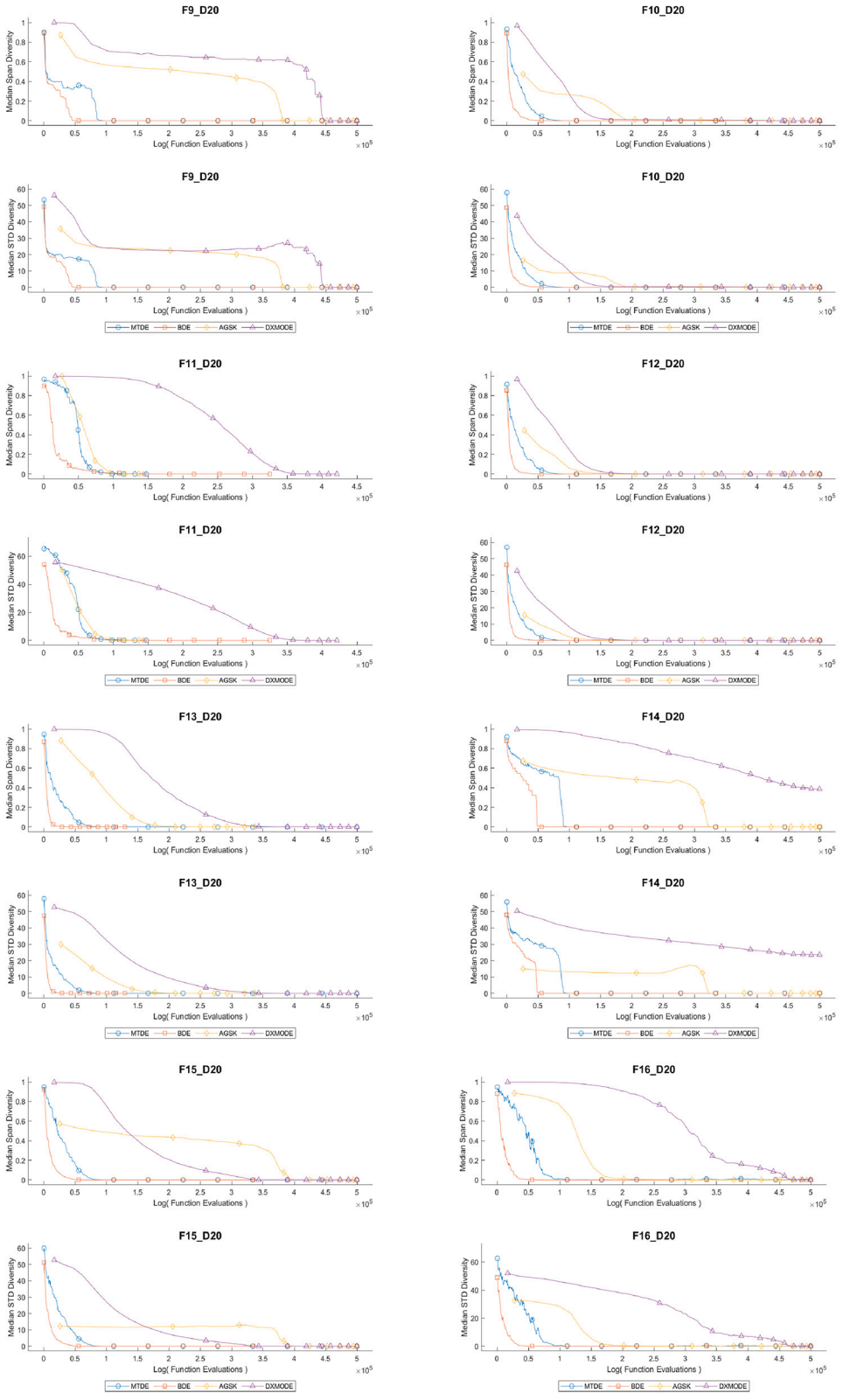


Fig. G.12. (*continued*) Median diversity plots for top DE variants, F9-F16 (20D).

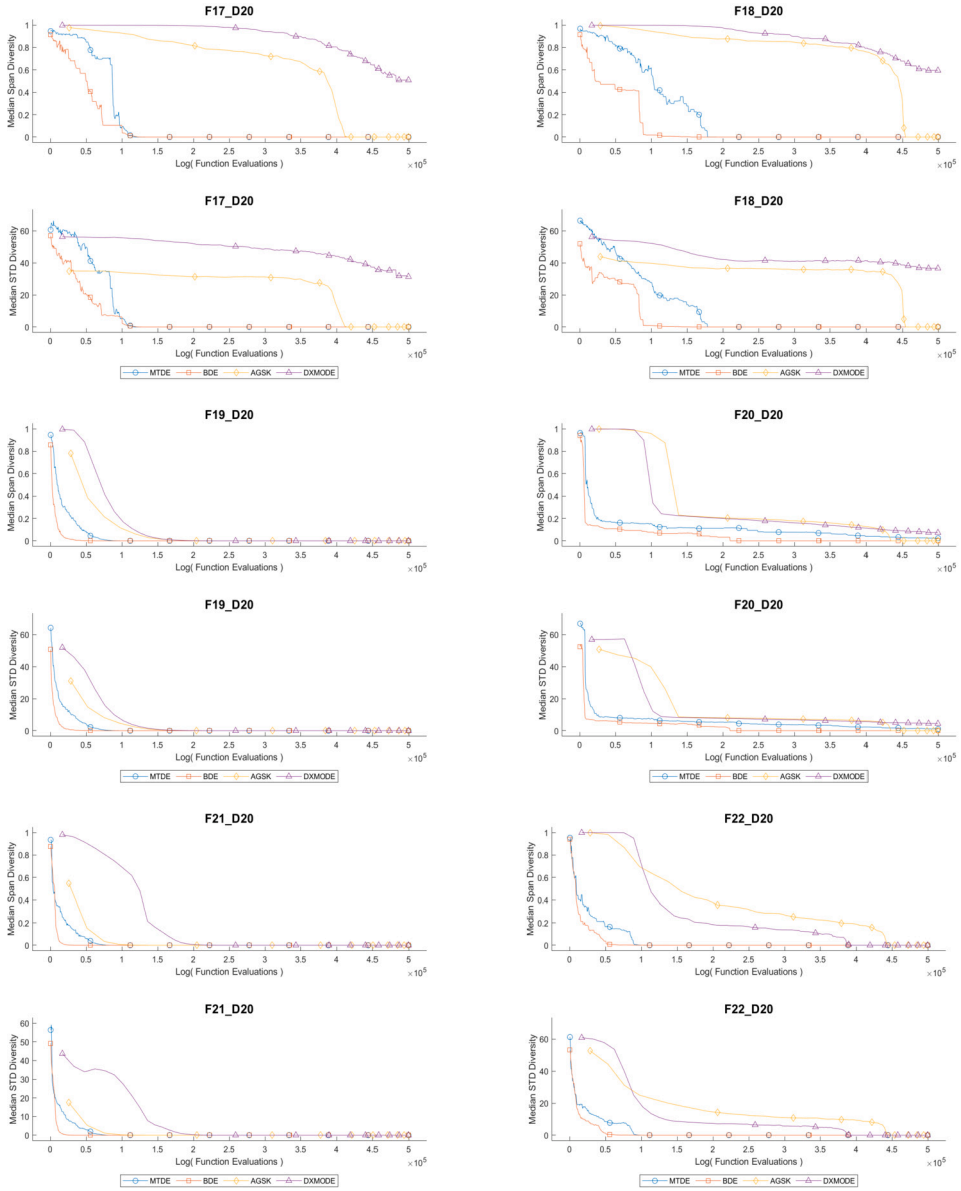


Fig. G.12. (*continued*) Median diversity plots for top DE variants, F17-F22 (20D).

Appendix H. CEC2020-2022 convergence plots

This appendix provides convergence plots showing the median fitness over 30 runs for all algorithms, including advanced DE variants, across all CEC2020-2022 functions in both 10D and 20D.

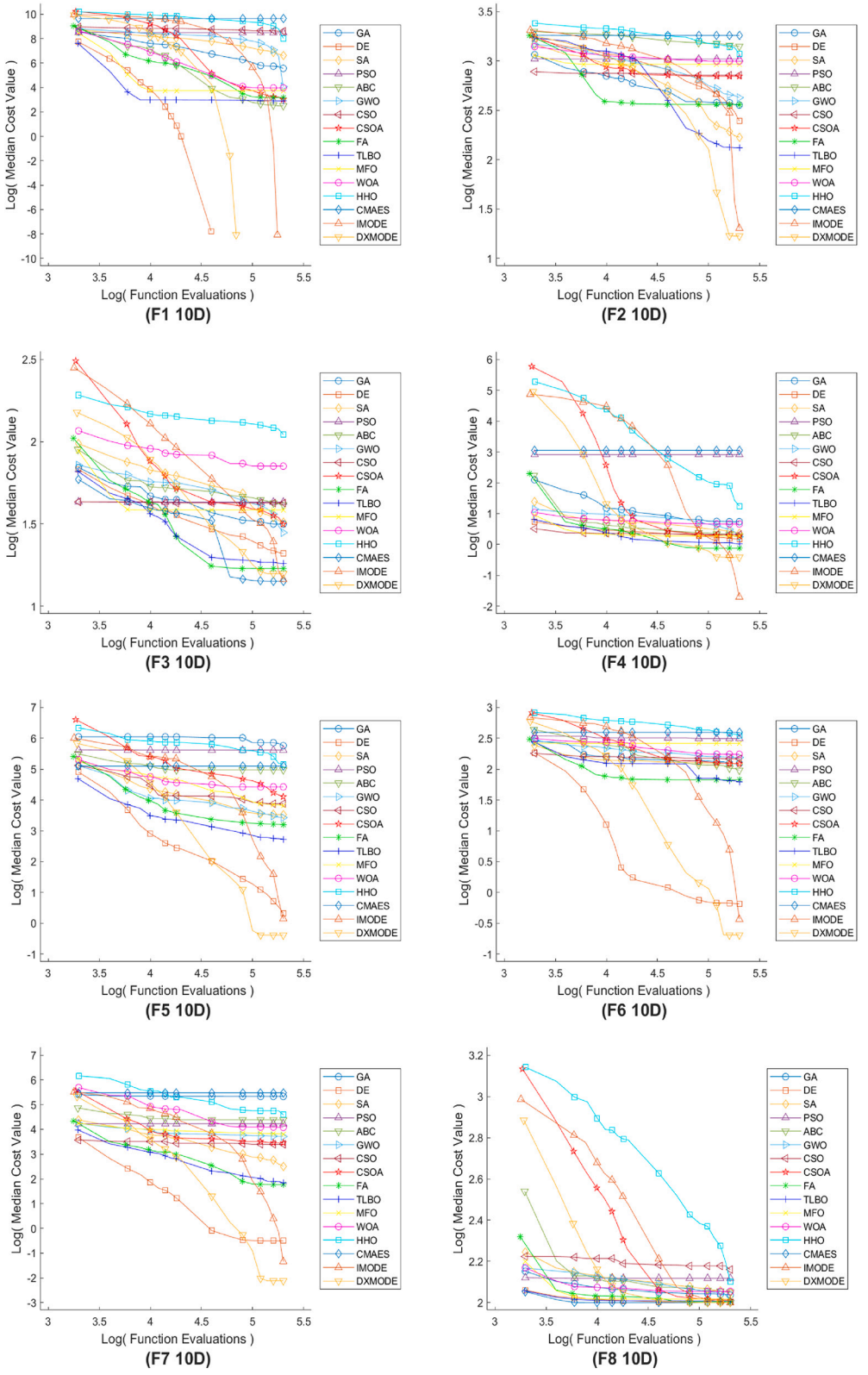


Fig. H.13. Convergence plots for median fitness in 30 runs for all algorithms, F1-F8 (10 Dim).

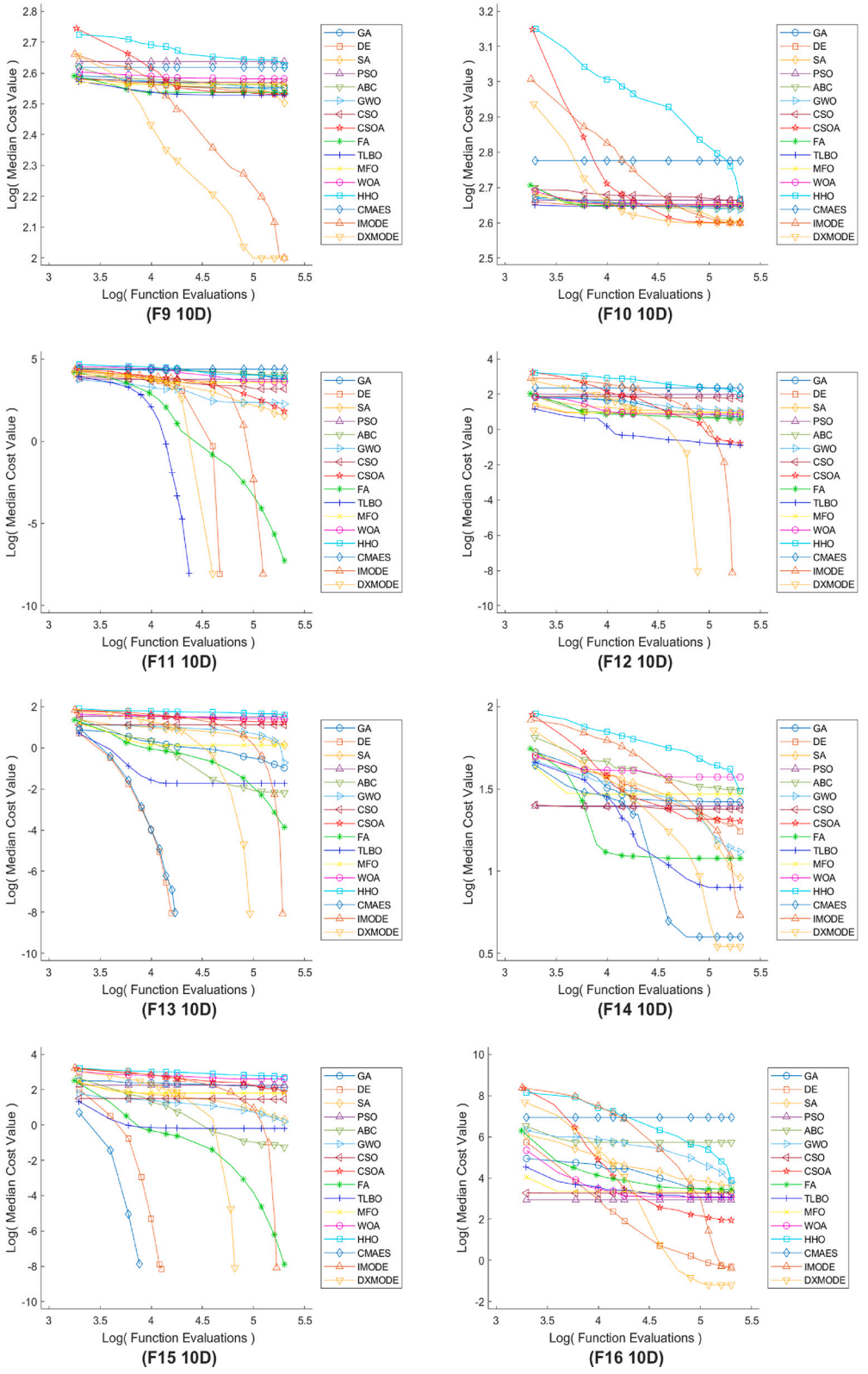


Fig. H.13. (*continued*) Convergence for median fitness in 30 runs, all algorithms, F9-F16 (10 Dim).

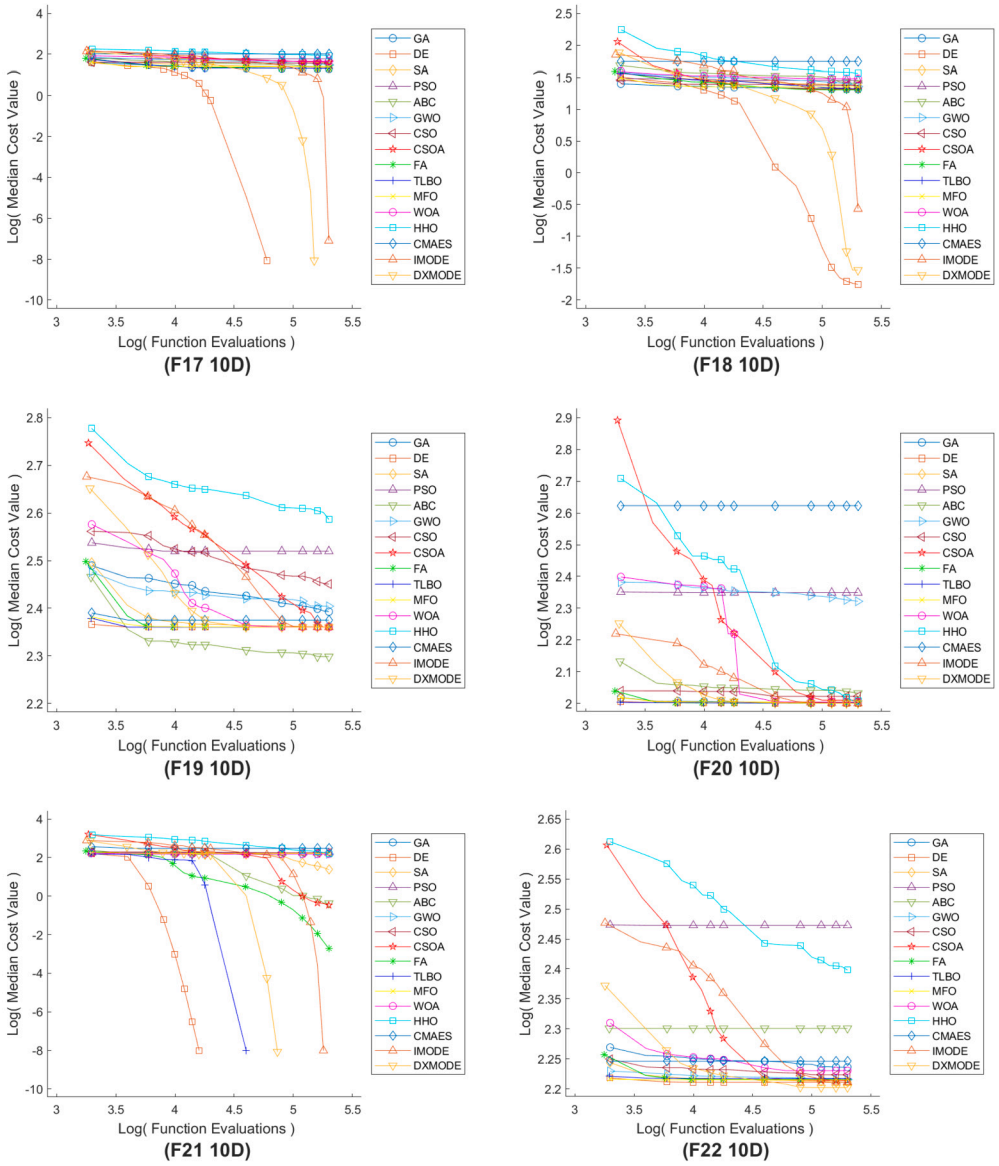


Fig. H.13. (*continued*) Convergence for median fitness in 30 runs, all algorithms, F17-F22 (10 Dim).

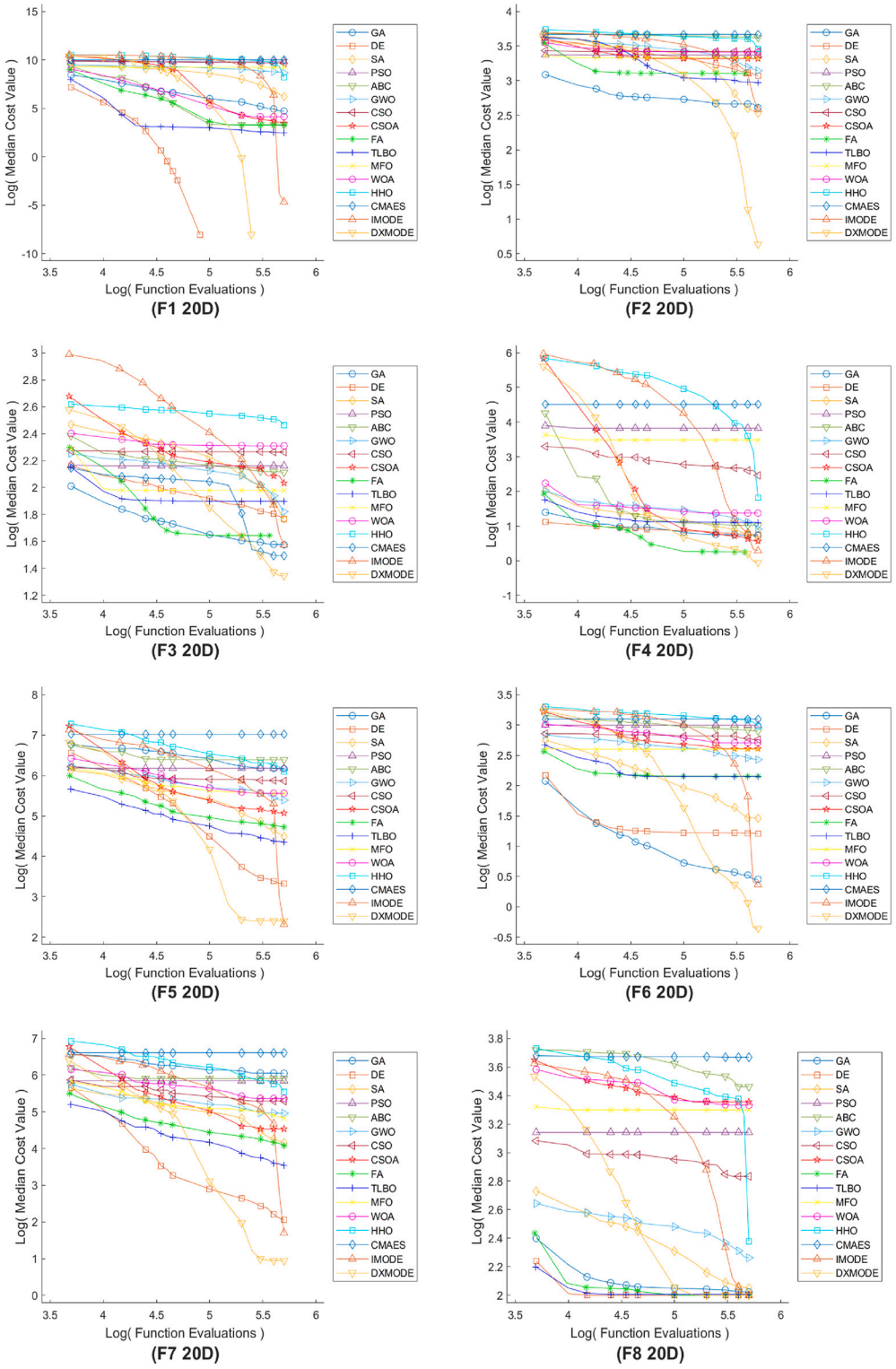


Fig. H.14. Convergence plots for median fitness in 30 runs for all algorithms, F1-F8 (20 Dim).

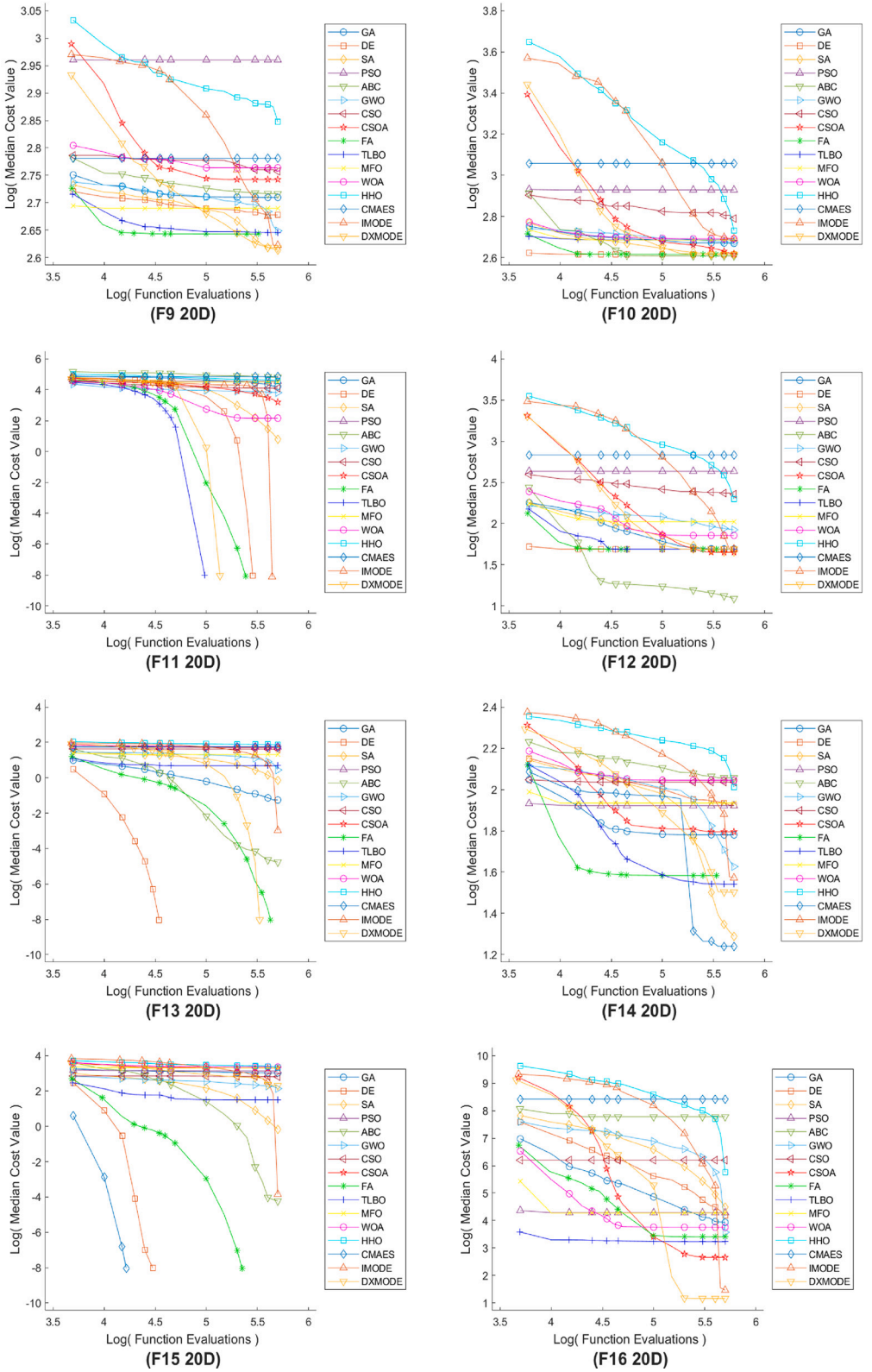


Fig. H.14. (*continued*) Convergence for median fitness, 30 runs for all algorithms, F9-F16 (20 Dim).

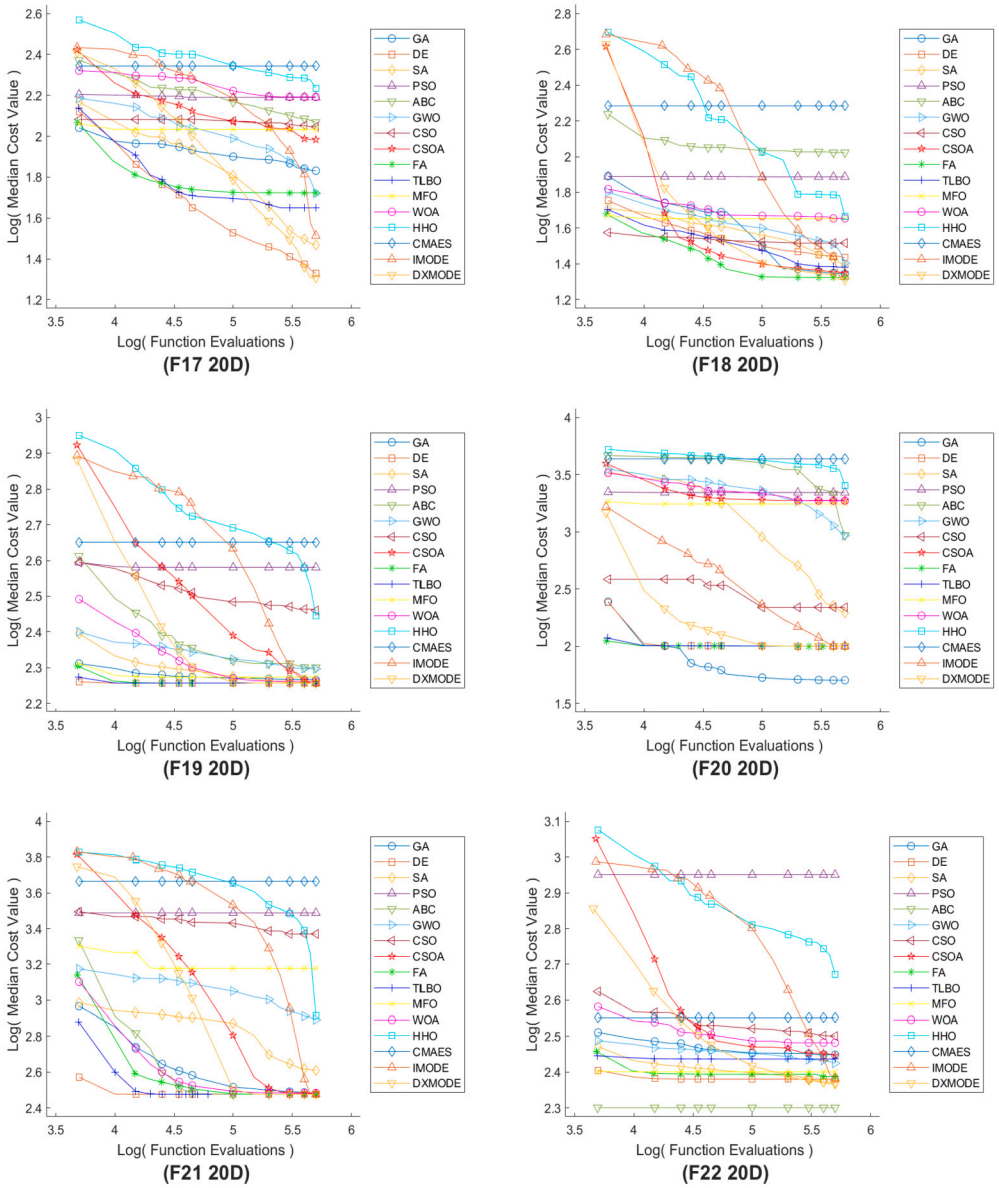


Fig. H.14. (*continued*) Convergence for median fitness in 30 runs, all algorithms, F17-F22 (20 Dim).

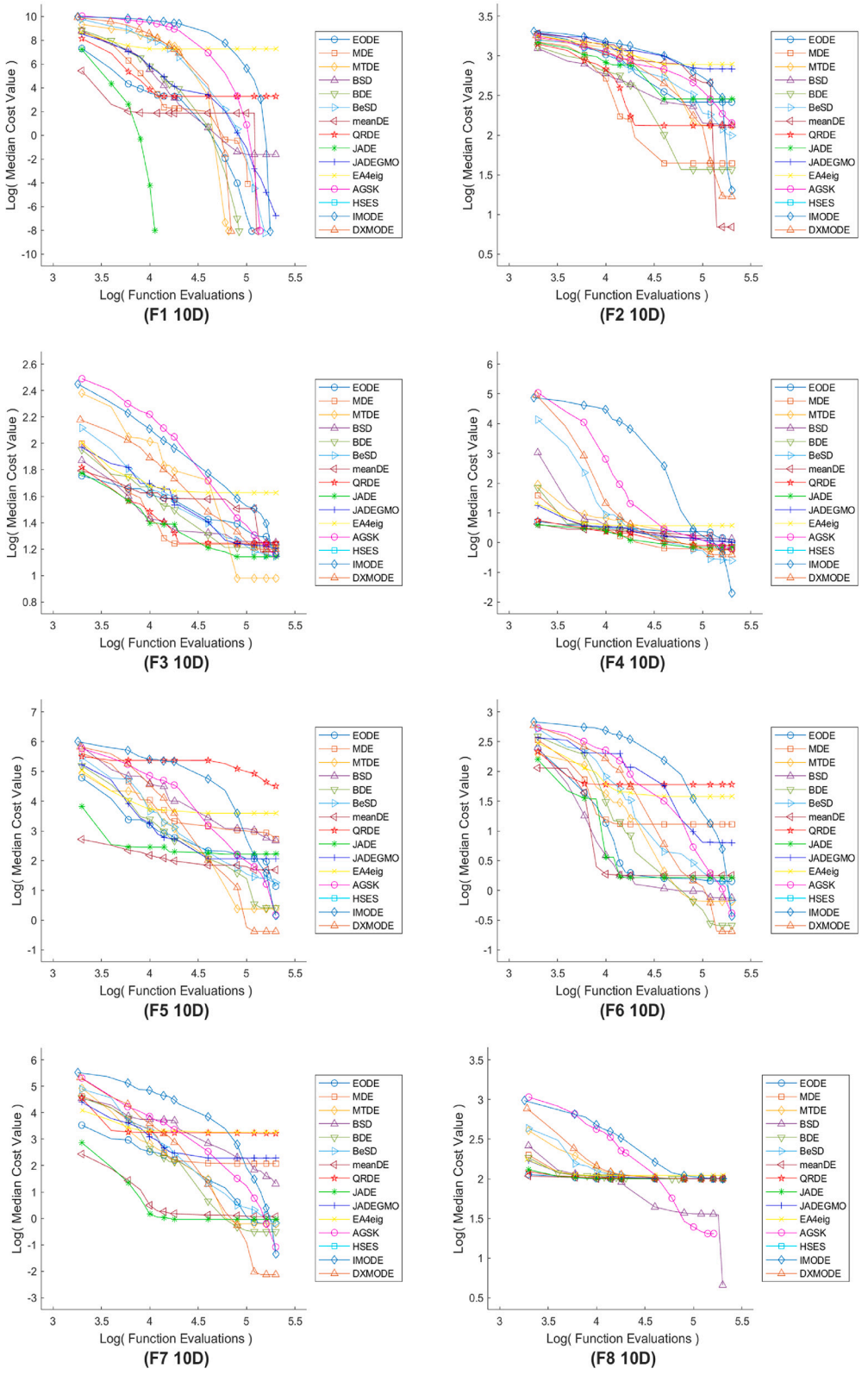


Fig. H.15. Convergence plots for median fitness in 30 runs for all advanced algorithms, F1-F8 (10D).

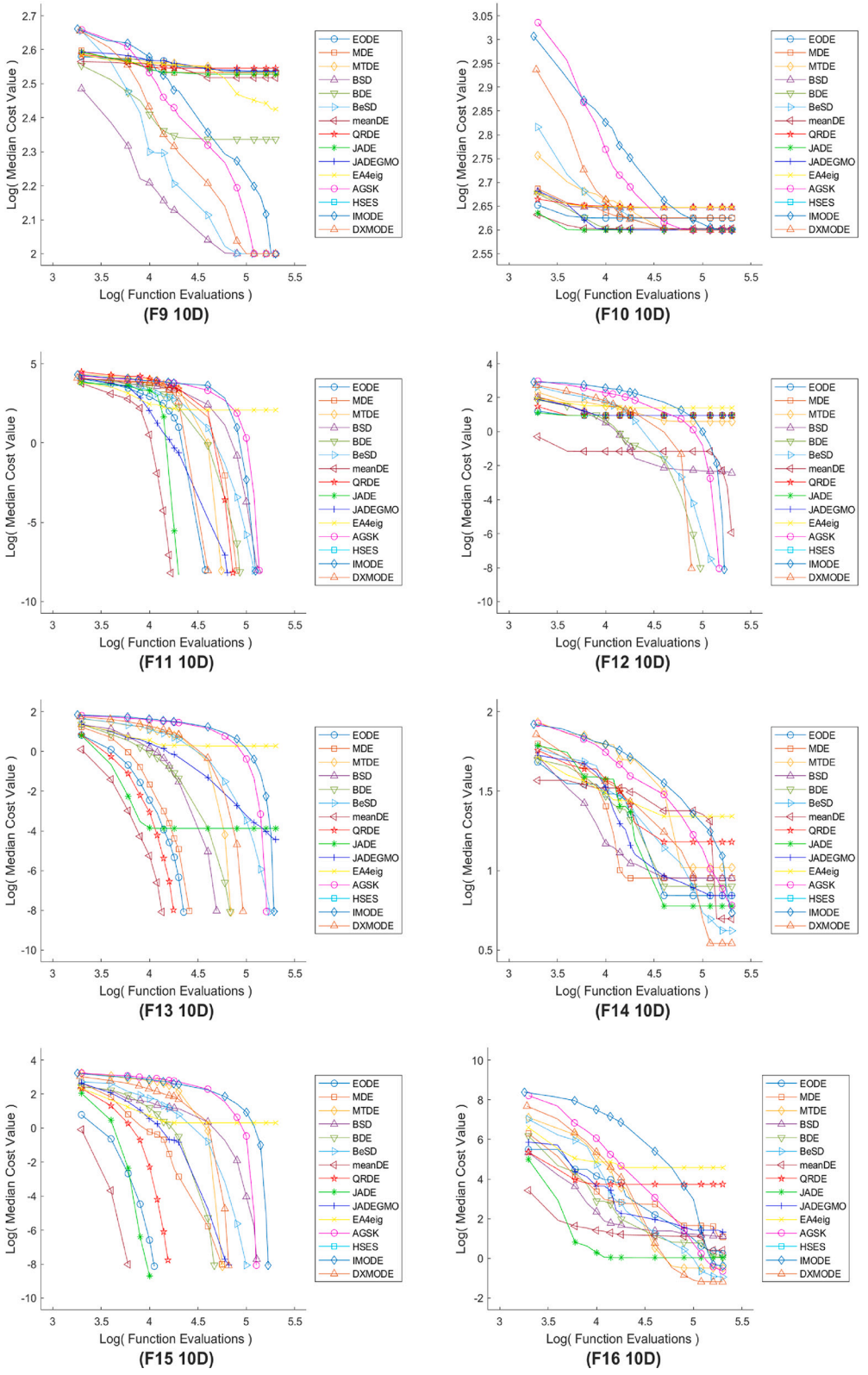


Fig. H.15. (*continued*) Convergence for median fitness in 30 runs, all advanced algorithms, F9-F16 (10D).

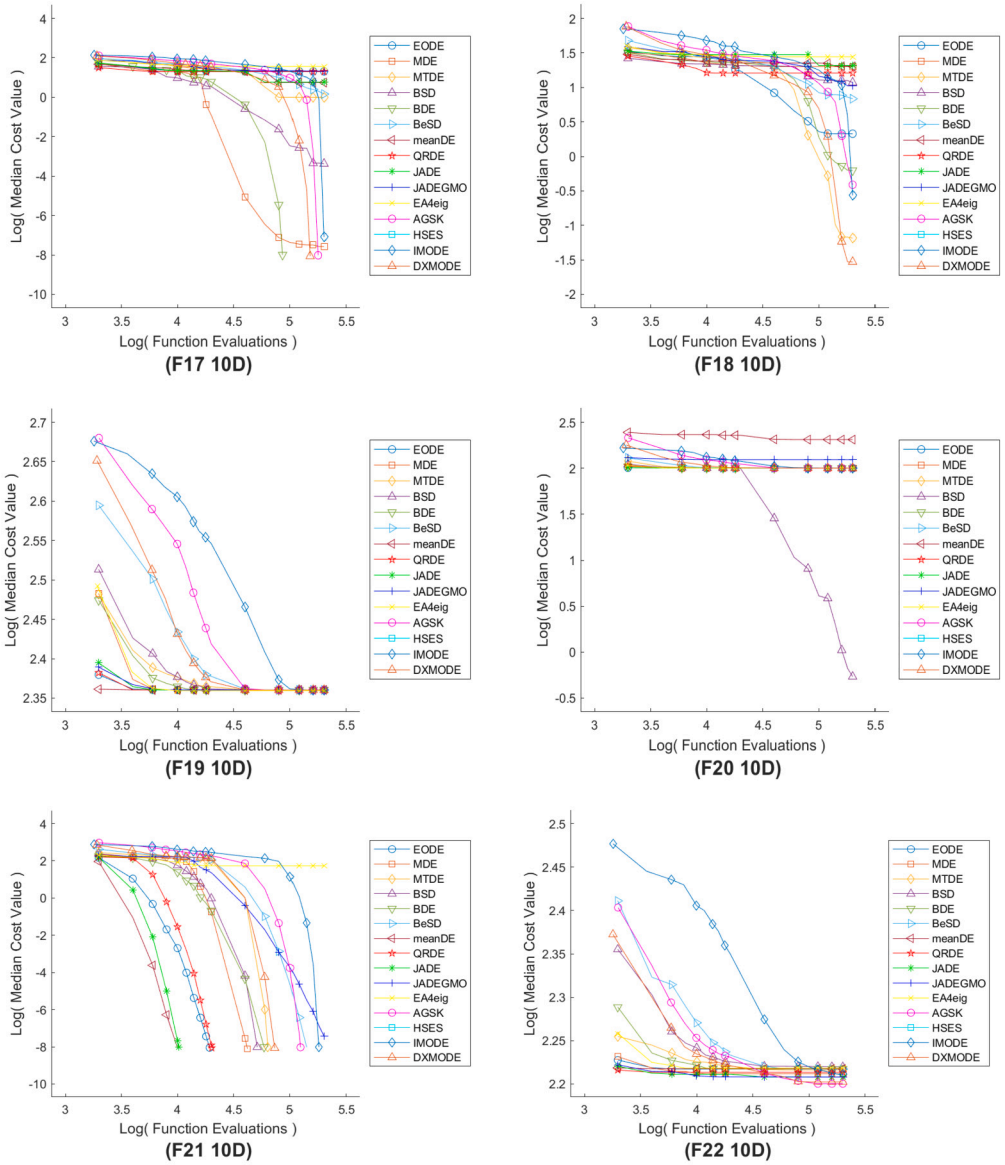


Fig. H.15. (*continued*) Convergence for median fitness in 30 runs, all advanced algorithms, F17-F22 (10D).

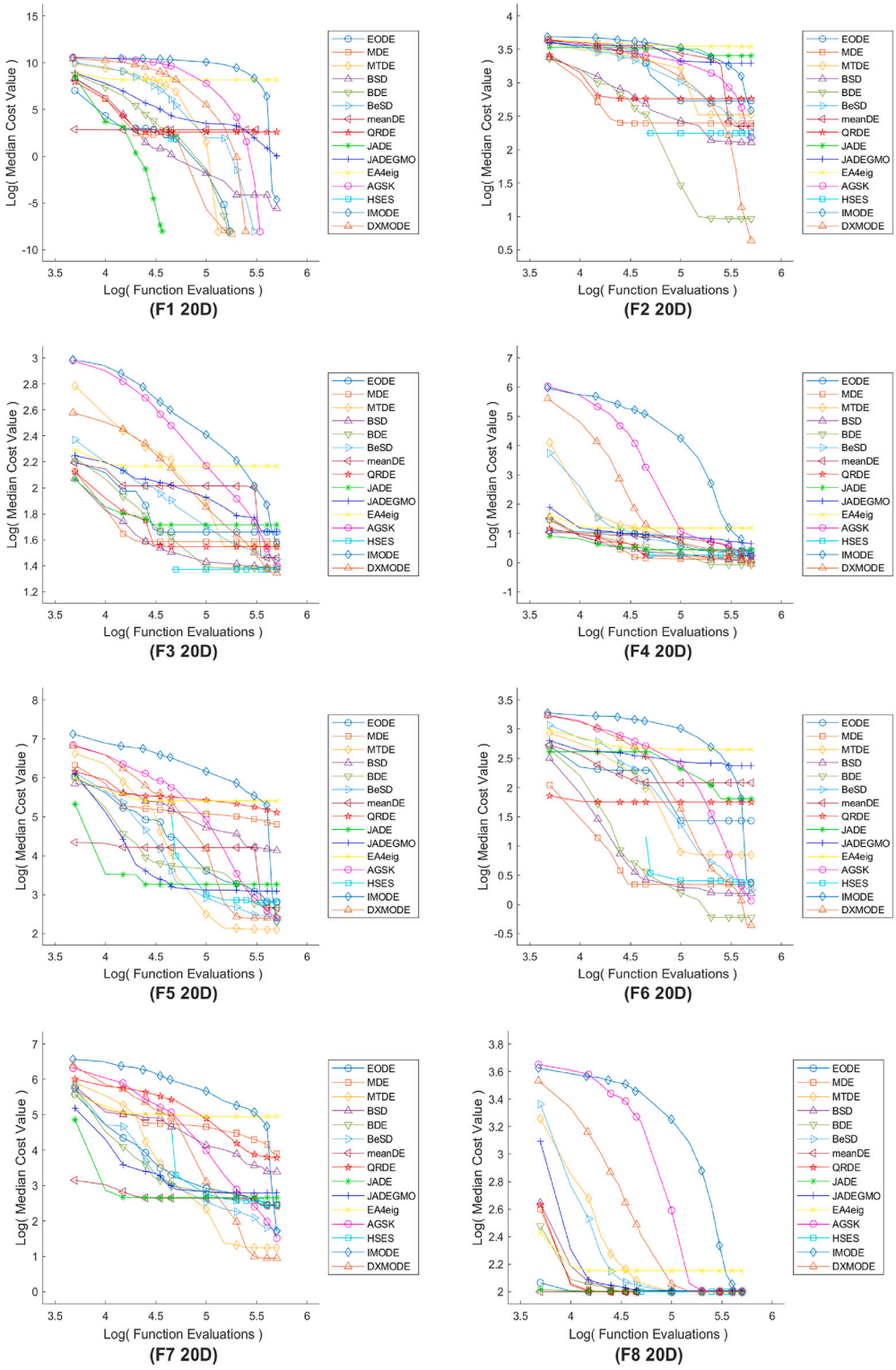


Fig. H.16. Convergence plots for median fitness in 30 runs for all advanced algorithms, F1-F8 (20D).

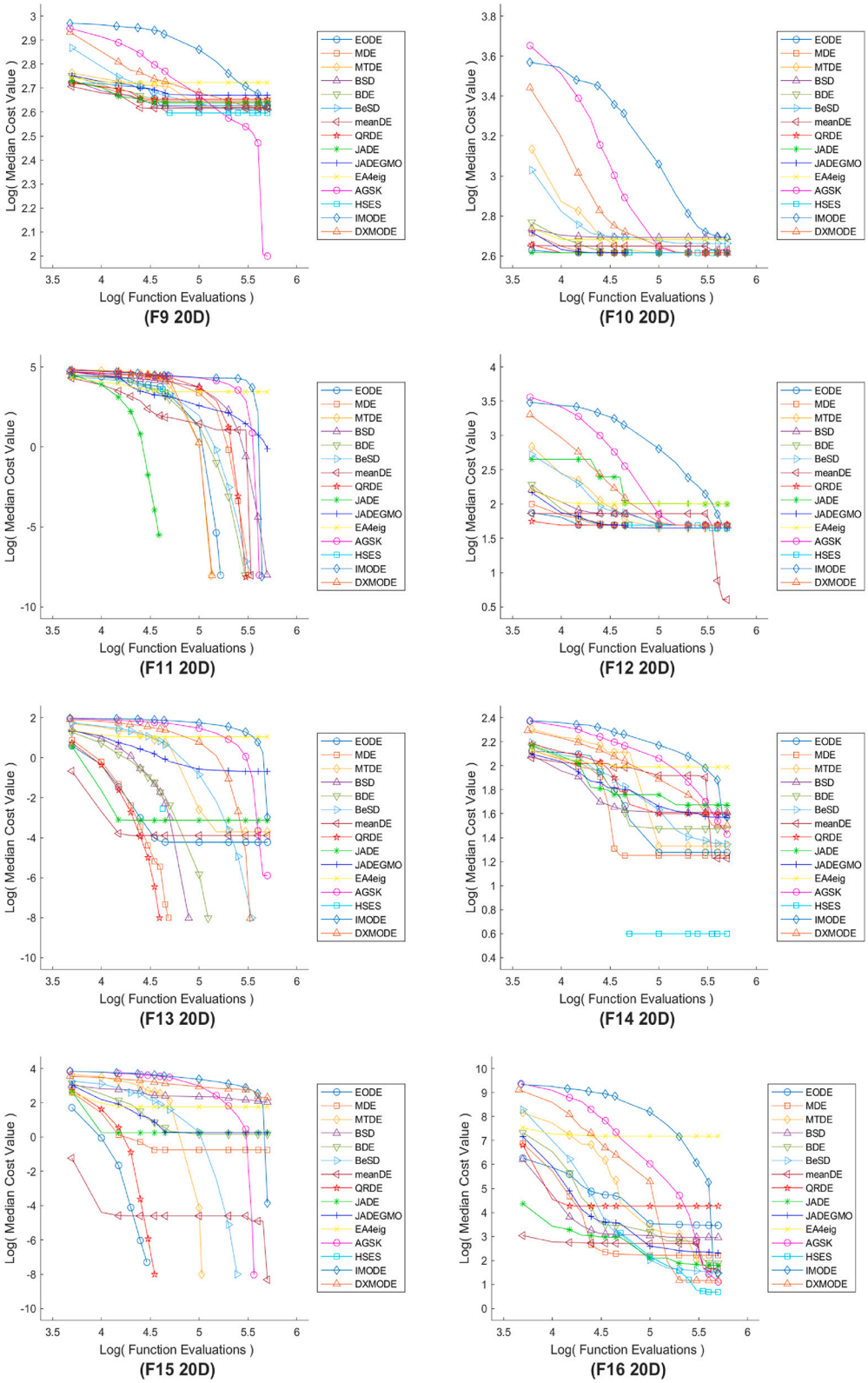


Fig. H.16. (*continued*) Convergence for median fitness, 30 runs for all advanced algorithms, F9-F16 (20D).

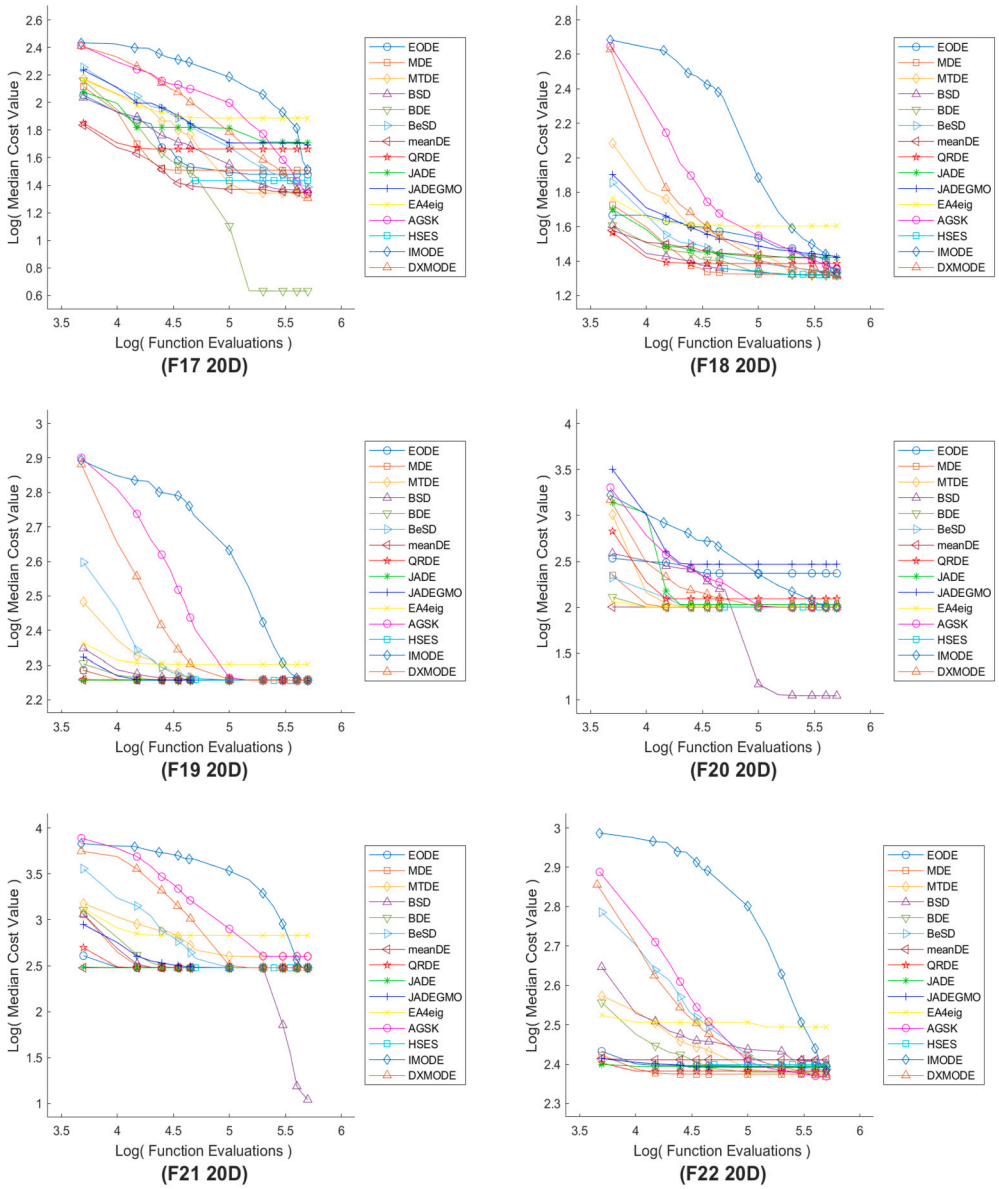


Fig. H.16. (*continued*) Convergence for median fitness in 30 runs, all advanced algorithms, F17-F22 (20D).

Appendix I. CEC2020-2022 Cohen's d effect size

This appendix presents Cohen's d effect size values comparing DXMODE against classical meta-heuristics and advanced DE variants across CEC2020-2022 benchmark functions.

Table I.8
Cohen's d effect values for DXMODE against meta-heuristic optimization algorithms on CEC2020-2022.

Dim.	Fn.	GA	DE	SA	PSO	ABC	GWO	CSO	CSOA	BAS	FA	TLBO	MFO	WOA	HHO	CMAES	IMODE
10D	F1	1.64	0.00	3.33	1.35	1.30	0.50	1.38	2.01	4.21	1.43	1.34	0.56	0.72	1.28	2.90	0.00
	F2	2.28	1.75	1.70	4.26	15.69	2.16	3.13	4.10	13.19	1.46	1.04	3.69	4.99	5.51	12.48	-0.31
	F3	2.56	2.32	3.99	2.26	6.47	1.83	3.52	3.37	5.03	0.43	0.90	2.49	3.03	6.54	-0.30	-0.84
	F4	2.21	5.38	7.08	0.79	5.51	2.21	0.91	4.02	1.28	1.79	1.39	0.34	3.82	0.59	1.78	-3.12
	F5	1.40	0.76	1.44	1.52	2.71	0.35	0.62	0.79	0.97	1.56	2.06	0.31	0.99	1.46	1.07	1.31
	F6	1.75	0.46	1.66	2.49	4.11	2.47	2.01	3.19	3.07	1.27	1.35	2.96	3.20	3.59	4.75	0.67
	F7	0.74	0.34	2.11	0.70	2.54	1.86	1.27	1.34	0.79	0.97	1.39	1.43	1.29	0.79	1.00	0.37
	F8	1.44	0.97	0.92	0.51	1.61	1.25	2.03	1.13	4.38	0.46	0.84	1.17	0.63	0.60	0.75	0.83
	F9	7.19	95.14	2.91	3.28	19.95	7.69	5.95	2.17	6.86	2.77	4.17	34.68	4.95	5.95	18.70	-0.37
	F10	2.87	1.76	0.56	1.64	2.71	2.53	4.17	0.36	3.15	1.53	1.35	2.07	0.54	2.29	2.72	-0.21
	F11	1.88	0.00	4.22	2.21	3.96	1.00	1.58	2.18	0.29	4.32	0.00	1.37	2.97	4.21	4.33	0.00
	F12	0.92	4.16	5.19	2.14	7.91	1.47	4.04	0.80	2.29	1.77	0.55	1.27	0.93	1.44	3.76	0.00
	F13	1.27	0.00	6.22	4.44	4.60	0.56	3.92	2.44	8.75	10.74	0.58	1.15	2.94	5.04	0.83	0.00
	F14	2.44	4.58	1.93	2.62	8.29	2.19	3.24	2.88	9.00	1.76	1.33	3.04	3.14	3.58	0.25	0.70
	F15	1.32	0.00	4.50	2.72	1.80	0.84	1.09	1.02	5.19	3.14	0.93	0.90	1.64	3.48	0.00	0.00
	F16	0.75	3.50	2.69	1.30	1.83	2.44	1.72	0.57	2.16	1.80	1.43	1.68	1.30	0.77	1.02	1.23
	F17	3.03	0.45	2.80	4.16	37.22	3.81	4.67	3.56	4.15	2.04	2.05	2.46	4.11	3.85	2.46	0.26
	F18	38.48	0.31	4.66	1.28	24.84	8.59	6.72	14.59	0.90	2.63	2.48	8.80	10.66	5.65	2.76	1.24
	F19	1.25	0.00	4.21	4.86	-10.26	1.46	2.88	0.81	4.78	3.92	0.98	0.57	0.37	4.47	0.85	0.00
	F20	0.92	0.37	0.77	1.08	2.46	1.70	1.32	0.80	2.32	0.46	0.84	0.87	0.99	0.72	1.43	-0.27
	F21	1.81	0.80	6.07	2.11	0.77	1.71	2.00	0.78	3.80	0.61	1.04	1.81	1.91	1.96	2.42	0.00
	F22	2.46	1.71	1.89	3.16	11.32	1.12	1.32	2.34	3.12	2.28	2.09	2.19	1.11	2.63	3.98	1.56
20D	F1	1.64	0.00	4.74	2.98	1.47	1.16	3.06	2.23	8.19	1.22	1.04	1.16	3.78	2.30	1.55	1.59
	F2	2.68	3.56	2.39	6.27	24.73	4.90	7.94	9.02	23.51	4.04	4.59	5.12	6.51	7.61	24.57	3.93
	F3	4.17	9.90	5.60	5.63	18.83	4.67	6.52	4.26	9.82	3.21	4.83	2.19	6.22	9.53	2.43	4.67
	F4	1.15	9.80	6.54	1.28	11.16	0.36	1.20	3.38	1.82	2.38	2.12	0.48	2.28	0.62	1.81	2.64
	F5	1.57	1.11	1.83	1.75	3.21	1.15	2.20	2.27	2.41	1.60	1.86	0.64	1.49	2.54	1.98	0.31
	F6	2.33	1.59	1.32	4.49	9.60	2.63	3.54	3.00	5.84	1.80	2.16	2.56	3.10	4.41	8.53	5.74
	F7	1.84	1.87	2.36	0.98	2.83	1.05	1.55	1.57	1.49	1.09	2.23	0.56	1.79	1.42	1.51	1.22
	F8	1.22	0.26	0.55	1.95	4.69	0.98	1.80	1.48	15.94	17.60	0.27	1.93	1.44	1.15	2.76	1.03
	F9	1.88	1.41	0.29	4.62	2.19	0.96	3.05	2.26	7.28	0.82	0.84	1.63	2.44	2.51	3.60	-0.46
	F10	1.93	0.84	19.92	2.87	-194.35	2.68	2.49	1.08	3.16	0.71	2.73	0.76	3.52	4.47	2.55	249.69
	F11	2.78	0.00	5.10	3.89	6.42	2.64	6.12	2.57	0.35	0.00	0.00	2.16	1.18	3.67	5.15	0.00
	F12	0.48	-0.32	-183.79	3.58	-96.80	1.47	4.11	-0.58	3.97	-0.03	-0.53	1.07	0.86	4.08	2.85	1.90
	F13	1.28	0.00	6.98	9.40	2.09	1.42	8.08	6.82	8.90	0.00	2.41	3.62	7.21	8.64	4.53	3.13
	F14	2.10	7.10	-2.26	3.63	10.66	1.27	5.37	2.49	11.63	0.68	0.58	3.00	4.05	5.64	0.42	0.75
	F15	1.42	-1.35	-1.35	3.18	-1.35	-0.27	1.46	3.41	5.68	-1.35	-1.02	2.47	3.30	5.15	-1.35	-1.35
	F16	1.74	1.16	3.70	0.32	2.45	0.49	0.75	0.81	4.04	1.25	1.23	0.79	1.56	2.10	1.52	1.98
	F17	2.08	0.93	1.11	3.38	9.72	2.27	4.27	3.58	5.82	2.01	2.75	2.82	4.19	4.73	4.73	2.64
	F18	0.55	3.86	0.57	1.31	4.66	0.73	3.44	0.78	0.80	0.74	0.60	1.23	2.90	1.36	2.27	1.03
	F19	1.36	0.00	6.00	3.57	3.46	1.31	3.65	0.45	4.15	0.98	1.80	0.90	1.30	2.98	2.82	1.15
	F20	-0.55	0.14	1.10	3.40	1.44	1.91	1.13	3.31	9.28	0.62	0.63	1.99	1.51	3.27	3.70	2.01
	F21	0.40	0.26	0.70	3.91	3.33	2.52	6.19	0.23	7.71	1.14	0.19	2.33	0.39	1.51	6.02	1.23
	F22	3.89	2.73	1.38	4.58	-35.91	2.59	2.46	2.40	5.67	2.47	2.60	1.82	2.12	3.01	6.02	3.78

Table I.9
Cohen's d effect values for DXMODEv2 against meta-heuristic optimization algorithms on CEC2020-2022.

Dim.	Fn.	GA	DE	SA	PSO	ABC	GWO	CSO	CSOA	BAS	FA	TLBO	MFO	WOA	HHO	CMAES	IMODEv2
10D	F1	1.64	0.00	3.33	1.35	1.30	0.50	1.38	2.01	4.21	1.43	1.34	0.56	0.72	1.28	2.90	0.60
	F2	2.41	1.94	2.03	4.35	16.75	2.27	3.21	4.26	13.43	1.53	1.20	3.78	5.12	5.62	12.85	0.55
	F3	2.79	3.21	4.43	2.36	6.98	2.05	3.72	3.67	5.05	0.91	1.38	2.63	3.10	6.65	0.12	0.19
	F4	2.21	5.92	7.45	0.79	5.82	2.26	0.92	4.15	1.28	1.96	1.44	0.34	3.84	0.59	1.78	0.65
	F5	1.40	0.49	1.44	1.52	2.71	0.35	0.62	0.79	0.97	1.56	2.05	0.31	0.99	1.46	1.07	2.33
	F6	1.75	0.46	1.66	2.49	4.11	2.47	2.01	3.19	3.07	1.27	1.35	2.96	3.20	3.59	4.75	1.92
	F7	0.74	0.40	2.11	0.70	2.54	1.86	1.27	1.34	0.79	0.97	1.39	1.43	1.29	0.79	1.00	2.44
	F8	1.19	0.27	0.39	0.45	1.54	0.81	1.80	0.59	4.35	-0.22	0.15	0.70	0.43	0.52	0.72	0.26
	F9	2.73	2.96	1.52	2.23	3.04	2.55	2.64	1.21	4.86	1.55	2.00	3.27	2.56	3.13	3.84	-0.70
	F10	2.87	1.76	0.55	1.64	2.70	2.53	4.17	0.36	3.15	1.53	1.35	2.07	0.54	2.29	2.72	-0.24
	F11	1.88	0.00	4.22	2.21	3.96	1.00	1.58	2.18	0.29	4.32	0.00	1.37	2.97	4.21	4.33	0.00
	F12	0.90	3.19	3.83	2.13	1.84	1.42	3.99	0.40	2.29	1.47	0.52	1.22	0.91	1.44	3.75	-0.35
	F13	1.27	0.00	6.22	4.44	4.60	0.56	3.92	2.44	8.75	10.74	0.58	1.15	2.94	5.04	0.83	0.00
	F14	2.37	5.09	1.94	2.55	9.27	2.10	3.19	2.81	9.00	1.65	1.18	2.98	3.08	3.53	-0.02	-0.36
	F15	1.32	0.00	4.50	2.72	1.80	0.84	1.09	1.02	5.19	3.14	0.93	0.90	1.64	3.48	0.00	0.00
	F16	0.75	4.16	2.69	1.30	1.83	2.44	1.72	0.57	2.16	1.80	1.43	1.68	1.30	0.77	1.02	1.42
	F17	3.03	0.45	2.80	4.16	37.22	3.81	4.67	3.56	4.15	2.04	2.05	2.46	4.11	3.85	2.46	0.81
	F18	37.61	0.28	4.64	1.28	24.63	8.55	6.69	14.49	0.90	2.61	2.47	8.76	10.63	5.63	2.76	2.15
	F19	1.25	0.00	4.21	4.86	-10.26	1.46	2.88	0.81	4.78	3.92	0.98	0.57	0.37	4.47	0.85	0.00
	F20	0.92	0.37	0.77	1.08	2.46	1.70	1.32	0.80	2.32	0.46	0.84	0.87	0.99	0.72	1.43	0.43
	F21	1.81	0.80	6.07	2.11	0.77	1.71	2.00	0.78	3.80	0.61	1.04	1.81	1.91	1.96	2.42	0.00
	F22	2.19	0.60	0.67	3.13	10.66	0.91	1.19	1.40	3.11	1.36	1.40	1.48	1.04	2.59	3.61	0.76
20D	F1	1.64	0.00	4.74	2.98	1.47	1.16	3.06	2.23	8.19	1.22	1.04	1.16	3.78	2.30	1.55	2.19
	F2	2.67	3.55	2.37	6.27	24.72	4.89	7.93	9.01	23.50	4.03	4.58	5.12	6.51	7.60	24.56	3.92
	F3	3.66	9.15	5.26	5.55	18.27	4.48	6.45	4.18	9.80	2.95	4.68	2.15	6.16	9.46	1.97	3.40
	F4	1.15	9.82	6.54	1.28	11.16	0.36	1.20	3.37	1.82	2.35	2.12	0.48	2.28	0.62	1.81	2.17
	F5	1.57	1.11	1.83	1.75	3.21	1.15	2.20	2.27	2.41	1.60	1.86	0.64	1.49	2.54	1.98	2.94
	F6	2.06	1.57	1.31	4.49	9.59	2.63	3.54	3.00	5.84	1.79	2.16	2.56	3.10	4.41	8.53	4.26
	F7	1.84	1.59	2.35	0.98	2.83	1.05	1.55	1.57	1.49	1.09	2.22	0.56	1.79	1.42	1.51	3.43
	F8	1.22	0.26	0.55	1.95	4.69	0.98	1.80	1.48	15.94	17.60	0.27	1.93	1.44	1.15	2.76	0.88
	F9	3.76	10.38	-0.35	5.25	19.43	1.85	8.77	3.68	7.85	2.85	2.41	4.90	3.29	2.75	12.83	0.73
	F10	1.93	0.93	20.00	2.87	-194.67	2.68	2.49	1.08	3.16	0.71	2.73	0.76	3.52	4.47	2.55	0.83
	F11	2.78	0.00	5.10	3.89	6.42	2.64	6.12	2.57	0.35	0.00	0.00	2.16	1.18	3.67	5.15	0.00
	F12	0.48	-0.32	-183.79	3.58	-96.80	1.47	4.11	-0.58	3.97	-0.03	-0.53	1.07	0.86	4.08	2.85	-0.70
	F13	1.28	0.00	6.98	9.40	2.09	1.42	8.08	6.82	8.90	0.00	2.41	3.62	7.21	8.64	4.53	3.11
	F14	2.71	8.43	-0.74	4.24	11.98	2.09	6.03	3.14	12.01	1.49	1.60	3.45	4.43	6.35	0.65	0.39
	F15	1.91	0.00	11.09	4.73	0.34	1.56	2.98	4.27	5.98	0.26	1.26	2.92	3.90	6.59	0.00	0.30
	F16	1.74	1.16	3.70	0.32	2.45	0.49	0.75	0.81	4.04	1.25	1.23	0.79	1.56	2.10	1.52	2.07
	F17	1.93	0.15	0.94	3.27	10.51	2.08	4.14	3.44	5.76	1.78	2.54	2.70	4.08	4.62	4.64	2.91
	F18	0.51	4.55	0.52	1.30	4.63	0.70	3.37	0.76	0.80	0.45	0.55	1.21	2.84	1.35	2.26	0.44
	F19	1.36	0.00	6.00	3.57	3.46	1.31	3.65	0.45	4.15	0.98	1.80	0.90	1.30	2.98	2.82	0.54
	F20	-0.55	0.14	1.10	3.40	1.44	1.91	1.13	3.31	9.28	0.62	0.63	1.99	1.51	3.27	3.70	1.15
	F21	0.32	-0.26	0.65	3.90	-0.26	2.50	6.17	0.18	7.70	0.98	0.14	2.32	0.39	1.50	6.01	-0.26
	F22	3.96	3.20	1.75	4.59	-48.85	2.66	2.49	2.44	5.68	2.63	2.66	1.87	2.15	3.02	6.07	1.43

Table I.10
Cohen's d effect values for DXMODE against advanced DE variants on CEC2020-2022.

Dim.	Fn.	EODE	MDE	MTDE	BSD	BDE	BeSD	meanDE	QRDE	JADE	JADEGMO	EA4eig	AGSK	HSES	IMODE
10D	F1	0.00	0.00	0.00	0.82	0.00	0.00	0.00	2.72	0.00	0.47	1.14	0.00	0.00	0.00
	F2	1.33	0.88	1.48	1.35	0.40	1.31	-0.18	1.53	1.75	3.25	3.20	1.48	-0.81	-0.31
	F3	0.38	0.69	-0.75	0.39	-0.08	-1.34	-0.75	0.23	-0.70	-0.20	4.96	-0.61	-2.80	-0.84
	F4	3.65	1.49	1.31	1.94	1.56	-1.14	1.12	2.38	1.52	3.50	3.73	1.48	1.15	-3.12
	F5	1.38	1.01	1.60	2.01	1.05	4.75	1.55	1.03	2.91	2.07	1.72	1.18	1.58	1.31
	F6	1.50	1.28	1.00	3.39	0.84	2.63	2.78	1.28	0.61	1.10	1.79	0.87	0.40	0.67
	F7	0.70	2.17	1.75	1.68	0.40	2.07	0.85	0.87	1.05	1.22	1.67	0.42	1.06	0.37
	F8	0.98	1.00	-0.01	-0.87	-0.18	0.02	0.98	0.99	0.25	1.01	1.26	-0.92	0.96	0.83
	F9	122.29	5.20	160.54	0.84	1.39	0.84	81.50	55.35	15.86	45.84	4.79	3.57	302.38	-0.37
	F10	1.25	1.29	-0.26	2.13	-0.26	-0.14	1.19	1.31	1.07	0.75	1.75	-0.93	7.91	-0.21
	F11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.00	1.62	0.00	0.00	0.00
	F12	2.01	0.00	0.00	1.29	0.70	0.00	0.77	22.06	1.49	0.68	2.40	0.46	0.00	0.00
	F13	0.00	0.00	0.46	0.00	0.00	0.00	0.55	0.00	0.84	0.43	1.61	0.46	0.00	0.00
	F14	1.51	1.84	1.45	2.16	1.85	-0.01	0.07	3.78	0.92	1.02	3.24	1.00	-1.77	0.70
	F15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	1.12	0.00	0.62	0.00
	F16	1.73	1.86	1.02	2.50	4.14	0.61	0.96	2.41	1.46	1.66	0.73	0.95	1.15	1.23
	F17	41.59	1.30	1.49	2.56	0.00	4.85	1.51	3.30	1.51	52.52	7.83	0.00	0.79	0.26
	F18	2.07	1.76	0.67	2.21	0.52	3.01	1.65	2.31	1.65	1.82	11.39	1.55	64.95	1.24
	F19	0.00	0.00	0.00	0.00	0.00	3.04	0.00	0.00	0.00	0.55	-0.46	0.00	1.85	0.00
	F20	0.98	1.05	-1.59	-46.42	1.89	1.36	2.30	0.14	0.53	1.36	0.64	0.03	1.40	-0.27
	F21	0.00	0.70	0.00	0.00	0.00	0.00	0.00	0.70	0.26	0.37	1.77	0.00	0.46	0.00
	F22	3.97	2.39	1.64	4.19	3.25	3.86	4.41	1.42	0.92	1.01	2.01	-1.10	5.90	1.56
20D	F1	0.00	0.00	0.00	0.96	0.00	0.00	1.81	0.95	0.70	1.23	1.75	0.00	0.00	1.59
	F2	2.94	2.29	5.87	1.57	1.27	3.71	2.08	5.79	5.54	9.12	20.83	3.63	1.48	3.93
	F3	5.35	3.23	0.97	2.98	1.69	6.61	3.30	3.95	2.29	5.61	16.22	2.82	1.11	4.67
	F4	2.21	0.90	2.75	1.99	-0.21	4.73	2.53	3.12	3.64	0.78	7.20	3.63	3.01	2.64
	F5	2.29	1.47	-0.81	1.46	1.00	0.52	1.05	2.29	1.89	5.90	2.35	0.33	2.33	0.31
	F6	1.33	1.75	1.93	4.48	0.49	6.08	1.54	1.45	1.47	3.18	4.75	2.53	0.85	5.74
	F7	1.96	2.48	0.85	1.81	1.61	1.35	4.59	0.92	2.45	0.56	2.06	0.58	2.00	1.22
	F8	0.37	0.26	2.58	-0.87	0.84	0.35	0.77	1.91	1.37	0.41	3.17	1.57	1.50	1.03
	F9	0.39	0.82	0.43	-0.37	0.66	0.10	0.24	0.97	0.86	1.32	2.31	-1.88	0.00	-0.46
	F10	0.47	0.87	2.99	6.62	-0.84	4.13	1.51	1.76	1.23	1.24	2.11	0.52	0.76	249.69
	F11	0.00	0.00	0.00	0.87	0.00	0.00	0.00	0.00	0.81	0.96	4.09	0.00	0.00	0.00
	F12	-1.06	15.06	-1.70	0.84	-0.46	-1.01	-2.29	6.71	2.23	-0.91	2.50	-0.70	-7.49	1.90
	F13	1.07	0.00	1.43	0.00	0.00	0.00	0.93	0.00	0.54	0.60	5.58	0.69	0.00	3.13
	F14	-1.40	-2.68	-0.82	1.53	-0.37	-2.03	-2.94	0.83	1.12	0.58	8.84	-0.92	-5.51	0.75
	F15	-1.35	-1.35	-1.35	-0.74	-1.34	-1.35	-1.35	-1.35	-1.14	-1.33	-1.06	-1.35	-1.35	-1.35
	F16	1.87	1.32	1.25	1.24	0.99	1.33	2.41	1.67	0.97	2.78	1.78	0.15	-1.71	1.98
	F17	2.02	2.48	1.52	1.01	-0.83	1.08	1.63	2.71	1.83	2.86	7.15	0.79	1.10	2.64
	F18	2.00	0.91	0.74	0.81	0.71	1.33	-0.54	2.51	3.19	2.34	6.03	2.10	0.90	1.03
	F19	0.00	0.67	1.64	4.20	4.57	2.71	0.84	0.83	1.22	0.52	2.66	2.06	4.27	1.15
	F20	1.45	-1.29	-1.77	-1.82	0.63	2.03	0.83	1.10	0.77	1.38	0.54	-1.58	0.77	2.01
	F21	0.46	24.45	2.31	-1.59	1.30	0.84	0.70	3.37	0.25	0.84	3.30	2.31	2.52	1.23
	F22	2.10	2.58	2.54	2.97	1.72	2.52	2.59	2.18	2.09	1.24	1.61	0.79	4.82	3.78

Appendix J. Engineering optimization problems: median results

This appendix reports the median results achieved by all algorithms across 30 independent runs on 13 engineering optimization problems.

Table J.11
Median results of the meta-heuristic algorithms on the 13 engineering optimization problems across 30 runs (F1-F13).

Fno	Alg.	Succ (%)	Cost	FEs	Iters	dim	Best Position
	GA	0.00	2995.16437268	12000	400	7	3.48, 0.70, 17.00, 7.30, 7.71, 3.35, 5.29
	DE	100.00	2994.42446580	6120	203	7	3.50, 0.70, 17.00, 7.30, 7.72, 3.35, 5.29
	SA	0.00	3000.31021483	12000	4	7	3.49, 0.70, 17.00, 7.31, 7.86, 3.35, 5.29
	PSO	0.00	3008.55469827	12000	207	7	3.50, 0.70, 17.00, 7.93, 7.92, 3.36, 5.29
	ABC	0.00	2994.42857756	12000	158	7	3.50, 0.70, 17.00, 7.30, 7.72, 3.35, 5.29
	GWO	0.00	3006.68667291	12000	397	7	3.47, 0.70, 17.00, 7.61, 8.01, 3.35, 5.29
	CSO	0.00	3135.20412413	12000	247	7	3.40, 0.71, 17.03, 8.08, 7.59, 3.48, 5.35
	CSOA	0.00	2998.99255184	12000	32	7	3.47, 0.70, 17.00, 7.30, 7.74, 3.35, 5.29
F1	BAS	0.00	3206.82136752	12000	3	7	3.14, 0.70, 17.21, 7.83, 7.61, 3.46, 5.43
	FA	0.00	2994.91810259	12000	25	7	3.50, 0.70, 17.00, 7.30, 7.73, 3.35, 5.29
	TLBO	100.00	2994.42446580	9090	151	7	3.50, 0.70, 17.00, 7.30, 7.72, 3.35, 5.29
	MFO	100.00	2994.42446580	7440	247	7	3.50, 0.70, 17.00, 7.30, 7.72, 3.35, 5.29
	WOA	0.00	3028.66235151	12000	392	7	3.31, 0.70, 17.00, 7.30, 7.30, 3.35, 5.29
	HHO	0.00	3106.30146945	12000	235	7	3.12, 0.70, 17.00, 7.63, 7.53, 3.49, 5.29
	CMAES	0.00	3294.29552190	12000	0	7	3.60, 0.70, 17.00, 7.30, 8.30, 3.22, 5.50
	IMODE	0.00	2994.78329527	12000	166	7	3.50, 0.70, 17.00, 7.30, 7.72, 3.35, 5.29
	DXMODE	100.00	2994.42446580	1463	6	7	3.63, 0.74, 14.36, 7.84, 7.90, 3.28, 5.38
	GA	0.00	0.01855933	12000	400	3	0.07, 0.78, 3.24
	DE	0.00	0.01266676	12000	400	3	0.05, 0.35, 11.70
	SA	0.00	0.01356130	12000	4	3	0.06, 0.52, 5.80
	PSO	0.00	0.01331191	12000	211	3	0.06, 0.44, 7.85
	ABC	0.00	0.01324532	12000	108	3	0.05, 0.31, 15.00
	GWO	0.00	0.01273971	12000	394	3	0.05, 0.32, 14.06
	CSO	0.00	0.01294453	12000	399	3	0.05, 0.31, 14.49
	CSOA	0.00	0.01472509	12000	32	3	0.06, 0.66, 3.73
F2	BAS	0.00	0.02673455	12000	47	3	0.06, 0.54, 12.24
	FA	0.00	0.01292217	12000	15	3	0.05, 0.41, 8.79
	TLBO	0.00	0.01269075	12000	167	3	0.05, 0.37, 10.83
	MFO	0.00	0.01319258	12000	115	3	0.05, 0.31, 15.00
	WOA	0.00	0.01318964	12000	374	3	0.06, 0.51, 5.97
	HHO	0.00	0.02985910	12000	251	3	0.07, 0.77, 7.17
	CMAES	0.00	0.37068703	12000	2	3	0.05, 0.35, 11.01
	IMODE	0.00	0.01266542	12000	621	3	0.05, 0.36, 11.15
	DXMODE	56.67	0.01266523	732	5	3	1.04, -0.26, 9.47
	GA	0.00	6567.18874627	12000	399	4	14.57, 7.64, 50.00, 98.36
	DE	50.00	6059.71433505	9120	303	4	12.67, 6.68, 42.10, 176.64
	SA	0.00	6152.93523720	12000	3	4	14.20, 6.58, 45.42, 141.36
	PSO	0.00	6640.58564242	12000	395	4	16.82, 8.29, 54.74, 64.69
	ABC	0.00	6253.57281383	12000	21	4	14.00, 7.49, 46.34, 130.50
	GWO	0.00	6069.66666867	12000	398	4	12.08, 6.00, 40.32, 200.00
	CSO	0.00	6339.01446521	12000	331	4	14.16, 7.92, 45.23, 141.65
	CSOA	0.00	6626.84798862	12000	33	4	14.27, 4.52, 45.43, 139.93
F3	BAS	0.00	15733.94308830	12000	134	4	28.19, 5.75, 44.95, 191.40
	FA	0.00	6064.09413197	12000	27	4	13.25, 6.80, 42.09, 176.92
	TLBO	0.00	6066.68009719	12000	193	4	13.41, 6.68, 42.14, 176.15
	MFO	0.00	7412.95989206	12000	133	4	20.03, 9.52, 65.23, 10.00
	WOA	0.00	6991.85691613	12000	382	4	16.70, 8.78, 56.45, 54.20
	HHO	0.00	8767.13332807	12000	256	4	10.55, 7.69, 52.37, 81.98
	CMAES	0.00	10948.17389189	12000	5	4	25.71, 0.51, 55.90, 60.20
	IMODE	50.00	6059.71433505	11794	366	4	12.67, 6.87, 42.10, 176.64
	DXMODE	100.00	6059.71433505	743	4	4	60.90, -40.99, 126.03, 19.85

(*continued on next page*)

Table J.11 (*continued*)

Fno	Alg.	Succ (%)	Cost	FEs	Iters	dim	Best Position
	GA	0.00	263.89703903	12000	94	2	0.79, 0.41
	DE	100.00	263.89584338	2790	92	2	0.79, 0.41
	SA	0.00	263.89840104	12000	2	2	0.79, 0.41
	PSO	0.00	263.89585456	12000	308	2	0.79, 0.41
	ABC	0.00	263.89607207	12000	122	2	0.79, 0.41
	GWO	0.00	263.89623338	12000	396	2	0.79, 0.41
	CSO	0.00	263.89705474	12000	205	2	0.79, 0.41
	CSOA	0.00	263.91242318	12000	32	2	0.78, 0.42
F4	BAS	0.00	270.25052083	12000	0	2	0.67, 0.49
	FA	0.00	263.89593024	12000	13	2	0.79, 0.41
	TLBO	0.00	263.89584418	12000	167	2	0.79, 0.41
	MFO	0.00	263.89596600	12000	163	2	0.79, 0.41
	WOA	0.00	263.97985040	12000	382	2	0.78, 0.44
	HHO	0.00	263.95284264	12000	258	2	0.80, 0.38
	CMAES	0.00	263.89584803	12000	352	2	0.79, 0.41
	IMODE	100.00	263.89584338	2998	139	2	0.79, 0.41
	DXMODE	100.00	263.89584338	192	1	2	-0.03, 0.18
	GA	0.00	0.00000001	12000	12	4	56.04, 18.62, 19.95, 46.88
	DE	0.00	0.00000000	12000	158	4	56.53, 30.90, 13.34, 49.18
	SA	0.00	0.00000000	12000	3	4	50.69, 29.92, 12.68, 52.71
	PSO	0.00	0.00000010	12000	7	4	41.77, 20.24, 12.70, 42.53
	ABC	0.00	0.00000000	12000	156	4	52.88, 14.88, 26.27, 51.41
	GWO	0.00	0.00000000	12000	239	4	57.12, 30.81, 12.90, 48.54
	CSO	0.00	0.00000000	12000	40	4	47.14, 24.68, 16.49, 59.06
	CSOA	0.00	0.00000000	12000	22	4	52.46, 18.39, 25.15, 60.00
F5	BAS	0.00	0.00000065	12000	6	4	51.15, 25.46, 12.00, 40.58
	FA	0.00	0.00000000	12000	66	4	47.46, 12.00, 25.81, 45.76
	TLBO	0.00	0.00000000	12000	178	4	52.55, 12.83, 20.46, 33.60
	MFO	0.00	0.00000001	12000	18	4	43.31, 12.00, 30.59, 60.00
	WOA	0.00	0.00000000	12000	135	4	53.53, 12.00, 36.87, 57.46
	HHO	0.00	0.00000138	12000	31	4	44.78, 12.00, 12.00, 21.92
	CMAES	0.00	0.00000030	12000	8	4	60.00, 42.43, 12.00, 57.91
	IMODE	0.00	0.00000000	12000	181	4	33.87, 20.01, 12.74, 52.88
	DXMODE	0.00	0.00000000	12000	93	4	66.65, 28.86, 20.14, 59.99
	GA	0.00	1.95766203	12000	144	5	11.23, 8.52, 6.88, 2.07, 2.67
	DE	0.00	1.33996671	12000	399	5	6.02, 5.29, 4.49, 3.51, 2.16
	SA	0.00	1.44669851	12000	4	5	7.85, 5.15, 4.79, 3.71, 1.69
	PSO	0.00	1.63223714	12000	279	5	5.15, 5.27, 10.18, 3.28, 2.28
	ABC	0.00	1.34140374	12000	191	5	5.94, 5.23, 4.58, 3.46, 2.28
	GWO	0.00	1.34022095	12000	399	5	5.96, 5.34, 4.49, 3.56, 2.13
	CSO	0.00	1.39114051	12000	378	5	5.37, 5.75, 4.89, 3.19, 3.10
	CSOA	0.00	4.73869595	12000	33	5	20.43, 17.38, 7.60, 3.51, 27.02
F6	BAS	0.00	7.60352343	12000	134	5	4.23, 37.20, 23.14, 48.21, 9.07
	FA	0.00	1.34279524	12000	20	5	6.05, 5.29, 4.57, 3.52, 2.08
	TLBO	0.00	1.33997129	12000	153	5	6.00, 5.32, 4.49, 3.51, 2.15
	MFO	0.00	1.34025215	12000	343	5	6.01, 5.24, 4.54, 3.55, 2.13
	WOA	0.00	1.46354823	12000	380	5	8.09, 5.55, 3.49, 4.40, 1.93
	HHO	0.00	1.67595731	12000	266	5	7.72, 7.88, 3.19, 3.32, 4.75
	CMAES	0.00	1.33997594	12000	293	5	6.00, 5.31, 4.50, 3.51, 2.15
	IMODE	0.00	1.34031187	12000	246	5	5.94, 5.36, 4.47, 3.50, 2.19
	DXMODE	100.00	1.33995760	352	1	5	9.72, -1.83, 8.54, 6.31, -7.33

Table J.11 (*continued*)

Fno	Alg.	Succ (%)	Cost	FEs	Iters	dim	Best Position
	GA	0.00	0.01966696	12000	399	4	69.09, 46.47, 1.65, 2.08
	DE	0.00	0.01307412	12000	400	4	80.00, 50.00, 0.90, 2.32
	SA	0.00	0.01307554	12000	4	4	80.00, 50.00, 0.90, 2.32
	PSO	0.00	0.01515293	12000	294	4	76.46, 40.92, 1.18, 2.64
	ABC	0.00	0.01308694	12000	160	4	80.00, 50.00, 0.90, 2.32
	GWO	0.00	0.01307507	12000	399	4	80.00, 49.99, 0.90, 2.32
	CSO	0.00	0.01308169	12000	399	4	80.00, 49.52, 0.90, 2.34
	CSOA	0.00	0.01447381	12000	33	4	80.00, 50.00, 1.36, 1.94
F7	BAS	0.00	0.01587895	12000	23	4	75.37, 30.81, 0.90, 3.68
	FA	0.00	0.01307428	12000	23	4	80.00, 50.00, 0.90, 2.32
	TLBO	0.00	0.01307412	12000	190	4	80.00, 50.00, 0.90, 2.32
	MFO	0.00	0.01307412	12000	114	4	80.00, 50.00, 0.90, 2.32
	WOA	0.00	0.01423025	12000	388	4	80.00, 33.74, 1.22, 3.11
	HHO	0.00	0.11504093	12000	249	4	47.78, 46.22, 1.36, 2.61
	CMAES	0.00	0.02293337	12000	6	4	64.06, 50.00, 0.90, 2.10
	IMODE	0.00	0.01307412	12000	398	4	80.00, 50.00, 0.90, 2.32
	DXMODE	100.00	0.01307410	304	1	4	4.73, -0.96, 0.04, 0.25
	GA	0.00	27.30525065	12000	400	2	5.25, 0.33
	DE	100.00	26.48636147	3690	122	2	5.45, 0.29
	SA	0.00	26.49955512	12000	4	2	5.45, 0.29
	PSO	46.67	28.22268839	12000	218	2	5.05, 0.37
	ABC	0.00	26.49052877	12000	132	2	5.45, 0.29
	GWO	0.00	26.48992936	12000	397	2	5.45, 0.29
	CSO	0.00	26.48909591	12000	159	2	5.45, 0.29
	CSOA	0.00	26.58571896	12000	23	2	5.43, 0.30
F8	BAS	0.00	29.40234702	12000	0	2	6.31, 0.27
	FA	0.00	26.49091558	12000	26	2	5.45, 0.29
	TLBO	100.00	26.48636147	5010	83	2	5.45, 0.29
	MFO	100.00	26.48636147	4350	144	2	5.45, 0.29
	WOA	0.00	26.65891427	12000	385	2	5.41, 0.30
	HHO	0.00	27.02978602	12000	251	2	5.72, 0.28
	CMAES	0.00	31.55791339	12000	2	2	7.97, 0.20
	IMODE	100.00	26.48636147	4305	212	2	5.45, 0.29
	DXMODE	100.00	26.48636147	7067	107	2	5.45, 0.29
	GA	0.00	322.65705762	12000	400	4	130.15, 499.92, 3.68, 60.33
	DE	73.33	8.41269832	5010	166	4	0.05, 2.04, 4.08, 120.00
	SA	0.00	12.21190019	12000	4	4	0.05, 2.54, 4.42, 120.00
	PSO	0.00	374.21561129	12000	215	4	217.56, 394.44, 3.18, 72.10
	ABC	0.00	10.29041778	12000	198	4	0.05, 2.23, 4.32, 108.40
	GWO	0.00	8.46593710	12000	399	4	0.06, 2.04, 4.08, 120.00
	CSO	0.00	9.62267444	12000	399	4	0.05, 2.17, 4.23, 119.73
	CSOA	0.00	1261.40167711	12000	33	4	204.80, 470.90, 6.56, 62.80
F9	BAS	0.00	19857.35843880	12000	134	4	245.49, 231.09, 23.54, 60.80
	FA	0.00	9.42763512	12000	18	4	0.05, 2.28, 4.10, 119.24
	TLBO	76.67	8.41269832	4650	77	4	0.05, 2.04, 4.08, 120.00
	MFO	73.33	8.41269832	5700	189	4	0.05, 2.04, 4.08, 120.00
	WOA	0.00	16.09107661	12000	398	4	0.08, 3.96, 4.05, 119.89
	HHO	0.00	2423.13621069	12000	267	4	97.79, 234.98, 7.57, 81.50
	CMAES	0.00	250.30858061	12000	24	4	0.05, 0.05, 5.09, 120.00
	IMODE	73.33	8.41269832	11563	325	4	0.05, 2.04, 4.08, 120.00
	DXMODE	100.00	8.41269832	304	1	4	-67.27, 46.88, 138.71, 122.57

(*continued on next page*)

Table J.11 (*continued*)

Fno	Alg.	Succ (%)	Cost	FEs	Iters	dim	Best Position
	GA	0.00	6.95127076	12000	400	4	57.35, 33.18, 52.07, 1.05
	DE	100.00	6.84295801	6000	199	4	57.69, 34.15, 57.69, 1.05
	SA	0.00	6.90310540	12000	3	4	56.85, 34.97, 57.95, 1.05
	PSO	0.00	6.95819099	12000	153	4	41.88, 34.08, 57.69, 1.05
	ABC	0.00	6.84731891	12000	139	4	57.52, 34.19, 57.72, 1.05
	GWO	0.00	6.84912256	12000	399	4	57.06, 34.15, 57.71, 1.05
	CSO	0.00	7.23351260	12000	162	4	61.85, 34.03, 63.46, 1.13
	CSOA	0.00	6.87335518	12000	31	4	57.15, 34.33, 57.99, 1.05
F10	BAS	0.00	7.98445276	12000	92	4	61.10, 44.55, 69.27, 1.15
	FA	0.00	6.85295905	12000	20	4	57.51, 34.24, 57.69, 1.05
	TLBO	100.00	6.84295801	5430	90	4	57.69, 34.15, 57.69, 1.05
	MFO	100.00	6.84295801	7410	246	4	57.69, 34.15, 57.69, 1.05
	WOA	0.00	7.30944908	12000	389	4	38.69, 36.35, 66.89, 1.05
	HHO	0.00	7.36516448	12000	260	4	46.86, 39.29, 55.21, 1.05
	CMAES	0.00	10.95817180	12000	2	4	63.79, 70.09, 94.39, 1.41
	IMODE	73.33	6.84295801	11607	331	4	57.69, 34.15, 57.69, 1.05
	DXMODE	33.33	6.84295803	12000	293	4	57.69, 34.15, 57.69, 1.05
	GA	0.00	23.52347194	12000	399	11	0.50, 1.25, 0.50, 1.18, 0.54, 1.02, 0.50, 0.67, 0.67, 3.70, 8.33
	DE	0.00	22.84298831	12000	370	11	0.50, 1.12, 0.50, 1.30, 0.50, 1.50, 0.50, 1.00, 0.57, -19.55, 0.04
	SA	0.00	22.97163475	12000	4	11	0.50, 1.11, 0.50, 1.34, 0.50, 1.50, 0.50, 1.00, 0.60, -20.94, -1.45
	PSO	0.00	25.12316805	12000	175	11	0.59, 0.97, 0.64, 1.09, 0.83, 1.50, 0.85, 0.68, 0.73, -29.99, 3.00
	ABC	0.00	22.87850485	12000	199	11	0.50, 1.12, 0.50, 1.30, 0.50, 1.50, 0.50, 1.00, 0.00, -19.09, 2.21
	GWO	0.00	23.19090931	12000	399	11	0.50, 1.04, 0.56, 0.59, 0.50, 1.50, 0.50, 0.96, 0.01, -30.00, -0.53
	CSO	0.00	23.85275370	12000	395	11	0.51, 1.25, 0.50, 1.17, 0.81, 1.02, 0.51, 0.54, 0.35, 5.75, -0.26
	CSOA	0.00	25.59855142	12000	33	11	0.50, 1.05, 0.99, 1.04, 0.91, 1.50, 0.52, 0.01, 0.68, -25.32, -12.12
F11	BAS	0.00	24.79742678	12000	105	11	0.66, 1.16, 0.59, 1.35, 0.51, 1.49, 0.50, 1.00, 0.49, -11.99, 17.06
	FA	0.00	22.85105854	12000	22	11	0.50, 1.12, 0.50, 1.29, 0.50, 1.50, 0.50, 0.70, 0.78, -18.72, 0.52
	TLBO	0.00	22.84348928	12000	199	11	0.50, 1.12, 0.50, 1.30, 0.50, 1.50, 0.50, 0.99, 0.01, -19.21, 0.02
	MFO	0.00	22.86331781	12000	399	11	0.50, 1.14, 0.50, 1.27, 0.50, 1.50, 0.50, 1.00, 1.00, -15.86, -0.00
	WOA	0.00	23.82964279	12000	400	11	0.50, 1.11, 0.64, 0.50, 0.65, 1.50, 0.50, 0.47, 0.00, -30.00, -3.66
	HHO	0.00	25.85963923	12000	254	11	0.50, 1.47, 0.50, 1.08, 0.56, 0.85, 0.74, 0.00, 0.19, 9.90, 7.24
	CMAES	0.00	25.19166069	12000	21	11	0.50, 1.50, 0.50, 0.50, 0.50, 1.50, 0.50, 0.00, 0.08, -30.00, -7.24
	IMODE	0.00	23.49565548	12000	72	11	0.50, 1.23, 0.51, 1.24, 0.50, 1.50, 0.54, 0.78, 0.10, -10.64, -3.12
	DXMODE	100.00	22.84296954	1939	6	11	0.65, 0.86, 0.82, 0.99, 0.46, 1.49, 0.05, 0.65, 0.37, -39.56, 9.85
	GA	0.00	2.96112639	12000	234	4	0.56, 1.66, 5.31, 0.60
	DE	0.00	1.72485240	12000	393	4	0.21, 3.47, 9.04, 0.21
	SA	0.00	1.77781287	12000	4	4	0.21, 3.51, 8.96, 0.21
	PSO	0.00	3.18661404	12000	203	4	0.32, 3.56, 5.11, 0.64
	ABC	0.00	1.91157999	12000	170	4	0.21, 3.45, 10.00, 0.21
	GWO	0.00	1.72701592	12000	399	4	0.21, 3.46, 9.03, 0.21
	CSO	0.00	1.84765631	12000	265	4	0.24, 3.10, 8.38, 0.24
	CSOA	0.00	2.22673085	12000	32	4	0.31, 2.57, 7.18, 0.34
F12	BAS	0.00	3.09770511	12000	5	4	0.21, 5.79, 6.89, 0.43
	FA	0.00	1.73307034	12000	27	4	0.20, 3.55, 9.04, 0.21
	TLBO	100.00	1.72485231	8490	141	4	0.21, 3.47, 9.04, 0.21
	MFO	0.00	1.72630313	12000	399	4	0.21, 3.46, 9.04, 0.21
	WOA	0.00	2.91425006	12000	371	4	0.47, 1.85, 5.90, 0.55
	HHO	0.00	3.82951084	12000	247	4	0.30, 6.18, 5.06, 0.66
	CMAES	0.00	4.63143020	12000	10	4	0.38, 5.27, 5.35, 0.77
	IMODE	10.00	1.72485239	12000	407	4	0.21, 3.47, 9.04, 0.21
	DXMODE	100.00	1.72485231	886	5	4	1.28, -3.07, 7.14, 0.94

Table J.11 (*continued*)

Fno	Alg.	Succ (%)	Cost	FEs	Iters	dim	Best Position
	GA	10.00	362.63400000	12000	38	3	0.48, 0.38, 8.00
	DE	100.00	359.20800000	3270	108	3	0.27, 0.49, 8.50
	SA	0.00	359.20909408	12000	3	3	0.21, 0.52, 8.50
	PSO	60.00	359.20800000	1110	36	3	0.21, 0.48, 8.50
	ABC	0.00	359.20801910	12000	188	3	0.23, 0.49, 8.50
	GWO	0.00	359.20810599	12000	398	3	0.24, 0.47, 8.50
	CSO	53.33	359.20800000	2640	87	3	0.27, 0.50, 8.50
	CSOA	0.00	362.45975810	12000	32	3	0.29, 0.41, 8.50
F13	BAS	0.00	371.86131470	12000	73	3	0.09, 0.68, 8.47
	FA	0.00	359.20801638	12000	21	3	0.19, 0.50, 8.50
	TLBO	100.00	359.20800000	8310	138	3	0.21, 0.52, 8.50
	MFO	56.67	359.20800000	2280	75	3	0.25, 0.52, 8.50
	WOA	0.00	362.63400028	12000	353	3	0.55, 0.37, 8.00
	HHO	0.00	364.85705372	12000	253	3	0.16, 0.57, 8.75
	CMAES	0.00	381.71511329	12000	5	3	0.00, 0.70, 9.12
	IMODE	100.00	359.20800000	6061	150	3	0.20, 0.51, 8.50
	DXMODE	100.00	359.20800000	6235	68	3	0.25, 0.50, 8.50

Appendix K. Engineering optimization problems: metrics table

This appendix summarizes detailed performance metrics—best, worst, mean, median, and SD—for both classical meta-heuristics and advanced DE variants across all engineering optimization problems.

Table K.12
The best, worst, mean, median, SD results for all meta-heuristic optimization algorithms (Engineering Optimization Problems), (F1-F13).

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	2.9947E+03	3.0427E+03	2.9968E+03	3.0040E+03	1.4281E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	5.4900E+03	6.4500E+03	5.9850E+03	5.9960E+03	2.2529E+02	100.00
	SA	2.9974E+03	3.0013E+03	3.0003E+03	2.9999E+03	1.2768E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	2.9980E+03	3.0199E+03	3.0086E+03	3.0069E+03	8.4153E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	1.6297E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	3.0039E+03	3.0080E+03	3.0067E+03	3.0060E+03	1.4586E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	3.0545E+03	3.1569E+03	3.1352E+03	3.1298E+03	2.6807E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	2.9964E+03	2.9990E+03	2.9990E+03	2.9983E+03	9.7395E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F1	BAS	3.1670E+03	3.3708E+03	3.2068E+03	3.2302E+03	8.0518E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	2.9948E+03	2.9951E+03	2.9950E+03	2.9949E+03	1.0560E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	7.4100E+03	9.0900E+03	8.9700E+03	8.6120E+03	5.3607E+02	100.00
	MFO	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	6.9000E+03	8.2500E+03	7.7100E+03	7.6480E+03	4.7662E+02	100.00
	WOA	3.0143E+03	3.3058E+03	3.0287E+03	3.1420E+03	1.3124E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	3.0863E+03	3.4230E+03	3.1063E+03	3.1830E+03	1.4736E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	3.2198E+03	3.3522E+03	3.2943E+03	3.2874E+03	5.4866E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	2.9945E+03	2.9950E+03	2.9948E+03	2.9948E+03	1.6686E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	4.4000E+02	1.4630E+03	1.0650E+03	9.8780E+02	2.4337E+02	100.00
	GA	1.3475E-02	4.2126E-02	1.8559E-02	1.9274E-02	6.9786E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	1.2665E-02	1.2936E-02	1.2667E-02	1.2698E-02	7.1302E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	SA	1.2885E-02	1.8567E-02	1.3561E-02	1.4782E-02	2.3780E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	1.3271E-02	1.4510E-02	1.3312E-02	1.3613E-02	4.9841E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	1.3021E-02	1.3657E-02	1.3245E-02	1.3237E-02	2.1314E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	1.2713E-02	1.3264E-02	1.2891E-02	1.2925E-02	2.1627E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	1.2688E-02	1.3717E-02	1.2945E-02	1.3112E-02	3.9551E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	1.4545E-02	3.1906E-02	1.4948E-02	1.9411E-02	7.6725E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F2	BAS	1.5469E-02	7.5439E-02	2.6735E-02	3.2650E-02	2.0361E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	1.2742E-02	1.3150E-02	1.2922E-02	1.2933E-02	1.3549E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	1.2680E-02	1.2692E-02	1.2691E-02	1.2686E-02	5.3213E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MFO	1.2684E-02	1.7773E-02	1.3193E-02	1.4324E-02	2.1442E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	1.2704E-02	1.5317E-02	1.3190E-02	1.3196E-02	5.8197E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	1.6337E-02	8.9323E-02	2.9859E-02	3.8659E-02	2.7688E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	5.6891E-02	1.4434E+00	3.7069E-01	6.2521E-01	5.4368E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	1.2665E-02	1.2670E-02	1.2666E-02	1.2667E-02	2.0546E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	1.2665E-02	1.2669E-02	1.2665E-02	1.2666E-02	1.0552E-06	2.5000E+02	1.2000E+04	1.1097E+04	7.1985E+03	5.3584E+03	56.67
	GA	6.1825E+03	7.3090E+03	6.5672E+03	6.6807E+03	4.2368E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	6.0597E+03	6.0905E+03	6.0751E+03	6.0751E+03	1.5669E+01	8.6400E+03	1.2000E+04	1.1070E+04	1.0649E+04	1.4222E+03	50.00
	SA	6.0995E+03	7.4283E+03	6.1529E+03	6.6251E+03	5.4446E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	6.3978E+03	6.8204E+03	6.6406E+03	6.6256E+03	1.2892E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	6.0977E+03	6.4579E+03	6.2536E+03	6.2506E+03	1.2088E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	6.0601E+03	7.5931E+03	6.0697E+03	6.3764E+03	6.1882E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	6.0804E+03	7.0031E+03	6.3390E+03	6.3790E+03	2.7646E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	6.6207E+03	7.6512E+03	6.7703E+03	6.8563E+03	2.6759E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F3	BAS	1.4899E+04	2.7874E+04	1.5734E+04	1.8830E+04	4.9105E+03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	6.0611E+03	6.0935E+03	6.0646E+03	6.0705E+03	1.2773E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	6.0597E+03	6.3277E+03	6.0667E+03	6.0751E+03	4.7963E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MFO	6.0905E+03	7.5803E+03	7.4130E+03	7.1049E+03	6.2612E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	6.0794E+03	7.7981E+03	6.9919E+03	6.8320E+03	7.1521E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	7.4779E+03	1.4893E+04	8.7671E+03	9.3420E+03	1.9037E+03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	6.9487E+03	1.3283E+04	1.1357E+04	1.1390E+04	1.4483E+03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	6.0597E+03	6.0905E+03	6.0597E+03	6.0731E+03	1.5529E+01	1.1746E+04	1.2000E+04	1.1921E+04	1.1886E+04	1.1811E+02	50.00
	DXMODE	6.0597E+03	6.0597E+03	6.0597E+03	6.0597E+03	9.2504E-13	3.0400E+02	8.8600E+02	4.5200E+02	5.0957E+02	1.6957E+02	100.00

Table K.12 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	2.6390E+02	2.6423E+02	2.6390E+02	2.6399E+02	1.5040E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	2.7900E+03	3.1200E+03	2.8800E+03	2.9200E+03	1.3968E+02	100.00
	SA	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	2.1857E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	2.6390E+02	2.6392E+02	2.6390E+02	2.6390E+02	8.1651E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	1.2168E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	2.2034E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	2.6390E+02	2.6397E+02	2.6390E+02	2.6392E+02	3.4773E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	2.6390E+02	2.6392E+02	2.6391E+02	2.6391E+02	7.1059E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F4	BAS	2.6585E+02	2.7531E+02	2.7033E+02	2.6993E+02	2.8710E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	6.3582E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	1.0443E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MFO	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	2.0229E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	2.6391E+02	2.6415E+02	2.6398E+02	2.6401E+02	8.3386E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	2.6390E+02	2.6440E+02	2.6395E+02	2.6409E+02	1.9912E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.9176E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	2.6930E+03	3.2830E+03	2.9600E+03	2.9801E+03	2.0106E+02	100.00
	DXMODE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	1.9200E+02	5.2710E+03	1.9200E+02	6.9803E+02	1.5441E+03	100.00
	GA	2.7009E-12	2.7265E-08	9.5209E-09	1.2351E-08	9.8183E-09	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	2.7009E-12	8.8876E-10	9.9399E-11	2.5593E-10	3.5737E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	SA	2.3078E-11	8.8876E-10	6.1238E-11	2.7174E-10	3.7971E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	1.2634E-09	6.3938E-04	1.6884E-07	6.4132E-05	1.9503E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	2.7009E-12	1.3616E-09	2.3078E-11	5.1621E-10	5.7096E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	2.3078E-11	2.3576E-09	7.3052E-10	9.7831E-10	9.9683E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	2.3078E-11	3.2999E-09	9.7457E-10	1.0737E-09	1.3161E-09	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	9.9216E-10	2.7265E-08	2.3576E-09	6.8640E-09	9.6595E-09	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F5	BAS	6.5123E-09	3.6320E-03	6.5174E-07	7.2831E-04	1.4767E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	2.3078E-11	2.0575E-09	9.9216E-10	1.0207E-09	7.2201E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	2.7009E-12	1.5450E-10	2.3078E-11	7.1398E-11	6.5377E-11	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MFO	1.1834E-09	2.7265E-08	8.7008E-09	1.3904E-08	1.1365E-08	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	2.7009E-12	9.9216E-10	8.8876E-10	7.0073E-10	4.3031E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	4.9152E-08	3.0965E-05	1.3811E-06	7.1137E-06	1.2152E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	2.3078E-11	8.9490E-07	3.0059E-07	3.9049E-07	3.4845E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	2.7009E-12	6.6021E-10	2.3078E-11	7.7282E-11	1.9787E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	5.5668E-15	2.7009E-12	5.1525E-13	6.3221E-13	5.8657E-13	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GA	1.3513E+00	2.0669E+00	1.9577E+00	1.8660E+00	1.9038E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	7.4990E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	SA	1.4205E+00	1.5336E+00	1.4467E+00	1.4596E+00	4.6412E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	1.4952E+00	4.1938E+00	1.6322E+00	2.7085E+00	1.2538E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	1.3413E+00	1.3452E+00	1.3422E+00	1.3428E+00	1.6439E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	1.3401E+00	1.3403E+00	1.3402E+00	1.3402E+00	5.0967E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	1.3470E+00	1.4287E+00	1.3969E+00	1.4012E+00	2.3872E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	3.0694E+00	6.0247E+00	4.7387E+00	4.7952E+00	9.4783E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F6	BAS	7.0871E+00	1.0637E+01	7.6035E+00	8.4416E+00	1.4267E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	1.3420E+00	1.3430E+00	1.3428E+00	1.3425E+00	4.2125E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	5.7587E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MFO	1.3401E+00	1.3418E+00	1.3403E+00	1.3405E+00	6.5864E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	1.4036E+00	1.8694E+00	1.4635E+00	1.5443E+00	1.1492E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	1.4081E+00	3.0785E+00	1.8659E+00	2.0099E+00	5.7558E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	1.1327E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	1.3400E+00	1.3403E+00	1.3403E+00	1.3402E+00	1.3244E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	1.1292E-15	3.5200E+02	5.2300E+02	3.5200E+02	3.6340E+02	4.3384E+01	100.00
	GA	1.3074E-02	1.3782E-01	1.9667E-02	4.7664E-02	4.5115E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	3.2300E-13	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	SA	1.3075E-02	1.3083E-02	1.3076E-02	1.3079E-02	3.9245E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	1.3523E-02	6.0790E-02	1.5153E-02	2.0420E-02	1.3798E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	1.3075E-02	1.3108E-02	1.3087E-02	1.3089E-02	1.1825E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	1.3074E-02	1.3076E-02	1.3075E-02	1.3075E-02	6.9205E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	1.3075E-02	1.3187E-02	1.3082E-02	1.3091E-02	3.2795E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	1.3842E-02	4.8746E-02	1.4474E-02	2.4269E-02	1.5627E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F7	BAS	1.4591E-02	1.9279E-02	1.5879E-02	1.6342E-02	1.8852E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	1.3074E-02	1.3076E-02	1.3074E-02	1.3074E-02	4.8724E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	1.9455E-12	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MFO	1.3074E-02	1.3220E-02	1.3074E-02	1.3100E-02	5.4345E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	1.3229E-02	1.6962E-02	1.4230E-02	1.4707E-02	1.4343E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	1.3664E-02	4.1863E-01	1.1504E-01	1.7907E-01	1.5668E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	1.4081E-02	1.8829E-01	2.2933E-02	4.8365E-02	5.8374E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	1.2261E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	5.2931E-18	3.0400E+02	7.4300E+02	3.0400E+02	3.2843E+02	9.4913E+01	100.00

(*continued on next page*)

Table K.12 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	2.6487E+01	2.8109E+01	2.7305E+01	2.7272E+01	5.3995E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	3.6900E+03	4.3800E+03	3.8100E+03	3.9110E+03	2.5571E+02	100.00
	SA	2.6487E+01	2.6550E+01	2.6500E+01	2.6513E+01	2.4732E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	2.6486E+01	2.9288E+01	2.8223E+01	2.7697E+01	1.2174E+00	1.2000E+03	1.2000E+04	1.2000E+04	6.9780E+03	5.4606E+03	46.67
	ABC	2.6490E+01	2.6499E+01	2.6492E+01	2.6493E+01	3.2504E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	2.6487E+01	2.6493E+01	2.6490E+01	2.6491E+01	2.3316E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	2.6486E+01	2.6569E+01	2.6489E+01	2.6515E+01	3.5340E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	2.6497E+01	2.6716E+01	2.6586E+01	2.6581E+01	7.9062E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F8	BAS	2.6919E+01	3.2537E+01	2.9402E+01	2.9370E+01	1.8221E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	2.6488E+01	2.6491E+01	2.6491E+01	2.6490E+01	1.4617E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	4.8300E+03	5.6100E+03	5.0100E+03	5.1300E+03	2.7832E+02	100.00
	MFO	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	4.2000E+03	4.5600E+03	4.3500E+03	4.3840E+03	1.3456E+02	100.00
	WOA	2.6590E+01	2.6804E+01	2.6717E+01	2.6709E+01	8.5637E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	2.6656E+01	2.7948E+01	2.7030E+01	2.7243E+01	4.9817E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	2.8516E+01	3.1651E+01	3.1558E+01	3.1228E+01	9.3951E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	4.1180E+03	4.3050E+03	4.2880E+03	4.2132E+03	9.0794E+01	100.00
	DXMODE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	6.4940E+03	7.6240E+03	7.1500E+03	7.1174E+03	2.4785E+02	100.00
	GA	3.1145E+01	5.0315E+02	3.2266E+02	2.4444E+02	1.9576E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	8.4127E+00	2.0153E+02	8.4127E+00	5.9911E+01	8.6861E+01	4.7100E+03	1.2000E+04	5.0100E+03	6.8720E+03	3.1541E+03	73.33
	SA	9.0404E+00	2.5397E+02	1.2212E+01	1.1986E+02	1.1891E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	3.7406E+02	6.7751E+02	3.7422E+02	4.8333E+02	1.3113E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	9.0079E+00	1.7791E+01	1.0290E+01	1.1946E+01	3.6059E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	8.4269E+00	1.6770E+02	8.4659E+00	1.3772E+01	2.9072E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	9.0167E+00	1.0699E+01	9.6227E+00	9.9849E+00	6.9072E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	2.3894E+02	5.0035E+03	1.3768E+03	1.9689E+03	1.9165E+03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F9	BAS	2.5666E+02	2.0338E+04	1.9857E+04	1.1836E+04	9.0769E+03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	8.7071E+00	1.7928E+02	1.0046E+01	5.3729E+01	7.4465E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	8.4127E+00	1.8103E+01	8.4127E+00	1.0674E+01	4.1687E+00	4.6500E+03	1.2000E+04	5.1300E+03	7.7850E+03	3.3876E+03	76.67
	MFO	8.4127E+00	2.0153E+02	8.4127E+00	5.9911E+01	8.6861E+01	5.3400E+03	1.2000E+04	5.7000E+03	7.4580E+03	2.8185E+03	73.33
	WOA	1.1183E+01	2.8392E+02	2.3842E+01	9.0616E+01	1.1875E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	6.0382E+02	1.6724E+04	2.4231E+03	5.6769E+03	6.8035E+03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	1.1421E+02	5.5741E+02	2.5031E+02	2.8837E+02	1.5324E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	8.4127E+00	8.4127E+00	8.4127E+00	8.4127E+00	1.0786E-08	1.1563E+04	1.2000E+04	1.1731E+04	1.1779E+04	1.6629E+02	73.33
	DXMODE	8.4127E+00	8.4127E+00	8.4127E+00	8.4127E+00	5.4202E-15	3.0400E+02	5.9800E+02	3.0400E+02	3.5327E+02	8.0698E+01	100.00
	GA	6.9191E+00	9.3187E+00	7.2076E+00	7.6042E+00	8.3724E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	4.5168E-15	5.8500E+03	6.0000E+03	5.9700E+03	5.9460E+03	6.0207E+01	100.00
	SA	6.8860E+00	6.9505E+00	6.9031E+00	6.9159E+00	2.5395E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	6.8564E+00	6.9984E+00	6.9582E+00	6.9276E+00	5.8123E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	6.8449E+00	6.8481E+00	6.8473E+00	6.8469E+00	1.2922E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	6.8466E+00	6.8729E+00	6.8491E+00	6.8533E+00	1.0073E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	7.0417E+00	7.5657E+00	7.2335E+00	7.2580E+00	1.8986E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	6.8507E+00	6.8854E+00	6.8734E+00	6.8706E+00	1.2216E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F10	BAS	7.5463E+00	8.1040E+00	7.9845E+00	7.8991E+00	2.2044E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	6.8479E+00	6.8552E+00	6.8530E+00	6.8525E+00	2.3896E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	4.5168E-15	5.1900E+03	6.6300E+03	5.4300E+03	5.6540E+03	5.2043E+02	100.00
	MFO	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	4.5168E-15	7.0500E+03	8.1300E+03	7.4100E+03	7.4820E+03	4.1849E+02	100.00
	WOA	7.2498E+00	7.7053E+00	7.3094E+00	7.3881E+00	1.6733E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	7.2882E+00	7.8965E+00	7.3652E+00	7.5084E+00	2.4661E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	9.4749E+00	1.1707E+01	1.0958E+01	1.0991E+01	5.3724E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	9.4784E-09	1.1458E+04	1.2000E+04	1.1607E+04	1.1687E+04	2.0801E+02	73.33
	DXMODE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	3.4812E-08	1.1649E+04	1.2000E+04	1.2000E+04	1.1941E+04	1.0727E+02	33.33
	GA	2.3177E+01	2.3930E+01	2.3523E+01	2.3459E+01	2.6998E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	2.2843E+01	2.3185E+01	2.2843E+01	2.2934E+01	1.5363E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	SA	2.2960E+01	2.3213E+01	2.2972E+01	2.3061E+01	1.0921E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	2.4360E+01	2.5348E+01	2.5123E+01	2.4854E+01	4.2474E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	2.2863E+01	2.2892E+01	2.2885E+01	2.2881E+01	1.1500E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	2.2916E+01	2.3489E+01	2.3191E+01	2.3196E+01	2.0685E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	2.3032E+01	2.5077E+01	2.3853E+01	2.3854E+01	6.9056E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	2.5397E+01	2.6061E+01	2.5750E+01	2.5721E+01	2.7194E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F11	BAS	2.4258E+01	2.5568E+01	2.4797E+01	2.4787E+01	5.2034E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	2.2846E+01	2.2934E+01	2.2851E+01	2.2872E+01	3.7856E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	2.2843E+01	2.3231E+01	2.2843E+01	2.3015E+01	1.8740E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MFO	2.2844E+01	2.3192E+01	2.2863E+01	2.2988E+01	1.6907E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	2.3541E+01	2.7261E+01	2.3830E+01	2.4738E+01	1.5631E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	2.4414E+01	2.7457E+01	2.5860E+01	2.5906E+01	1.0594E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	2.4900E+01	2.6195E+01	2.5192E+01	2.5561E+01	5.7550E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	2.2861E+01	2.4009E+01	2.3496E+01	2.3476E+01	4.9818E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	2.2843E+01	2.2843E+01	2.2843E+01	2.2843E+01	1.0840E-14	1.1520E+03	2.4330E+03	1.9390E+03	1.9230E+03	4.1041E+02	100.00

Table K.12 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	GA	1.9729E+00	3.1402E+00	2.9611E+00	2.7931E+00	4.3976E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DE	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	8.0175E-08	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	SA	1.7465E+00	1.7820E+00	1.7778E+00	1.7703E+00	1.4750E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	2.0718E+00	4.5856E+00	3.2748E+00	3.1788E+00	1.0235E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	ABC	1.8203E+00	1.9911E+00	1.9116E+00	1.9062E+00	6.0941E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	1.7262E+00	1.7289E+00	1.7270E+00	1.7276E+00	1.1645E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	1.7807E+00	2.0661E+00	1.8477E+00	1.9103E+00	9.2786E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSOA	1.7652E+00	2.4663E+00	2.2267E+00	2.1423E+00	2.2989E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F12	BAS	2.4081E+00	3.5853E+00	3.1845E+00	2.9976E+00	4.7874E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	1.7327E+00	1.7370E+00	1.7349E+00	1.7348E+00	2.0805E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	6.7752E-16	8.1900E+03	9.8100E+03	8.4900E+03	8.7140E+03	6.8228E+02	100.00
	MFO	1.7249E+00	2.0250E+00	1.7263E+00	1.7669E+00	7.0459E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	WOA	1.8922E+00	5.7041E+00	3.0638E+00	3.2275E+00	1.4943E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	2.3434E+00	4.6490E+00	3.8295E+00	3.6280E+00	8.3644E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	2.7479E+00	7.4225E+00	4.6314E+00	4.7870E+00	9.6455E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	5.6828E-08	1.1747E+04	1.2000E+04	1.2000E+04	1.1975E+04	7.7198E+01	10.00
	DXMODE	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	6.7752E-16	3.0400E+02	1.5740E+03	5.9800E+02	6.1387E+02	3.0405E+02	100.00
	GA	3.5921E+02	3.6486E+02	3.6263E+02	3.6233E+02	1.9523E+00	4.5000E+02	1.2000E+04	1.2000E+04	1.0852E+04	3.5030E+03	10.00
	DE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	2.7900E+03	3.2700E+03	3.2400E+03	3.0800E+03	2.0383E+02	100.00
	SA	3.5921E+02	3.6026E+02	3.5921E+02	3.5949E+02	4.7311E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	PSO	3.5921E+02	3.6263E+02	3.5921E+02	3.6058E+02	1.7071E+00	9.0000E+02	1.2000E+04	1.1100E+03	5.4120E+03	5.4714E+03	60.00
	ABC	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	7.5926E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	GWO	3.5921E+02	3.6225E+02	3.5921E+02	3.5992E+02	1.3097E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CSO	3.5921E+02	3.6263E+02	3.5921E+02	3.6080E+02	1.7288E+00	9.6000E+02	1.2000E+04	2.6400E+03	6.5600E+03	5.2131E+03	53.33
	CSOA	3.5921E+02	3.6265E+02	3.6246E+02	3.6183E+02	1.3346E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F13	BAS	3.6566E+02	3.7495E+02	3.7186E+02	3.7214E+02	2.1953E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	FA	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	1.7063E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	TLBO	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	2.4900E+03	8.3100E+03	3.2100E+03	4.1660E+03	2.3431E+03	100.00
	MFO	3.5921E+02	3.6263E+02	3.5921E+02	3.6012E+02	1.5406E+00	1.9500E+03	1.2000E+04	2.4150E+03	6.4850E+03	4.9067E+03	56.67
	WOA	3.5921E+02	3.6915E+02	3.6263E+02	3.6345E+02	2.5130E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HHO	3.5924E+02	3.6731E+02	3.6486E+02	3.6403E+02	2.9337E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	CMAES	3.5929E+02	3.8640E+02	3.8172E+02	3.7844E+02	9.7155E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	6.0610E+03	7.0990E+03	6.8230E+03	6.6299E+03	3.9131E+02	100.00
	DXMODE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	5.0020E+03	7.1570E+03	6.2970E+03	6.2842E+03	4.7309E+02	100.00

Table K.13
The best, worst, mean, median, SD results for advanced DE variants (Engineering Optimization Problems), (F1-F13).

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	3.9734E-06	1.0860E+04	1.2000E+04	1.2000E+04	1.1962E+04	2.0813E+02	3.33
	MDE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	7.2000E+02	1.7400E+03	1.2300E+03	1.2280E+03	3.6163E+02	100.00
	MTDE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	2.2844E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	2.9946E+03	2.9948E+03	2.9948E+03	2.9947E+03	6.2561E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	2.9945E+03	2.9946E+03	2.9946E+03	2.9946E+03	4.4918E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	3.0080E+03	3.0287E+03	3.0255E+03	3.0232E+03	6.1877E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	8.8500E+03	1.0350E+04	9.9900E+03	9.8740E+03	4.1162E+02	100.00
F1	QRDE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	6.5100E+03	7.0800E+03	6.8400E+03	6.8080E+03	2.1241E+02	100.00
	JADE	2.9944E+03	2.9964E+03	2.9944E+03	2.9948E+03	7.0795E-01	7.6800E+03	1.2000E+04	1.1070E+04	1.0572E+04	1.6094E+03	56.67
	JADEGMO	2.9945E+03	3.0210E+03	2.9945E+03	2.9980E+03	9.1479E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	2.9944E+03	3.0146E+03	2.9944E+03	2.9978E+03	7.0703E+00	7.8600E+02	1.2000E+04	1.9220E+03	4.2673E+03	4.3716E+03	80.00
	AGSK	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	1.1946E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	1.1700E+03	1.5700E+03	1.3700E+03	1.3700E+03	1.2865E+02	100.00
	IMODE	2.9945E+03	2.9950E+03	2.9948E+03	2.9948E+03	1.6686E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	2.9944E+03	2.9944E+03	2.9944E+03	2.9944E+03	4.6252E-13	4.4000E+02	1.4630E+03	1.0650E+03	9.8780E+02	2.4337E+02	100.00
	EODE	1.2666E-02	1.2683E-02	1.2673E-02	1.2673E-02	4.5541E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MDE	1.2679E-02	1.4347E-02	1.3524E-02	1.3640E-02	4.8773E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MTDE	1.2665E-02	1.2670E-02	1.2666E-02	1.2667E-02	1.1228E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	1.3200E-02	1.4221E-02	1.3380E-02	1.3469E-02	2.9144E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	1.2749E-02	1.2937E-02	1.2843E-02	1.2852E-02	4.8559E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	1.3098E-02	1.4161E-02	1.3313E-02	1.3556E-02	4.2433E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	1.3133E-02	1.5010E-02	1.3611E-02	1.3717E-02	5.5245E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F2	QRDE	1.2688E-02	1.2921E-02	1.2717E-02	1.2744E-02	6.5620E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADE	1.2665E-02	1.2812E-02	1.2797E-02	1.2738E-02	6.9314E-05	5.6100E+03	1.2000E+04	1.2000E+04	9.2600E+03	3.0897E+03	46.67
	JADEGMO	1.2685E-02	1.3196E-02	1.2703E-02	1.2805E-02	1.8986E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	1.2665E-02	1.9378E-02	1.2665E-02	1.3037E-02	1.2792E-03	3.0000E+02	1.2000E+04	8.8605E+03	8.5104E+03	2.9653E+03	86.67
	AGSK	1.2665E-02	1.2669E-02	1.2666E-02	1.2666E-02	8.1618E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	1.3641E-02	1.5121E-02	1.4216E-02	1.4346E-02	5.0393E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	1.2665E-02	1.2670E-02	1.2666E-02	1.2667E-02	2.0546E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	1.2665E-02	1.2669E-02	1.2665E-02	1.2666E-02	1.0552E-06	2.5000E+02	1.2000E+04	1.1097E+04	7.1985E+03	5.3584E+03	56.67
	EODE	6.0597E+03	6.0597E+03	6.0597E+03	6.0597E+03	9.2504E-13	9.1800E+03	1.0980E+04	9.8400E+03	9.9580E+03	5.3636E+02	100.00
	MDE	6.0598E+03	6.6363E+03	6.0789E+03	6.2225E+03	2.5411E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MTDE	6.0597E+03	6.0597E+03	6.0597E+03	6.0597E+03	1.1431E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	6.3160E+03	6.4739E+03	6.4551E+03	6.4070E+03	6.6133E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	6.0603E+03	6.4104E+03	6.0663E+03	6.1284E+03	1.2888E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	6.0967E+03	6.2191E+03	6.1196E+03	6.1324E+03	4.3055E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	6.0597E+03	6.0905E+03	6.0597E+03	6.0659E+03	1.2535E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F3	QRDE	6.0597E+03	6.0696E+03	6.0597E+03	6.0607E+03	3.0124E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADE	6.0597E+03	6.0602E+03	6.0597E+03	6.0598E+03	2.0854E-01	6.2700E+03	1.2000E+04	7.3500E+03	8.4630E+03	2.2127E+03	73.33
	JADEGMO	6.0598E+03	7.0479E+03	6.0928E+03	6.3257E+03	4.2797E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	6.0597E+03	6.0785E+03	6.0597E+03	6.0608E+03	3.6307E+00	2.0000E+02	1.2000E+04	1.0079E+04	8.3494E+03	4.5402E+03	53.33
	AGSK	6.0597E+03	6.0597E+03	6.0597E+03	6.0597E+03	1.1132E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	6.6366E+03	6.8427E+03	6.6443E+03	6.7284E+03	1.0092E+02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	6.0597E+03	6.0905E+03	6.0597E+03	6.0731E+03	1.5529E+01	1.1746E+04	1.2000E+04	1.1921E+04	1.1886E+04	1.1811E+02	50.00
	DXMODE	6.0597E+03	6.0597E+03	6.0597E+03	6.0597E+03	9.2504E-13	3.0400E+02	8.8600E+02	4.5200E+02	5.0957E+02	1.6957E+02	100.00
	EODE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	7.4700E+03	1.0710E+04	7.7100E+03	8.7300E+03	1.4137E+03	100.00
	MDE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	1.1619E-06	1.1760E+04	1.2000E+04	1.2000E+04	1.1992E+04	4.3818E+01	3.33
	MTDE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	7.3200E+03	8.9100E+03	8.5200E+03	8.3800E+03	5.3162E+02	100.00
	BSD	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	1.8764E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	1.9587E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	3.7948E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	2.6390E+02	2.6392E+02	2.6390E+02	2.6390E+02	8.4180E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F4	QRDE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	7.6500E+03	8.9400E+03	8.5200E+03	8.3650E+03	4.8413E+02	100.00
	JADE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	2.6100E+03	3.8100E+03	2.9100E+03	2.9790E+03	4.4526E+02	100.00
	JADEGMO	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	6.2072E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	3.0000E+02	6.1310E+03	4.7400E+03	3.7954E+03	2.1681E+03	100.00
	AGSK	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	5.9790E+03	8.1760E+03	7.0625E+03	7.0023E+03	5.0282E+02	100.00
	HSES	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	2.2531E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	2.6930E+03	3.2830E+03	2.9600E+03	2.9801E+03	2.0106E+02	100.00
	DXMODE	2.6390E+02	2.6390E+02	2.6390E+02	2.6390E+02	5.7815E-14	1.9200E+02	5.2710E+03	1.9200E+02	6.9803E+02	1.5441E+03	100.00
	EODE	2.3078E-11	9.9216E-10	2.3078E-11	2.4920E-10	4.1688E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MDE	3.0676E-10	2.3576E-09	9.3166E-10	1.0940E-09	6.8828E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MTDE	2.7009E-12	1.1661E-10	2.7009E-12	2.9558E-11	4.4992E-11	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	2.7009E-12	2.0575E-09	1.1661E-10	7.2784E-10	8.8801E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	2.7009E-12	1.3616E-09	2.1168E-10	4.7456E-10	4.6635E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	2.7009E-12	1.1661E-10	2.7009E-12	1.0295E-11	2.8900E-11	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	2.7009E-12	1.5450E-10	2.7009E-12	3.1501E-11	4.7687E-11	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F5	QRDE	6.6021E-10	1.3616E-09	1.2634E-09	1.0538E-09	2.9433E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADE	2.7009E-12	2.3576E-09	9.7457E-10	9.2952E-10	7.9018E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADEGMO	1.1661E-10	8.7008E-09	9.9216E-10	1.5569E-09	1.5813E-09	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	9.9399E-11	5.7228E-07	2.3576E-09	8.8334E-08	1.7016E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	AGSK	2.7009E-12	3.2999E-09	3.0676E-10	8.3119E-10	1.0003E-09	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	2.7009E-12	2.3576E-09	2.7009E-12	5.0407E-10	9.4390E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	2.7009E-12	6.6021E-10	2.3078E-11	7.7282E-11	1.9787E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00

Table K.13 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	2.5253E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MDE	1.3401E+00	1.3407E+00	1.3401E+00	1.3402E+00	1.9055E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MTDE	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	3.2563E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	1.3406E+00	1.3470E+00	1.3422E+00	1.3423E+00	1.6403E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	1.3408E+00	1.3425E+00	1.3413E+00	1.3416E+00	6.9118E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	1.4192E+00	1.5402E+00	1.4544E+00	1.4670E+00	4.6493E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	3.3725E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F6	QRDE	1.3401E+00	1.0695E+01	1.3401E+00	3.2110E+00	3.8059E+00	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADE	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	1.1292E-15	4.8000E+03	6.7500E+03	6.2400E+03	5.9900E+03	7.5177E+02	100.00
	JADEGMO	1.3403E+00	1.3540E+00	1.3412E+00	1.3414E+00	2.4480E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	1.3400E+00	1.5507E+00	1.3400E+00	1.3470E+00	3.8480E-02	1.0680E+03	1.2000E+04	1.7030E+03	2.8549E+03	2.3976E+03	96.67
	AGSK	1.3400E+00	1.3403E+00	1.3400E+00	1.3401E+00	6.0991E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	1.8943E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	1.3400E+00	1.3403E+00	1.3403E+00	1.3402E+00	1.3244E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	1.3400E+00	1.3400E+00	1.3400E+00	1.3400E+00	1.1292E-15	3.5200E+02	5.2300E+02	3.5200E+02	3.6340E+02	4.3384E+01	100.00
	EODE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	1.0852E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MDE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	5.2931E-18	1.2000E+02	1.2000E+03	5.1000E+02	5.9500E+02	3.2637E+02	100.00
	MTDE	1.3074E-02	1.3076E-02	1.3074E-02	1.3075E-02	5.4584E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	1.3525E-02	1.3856E-02	1.3823E-02	1.3758E-02	1.3742E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	1.3091E-02	1.3224E-02	1.3102E-02	1.3147E-02	5.7033E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	1.3267E-02	1.3620E-02	1.3514E-02	1.3454E-02	1.1666E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	3.3574E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F7	QRDE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	8.8219E-18	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADE	1.3074E-02	1.3092E-02	1.3083E-02	1.3085E-02	5.5058E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADEGMO	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	2.1097E-08	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	5.2931E-18	3.0000E+02	7.2700E+03	2.5515E+03	2.6424E+03	2.0596E+03	100.00
	AGSK	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	2.2711E-09	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	5.2931E-18	9.6800E+02	2.5680E+03	2.3680E+03	2.1280E+03	4.7677E+02	100.00
	IMODE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	1.2261E-10	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	1.3074E-02	1.3074E-02	1.3074E-02	1.3074E-02	5.2931E-18	3.0400E+02	7.4300E+02	3.0400E+02	3.2843E+02	9.4913E+01	100.00
	EODE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	5.1000E+03	5.9100E+03	5.2800E+03	5.3850E+03	2.5060E+02	100.00
	MDE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	1.5463E-06	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MTDE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	1.0320E+04	1.1340E+04	1.0380E+04	1.0640E+04	3.8831E+02	100.00
	BSD	2.6486E+01	2.6498E+01	2.6495E+01	2.6493E+01	4.1709E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	3.4882E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	2.6489E+01	2.6499E+01	2.6490E+01	2.6492E+01	3.3107E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	2.6495E+01	2.6759E+01	2.6509E+01	2.6572E+01	1.1514E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F8	QRDE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	6.3600E+03	7.8300E+03	7.2600E+03	7.2390E+03	4.8027E+02	100.00
	JADE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	3.4200E+03	1.0860E+04	4.0500E+03	4.7040E+03	2.1866E+03	100.00
	JADEGMO	2.6486E+01	2.6487E+01	2.6486E+01	2.6486E+01	4.2193E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	2.6486E+01	2.6668E+01	2.6487E+01	2.6501E+01	3.4655E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	AGSK	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	7.3780E+03	9.7180E+03	8.4610E+03	8.5251E+03	5.8991E+02	100.00
	HSES	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	1.0964E+04	1.1964E+04	1.1264E+04	1.1491E+04	3.6571E+02	100.00
	IMODE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	4.1180E+03	4.3050E+03	4.2880E+03	4.2132E+03	9.0794E+01	100.00
	DXMODE	2.6486E+01	2.6486E+01	2.6486E+01	2.6486E+01	7.2269E-15	6.4940E+03	7.6240E+03	7.1500E+03	7.1174E+03	2.4785E+02	100.00
	EODE	8.4127E+00	1.6747E+02	1.6747E+02	1.1445E+02	7.6263E+01	8.4600E+03	1.2000E+04	1.2000E+04	1.0852E+04	1.6541E+03	33.33
	MDE	8.4127E+00	1.3676E+01	8.4127E+00	9.8162E+00	2.3672E+00	3.9000E+03	1.2000E+04	4.6800E+03	6.5320E+03	3.3678E+03	73.33
	MTDE	8.4130E+00	8.6950E+00	8.4132E+00	8.4320E+00	7.1484E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	2.7099E+01	2.8599E+02	1.2514E+02	1.2739E+02	9.6621E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	8.4741E+00	6.6861E+01	1.0033E+01	2.7652E+01	2.3645E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	2.6646E+01	2.3294E+02	1.2972E+02	1.3035E+02	6.0210E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	1.6747E+02	1.6747E+02	1.6747E+02	1.6747E+02	6.1713E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F9	QRDE	8.4127E+00	2.0153E+02	1.6747E+02	1.0233E+02	9.0242E+01	5.1900E+03	1.2000E+04	1.2000E+04	8.9120E+03	3.3612E+03	46.67
	JADE	8.4134E+00	1.6747E+02	1.3155E+02	1.0868E+02	6.7249E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADEGMO	8.4209E+00	2.0154E+02	1.6777E+02	1.6293E+02	4.3858E+01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	8.4127E+00	8.4127E+00	8.4127E+00	8.4127E+00	5.4202E-15	2.0000E+02	8.0270E+03	2.5490E+03	2.9166E+03	2.6987E+03	100.00
	AGSK	8.4127E+00	8.4128E+00	8.4127E+00	8.4127E+00	1.8585E-05	1.1503E+04	1.2000E+04	1.2000E+04	1.1920E+04	1.4582E+02	33.33
	HSES	8.4127E+00	2.3393E+02	8.4127E+00	6.8866E+01	1.0124E+02	9.6800E+02	1.2000E+04	9.6800E+02	6.1163E+03	5.5978E+03	53.33
	IMODE	8.4127E+00	8.4127E+00	8.4127E+00	8.4127E+00	1.0786E-08	1.1563E+04	1.2000E+04	1.1731E+04	1.1779E+04	1.6629E+02	73.33
	DXMODE	8.4127E+00	8.4127E+00	8.4127E+00	8.4127E+00	5.4202E-15	3.0400E+02	5.9800E+02	3.0400E+02	3.5327E+02	8.0698E+01	100.00
	EODE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	4.5168E-15	7.0800E+03	7.7700E+03	7.4400E+03	7.4230E+03	2.2843E+02	100.00
	MDE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	4.5489E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MTDE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	4.1221E-08	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	6.8453E+00	6.8515E+00	6.8466E+00	6.8471E+00	2.0067E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	6.8430E+00	6.8432E+00	6.8431E+00	6.8431E+00	5.8970E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	6.8743E+00	6.9057E+00	6.8884E+00	6.8882E+00	1.0319E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	4.5168E-15	1.0590E+04	1.1700E+04	1.0980E+04	1.1008E+04	3.9525E+02	100.00
F10	QRDE	6.8430E+00	9.6138E+00	6.8430E+00	6.9353E+00	5.0588E-01	6.7200E+03	1.2000E+04	7.0800E+03	7.3180E+03	9.3061E+02	96.67
	JADE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	2.6000E-08	5.8200E+03	1.2000E+04	6.1950E+03	8.4590E+03	2.7644E+03	80.00
	JADEGMO	6.8434E+00	6.8456E+00	6.8453E+00	6.8448E+00	7.4366E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	6.8430E+00	7.0611E+00	6.8895E+00	6.9005E+00	5.7863E-02	9.7360E+03	1.2000E+04	1.2000E+04	1.1925E+04	4.1335E+02	3.33
	AGSK	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	6.1142E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	5.0277E-08	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	IMODE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	9.4784E-09	1.1458E+04	1.2000E+04	1.1607E+04	1.1687E+04	2.0801E+02	73.33
	DXMODE	6.8430E+00	6.8430E+00	6.8430E+00	6.8430E+00	3.4812E-08	1.1649E+04	1.2000E+04	1.2000E+04	1.1941E+04	1.0727E+02	33.33

(*continued on next page*)

Table K.13 (*continued*)

Fun	Alg.	Error					Function Evaluations					SR (%)
No.	Name	Best	Worst	Median	Mean	SD	Best	Worst	Median	Mean	SD	
	EODE	2.2843E+01	2.2846E+01	2.2844E+01	2.2844E+01	1.1867E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MDE	2.2843E+01	2.2843E+01	2.2843E+01	2.2843E+01	1.0840E-14	4.5000E+02	1.5900E+03	1.0500E+03	1.0610E+03	3.1695E+02	100.00
	MTDE	2.2844E+01	2.2847E+01	2.2845E+01	2.2845E+01	1.2041E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	2.3113E+01	2.3581E+01	2.3217E+01	2.3317E+01	1.9166E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	2.2931E+01	2.3146E+01	2.3006E+01	2.3011E+01	7.3239E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	2.3969E+01	2.4414E+01	2.4022E+01	2.4125E+01	1.9325E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	2.2843E+01	2.2843E+01	2.2843E+01	2.2843E+01	1.0875E-06	9.9300E+03	1.2000E+04	1.0380E+04	1.1016E+04	9.5098E+02	53.33
F11	QRDE	2.2843E+01	2.3185E+01	2.2843E+01	2.2889E+01	1.1805E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADE	2.2843E+01	2.3453E+01	2.2843E+01	2.2909E+01	1.7515E-01	7.2300E+03	1.2000E+04	8.3100E+03	9.2490E+03	2.1672E+03	63.33
	JADEGMO	2.2849E+01	2.3272E+01	2.3185E+01	2.3175E+01	8.9036E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	2.2843E+01	2.4106E+01	2.2942E+01	2.3111E+01	4.0217E-01	2.7150E+03	1.2000E+04	8.6400E+03	8.0480E+03	4.0705E+03	50.00
	AGSK	2.2843E+01	2.3222E+01	2.2846E+01	2.2882E+01	1.0725E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	2.2843E+01	2.2843E+01	2.2843E+01	2.2843E+01	1.0840E-14	1.9740E+03	2.3740E+03	2.1740E+03	2.1740E+03	1.4856E+02	100.00
	IMODE	2.2861E+01	2.4009E+01	2.3496E+01	2.3476E+01	4.9818E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	DXMODE	2.2843E+01	2.2843E+01	2.2843E+01	2.2843E+01	1.0840E-14	1.1520E+03	2.4330E+03	1.9390E+03	1.9230E+03	4.1041E+02	100.00
	EODE	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	2.1964E-06	1.0170E+04	1.2000E+04	1.2000E+04	1.1459E+04	8.4157E+02	30.00
	MDE	1.7251E+00	1.7979E+00	1.7512E+00	1.7546E+00	2.2994E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	MTDE	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	5.2179E-07	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BSD	1.8641E+00	2.5036E+00	2.3016E+00	2.2507E+00	1.9834E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BDE	1.7280E+00	1.7321E+00	1.7287E+00	1.7291E+00	1.4911E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	BeSD	1.8118E+00	1.8801E+00	1.8576E+00	1.8512E+00	2.6169E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	1.7249E+00	1.7250E+00	1.7250E+00	1.7250E+00	7.5282E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
F12	QRDE	3.4290E+00	5.1937E+00	3.4529E+00	3.9734E+00	7.5907E-01	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	JADE	1.7249E+00	1.7909E+00	1.7249E+00	1.7271E+00	1.2065E-02	6.5700E+03	1.2000E+04	7.2600E+03	9.0940E+03	2.5935E+03	56.67
	JADEGMO	1.7266E+00	1.7512E+00	1.7280E+00	1.7332E+00	1.0192E-02	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	6.7752E-16	3.9900E+02	7.7490E+03	4.6985E+03	4.2840E+03	2.8060E+03	100.00
	AGSK	1.7249E+00	1.7252E+00	1.7249E+00	1.7249E+00	7.3523E-05	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	HSES	1.7249E+00	2.2297E+00	2.1453E+00	2.0712E+00	1.8182E-01	9.6800E+02	1.2000E+04	1.2000E+04	9.7936E+03	4.4882E+03	20.00
	IMODE	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	5.6828E-08	1.1747E+04	1.2000E+04	1.2000E+04	1.1975E+04	7.7198E+01	10.00
	DXMODE	1.7249E+00	1.7249E+00	1.7249E+00	1.7249E+00	6.7752E-16	3.0400E+02	1.5740E+03	5.9800E+02	6.1387E+02	3.0405E+02	100.00
	EODE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	2.7600E+03	3.7800E+03	3.3600E+03	3.2800E+03	3.7398E+02	100.00
	MDE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	5.6700E+03	8.8200E+03	7.6800E+03	7.1770E+03	1.1118E+03	100.00
	MTDE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	7.1700E+03	7.7700E+03	7.7100E+03	7.5850E+03	2.3011E+02	100.00
	BSD	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	3.5238E-05	9.6000E+03	1.2000E+04	1.2000E+04	1.1360E+04	1.0795E+03	26.67
	BDE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	2.0230E-08	9.3000E+03	1.2000E+04	1.1940E+04	1.1091E+04	1.0593E+03	73.33
	BeSD	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	2.5838E-04	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	meanDE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	6.0860E-08	5.8200E+03	1.2000E+04	7.8000E+03	8.0990E+03	1.7487E+03	86.67
F13	QRDE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	1.4502E-04	3.2100E+03	1.2000E+04	4.4100E+03	4.4440E+03	1.4929E+03	96.67
	JADE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	2.2200E+03	1.1640E+04	3.8400E+03	5.4790E+03	3.3729E+03	100.00
	JADEGMO	3.5921E+02	3.5923E+02	3.5921E+02	3.5921E+02	3.7118E-03	1.2000E+04	1.2000E+04	1.2000E+04	1.2000E+04	0.0000E+00	0.00
	EA4eig	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	4.4603E-04	2.4840E+03	1.2000E+04	1.2000E+04	1.0198E+04	3.3726E+03	23.33
	AGSK	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	6.5110E+03	8.6320E+03	7.8150E+03	7.7772E+03	5.0236E+02	100.00
	HSES	3.5921E+02	3.5931E+02	3.5921E+02	3.5922E+02	3.1350E-02	5.3660E+03	1.2000E+04	5.7660E+03	6.3361E+03	1.9337E+03	90.00
	IMODE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	6.0610E+03	7.0990E+03	6.8230E+03	6.6299E+03	3.9131E+02	100.00
	DXMODE	3.5921E+02	3.5921E+02	3.5921E+02	3.5921E+02	5.7815E-14	5.0020E+03	7.1570E+03	6.2970E+03	6.2842E+03	4.7309E+02	100.00

Appendix L. Engineering optimization problems: box plots

This appendix presents box plots visualizing the distribution of results across 30 runs for all algorithms on the 13 engineering optimization problems.

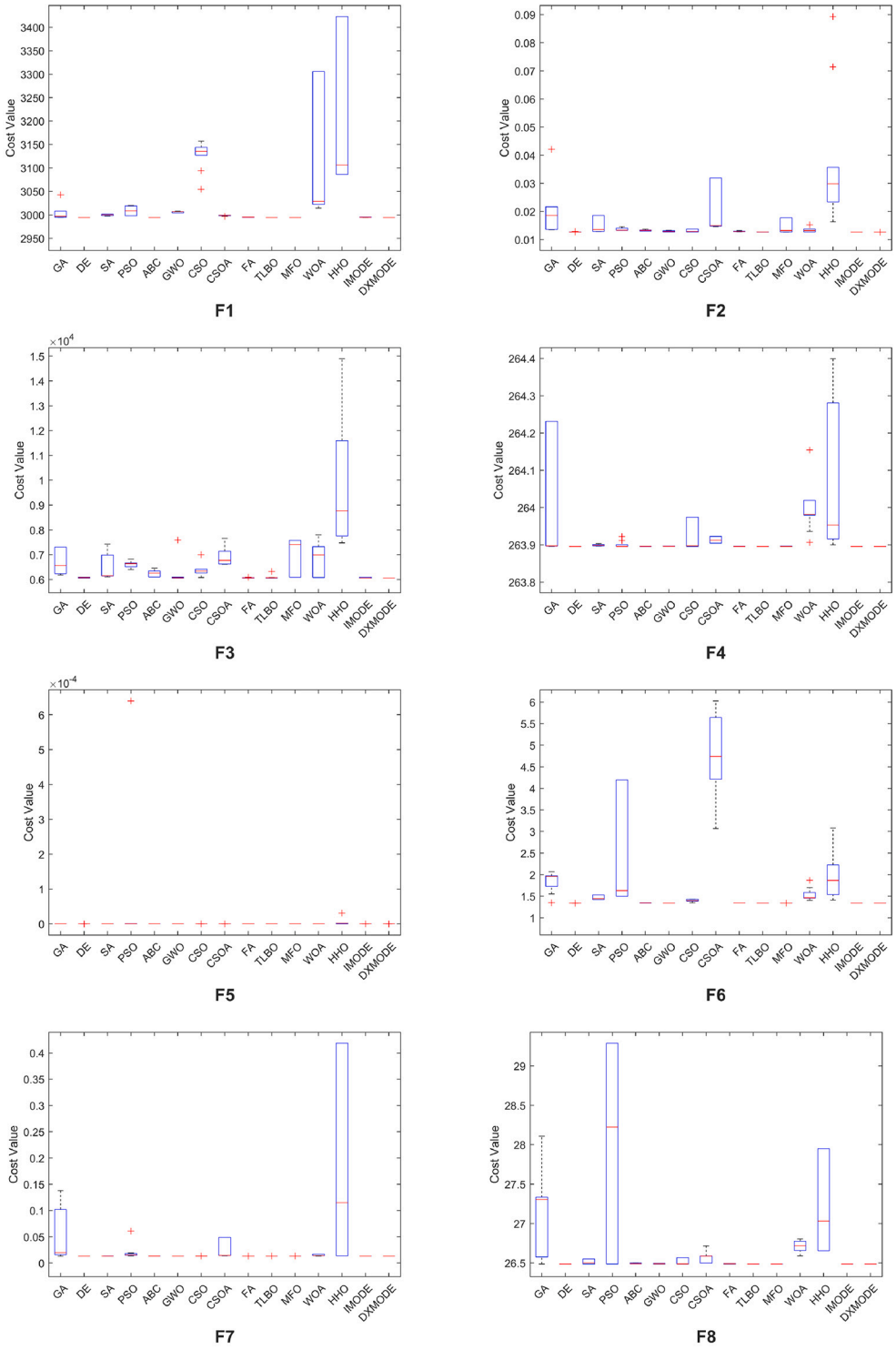
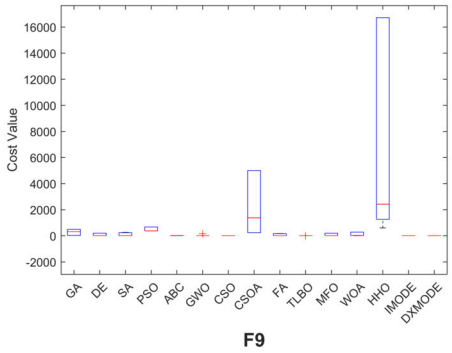
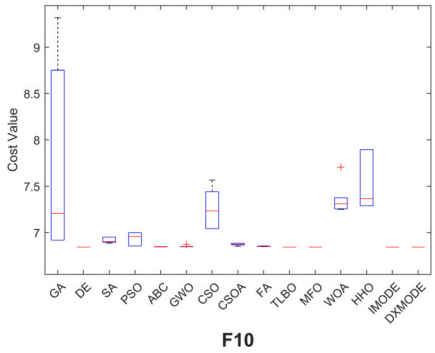


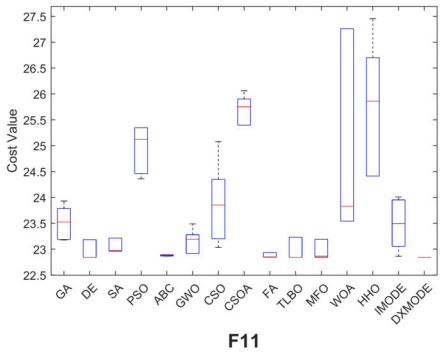
Fig. L.17. Box plots for the Engineering Optimization Problems.



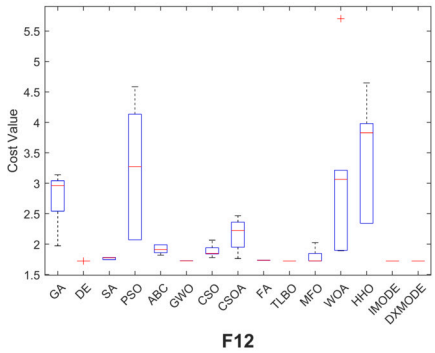
F9



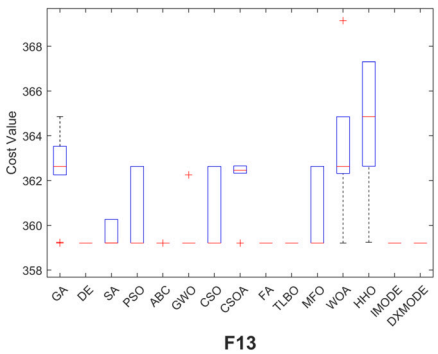
F10



F11



F12



F13

Fig. L.17. (*continued*)

Appendix M. Engineering optimization problems: Cohen's d effect size

This appendix shows Cohen's d effect size comparisons for DXMODE against both meta-heuristic algorithms and DE variants on engineering optimization problems.

Table M.14
Cohen's d effect values for DXMODE against meta-heuristic optimization algorithms on Engineering Optimization Problems.

Fn.	GA	DE	SA	PSO	ABC	GWO	CSO	CSOA	BAS	FA	TLBO	MFO	WOA	HHO	CMAES	IMODE
F1	0.94	0.00	6.11	2.09	4.52	11.27	7.14	5.63	4.14	7.02	0.00	0.00	1.59	1.81	7.55	2.78
F2	1.34	0.64	1.26	2.69	3.79	1.70	1.60	1.24	1.39	2.79	5.35	1.09	1.29	1.33	1.59	0.63
F3	2.07	1.39	1.47	6.21	2.23	0.72	1.63	4.21	3.68	1.19	0.45	2.36	1.53	2.44	5.20	1.22
F4	0.85	0.00	1.87	0.76	3.02	3.39	0.88	3.25	2.97	2.70	2.26	1.31	1.98	1.35	2.31	0.00
F5	1.78	1.01	1.01	0.47	1.28	1.39	1.15	1.00	0.70	2.00	1.53	1.73	2.30	0.83	1.58	0.55
F6	3.91	2.00	3.65	1.54	2.41	7.15	3.63	5.16	7.04	8.61	3.38	1.26	2.51	1.65	2.27	2.61
F7	1.08	82776.01	1.80	0.75	1.73	2.24	0.72	1.01	2.45	0.81	13743.02	0.69	1.61	1.50	0.85	219.50
F8	2.06	0.00	1.50	1.41	3.00	2.58	1.15	1.69	2.24	3.65	0.00	0.00	3.67	2.15	7.14	0.00
F9	1.71	0.84	1.33	5.12	1.39	0.26	3.22	1.45	1.84	0.86	0.77	0.84	0.98	1.18	2.58	0.84
F10	1.29	-1.32	4.06	2.06	4.32	1.45	3.09	3.20	6.78	5.64	-1.32	-1.32	4.61	3.82	10.92	-1.06
F11	3.23	0.84	2.82	6.70	4.72	2.42	2.07	14.96	5.28	1.09	1.30	1.21	1.71	4.09	6.68	1.80
F12	3.44	1.94	4.36	2.01	4.21	3.35	2.83	2.57	3.76	6.79	0.00	0.84	1.42	3.22	4.49	1.71
F13	2.26	0.00	0.84	1.14	0.97	0.77	1.30	2.77	8.33	2.04	0.00	0.84	2.38	2.32	2.80	0.00

Table M.15
Cohen's d effect values for DXMODE against DE variants on Engineering Optimization Problems.

Fn.	EODE	MDE	MTDE	BSD	BDE	BeSD	meanDE	QRDE	JADE	JADEGMO	EA4eig	AGSK	HSES	IMODE
F1	1.2E+00	0.0E+00	2.0E+00	6.9E+00	5.0E+00	6.6E+00	0.0E+00	0.0E+00	8.3E-01	5.6E-01	6.8E-01	1.6E+00	0.0E+00	2.8E+00
F2	2.2E+00	2.8E+00	7.6E-01	3.9E+00	5.4E+00	3.0E+00	2.7E+00	1.7E+00	1.5E+00	1.0E+00	4.1E-01	3.8E-01	4.7E+00	6.3E-01
F3	0.0E+00	9.1E-01	8.1E-01	7.4E+00	7.5E-01	2.4E+00	7.0E-01	4.6E-01	8.4E-01	8.8E-01	4.3E-01	9.1E-01	9.4E+00	1.2E+00
F4	0.0E+00	1.7E+00	0.0E+00	1.0E+00	1.0E+00	2.1E+00	1.3E+00	0.0E+00	0.0E+00	2.8E+00	0.0E+00	0.0E+00	1.4E+00	0.0E+00
F5	8.4E-01	2.2E+00	9.1E-01	1.2E+00	1.4E+00	4.7E-01	9.2E-01	5.1E+00	1.7E+00	1.4E+00	7.3E-01	1.2E+00	7.5E-01	5.5E-01
F6	1.7E+00	1.6E+00	1.9E+00	2.0E+00	3.4E+00	3.9E+00	3.2E+00	7.0E-01	0.0E+00	8.6E-01	2.6E-01	2.3E+00	3.2E+00	2.6E+00
F7	2.5E+02	0.0E+00	1.4E+00	7.0E+00	1.8E+00	4.6E+00	8.2E+01	2.6E+09	2.7E+00	3.7E+00	0.0E+00	1.3E+01	0.0E+00	2.2E+02
F8	0.0E+00	6.9E-01	0.0E+00	2.2E+00	1.4E+00	2.2E+00	1.0E+00	0.0E+00	0.0E+00	2.6E+00	6.0E-01	0.0E+00	0.0E+00	0.0E+00
F9	2.0E+00	8.4E-01	3.8E-01	1.7E+00	1.2E+00	2.9E+00	3.6E+06	1.5E+00	2.1E+00	5.0E+00	0.0E+00	2.9E-01	8.4E-01	8.4E-01
F10	-1.3E+00	2.6E+00	5.6E-01	2.9E+00	2.9E+00	6.2E+00	-1.3E+00	2.6E-01	-6.4E-01	3.5E+00	1.4E+00	1.5E+00	3.1E+00	-1.1E+00
F11	1.7E+00	0.0E+00	2.3E+00	3.5E+00	3.2E+00	9.4E+00	1.0E+00	5.5E-01	5.3E-01	5.3E+00	9.4E-01	5.2E-01	0.0E+00	1.8E+00
F12	7.8E-01	1.8E+00	5.1E+00	3.7E+00	4.1E+00	6.8E+00	2.3E+00	4.2E+00	2.6E-01	1.2E+00	0.0E+00	1.2E+00	2.7E+00	1.7E+00
F13	0.0E+00	0.0E+00	0.0E+00	2.8E-01	8.4E-01	1.9E+00	5.5E-01	2.6E-01	0.0E+00	2.6E-01	4.6E-01	0.0E+00	4.6E-01	0.0E+00

Data availability

No datasets were used during the current study.

References

[1] R. Salgotra, P. Sharma, S. Raju, A.H. Gandomi, A contemporary systematic review on meta-heuristic optimization algorithms with their Matlab and python code reference, Arch. Comput. Methods Eng. 31 (3) (2024) 1749–1822.

[2] A. Kumar, S. Pant, M. Ram, O. Yadav, Meta-Heuristic Optimization Techniques: Applications in Engineering, vol. 10, Walter de Gruyter GmbH & Co KG, 2022.

[3] S. Mirjalili, S.M. Mirjalili, A. Lewis, Grey wolf optimizer, Adv. Eng. Softw. 69 (2014) 46–61.

[4] S. Mirjalili, Moth-flame optimization algorithm: a novel nature-inspired heuristic paradigm, Knowl.-Based Syst. 89 (2015) 228–249.

[5] M. Reda, A. Onsy, A.Y. Haikal, A. Ghanbari, A novel reinforcement learning-based multi-operator differential evolution with cubic spline for the path planning problem, Artif. Intell. Rev. 58 (5) (2025) 142.

[6] K. Rajwar, K. Deep, Structural bias in metaheuristic algorithms: insights, open problems, and future prospects, Swarm Evol. Comput. 92 (2025) 101812.

[7] C.T. Yue, K.V. Price, P.N. Suganthan, J.J. Liang, M.Z. Ali, B.Y. Qu, N.H. Awad, P.P. Biswas, Problem definitions and evaluation criteria for the cec 2020 special session and competition on single objective bound constrained numerical optimization, Technical Report, Nanyang Technological University, Singapore, November 2019, https://github.com/P-N-Suganthan/2020-Bound-Constrained-Opt-Benchmark.

[8] J. Zhang, A.C. Sanderson, Jade: adaptive differential evolution with optional external archive, IEEE Trans. Evol. Comput. 13 (5) (2009) 945–958.

[9] K.M. Sallam, S.M. Elsayed, R.K. Chakrabortty, M.J. Ryan, Improved multi-operator differential evolution algorithm for solving unconstrained problems, in: 2020 IEEE Congress on Evolutionary Computation (CEC), IEEE, 2020, pp. 1–8.

[10] A. Moharam, A.Y. Haikal, M. Elhosseini, Economically optimized heat exchanger design: a synergistic approach using differential evolution and equilibrium optimizer within an evolutionary algorithm framework, Neural Comput. Appl. 36 (24) (2024) 14999–15026.

[11] P. Civicioglu, E. Besdok, Bezier search differential evolution algorithm for numerical function optimization: a comparative study with crmlsp, mvo, wa, shade and lshade, Expert Syst. Appl. 165 (2021) 113875.

[12] E.H. Haro, D. Oliva, A. Casas-Ordaz, E. Reyes-Davila, O. Avalos, Improving the selection of differential evolution through a quartile-based ranked operator, Int. J. Mach. Learn. Cybern. (2024) 1–36.

[13] P. Bujok, P. Kolenovsky, Eigen crossover in cooperative model of evolutionary algorithms applied to cec 2022 single objective numerical optimisation, in: 2022 IEEE Congress on Evolutionary Computation (CEC), IEEE, 2022, pp. 1–8.

[14] M. Pant, H. Zaheer, L. Garcia-Hernandez, A. Abraham, et al., Differential evolution: a review of more than two decades of research, Eng. Appl. Artif. Intell. 90 (2020) 103479.

[15] Z. Tan, K. Li, Y. Wang, Differential evolution with adaptive mutation strategy based on fitness landscape analysis, Inf. Sci. 549 (2021) 142–163.
[16] M. Reda, A. Onsy, A.Y. Haikal, A. Ghanbari, Optimizing the steering of driverless personal mobility pods with a novel differential Harris hawks optimization algorithm (dhho) and encoder modeling, Sensors 24 (14) (2024) 4650.
[17] M.K. Heris, Simulated annealing in Matlab (2015). URL, https://yarpiz.com/223/ypea105-simulated-annealing.
[18] A. Thomas, P. Majumdar, T. Eldho, A. Rastogi, Simulation optimization model for aquifer parameter estimation using coupled meshfree point collocation method and cat swarm optimization, Eng. Anal. Bound. Elem. 91 (2018) 60–72.
[19] A.A. Heidari, S. Mirjalili, H. Faris, I. Aljarah, M. Mafarja, H. Chen, Harris hawks optimization: algorithm and applications, Future Gener. Comput. Syst. 97 (2019) 849–872.
[20] X. Meng, Y. Liu, X. Gao, H. Zhang, A new bio-inspired algorithm: chicken swarm optimization, in: International Conference in Swarm Intelligence, Springer, 2014, pp. 86–94.
[21] X. Jiang, S. Li, Bas: beetle antennae search algorithm for optimization problems, arXiv preprint arXiv:1710.10724, 2017.
[22] R.V. Rao, V.J. Savsani, D. Vakharia, Teaching–learning-based optimization: a novel method for constrained mechanical design optimization problems, Comput. Aided Des. 43 (3) (2011) 303–315.
[23] A. Kumar, K.V. Price, A.W. Mohamed, A.A. Hadi, P.N. Suganthan, Problem Definitions and Evaluation Criteria for the CEC 2022 Special Session and Competition on Single Objective Bound Constrained Numerical Optimization, Technical Report, Nanyang Technological University, December 2021, https://github.com/P-N-Suganthan/2022-SO-BO.
[24] A.W. Mohamed, A.A. Hadi, A.K. Mohamed, N.H. Awad, Evaluating the performance of adaptive gainingsharing knowledge based algorithm on cec 2020 benchmark problems, in: 2020 IEEE Congress on Evolutionary Computation (CEC), IEEE, 2020, pp. 1–8.
[25] G. Zhang, Y. Shi, Hybrid sampling evolution strategy for solving single objective bound constrained problems, in: 2018 IEEE Congress on Evolutionary Computation (CEC), IEEE, 2018, pp. 1–7.
[26] A.E. Karkinli, Detection of object boundary from point cloud by using multi-population based differential evolution algorithm, Neural Comput. Appl. 35 (7) (2023) 5193–5206.
[27] M.H. Nadimi-Shahraki, S. Taghian, S. Mirjalili, H. Faris, Mtde: an effective multi-trial vector-based differential evolution algorithm and its applications for engineering design problems, Appl. Soft Comput. 97 (2020) 106761.
[28] P. Civicioglu, E. Besdok, Bernstain-search differential evolution algorithm for numerical function optimization, Expert Syst. Appl. 138 (2019) 112831.
[29] P. Civicioglu, E. Besdok, Bernstein-Levy differential evolution algorithm for numerical function optimization, Neural Comput. Appl. 35 (9) (2023) 6603–6621.
[30] A. Layeb, Differential evolution algorithms with novel mutations, adaptive parameters, and Weibull flight operator, Soft Comput. 28 (11) (2024) 7039–7091.
[31] A.K. Al Hwaitat, H.N. Fakhouri, Multi-cloud security optimization using novel hybrid jade-geometric mean optimizer, Symmetry 17 (4) (2025) 503.
[32] R. Tanabe, A.S. Fukunaga, Improving the search performance of shade using linear population size reduction, in: 2014 IEEE Congress on Evolutionary Computation (CEC), IEEE, 2014, pp. 1658–1665.
[33] K.M. Sallam, S.M. Elsayed, R.A. Sarker, D.L. Essam, Landscape-assisted multi-operator differential evolution for solving constrained optimization problems, Expert Syst. Appl. 162 (2020) 113033.
[34] Z. Meng, J.-S. Pan, K.-K. Tseng, Pade: an enhanced differential evolution algorithm with novel control parameter adaptation schemes for numerical optimization, Knowl.-Based Syst. 168 (2019) 80–99.
[35] R. Tanabe, A. Fukunaga, Success-history based parameter adaptation for differential evolution, in: 2013 IEEE Congress on Evolutionary Computation, IEEE, 2013, pp. 71–78.
[36] Z.-H. Zhan, J. Zhang, O. Liu, Orthogonal learning particle swarm optimization, in: Proceedings of the 11th Annual Conference on Genetic and Evolutionary Computation, 2009, pp. 1763–1764.
[37] S. Song, P. Wang, A.A. Heidari, M. Wang, X. Zhao, H. Chen, W. He, S. Xu, Dimension decided Harris hawks optimization with Gaussian mutation: balance analysis and diversity patterns, Knowl.-Based Syst. 215 (2021) 106425.
[38] S. Gao, Y. Yu, Y. Wang, J. Wang, J. Cheng, M. Zhou, Chaotic local search-based differential evolution algorithms for optimization, IEEE Trans. Syst. Man Cybern. Syst. 51 (6) (2019) 3954–3967.
[39] C.R. Fadragas, R.O. Morales, Using the magnitude-squared coherence for determining order-chaos transition in a system governed by logistic equation dynamics, arXiv preprint arXiv:nlin/0304043, 2003.
[40] X.-S. Yang, S. Deb, Cuckoo search via Lévy flights, in: 2009 World Congress on Nature & Biologically Inspired Computing (NaBIC), Ieee, 2009, pp. 210–214.
[41] H. Bayzidi, Social network search for solving engineering problems, available: https://www.mathworks.com/matlabcentral/fileexchange/97577-social-network-search-for-solving-engineering-problems, 2024. (Accessed 18 November 2024).
[42] S.Z. Koohi, N.A.W.A. Hamid, M. Othman, G. Ibragimov, Raccoon optimization algorithm, IEEE Access 7 (2018) 5383–5399.
[43] D. Simon, Biogeography-based optimization, IEEE Trans. Evol. Comput. 12 (6) (2008) 702–713.
[44] M. Fischetti, M. Stringher, Embedded hyper-parameter tuning by simulated annealing, arXiv preprint arXiv:1906.01504, 2019.
[45] S. Mirjalili, A. Lewis, The whale optimization algorithm, Adv. Eng. Softw. 95 (2016) 51–67.
[46] N. Hansen, A. Ostermeier, Completely derandomized self-adaptation in evolution strategies, Evol. Comput. 9 (2) (2001) 159–195.
[47] J. Carrasco, S. García, M. Rueda, S. Das, F. Herrera, Recent trends in the use of statistical tests for comparing swarm and evolutionary computing algorithms: practical guidelines and a critical review, Swarm Evol. Comput. 54 (2020) 100665.
[48] C.R. Brydges, Effect size guidelines, sample size calculations, and statistical power in gerontology, Innov. Aging 3 (4) (2019) igz036.
[49] S. Das, P.N. Suganthan, Differential evolution: a survey of the state-of-the-art, IEEE Trans. Evol. Comput. 15 (1) (2010) 4–31.
[50] K. Qiao, X. Wen, X. Ban, P. Chen, K.V. Price, P.N. Suganthan, J. Liang, G. Wu, C. Yue, Evaluation criteria for cec 2024 competition and special session on numerical optimization considering accuracy and speed, Technical Report, November 2023, https://github.com/P-N-Suganthan/2024-CEC.