On the Repeatability of Metaheuristic Research: A Reproduction Study of the Arithmetic Optimization Algorithm

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On the Repeatability of Meta-heuristic Research: A Reproduction Study of the Arithmetic Optimization Algorithm

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Abstract

In recent years, the literature has been flooded with meta optimization algorithms. These appear to involve the creation of unoriginal methods under the guise of innovation. They also often publish under sensational names like "Ebola optimization search", "Learning Cooking algorithm," and "Coati Optimization." These papers appear to gain legitimacy through publication in high impact, but not optimization, journals and garner high numbers of citations from similar works. While there have been criticisms of this field, to the best of our knowledge, nobody has attempted to test the veracity of these papers though a replication. Thus, we attempted to replicate the Arithmetic Optimization Algorithm (AOA), a seemingly well regarded, highly cited algorithm (more than 2,200 on Google Scholar) published in a reputed journal (impact factor 7.2). Our findings reveal discrepancies in execution times, convergence, and error rates, as well as seemingly nonstandard evaluation practices and potential manipulation of algorithm hyperparameters to facilitate favorable comparisons between the AOA algorithm and alternatives. These results highlight the need for robust evaluation methodologies to detect and mitigate the practices revealed by this effort to help maintain the credibility of the scientific record.

1 Introduction

Scientific and engineering research is often so specialized that only a small population of scholars may be able to assess a paper's veracity. As a result, people often rely on citation metrics (total citations, h-index, etc.) as an indicator of value. The reasoning is that one's ability to produce well-cited work means that the work must be making substantial scientific contributions. But like many metrics, people ultimately find ways of gaming them. This includes publishing in predatory or low-tier journals, "salami slicing" (breaking contributions up into multiple papers), inflating self-citations, using citation farms and/or cartels (groups of researchers or journals colluding to cite each other excessively), coercing citations through reviews or editorial positions, and using schemes for sharing or inflating authorship [12, 18, 22].

We believe that we have discovered a new citation-magnifying method, a self-perpetuating citation farm. In such a farm, researchers publish iterative or even borderline fraudulent results around a specific topic area. Because there are enough other researchers complicit in the phenomenon, authors are able to get positive reviews, get published (sometimes in high-impact journals), and garner citations in an ever expanding farm.

The research area where we encountered this is meta-heuristic-based optimization. There has been an explosion of papers claiming to introduce novel methods for solving engineering optimization problems with meta-heuristic algorithms"inspired" by behaviors of biological entities (e.g., insects, birds, animals, humans, and plants) and/or natural forces (e.g., evolution, ecosystem forces, or electromagnetism) [2, 16, 19, 21, 23, 27, 30, 32, 33, 39, 41] (all of these are reviews published since 2021). Many of the algorithms have seemingly ridiculous names such as "learning cooking algorithm," "harris hawks optimization," "Ebola Optimization Search," "coati Optimization," and many more [7, 11, 17, 28, 40].

In fact, a few other researchers have noticed this trend, and done work to manually show that most are highly derivative and thus lack substantive contributions to the field [3, 5, 6, 31, 41]. This includes some of the most well cited algorithms in the area, such as the gray wolf optimizer [26] (13,905 citations) and cuckoo search [42] (8,239 citations). Despite this attention, the trend continues and even appears to be accelerating. This is a problem for the optimization research community because the phenomenon obscures actual substantive contributions. However, this issue is likely bigger than one research area, as we suspect that there are other topics where this self-perpetuating farm occurs. In this research, we sought to investigate methods that would allow us to understand and identify this phenomenon.

Before investigating the phenomenon deeply, a better understand the veracity of the research was warranted. Cursory inspection of the papers arouses suspicion because the majority follow a standard template with similar mathematical formulas. They all introduce an algorithm and compare it with several others using a standard set of case studies and performance metrics. However, this does not inherently make the work fraudulent. Furthermore, to the best of our knowledge, the critical reviews of this literature [3, 5, 6, 31, 41] have predominantly focussed on the nature of the intellectual novelty of the algorithms, not the substance of their analysis. Thus, we attempted to replicate a one of these papers to determine the validity of its results.

The paper we picked was the Arithmetic Optimization Algorithm (AOA) [1]. We chose this one because it appeared to represent an approach that was more scholarly than the average paper in this field. It was published in a seemingly legitimate (non-open access; 7.2 impact factor) journal and it was cited more than 1,653 times at the time of analysis (it currently has 2,177 citations). Thus, any problems discovered in this paper would likely be even more extreme in standard entries.

In what follows, we provide basic background on meta-heuristic models. We then describe the methods we used to replicate the results of the AOA paper [1]. We report the results of our replication. We ultimately interpret these results and discuss the implications of our findings.

2 Background

Meta-heuristics optimization algorithms are designed to solve complex optimization problems in situations were where traditional methods falter. They can be thought of as the "Swiss Army Knives of optimization", wherein tweaking parameters and approaches can find optimal or near optimal solution for nearly any objective function.

Typically, these algorithms take a set of parameters as defined below:

- Objective Function: The function that measures the quality of the given solution.
- Population Size [1]: This indicates the number of candidate solutions maintained at any given time.
- Selection Mechanism: The mechanism for choosing candidate solutions or creating new candidates (e.g., using a roulette wheel / weighted lottery, tournament, or based on ranks).
- Mutation rate [2]: The rate or percentage of times random changes are introduced to explore new solutions. A high mutation rate is better for exploration phases (searching widely across a solution space to avoid getting caught in local minima or maxima) and a low mutation rate is better for exploitation phases (where good candidate solutions are refined).
- Cooling Schedule: The mechanism that determines how the algorithm transitions between the exploration and exploitation phases.

The AOA is a meta-heuristic optimization algorithm that mimics basic arithmetic operations (multiplication, division, addition, and subtraction) to explore and exploit the search space. It starts by randomly assigning starting positions to the population of candidate solutions. Each candidate is evaluated using a fitness function which quantifies how close the solution is to the optimal value. A hyperparameter α balances exploration (global search) and exploitation (local search). α decreases linearly with iterations, with more exploration in the initial stages and more exploitation in the later stages. The balance between the exploration and exploitation phase are calculated by eq. (2). The location is updated based on eqs. (3) and (4) for the exploration phase and eqs. (5) and (6) for the exploitation phase. hyperparameter μ is used to control the search process by how the arithmetic operations are applied to the candidate solutions. Using the random variable r_1, if $r_1 > MOA$, then the exploration phase is started else the exploitation phase is started. Then, the random variables r_2 and r_3 are used to decide which operation to perform, if $r_2 < 0.5$ then eq. (4) is used else eq. (3). Similarly if $r3 < 0.5$ then eq. (6) is used else eq. (5) is used.

$$MOA(t) = Min + t \times \frac{Max - Min}{T} \tag{1}$$

[1] in population based algorithms
[2] in algorithms like Genetic Algorithms

$$MOP(t) = 1 - \frac{t^{-\alpha}}{T^{-\alpha}} \tag{2}$$

$$X_{new} = X_{best} \times MOP \times ((UB_j - LB_j) \times \mu + LB_j) \tag{3}$$

$$X_{new} = X_{best}/(MOP + \epsilon) \times (UB_j - LB_j) \times \mu + LB_j \tag{4}$$

$$X_{new} = X_{best} + MOP \times ((UB_j - LB_j) \times \mu + LB_j) \tag{5}$$

$$X_{new} = X_{best} - MOP \times ((UB_j - LB_j) \times \mu + LB_j) \tag{6}$$

In these, t is the current iteration; T is the maximum number of iterations; and Min and Max denote the minimum and maximum values of the MOA function, respectively. UB_j and LB_j are the upper-bound and lower-bound for that j^{th} dimension; X_{new} is the updated location of the candidate solutions; and X_{best} is the best candidate solution found till then.

The algorithm iterates until the termination criteria is met. Termination criteria can be based on the maximum number of function evaluations (iterations) or satisfactory fitness value. The best candidate solution from the final population is considered the optimal or near-optimal solution.

The standard methodology to evaluate optimization algorithms is to first record error values for solutions to a standard set of test functions: functions the optimization community has identified for benchmarking optimization algorithms (more details about these functions are described later). From these analyses, analysts compute the success rate and performance for each problem for each algorithm. The aforementioned data are then used to create convergence graphs and compute an algorithm's time complexity [37].

3 Methods

To recreate the results of the AOA, we first identified all the algorithms analyzed in the original paper [1]. We then identified the hyperparameters that were used in the paper for each algorithm 1 We then identified the standard hyperparameters that were recommended for each algorithm in the optimization literature. This was done because discrepancies between these were noted as we worked through the replication. Next, we located or created implementations of each algorithm within a test bed and recreated each of the test functions used in the original paper within it.

We also implemented all the metrics used in the original paper in the test bed. Furthermore, the original paper had limited reporting of algorithm temporal performance or trade-offs between discovered optimal value error and temporal performance. Thus, we introduced metrics for convergence time and trade-offs between error and convergence time. We then ran multiple replications of each algorithm (including AOA) for each test function and analysis context from the original paper for both sets of hyperparameters. We thus computed the performance of each algorithm based on the considered performance indices. For metrics that were reported in the original paper, we compared the results we obtained to those originally reported. This was done in terms of both raw performance and performance rank order (something the original paper reported). The following provides details about this process.

It is important to note that the AOA paper presents five "real-world" engineering problems to test the ability of the AOA algorithm to find solutions to known problems. The problems evaluated included designs of a welded beam, a tension/compression spring, a pressure vessel, a 3-bar truss, and a speed reducer. However the paper lacks sufficient details about the formulations of the problems. This prevented replication.

3.1 Algorithms and hyperparameters

The algorithms used in the recreation matched those evaluated in the original AOA paper:

- Arithmetic Optimization Algorithm (AOA) [1]: Arithmetic operations are used to balance exploitation and exploration phases in the search space.
- Bat Algorithm (BAT) [43]: Loudness and pulse emission inspired from echolocation of bats are used to dynamically adjust the exploitation and exploration in search space.

- Biogeography-based Optimization (BBO) [35]: Balances exploration and exploitation based on an approximation of species migration spurred by habitat similarities.
- Cuckoo Search Algorithm (CSA) [14]: Lévy flights and random walks based on parasitism of cuckoo birds.
- Differential Evolution (DE) [36]: Vector Differences between solutions are used to mutate candidate to enhance convergence while avoiding local optima.
- Firefly Algorithm (FFA) [13]: Simulates the attraction of fireflies: brighter fireflies attract others to get solutions to converge on the brightest spots.
- Flower Pollination Algorithm (FPA) [44]: Different pollination modes allow for a balance between global (exploration) and local (exploitation) search.
- Grey Wolf Optimizer (GWO) [26]: Uses hierarchical hunting structure (alpha, beta, delta and omega) of grey wolves to guide the search.
- Moth-Flame Optimization (MFO) [25]: Models the spiral motion of the moths towards flame to ensure optimization while maintaining exploitation and exploration.
- Particle Swarm Optimization (PSO) [20]: Mimicking the bird flocking to update the positions based on individual and group best positions to find optimal position.
- Gravitational Search Algorithm (GSA) [34]: Based on the law of gravity, agents move according to gravitational force, balancing exploration and intensification (exploitation).
- Genetic Algorithm (GA) [4]: Inspired by natural selection, it evolves solutions using selection, crossover, and mutation to explore optimal solutions.

All these algorithms were implemented through the use of a modified version of the Mealpy library (version 3.0.1) [38]. This is a free and open source library that contains implementations of a number of meta-heuristic search algorithm in Python. This contained implementations of all the algorithms above. In our testing, GSA, FA, and BAT had non-working implementations. For these, we used the original papers to create working versions or to modify the Mealpy implementation. The one exception was the Genetic Algorithm, which was non-functional and we were unable to achieve a working example.[3]

The hyperparameters used for the executions are shown in table 1. Something we noticed in preparing the analyses is that the AOA paper did not always use the default hyperparameters, and no explanation for this was given. Thus, to perform a comprehensive analysis, we considered both the ones used by the AOA paper and the default values recommended from each algorithm's respective original paper. This meant that we ran two experiments: one with the AOA values for the hyperparameters and one with the default values. It is important to note that for the AOA, FPA, GSA, GWO and MFO algorithms, the AOA paper used the algorithms' default hyperparameters. Thus, the default hyperparameters for these algorithms were used in both experiments.

3.2 Test Functions

The test functions used in the AOA paper (and reproduced here) are originally benchmark problems from the CEC (Congress on Evolutionary Computation) 2005 [37]. These benchmarks are widely regarded as some of the most effective for evaluating algorithms due to the wide range of problem characteristics that are supported. There are newer versions, namely CEC 2017, CEC 2018, CEC 2020, CEC 2021 and CEC 2022. These introduce additional functions and modifications to better evaluate performances of optimization algorithms under various conditions. However, CEC 2005 is still widely used because its historical use enables comparison with historical data.

Tables 2 to 5 present these functions along with their different dimensions (number of variables to be optimized), ranges of variables, and global minima.

[3]It consistently got stuck in infinite loops.

Table 1: Parameter values from AOA and default values for the comparative algorithms.

Algorithm	Parameter	AOA Values	Default Values
PSO	Topology	Fully connected	Fully connected
	Cognitive and social constant	(C1,C2) 2,2	(C1,C2) 2.05,2.05
	Inertia Weight	Linear reduction from 0.9 to 0.1	Linear Reduction from 0.9 to 0.4
	Velocity Limit	10% of dimension range	50% of the dimension range
CSA	p_a	0.25	0.3
BBO	Probability of modifying a habitat	1	$[0.1 - 0.5]$
	Probability limits of immigration's	$[0, 1]$	$[0, 1]$
	Size of each step	1	1
	I and E	1	-
	Probability of mutation	0.005	0.01
DE	Scaling Factor	0.5	0.1
	Crossover probability	0.5	0.9
GSA	Alpha, G0, Rnorm, Rpower	20, 100, 2, 1	20, 100, 2, 1
FFA	α	0.5	0.2
	β	0.2	2
	γ	1	0.001
MFO	a	[-2 ,-1]	[-2 ,-1]
	b	1	1
GWO	Convergence parameter (a)	Linear Reduction from 2 to 0	Linear Reduction from 2 to 0
BAT	Q_{min}	0	0
	Q_{max}	2(5*)	10
	A	0.5	0.8
	r	0.5	0.95
FPA	Probability switch p	0.8	0.8
AOA	α	5	5
	μ	0.5	0.5

Table 2: Unimodal test functions

Function	Description	Dimensions	Range	f_{min}
F1	$f(x) = \sum_{i=1}^{n} x_i^2$	30, 100, 500, 1000	[-100,100]	0
F2	$f(x) = \sum_{i=0}^{n} \lvert x_i \rvert + \prod_{i=0}^{n} \lvert x_i \rvert$	30, 100, 500, 1000	[-10,10]	0
F3	$f(x) = \sum_{i=1}^{d} (\sum_{j=1}^{i} x_j)^2$	30, 100, 500, 1000	[-100,100]	0
F4	$f(x) = max_i\{\lvert x_i \rvert, 1 \leq i \leq n\}$	30, 100, 500, 1000	[-100,100]	0
F5	$f(x) = \sum_{i=1}^{n-1} [100(x_i^2 - x_{i+1})^2 + (1 - x_i)^2]$	30, 100, 500, 1000	[-30,30]	0
F6	$f(x) = \sum_{i=1}^{n} (\lvert x_i + 0.5 \rvert)^2$	30, 100, 500, 1000	[-100,100]	0
F7	$f(x) = \sum_{i=0}^{n} i x_i^4 + random[0, 1)$	30, 100, 500, 1000	[-128,128]	0

Table 3: Multimodal test functions

Function	Description	Dimensions	Range	f_{min}
F8	$f(x) = \sum_{i=1}^{n} (-x_i sin(\sqrt{\lvert x_i \rvert}))$	30, 100, 500, 1000	[-500,500]	-418.9829 x n
F9	$f(x) = \sum_{i=0}^{n} [x_i^2 - 10cos(2\pi x_i) + 10]$	30, 100, 500, 1000	[-5.12,5.12]	0
F10	$f(x) = -20exp(-0.2\sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2}) - exp(\frac{1}{n}\sum_{i=1}^{n} cos(2\pi x_i)) + 20 + e$	30, 100, 500, 1000	[-32,32]	0
F11	$f(x) = 1 + \frac{1}{4000}\sum_{i=1}^{n} x_i^2 - \prod_{i=1}^{n} cos(\frac{x_i}{\sqrt{i}})$	30, 100, 500, 1000	[-600,600]	0
F12	$f(x) = \frac{\pi}{n}\{10sin(\pi y_i)\} + \sum_{i=1}^{n-1}(y_i - 1)^2[1 + 10sin^2(\pi y_{i+1}) + \sum_{i=1}^{n} u(x_i, 10, 100, 4)], where \quad y_i = 1 + \frac{x_i+1}{4}, u(x_i, 10, 100, 4) = K(x_i - a)^m : if \ x_1 < a; 0 : if - a \leq x_i \geq a; K(-x_i - a)^m : if - a \leq x_i$	30, 100, 500, 1000	[-50,50]	0
F13	$f(x) = 0.1(sin^2(3\pi x_1) + \sum_{i=1}^{n}(x_i - 1)^2[1 + sin^2(3\pi x_i + 1)] + (x_n - 1)^2 1 + sin^2(2\pi x_n)) + \sum_{i=1}^{n} u(x_i, 5, 100, 4)$	30, 100, 500, 1000	[-50,50]	0

Table 4: Fixed-dimension multimodal test functions.

Function	Description	Dimensions	Range	f_{min}
F14	$f(x) = \left(\frac{1}{500} + \sum_{j=1}^{25} \frac{1}{j+\sum_{i=1}^{2}(x_i - aS_{i,j})^6}\right)^{-1}$	2	$[-65, 65]$	1
F15	$f(x) = \sum_{i=1}^{11}[a_i - \frac{x_1(b_i^2+b_i x_2)}{b_i^2+b_i x_3+x_4}]^2$	4	$[-5, 5]$	0.00030
F16	$f(x) = 4x_1^2 - 2.1x_1^4 + \frac{1}{3}x_1^6 + x_1x_2 - 4x_2^2 + 4x_2^4$	2	$[-5, 5]$	-1.0316
F17	$f(x) = (x_2 - \frac{5.1}{4\pi^2}x_1^2 + \frac{5}{\pi}x_1 - 6)^2 + 10(1 - \frac{1}{8\pi})cosx_1 + 10$	2	$[-5, 5]$	0.398
F18	$f(x) = [1+(x_1+x_2+1)^2(19-14x_1+3x_1^2-14x_2+6x_1x_2+3x_2^2)]x[30+(2x_1-3x_2)^2x(18-32x_i+12x_1^2+48x_2-36x_1x_2+27x_2^2)]$	2	$[-2, 2]$	3
F19	$f(x) = -\sum_{i=1}^{4} c_i exp(-\sum_{i=1}^{3} a_{ij}(x_j - p_{ij})^2)$	3	$[-1, 2]$	-3.86
F20	$f(x) = -\sum_{i=1}^{4} c_i exp(-\sum_{i=1}^{6} a_{ij}(x_j - p_{ij})^2)$	6	$[0, 1]$	-0.32
F21	$f(x) = -\sum_{i=1}^{5}[(X - a_i)(X - a_i)^T + c_i]^{-1}$	4	$[0, 1]$	-10.1532
F22	$f(x) = -\sum_{i=1}^{7}[(X - a_i)(X - a_i)^T + c_i]^{-1}$	4	$[0, 1]$	-10.4028
F23	$f(x) = -\sum_{i=1}^{10}[(X - a_i)(X - a_i)^T + c_i]^{-1}$	4	$[0, 1]$	-10.5363

Table 5: Hybrid composition functions F24–F29 (M: Multimodal, R: Rotated, N: Non-Separable, S: Scalable, D: Dimension).

F(CEC5-F)	Description	Properties	Dimensions	Range
F24	Rotated Hybrid Composition Function	M, R, N, S	30	$[-5, 5]^D$
F25	Rotated Hybrid Composition Function	M, R, N, S	30	$[-5, 5]^D$
F26	Rotated Hybrid Composition Function with narrow basin global optimum	M, N, S	30	$[-5, 5]^D$
F27	Rotated Hybrid Composition Function with Global Optimum on the Bounds	M, N, S	30	$[-5, 5]^D$
F28	Rotated Hybrid Composition Function	M, R, N, S	30	$[-5, 5]^D$
F29	Rotated Hybrid Composition Function without bounds	M, N, S	30	$[-5, 5]^D$

4 Performance Metrics and Evaluation Approach

Each algorithm was evaluated based on its ability to find the minimum of each function for the different numbers of dimensions (number of open parameters). Performance of the algorithms was assessed based on several different measures, all present in the original paper to varying degrees:

- Fitness Value: The minimum returned by the algorithm;
- Runtime: The total execution time of the algorithm (in seconds)
- Error: The difference between the fitness values and the true minimum;
- Convergence Iteration: The iteration at which the algorithm stopped improving (this is reported in graphs in the original paper, though not used as a metric of comparison)
- Convergence Time: The time taken to get to the convergence iteration (this is reported in graphs in the original paper, though not used as a metric of comparison);

As stated above, two sets of experiments were conducted for each algorithm, for each function, and for each number of dimensions; one with the hyperparameters as given in the AOA paper and the other with the original default hyperparameters (see Table 1). Each experiment (for each algorithm, function, and dimension combination) was repeated for 30 runs. Each of the performance metrics was collected for

each run and arithmetically averaged across the 30 runs. It is important to note that for the AOA, FPA, GSA, GWO and MFO algorithms, the original and AOA paper hyperparameters were equivalent. Thus, the two experiments run for these algorithms were replications of each other. The fitness values for both the executions with default hyperparameters and the AOA paper's hyperparameters are similar.

The data from both sets of executions were analyzed using the methods outlined in [37]. However, in line with the AOA paper [1], the termination criterion for the experiments was set at a maximum of 500 iterations.

All analyses were run on a computer workstation with an Intel(R) Core(TM) i9-10920X CPU @ 3.5 GHZ and 256 GB RAM running MS Windows (ver 23H2).

5 Results

The fitness value and execution time for all algorithms for all functions for AOA paper's hyperparameters in tables 6 to 17 and for default hyperparameters in tables 18 to 29. There are few notable difference between the results from our execution and the results shown in the AOA paper, like AOA algorithm fitness values for our execution for functions F1-F4 were all zero with standard deviation zero as well compared to slightly higher values reported in the AOA paper. Also, fitness values for CSA, FFA algorithms were much worse in our recreation results compared to AOA paper. Additional issues are highlighted in the following sections.

5.1 Limitations of our Replication

While studying AOA paper [1] and trying to recreate its results, we noted multiple discrepancies.

Since the exact code used in the paper was unavailable in Python, an equivalent implementation based on the pseudo-code provided in the literature was utilized, specifically from the Mealpy library [38]. However, certain algorithms have fixed parameter limits, some could be modified to the hyperparameters used in the AOA paper, some could not be. For instance, the hyperparameter Q_{max} for the BAT algorithm was intended to be set at 2, but the lowest permissible value by mealpy library in the implementation was 5. Additionally, GA was excluded in this study due to functionality issues like getting stuck in infinite loops with the code provided in Mealpy library [38]. To maintain the uniformity of the testbed for all the algorithms, GA was not recreated.

The real-world application problems due to poor documentation. It is worth noting that the AOA paper did not explain the rationale behind the algorithms that are used for comparative analysis in this section (they were not the same as used in the other algorithmic comparisons).

5.2 Predication Error

We compared the fitness values and execution times for the executions with AOA paper's hyperparameters and default hyperparameters to get better understanding of the effects of hyperparameters on the algorithms. As expected for AOA, FPA, GSA, GWO and MFO algorithms, which have same hyperparameters in both executions, there were small differences for fitness values of most of the functions F1-F13 for all dimensions.

Absolute Error (log of absolute error) for each algorithm with respect to each function for both executions as well the results shown in the AOA paper [1] are shown in figs. 1 to 6. The absolute error values for function F8 for 30 and 100 dimensions for algorithms were worse in the AOA paper when compared to our executions with AOA paper's hyperparameters and the default hyperparameters from the literature. For 500 and 1000 dimensions, the error values were worse for our executions with AOA paper's hyperparameters and default hyperparameters. For functions F14-F20, the error values from the AOA paper and both of our executions were very different, but there was no apparent systemic pattern in the differences. The graphs for F21-F23 displayed similar error values for executions with AOA paper's hyperparameters and the default hyperparameters, but were different from the AOA paper's values, sometimes with our results being much better and sometimes much worse. The graphs for F24-F29 indicated a similar error values from AOA paper as well as our executions.

Both FFA and GSA are computationally intensive algorithms, as evidenced by their higher convergence times depicted in the graphs. Among the test functions F1 through F13, only F8 has a non-zero minimum. Notably, AOA exhibits the highest error for F8 compared to other functions with zero minima, as shown

in figs. 45 to 64. These trends can be seen in 30, 100, 500, 1000 dimensions. For functions with non-zero function minima, like F14-F23, the error for AOA is much higher compared to algorithms like DE, GSA as seen in figs. 65 to 68. This is due to functions having very low dimensions, so computationally intensive algorithms like GSA get lower error values. As seen in figs. 69 and 70, GSA has the most error and lower convergence time while FFA has lower error and the largest convergence time. Meanwhile, the rest of the algorithms have much faster convergence time and lower errors.

5.3 Convergence Time and Error Trade-offs

The trade-off between convergence time and absolute error is a key consideration in optimization, which can been seen in figs. 45 to 70. These show how the two set of considered hyperparameters affect the results: both the AOA paper's hyperparameters and the recommended ones from the literature. For functions F1-F7 for 30 dimensions, BAT has higher error but faster convergence, whereas GSA has slower convergence but lower error. AOA, GWO, DE have faster convergence and lower error while FFA has slower convergence time as well as higher error. With the non-zero minima functions like F8 and F14-F29, BBO has consistently very low error values compared to other algorithms with both set of hyperparameters for all dimensions.

Line Graphs for the error and fitness values vs the iterations are used to understand the behaviors of the algorithms and to check if both exploratory and exploitation phase are working as intended. Each function has four graphs, one for log of absolute error vs iteration and one for fitness vs iteration for the AOA paper based hyperparameters and the same for the default hyperparameters (figs. 7 to 44). In the AOA paper, the convergence graphs for all the functions had continuous improvement in the AOA algorithm's fitness value throughout the iteration. However, in the replicated results, the AOA algorithm achieves the function minima with the initial iterations for most functions (excepting F8, F19, F20, F21, F22, and F23). These exceptions correspond to the non-zero minima for those functions.

5.4 Ranking

In conformance with the original paper, we present rankings between the algorithms. This includes ranking based on error (fitness values) and execution time for each algorithm for each function for each execution along with the comparable rankings from the AOA paper are shown in figs. 71 to 106. Note that these show how the two sets of considered hyperparameters affect the results: both the original paper's ranking, our reproduction using the AOA paper's hyperparameters, and our results using the recommended default hyperparameters from the literature. The AOA ranks really high in terms of fitness values across all the results, but showed lower ranking for execution time. The timing ranking is likely due to the spectral distance calculation that is inherent in the algorithm. Comparably, the BAT and CSA algorithms show higher rank in execution time compared to the fitness value. This means they are much faster to execute but have higher error in their fitness values. Also, the FFA algorithm, which has a high ranking in the AOA paper for the fitness value, is shown to have much worse ranking in our reproduced fitness value rankings.

6 Discussion

AOA is one of the most well documented and most veritable algorithm in meta-heuristic optimization. This study looked closely at the AOA paper [1] and attempted to recreate its results. This revealed a number of concerning problems.

6.1 Problems with the Experiment

During the process of recreating the AOA paper, several discrepancies in the experimental design were identified. These are outlined below:

- Lack of Theoretical Foundation: The AOA paper lacks a rigorous theoretical analysis of the algorithm's convergence methodology and performance [9]. This makes it harder to assess the reliability of the algorithm for diverse optimization problems. Also, space and time complexity analysis along with rate of convergence of the algorithm can give insights on the efficiency of the algorithm.

- Benchmarking Limitations: The use of CEC 2005 [15] is common for benchmarking, but it may not completely capture the complexities as it typically focuses on 10, 30 or 50 dimensions [37]. CEC 2005 benchmark functions are static. Thus, they do not reproduce uncertainties and variations present in practical applications[24]. Using recent versions of CEC benchmark suits (e.g., CEC 2017 or CEC 2021) along with dynamic problems which change over time (like for a noisy environment) would help us better understand the strengths and limitations of the AOA algorithm.

- Insufficient Comparative Analysis: The comparative analysis performed in the AOA paper is lacking, as convergence speed and iteration based performance was only shown in graphs and not discussed at all in the paper. The paper also did not provide details about the execution time and its metrics for any of the evaluated numbers of dimensions, except for the 1000 dimension case [8]. Additionally, the original AOA paper does not provide good justification for the algorithms it was compared against or the hyperparameter tunings used. A proper comparison would ensure that comparisons were done against a diverse set of state of art algorithms with well-tuned and up-to-date hyperparameters.

- Shortcomings of the Algorithm: The AOA algorithm appears to be highly susceptible to local optima as the location update is based on optimal value as well as premature convergence and low solution accuracy [10]. Introducing population control mechanisms to subdivide the population with occasional information sharing, having dynamic hyperparameters, and or generating opposite solutions periodically.

6.2 Problems with Documentation

The discrepancies in the documentation were identified during recreation of the AOA paper. These are discussed below:

- Reproducibility Problems: The AOA paper does not provide access to the source code or the detailed experimental setups, which impedes independent verification of the reported results [29]. Providing access to source code, detailed results (worst-case, average-case and best-case) as well as experimental setups would help independent parties to verify the validity. The AOA paper presents several real-world optimization problems to demonstrate the efficacy of the algorithm. However, the paper lacks sufficient details to reproduce these analyses.

- Timing as a performance metric: Time is a important metric to compare the performances of the optimization algorithms. AOA paper doesn't present timing as a metric except for F1-F13 for 1000 dimensions and F14-F29. These are then ranked and then used to compute the mean ranks. These are then ranked using the mean rank. This way of ranking introduces unnecessary redundancy and dilutes the significance of the actual execution times. Also, due to the loss of detailed timing data, the mean ranks hide the actual performance of the algorithms across various different functions and dimensions. Just considering time for F1-F13 for 1000 dimensions and omitting the time for 30, 100, 500 dimensions can lead to incomplete and potentially misleading performance evaluations.

- Readability: The formulae as well as their explanations were split across multiple pages due to the inclusion of multiple inline tables and graphs. This makes it extremely challenging for readers to follow and comprehend the material effectively.

6.3 Suspicious Results

Finally, our reproduction revealed several concerning and potentially suspicious results. These suggest that either sloppy or less than ethical methods were used in the paper.

- Inconsistent Results: The replicated and reported fitness value for the algorithms did not match. As reported in the results, the fitness values for AOA algorithm on function F1-F4 in our experiments were consistently zero with zero standard deviation indicated perfect optimization. However the AOA paper reports slightly higher values for these functions. Some algorithms like FFA and CSA performed significantly worse in our replication compared to the values reported in the AOA paper.

- Convergence Behavior: Contrary to how the AOA paper states that AOA doesn't provide a distinct advantage in the initial iterations, the graphs from the recreation show a distinct advantage for AOA. This can be seen in the early few iterations for every run where AOA jumps closest to the optimal value in figs. 7 to 44.
- Hyperparameters: AOA paper doesn't provide proper explanation for the selection of the hyperparameters. Certain algorithms used in the comparative study have hyperparameters that differ significantly from their respective original works. These modifications are not sufficiently justified and bias the comparative study. For example, algorithms like BBO performed really well with the default hyperparameters in our analysis, but noticeably poorer in the AOA paper.
- Bias towards functions with zero function minima: Another notable issue with the AOA algorithms is its apparent bias towards functions with zero function minima. This can inflate the performance of algorithms like AOA that are tuned for convergence to zero but struggle with more complex, non-zero minima functions. In the rankings for each algorithm for each function (figs. 74, 81, 88, 95 and 99 to 106) we can see that the performance for AOA drops significantly when function minima is non-zero or if the function has a lot of local minima. This is not reflected in the results shown in the AOA paper.

Collectively, these results suggest that standards of practice with meta-heuristic algorithm analyses are wanting and in need of standardization. Interestingly, some of the discrepancies we identified actually had AOA perform worse in their original analysis that in did in ours. It is worth noting that this is still suspicious because it may suggest that the authors deliberately disguised the algorithm's issues with local minima and convergence (towards 0) behavior.

7 Future Work

This study raises several paths for future research to alleviate the problems identified in both AOA paper and the broader meta-heuristic optimization field. Some of these are explored below.

7.1 Recreating Real-world Problems

In this effort, we did not recreate the "real world" applications (the welded beam, the tension/compression spring, the pressure vessel, the 3-bar truss, and the speed reducer) the AOA paper presented. This occurred because the AOA paper did not provide enough information to recreate the applications or provide references to them. However, these problems seem to be standardized across the meta-heuristic literature. Future work should identify where these problems come from and incorperate them into our analysis.

7.2 Proposed Performance Metrics

In our comparisons between AOA and the other algorithms, we attempted to define a metric that captured the performance and timing tradeoffs between them. However, the performance of the algorithms varied so widely that this proved difficult, with errors or times that were extremely small throw off results with ratio-based measures (e.g., an algorithm getting a near perfect optimum but taking days to do so or an algorithm terminating immediately but having terrible error could create desirable metrics even though the algorithm performed badly). Both error and convergence time are almost independent variables, thus some form of euclidean distance could be used to a compare algorithm. However, doing this would require some sort of weighting or normalization between the two dimensions. We propose future work investigate a performance metrics similar to the following:

- $PM = w_1 \frac{\epsilon}{Max(\epsilon)} + w_2 \frac{T_c}{Max(T_c)}$
- $PM = (\frac{\epsilon}{Max(\epsilon)}^2 + \frac{T_c}{Max(T_c)}^2)^{1/2}$
- $R_C = R_E + R_{Tc}$

where, ϵ is the Error($|FitnessValue - FunctionMinima|$), T_c is the convergence time, R_C is the combined Rank, R_E is the Rank for Error, R_{Tc} is the Rank for Convergence Time.

Future work should evaluate these metrics to see which is most appropriate for comparing optimization algorithms.

7.3 Analysis of the Citation Farms

The veracity of the science of meta-heuristic papers is only part of the problem with this literature. There is also suspicious activity in how these papers are achieve such elevated citations. As such, future work should investigate these apparent self-propagating/perpetuating citation farms. This could include methods for identifying other research areas that may be using similar techniques; methods for identifying if a given paper is part of a suspicious research area; and techniques for combatting the problem.

7.4 Support for Assess Algorithm Novelty

One potential mechanism for gray-zone papers making it though peer review could be the difficulty of evaluating algorithm novelty. Such assessment is nontrivial, as it requires good faith reviews to have deep knowledge of search- and meta-heuristic-based optimization. Further, as our result replication appears to indicate, the algorithms in these papers do work. Thus, they will not be obviously wrong. However, as the extended literature shows (based on extensive manual analyses by experts; [7, 11, 17, 28, 40]), the algorithms are highly derivative. This suggests that automated analyses (akin to plagiarism detection) could be used to assess algorithm novelty. That is, an algorithm in a submitted paper could be evaluated against a database of established algorithms to determine uniqueness. If such a system were accurate, it would allow journal editors to filter out low-quality research before review.

8 Conclusions

This study helps highlight the significant issues in the field of meta-heuristic optimization especially the reliance on iterative versions of algorithms with questionable novelty and innovation. By replicating the AOA algorithm, discrepancies in the reported results as well as flaws in the methodology were discovered. This emphasizes the need for more stringent evaluation criteria and reproducibility practices. If these concerns are recognized and addressed it will enhance the domain's integrity and helping advance the usage in practical applications.

Table 6: Our Results 30 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	1.53E+00	2.32E-02	1.28E+02	4.63E+01	2.75E+00	4.17E-02
F2	0.00E+00	0.00E+00	1.60E+00	4.35E-02	3.86E+00	6.78E-01	2.79E+00	3.01E-02
F3	0.00E+00	0.00E+00	2.81E+00	6.32E-02	2.47E+04	5.93E+03	4.17E+00	7.82E-02
F4	0.00E+00	0.00E+00	1.71E+00	3.63E-02	2.43E+01	4.35E+00	2.70E+00	3.66E-02
F5	2.90E+01	0.00E+00	1.72E+00	2.35E-02	6.17E+03	4.49E+03	3.04E+00	5.14E-02
F6	7.49E+00	3.30E-02	1.55E+00	2.24E-02	1.37E+02	5.70E+01	2.80E+00	4.08E-02
F7	8.89E+00	4.30E-01	1.59E+00	2.37E-02	1.24E+05	2.48E+05	2.85E+00	4.68E-02
F8	-2.50E+03	5.74E+02	2.14E+00	2.71E-02	-1.22E+04	1.02E+02	3.44E+00	5.40E-02
F9	0.00E+00	0.00E+00	1.97E+00	2.57E-02	1.94E+01	3.46E+00	3.25E+00	4.05E-02
F10	4.44E+00	0.00E+00	1.70E+00	2.48E-02	4.19E+00	4.51E-01	2.91E+00	2.67E-02
F11	0.00E+00	0.00E+00	1.61E+00	2.95E-02	2.13E+00	4.86E-01	2.79E+00	3.21E-02
F12	-4.28E-01	1.28E-01	2.22E+00	2.48E-02	-9.63E-01	1.31E-01	3.57E+00	4.30E-02
F13	5.21E+01	3.92E-01	1.85E+00	2.32E-02	5.30E+01	2.19E+01	3.10E+00	3.63E-02
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.24E+04	8.04E+03	8.96E-01	3.72E-02	3.14E-04	1.48E-04	1.06E+00	5.11E-02
F2	1.19E+03	2.43E+03	9.51E-01	3.43E-02	3.54E-03	8.25E-04	1.13E+00	5.32E-02
F3	4.89E+04	1.08E+04	2.51E+00	3.92E-02	3.53E+04	6.94E+03	2.52E+00	5.49E-02
F4	6.83E+01	6.47E+00	9.90E-01	3.71E-02	9.06E+00	1.59E+00	1.06E+00	5.74E-02
F5	6.83E+07	3.25E+07	1.21E+00	4.16E-02	8.25E+01	7.31E+01	1.39E+00	4.78E-02
F6	3.62E+04	8.60E+03	9.51E-01	3.68E-02	2.84E-04	1.21E-04	1.14E+00	5.34E-02
F7	3.31E+09	1.32E+09	1.01E+00	3.80E-02	1.16E+01	8.23E-01	1.20E+00	5.16E-02
F8	-3.86E+03	2.95E+02	1.72E+00	3.81E-02	-6.77E+03	3.39E+02	1.84E+00	4.87E-02
F9	3.48E+02	1.97E+01	1.50E+00	3.92E-02	1.49E+02	9.16E+00	1.65E+00	5.05E-02
F10	1.94E+01	5.74E-01	1.12E+00	5.59E-02	5.49E-03	1.75E-03	1.26E+00	5.32E-02
F11	3.06E+02	6.95E+01	1.01E+00	3.50E-02	1.43E-01	4.21E-02	1.18E+00	5.27E-02
F12	2.48E+04	4.07E+04	1.94E+00	4.36E-02	-1.05E+00	0.00E+00	2.05E+00	5.96E-02
F13	2.58E+08	1.37E+08	1.40E+00	4.24E-02	9.48E-03	6.21E-03	1.48E+00	5.22E-02
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.43E+04	3.05E+03	1.81E+01	3.06E-01	6.46E+02	6.50E+01	1.49E+00	6.77E-02
F2	2.19E+03	2.14E+03	2.00E+01	4.90E-01	1.39E+01	1.67E+00	1.54E+00	7.37E-02
F3	3.71E+04	3.61E+03	5.76E+01	3.22E-01	8.44E+03	8.51E+02	2.98E+00	8.42E-02
F4	6.52E+01	1.76E+00	1.86E+01	2.03E-01	3.86E+01	2.83E+00	1.47E+00	6.66E-02
F5	6.87E+07	1.09E+07	2.65E+01	2.78E-01	1.13E+05	2.57E+04	1.82E+00	6.70E-02
F6	3.30E+04	2.84E+03	1.99E+01	2.71E-01	6.64E+02	8.53E+01	1.57E+00	6.15E-02
F7	2.73E+09	5.36E+08	2.13E+01	1.86E-01	3.83E+06	1.06E+06	1.62E+00	6.50E-02
F8	-4.88E+03	2.80E+02	3.84E+01	3.35E-01	-8.06E+03	2.86E+02	2.25E+00	6.67E-02
F9	3.05E+02	1.89E+01	3.29E+01	3.35E-01	9.32E+01	7.77E+00	2.08E+00	7.53E-02
F10	1.93E+01	2.28E-01	2.30E+01	2.71E-01	1.16E+01	7.75E-01	1.67E+00	6.94E-02
F11	3.06E+02	2.22E+01	2.07E+01	3.16E-01	6.68E+00	9.17E-01	1.58E+00	6.47E-02
F12	3.99E+00	6.27E+00	4.33E+01	3.68E-01	-1.05E+00	1.19E-04	2.47E+00	9.60E-02
F13	2.51E+08	5.09E+07	3.05E+01	3.68E-01	1.74E+04	1.54E+04	1.97E+00	6.65E-02

Table 7: Our Results 30 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	4.51E+00	2.80E+00	1.03E+00	8.77E-02	5.51E-01	2.10E+00	1.07E+00	8.17E-02
F2	3.80E+00	2.72E+00	1.07E+00	8.46E-02	3.01E+00	5.35E+00	1.12E+00	7.31E-02
F3	1.34E+00	3.04E+00	2.28E+00	8.04E-02	1.89E+04	7.51E+03	2.56E+00	9.77E-02
F4	3.61E+00	2.59E+00	1.14E+00	8.46E-02	4.84E+01	1.47E+01	1.06E+00	7.46E-02
F5	2.66E+01	6.52E-01	1.27E+00	8.32E-02	6.59E+03	2.26E+04	1.38E+00	7.76E-02
F6	8.56E-01	1.18E+00	1.07E+00	8.68E-02	2.28E-01	1.22E+00	1.16E+00	8.50E-02
F7	9.55E+00	5.03E-01	1.11E+00	8.60E-02	1.79E+07	6.81E+07	1.21E+00	9.39E-02
F8	-5.82E+03	1.76E+03	1.65E+00	8.77E-02	-8.25E+03	5.33E+02	1.88E+00	1.33E-01
F9	1.89E+01	1.08E+01	1.50E+00	8.14E-02	1.08E+02	3.47E+01	1.63E+00	7.54E-02
F10	3.19E+00	4.82E-01	1.18E+00	8.78E-02	1.78E+01	5.21E+00	1.26E+00	7.62E-02
F11	2.39E+00	6.59E-01	1.11E+00	8.43E-02	3.99E-01	2.59E-01	1.18E+00	7.75E-02
F12	-8.21E-01	2.47E-01	1.81E+00	8.39E-02	-1.05E+00	2.11E-12	2.03E+00	7.72E-02
F13	4.45E+00	2.27E+00	1.33E+00	9.37E-02	6.20E+01	4.91E+01	1.51E+00	7.16E-02
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.45E+04	8.39E+03	1.33E+00	2.41E-02	6.70E+04	6.15E+03	6.10E-01	2.27E-02
F2	3.98E+05	1.21E+06	1.42E+00	2.23E-02	6.03E+11	1.60E+12	6.55E-01	1.50E-02
F3	2.53E+04	1.34E+04	3.76E+00	2.85E-02	1.25E+05	2.85E+04	1.87E+00	4.07E-02
F4	4.69E+01	1.34E+01	1.36E+00	3.07E-02	8.50E+01	3.95E+00	6.34E-01	1.94E-02
F5	2.57E+07	3.11E+07	1.86E+00	2.26E-02	2.44E+08	4.40E+07	8.52E-01	2.12E-02
F6	1.70E+04	1.24E+04	1.46E+00	2.71E-02	6.79E+04	6.53E+03	6.44E-01	1.81E-02
F7	5.57E+08	8.94E+08	1.55E+00	2.61E-02	1.12E+10	1.87E+09	6.91E-01	9.74E-03
F8	-5.12E+03	5.12E+02	2.61E+00	3.03E-02	-2.46E+03	3.21E+02	1.21E+00	1.91E-02
F9	2.77E+02	4.60E+01	2.29E+00	2.82E-02	4.28E+02	2.86E+01	1.05E+00	1.80E-02
F10	1.66E+01	2.24E+00	1.66E+00	3.55E-02	2.04E+01	2.15E-01	7.56E-01	1.65E-02
F11	1.36E+02	8.81E+01	1.50E+00	2.16E-02	6.00E+02	7.09E+01	6.89E-01	1.57E-02
F12	2.23E+00	1.06E+01	2.95E+00	3.04E-02	5.41E+06	1.58E+07	1.39E+00	1.78E-02
F13	5.27E+07	7.58E+07	2.13E+00	3.04E-02	1.00E+09	2.19E+08	9.87E-01	1.61E-02
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	2.77E+00	1.41E+00	1.13E+01	1.53E-01				
F2	2.99E+00	2.97E+00	1.13E+01	9.66E-02				
F3	9.64E+02	3.36E+02	1.26E+01	8.15E-02				
F4	6.70E+00	2.04E+00	1.13E+01	9.59E-02				
F5	5.78E+01	4.73E+01	1.14E+01	6.77E-02				
F6	2.67E+00	1.29E+00	1.12E+01	9.72E-02				
F7	7.65E+03	2.12E+04	1.13E+01	7.32E-02				
F8	-2.49E+03	3.28E+02	1.18E+01	9.90E-02				
F9	3.68E+01	9.34E+00	1.16E+01	7.30E-02				
F10	2.46E+00	2.76E+00	1.13E+01	6.38E-02				
F11	2.65E+01	6.19E+00	1.13E+01	6.54E-02				
F12	1.25E+12	0.00E+00	1.12E+01	1.09E-01				
F13	7.43E+01	5.44E+01	1.15E+01	9.69E-02				

Table 8: Our Results 100 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	3.51E+00	6.07E-02	1.14E+03	2.16E+02	5.66E+00	9.03E-02
F2	0.00E+00	0.00E+00	3.54E+00	3.51E-02	1.97E+05	7.40E+05	5.65E+00	3.38E-02
F3	0.00E+00	0.00E+00	7.42E+00	1.08E-01	1.83E+05	2.71E+04	9.77E+00	4.39E-02
F4	0.00E+00	0.00E+00	3.50E+00	6.87E-02	5.48E+01	3.99E+00	5.60E+00	1.94E-02
F5	9.90E+01	0.00E+00	4.29E+00	4.68E-02	1.04E+05	3.56E+04	6.59E+00	5.10E-02
F6	2.50E+01	4.23E-02	3.78E+00	5.59E-02	1.25E+03	1.60E+02	5.91E+00	2.71E-02
F7	3.87E+01	1.01E+00	3.91E+00	9.09E-02	1.11E+07	4.45E+06	6.06E+00	1.68E-02
F8	-4.35E+03	1.00E+03	5.81E+00	6.20E-02	-3.96E+04	2.75E+02	8.01E+00	1.28E-01
F9	0.00E+00	0.00E+00	5.29E+00	1.08E-01	1.07E+02	9.81E+00	7.49E+00	5.54E-02
F10	4.44E+00	0.00E+00	3.67E+00	4.78E-02	5.69E+00	3.30E-01	5.79E+00	3.68E-02
F11	0.00E+00	0.00E+00	3.58E+00	4.28E-02	1.22E+01	1.79E+00	5.70E+00	3.35E-02
F12	9.34E-02	1.27E-01	6.12E+00	5.46E-02	-2.19E-01	1.45E-01	8.38E+00	4.17E-02
F13	1.72E+02	5.75E-01	4.06E+00	5.38E-02	4.93E+03	5.48E+03	6.37E+00	3.20E-02
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.55E+05	3.40E+04	8.68E-01	2.46E-02	3.37E+03	7.82E+02	9.53E-01	4.38E-02
F2	3.61E+00	2.38E+00	9.31E-01	3.98E-02	7.85E+02	2.68E+02	9.86E-01	3.39E-02
F3	5.40E+05	1.02E+05	5.79E+00	6.53E-02	4.87E+05	5.38E+04	4.97E+00	7.29E-02
F4	8.23E+01	4.69E+00	8.64E-01	2.82E-02	9.62E+01	1.34E+00	9.44E-01	3.67E-02
F5	4.19E+08	1.40E+08	2.06E+00	4.88E-02	5.73E+06	2.27E+06	1.92E+00	4.35E-02
F6	1.38E+05	3.74E+04	1.24E+00	2.81E-02	3.52E+03	7.21E+02	1.26E+00	3.47E-02
F7	5.92E+10	2.10E+10	1.43E+00	4.36E-02	6.35E+08	2.26E+08	1.40E+00	3.25E-02
F8	-7.03E+03	5.15E+02	3.78E+00	6.13E-02	-1.17E+04	4.87E+02	3.33E+00	5.13E-02
F9	1.36E+03	8.83E+01	3.16E+00	4.54E-02	9.78E+02	2.38E+01	2.81E+00	3.51E-02
F10	1.99E+01	6.08E-01	1.07E+00	2.74E-02	9.24E+00	9.89E-01	1.12E+00	3.39E-02
F11	1.37E+03	2.67E+02	1.00E+00	3.29E-02	3.32E+01	5.67E+00	1.05E+00	3.60E-02
F12	7.41E+04	1.23E+05	4.48E+00	6.69E-02	-3.14E-01	0.00E+00	3.90E+00	3.75E-02
F13	1.66E+09	6.60E+08	1.94E+00	4.69E-02	1.99E+07	7.37E+06	1.81E+00	4.22E-02
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	2.03E+05	7.80E+03	3.01E+01	1.12E+00	2.31E+04	1.45E+03	1.39E+00	5.80E-02
F2	4.17E+00	2.99E+00	3.24E+01	9.27E-01	4.16E+00	2.41E+00	1.41E+00	4.53E-02
F3	3.74E+05	3.62E+04	1.65E+02	7.55E+00	1.60E+05	1.13E+04	5.39E+00	8.56E-02
F4	8.79E+01	9.96E-01	3.20E+01	1.04E+00	6.78E+01	1.62E+00	1.37E+00	4.85E-02
F5	7.23E+08	4.47E+07	6.32E+01	3.57E+00	2.17E+07	2.08E+06	2.36E+00	5.77E-02
F6	2.03E+05	7.24E+03	4.18E+01	2.61E+00	2.31E+04	8.81E+02	1.70E+00	5.53E-02
F7	1.04E+11	9.63E+09	4.44E+01	1.19E+00	2.81E+09	2.97E+08	1.85E+00	6.35E-02
F8	-9.02E+03	4.74E+02	1.03E+02	2.33E+00	-1.72E+04	3.60E+02	3.78E+00	8.46E-02
F9	1.40E+03	1.81E+01	8.63E+01	1.24E+00	7.41E+02	1.90E+01	3.27E+00	5.78E-02
F10	2.05E+01	6.58E-02	3.70E+01	7.67E-01	1.77E+01	4.06E-01	1.56E+00	5.34E-02
F11	1.81E+03	6.25E+01	3.32E+01	8.82E-01	2.09E+02	8.40E+00	1.47E+00	4.60E-02
F12	1.04E+01	1.51E+01	1.17E+02	6.09E-01	-3.14E-01	8.69E-05	4.37E+00	1.14E-01
F13	3.10E+09	1.64E+08	5.72E+01	1.00E+00	4.58E+07	6.05E+06	2.24E+00	4.31E-02

Table 9: Our Results 100 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.31E+00	2.19E+00	1.07E+00	7.37E-02	3.35E+04	1.78E+04	9.74E-01	5.69E-02
F2	5.21E+00	3.06E+00	1.12E+00	7.92E-02	1.91E+11	7.64E+11	1.02E+00	4.87E-02
F3	6.54E+03	3.63E+03	5.16E+00	9.06E-02	3.17E+05	7.28E+04	4.95E+00	7.82E-02
F4	1.38E+01	4.59E+00	1.06E+00	6.72E-02	9.60E+01	1.48E+00	9.66E-01	5.07E-02
F5	9.76E+01	9.24E-01	2.03E+00	7.89E-02	1.42E+08	1.00E+08	1.93E+00	6.10E-02
F6	7.87E+00	1.04E+00	1.38E+00	6.96E-02	3.43E+04	1.53E+04	1.27E+00	4.89E-02
F7	4.22E+01	1.37E+00	1.52E+00	6.79E-02	1.39E+10	8.66E+09	1.42E+00	5.40E-02
F8	-1.61E+04	4.90E+03	3.48E+00	6.96E-02	-2.25E+04	2.94E+03	3.32E+00	5.87E-02
F9	7.25E+01	3.04E+01	2.95E+00	6.50E-02	8.98E+02	1.23E+02	2.81E+00	5.61E-02
F10	3.94E+00	1.27E+00	1.26E+00	1.08E-01	2.01E+01	1.82E-01	1.14E+00	5.31E-02
F11	3.35E+00	2.87E+00	1.20E+00	1.10E-01	3.18E+02	1.11E+02	1.07E+00	5.26E-02
F12	-1.86E-01	1.62E-01	4.06E+00	9.35E-02	-3.14E-01	2.53E-16	3.93E+00	8.38E-02
F13	6.63E+01	6.12E+00	1.78E+00	2.03E-01	1.28E+09	1.00E+09	1.84E+00	6.12E-02
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	6.24E+04	2.61E+04	1.24E+00	1.67E-02	2.74E+05	1.56E+04	7.51E-01	2.12E-02
F2	4.07E+00	2.60E+00	1.33E+00	2.87E-02	3.87E+00	2.47E+00	8.09E-01	1.64E-02
F3	2.99E+05	1.52E+05	8.54E+00	1.33E-01	1.30E+06	3.26E+05	5.67E+00	3.78E-02
F4	6.01E+01	1.03E+01	1.24E+00	1.61E-02	9.61E+01	1.27E+00	7.43E-01	1.57E-02
F5	1.49E+08	1.65E+08	3.01E+00	5.93E-02	1.18E+09	1.03E+08	1.93E+00	2.04E-02
F6	8.24E+04	4.73E+04	1.81E+00	2.55E-02	2.72E+05	1.23E+04	1.11E+00	1.92E-02
F7	2.30E+10	2.56E+10	2.09E+00	3.13E-02	1.84E+11	1.96E+10	1.27E+00	1.56E-02
F8	-1.52E+04	3.00E+03	5.58E+00	7.37E-02	-4.80E+03	9.52E+02	3.31E+00	4.45E-02
F9	1.09E+03	1.60E+02	4.65E+00	5.36E-02	1.63E+03	5.19E+01	2.67E+00	2.39E-02
F10	1.77E+01	1.59E+00	1.55E+00	2.01E-02	2.03E+01	2.20E-01	9.43E-01	2.07E-02
F11	5.84E+02	3.26E+02	1.42E+00	2.51E-02	2.41E+03	1.27E+02	8.65E-01	1.90E-02
F12	2.70E+02	1.24E+03	6.70E+00	8.15E-02	4.43E+07	9.26E+07	3.88E+00	4.34E-02
F13	4.60E+08	6.00E+08	2.87E+00	8.08E-02	5.26E+09	4.96E+08	1.73E+00	3.86E-02
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	3.88E+03	8.38E+02	3.68E+01	3.53E-01				
F2	2.44E+01	8.28E+00	3.67E+01	1.53E-01				
F3	1.47E+04	3.50E+03	4.06E+01	2.04E-01				
F4	1.85E+01	2.28E+00	3.68E+01	1.95E-01				
F5	7.49E+04	3.79E+04	3.78E+01	3.48E-01				
F6	3.79E+03	1.11E+03	3.69E+01	2.14E-01				
F7	8.12E+07	4.48E+07	3.72E+01	3.67E-01				
F8	-4.68E+03	8.48E+02	3.88E+01	2.36E-01				
F9	2.47E+02	4.21E+01	3.82E+01	2.04E-01				
F10	4.67E+00	7.20E-01	3.69E+01	2.12E-01				
F11	6.25E+02	4.11E+01	3.68E+01	3.16E-01				
F12	4.16E+12	0.00E+00	3.67E+01	3.66E-01				
F13	3.44E+03	2.40E+03	3.75E+01	2.15E-01				

Table 10: Our Results 500 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	1.76E+01	3.37E+00	5.51E+05	1.54E+04	5.24E+01	1.74E-01
F2	0.00E+00	0.00E+00	1.75E+01	3.00E-01	4.34E+02	1.72E+01	2.90E+01	3.50E-01
F3	0.00E+00	0.00E+00	5.19E+01	3.56E+01	1.07E+07	1.37E+06	9.78E+01	2.64E-01
F4	0.00E+00	0.00E+00	2.24E+03	1.22E+04	9.24E+01	8.13E-01	5.27E+01	3.03E-01
F5	4.99E+02	0.00E+00	2.16E+01	2.94E-01	9.92E+08	4.75E+07	6.29E+01	2.32E-01
F6	1.25E+02	7.39E-02	1.85E+01	9.69E-02	5.47E+05	1.64E+04	5.57E+01	1.64E-01
F7	2.25E+02	1.68E+00	1.89E+01	1.15E-01	1.31E+12	5.97E+10	5.73E+01	1.47E-01
F8	-1.04E+04	2.60E+03	2.76E+01	1.45E-01	-2.54E+05	2.92E+03	7.44E+01	1.95E-01
F9	0.00E+00	0.00E+00	2.48E+01	1.24E-01	6.32E+03	1.18E+02	7.02E+01	1.98E-01
F10	4.44E+00	0.00E+00	1.88E+01	8.50E-02	1.72E+01	1.09E-01	5.26E+01	1.63E-01
F11	0.00E+00	0.00E+00	1.70E+01	1.08E-01	5.00E+03	2.11E+02	5.26E+01	1.44E-01
F12	2.88E-01	1.12E-01	2.88E+01	1.54E-01	1.50E+07	2.12E+07	8.08E+01	7.95E-01
F13	8.55E+02	3.95E-01	2.06E+01	9.34E-02	3.07E+09	2.44E+08	5.87E+01	1.82E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	8.26E+05	1.75E+05	1.61E+00	3.82E-02	5.57E+05	3.30E+04	1.68E+00	5.47E-02
F2	3.79E+00	2.38E+00	1.84E+00	9.24E-02	1.52E+03	4.49E+01	1.83E+00	6.81E-02
F3	1.21E+07	2.90E+06	2.86E+01	1.32E-01	1.18E+07	1.26E+06	2.50E+01	1.04E-01
F4	8.93E+01	3.64E+00	1.68E+00	4.34E-02	9.92E+01	3.26E-01	1.75E+00	5.72E-02
F5	2.08E+09	7.89E+08	9.25E+00	5.59E-02	2.79E+09	8.25E+08	7.91E+00	6.78E-02
F6	7.64E+05	2.00E+05	4.11E+00	5.45E-02	5.62E+05	3.59E+04	3.72E+00	6.02E-02
F7	1.82E+12	6.21E+11	5.07E+00	5.70E-02	1.56E+12	2.29E+11	4.51E+00	5.17E-02
F8	-1.58E+04	1.03E+03	1.52E+01	8.11E-02	-2.63E+04	1.55E+03	1.41E+01	1.14E-01
F9	7.04E+03	4.07E+02	1.29E+01	8.71E-02	6.81E+03	1.17E+02	1.16E+01	6.63E-02
F10	2.00E+01	5.83E-01	1.95E+00	3.59E-02	1.98E+01	2.21E-01	1.96E+00	5.26E-02
F11	7.05E+03	2.02E+03	1.87E+00	3.51E-02	5.07E+03	3.86E+02	1.89E+00	5.67E-02
F12	4.32E+05	6.68E+05	1.85E+01	8.16E-02	-6.28E-02	0.00E+00	1.66E+01	9.58E-02
F13	8.51E+09	3.55E+09	6.35E+00	5.41E-02	1.79E+10	7.53E+09	5.54E+00	7.23E-02
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.36E+06	2.26E+04	3.51E+02	2.10E+01	4.60E+05	7.81E+03	2.09E+03	1.14E+04
F2	inf	nan	3.83E+01	1.76E-01	4.04E+00	2.60E+00	3.17E+00	1.01E-01
F3	9.11E+06	1.28E+06	1.35E+03	1.99E+01	4.00E+06	3.33E+05	2.52E+01	3.01E-01
F4	9.74E+01	1.87E-01	3.65E+02	1.76E+01	9.00E+01	4.50E-01	3.11E+00	5.11E-02
F5	5.99E+09	1.34E+08	6.02E+02	1.31E+01	1.16E+09	3.46E+07	9.06E+00	1.23E-01
F6	1.37E+06	1.90E+04	4.23E+02	2.47E+01	4.64E+05	6.24E+03	4.88E+00	4.43E-02
F7	4.66E+12	1.22E+11	4.59E+02	2.32E+01	8.13E+11	2.26E+10	5.72E+00	3.79E-02
F8	-2.02E+04	9.97E+02	8.75E+02	2.00E+01	-4.04E+04	7.17E+02	1.48E+01	6.08E-02
F9	8.21E+03	5.15E+01	7.94E+02	9.24E+00	5.83E+03	4.58E+01	1.24E+01	6.40E-02
F10	2.10E+01	1.59E-02	3.73E+02	1.69E+01	1.98E+01	5.83E-02	3.18E+00	2.89E-02
F11	1.23E+04	1.37E+02	3.38E+02	2.56E+01	4.15E+03	6.11E+01	3.12E+00	3.30E-02
F12	8.39E+01	1.41E+02	9.89E+02	8.12E+00	-6.28E-02	3.20E-05	1.72E+01	8.40E-02
F13	2.64E+10	7.60E+08	4.94E+02	1.86E+01	4.25E+09	1.72E+08	6.65E+00	5.89E-02

Table 11: Our Results 500 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.64E-03	6.69E-04	1.93E+00	5.40E-02	1.52E+06	3.56E+04	1.96E+00	3.48E-02
F2	5.62E-03	7.74E-04	2.10E+00	1.01E-01	4.25E+00	1.93E+00	2.13E+00	1.03E-01
F3	8.37E+05	1.32E+05	2.44E+01	1.12E-01	7.51E+06	1.89E+06	2.51E+01	4.63E-01
F4	7.01E+01	3.82E+00	1.98E+00	5.89E-02	9.92E+01	2.06E-01	2.11E+00	8.83E-02
F5	5.04E+02	6.90E+00	7.96E+00	8.55E-02	7.17E+09	2.58E+08	8.22E+00	1.34E-01
F6	8.78E+01	2.54E+00	3.85E+00	6.75E-02	1.52E+06	2.80E+04	3.99E+00	8.19E-02
F7	3.58E+02	4.24E+01	4.73E+00	5.88E-02	5.81E+12	2.29E+11	4.78E+00	1.37E-01
F8	-5.61E+04	1.91E+04	1.38E+01	1.13E-01	-6.69E+04	6.97E+03	1.45E+01	2.02E-01
F9	2.73E+02	8.28E+01	1.12E+01	1.32E-01	7.86E+03	4.48E+02	1.18E+01	1.43E-01
F10	1.92E-03	4.47E-04	2.17E+00	5.31E-02	2.07E+01	1.77E-01	2.28E+00	5.53E-02
F11	8.73E-01	5.11E-02	2.10E+00	5.71E-02	1.36E+04	3.61E+02	2.17E+00	3.52E-02
F12	-9.03E-03	4.27E-02	1.61E+01	1.14E-01	-6.28E-02	1.57E-12	1.67E+01	6.64E-02
F13	8.45E+02	1.24E+02	4.66E+00	6.56E-02	3.21E+10	1.26E+09	5.79E+00	3.87E-02
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	4.80E+05	2.42E+05	2.65E+00	4.25E-02	1.53E+06	3.20E+04	1.31E+00	4.67E-02
F2	6.03E+01	2.12E+02	2.93E+00	5.88E-02	3.78E+00	2.37E+00	1.37E+00	2.50E-02
F3	9.25E+06	3.63E+06	4.33E+01	2.23E-01	3.10E+07	6.85E+06	2.29E+01	6.06E-02
F4	7.27E+01	9.53E+00	2.76E+00	2.97E-02	9.91E+01	3.65E-01	1.35E+00	2.44E-02
F5	8.94E+08	5.88E+08	1.39E+01	6.50E-02	7.05E+09	3.20E+08	7.52E+00	4.95E-02
F6	5.11E+05	3.09E+05	6.39E+00	1.13E-01	1.52E+06	3.73E+04	3.33E+00	2.70E-02
F7	9.69E+11	7.92E+11	7.77E+00	4.65E-02	5.73E+12	2.39E+11	4.18E+00	3.20E-02
F8	-7.40E+04	1.67E+04	2.37E+01	1.08E-01	-1.01E+04	1.48E+03	1.24E+01	4.89E-02
F9	6.12E+03	5.47E+02	1.98E+01	7.39E-02	8.79E+03	1.14E+02	1.05E+01	4.31E-02
F10	1.89E+01	1.02E+00	3.13E+00	3.18E-02	2.01E+01	2.66E-02	1.56E+00	2.51E-02
F11	4.76E+03	2.01E+03	3.00E+00	4.49E-02	1.38E+04	2.97E+02	1.49E+00	1.82E-02
F12	1.67E+03	6.34E+03	2.84E+01	2.46E-01	1.90E+08	5.06E+08	1.50E+01	6.87E-02
F13	4.16E+09	4.55E+09	9.75E+00	2.00E-01	3.21E+10	1.05E+09	5.22E+00	3.58E-02
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	5.30E+04	2.78E+03	1.85E+02	1.60E+00				
F2	2.87E+02	5.65E+01	1.84E+02	2.44E+00				
F3	1.10E+06	9.80E+05	2.06E+02	9.13E-01				
F4	2.73E+01	1.90E+00	1.85E+02	3.18E-01				
F5	6.95E+06	1.42E+06	1.90E+02	3.30E-01				
F6	5.29E+04	3.35E+03	1.87E+02	2.60E-01				
F7	1.08E+10	1.96E+09	1.87E+02	3.12E-01				
F8	-1.12E+04	1.86E+03	1.96E+02	2.82E-01				
F9	2.79E+03	1.41E+02	1.93E+02	2.46E-01				
F10	1.03E+01	2.00E-01	1.85E+02	2.64E-01				
F11	8.39E+03	1.99E+02	1.85E+02	2.32E-01				
F12	2.08E+13	0.00E+00	1.86E+02	2.22E-01				
F13	3.32E+06	1.09E+06	1.88E+02	1.60E-01				

Table 12: Our Results 1000 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	3.11E+01	3.37E-01	7.82E+05	2.24E+04	5.13E+01	3.20E-01
F2	0.00E+00	0.00E+00	3.38E+01	4.95E-01	inf	nan	5.15E+01	2.21E-01
F3	0.00E+00	0.00E+00	7.40E+01	1.72E-01	1.19E+07	1.14E+06	9.54E+01	4.52E-01
F4	0.00E+00	0.00E+00	3.27E+01	1.67E-01	9.08E+01	5.55E-01	5.22E+01	1.08E+00
F5	9.99E+02	0.00E+00	3.99E+01	1.60E-01	1.79E+09	9.83E+07	6.17E+01	2.00E-01
F6	2.50E+02	4.36E-02	3.44E+01	1.66E-01	7.81E+05	2.32E+04	5.48E+01	3.44E-01
F7	4.64E+02	2.36E+00	3.52E+01	1.37E-01	2.39E+12	1.21E+11	5.60E+01	2.52E-01
F8	-1.47E+04	3.82E+03	5.18E+01	1.85E-01	-2.20E+05	2.79E+03	7.28E+01	2.38E-01
F9	0.00E+00	0.00E+00	4.61E+01	1.54E-01	7.82E+03	1.90E+02	6.77E+01	1.70E-01
F10	4.44E+00	0.00E+00	3.29E+01	1.33E-01	1.83E+01	1.08E-01	5.16E+01	3.16E-01
F11	0.00E+00	0.00E+00	3.11E+01	1.86E-01	7.04E+03	2.54E+02	5.16E+01	3.18E-01
F12	2.90E-01	1.30E-01	5.43E+01	1.71E-01	1.84E+07	2.94E+07	7.75E+01	3.37E-01
F13	1.71E+03	4.13E-01	3.64E+01	1.39E-01	6.17E+09	3.58E+08	5.75E+01	2.76E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.71E+06	4.05E+05	2.25E+00	4.85E-02	1.61E+06	6.23E+04	2.33E+00	6.45E-02
F2	inf	nan	2.37E+00	3.58E-02	inf	nan	2.45E+00	6.34E-02
F3	5.05E+07	1.10E+07	5.67E+01	1.59E-01	4.71E+07	4.88E+06	4.78E+01	4.88E-01
F4	9.03E+01	3.00E+00	2.28E+00	4.41E-02	9.96E+01	1.05E-01	2.39E+00	7.07E-02
F5	4.72E+09	1.73E+09	1.51E+01	7.32E-02	1.43E+10	1.80E+09	1.41E+01	1.30E-01
F6	1.62E+06	3.88E+05	7.14E+00	8.77E-02	1.66E+06	1.41E+05	6.36E+00	1.04E-01
F7	7.93E+12	3.07E+12	9.22E+00	5.44E-02	2.30E+13	3.89E+12	8.02E+00	8.83E-02
F8	-2.21E+04	1.42E+03	2.85E+01	1.40E-01	-3.70E+04	2.11E+03	2.50E+01	1.40E-01
F9	1.48E+04	1.12E+03	2.21E+01	1.30E-01	1.43E+04	1.43E+02	1.98E+01	1.35E-01
F10	2.02E+01	4.62E-01	2.70E+00	4.41E-02	2.03E+01	8.72E-02	2.74E+00	6.68E-02
F11	1.48E+04	3.75E+03	2.67E+00	4.87E-02	1.49E+04	1.91E+03	2.66E+00	6.10E-02
F12	3.25E+06	1.13E+07	3.45E+01	1.13E-01	-3.14E-02	0.00E+00	2.98E+01	2.20E-01
F13	2.01E+10	7.07E+09	1.13E+01	8.70E-02	6.74E+10	1.54E+09	9.75E+00	1.21E-01
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.40E+04	2.37E+03	1.82E+01	3.39E-01	1.19E+06	1.24E+04	4.46E+00	9.87E-02
F2	6.34E+03	1.32E+04	1.95E+01	2.09E-01	inf	nan	4.57E+00	8.52E-02
F3	3.57E+04	4.08E+03	5.69E+01	4.41E-01	1.61E+07	1.12E+06	4.97E+01	1.74E-01
F4	6.38E+01	3.16E+00	1.84E+01	2.23E-01	9.42E+01	3.80E-01	4.51E+00	1.05E-01
F5	6.87E+07	9.81E+06	2.63E+01	3.04E-01	3.48E+09	6.11E+07	1.59E+01	1.48E-01
F6	3.43E+04	2.34E+03	1.98E+01	2.79E-01	1.18E+06	1.26E+04	8.52E+00	1.59E-01
F7	2.78E+09	5.19E+08	2.12E+01	2.40E-01	5.14E+12	1.18E+11	1.02E+01	1.21E-01
F8	-4.83E+03	2.25E+02	3.75E+01	3.42E-01	-5.75E+04	1.23E+03	2.69E+01	2.22E-01
F9	3.14E+02	9.36E+00	3.35E+01	2.70E-01	1.27E+04	7.22E+01	2.18E+01	2.13E-01
F10	1.94E+01	2.01E-01	2.30E+01	2.83E-01	2.01E+01	4.03E-02	4.93E+00	1.43E-01
F11	3.03E+02	2.85E+01	2.08E+01	2.40E-01	1.07E+04	1.65E+02	4.80E+00	9.15E-02
F12	4.68E+00	1.16E+01	4.38E+01	2.38E-01	-3.14E-02	1.47E-05	3.16E+01	2.46E-01
F13	2.40E+08	5.34E+07	3.06E+01	3.31E-01	1.37E+10	3.13E+08	1.18E+01	1.33E-01

Table 13: Our Results 1000 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	2.90E-01	9.74E-02	2.81E+00	1.01E-01	3.13E+06	5.70E+04	2.95E+00	9.48E-02
F2	3.29E+14	1.80E+15	3.05E+00	9.31E-02	inf	nan	3.08E+00	9.67E-02
F3	3.43E+06	3.70E+05	4.82E+01	2.54E-01	2.84E+07	6.60E+06	4.87E+01	2.29E-01
F4	7.86E+01	4.13E+00	2.85E+00	9.68E-02	9.96E+01	1.07E-01	2.99E+00	8.08E-02
3 F5	1.72E+03	3.01E+02	1.45E+01	1.86E-01	1.48E+10	3.73E+08	1.48E+01	1.29E-01
F6	1.98E+02	2.31E+00	6.76E+00	1.32E-01	3.14E+06	4.90E+04	6.94E+00	1.16E-01
F7	6.50E+04	6.62E+04	8.51E+00	1.79E-01	2.42E+13	6.37E+11	8.65E+00	1.12E-01
F8	-8.23E+04	3.50E+04	2.54E+01	3.08E-01	-9.91E+04	8.20E+03	2.58E+01	3.07E-01
F9	5.54E+02	1.30E+02	2.02E+01	3.04E-01	1.71E+04	5.82E+02	2.06E+01	1.96E-01
F10	1.93E-02	3.18E-03	3.11E+00	1.04E-01	2.08E+01	9.17E-02	3.32E+00	9.33E-02
F11	1.00E+00	7.95E-04	3.08E+00	1.01E-01	2.83E+04	4.29E+02	3.27E+00	8.50E-02
F12	3.72E-02	1.59E-01	3.01E+01	2.84E-01	-3.14E-02	5.92E-15	3.07E+01	2.77E-01
F13	4.12E+03	6.96E+02	8.40E+00	1.44E-01	6.68E+10	2.16E+09	1.04E+01	1.68E-01
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	9.95E+05	4.17E+05	3.94E+00	4.22E-02	3.14E+06	5.35E+04	1.99E+00	4.51E-02
F2	inf	nan	4.18E+00	5.77E-02	inf	nan	2.12E+00	3.22E-02
F3	3.72E+07	1.08E+07	8.58E+01	3.18E-01	1.25E+08	3.49E+07	4.75E+01	1.41E-01
F4	8.05E+01	8.68E+00	4.05E+00	4.69E-02	9.96E+01	1.38E-01	2.01E+00	1.66E-02
F5	2.40E+09	2.26E+09	2.39E+01	7.93E-02	1.48E+10	3.13E+08	1.27E+01	5.96E-02
F6	9.35E+05	4.73E+05	1.12E+01	6.06E-02	3.15E+06	5.05E+04	6.20E+00	3.26E-02
F7	3.27E+12	2.99E+12	1.42E+01	6.31E-02	2.44E+13	6.09E+11	7.85E+00	4.40E-02
F8	-1.48E+05	4.07E+04	4.37E+01	1.24E-01	-1.42E+04	2.44E+03	2.47E+01	4.43E-02
F9	1.23E+04	1.28E+03	3.42E+01	1.22E-01	1.77E+04	2.29E+02	1.90E+01	7.57E-02
F10	1.89E+01	9.98E-01	4.60E+00	5.64E-02	2.00E+01	7.27E-02	2.32E+00	2.50E-02
F11	1.01E+04	5.15E+03	4.47E+00	4.95E-02	2.83E+04	4.30E+02	2.30E+00	2.26E-02
F12	7.73E+03	3.95E+04	5.29E+01	1.56E-01	5.20E+08	7.85E+08	2.93E+01	7.36E-02
F13	1.29E+10	1.17E+10	1.75E+01	3.97E-01	6.71E+10	1.74E+09	9.63E+00	4.20E-02
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	1.13E+05	4.06E+03	3.59E+02	3.03E+00				
F2	4.70E+05	2.57E+06	3.32E+02	1.08E+00				
F3	8.56E+06	3.91E+06	4.01E+02	4.55E-01				
F4	6.80E+05	3.73E+06	3.59E+02	4.04E-01				
F5	2.26E+07	4.82E+06	3.69E+02	3.13E-01				
F6	1.65E+10	9.02E+10	3.62E+02	5.01E-01				
F7	4.80E+11	9.21E+10	3.63E+02	1.05E+00				
F8	-1.35E+04	4.72E+03	3.79E+02	1.44E+00				
F9	7.75E+03	1.47E+03	3.74E+02	7.71E-01				
F10	7.11E+02	3.83E+03	3.58E+02	3.88E-01				
F11	1.39E+12	7.60E+12	3.58E+02	6.35E-01				
F12	4.02E+13	7.60E+12	3.58E+02	6.49E-01				
F13	1.26E+07	2.61E+06	3.63E+02	5.64E-01				

Table 14: Our Results F14-F23 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	1.10E+01	2.45E+00	2.81E+00	1.03E-01	2.53E+00	1.95E+00	3.59E+00	1.14E-01
F15	1.31E-01	3.34E-02	8.00E-01	2.70E-02	6.21E-02	2.67E-02	1.32E+00	1.09E-01
F16	-4.94E-01	3.71E-01	5.18E-01	2.89E-02	-9.80E-01	5.54E-02	9.99E-01	1.16E-01
F17	3.03E+00	2.10E+00	5.42E-01	2.92E-02	4.33E-01	6.30E-02	1.03E+00	1.07E-01
F18	6.70E+01	6.70E+01	5.58E-01	3.43E-02	8.40E+00	1.01E+01	1.03E+00	1.14E-01
F19	-3.77E+00	5.23E-01	9.90E-01	3.30E-02	-3.75E+00	2.13E-01	1.50E+00	1.06E-01
F20	-3.31E+00	3.02E-02	1.13E+00	2.68E-02	-3.27E+00	5.72E-02	1.72E+00	1.07E-01
F21	-5.06E+00	0.00E+00	8.41E-01	3.03E-02	-5.03E+00	3.56E-02	1.41E+00	1.08E-01
F22	-5.09E+00	0.00E+00	8.97E-01	2.95E-02	-5.05E+00	2.91E-02	1.48E+00	1.08E-01
F23	-5.13E+00	0.00E+00	1.01E+00	3.77E-02	-5.10E+00	2.48E-02	1.58E+00	1.16E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	1.81E+00	9.03E-01	3.61E+00	6.81E-02	1.03E+00	1.81E-01	3.62E+00	7.56E-02
F15	5.82E-02	1.79E-02	1.04E+00	4.92E-02	1.08E-02	1.25E-02	1.19E+00	5.24E-02
F16	-1.01E+00	2.17E-02	7.86E-01	3.38E-02	-1.03E+00	5.63E-17	9.66E-01	5.40E-02
F17	4.21E-01	2.11E-02	8.15E-01	4.45E-02	3.98E-01	0.00E+00	9.87E-01	5.74E-02
F18	3.51E+00	4.80E-01	8.27E-01	4.01E-02	3.00E+00	6.95E-16	1.01E+00	5.62E-02
F19	-3.69E+00	7.94E-02	1.31E+00	4.81E-02	-3.86E+00	0.00E+00	1.45E+00	5.87E-02
F20	-2.91E+00	1.11E-01	1.34E+00	5.57E-02	-3.30E+00	4.28E-02	1.49E+00	6.01E-02
F21	-4.51E+00	2.75E-01	1.08E+00	4.04E-02	-5.06E+00	0.00E+00	1.25E+00	6.33E-02
F22	-4.49E+00	3.04E-01	1.16E+00	4.11E-02	-5.09E+00	0.00E+00	1.33E+00	6.09E-02
F23	-4.54E+00	2.88E-01	1.28E+00	4.59E-02	-5.13E+00	0.00E+00	1.44E+00	5.69E-02
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	9.98E-01	2.06E-04	8.13E+01	4.25E-01	9.98E-01	8.06E-04	3.98E+00	7.96E-02
F15	1.49E-02	4.17E-03	1.92E+01	1.67E-01	5.18E-03	6.19E-04	1.55E+00	6.49E-02
F16	-1.03E+00	3.40E-04	1.32E+01	2.44E-01	-1.03E+00	3.17E-10	1.32E+00	6.83E-02
F17	3.98E-01	2.13E-04	1.38E+01	1.48E-01	3.98E-01	6.01E-11	1.34E+00	6.28E-02
F18	3.01E+00	5.15E-03	1.44E+01	2.16E-01	3.00E+00	5.54E-08	1.36E+00	6.91E-02
F19	-3.85E+00	4.55E-03	2.55E+01	2.65E-01	-3.86E+00	8.36E-08	1.82E+00	6.90E-02
F20	-3.20E+00	3.51E-02	2.65E+01	2.48E-01	-3.32E+00	2.00E-04	1.86E+00	8.32E-02
F21	-4.98E+00	3.48E-02	1.94E+01	1.47E-01	-5.06E+00	6.29E-05	1.62E+00	7.05E-02
F22	-5.04E+00	2.29E-02	2.14E+01	1.91E-01	-5.09E+00	6.88E-05	1.70E+00	6.38E-02
F23	-5.07E+00	3.01E-02	2.44E+01	2.94E-01	-5.13E+00	6.91E-05	1.81E+00	7.08E-02

Table 15: Our Results F14-F23 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	1.92E+00	1.89E+00	3.13E+00	1.02E-01	9.98E-01	6.78E-17	3.58E+00	1.04E-01
F15	1.37E-02	1.34E-02	1.10E+00	9.05E-02	5.09E-03	3.99E-03	1.17E+00	8.16E-02
F16	-1.03E+00	7.57E-09	9.13E-01	9.20E-02	-1.03E+00	1.21E-16	9.31E-01	7.86E-02
F17	3.98E-01	2.32E-07	9.04E-01	8.59E-02	3.98E-01	0.00E+00	9.46E-01	7.89E-02
F18	3.00E+00	1.07E-05	9.42E-01	9.01E-02	3.00E+00	8.06E-16	9.62E-01	7.73E-02
F19	-3.86E+00	1.54E-03	1.33E+00	9.25E-02	-3.86E+00	2.21E-16	1.46E+00	9.10E-02
F20	-3.26E+00	6.77E-02	1.36E+00	7.35E-02	-3.26E+00	6.02E-02	1.47E+00	8.74E-02
F21	-5.06E+00	0.00E+00	1.16E+00	8.55E-02	-5.06E+00	0.00E+00	1.21E+00	8.16E-02
F22	-5.09E+00	0.00E+00	1.20E+00	8.32E-02	-5.09E+00	0.00E+00	1.30E+00	7.96E-02
F23	-5.13E+00	0.00E+00	1.30E+00	8.38E-02	-5.13E+00	0.00E+00	1.41E+00	8.10E-02
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	1.12E+00	2.20E-01	5.40E+00	8.62E-02	1.88E+01	2.23E+01	2.75E+00	3.86E-02
F15	3.65E-02	1.50E-02	1.52E+00	3.49E-02	1.31E-01	8.89E-02	6.96E-01	1.71E-02
F16	-1.03E+00	2.56E-03	1.17E+00	3.84E-02	-3.84E-01	6.64E-01	4.83E-01	2.80E-02
F17	3.99E-01	3.09E-03	1.21E+00	3.42E-02	7.52E-01	4.30E-01	5.10E-01	2.70E-02
F18	3.03E+00	9.97E-02	1.24E+00	4.21E-02	1.80E+01	1.58E+01	5.18E-01	2.75E-02
F19	-3.82E+00	4.23E-02	1.93E+00	4.90E-02	-2.62E+00	8.60E-01	9.07E-01	2.28E-02
F20	-3.11E+00	1.06E-01	1.98E+00	5.34E-02	-1.68E+00	4.30E-01	9.39E-01	1.85E-02
F21	-4.76E+00	1.32E-01	1.61E+00	3.84E-02	-5.06E+00	0.00E+00	7.34E-01	2.01E-02
F22	-4.77E+00	1.68E-01	1.72E+00	3.90E-02	-5.09E+00	0.00E+00	7.94E-01	1.40E-02
F23	-4.78E+00	1.76E-01	1.90E+00	3.60E-02	-5.13E+00	0.00E+00	8.92E-01	1.68E-02
	GSA							
F	Fitness		Execution Time					
	Ave	Std	Ave	Std				
F14	5.33E+00	4.57E+00	3.52E+00	8.28E-02				
F15	8.02E-02	1.76E-02	2.01E+00	3.93E-02				
F16	-1.03E+00	7.68E-17	1.06E+00	1.46E-02				
F17	3.98E-01	0.00E+00	1.33E+00	1.41E+00				
F18	3.01E+00	4.53E-02	1.09E+00	1.23E-02				
F19	-1.58E+00	9.86E-01	1.78E+00	2.92E-02				
F20	-1.57E+00	5.26E-01	2.90E+00	5.51E-02				
F21	-5.06E+00	0.00E+00	1.93E+00	1.76E-02				
F22	-5.09E+00	0.00E+00	2.01E+00	2.01E-02				
F23	-5.13E+00	0.00E+00	2.11E+00	2.81E-02				

Table 16: Our Results F24-F29 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	1.35E+03	1.57E+02	1.55E+02	8.26E-01	4.51E+02	1.11E+02	1.57E+02	3.35E-01
F25	1.53E+03	5.07E+01	1.56E+02	3.85E-01	9.56E+02	2.39E+01	1.58E+02	5.36E-01
F26	1.52E+03	6.43E+01	1.55E+02	5.78E-01	9.58E+02	2.58E+01	1.58E+02	8.64E-01
F27	1.52E+03	6.89E+01	1.56E+02	6.52E-01	9.56E+02	2.96E+01	1.58E+02	4.18E-01
F28	1.77E+03	1.77E+01	1.58E+02	1.09E+00	1.06E+03	2.88E+02	1.60E+02	4.97E-01
F29	1.74E+03	2.06E+01	1.50E+02	7.11E-01	6.92E+02	3.62E+02	1.52E+02	3.27E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	9.92E+02	7.72E+01	1.91E+02	4.89E-01	4.18E+02	6.85E+01	1.56E+02	5.57E-01
F25	1.35E+03	3.73E+01	1.91E+02	5.74E-01	9.13E+02	1.14E+00	1.56E+02	5.19E-01
F26	1.36E+03	3.18E+01	1.92E+02	6.61E-01	9.13E+02	9.47E-01	1.56E+02	6.97E-01
F27	1.36E+03	3.85E+01	1.91E+02	6.62E-01	9.13E+02	1.04E+00	1.56E+02	5.70E-01
F28	1.78E+03	2.69E+01	1.95E+02	8.17E-01	8.66E+02	3.49E+01	1.58E+02	5.73E-01
F29	1.73E+03	2.29E+01	1.85E+02	6.16E-01	8.80E+02	3.72E+02	1.51E+02	5.09E-01
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	7.76E+02	4.24E+01	4.66E+03	9.36E+00	5.32E+02	4.04E+01	1.56E+02	5.62E-01
F25	1.24E+03	2.44E+01	4.66E+03	6.90E+00	1.04E+03	1.79E+01	1.57E+02	6.63E-01
F26	1.23E+03	3.22E+01	4.66E+03	1.16E+01	1.04E+03	2.19E+01	1.57E+02	3.35E-01
F27	1.23E+03	2.33E+01	4.67E+03	6.97E+00	1.04E+03	1.75E+01	1.57E+02	2.77E-01
F28	1.71E+03	1.87E+01	4.60E+03	1.37E+02	1.51E+03	7.97E+01	1.59E+02	4.45E-01
F29	1.66E+03	1.88E+01	4.47E+03	7.43E+00	1.50E+03	5.30E+01	1.52E+02	9.12E-01

Table 17: Our Results F24-F29 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	4.52E+02	1.60E+02	1.56E+02	6.04E-01	3.19E+02	8.06E+01	1.56E+02	2.80E-01
F25	9.45E+02	2.19E+01	1.57E+02	4.63E-01	9.17E+02	1.12E+01	1.57E+02	5.45E-01
F26	9.48E+02	1.69E+01	1.57E+02	8.39E-01	9.14E+02	3.00E+00	1.57E+02	4.62E-01
F27	9.42E+02	1.50E+01	1.57E+02	4.82E-01	9.13E+02	1.83E+00	1.56E+02	2.90E-01
F28	1.19E+03	2.51E+02	1.59E+02	4.17E-01	1.46E+03	4.89E+00	1.59E+02	9.71E-01
F29	7.42E+02	3.44E+02	1.51E+02	4.64E-01	1.25E+03	4.29E+00	1.52E+02	6.38E-01
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	9.04E+02	5.81E+01	2.82E+02	8.11E-01	1.09E+03	1.89E+02	1.61E+02	2.08E+00
F25	1.32E+03	4.20E+01	2.83E+02	9.18E-01	1.36E+03	1.02E+02	1.60E+02	4.98E-01
F26	1.31E+03	4.22E+01	2.83E+02	1.08E+00	1.37E+03	1.09E+02	1.60E+02	6.98E-01
F27	1.31E+03	3.99E+01	2.83E+02	6.49E-01	1.33E+03	8.57E+01	1.61E+02	7.02E-01
F28	1.75E+03	3.15E+01	2.87E+02	4.46E-01	1.89E+03	8.89E+01	1.63E+02	8.98E-01
F29	1.68E+03	4.60E+01	2.74E+02	8.63E-01	1.84E+03	5.54E+01	1.55E+02	4.67E-01
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F24	2.23E+03	0.00E+00	1.71E+02	1.44E+00				
F25	3.97E+03	0.00E+00	1.69E+02	5.28E-01				
F26	3.97E+03	0.00E+00	1.69E+02	5.20E-01				
F27	3.97E+03	0.00E+00	1.70E+02	3.97E-01				
F28	3.58E+03	0.00E+00	1.72E+02	3.15E-01				
F29	3.08E+03	0.00E+00	1.63E+02	2.61E-01				

Table 18: Our Results Default hyperparameter 30 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	1.37E+00	3.77E-02	5.04E+01	1.82E+01	2.20E+00	7.12E-02
F2	0.00E+00	0.00E+00	1.61E+00	1.04E-01	2.56E+00	5.93E-01	2.91E+00	1.42E-01
F3	0.00E+00	0.00E+00	2.51E+00	2.17E-02	1.93E+04	4.59E+03	3.37E+00	8.55E-02
F4	0.00E+00	0.00E+00	1.35E+00	3.98E-02	1.55E+01	2.42E+00	2.19E+00	7.64E-02
F5	2.90E+01	0.00E+00	1.54E+00	3.26E-02	1.83E+03	1.05E+03	2.45E+00	6.44E-02
F6	7.49E+00	4.29E-02	1.40E+00	3.59E-02	5.35E+01	1.99E+01	2.25E+00	7.25E-02
F7	8.96E+00	4.28E-01	1.44E+00	3.30E-02	2.12E+04	2.49E+04	2.31E+00	6.35E-02
F8	-2.29E+03	5.12E+02	2.04E+00	6.54E-02	-1.24E+04	5.26E+01	2.85E+00	7.03E-02
F9	0.00E+00	0.00E+00	1.84E+00	5.69E-02	1.18E+01	2.18E+00	2.70E+00	6.49E-02
F10	4.44E+00	0.00E+00	1.52E+00	2.09E-02	3.16E+00	3.37E-01	2.38E+00	6.84E-02
F11	0.00E+00	0.00E+00	1.44E+00	3.07E-02	1.39E+00	1.02E-01	2.28E+00	7.20E-02
F12	-4.29E-01	1.36E-01	2.16E+00	3.73E-02	-1.02E+00	2.72E-02	3.00E+00	6.55E-02
F13	5.21E+01	4.66E-01	1.71E+00	3.87E-02	2.34E+01	8.23E+00	2.55E+00	7.43E-02
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.57E+04	9.20E+03	8.40E-01	3.20E-02	1.73E+04	5.09E+03	8.97E-01	4.27E-02
F2	1.34E+03	4.80E+03	9.91E-01	1.00E-01	5.43E+01	1.37E+01	1.14E+00	1.09E-01
F3	4.71E+04	9.65E+03	2.44E+00	4.56E-02	2.28E+04	8.12E+03	2.13E+00	4.62E-02
F4	6.84E+01	5.15E+00	8.35E-01	3.01E-02	6.05E+01	5.16E+00	8.88E-01	4.23E-02
F5	6.69E+07	2.47E+07	1.17E+00	3.80E-02	3.05E+07	1.52E+07	1.16E+00	4.35E-02
F6	3.40E+04	7.88E+03	9.10E-01	3.80E-02	1.76E+04	5.78E+03	9.52E-01	4.27E-02
F7	2.99E+09	1.08E+09	9.60E-01	2.80E-02	1.54E+09	8.16E+08	1.00E+00	4.10E-02
F8	-3.88E+03	2.24E+02	1.68E+00	4.29E-02	-8.20E+03	7.35E+02	1.57E+00	4.27E-02
F9	3.46E+02	2.21E+01	1.49E+00	4.54E-02	1.31E+02	2.84E+01	1.42E+00	4.07E-02
F10	1.93E+01	5.38E-01	1.04E+00	2.79E-02	1.63E+01	1.18E+00	1.07E+00	4.38E-02
F11	2.96E+02	7.31E+01	9.54E-01	3.15E-02	1.68E+02	4.93E+01	9.95E-01	4.20E-02
F12	2.01E+04	3.25E+04	1.99E+00	5.05E-02	1.88E+03	7.50E+03	1.78E+00	4.81E-02
F13	2.77E+08	1.13E+08	1.38E+00	3.28E-02	8.85E+07	5.33E+07	1.32E+00	4.17E-02
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.38E+04	2.89E+03	2.03E+01	3.57E-01	6.64E+02	9.55E+01	1.24E+00	5.29E-02
F2	3.63E+03	6.71E+03	2.34E+01	3.61E-01	1.30E+01	1.24E+00	1.58E+00	1.27E-01
F3	3.55E+04	3.50E+03	6.34E+01	7.72E-01	8.36E+03	1.05E+03	2.49E+00	5.47E-02
F4	6.46E+01	2.47E+00	2.15E+01	4.33E-01	3.81E+01	2.37E+00	1.25E+00	5.91E-02
F5	6.89E+07	1.28E+07	3.08E+01	2.32E-01	1.09E+05	3.04E+04	1.53E+00	5.16E-02
F6	3.48E+04	2.17E+03	2.24E+01	1.89E-01	6.15E+02	9.21E+01	1.32E+00	5.86E-02
F7	2.74E+09	3.90E+08	2.19E+01	2.77E-01	4.05E+06	1.10E+06	1.32E+00	5.42E-02
F8	-4.87E+03	2.43E+02	4.23E+01	4.31E-01	-8.02E+03	1.53E+02	1.87E+00	4.72E-02
F9	3.12E+02	1.29E+01	3.95E+01	4.23E-01	9.37E+01	7.66E+00	1.73E+00	5.44E-02
F10	1.94E+01	1.66E-01	2.40E+01	2.53E-01	1.16E+01	6.36E-01	1.37E+00	5.19E-02
F11	3.13E+02	2.04E+01	2.33E+01	3.80E-01	6.76E+00	9.29E-01	1.29E+00	4.47E-02
F12	3.08E+00	7.38E+00	4.92E+01	3.37E-01	-1.05E+00	5.87E-05	2.07E+00	4.65E-02
F13	2.92E+08	5.42E+07	3.18E+01	2.32E-01	1.30E+04	8.44E+03	1.62E+00	4.16E-02

Table 19: Our Results Default hyperparameter 30 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.84E+00	2.77E+00	9.21E-01	5.97E-02	2.58E-01	1.38E+00	8.73E-01	5.36E-02
F2	4.21E+00	2.83E+00	1.09E+00	1.30E-01	7.34E+00	8.66E+00	1.13E+00	1.22E-01
F3	3.79E-01	1.16E+00	2.12E+00	6.42E-02	1.68E+04	6.26E+03	2.07E+00	5.57E-02
F4	3.60E+00	2.32E+00	9.09E-01	5.80E-02	4.59E+01	1.78E+01	8.62E-01	5.39E-02
F5	2.67E+01	5.51E-01	1.15E+00	5.89E-02	3.36E+03	1.64E+04	1.11E+00	5.03E-02
F6	1.55E+00	2.36E+00	9.55E-01	6.26E-02	2.99E-01	1.62E+00	9.16E-01	6.14E-02
F7	9.62E+00	5.48E-01	1.01E+00	6.13E-02	8.95E+06	4.90E+07	9.61E-01	4.77E-02
F8	-5.99E+03	1.62E+03	1.55E+00	5.88E-02	-8.23E+03	5.48E+02	1.51E+00	5.05E-02
F9	1.93E+01	1.02E+01	1.41E+00	5.69E-02	1.21E+02	2.99E+01	1.37E+00	5.27E-02
F10	3.30E+00	5.12E-01	1.06E+00	6.07E-02	1.72E+01	5.65E+00	1.02E+00	5.06E-02
F11	2.42E+00	7.05E-01	1.01E+00	6.38E-02	3.49E-01	2.29E-01	9.62E-01	5.24E-02
F12	-8.20E-01	3.38E-01	1.75E+00	6.72E-02	-1.05E+00	5.96E-14	1.73E+00	5.29E-02
F13	3.69E+00	1.99E+00	1.23E+00	6.02E-02	6.99E+01	4.95E+01	1.26E+00	5.15E-02
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.58E+04	9.30E+03	1.11E+00	2.03E-02	6.71E+04	7.04E+03	5.96E-01	5.45E-02
F2	2.71E+04	9.56E+04	1.45E+00	9.21E-02	6.80E+11	1.57E+12	6.30E-01	2.20E-02
F3	3.54E+04	1.46E+04	3.37E+00	7.07E-02	1.35E+05	3.35E+04	1.82E+00	4.40E-02
F4	4.14E+01	1.33E+01	1.10E+00	2.22E-02	8.64E+01	4.09E+00	6.29E-01	3.43E-02
F5	1.84E+07	2.61E+07	1.58E+00	6.24E-02	2.33E+08	5.05E+07	8.38E-01	2.50E-02
F6	1.50E+04	1.18E+04	1.21E+00	2.98E-02	6.52E+04	8.50E+03	6.65E-01	4.26E-02
F7	1.29E+09	1.56E+09	1.30E+00	1.87E-02	1.13E+10	2.65E+09	6.93E-01	3.05E-02
F8	-5.20E+03	4.58E+02	2.35E+00	3.14E-02	-2.66E+03	4.44E+02	1.22E+00	5.92E-02
F9	2.88E+02	4.29E+01	2.05E+00	2.32E-02	4.27E+02	2.97E+01	1.04E+00	3.83E-02
F10	1.74E+01	2.15E+00	1.41E+00	3.13E-02	2.01E+01	9.15E-02	7.44E-01	2.34E-02
F11	1.42E+02	9.91E+01	1.26E+00	2.07E-02	6.08E+02	5.23E+01	6.83E-01	3.33E-02
F12	5.43E+02	2.24E+03	2.74E+00	4.16E-02	2.92E+07	6.57E+07	1.38E+00	2.93E-02
F13	8.48E+07	1.34E+08	1.90E+00	3.99E-02	1.07E+09	2.21E+08	9.96E-01	4.54E-02
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	2.82E-16	9.96E-17	1.09E+01	1.74E-01				
F2	5.49E-01	9.98E-01	1.08E+01	8.65E-02				
F3	1.09E+03	3.79E+02	1.19E+01	9.42E-02				
F4	7.23E+00	2.47E+00	1.09E+01	1.51E-01				
F5	6.76E+01	5.09E+01	1.10E+01	7.77E-02				
F6	2.78E-16	1.36E-16	1.11E+01	1.20E-01				
F7	8.25E+03	3.12E+04	1.12E+01	9.94E-02				
F8	-2.57E+03	4.61E+02	1.16E+01	9.50E-02				
F9	3.34E+01	9.27E+00	1.15E+01	1.03E-01				
F10	3.10E-02	1.70E-01	1.12E+01	1.17E-01				
F11	2.53E+01	7.28E+00	1.11E+01	9.80E-02				
F12	1.25E+12	0.00E+00	1.11E+01	1.06E-01				
F13	7.00E+01	4.51E+01	1.13E+01	1.16E-01				

Table 20: Our Results Default hyperparameter 100 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	3.72E+00	9.30E-02	9.77E+02	2.04E+02	5.51E+00	1.05E-01
F2	0.00E+00	0.00E+00	3.94E+00	9.57E-02	1.87E+01	1.54E+00	7.18E+00	1.52E-01
F3	0.00E+00	0.00E+00	7.71E+00	1.46E-01	1.61E+05	2.38E+04	9.43E+00	8.02E-02
F4	0.00E+00	0.00E+00	3.62E+00	3.53E-02	4.49E+01	3.19E+00	5.49E+00	7.21E-02
F5	9.90E+01	0.00E+00	4.46E+00	5.71E-02	7.35E+04	2.59E+04	6.47E+00	7.17E-02
F6	2.50E+01	0.00E+00	3.97E+00	8.84E-02	1.05E+03	1.85E+02	5.81E+00	7.65E-02
F7	3.85E+01	7.34E-01	4.03E+00	5.60E-02	7.89E+06	2.63E+06	5.97E+00	7.87E-02
F8	-4.50E+03	1.21E+03	5.97E+00	7.26E-02	-4.01E+04	2.39E+02	7.85E+00	7.09E-02
F9	0.00E+00	0.00E+00	5.37E+00	1.05E-01	9.23E+01	8.96E+00	7.28E+00	7.81E-02
F10	4.44E+00	0.00E+00	3.83E+00	5.77E-02	5.32E+00	2.70E-01	5.69E+00	8.21E-02
F11	0.00E+00	0.00E+00	3.71E+00	3.40E-02	1.04E+01	1.31E+00	5.59E+00	7.00E-02
F12	9.69E-02	1.23E-01	6.25E+00	4.23E-02	-2.44E-01	1.96E-01	8.24E+00	7.43E-02
F13	1.72E+02	2.92E-01	4.20E+00	4.41E-02	1.17E+03	1.06E+03	6.26E+00	9.58E-02
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.42E+05	3.16E+04	9.28E-01	5.92E-02	1.12E+05	1.72E+04	9.71E-01	3.37E-02
F2	4.51E+00	2.93E+00	1.23E+00	1.02E-01	2.86E+02	3.16E+01	1.25E+00	1.11E-01
F3	4.49E+05	1.09E+05	6.11E+00	3.87E-02	1.84E+05	3.99E+04	5.00E+00	4.66E-02
F4	8.16E+01	5.55E+00	9.02E-01	2.46E-02	7.48E+01	4.13E+00	9.65E-01	4.43E-02
F5	3.92E+08	1.50E+08	2.16E+00	4.27E-02	2.67E+08	6.65E+07	1.94E+00	3.10E-02
F6	1.33E+05	3.82E+04	1.30E+00	2.34E-02	1.12E+05	2.17E+04	1.29E+00	3.76E-02
F7	5.35E+10	1.87E+10	1.50E+00	2.55E-02	3.71E+10	1.06E+10	1.44E+00	3.79E-02
F8	-7.19E+03	5.27E+02	3.99E+00	3.84E-02	-1.78E+04	1.80E+03	3.36E+00	5.88E-02
F9	1.38E+03	8.99E+01	3.25E+00	6.08E-02	8.31E+02	8.77E+01	2.78E+00	5.46E-02
F10	2.01E+01	4.49E-01	1.14E+00	3.00E-02	1.89E+01	2.91E-01	1.15E+00	3.26E-02
F11	1.24E+03	3.22E+02	1.05E+00	2.12E-02	1.09E+03	1.71E+02	1.08E+00	3.29E-02
F12	3.03E+04	4.46E+04	4.73E+00	3.49E-02	9.09E+04	4.41E+05	3.94E+00	3.98E-02
F13	1.30E+09	7.89E+08	2.06E+00	4.49E-02	9.56E+08	2.33E+08	1.85E+00	3.81E-02
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	2.05E+05	5.28E+03	6.26E+01	2.38E+00	2.34E+04	1.51E+03	1.43E+00	4.57E-02
F2	4.77E+00	2.69E+00	8.97E+01	1.40E+00	2.32E+02	2.71E+01	1.82E+00	1.30E-01
F3	3.78E+05	3.81E+04	2.55E+02	6.53E+00	1.61E+05	1.20E+04	5.45E+00	6.21E-02
F4	8.76E+01	8.21E-01	7.38E+01	1.65E+00	6.77E+01	1.38E+00	1.42E+00	4.07E-02
F5	7.39E+08	4.04E+07	1.26E+02	1.25E+00	2.23E+07	2.64E+06	2.42E+00	5.38E-02
F6	2.03E+05	5.67E+03	7.32E+01	1.58E+00	2.30E+04	1.03E+03	1.75E+00	4.11E-02
F7	1.06E+11	6.73E+09	6.28E+01	2.72E+00	2.86E+09	2.76E+08	1.91E+00	4.18E-02
F8	-9.12E+03	5.02E+02	1.63E+02	3.95E+00	-1.72E+04	4.64E+02	3.84E+00	7.18E-02
F9	1.39E+03	2.77E+01	1.55E+02	3.06E+00	7.41E+02	2.19E+01	3.25E+00	4.47E-02
F10	2.06E+01	7.49E-02	3.97E+01	6.58E-01	1.76E+01	3.88E-01	1.61E+00	4.84E-02
F11	1.83E+03	5.81E+01	7.33E+01	4.21E+00	2.08E+02	1.30E+01	1.53E+00	4.11E-02
F12	2.56E+01	6.80E+01	2.02E+02	4.73E+00	-3.14E-01	9.82E-05	4.39E+00	5.62E-02
F13	3.13E+09	1.62E+08	1.18E+02	9.89E-01	4.56E+07	5.40E+06	2.30E+00	5.69E-02

Table 21: Our Results Default hyperparameter 100 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.87E+00	2.86E+00	1.03E+00	5.60E-02	3.24E+04	1.93E+04	9.87E-01	4.77E-02
F2	5.19E+00	2.53E+00	1.35E+00	1.34E-01	7.98E+04	4.35E+05	1.28E+00	1.24E-01
F3	8.05E+03	5.13E+03	5.02E+00	7.34E-02	3.26E+05	5.94E+04	4.99E+00	6.30E-02
F4	1.38E+01	5.69E+00	1.03E+00	5.71E-02	9.57E+01	1.20E+00	9.86E-01	5.18E-02
F5	9.78E+01	7.35E-01	1.99E+00	6.06E-02	1.81E+08	2.01E+08	1.95E+00	5.05E-02
F6	7.63E+00	9.62E-01	1.33E+00	6.00E-02	3.59E+04	1.46E+04	1.29E+00	5.14E-02
F7	4.20E+01	1.33E+00	1.48E+00	5.82E-02	1.34E+10	8.46E+09	1.44E+00	5.39E-02
F8	-1.67E+04	4.67E+03	3.38E+00	6.99E-02	-2.38E+04	2.05E+03	3.34E+00	6.48E-02
F9	6.77E+01	3.37E+01	2.80E+00	6.42E-02	9.48E+02	1.33E+02	2.78E+00	7.08E-02
F10	4.66E+00	1.62E+00	1.20E+00	6.14E-02	2.01E+01	1.90E-01	1.16E+00	5.22E-02
F11	3.45E+00	3.00E+00	1.13E+00	5.65E-02	2.85E+02	1.28E+02	1.10E+00	5.26E-02
F12	-1.50E-01	1.69E-01	3.95E+00	7.30E-02	-3.14E-01	1.88E-11	3.98E+00	1.20E-01
F13	6.58E+01	6.51E+00	1.64E+00	5.89E-02	9.36E+08	8.68E+08	1.87E+00	5.15E-02
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	8.18E+04	4.42E+04	1.28E+00	1.54E-02	2.73E+05	1.28E+04	7.30E-01	4.32E-02
F2	4.48E+13	1.72E+14	1.71E+00	9.07E-02	3.57E+00	2.36E+00	8.01E-01	3.20E-02
F3	3.92E+05	1.53E+05	8.57E+00	4.30E-02	1.17E+06	3.75E+05	5.70E+00	1.59E-01
F4	5.77E+01	9.39E+00	1.27E+00	1.78E-02	9.54E+01	1.59E+00	7.43E-01	4.30E-02
F5	1.50E+08	1.43E+08	3.06E+00	4.47E-02	1.17E+09	9.38E+07	1.90E+00	3.63E-02
F6	7.07E+04	3.11E+04	1.84E+00	2.87E-02	2.73E+05	1.53E+04	1.04E+00	2.37E-02
F7	2.45E+10	2.33E+10	2.13E+00	3.30E-02	1.89E+11	1.40E+10	1.21E+00	3.62E-02
F8	-1.51E+04	3.28E+03	5.60E+00	3.48E-02	-4.94E+03	7.65E+02	3.22E+00	5.59E-02
F9	1.12E+03	1.21E+02	4.54E+00	3.78E-02	1.62E+03	4.33E+01	2.60E+00	4.60E-02
F10	1.82E+01	1.46E+00	1.60E+00	2.94E-02	2.01E+01	5.40E-02	9.04E-01	1.96E-02
F11	6.18E+02	2.99E+02	1.45E+00	2.06E-02	2.45E+03	9.28E+01	8.30E-01	2.42E-02
F12	4.21E+02	1.94E+03	6.71E+00	5.64E-02	7.08E+07	2.35E+08	3.79E+00	4.96E-02
F13	5.96E+08	5.46E+08	2.90E+00	4.04E-02	5.24E+09	4.53E+08	1.67E+00	3.26E-02
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	3.67E+03	9.31E+02	3.53E+01	3.25E-01				
F2	2.20E+01	7.47E+00	3.52E+01	1.91E-01				
F3	1.47E+04	5.39E+03	3.92E+01	2.26E-01				
F4	1.78E+01	1.29E+00	3.54E+01	2.38E-01				
F5	8.69E+04	4.34E+04	3.62E+01	2.17E-01				
F6	3.77E+03	6.31E+02	3.55E+01	2.26E-01				
F7	8.16E+07	2.33E+07	3.56E+01	2.27E-01				
F8	-4.85E+03	9.71E+02	3.74E+01	2.00E-01				
F9	2.44E+02	3.89E+01	3.67E+01	2.36E-01				
F10	4.88E+00	7.01E-01	3.54E+01	2.58E-01				
F11	6.34E+02	3.32E+01	3.53E+01	2.24E-01				
F12	4.16E+12	0.00E+00	3.57E+01	1.73E-01				
F13	3.19E+03	2.00E+03	3.61E+01	1.92E-01				

Table 22: Our Results Default hyperparameter 500 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	3.23E+01	1.59E-01	1.93E+05	7.63E+03	2.78E+01	4.00E-01
F2	0.00E+00	0.00E+00	1.69E+01	2.22E-01	5.60E+02	1.98E+01	2.89E+01	2.28E-01
F3	0.00E+00	0.00E+00	7.68E+01	2.23E-01	2.98E+06	3.22E+05	4.84E+01	2.40E-01
F4	0.00E+00	0.00E+00	3.40E+01	1.46E-01	8.29E+01	1.37E+00	2.81E+01	2.87E-01
F5	9.99E+02	0.00E+00	4.15E+01	1.89E-01	2.45E+08	2.26E+07	3.28E+01	3.45E-01
F6	2.50E+02	0.00E+00	3.56E+01	1.85E-01	1.89E+05	6.75E+03	2.94E+01	3.81E-01
F7	4.63E+02	3.16E+00	3.69E+01	1.77E-01	1.53E+11	1.41E+10	3.00E+01	3.21E-01
F8	-1.38E+04	2.56E+03	5.43E+01	1.60E-01	-1.42E+05	1.60E+03	3.83E+01	3.69E-01
F9	0.00E+00	0.00E+00	4.99E+01	2.03E-01	2.57E+03	6.65E+01	3.58E+01	3.34E-01
F10	4.44E+00	0.00E+00	3.45E+01	2.12E-01	1.59E+01	1.61E-01	2.80E+01	3.02E-01
F11	0.00E+00	0.00E+00	3.25E+01	2.33E-01	1.70E+03	9.30E+01	2.79E+01	2.88E-01
F12	2.52E-01	1.59E-01	5.86E+01	2.33E-01	1.52E+06	2.54E+06	4.05E+01	3.46E-01
F13	1.71E+03	6.64E-01	3.82E+01	2.13E-01	6.23E+08	6.46E+07	3.09E+01	3.47E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.65E+06	3.28E+05	2.30E+00	5.36E-02	1.77E+06	1.59E+05	2.34E+00	6.70E-02
F2	3.29E+00	2.14E+00	1.81E+00	1.36E-01	1.76E+06	8.80E+06	1.87E+00	1.60E-01
F3	4.59E+07	9.77E+06	6.13E+01	2.53E-01	1.45E+07	4.64E+06	4.89E+01	2.15E-01
F4	9.18E+01	1.81E+00	2.39E+00	6.60E-02	9.96E+01	1.54E-01	2.44E+00	6.96E-02
F5	4.80E+09	1.61E+09	1.65E+01	1.60E-01	5.18E+09	7.80E+08	1.45E+01	1.67E-01
F6	1.62E+06	3.44E+05	7.68E+00	1.19E-01	1.73E+06	1.47E+05	6.52E+00	1.13E-01
F7	8.32E+12	2.54E+12	1.03E+01	1.25E-01	8.59E+12	1.44E+12	8.51E+00	1.24E-01
F8	-2.25E+04	1.38E+03	3.15E+01	2.62E-01	-6.78E+04	7.36E+03	2.61E+01	2.73E-01
F9	1.42E+04	9.90E+02	2.61E+01	2.37E-01	1.32E+04	4.17E+02	2.21E+01	2.71E-01
F10	2.03E+01	3.26E-01	2.82E+00	5.94E-02	2.02E+01	1.49E-01	2.76E+00	8.20E-02
F11	1.51E+04	3.55E+03	2.74E+00	6.19E-02	1.53E+04	1.30E+03	2.70E+00	7.20E-02
F12	4.62E+05	1.07E+06	4.04E+01	2.49E-01	2.63E+07	1.21E+08	3.28E+01	2.93E-01
F13	1.89E+10	9.39E+09	1.23E+01	1.46E-01	2.06E+10	3.10E+09	1.01E+01	1.53E-01
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.37E+06	1.84E+04	1.92E+02	2.30E+01	1.19E+06	1.35E+04	4.50E+00	1.04E-01
F2	inf	nan	3.81E+01	3.26E-01	inf	nan	4.63E+00	1.01E-01
F3	8.81E+06	8.72E+05	1.23E+03	2.70E+01	1.59E+07	1.04E+06	5.12E+01	1.97E-01
F4	9.74E+01	2.10E-01	4.20E+02	9.20E+00	9.43E+01	4.13E-01	4.59E+00	9.90E-02
F5	5.99E+09	9.65E+07	6.82E+02	5.68E+00	3.47E+09	7.93E+07	1.64E+01	1.95E-01
F6	1.36E+06	1.88E+04	2.68E+02	2.50E+01	1.19E+06	1.27E+04	8.69E+00	1.37E-01
F7	4.67E+12	1.22E+11	3.07E+02	1.35E+01	5.11E+12	1.36E+11	1.08E+01	2.27E-01
F8	-2.04E+04	9.55E+02	8.59E+02	1.41E+01	-5.75E+04	9.82E+02	2.81E+01	3.02E-01
F9	8.23E+03	5.49E+01	8.50E+02	4.64E+01	1.27E+04	7.32E+01	2.40E+01	2.53E-01
F10	2.10E+01	1.71E-02	8.24E+01	3.27E+00	2.01E+01	4.61E-02	4.93E+00	1.21E-01
F11	1.23E+04	1.32E+02	3.40E+02	2.25E+01	1.07E+04	1.64E+02	4.88E+00	1.54E-01
F12	1.04E+02	2.04E+02	9.53E+02	6.66E+01	-3.14E-02	2.63E-05	3.47E+01	3.24E-01
F13	2.66E+10	5.16E+08	5.82E+02	7.73E+00	1.37E+10	3.67E+08	1.22E+01	1.64E-01

Table 23: Our Results Default hyperparameter 500 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.64E-03	6.69E-04	1.93E+00	5.40E-02	1.52E+06	3.56E+04	1.96E+00	3.48E-02
F2	5.73E-03	8.82E-04	2.09E+00	1.34E-01	3.43E+00	1.94E+00	2.18E+00	1.33E-01
F3	8.37E+05	1.32E+05	2.44E+01	1.12E-01	7.51E+06	1.89E+06	2.51E+01	4.63E-01
F4	7.01E+01	3.82E+00	1.98E+00	5.89E-02	9.92E+01	2.06E-01	2.11E+00	8.83E-02
F5	5.04E+02	6.90E+00	7.96E+00	8.55E-02	7.17E+09	2.58E+08	8.22E+00	1.34E-01
F6	8.78E+01	2.54E+00	3.85E+00	6.75E-02	1.52E+06	2.80E+04	3.99E+00	8.19E-02
F7	3.58E+02	4.24E+01	4.73E+00	5.88E-02	5.81E+12	2.29E+11	4.78E+00	1.37E-01
F8	-5.61E+04	1.91E+04	1.38E+01	1.13E-01	-6.69E+04	6.97E+03	1.45E+01	2.02E-01
F9	2.73E+02	8.28E+01	1.12E+01	1.32E-01	7.86E+03	4.48E+02	1.18E+01	1.43E-01
F10	1.92E-03	4.47E-04	2.17E+00	5.31E-02	2.07E+01	1.77E-01	2.28E+00	5.53E-02
F11	8.73E-01	5.11E-02	2.10E+00	5.71E-02	1.36E+04	3.61E+02	2.17E+00	3.52E-02
F12	-9.03E-03	4.27E-02	1.61E+01	1.14E-01	-6.28E-02	1.57E-12	1.67E+01	6.64E-02
F13	8.45E+02	1.24E+02	4.66E+00	6.56E-02	3.21E+10	1.26E+09	5.79E+00	3.87E-02
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.09E+06	5.09E+05	3.98E+00	6.24E-02	3.13E+06	4.79E+04	1.99E+00	1.11E-01
F2	1.35E+02	3.39E+02	2.91E+00	1.38E-01	inf	nan	2.05E+00	8.25E-02
F3	3.89E+07	1.07E+07	8.81E+01	2.31E-01	1.29E+08	4.08E+07	4.65E+01	7.91E-01
F4	8.42E+01	9.09E+00	4.11E+00	6.84E-02	9.96E+01	1.58E-01	1.85E+00	5.41E-02
F5	2.75E+09	2.31E+09	2.46E+01	1.65E-01	1.48E+10	2.42E+08	1.22E+01	2.06E-01
F6	9.42E+05	3.75E+05	1.15E+01	1.44E-01	3.13E+06	5.09E+04	5.68E+00	1.21E-01
F7	4.40E+12	3.70E+12	1.50E+01	1.06E-01	2.42E+13	4.83E+11	7.26E+00	1.78E-01
F8	-1.50E+05	3.53E+04	4.57E+01	2.12E-01	-1.56E+04	2.88E+03	2.30E+01	2.99E-01
F9	1.27E+04	1.37E+03	3.81E+01	2.30E-01	1.77E+04	2.11E+02	1.80E+01	2.90E-01
F10	1.87E+01	8.37E-01	4.67E+00	8.90E-02	1.99E+01	2.12E-02	2.16E+00	6.40E-02
F11	8.86E+03	3.73E+03	4.54E+00	6.86E-02	2.83E+04	4.27E+02	2.12E+00	6.17E-02
F12	1.17E+04	4.22E+04	5.83E+01	2.97E-01	6.36E+08	1.08E+09	2.80E+01	3.49E-01
F13	9.65E+09	8.03E+09	1.83E+01	3.78E-01	6.70E+10	1.75E+09	9.05E+00	2.15E-01
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	5.24E+04	2.86E+03	1.67E+02	1.59E+00				
F2	4.91E+265	inf	1.66E+02	3.38E+00				
F3	1.22E+06	5.80E+05	1.86E+02	8.68E-01				
F4	2.72E+01	1.71E+00	1.68E+02	9.08E-01				
F5	6.55E+06	1.28E+06	1.73E+02	8.69E-01				
F6	5.25E+04	3.33E+03	1.69E+02	9.74E-01				
F7	1.15E+10	1.70E+09	1.69E+02	7.96E-01				
F8	-1.04E+04	1.63E+03	1.76E+02	1.31E+00				
F9	2.82E+03	1.30E+02	1.74E+02	1.20E+00				
F10	1.02E+01	1.99E-01	1.67E+02	1.01E+00				
F11	8.40E+03	1.92E+02	1.68E+02	1.02E+00				
F12	2.08E+13	0.00E+00	1.70E+02	9.62E-01				
F13	3.10E+06	8.32E+05	1.70E+02	8.10E-01				

Table 24: Our Results Default hyperparameter 1000 dimensions F1-F13 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	0.00E+00	0.00E+00	3.24E+01	2.03E-01	7.82E+05	2.24E+04	5.13E+01	3.20E-01
F2	0.00E+00	0.00E+00	3.24E+01	3.03E-01	inf	nan	5.16E+01	2.89E-01
F3	0.00E+00	0.00E+00	7.56E+01	7.38E-01	1.19E+07	1.14E+06	9.54E+01	4.52E-01
F4	0.00E+00	0.00E+00	3.41E+01	2.87E-01	9.08E+01	5.55E-01	5.22E+01	1.08E+00
F5	9.99E+02	0.00E+00	4.13E+01	2.23E-01	1.79E+09	9.83E+07	6.17E+01	2.00E-01
F6	2.50E+02	0.00E+00	3.57E+01	3.42E-01	7.81E+05	2.32E+04	5.48E+01	3.44E-01
F7	4.65E+02	2.77E+00	3.67E+01	3.37E-01	2.39E+12	1.21E+11	5.60E+01	2.52E-01
F8	-1.38E+04	3.10E+03	5.36E+01	3.46E-01	-2.20E+05	2.79E+03	7.28E+01	2.38E-01
F9	0.00E+00	0.00E+00	4.79E+01	2.44E-01	7.82E+03	1.90E+02	6.77E+01	1.70E-01
F10	4.44E+00	0.00E+00	3.45E+01	3.61E-01	1.83E+01	1.08E-01	5.16E+01	3.16E-01
F11	0.00E+00	0.00E+00	3.25E+01	3.55E-01	7.04E+03	2.54E+02	5.16E+01	3.18E-01
F12	2.95E-01	1.24E-01	5.62E+01	2.57E-01	1.84E+07	2.94E+07	7.75E+01	3.37E-01
F13	1.71E+03	4.97E-01	3.81E+01	3.06E-01	6.17E+09	3.58E+08	5.75E+01	2.76E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	1.63E+06	3.79E+05	2.28E+00	6.52E-02	1.74E+06	1.40E+05	2.34E+00	8.34E-02
F2	inf	nan	2.58E+00	1.35E-01	inf	nan	2.64E+00	1.40E-01
F3	4.62E+07	1.04E+07	5.94E+01	2.24E-01	1.34E+07	3.76E+06	4.73E+01	2.61E-01
F4	9.13E+01	1.90E+00	2.37E+00	6.25E-02	9.96E+01	1.31E-01	2.41E+00	8.51E-02
F5	5.16E+09	2.35E+09	1.61E+01	2.11E-01	5.12E+09	8.76E+08	1.42E+01	1.66E-01
F6	1.69E+06	4.57E+05	7.58E+00	1.16E-01	1.69E+06	1.01E+05	6.46E+00	1.22E-01
F7	8.41E+12	3.32E+12	9.66E+00	1.49E-01	8.82E+12	1.27E+12	8.05E+00	1.43E-01
F8	-2.30E+04	1.98E+03	3.05E+01	2.05E-01	-6.77E+04	5.65E+03	2.54E+01	3.18E-01
F9	1.49E+04	8.83E+02	2.37E+01	2.72E-01	1.33E+04	4.67E+02	2.01E+01	2.36E-01
F10	2.04E+01	3.57E-01	2.79E+00	7.66E-02	2.02E+01	1.54E-01	2.75E+00	7.70E-02
F11	1.39E+04	3.74E+03	2.72E+00	5.73E-02	1.57E+04	1.43E+03	2.70E+00	7.78E-02
F12	6.58E+05	1.08E+06	3.69E+01	3.35E-01	3.14E+06	1.65E+07	3.02E+01	3.50E-01
F13	2.01E+10	7.11E+09	1.20E+01	1.64E-01	1.99E+10	2.82E+09	9.80E+00	2.04E-01
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	2.92E+06	2.45E+04	3.22E+02	2.58E+01	1.19E+06	1.24E+04	4.53E+00	9.22E-02
F2	inf	nan	6.09E+01	2.52E-01	inf	nan	4.67E+00	1.58E-01
F3	3.63E+07	3.77E+06	2.88E+03	8.82E+01	1.59E+07	1.32E+06	4.92E+01	3.01E-01
F4	9.87E+01	1.02E-01	1.25E+03	6.96E+01	9.43E+01	3.70E-01	4.58E+00	1.16E-01
F5	1.31E+10	1.82E+08	1.85E+03	3.10E+01	3.50E+09	6.40E+07	1.62E+01	2.55E-01
F6	2.93E+06	2.94E+04	5.57E+02	3.12E+01	1.19E+06	1.58E+04	8.57E+00	1.50E-01
F7	2.10E+13	2.72E+11	9.00E+02	7.59E+01	5.18E+12	1.26E+11	1.03E+01	2.18E-01
F8	-2.82E+04	1.65E+03	2.10E+03	1.25E+02	-5.70E+04	1.14E+03	2.73E+01	2.78E-01
F9	1.71E+04	9.61E+01	2.17E+03	2.61E+01	1.27E+04	8.24E+01	2.20E+01	2.49E-01
F10	2.11E+01	1.17E-02	1.92E+02	4.29E+00	2.01E+01	3.66E-02	4.97E+00	1.15E-01
F11	2.62E+04	1.76E+02	1.03E+03	6.07E+01	1.07E+04	1.08E+02	4.89E+00	1.24E-01
F12	1.76E+02	2.90E+02	2.56E+03	2.33E+02	-3.14E-02	2.93E-05	3.20E+01	3.17E-01
F13	5.90E+10	6.32E+08	1.57E+03	2.97E+01	1.36E+10	3.54E+08	1.20E+01	1.81E-01

Table 25: Our Results Default hyperparameter 1000 dimensions F1-F13 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	3.10E-01	8.83E-02	2.81E+00	9.90E-02	3.14E+06	4.92E+04	2.99E+00	1.09E-01
F2	2.05E+14	1.12E+15	2.92E+00	1.11E-01	inf	nan	3.12E+00	9.72E-02
F3	3.51E+06	4.32E+05	4.78E+01	2.75E-01	2.66E+07	5.42E+06	4.83E+01	2.72E-01
F4	7.84E+01	3.80E+00	2.87E+00	1.13E-01	9.96E+01	1.15E-01	3.05E+00	9.19E-02
F5	1.84E+03	3.71E+02	1.46E+01	2.14E-01	1.48E+10	2.92E+08	1.50E+01	1.87E-01
F6	1.97E+02	2.84E+00	6.80E+00	1.32E-01	3.15E+06	4.83E+04	7.08E+00	1.77E-01
F7	8.16E+04	8.18E+04	8.52E+00	1.78E-01	2.42E+13	6.47E+11	8.71E+00	1.85E-01
F8	-8.78E+04	3.00E+04	2.57E+01	3.30E-01	-9.93E+04	1.06E+04	2.60E+01	2.86E-01
F9	5.52E+02	1.47E+02	2.04E+01	2.11E-01	1.72E+04	4.58E+02	2.08E+01	2.78E-01
F10	1.95E-02	3.33E-03	3.13E+00	9.76E-02	2.08E+01	1.39E-01	3.35E+00	8.85E-02
F11	1.00E+00	8.55E-04	3.09E+00	9.72E-02	2.82E+04	3.43E+02	3.32E+00	8.79E-02
F12	1.02E-01	4.15E-01	3.03E+01	3.04E-01	-3.14E-02	2.16E-13	3.11E+01	3.63E-01
F13	4.06E+03	6.68E+02	8.44E+00	1.76E-01	6.70E+10	1.37E+09	1.07E+01	2.01E-01
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F1	9.55E+05	3.77E+05	3.97E+00	6.73E-02	3.14E+06	4.94E+04	1.92E+00	7.85E-02
F2	inf	nan	4.22E+00	8.76E-02	inf	nan	2.09E+00	9.72E-02
F3	4.05E+07	1.23E+07	8.55E+01	6.85E-01	1.32E+08	3.79E+07	4.67E+01	8.50E-01
F4	8.38E+01	7.01E+00	4.10E+00	9.87E-02	9.96E+01	1.12E-01	1.85E+00	5.50E-02
F5	2.06E+09	1.03E+09	2.42E+01	2.28E-01	1.47E+10	3.82E+08	1.23E+01	2.20E-01
F6	1.16E+06	5.23E+05	1.14E+01	1.56E-01	3.14E+06	4.04E+04	5.66E+00	1.17E-01
F7	4.23E+12	3.10E+12	1.43E+01	1.86E-01	2.42E+13	7.29E+11	7.36E+00	1.64E-01
F8	-1.42E+05	3.81E+04	4.45E+01	2.67E-01	-1.58E+04	3.50E+03	2.29E+01	3.13E-01
F9	1.24E+04	8.67E+02	3.47E+01	2.91E-01	1.77E+04	1.86E+02	1.79E+01	2.30E-01
F10	1.85E+01	8.47E-01	4.68E+00	1.14E-01	1.99E+01	2.14E-02	2.19E+00	7.73E-02
F11	1.10E+04	4.90E+03	4.53E+00	9.56E-02	2.82E+04	4.25E+02	2.12E+00	7.24E-02
F12	2.31E+04	1.20E+05	5.40E+01	4.38E-01	7.75E+08	1.43E+09	2.80E+01	3.49E-01
F13	9.49E+09	8.56E+09	1.80E+01	4.16E-01	6.68E+10	1.56E+09	9.01E+00	1.81E-01
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F1	1.13E+05	4.54E+03	3.31E+02	3.37E+00				
F2	4.92E+273	inf	3.10E+02	1.39E+00				
F3	7.29E+06	4.16E+06	3.79E+02	2.21E+00				
F4	3.19E+01	1.51E+00	3.30E+02	3.04E+00				
F5	2.12E+07	2.11E+06	3.42E+02	1.25E+00				
F6	1.11E+05	5.05E+03	3.34E+02	1.98E+00				
F7	2.64E+11	1.38E+10	3.36E+02	1.01E+00				
F8	-1.49E+04	2.92E+03	3.52E+02	1.72E+00				
F9	6.60E+03	3.12E+02	3.47E+02	1.57E+00				
F10	1.09E+01	1.64E-01	3.31E+02	1.71E+00				
F11	2.02E+04	2.49E+02	3.30E+02	1.51E+00				
F12	4.16E+13	0.00E+00	3.38E+02	1.90E+00				
F13	1.18E+07	2.44E+06	3.37E+02	1.71E+00				

Table 26: Our Results Default hyperparameter F14-F23 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	1.18E+01	2.45E+00	2.75E+00	1.35E-01	1.41E+00	9.80E-01	3.59E+00	1.16E-01
F15	1.30E-01	2.95E-02	7.76E-01	1.12E-01	4.70E-02	2.13E-02	1.33E+00	1.11E-01
F16	-5.93E-01	3.96E-01	4.89E-01	1.14E-01	-1.02E+00	1.95E-02	9.97E-01	1.10E-01
F17	1.95E+00	1.79E+00	5.26E-01	1.12E-01	4.11E-01	1.53E-02	1.02E+00	1.09E-01
F18	5.43E+01	6.58E+01	5.42E-01	1.13E-01	1.72E+01	2.01E+01	1.02E+00	1.02E-01
F19	-3.86E+00	6.75E-05	9.53E-01	1.14E-01	-3.79E+00	1.92E-01	1.51E+00	1.13E-01
F20	-3.28E+00	5.71E-02	1.11E+00	1.11E-01	-3.27E+00	5.95E-02	1.72E+00	1.11E-01
F21	-5.06E+00	0.00E+00	8.28E-01	1.14E-01	-5.05E+00	9.26E-03	1.41E+00	1.18E-01
F22	-5.09E+00	0.00E+00	8.96E-01	1.04E-01	-5.08E+00	1.11E-02	1.47E+00	1.06E-01
F23	-5.13E+00	0.00E+00	9.79E-01	1.17E-01	-5.12E+00	1.06E-02	1.59E+00	1.14E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	1.55E+00	5.38E-01	3.75E+00	1.29E-01	4.66E+00	4.11E+00	3.56E+00	1.20E-01
F15	5.82E-02	1.76E-02	1.05E+00	1.13E-01	5.33E-02	3.81E-02	1.17E+00	1.13E-01
F16	-1.02E+00	1.43E-02	7.90E-01	9.96E-02	-9.81E-01	1.72E-01	9.41E-01	1.12E-01
F17	4.10E-01	9.14E-03	8.30E-01	1.19E-01	5.28E-01	3.04E-01	9.68E-01	1.05E-01
F18	3.25E+00	1.95E-01	8.40E-01	1.08E-01	8.40E+00	1.07E+01	9.87E-01	1.12E-01
F19	-3.75E+00	5.58E-02	1.35E+00	1.21E-01	-3.66E+00	3.00E-01	1.43E+00	1.08E-01
F20	-2.96E+00	1.03E-01	1.40E+00	1.12E-01	-2.99E+00	3.02E-01	1.47E+00	1.13E-01
F21	-4.65E+00	2.24E-01	1.11E+00	1.09E-01	-4.13E+00	6.37E-01	1.23E+00	1.11E-01
F22	-4.66E+00	2.52E-01	1.19E+00	1.12E-01	-4.47E+00	4.76E-01	1.31E+00	1.06E-01
F23	-4.67E+00	2.87E-01	1.33E+00	1.08E-01	-4.31E+00	6.82E-01	1.43E+00	1.13E-01
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	9.98E-01	1.32E-05	8.30E+01	5.78E-01	9.98E-01	3.92E-06	3.96E+00	1.26E-01
F15	1.56E-02	6.35E-03	1.98E+01	1.29E-01	5.22E-03	7.02E-04	1.53E+00	1.10E-01
F16	-1.03E+00	4.04E-04	1.32E+01	1.14E-01	-1.03E+00	9.31E-10	1.29E+00	1.20E-01
F17	3.98E-01	3.06E-04	1.38E+01	1.21E-01	3.98E-01	4.55E-11	1.31E+00	1.13E-01
F18	3.00E+00	4.63E-03	1.41E+01	8.91E-02	3.00E+00	5.62E-08	1.32E+00	1.09E-01
F19	-3.85E+00	5.10E-03	2.62E+01	1.31E-01	-3.86E+00	2.46E-07	1.81E+00	1.21E-01
F20	-3.19E+00	4.22E-02	2.72E+01	1.60E-01	-3.32E+00	2.06E-04	1.83E+00	1.10E-01
F21	-4.96E+00	6.15E-02	1.99E+01	1.02E-01	-5.06E+00	8.60E-05	1.59E+00	1.06E-01
F22	-4.98E+00	5.11E-02	2.19E+01	1.13E-01	-5.09E+00	5.27E-05	1.69E+00	1.08E-01
F23	-5.03E+00	5.14E-02	2.48E+01	8.81E-02	-5.13E+00	5.77E-05	1.79E+00	1.13E-01

Table 27: Our Results Default hyperparameter Default hyperparameter F14-F23 - Part 2

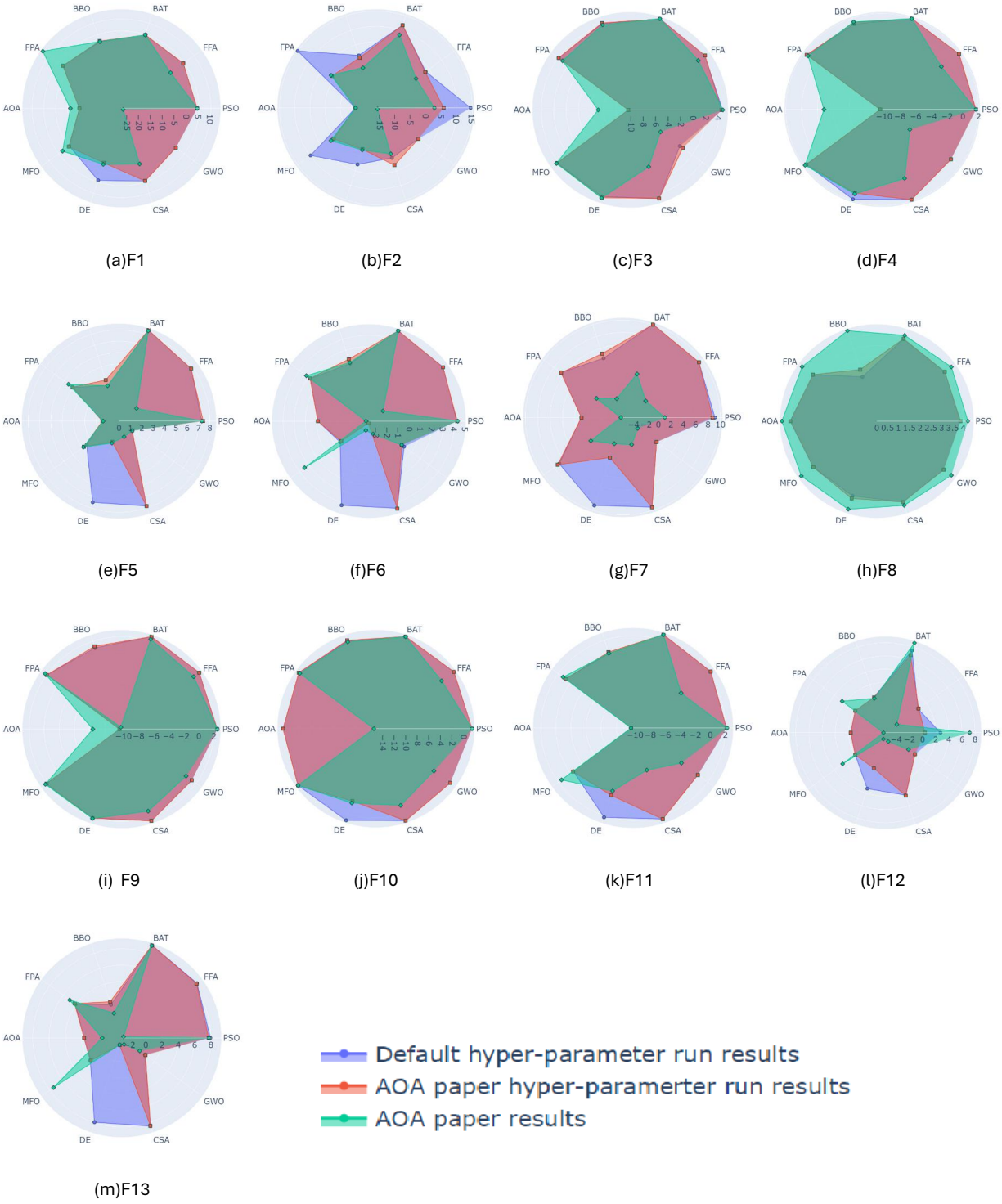
	GWO				MFO			
F	Fitness		Execution Time		Fitness		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	2.28E+00	2.61E+00	3.12E+00	1.21E-01	9.98E-01	8.42E-17	3.53E+00	1.08E-01
F15	1.37E-02	1.34E-02	1.09E+00	1.19E-01	4.36E-03	7.53E-19	1.15E+00	1.18E-01
F16	-1.03E+00	7.53E-09	8.54E-01	1.06E-01	-1.03E+00	1.35E-16	9.23E-01	1.13E-01
F17	3.98E-01	2.03E-07	8.93E-01	1.17E-01	3.98E-01	0.00E+00	9.38E-01	1.05E-01
F18	3.00E+00	8.83E-06	8.96E-01	1.21E-01	3.00E+00	3.99E-16	9.49E-01	1.15E-01
F19	-3.86E+00	2.37E-03	1.31E+00	1.01E-01	-3.86E+00	2.50E-16	1.40E+00	1.08E-01
F20	-3.25E+00	6.71E-02	1.32E+00	1.10E-01	-3.26E+00	6.05E-02	1.43E+00	1.09E-01
F21	-5.06E+00	0.00E+00	1.12E+00	1.11E-01	-5.06E+00	0.00E+00	1.20E+00	1.14E-01
F22	-5.09E+00	0.00E+00	1.19E+00	1.05E-01	-5.09E+00	0.00E+00	1.28E+00	1.13E-01
F23	-5.13E+00	0.00E+00	1.29E+00	1.16E-01	-5.13E+00	0.00E+00	1.39E+00	1.10E-01
	PSO				BAT			
F	Fitness		Execution Time		Fitness		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F14	1.14E+00	3.12E-01	5.35E+00	1.26E-01	2.06E+01	2.45E+01	2.79E+00	3.51E-02
F15	3.95E-02	1.47E-02	1.50E+00	1.06E-01	1.26E-01	4.72E-02	6.91E-01	2.02E-02
F16	-1.03E+00	1.48E-03	1.15E+00	1.11E-01	-5.61E-01	4.66E-01	4.86E-01	2.84E-02
F17	4.00E-01	3.14E-03	1.19E+00	1.10E-01	7.77E-01	4.22E-01	5.04E-01	2.68E-02
F18	3.06E+00	9.93E-02	1.20E+00	1.04E-01	1.70E+01	2.27E+01	5.06E-01	2.70E-02
F19	-3.82E+00	4.85E-02	1.91E+00	1.05E-01	-2.56E+00	8.59E-01	9.06E-01	1.93E-02
F20	-3.12E+00	9.14E-02	1.95E+00	1.14E-01	-1.58E+00	6.73E-01	9.47E-01	1.36E-02
F21	-4.71E+00	1.82E-01	1.60E+00	1.05E-01	-5.06E+00	0.00E+00	7.41E-01	1.96E-02
F22	-4.84E+00	1.83E-01	1.73E+00	1.13E-01	-5.09E+00	0.00E+00	7.99E-01	1.73E-02
F23	-4.80E+00	1.82E-01	1.90E+00	1.13E-01	-5.13E+00	0.00E+00	9.00E-01	2.22E-02
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F14	5.33E+00	4.57E+00	3.52E+00	8.28E-02				
F15	8.02E-02	1.76E-02	2.01E+00	3.93E-02				
F16	-1.03E+00	7.68E-17	1.06E+00	1.46E-02				
F17	3.98E-01	0.00E+00	1.33E+00	1.41E+00				
F18	3.01E+00	4.53E-02	1.09E+00	1.23E-02				
F19	-1.58E+00	9.86E-01	1.78E+00	2.92E-02				
F20	-1.57E+00	5.26E-01	2.90E+00	5.51E-02				
F21	-5.06E+00	0.00E+00	1.93E+00	1.76E-02				
F22	-5.09E+00	0.00E+00	2.01E+00	2.01E-02				
F23	-5.13E+00	0.00E+00	2.11E+00	2.81E-02				

Table 28: Our Results Default hyperparameter F24-F29 - Part 1

	AOA				BBO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	1.36E+03	1.41E+02	1.56E+02	4.66E-01	4.48E+02	1.20E+02	1.59E+02	6.60E-01
F25	1.54E+03	4.82E+01	1.56E+02	5.10E-01	9.41E+02	2.90E+01	1.59E+02	7.50E-01
F26	1.51E+03	5.68E+01	1.57E+02	3.58E-01	9.47E+02	3.54E+01	1.60E+02	7.91E-01
F27	1.53E+03	6.10E+01	1.57E+02	5.39E-01	9.36E+02	2.54E+01	1.60E+02	6.72E-01
F28	1.78E+03	2.11E+01	1.59E+02	6.11E-01	1.03E+03	2.91E+02	1.62E+02	7.86E-01
F29	1.74E+03	2.21E+01	1.51E+02	5.02E-01	5.89E+02	3.23E+02	1.54E+02	6.85E-01
	CSA				DE			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	9.75E+02	8.35E+01	2.02E+02	5.79E-01	6.83E+02	1.58E+02	1.56E+02	7.13E-01
F25	1.36E+03	3.92E+01	2.02E+02	4.07E-01	1.19E+03	5.83E+01	1.57E+02	4.60E-01
F26	1.35E+03	3.98E+01	2.03E+02	6.66E-01	1.18E+03	5.27E+01	1.57E+02	5.05E-01
F27	1.35E+03	3.06E+01	2.03E+02	2.16E+00	1.18E+03	5.13E+01	1.57E+02	1.12E+00
F28	1.78E+03	3.18E+01	2.05E+02	7.29E-01	1.66E+03	4.80E+01	1.59E+02	7.80E-01
F29	1.72E+03	2.35E+01	1.95E+02	5.21E-01	1.59E+03	4.55E+01	1.52E+02	5.82E-01
	FFA				FPA			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	7.89E+02	4.09E+01	4.55E+03	5.04E+00	4.88E+02	3.57E+01	1.57E+02	7.28E-01
F25	1.23E+03	3.58E+01	4.60E+03	1.29E+01	1.04E+03	1.76E+01	1.58E+02	5.11E-01
F26	1.24E+03	2.09E+01	4.79E+03	1.42E+02	1.04E+03	1.87E+01	1.58E+02	5.59E-01
F27	1.24E+03	3.24E+01	4.74E+03	4.38E+01	1.04E+03	1.84E+01	1.58E+02	4.37E-01
F28	1.71E+03	2.17E+01	4.87E+03	6.15E+01	1.51E+03	4.82E+01	1.60E+02	5.84E-01
F29	1.66E+03	2.43E+01	4.59E+03	6.26E+00	1.48E+03	5.85E+01	1.53E+02	6.22E-01

Table 29: Our Results Default hyperparameter F24-F29 - Part 2

	GWO				MFO			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	4.90E+02	1.84E+02	1.57E+02	7.27E-01	3.22E+02	7.96E+01	1.57E+02	4.35E-01
F25	9.48E+02	2.98E+01	1.57E+02	6.58E-01	9.14E+02	3.62E+00	1.57E+02	6.80E-01
F26	9.39E+02	1.32E+01	1.58E+02	6.00E-01	9.14E+02	1.85E+00	1.57E+02	6.87E-01
F27	9.45E+02	1.55E+01	1.57E+02	1.04E+00	9.14E+02	2.81E+00	1.57E+02	6.39E-01
F28	1.26E+03	2.22E+02	1.60E+02	7.12E-01	1.44E+03	8.36E+01	1.60E+02	8.04E-01
F29	8.64E+02	3.02E+02	1.52E+02	8.51E-01	1.25E+03	4.84E+00	1.52E+02	4.55E-01
	PSO				BAT			
F	Fitness Value		Execution Time		Fitness Value		Execution Time	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std
F24	8.96E+02	1.02E+02	2.83E+02	7.99E-01	1.11E+03	1.80E+02	1.61E+02	2.20E+00
F25	1.33E+03	3.25E+01	2.84E+02	1.16E+00	1.36E+03	1.10E+02	1.60E+02	8.09E-01
F26	1.30E+03	4.12E+01	2.83E+02	1.35E+00	1.35E+03	9.67E+01	1.59E+02	8.46E-01
F27	1.33E+03	2.89E+01	2.84E+02	7.45E-01	1.33E+03	1.08E+02	1.59E+02	7.18E-01
F28	1.73E+03	3.74E+01	2.87E+02	1.22E+00	1.90E+03	1.03E+02	1.60E+02	4.18E-01
F29	1.70E+03	2.82E+01	2.74E+02	1.03E+00	1.84E+03	8.53E+01	1.52E+02	4.20E-01
	GSA							
F	Fitness Value		Execution Time					
	Ave	Std	Ave	Std				
F24	2.23E+03	0.00E+00	1.71E+02	1.44E+00				
F25	3.97E+03	0.00E+00	1.69E+02	5.28E-01				
F26	3.97E+03	0.00E+00	1.69E+02	5.20E-01				
F27	3.97E+03	0.00E+00	1.70E+02	3.97E-01				
F28	3.58E+03	0.00E+00	1.72E+02	3.15E-01				
F29	3.08E+03	0.00E+00	1.63E+02	2.61E-01				



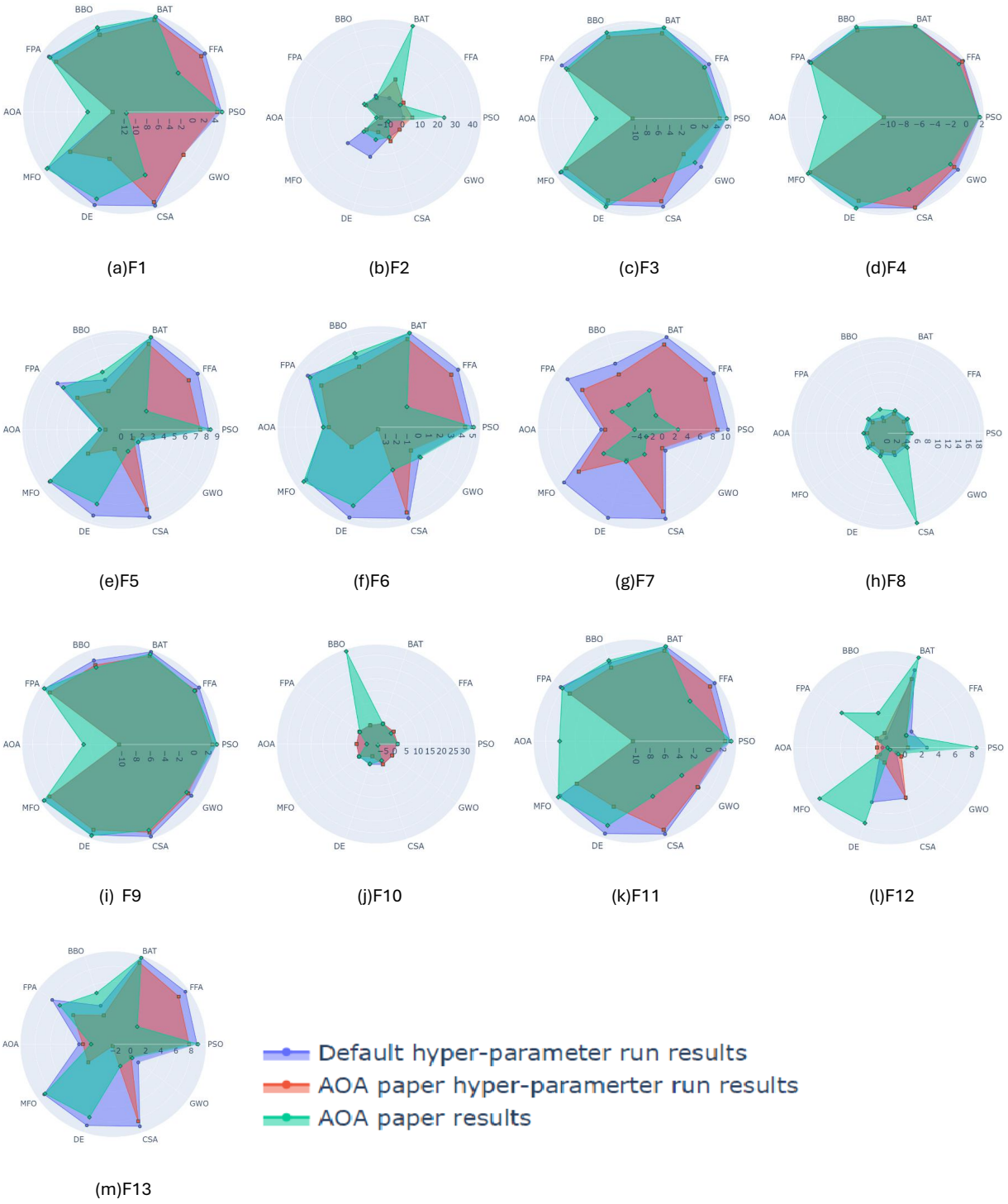
(a)F1 (b)F2 (c)F3 (d)F4

(e)F5 (f)F6 (g)F7 (h)F8

(i) F9 (j)F10 (k)F11 (l)F12

(m)F13

Figure 1: Radar-Chart for F1-F13 for 30 dimensions



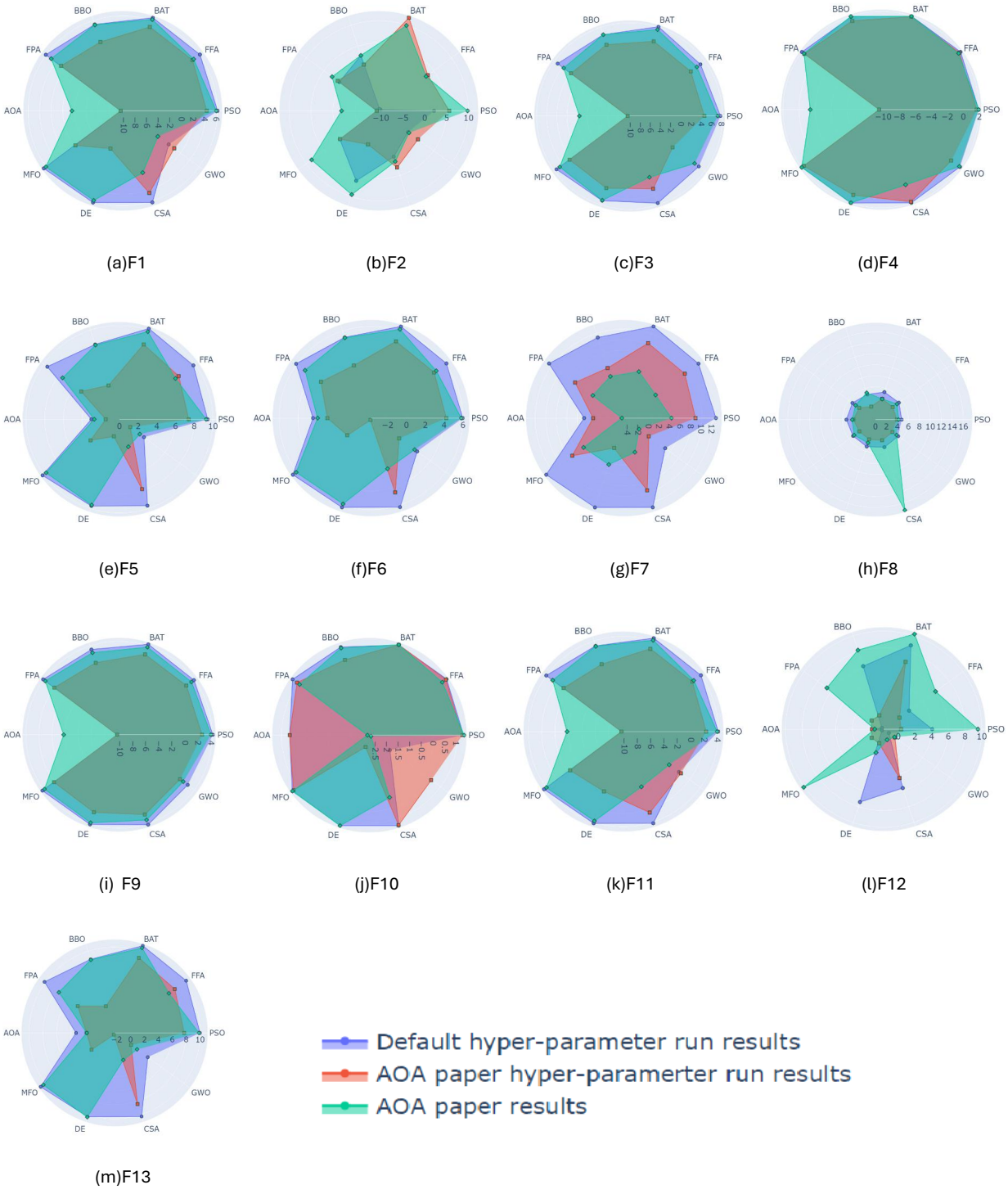
(a)F1 (b)F2 (c)F3 (d)F4

(e)F5 (f)F6 (g)F7 (h)F8

(i) F9 (j)F10 (k)F11 (l)F12

(m)F13

Figure 2: Radar-Chart for F1-F13 for 100 dimensions



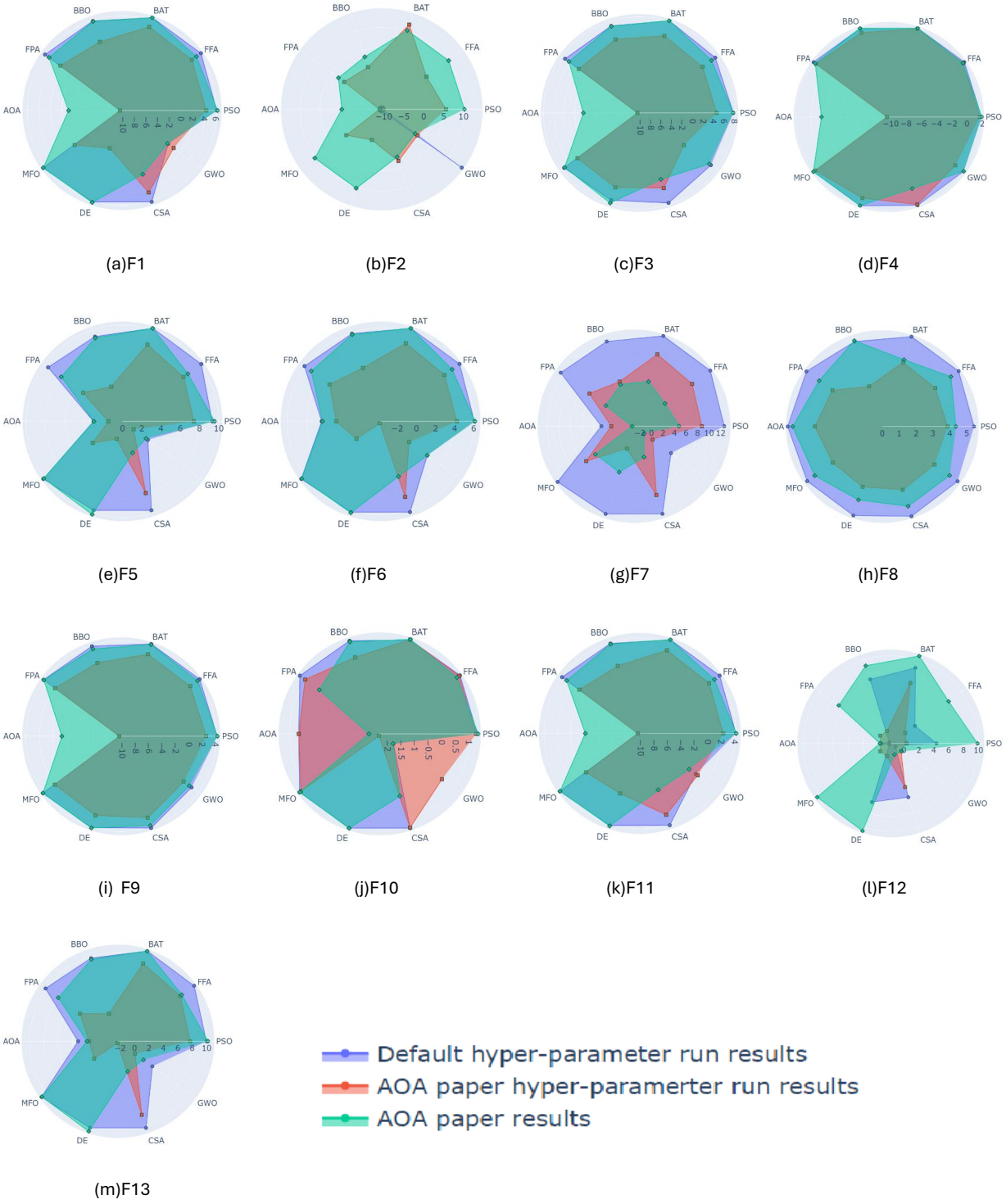
(a)F1 (b)F2 (c)F3 (d)F4

(e)F5 (f)F6 (g)F7 (h)F8

(i) F9 (j)F10 (k)F11 (l)F12

(m)F13

Figure 3: Radar-Chart for F1-F13 for 500 dimensions



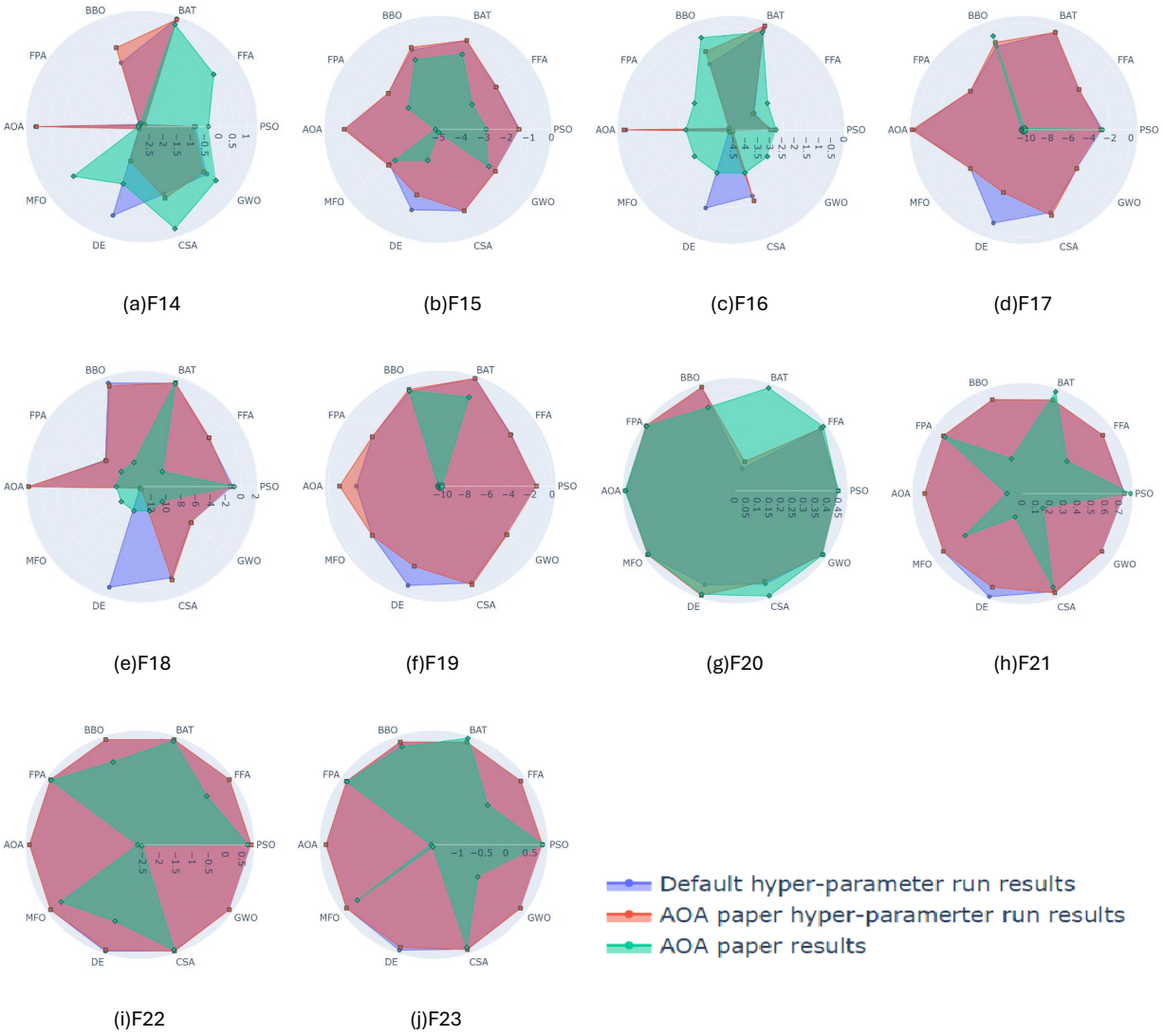
(a)F1 (b)F2 (c)F3 (d)F4

(e)F5 (f)F6 (g)F7 (h)F8

(i) F9 (j)F10 (k)F11 (l)F12

(m)F13

Figure 4: Radar-Chart for F1-F13 for 1000 dimensions

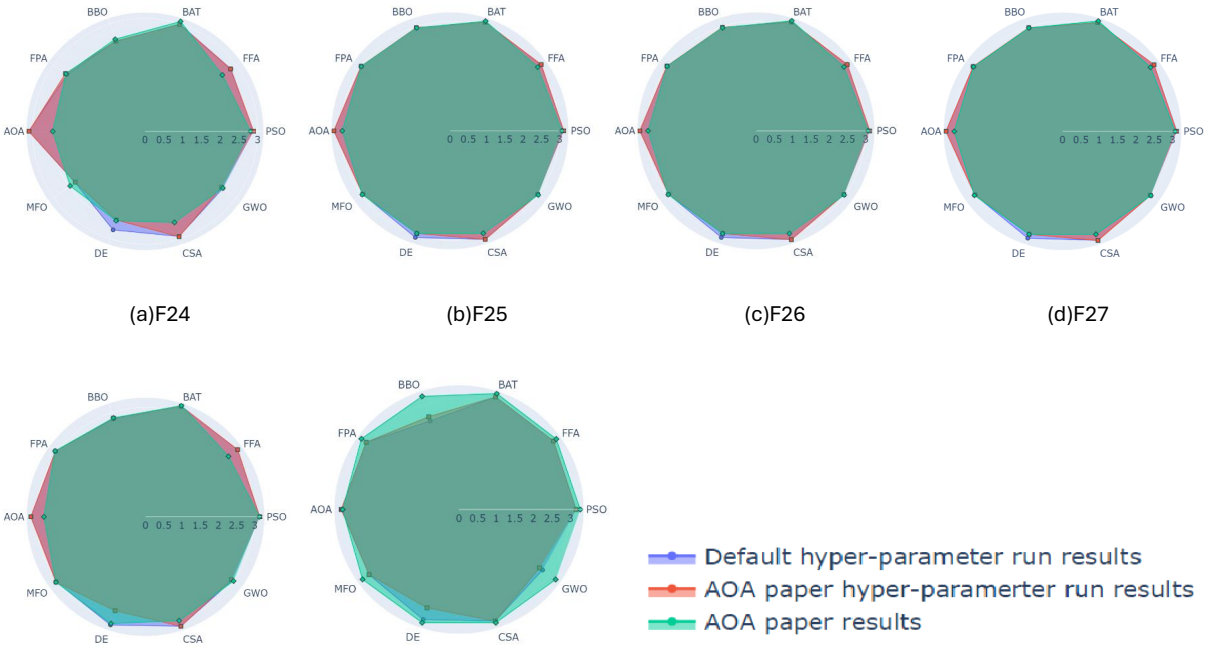


(a)F14 (b)F15 (c)F16 (d)F17

(e)F18 (f)F19 (g)F20 (h)F21

(i)F22 (j)F23

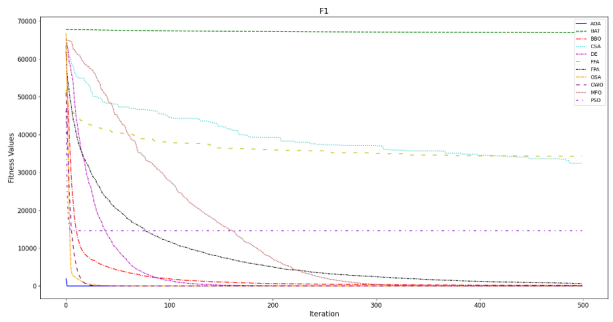
Figure 5: Radar-Chart for F14-F23



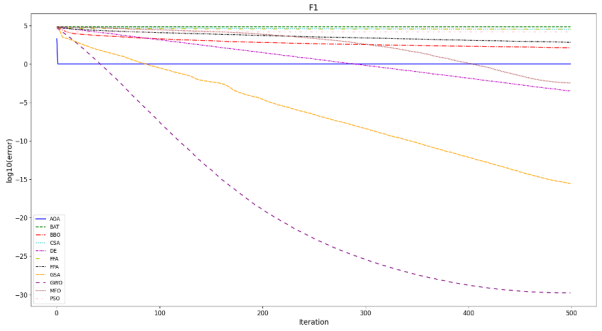
(a)F24 (b)F25 (c)F26 (d)F27

(i)F28 (j)F29

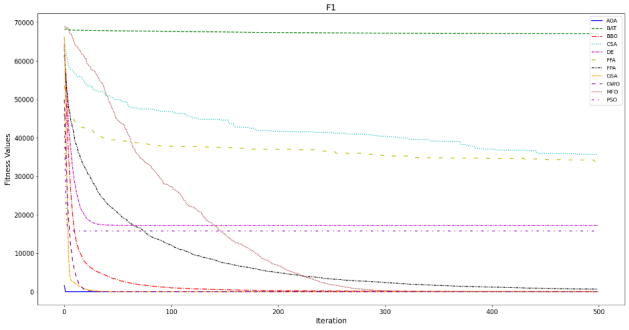
Figure 6: Radar-Chart for F24-F29



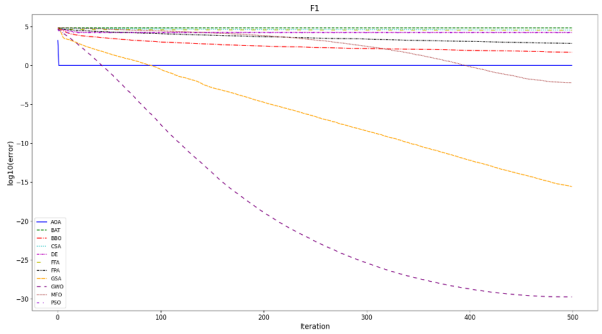
a) Fitness Value vs Iterations - AOA Hyper-parameters



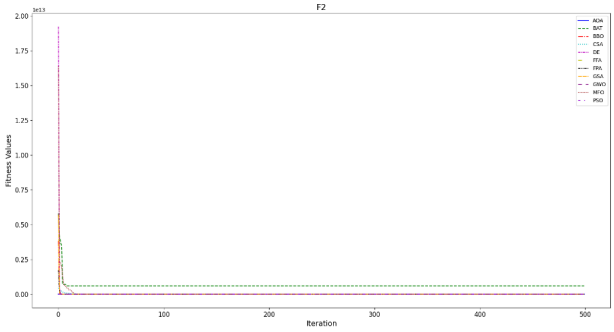
b) Error vs Iterations – AOA Hyper-parameters



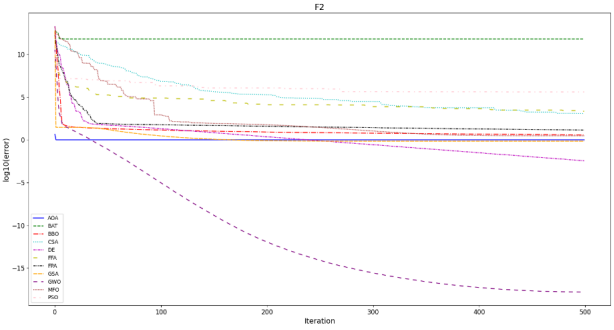
c) Fitness Value vs Iterations - Default Hyper-parameters



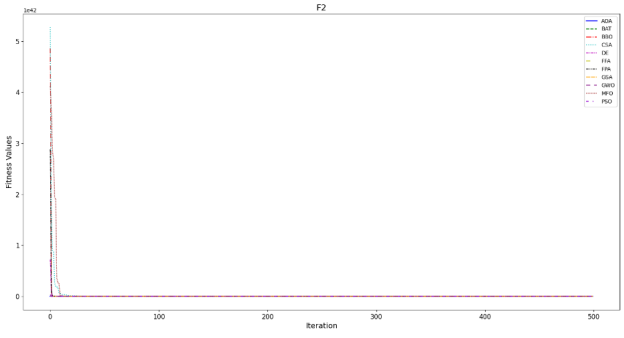
d) Error vs Iterations – Default Hyper-parameters



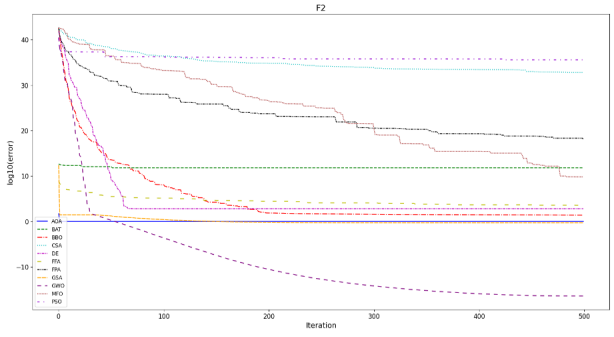
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

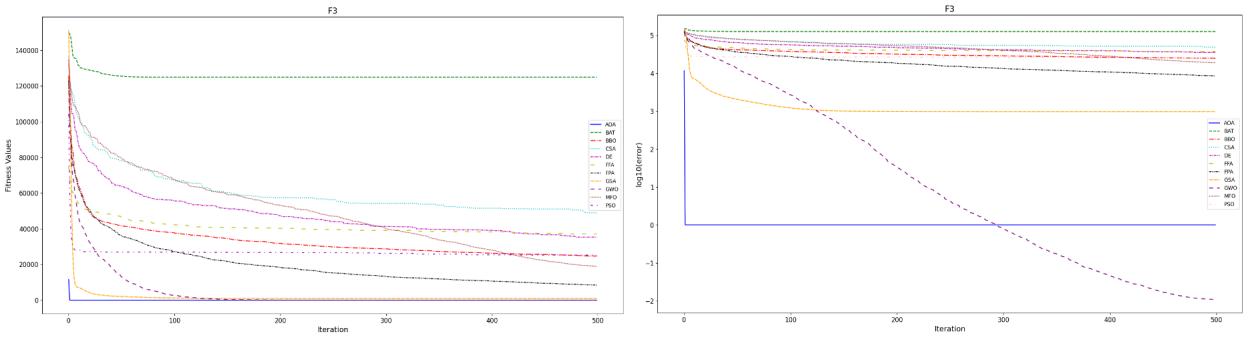


g) Fitness Value vs Iterations - Default Hyper-parameters



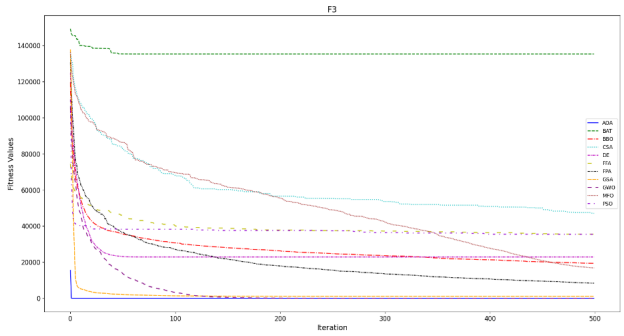
h) Error vs Iterations – Default Hyper-parameters

Figure 7: Line-Chart for F1-F2 for 30 dimensions

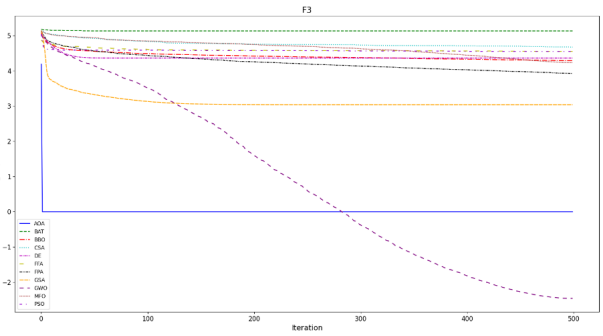


a) Fitness Value vs Iterations - AOA Hyper-parameters

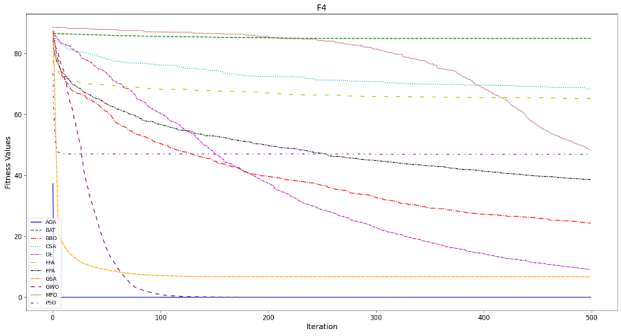
b) Error vs Iterations – AOA Hyper-parameters



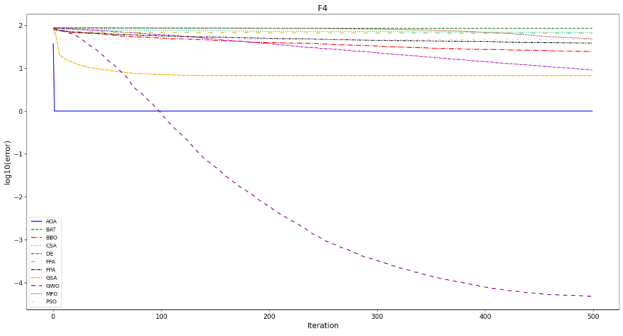
c) Fitness Value vs Iterations - Default Hyper-parameters



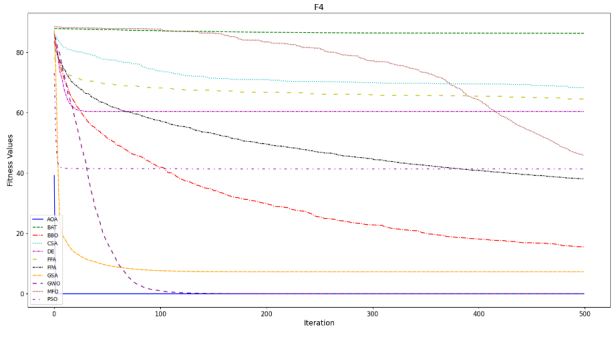
d) Error vs Iterations – Default Hyper-parameters



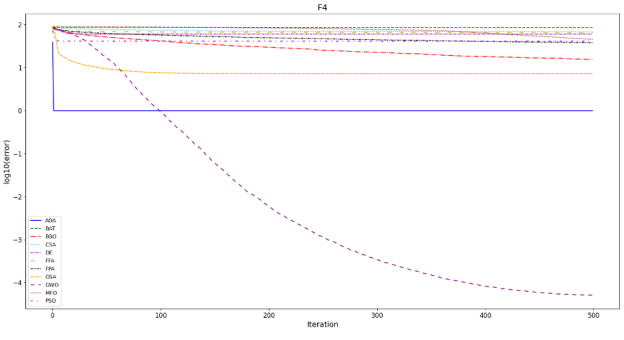
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

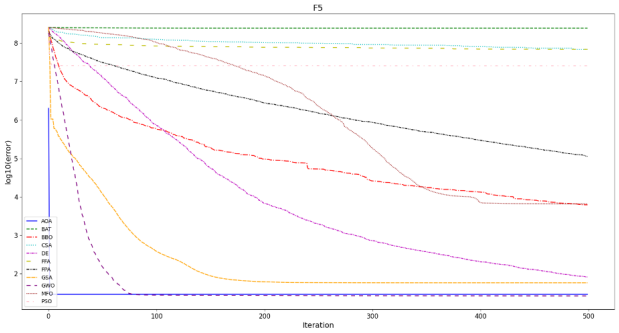


g) Fitness Value vs Iterations - Default Hyper-parameters

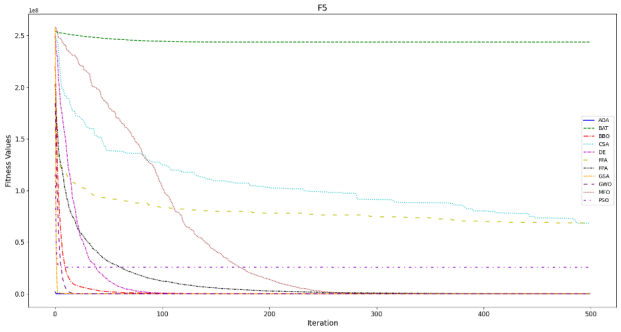


h) Error vs Iterations – Default Hyper-parameters

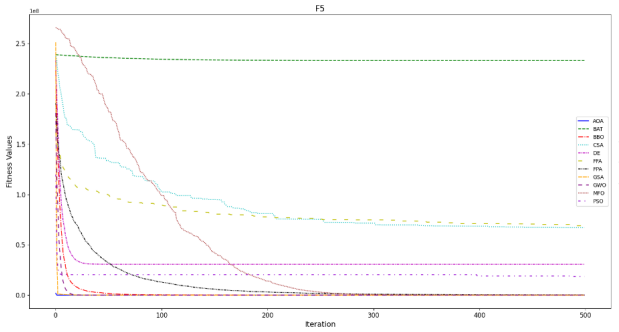
Figure 8: Line-Chart for F3-F4 for 30 dimensions



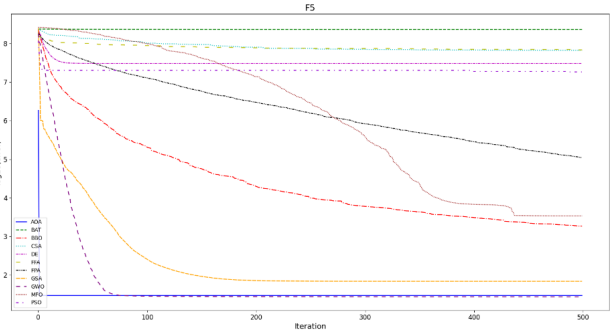
a) Fitness Value vs Iterations - AOA Hyper-parameters



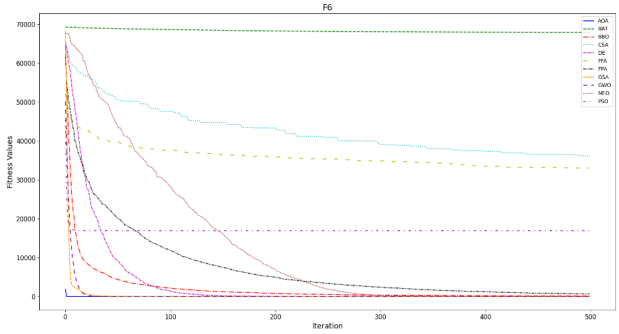
b) Error vs Iterations – AOA Hyper-parameters



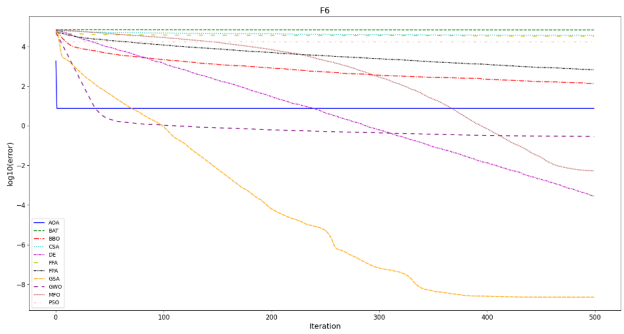
c) Fitness Value vs Iterations - Default Hyper-parameters



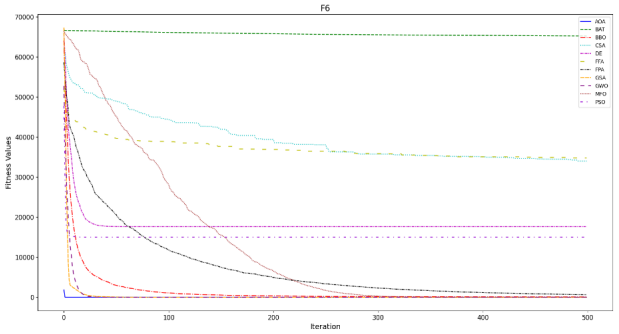
d) Error vs Iterations – Default Hyper-parameters



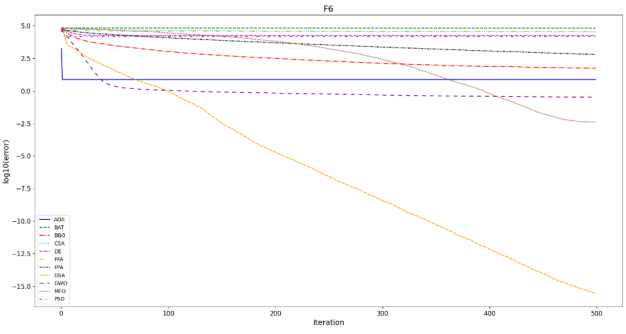
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

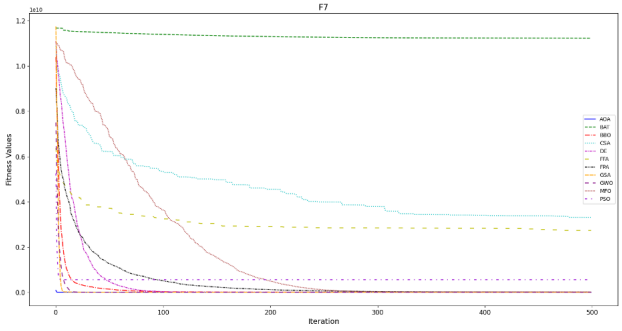


g) Fitness Value vs Iterations - Default Hyper-parameters

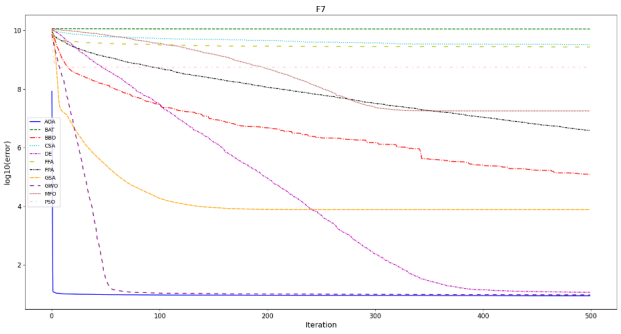


h) Error vs Iterations – Default Hyper-parameters

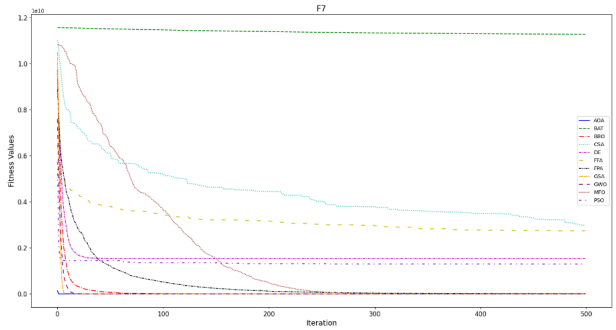
Figure 9: Line-Chart for F5-F6 for 30 dimensions



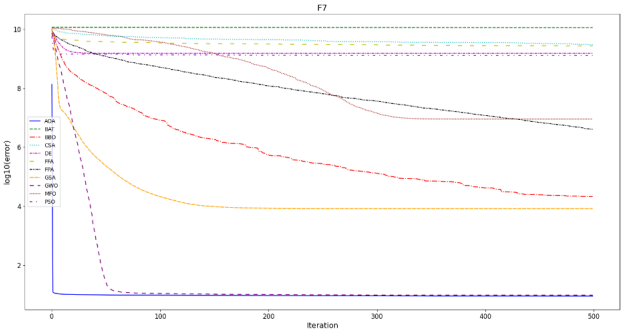
a) Fitness Value vs Iterations - AOA Hyper-parameters



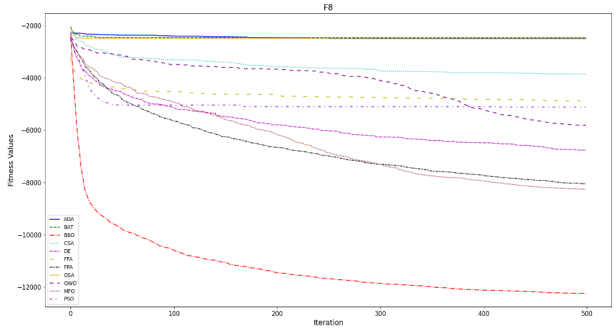
b) Error vs Iterations – AOA Hyper-parameters



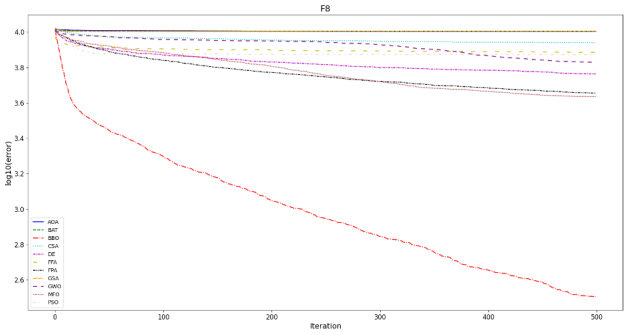
c) Fitness Value vs Iterations - Default Hyper-parameters



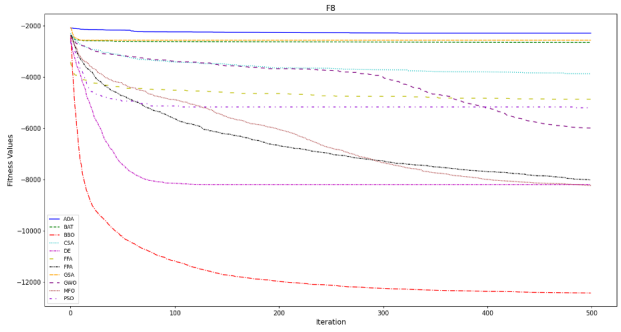
d) Error vs Iterations – Default Hyper-parameters



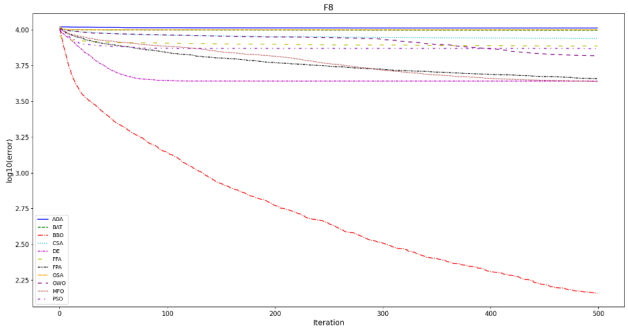
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

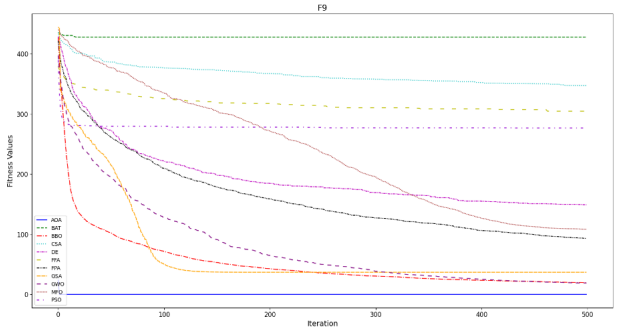


g) Fitness Value vs Iterations - Default Hyper-parameters

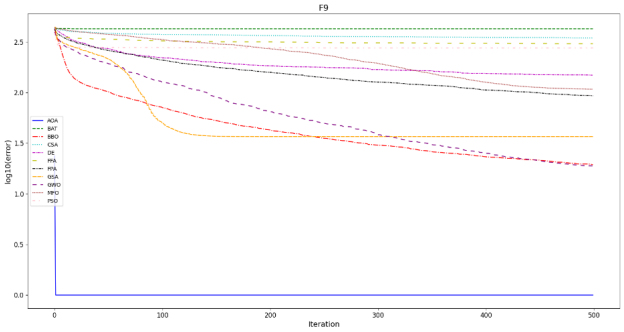


h) Error vs Iterations – Default Hyper-parameters

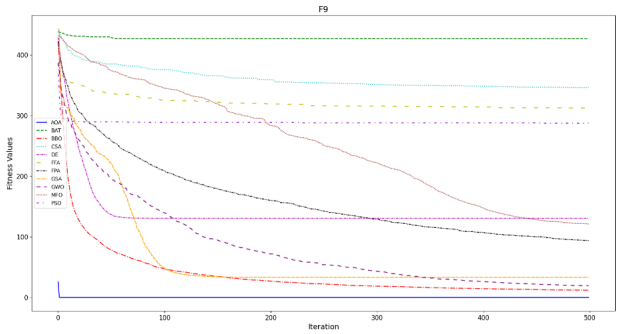
Figure 10: Line-Chart for F7-F8 for 30 dimensions



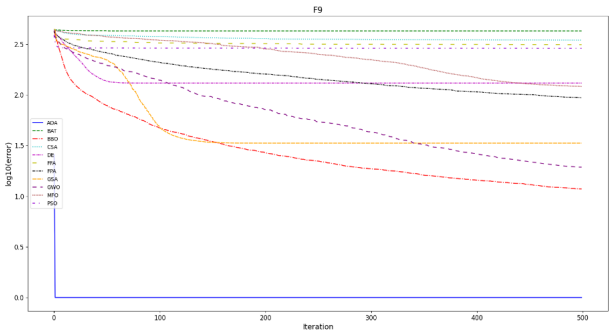
a) Fitness Value vs Iterations - AOA Hyper-parameters



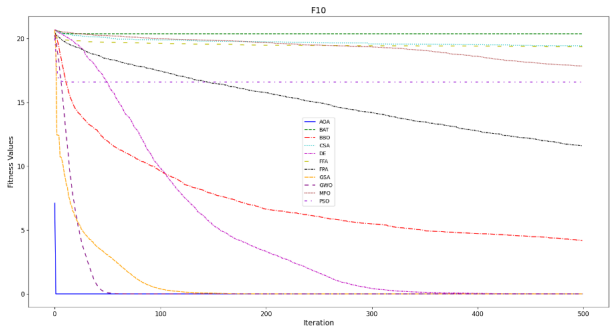
b) Error vs Iterations – AOA Hyper-parameters



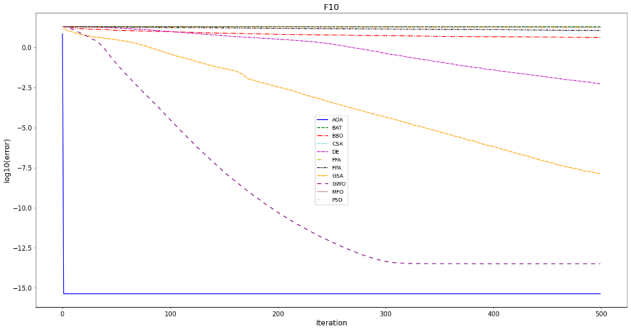
c) Fitness Value vs Iterations - Default Hyper-parameters



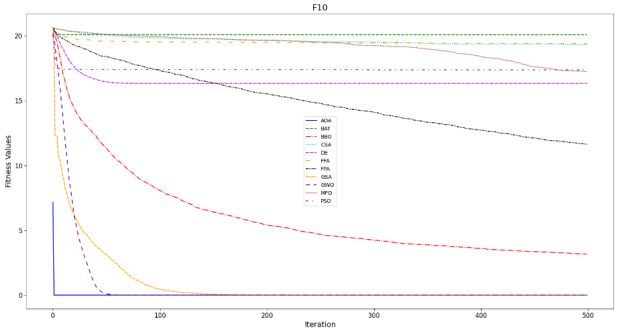
d) Error vs Iterations – Default Hyper-parameters



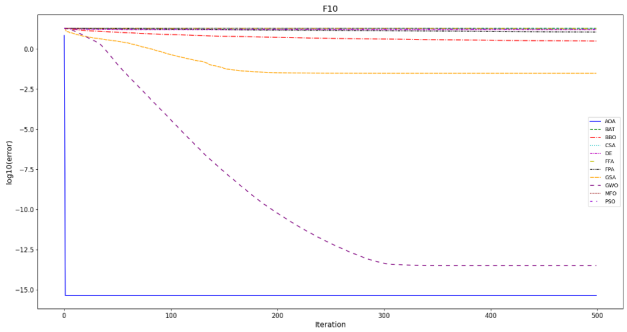
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

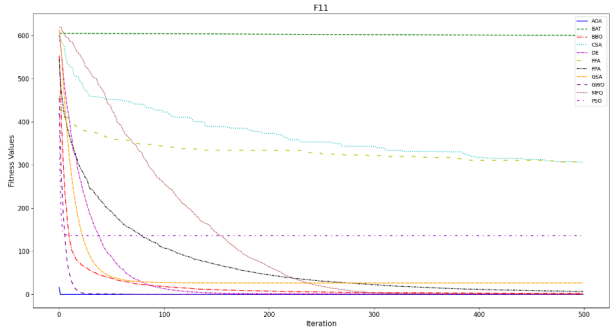


g) Fitness Value vs Iterations - Default Hyper-parameters

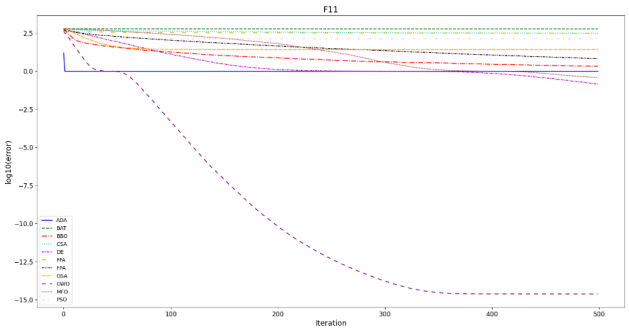


h) Error vs Iterations – Default Hyper-parameters

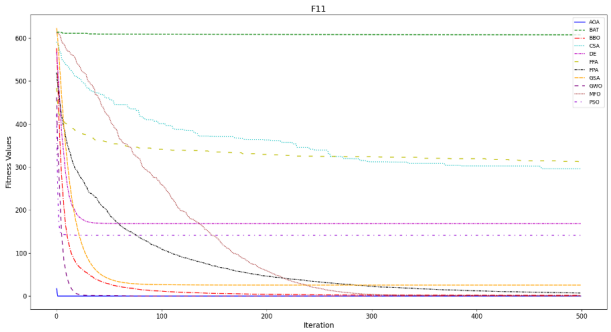
Figure 11: Line-Chart for F9-F10 for 30 dimensions



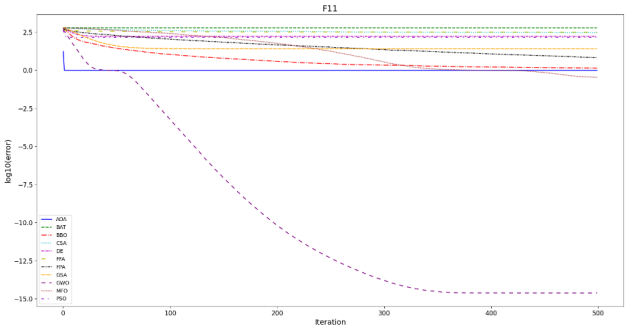
a) Fitness Value vs Iterations - AOA Hyper-parameters



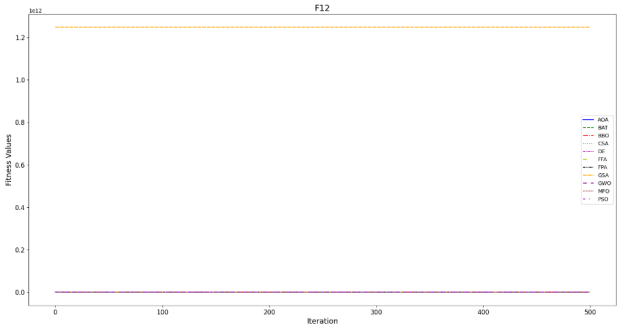
b) Error vs Iterations – AOA Hyper-parameters



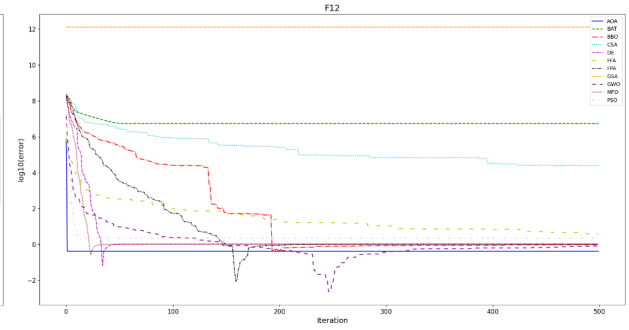
c) Fitness Value vs Iterations - Default Hyper-parameters



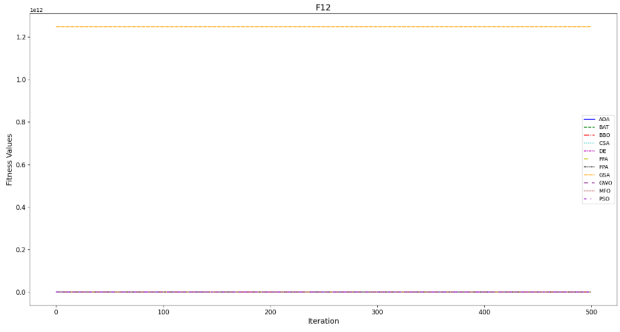
d) Error vs Iterations – Default Hyper-parameters



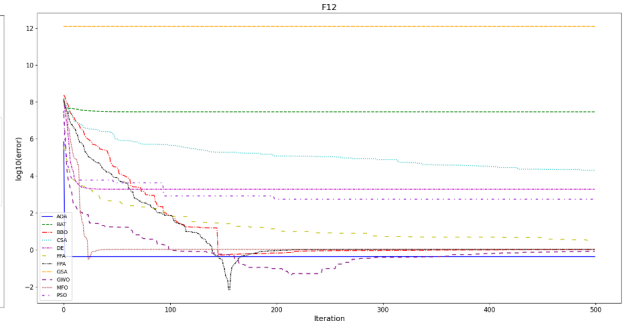
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

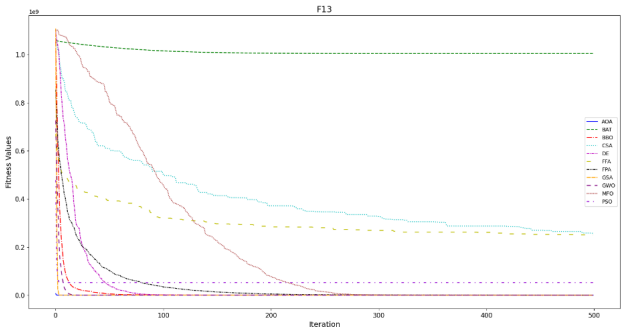


g) Fitness Value vs Iterations - Default Hyper-parameters

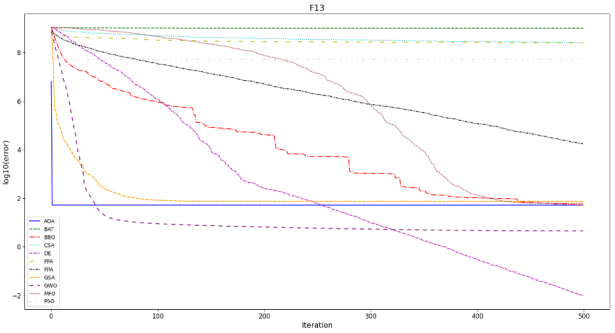


h) Error vs Iterations – Default Hyper-parameters

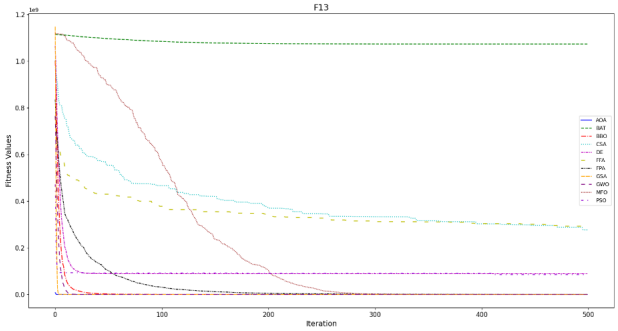
Figure 12: Line-Chart for F11-F12 for 30 dimensions



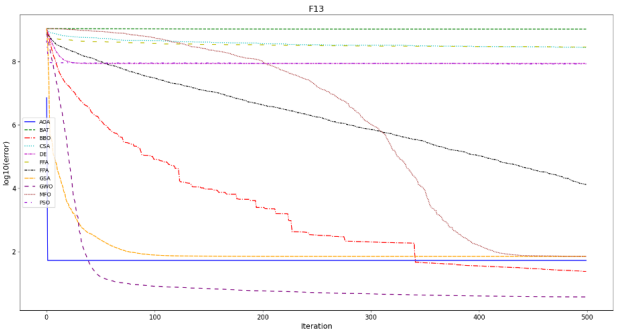
a) Fitness Value vs Iterations - AOA Hyper-parameters



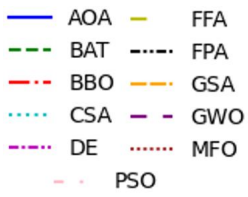
b) Error vs Iterations – AOA Hyper-parameters



c) Fitness Value vs Iterations - Default Hyper-parameters

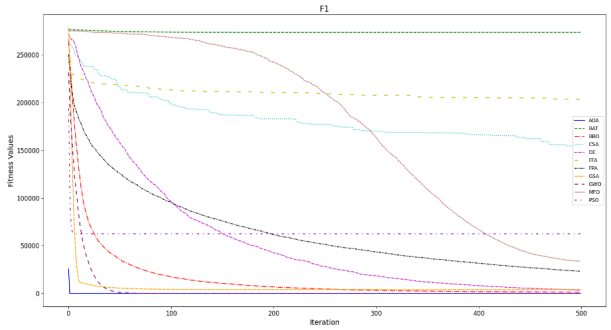


d) Error vs Iterations – Default Hyper-parameters

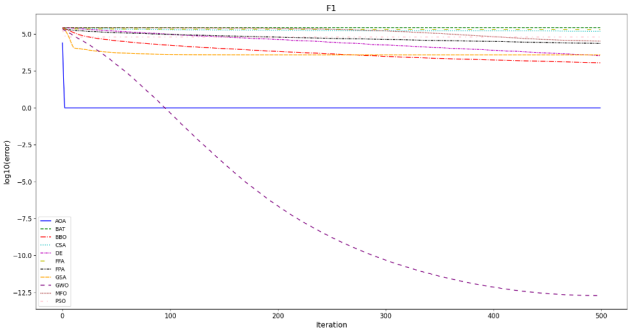


e) Legend

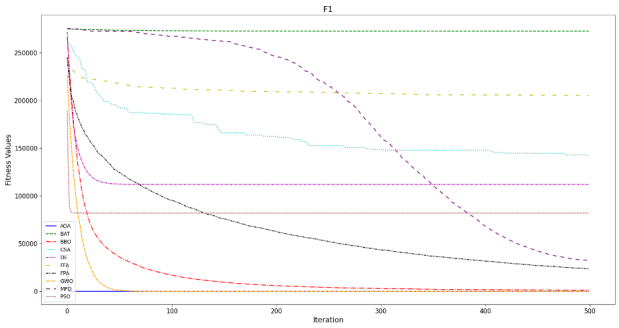
Figure 13: Line-Chart for F13 for 30 dimensions



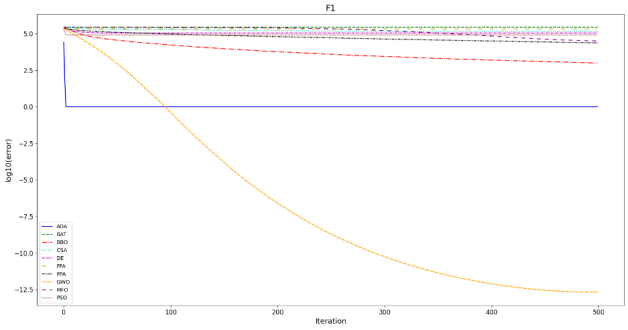
a) Fitness Value vs Iterations - AOA Hyper-parameters



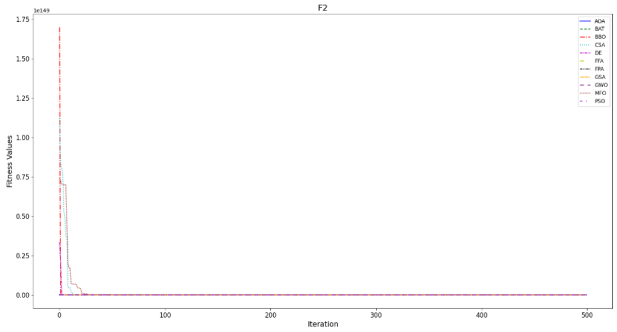
b) Error vs Iterations – AOA Hyper-parameters



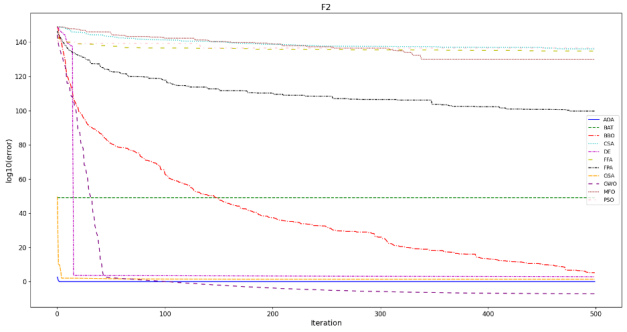
c) Fitness Value vs Iterations - Default Hyper-parameters



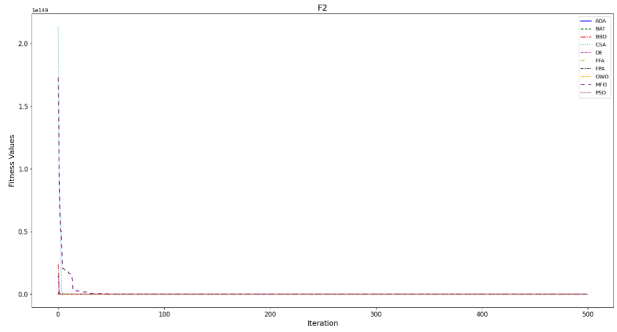
d) Error vs Iterations – Default Hyper-parameters



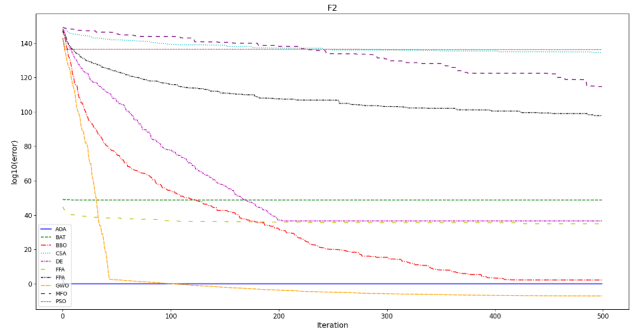
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

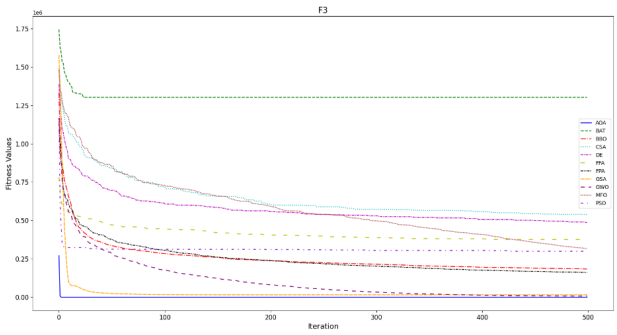


g) Fitness Value vs Iterations - Default Hyper-parameters

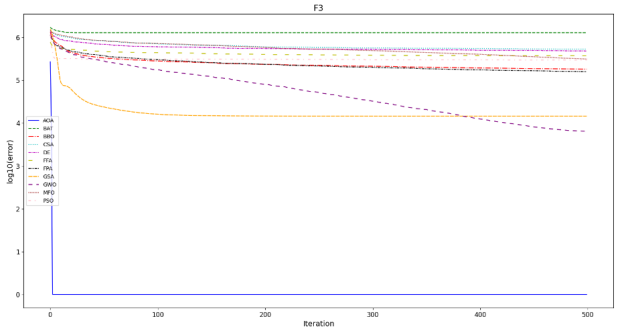


h) Error vs Iterations – Default Hyper-parameters

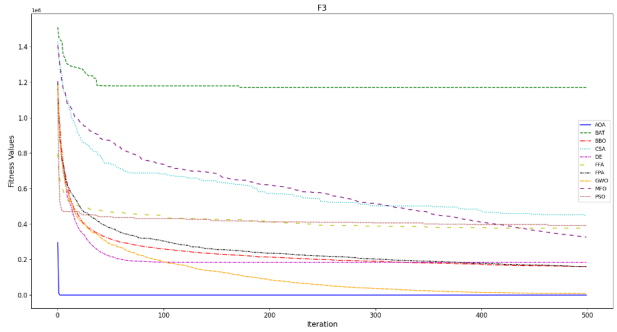
Figure 14: Line-Chart for F1-F2 for 100 dimensions



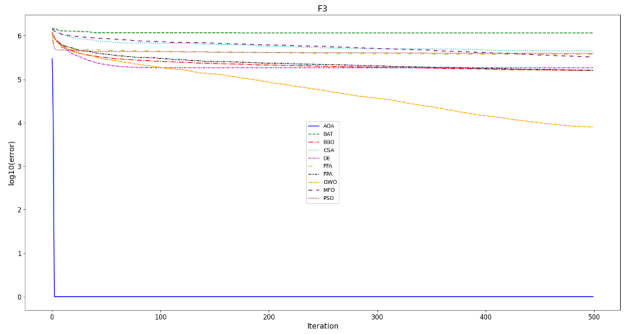
a) Fitness Value vs Iterations - AOA Hyper-parameters



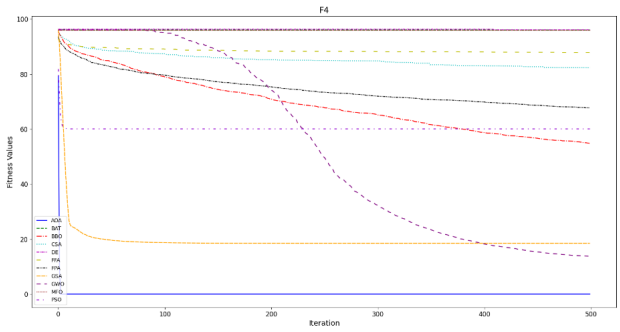
b) Error vs Iterations – AOA Hyper-parameters



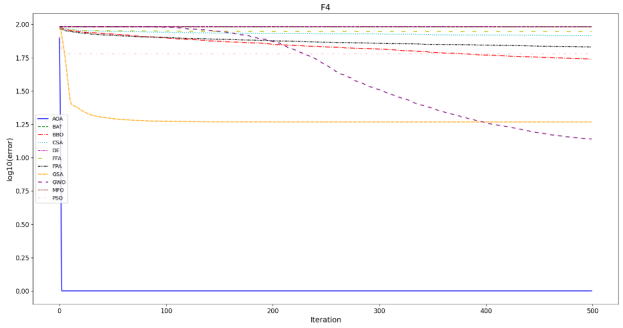
c) Fitness Value vs Iterations - Default Hyper-parameters



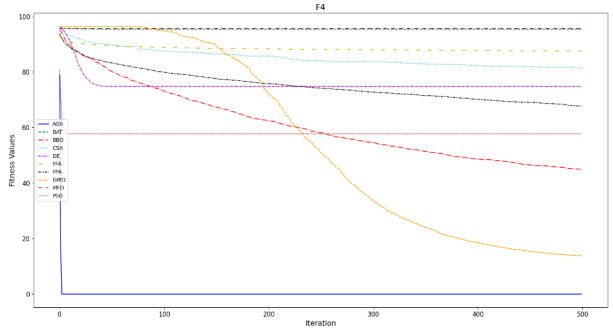
d) Error vs Iterations – Default Hyper-parameters



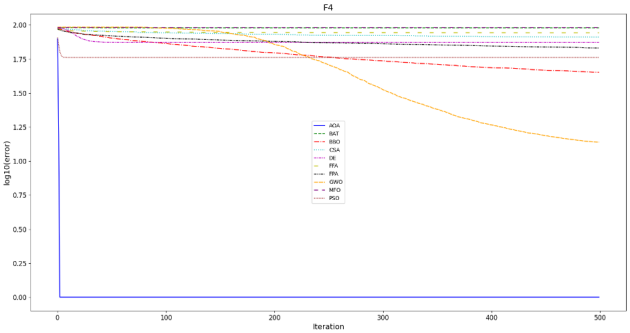
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

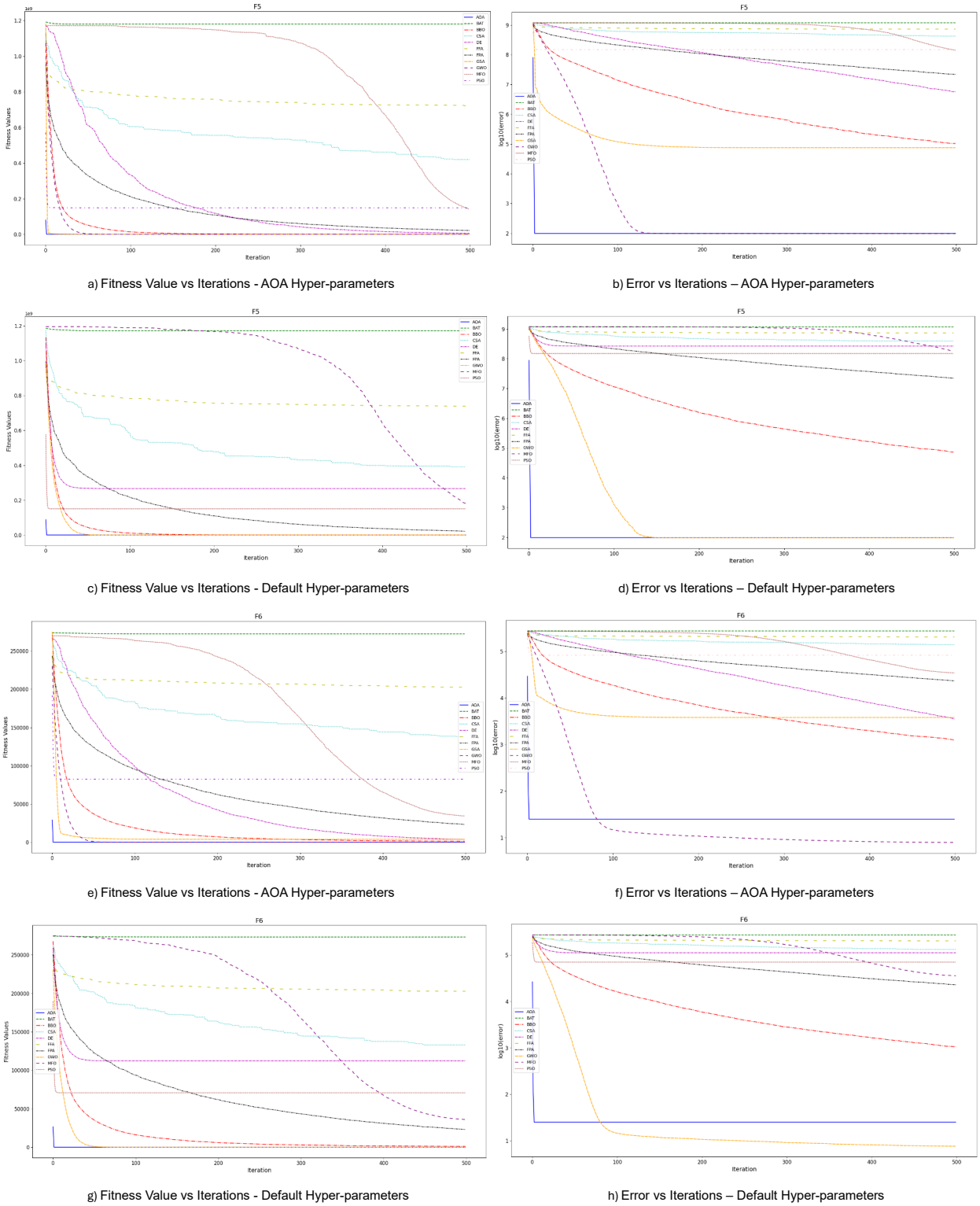


g) Fitness Value vs Iterations - Default Hyper-parameters



h) Error vs Iterations – Default Hyper-parameters

Figure 15: Line-Chart for F3-F4 for 100 dimensions



a) Fitness Value vs Iterations - AOA Hyper-parameters

b) Error vs Iterations – AOA Hyper-parameters

c) Fitness Value vs Iterations - Default Hyper-parameters

d) Error vs Iterations – Default Hyper-parameters

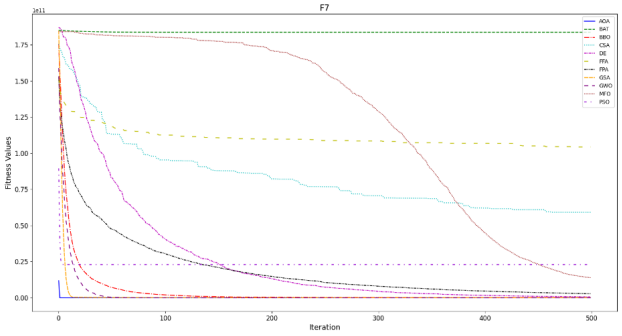
e) Fitness Value vs Iterations - AOA Hyper-parameters

f) Error vs Iterations – AOA Hyper-parameters

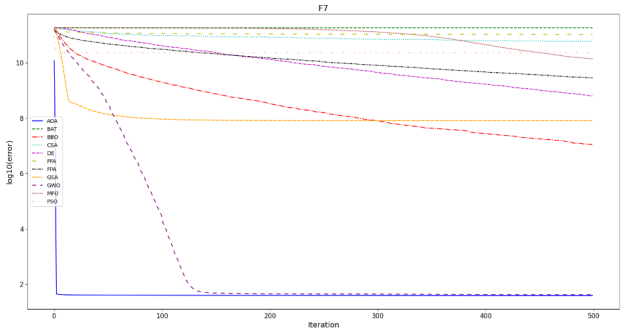
g) Fitness Value vs Iterations - Default Hyper-parameters

h) Error vs Iterations – Default Hyper-parameters

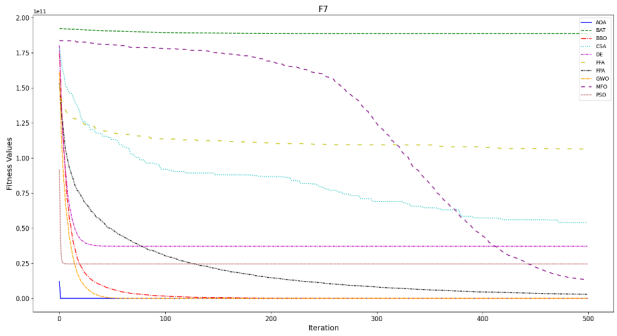
Figure 16: Line-Chart for F5-F6 for 100 dimensions



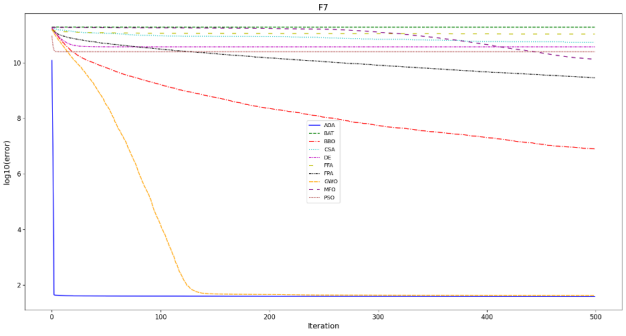
a) Fitness Value vs Iterations - AOA Hyper-parameters



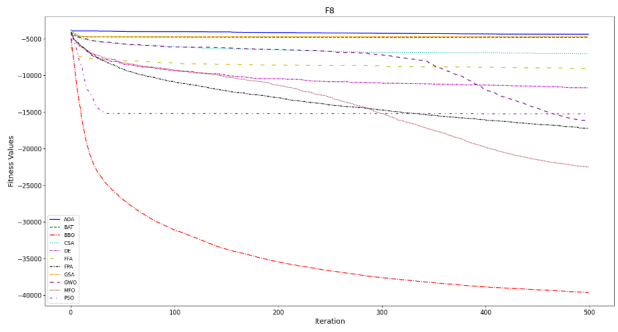
b) Error vs Iterations – AOA Hyper-parameters



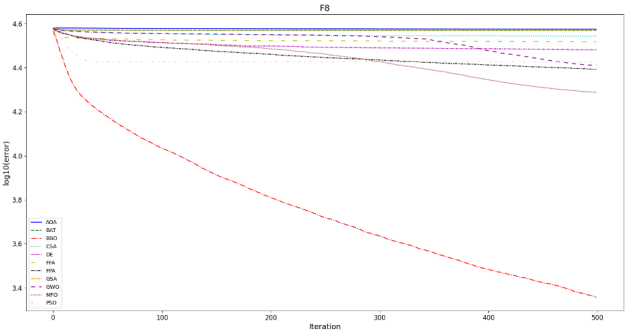
c) Fitness Value vs Iterations - Default Hyper-parameters



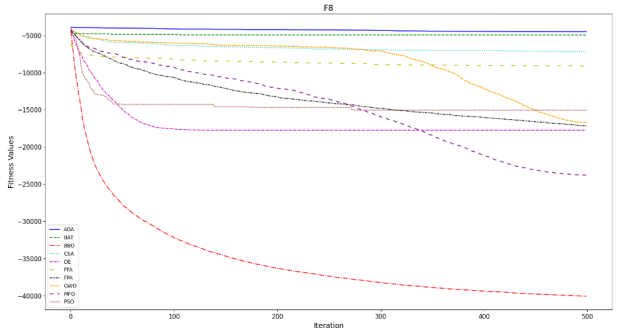
d) Error vs Iterations – Default Hyper-parameters



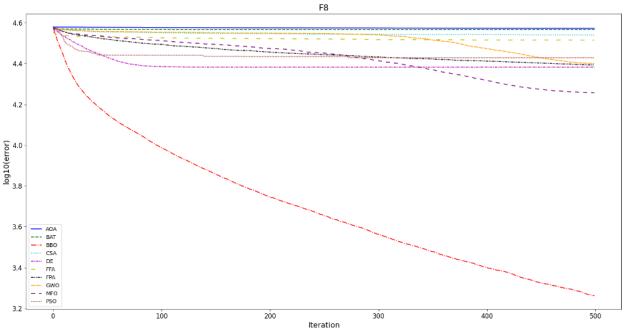
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

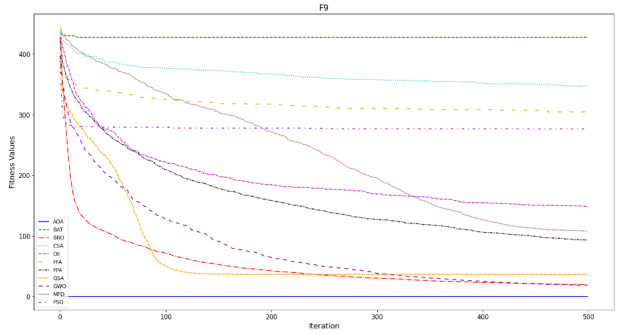


g) Fitness Value vs Iterations - Default Hyper-parameters

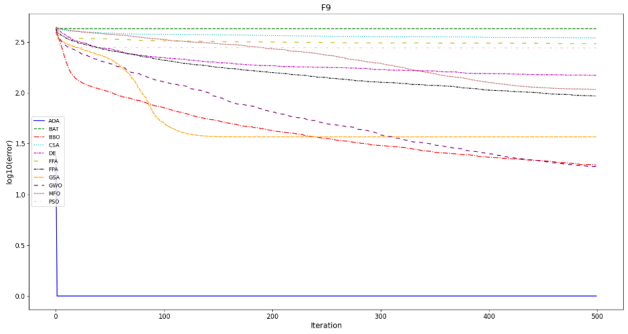


h) Error vs Iterations – Default Hyper-parameters

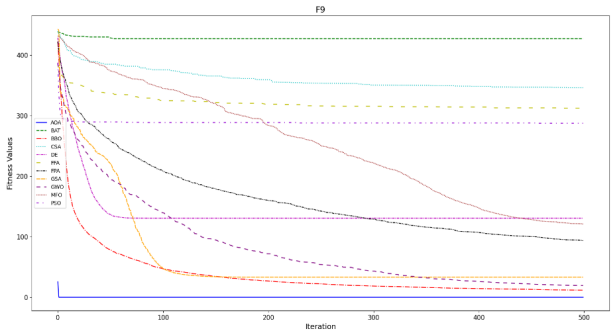
Figure 17: Line-Chart for F7-F8 for 100 dimensions



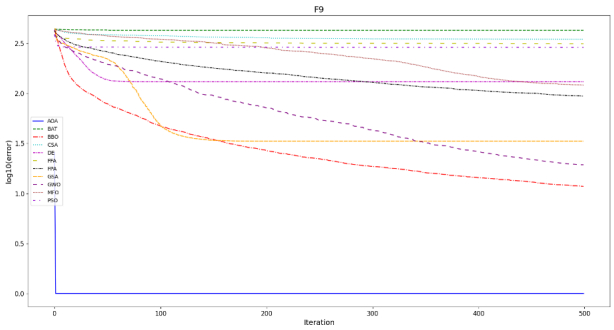
a) Fitness Value vs Iterations - AOA Hyper-parameters



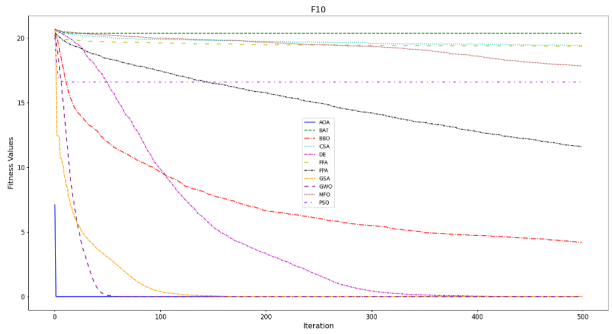
b) Error vs Iterations – AOA Hyper-parameters



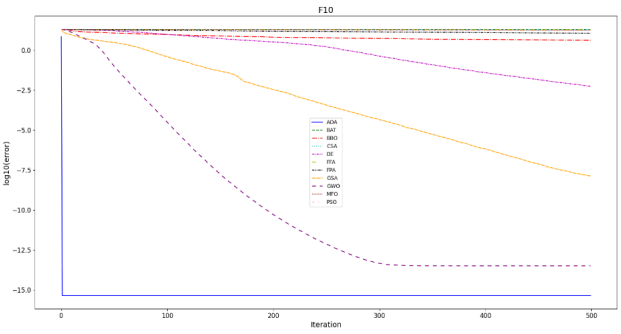
c) Fitness Value vs Iterations - Default Hyper-parameters



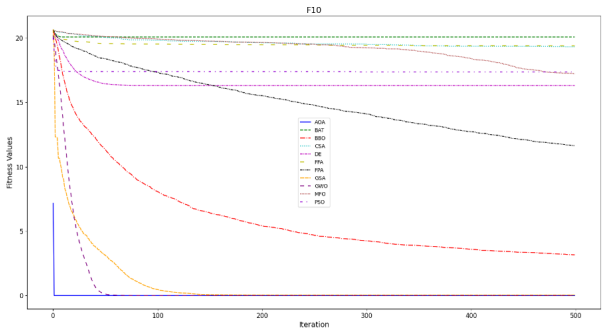
d) Error vs Iterations – Default Hyper-parameters



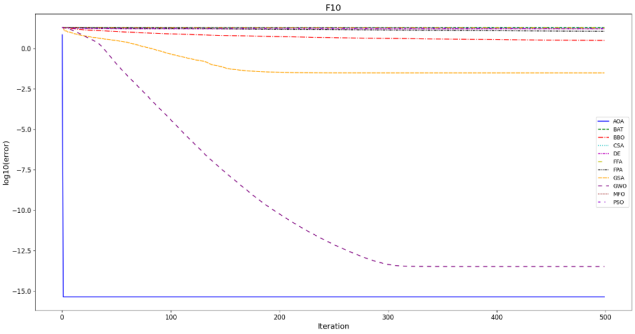
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

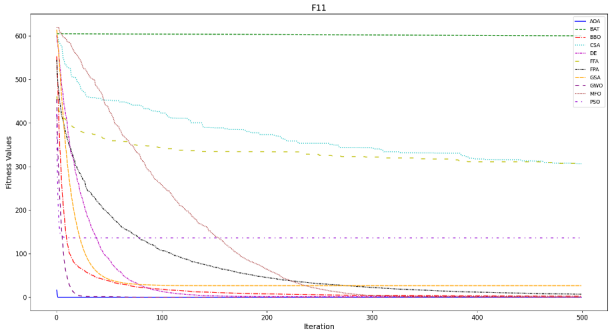


g) Fitness Value vs Iterations - Default Hyper-parameters

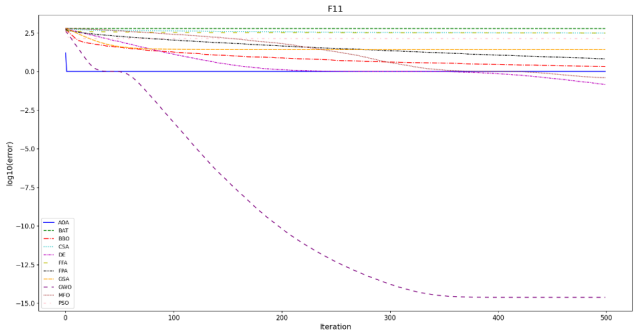


h) Error vs Iterations – Default Hyper-parameters

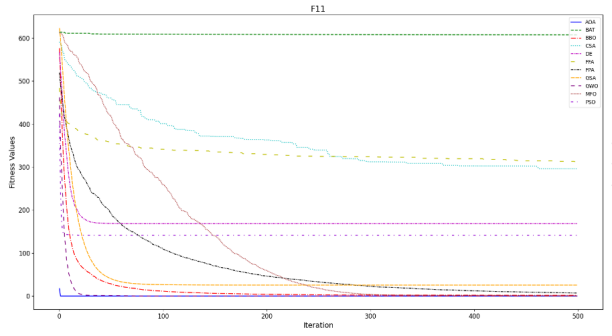
Figure 18: Line-Chart for F9-F10 for 100 dimensions



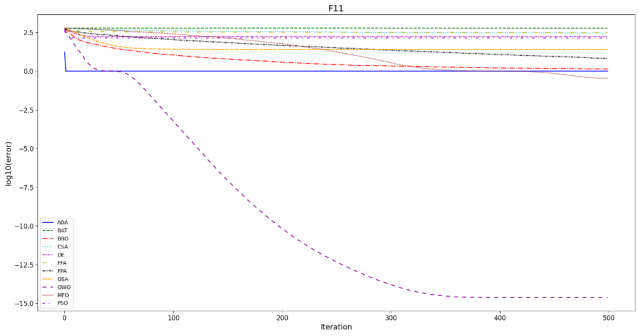
a) Fitness Value vs Iterations - AOA Hyper-parameters



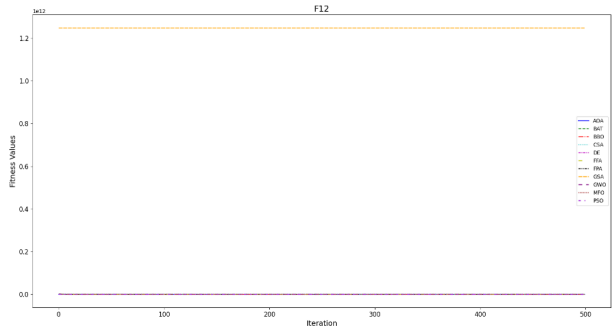
b) Error vs Iterations – AOA Hyper-parameters



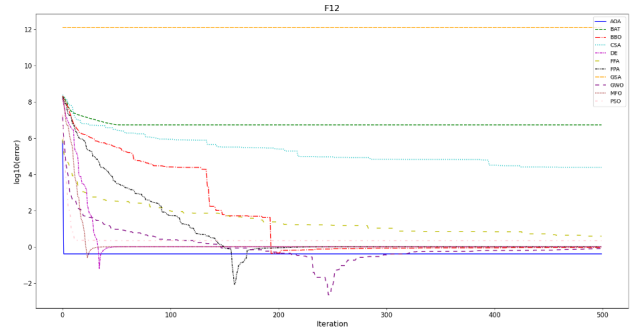
c) Fitness Value vs Iterations - Default Hyper-parameters



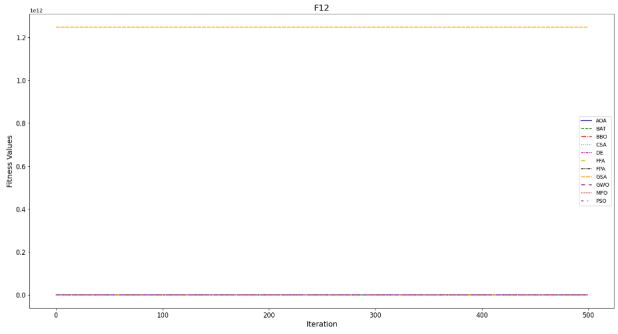
d) Error vs Iterations – Default Hyper-parameters



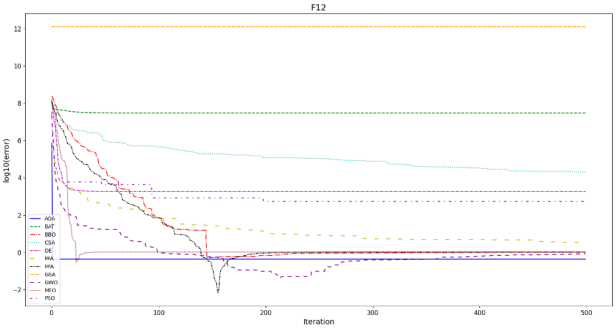
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

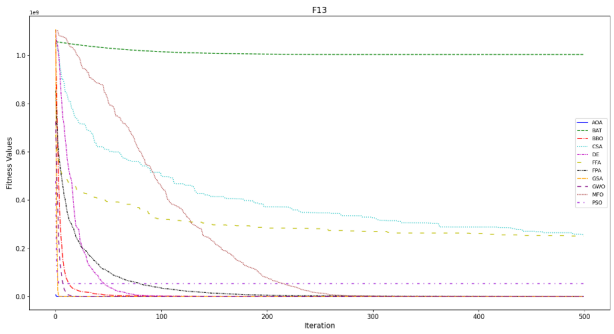


g) Fitness Value vs Iterations - Default Hyper-parameters

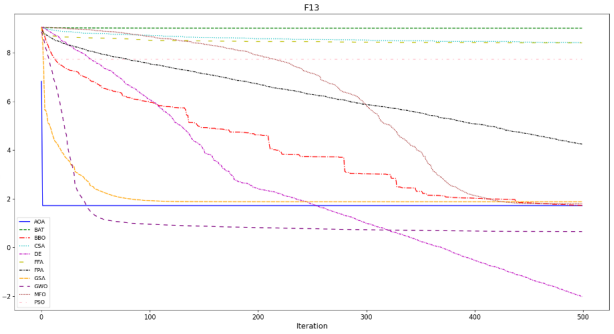


h) Error vs Iterations – Default Hyper-parameters

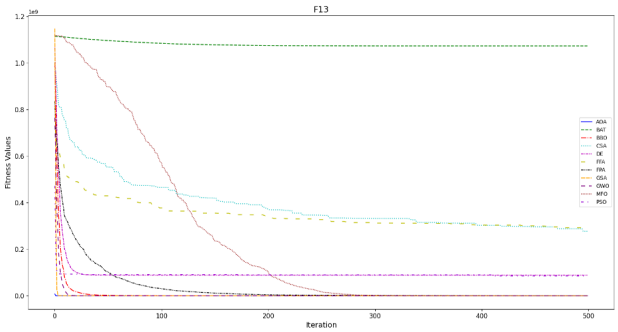
Figure 19: Line-Chart for F11-F12 for 100 dimensions



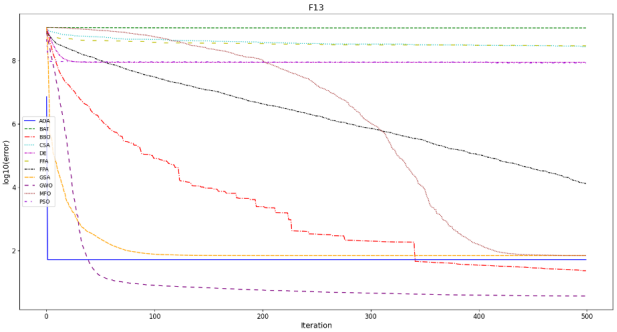
a) Fitness Value vs Iterations - AOA Hyper-parameters



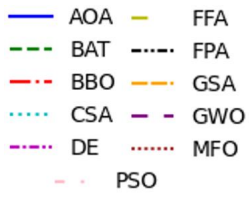
b) Error vs Iterations – AOA Hyper-parameters



c) Fitness Value vs Iterations - Default Hyper-parameters

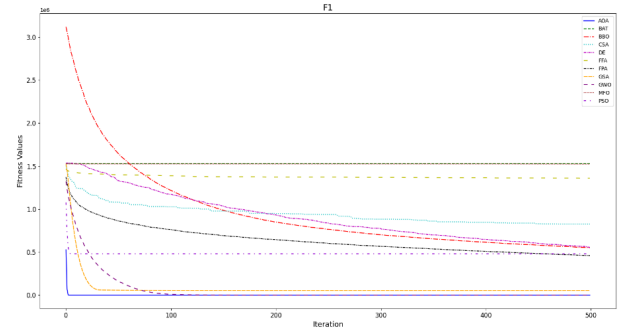


d) Error vs Iterations – Default Hyper-parameters

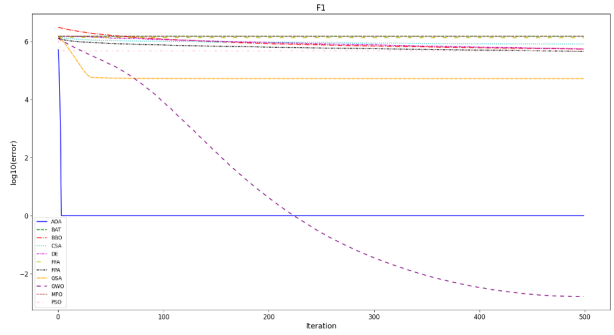


e) Legend

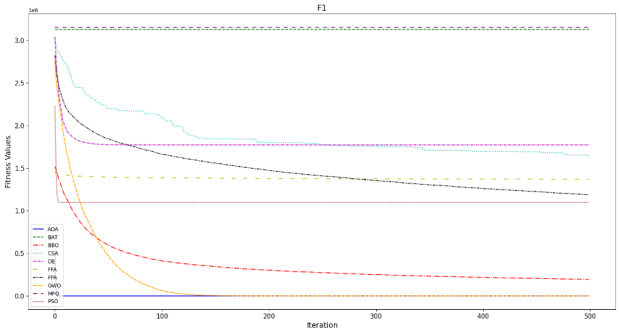
Figure 20: Line-Chart for F13 for 100 dimensions



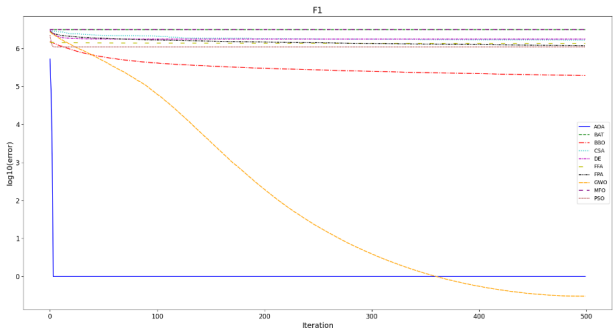
a) Fitness Value vs Iterations - AOA Hyper-parameters



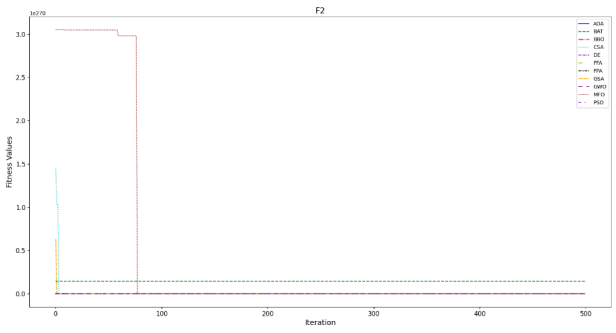
b) Error vs Iterations – AOA Hyper-parameters



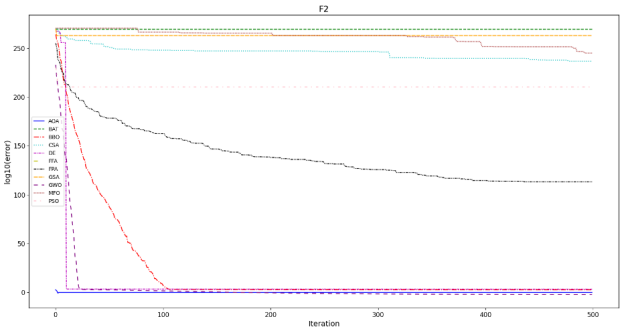
c) Fitness Value vs Iterations - Default Hyper-parameters



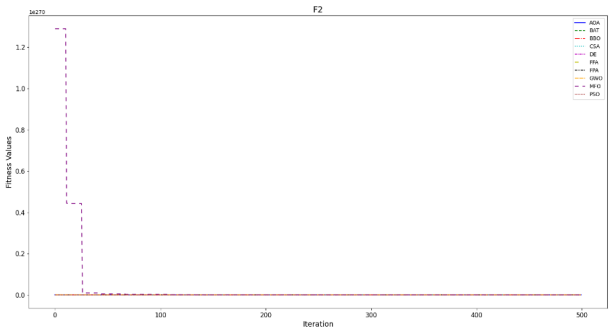
d) Error vs Iterations – Default Hyper-parameters



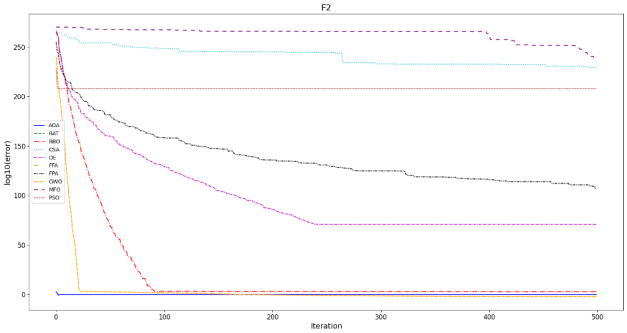
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

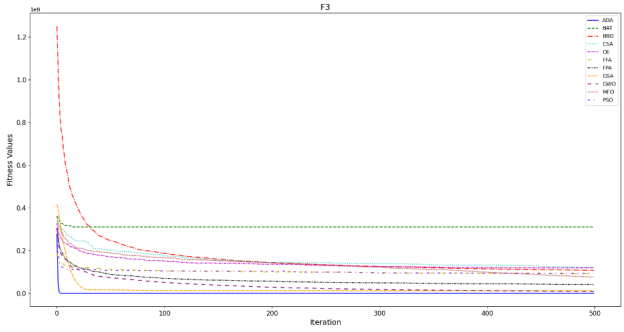


g) Fitness Value vs Iterations - Default Hyper-parameters

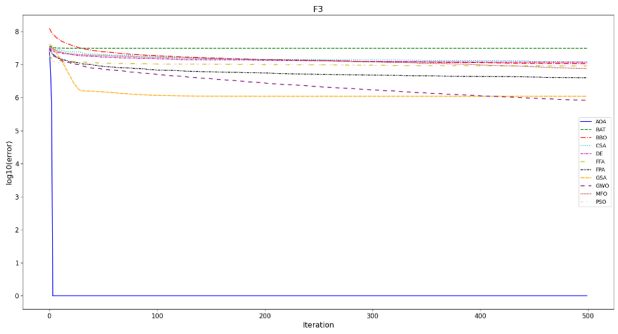


h) Error vs Iterations – Default Hyper-parameters

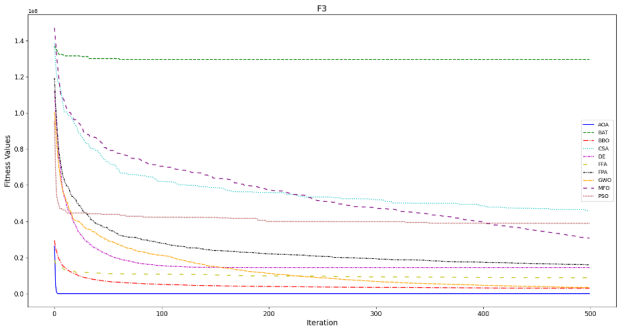
Figure 21: Line-Chart for F1-F2 for 500 dimensions



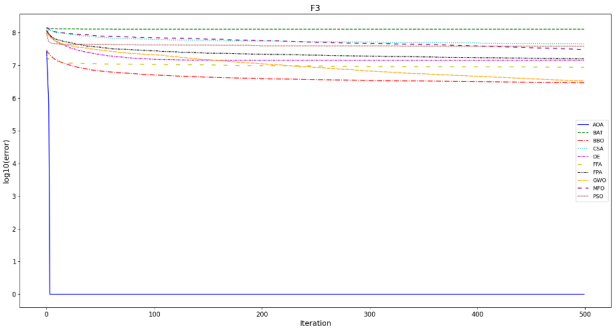
a) Fitness Value vs Iterations - AOA Hyper-parameters



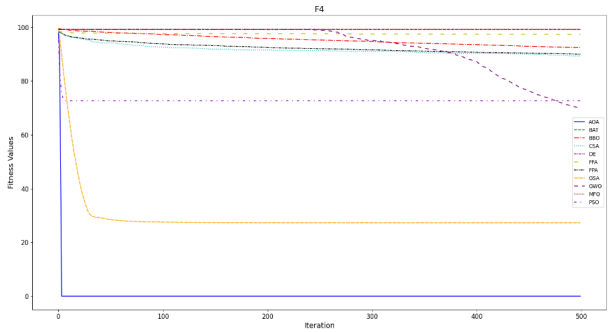
b) Error vs Iterations – AOA Hyper-parameters



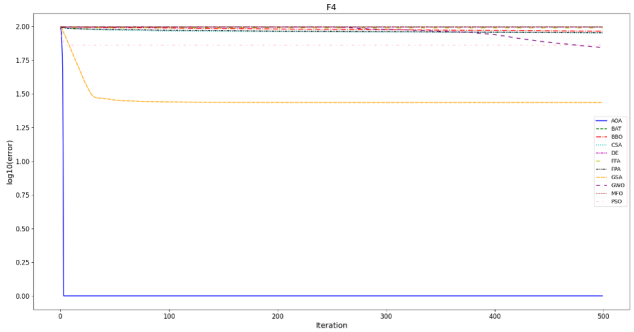
c) Fitness Value vs Iterations - Default Hyper-parameters



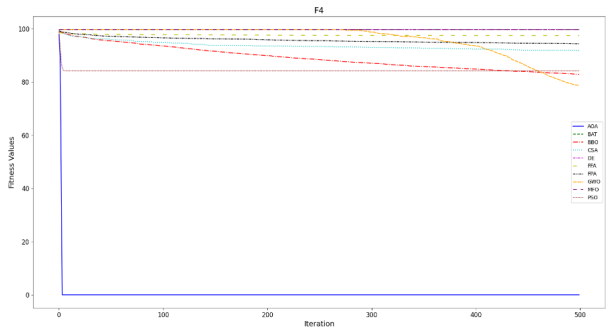
d) Error vs Iterations – Default Hyper-parameters



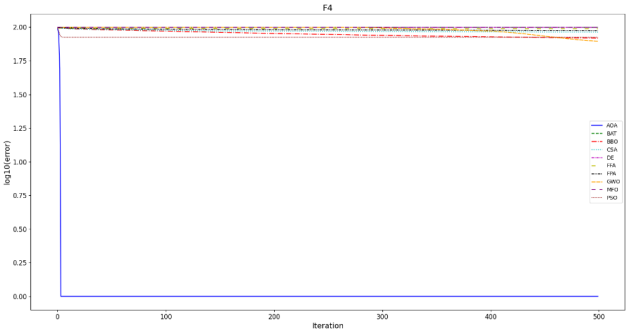
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

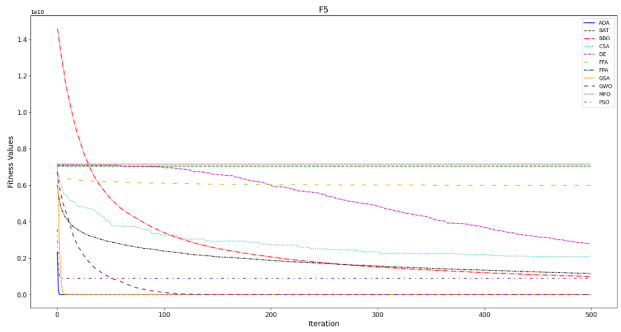


g) Fitness Value vs Iterations - Default Hyper-parameters

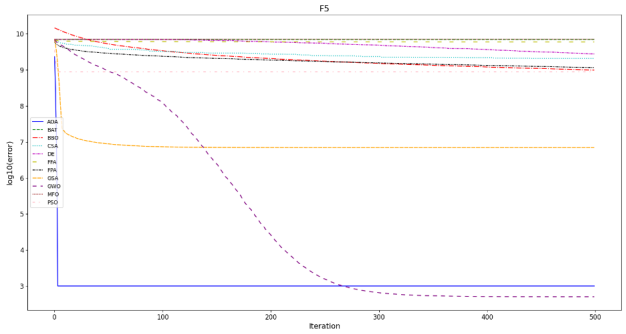


h) Error vs Iterations – Default Hyper-parameters

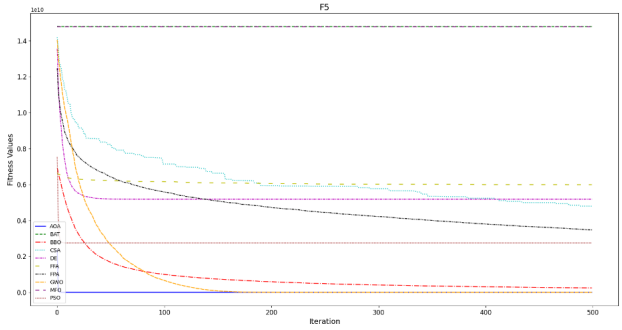
Figure 22: Line-Chart for F3-F4 for 500 dimensions



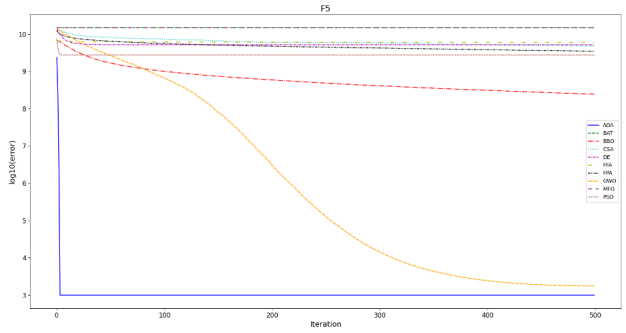
a) Fitness Value vs Iterations - AOA Hyper-parameters



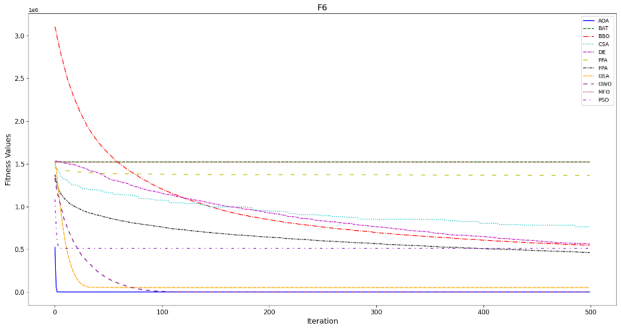
b) Error vs Iterations – AOA Hyper-parameters



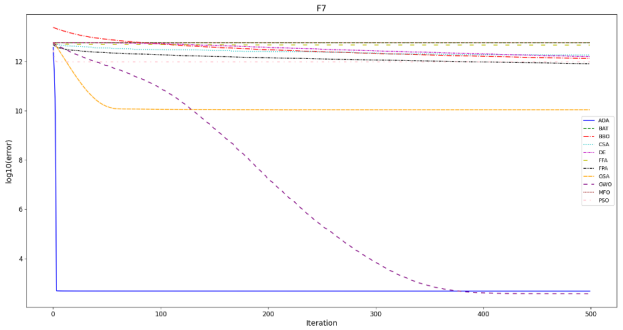
c) Fitness Value vs Iterations - Default Hyper-parameters



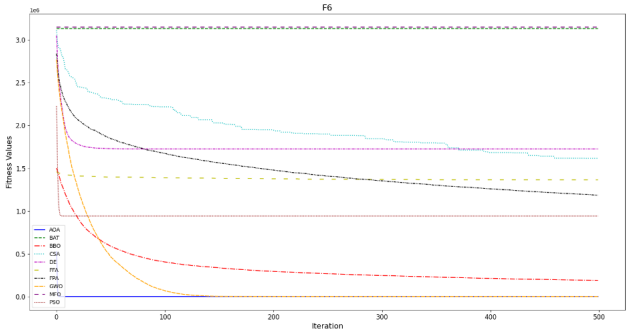
d) Error vs Iterations – Default Hyper-parameters



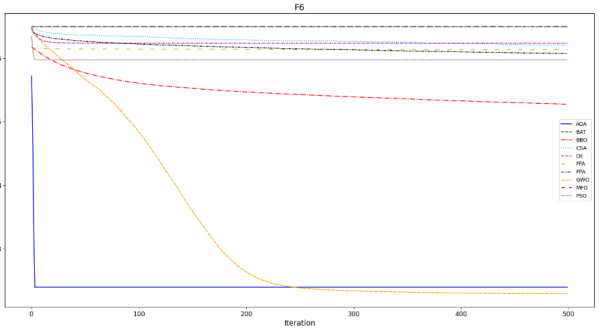
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

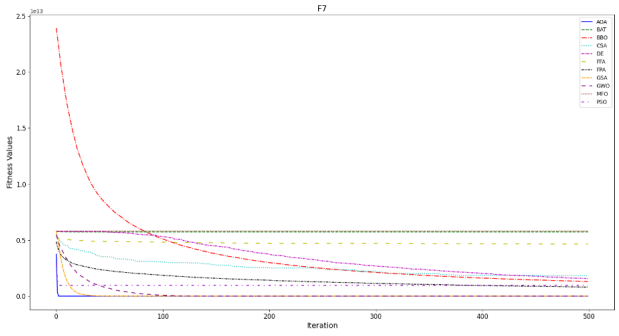


g) Fitness Value vs Iterations - Default Hyper-parameters

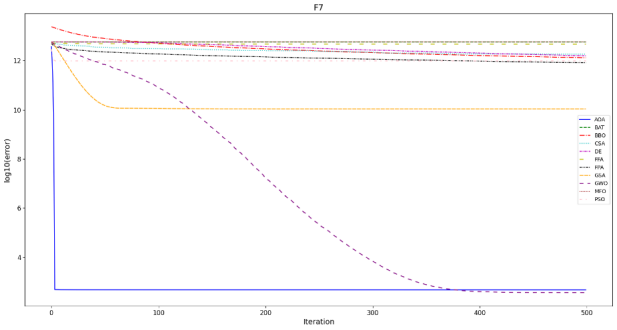


h) Error vs Iterations – Default Hyper-parameters

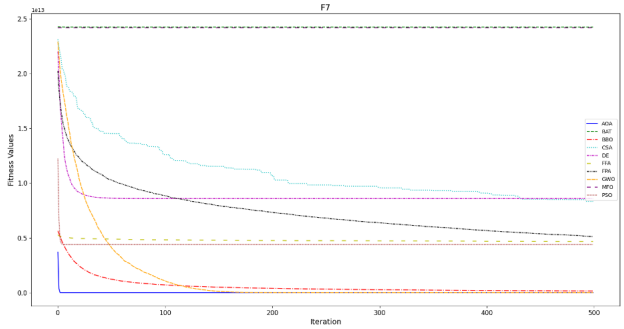
Figure 23: Line-Chart for F5-F6 for 500 dimensions



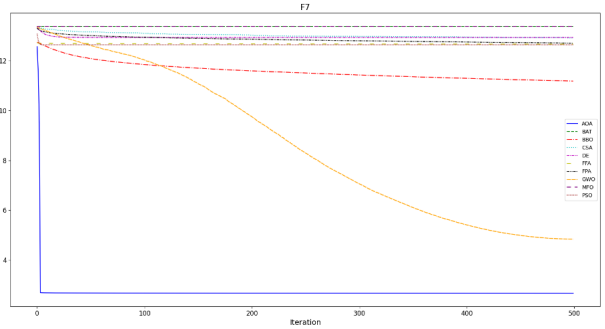
a) Fitness Value vs Iterations - AOA Hyper-parameters



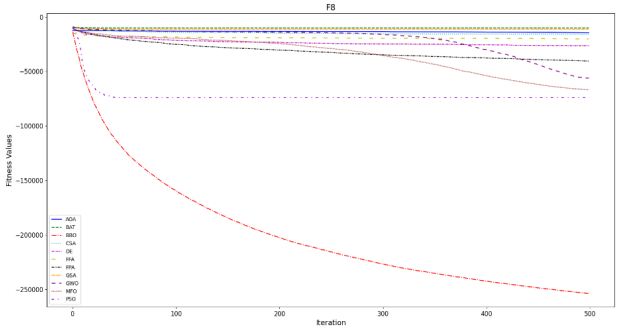
b) Error vs Iterations – AOA Hyper-parameters



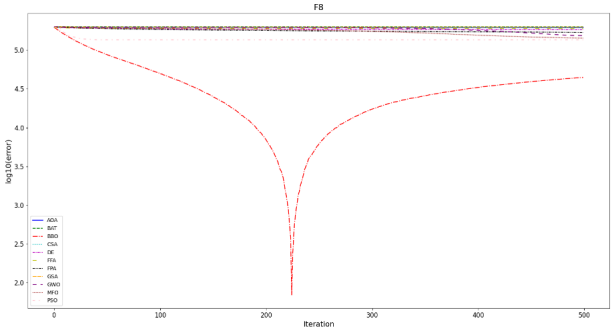
c) Fitness Value vs Iterations - Default Hyper-parameters



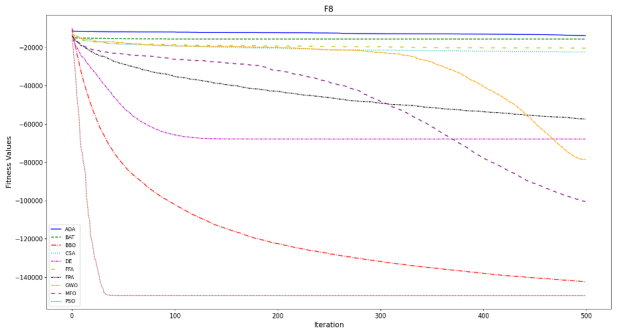
d) Error vs Iterations – Default Hyper-parameters



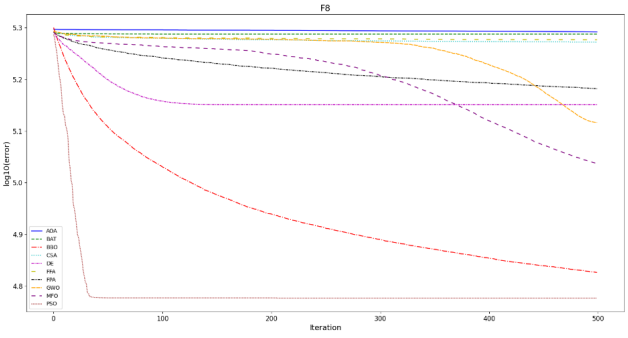
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

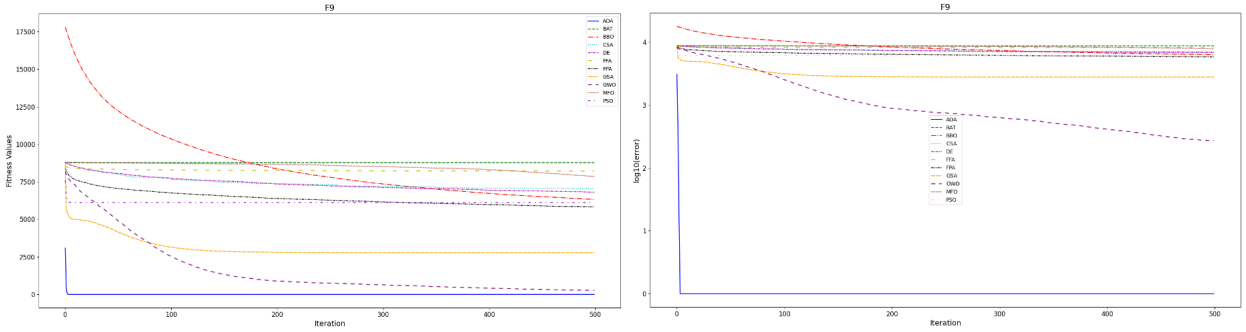


g) Fitness Value vs Iterations - Default Hyper-parameters



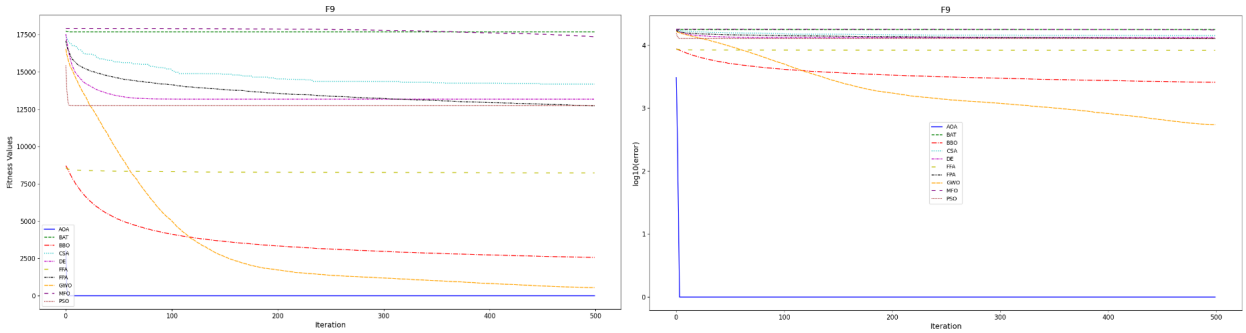
h) Error vs Iterations – Default Hyper-parameters

Figure 24: Line-Chart for F7-F8 for 500 dimensions



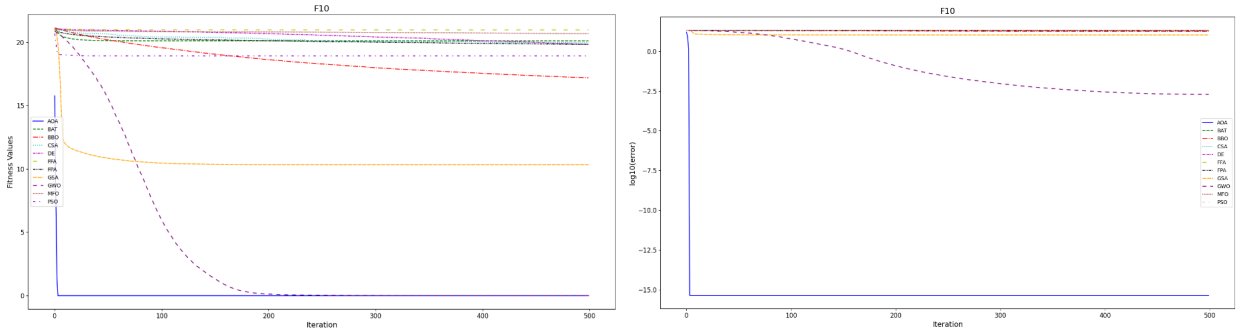
a) Fitness Value vs Iterations - AOA Hyper-parameters

b) Error vs Iterations – AOA Hyper-parameters



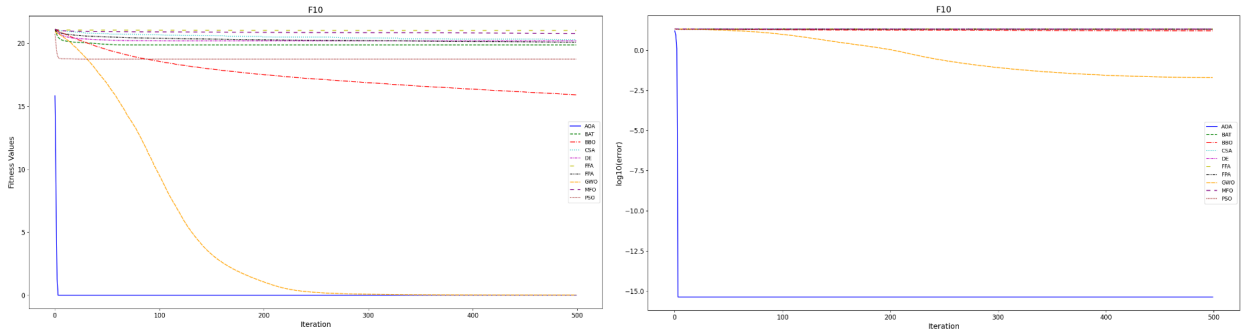
c) Fitness Value vs Iterations - Default Hyper-parameters

d) Error vs Iterations – Default Hyper-parameters



e) Fitness Value vs Iterations - AOA Hyper-parameters

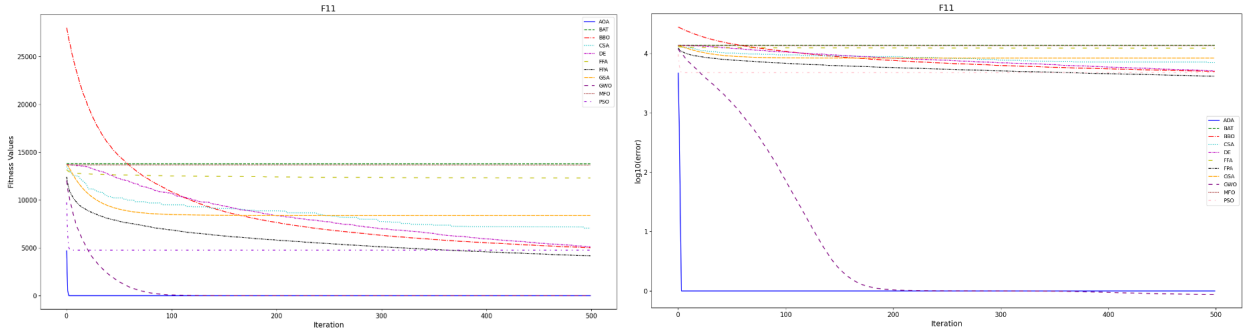
f) Error vs Iterations – AOA Hyper-parameters



g) Fitness Value vs Iterations - Default Hyper-parameters

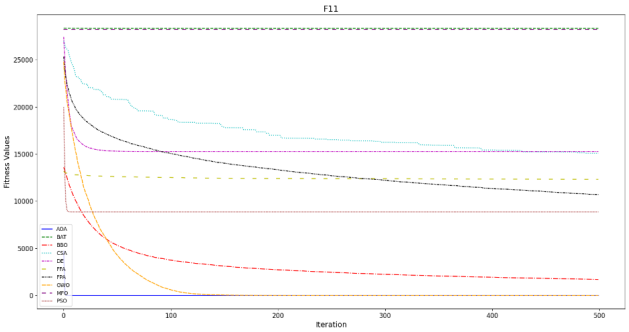
h) Error vs Iterations – Default Hyper-parameters

Figure 25: Line-Chart for F9-F10 for 500 dimensions

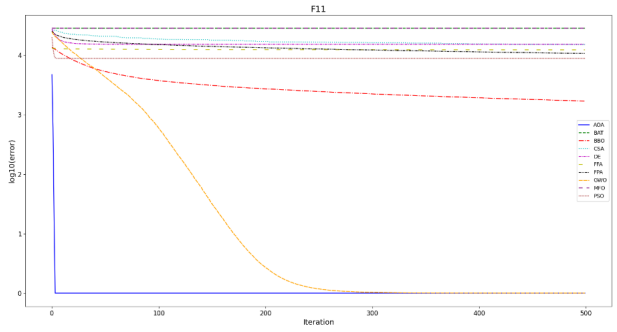


a) Fitness Value vs Iterations - AOA Hyper-parameters

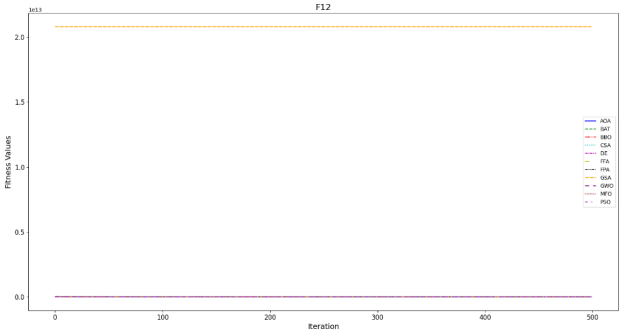
b) Error vs Iterations – AOA Hyper-parameters



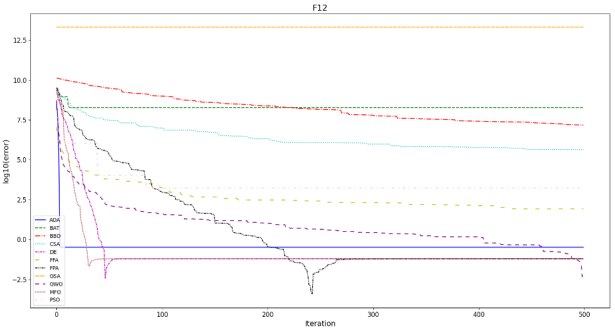
c) Fitness Value vs Iterations - Default Hyper-parameters



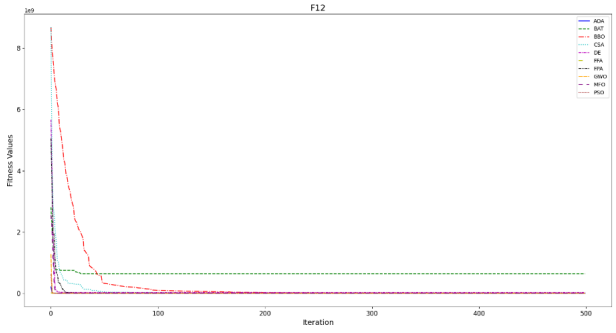
d) Error vs Iterations – Default Hyper-parameters



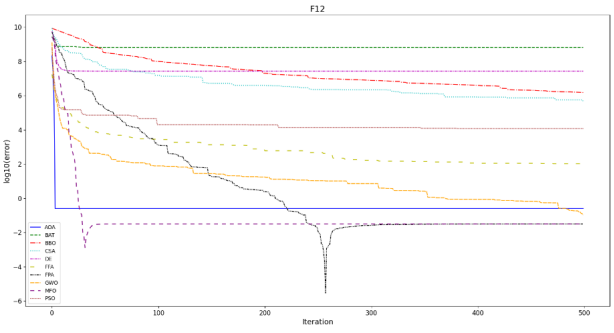
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

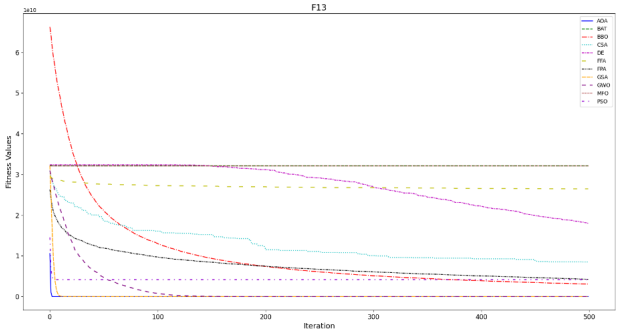


g) Fitness Value vs Iterations - Default Hyper-parameters

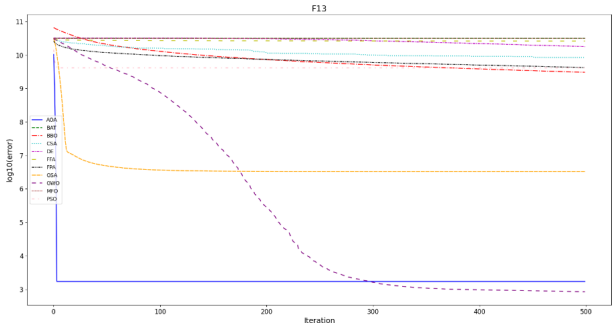


h) Error vs Iterations – Default Hyper-parameters

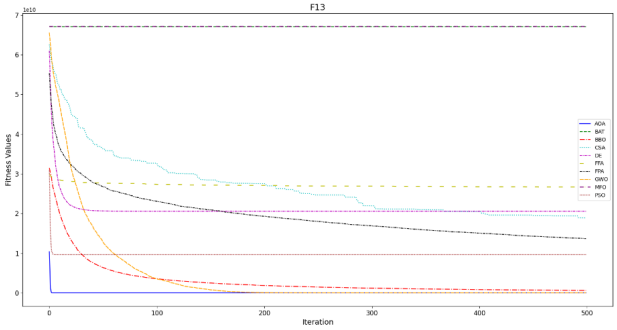
Figure 26: Line-Chart for F11-F12 for 500 dimensions



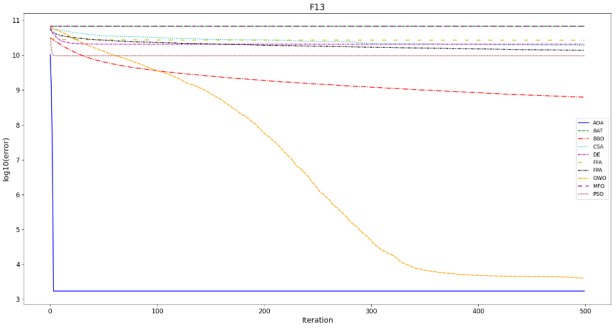
a) Fitness Value vs Iterations - AOA Hyper-parameters



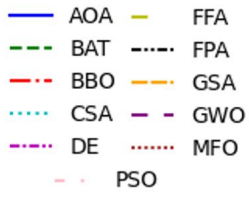
b) Error vs Iterations – AOA Hyper-parameters



c) Fitness Value vs Iterations - Default Hyper-parameters

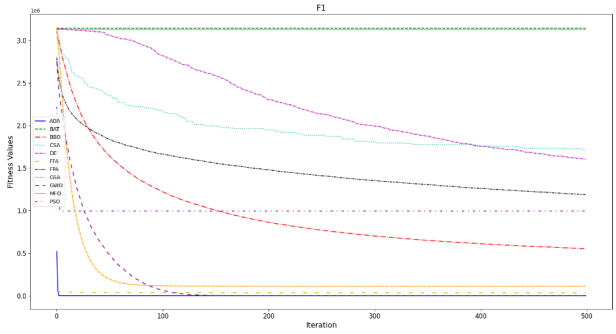


d) Error vs Iterations – Default Hyper-parameters

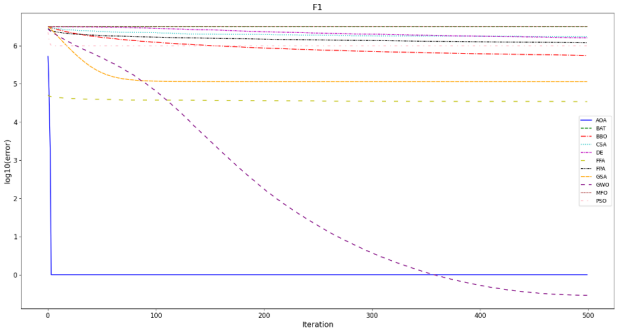


e) Legend

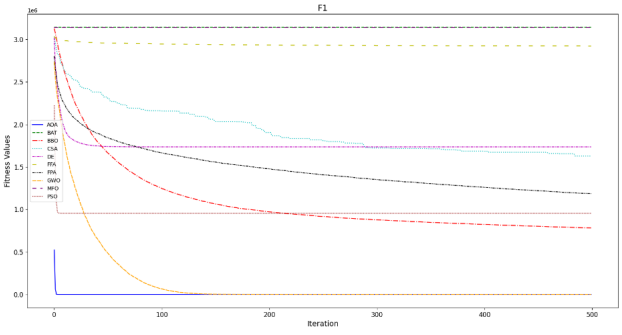
Figure 27: Line-Chart for F13 for 500 dimensions



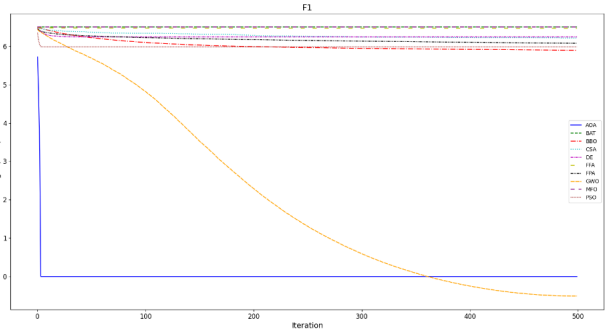
a) Fitness Value vs Iterations - AOA Hyper-parameters



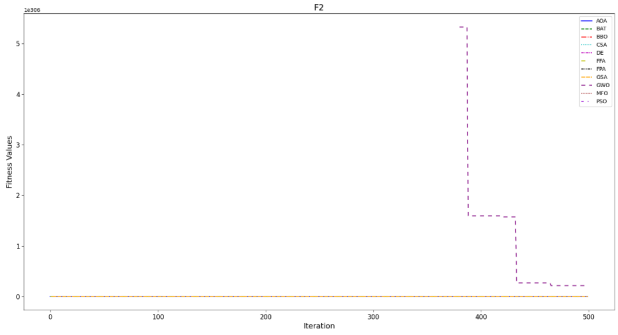
b) Error vs Iterations – AOA Hyper-parameters



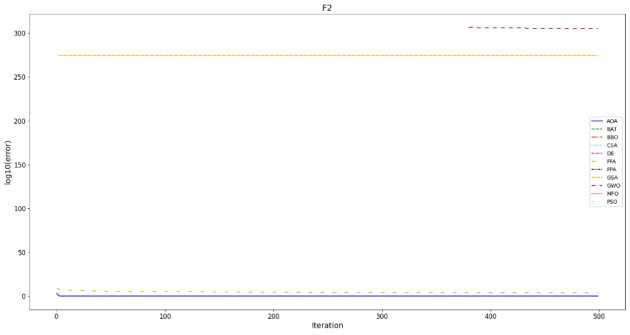
c) Fitness Value vs Iterations - Default Hyper-parameters



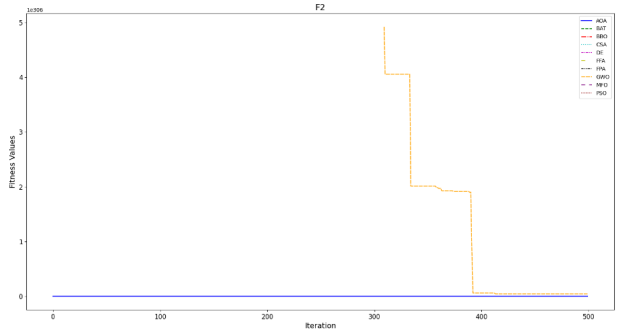
d) Error vs Iterations – Default Hyper-parameters



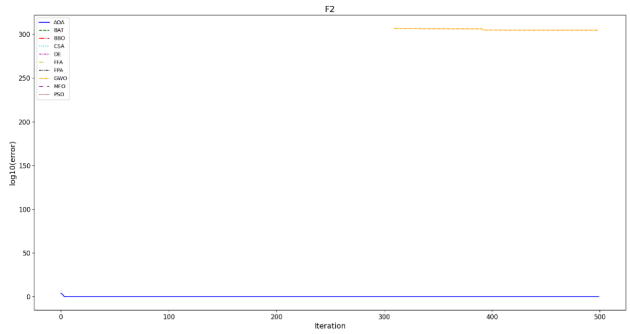
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

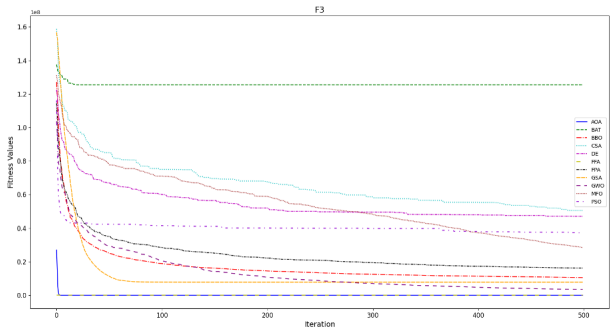


g) Fitness Value vs Iterations - Default Hyper-parameters

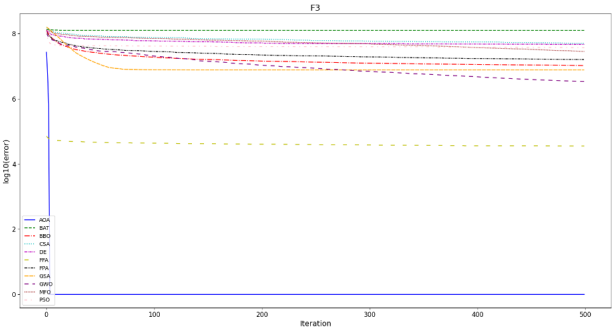


h) Error vs Iterations – Default Hyper-parameters\

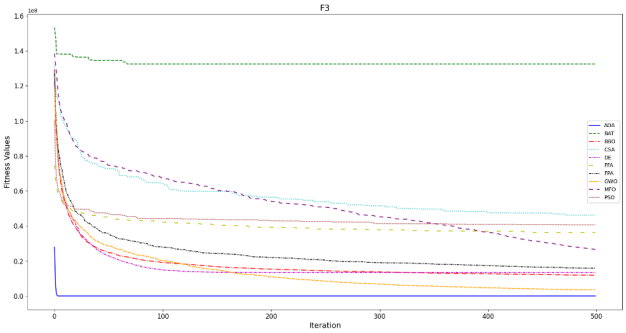
Figure 28: Line-Chart for F1-F2 for 1000 dimensions



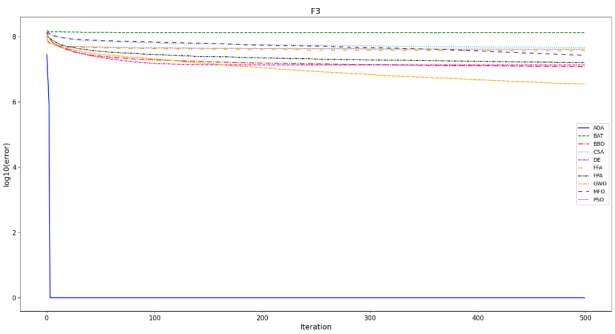
a) Fitness Value vs Iterations - AOA Hyper-parameters



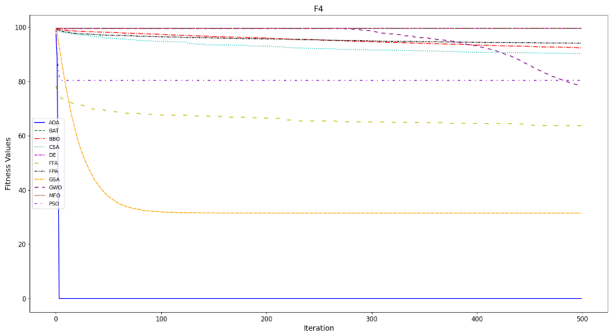
b) Error vs Iterations – AOA Hyper-parameters



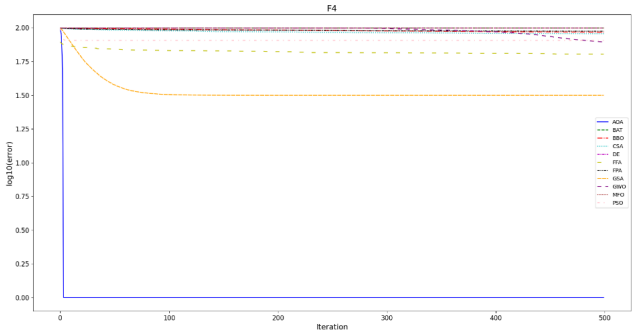
c) Fitness Value vs Iterations - Default Hyper-parameters



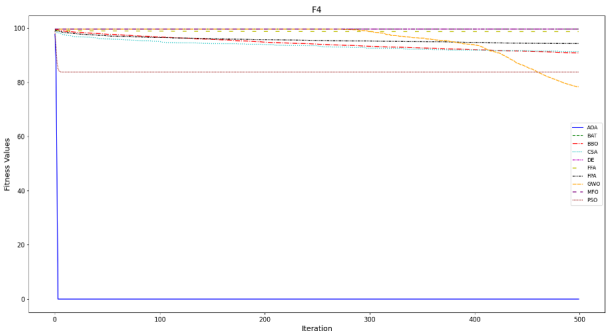
d) Error vs Iterations – Default Hyper-parameters



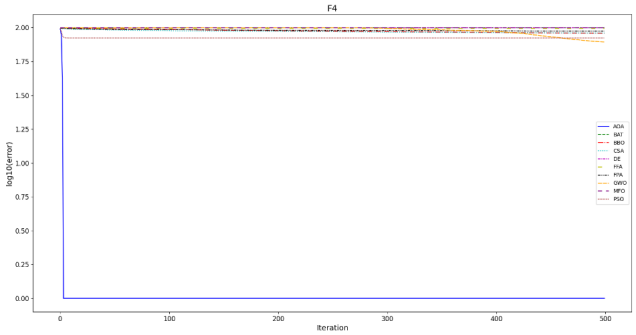
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

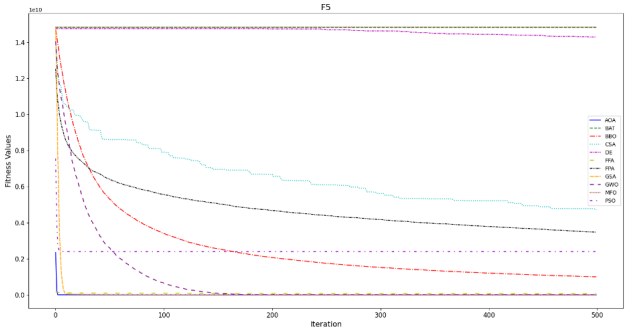


g) Fitness Value vs Iterations - Default Hyper-parameters

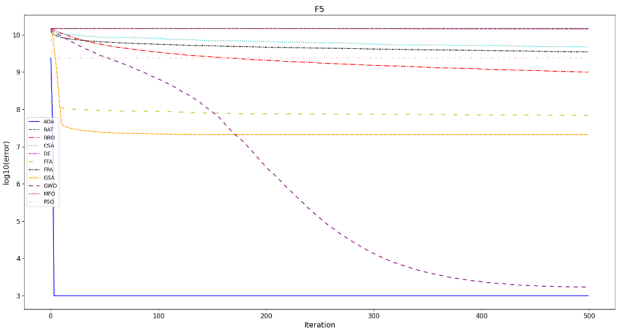


h) Error vs Iterations – Default Hyper-parameters

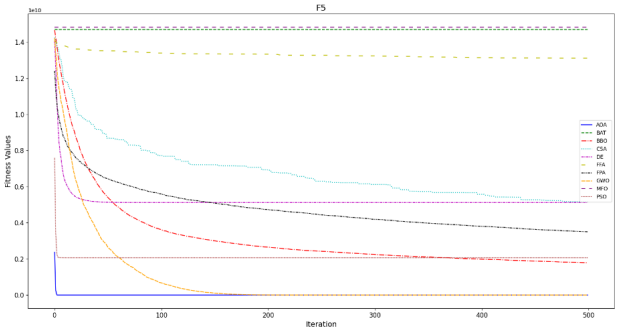
Figure 29: Line-Chart for F3-F4 for 1000 dimensions



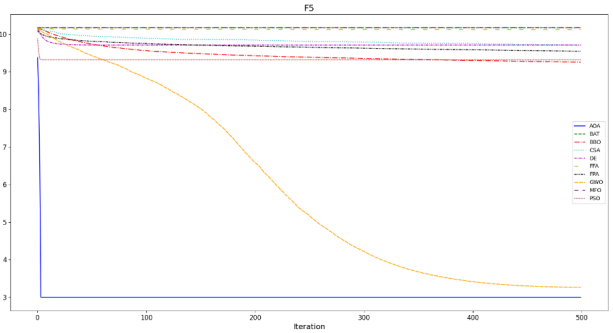
a) Fitness Value vs Iterations - AOA Hyper-parameters



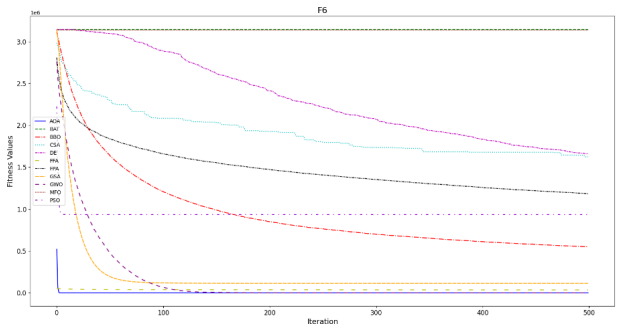
b) Error vs Iterations – AOA Hyper-parameters



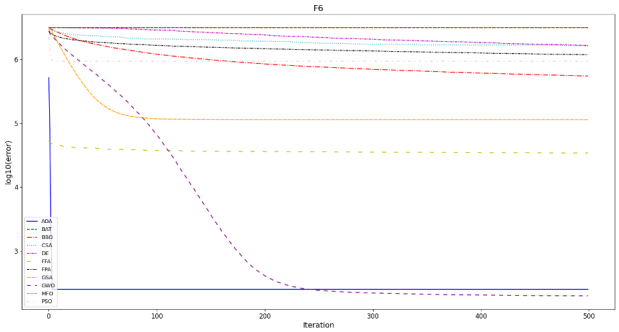
c) Fitness Value vs Iterations - Default Hyper-parameters



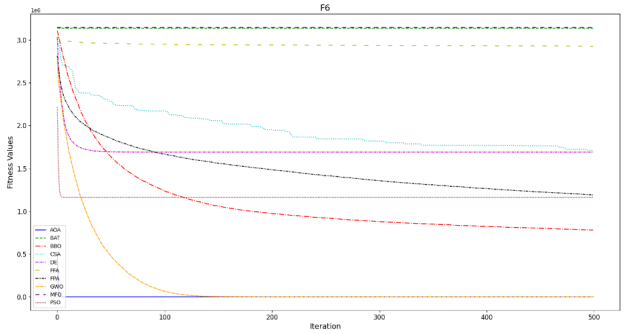
d) Error vs Iterations – Default Hyper-parameters



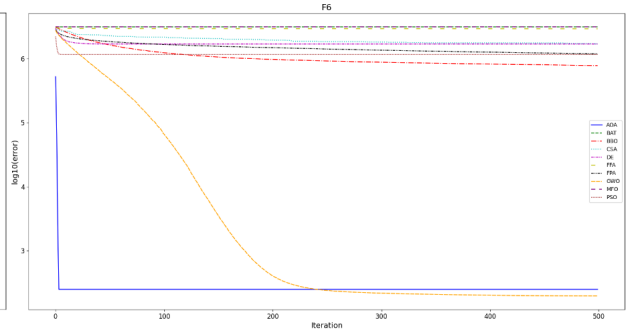
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

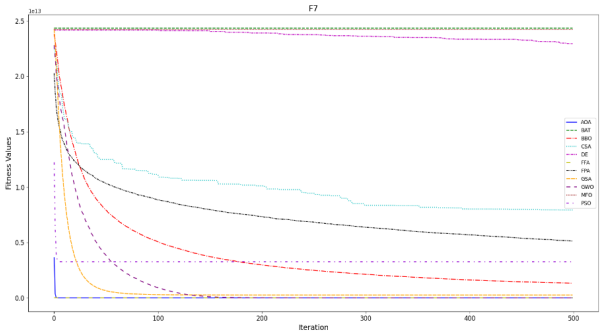


g) Fitness Value vs Iterations - Default Hyper-parameters

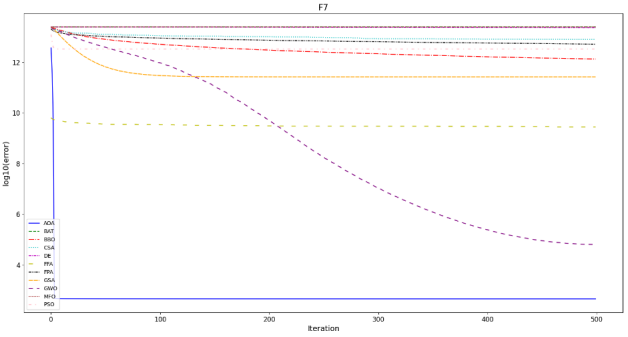


h) Error vs Iterations – Default Hyper-parameters

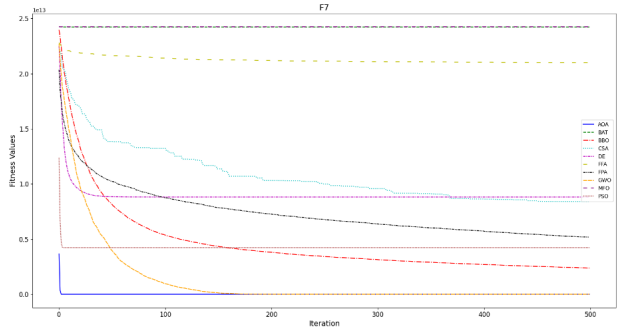
Figure 30: Line-Chart for F5-F6 for 1000 dimensions



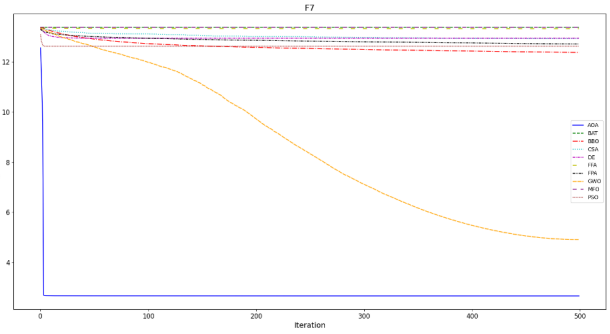
a) Fitness Value vs Iterations - AOA Hyper-parameters



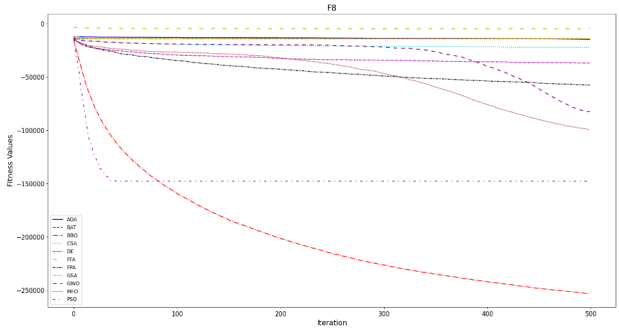
b) Error vs Iterations – AOA Hyper-parameters



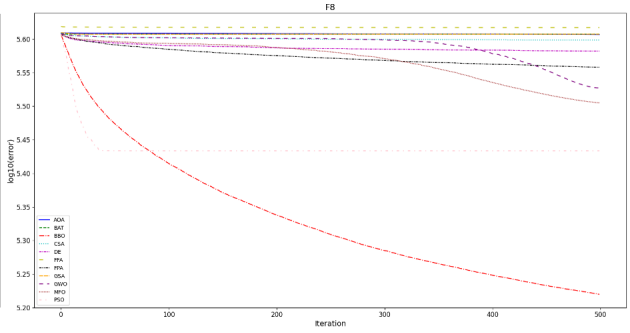
c) Fitness Value vs Iterations - Default Hyper-parameters



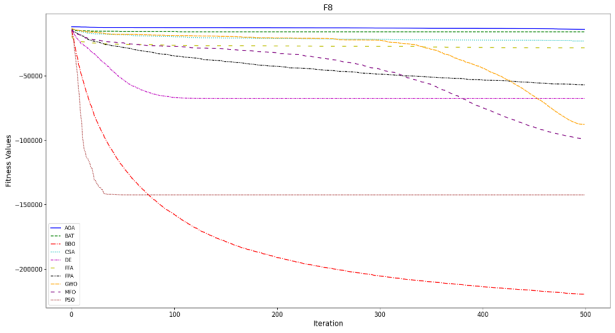
d) Error vs Iterations – Default Hyper-parameters



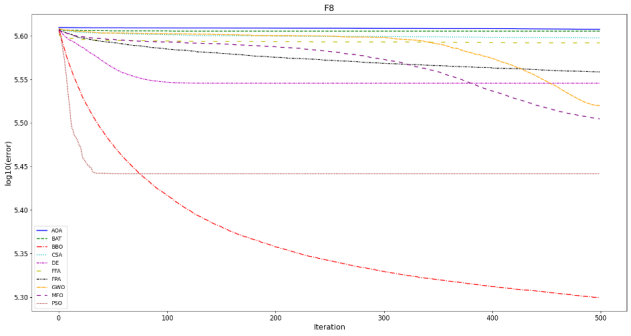
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

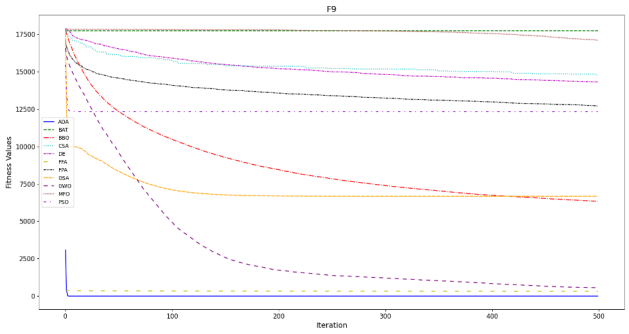


g) Fitness Value vs Iterations - Default Hyper-parameters

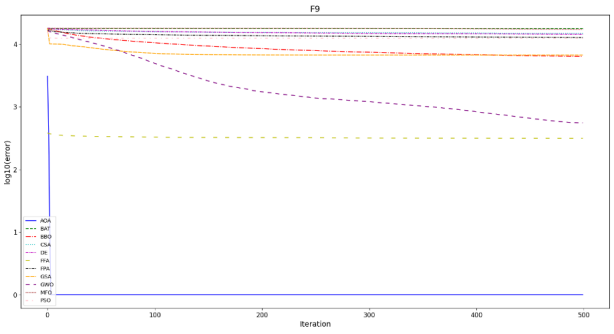


h) Error vs Iterations – Default Hyper-parameters

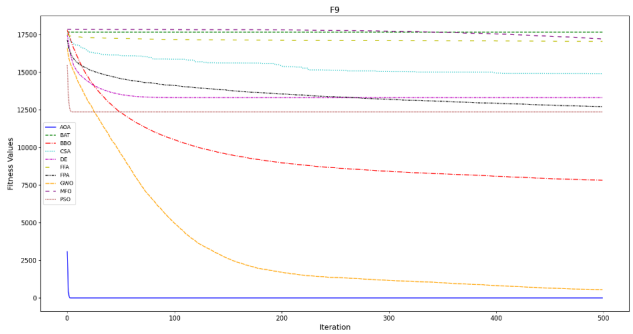
Figure 31: Line-Chart for F7-F8 for 1000 dimensions



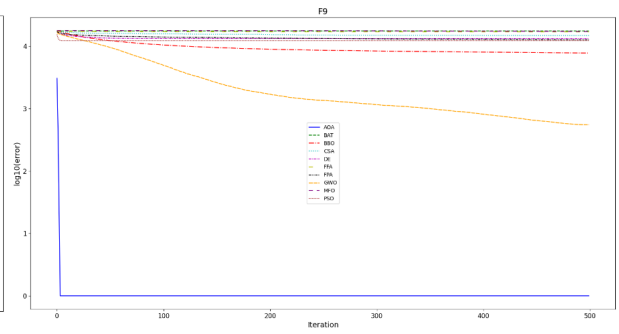
a) Fitness Value vs Iterations - AOA Hyper-parameters



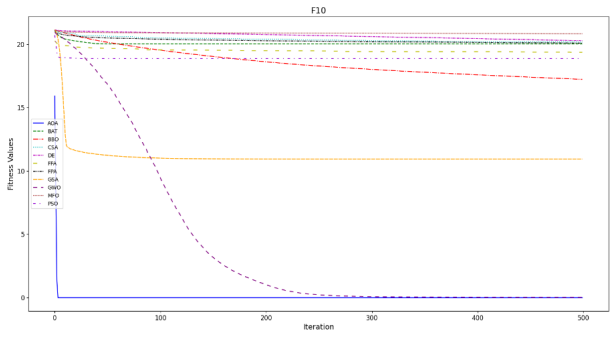
b) Error vs Iterations – AOA Hyper-parameters



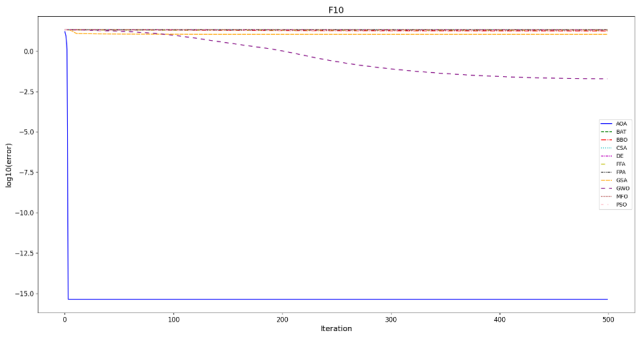
c) Fitness Value vs Iterations - Default Hyper-parameters



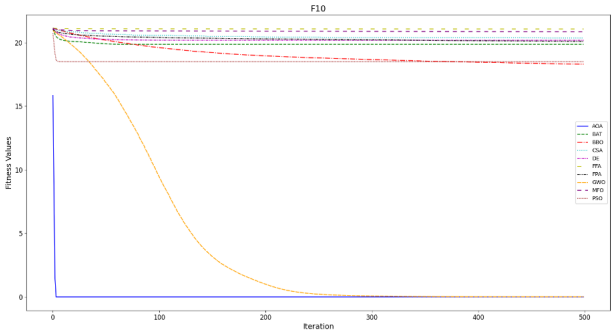
d) Error vs Iterations – Default Hyper-parameters



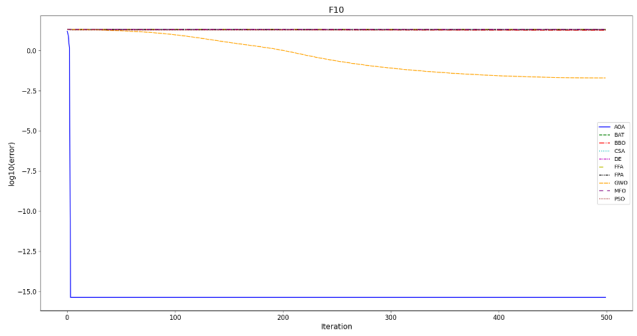
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

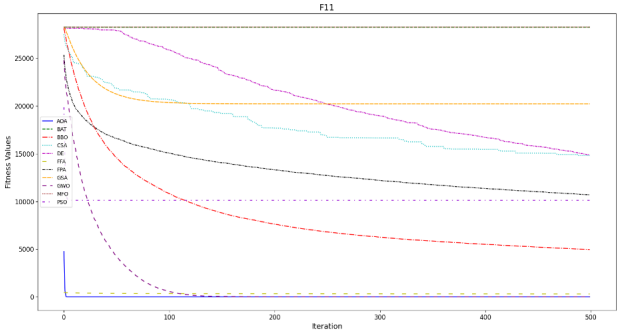


g) Fitness Value vs Iterations - Default Hyper-parameters

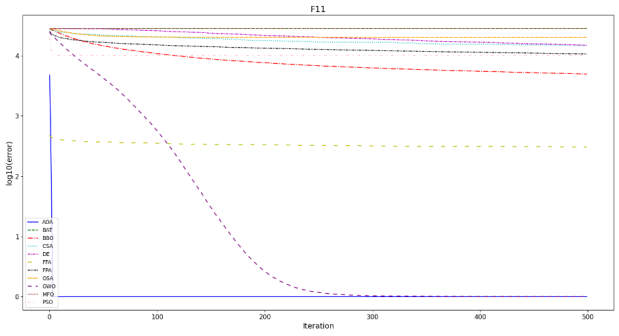


h) Error vs Iterations – Default Hyper-parameters

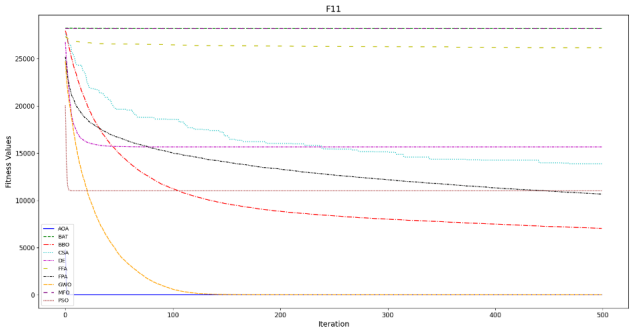
Figure 32: Line-Chart for F9-F10 for 1000 dimensions



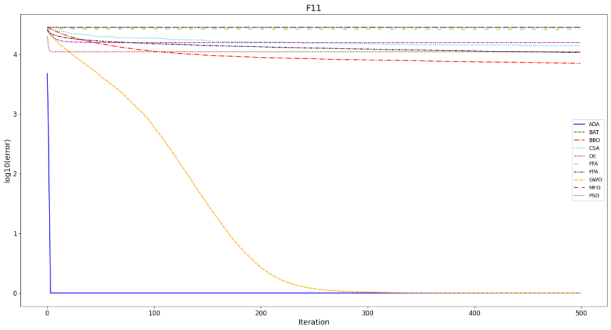
a) Fitness Value vs Iterations - AOA Hyper-parameters



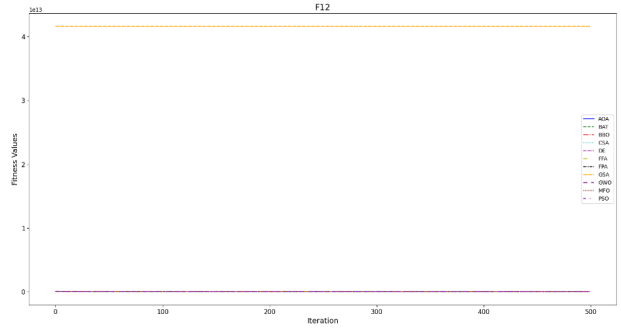
b) Error vs Iterations – AOA Hyper-parameters



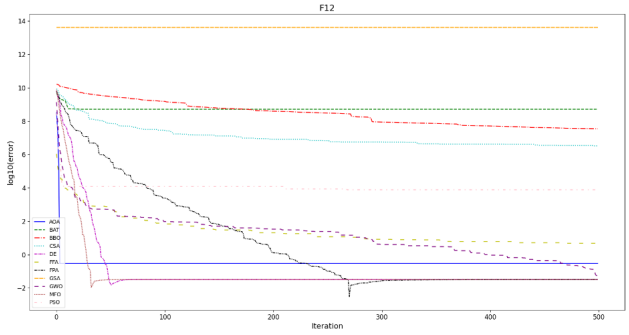
c) Fitness Value vs Iterations - Default Hyper-parameters



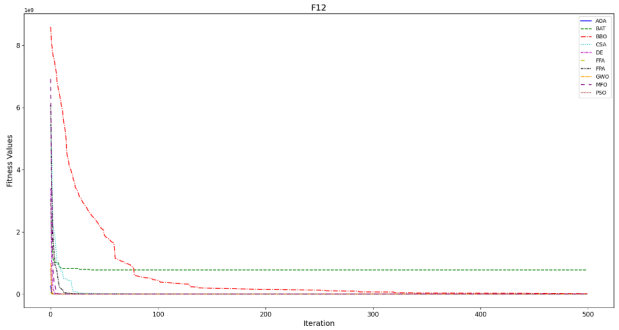
d) Error vs Iterations – Default Hyper-parameters



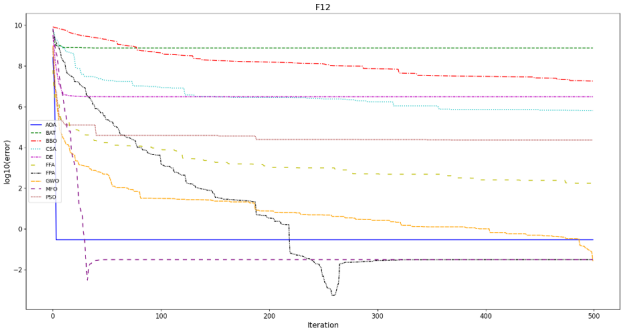
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

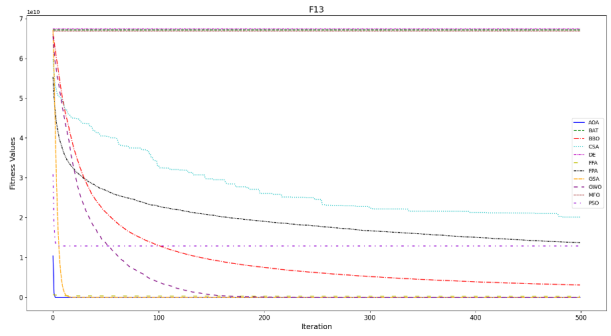


g) Fitness Value vs Iterations - Default Hyper-parameters

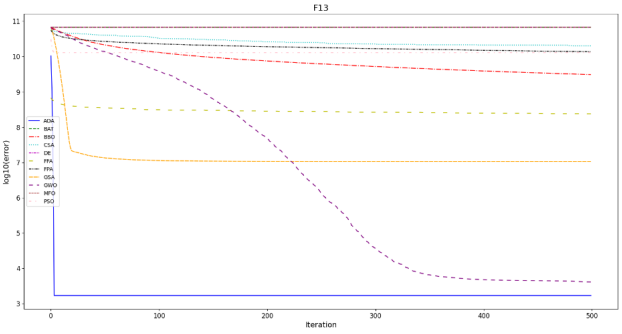


h) Error vs Iterations – Default Hyper-parameters

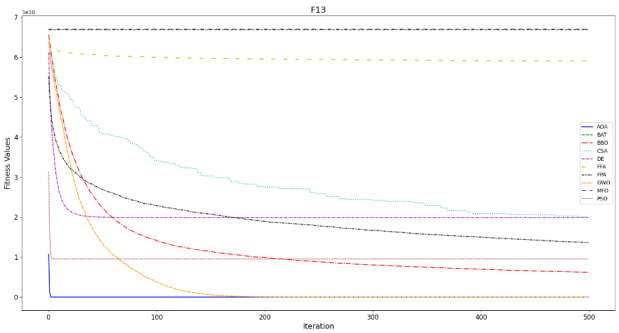
Figure 33: Line-Chart for F11-F12 for 1000 dimensions



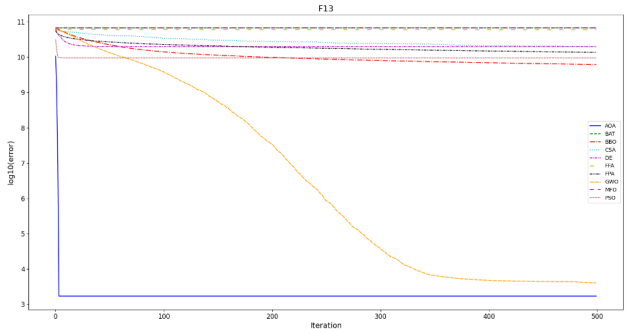
a) Fitness Value vs Iterations - AOA Hyper-parameters



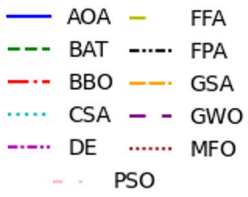
b) Error vs Iterations – AOA Hyper-parameters



c) Fitness Value vs Iterations - Default Hyper-parameters

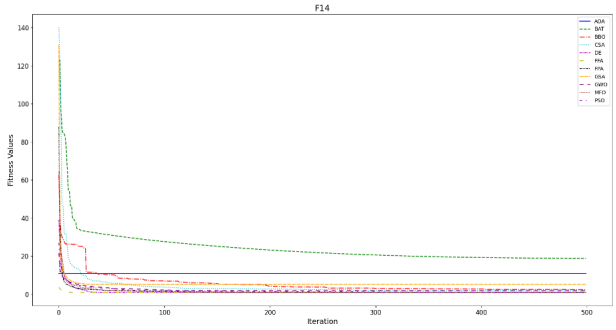


d) Error vs Iterations – Default Hyper-parameters

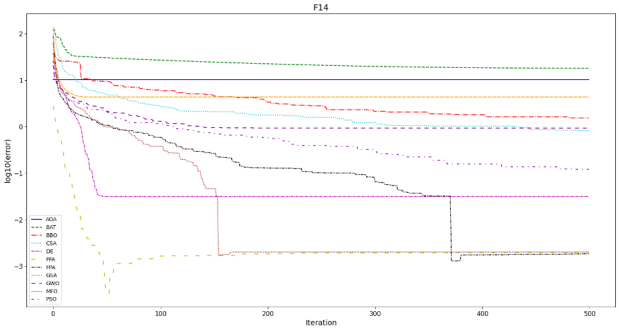


e) Legend

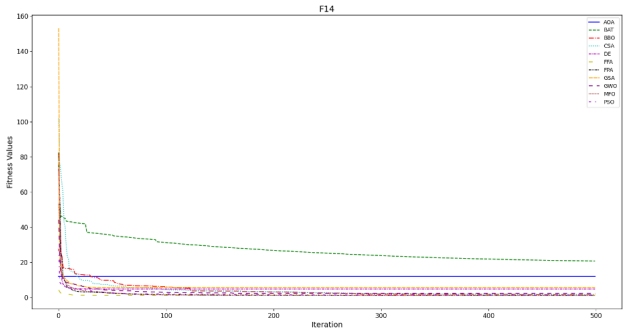
Figure 34: Line-Chart for F13 for 1000 dimensions



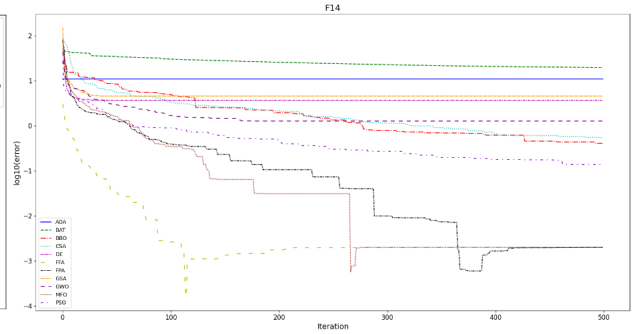
a) Fitness Value vs Iterations - AOA Hyper-parameters



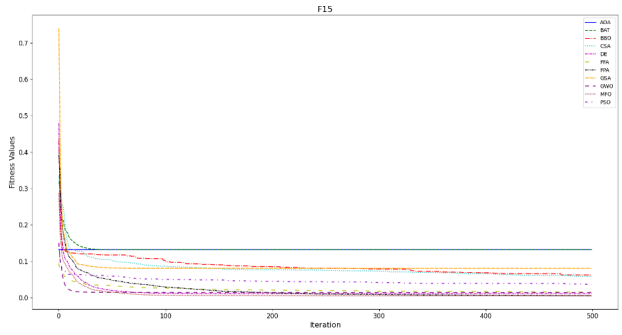
b) Error vs Iterations – AOA Hyper-parameters



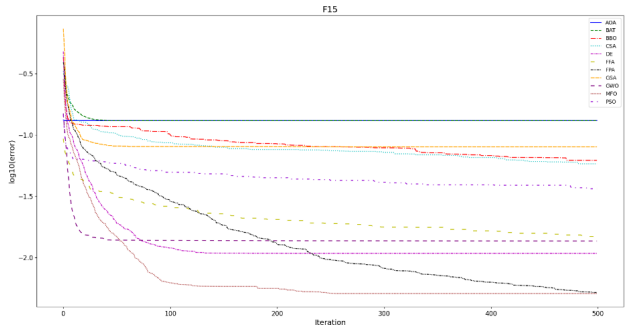
c) Fitness Value vs Iterations - Default Hyper-parameters



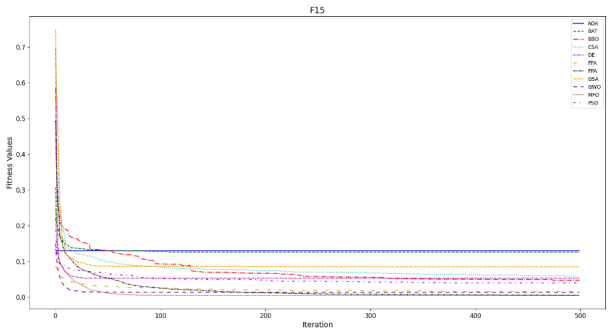
d) Error vs Iterations – Default Hyper-parameters



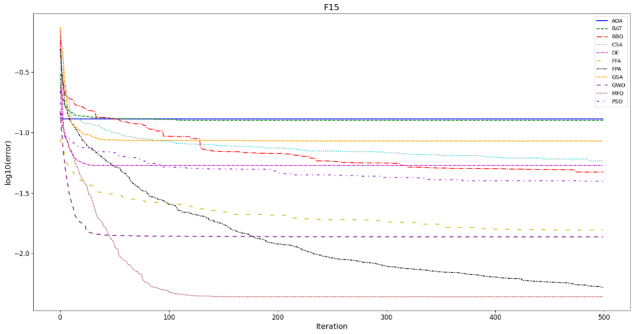
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

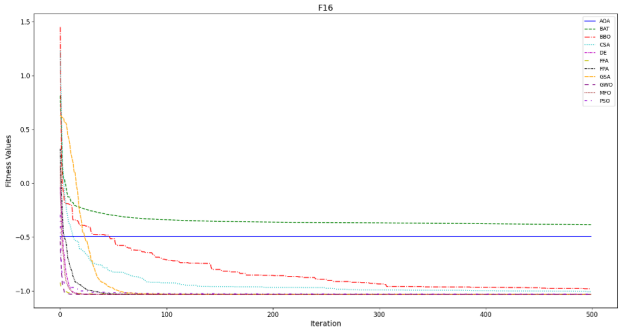


g) Fitness Value vs Iterations - Default Hyper-parameters

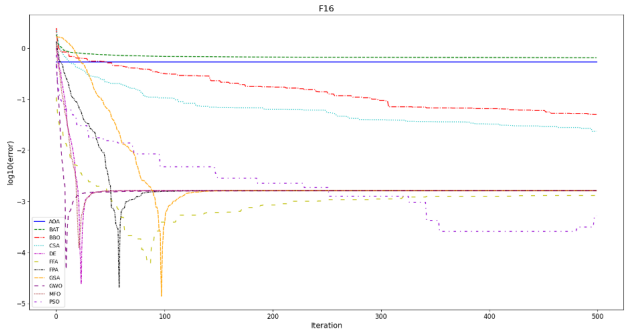


h) Error vs Iterations – Default Hyper-parameters

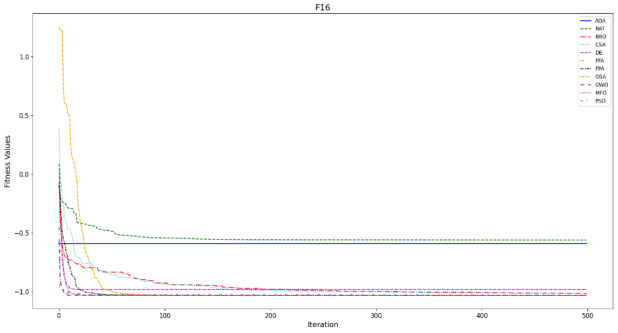
Figure 35: Line-Chart for F14-F15



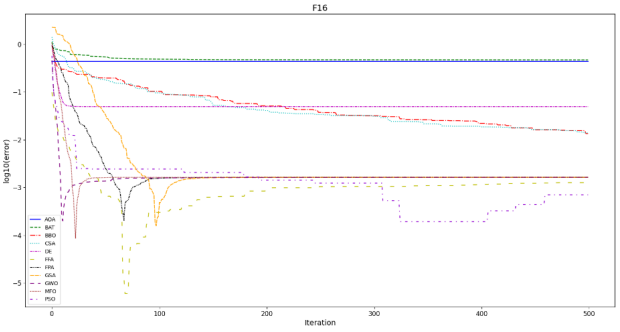
a) Fitness Value vs Iterations - AOA Hyper-parameters



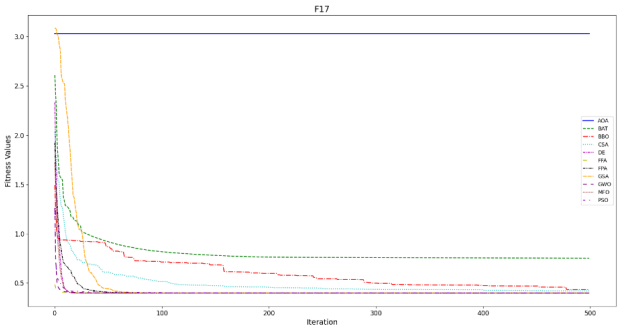
b) Error vs Iterations – AOA Hyper-parameters



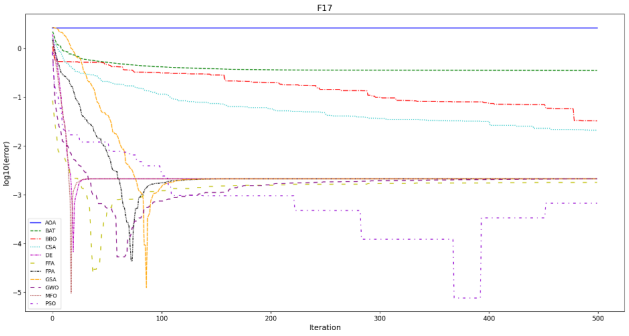
c) Fitness Value vs Iterations - Default Hyper-parameters



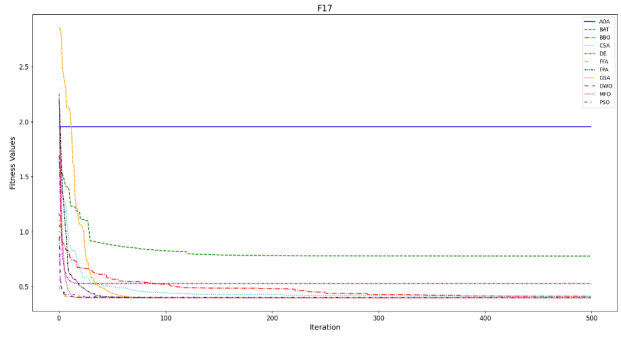
d) Error vs Iterations – Default Hyper-parameters



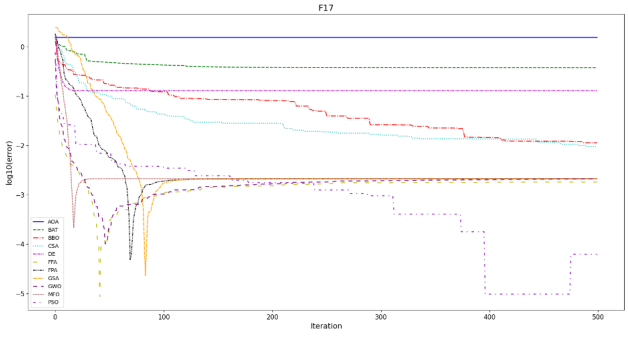
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

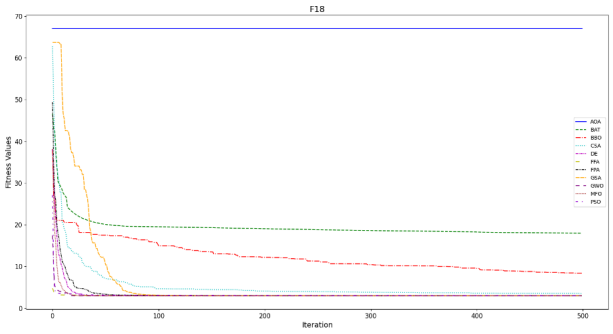


g) Fitness Value vs Iterations - Default Hyper-parameters

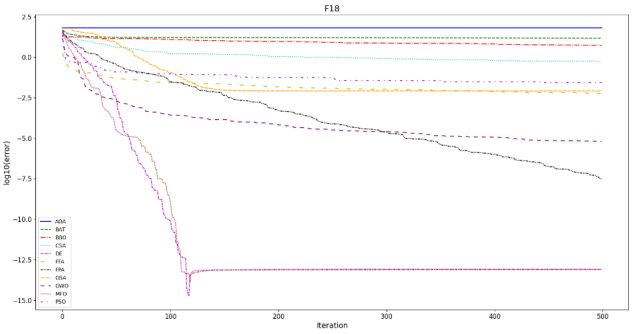


h) Error vs Iterations – Default Hyper-parameters

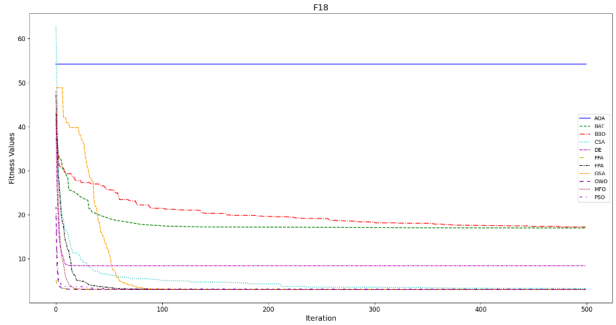
Figure 36: Line-Chart for F16-F17



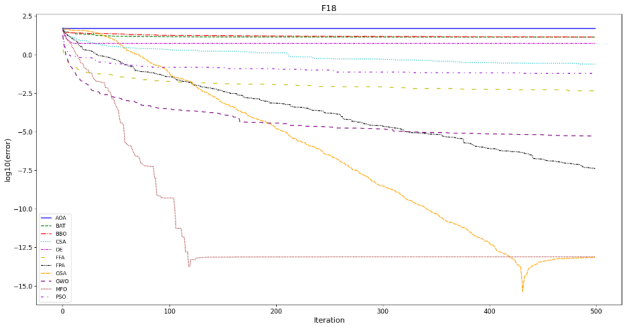
a) Fitness Value vs Iterations - AOA Hyper-parameters



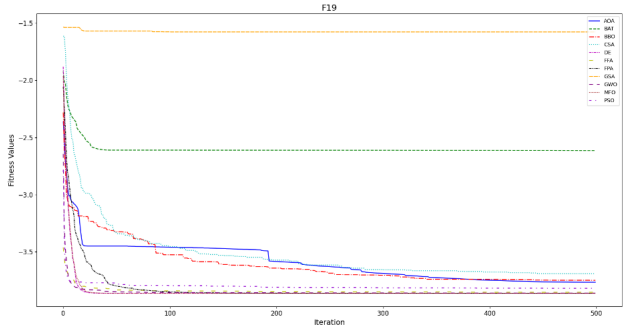
b) Error vs Iterations – AOA Hyper-parameters



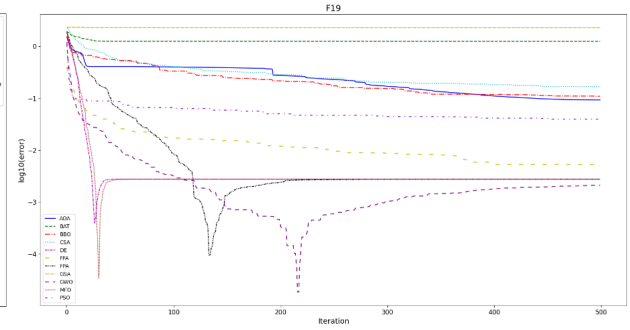
c) Fitness Value vs Iterations - Default Hyper-parameters



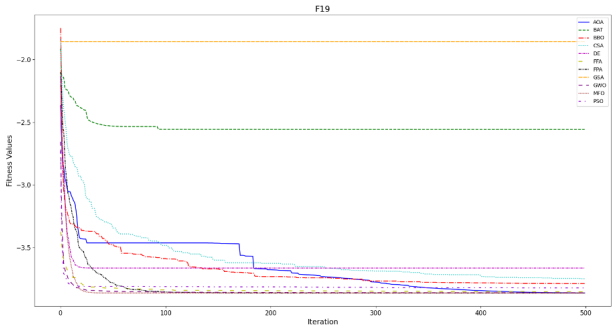
d) Error vs Iterations – Default Hyper-parameters



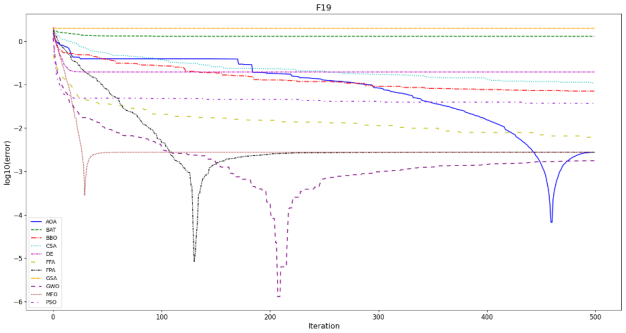
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

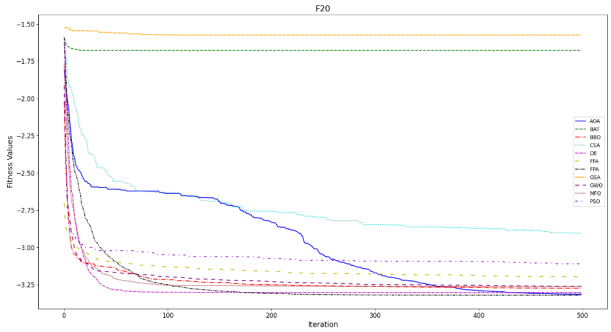


g) Fitness Value vs Iterations - Default Hyper-parameters

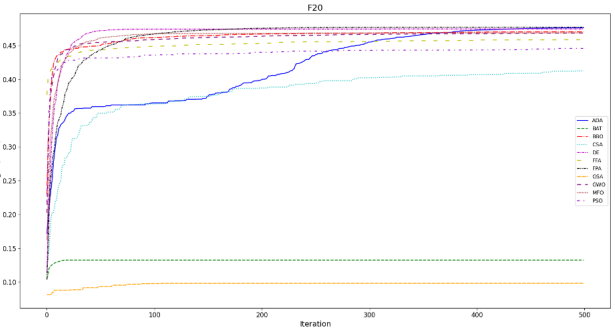


h) Error vs Iterations – Default Hyper-parameters

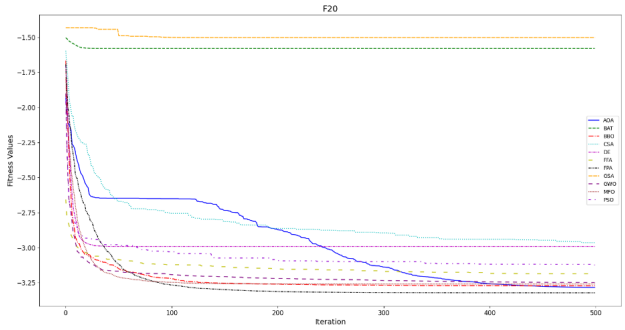
Figure 37: Line-Chart for F18-F19



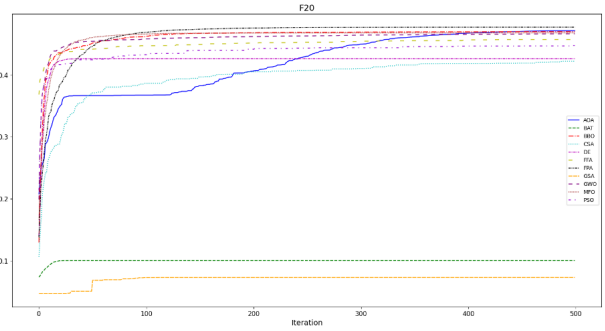
a) Fitness Value vs Iterations - AOA Hyper-parameters



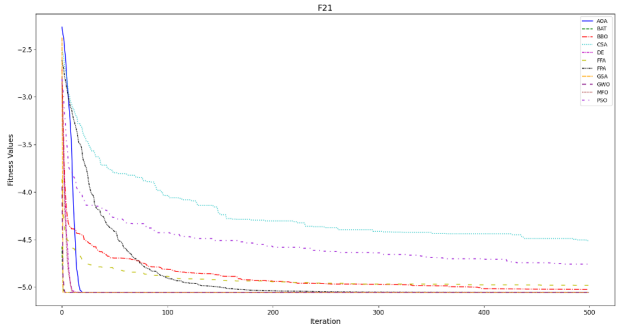
b) Error vs Iterations – AOA Hyper-parameters



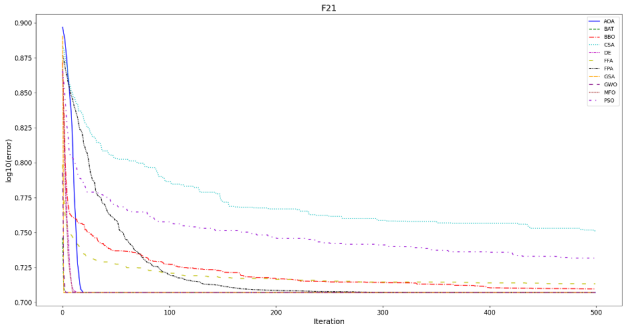
c) Fitness Value vs Iterations - Default Hyper-parameters



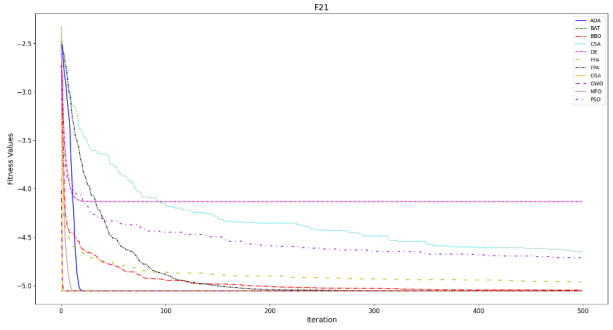
d) Error vs Iterations – Default Hyper-parameters



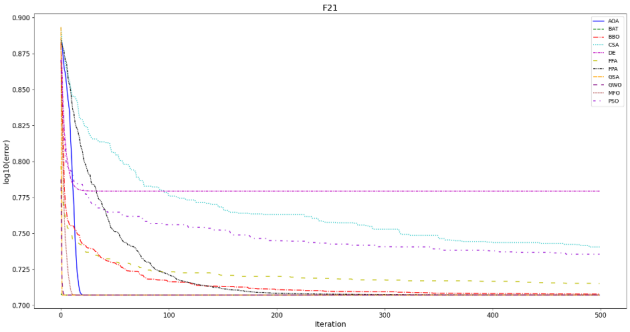
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

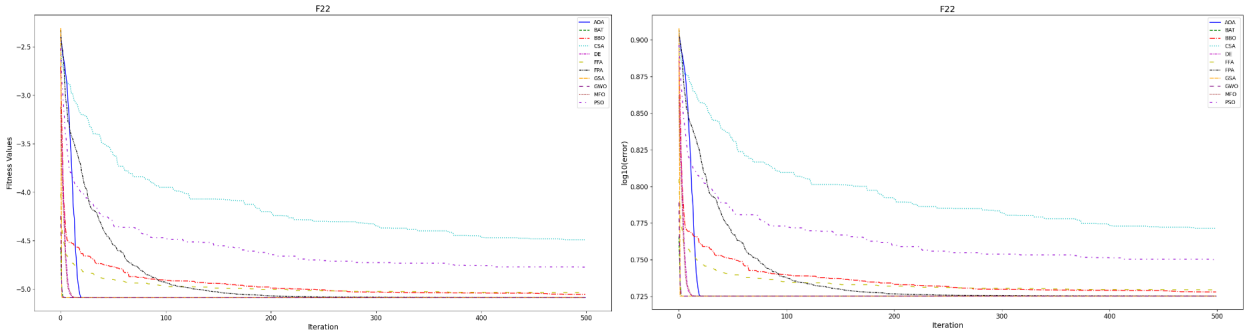


g) Fitness Value vs Iterations - Default Hyper-parameters



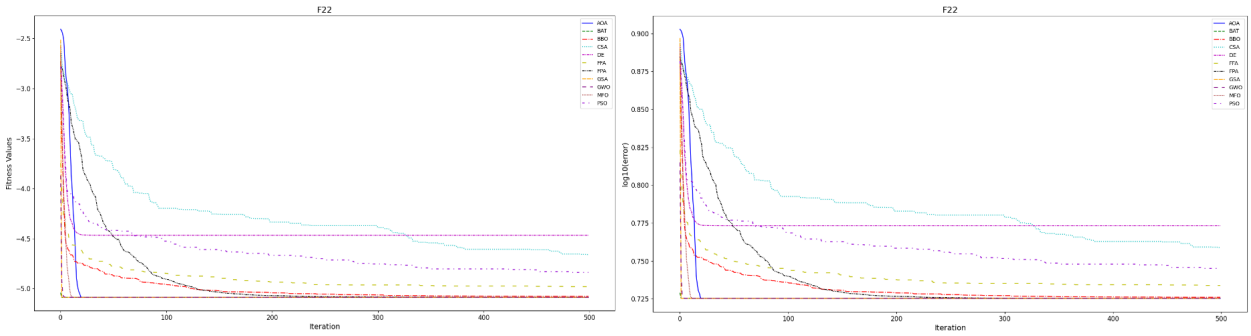
h) Error vs Iterations – Default Hyper-parameters

Figure 38: Line-Chart for F20-F21



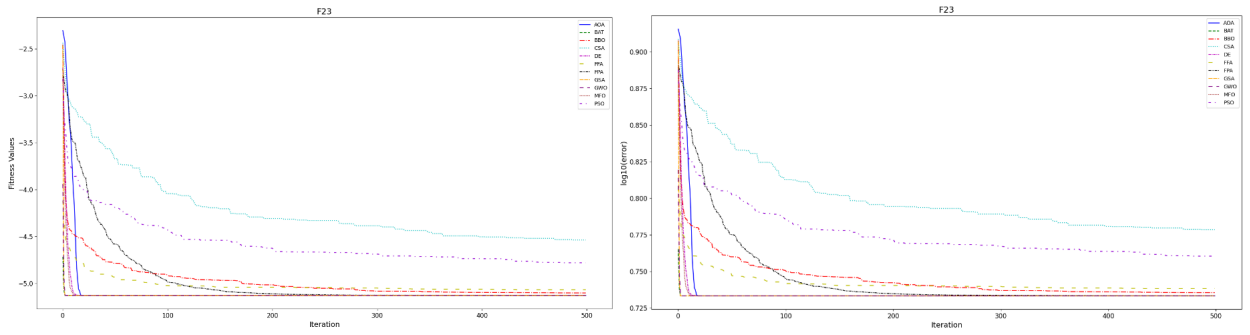
a) Fitness Value vs Iterations - AOA Hyper-parameters

b) Error vs Iterations – AOA Hyper-parameters



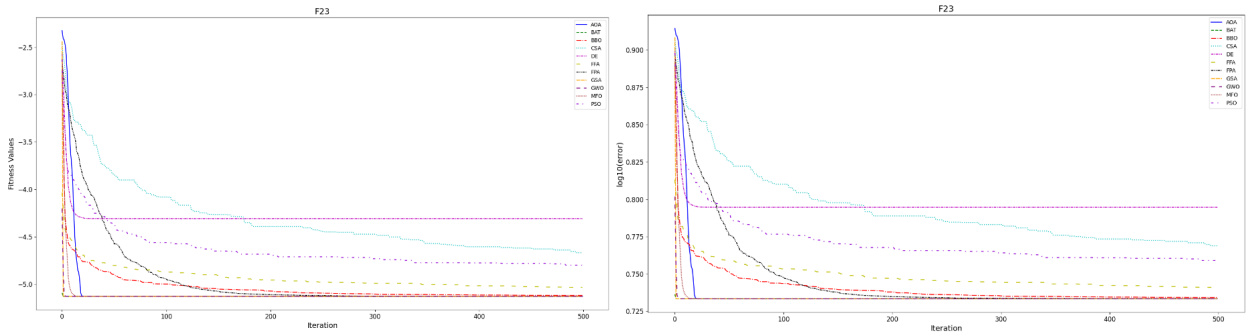
c) Fitness Value vs Iterations - Default Hyper-parameters

d) Error vs Iterations – Default Hyper-parameters



e) Fitness Value vs Iterations - AOA Hyper-parameters

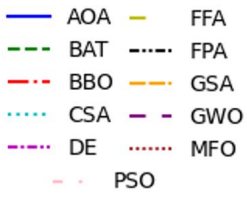
f) Error vs Iterations – AOA Hyper-parameters



g) Fitness Value vs Iterations - Default Hyper-parameters

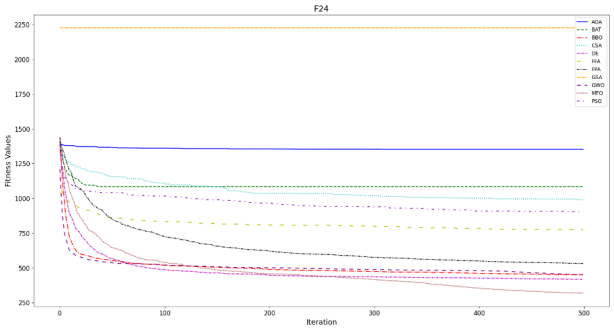
h) Error vs Iterations – Default Hyper-parameters

Figure 39: Line-Chart for F22-F23

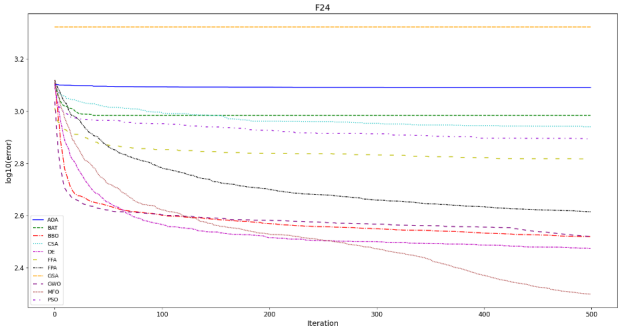


a) Legend

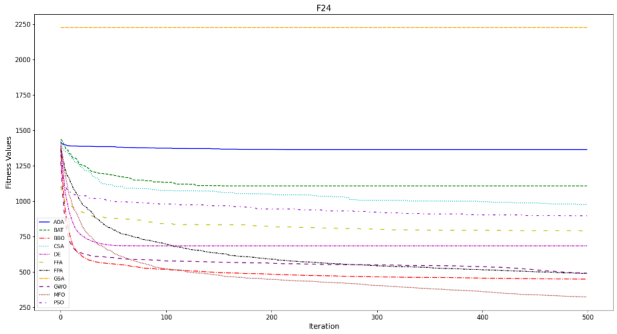
Figure 40: Legend for F14-F23



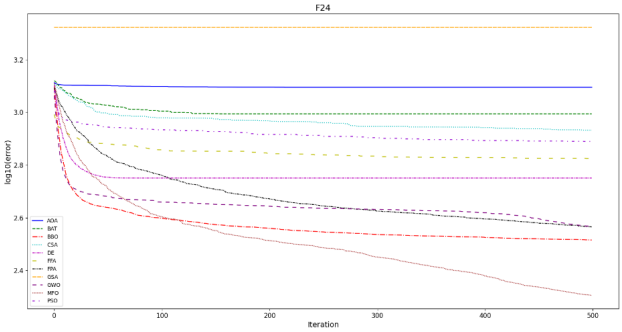
a) Fitness Value vs Iterations - AOA Hyper-parameters



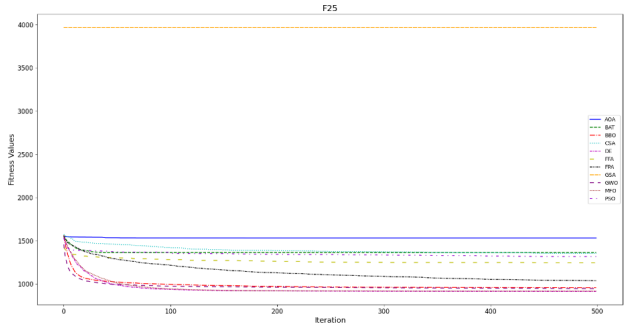
b) Error vs Iterations – AOA Hyper-parameters



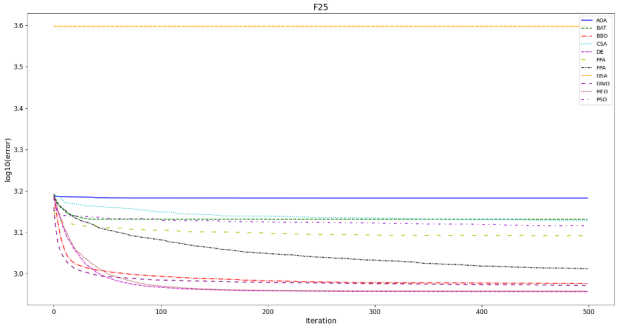
c) Fitness Value vs Iterations - Default Hyper-parameters



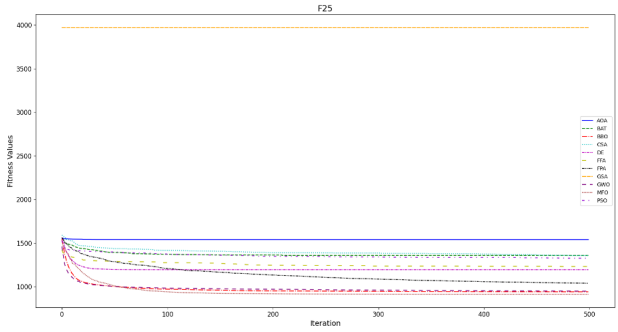
d) Error vs Iterations – Default Hyper-parameters



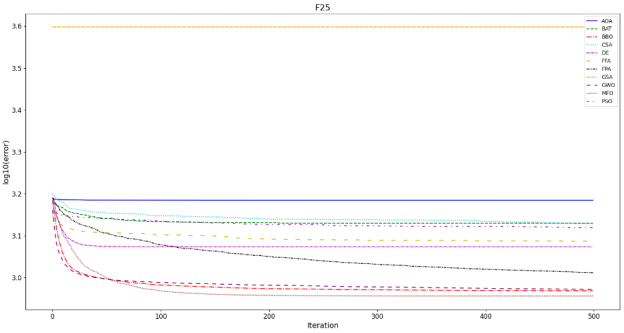
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

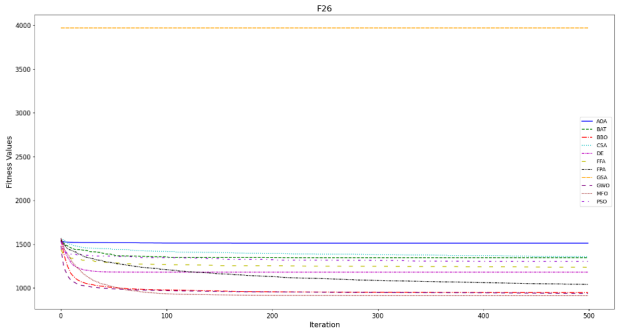


g) Fitness Value vs Iterations - Default Hyper-parameters

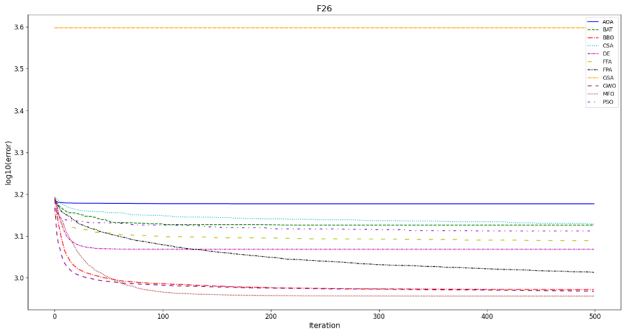


h) Error vs Iterations – Default Hyper-parameters

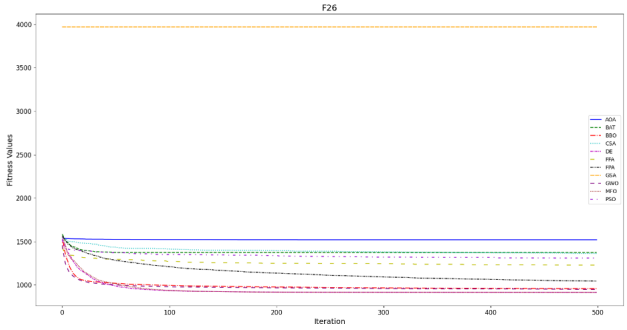
Figure 41: Line-Chart for F24-F25



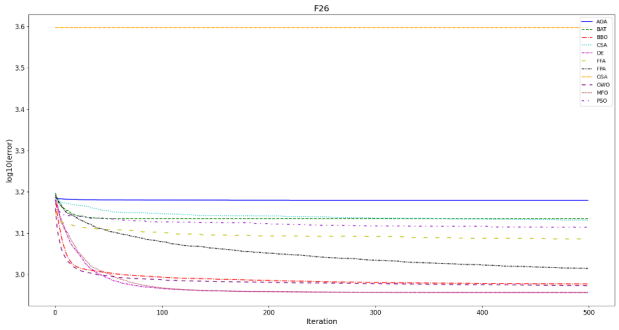
a) Fitness Value vs Iterations - AOA Hyper-parameters



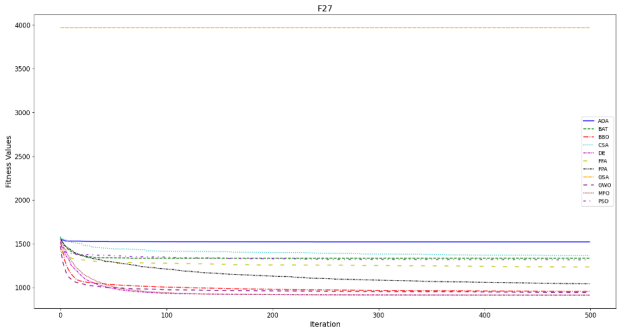
b) Error vs Iterations – AOA Hyper-parameters



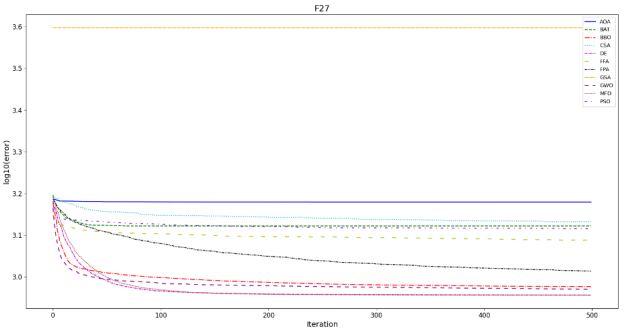
c) Fitness Value vs Iterations - Default Hyper-parameters



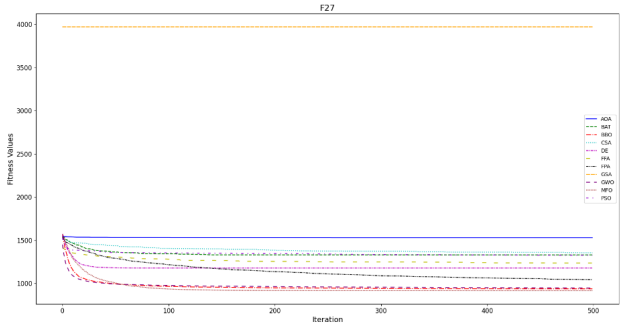
d) Error vs Iterations – Default Hyper-parameters



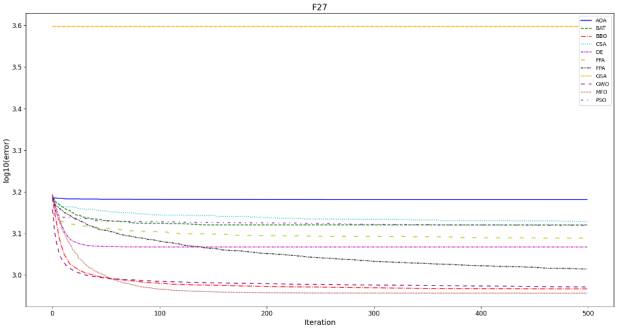
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

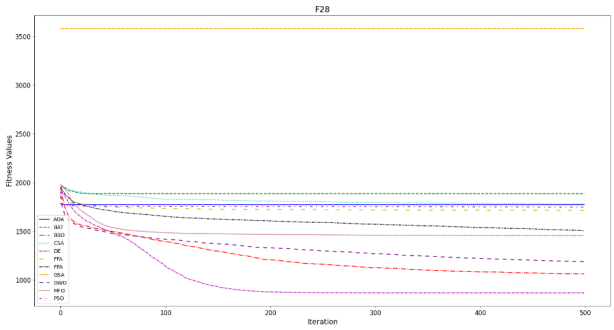


g) Fitness Value vs Iterations - Default Hyper-parameters

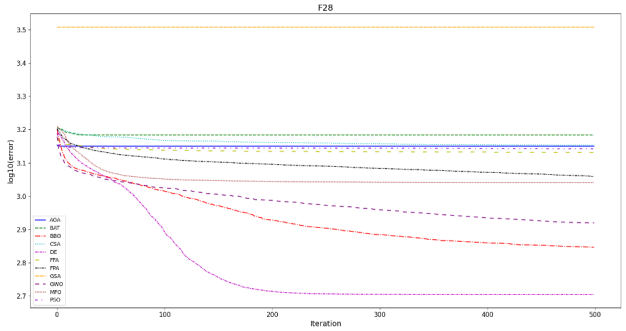


h) Error vs Iterations – Default Hyper-parameters

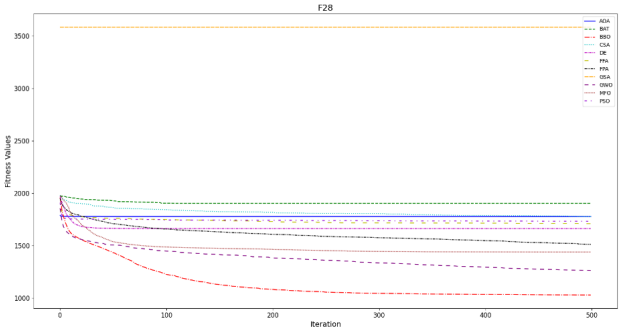
Figure 42: Line-Chart for F26-F27



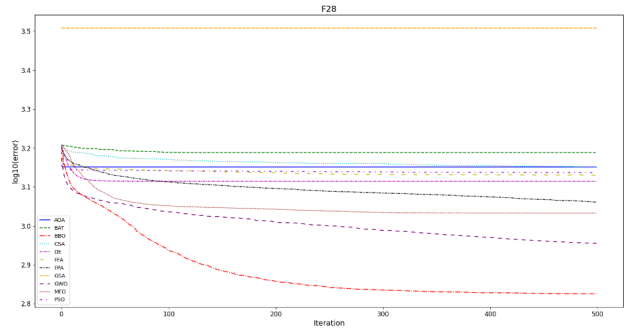
a) Fitness Value vs Iterations - AOA Hyper-parameters



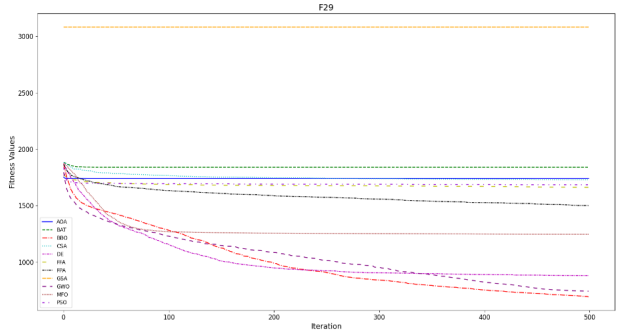
b) Error vs Iterations – AOA Hyper-parameters



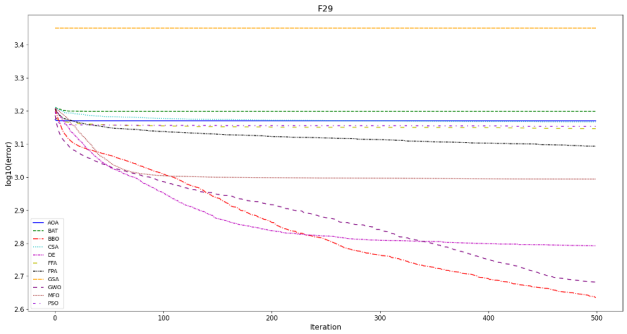
c) Fitness Value vs Iterations - Default Hyper-parameters



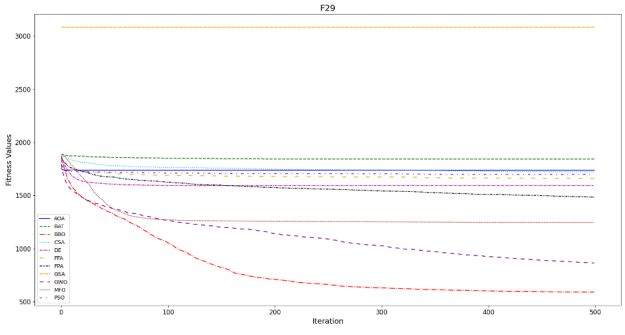
d) Error vs Iterations – Default Hyper-parameters



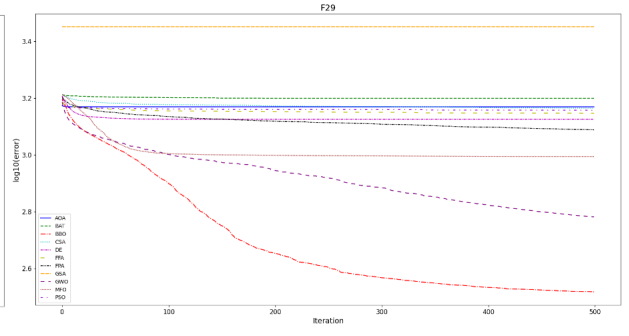
e) Fitness Value vs Iterations - AOA Hyper-parameters



f) Error vs Iterations – AOA Hyper-parameters

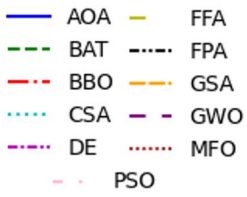


g) Fitness Value vs Iterations - Default Hyper-parameters



h) Error vs Iterations – Default Hyper-parameters

Figure 43: Line-Chart for F28-F29



a) Legend

Figure 44: Legend for F24-F29

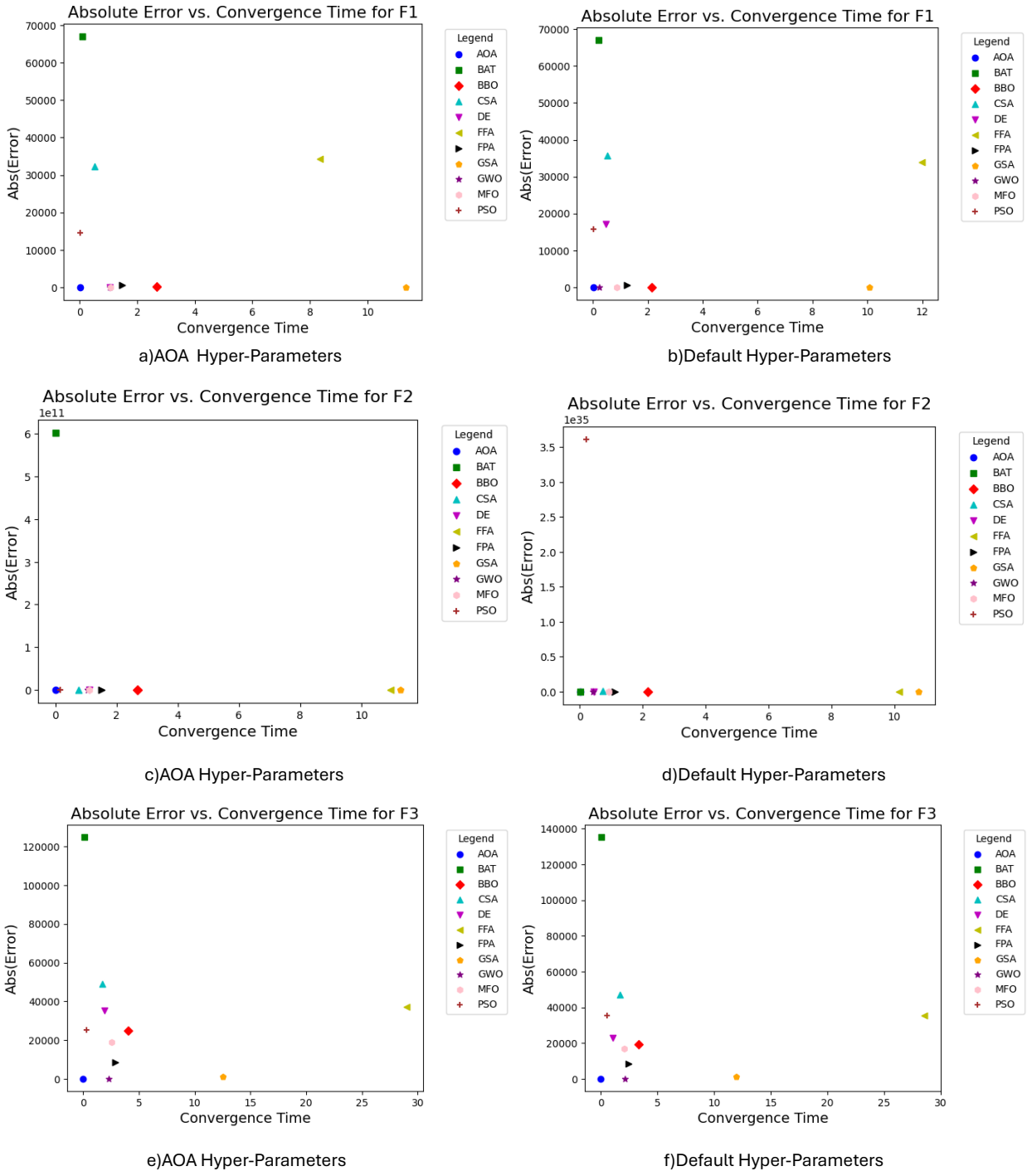


Figure 45: Absolute Error vs Convergence Time for F1 to F3 for 30 dimensions

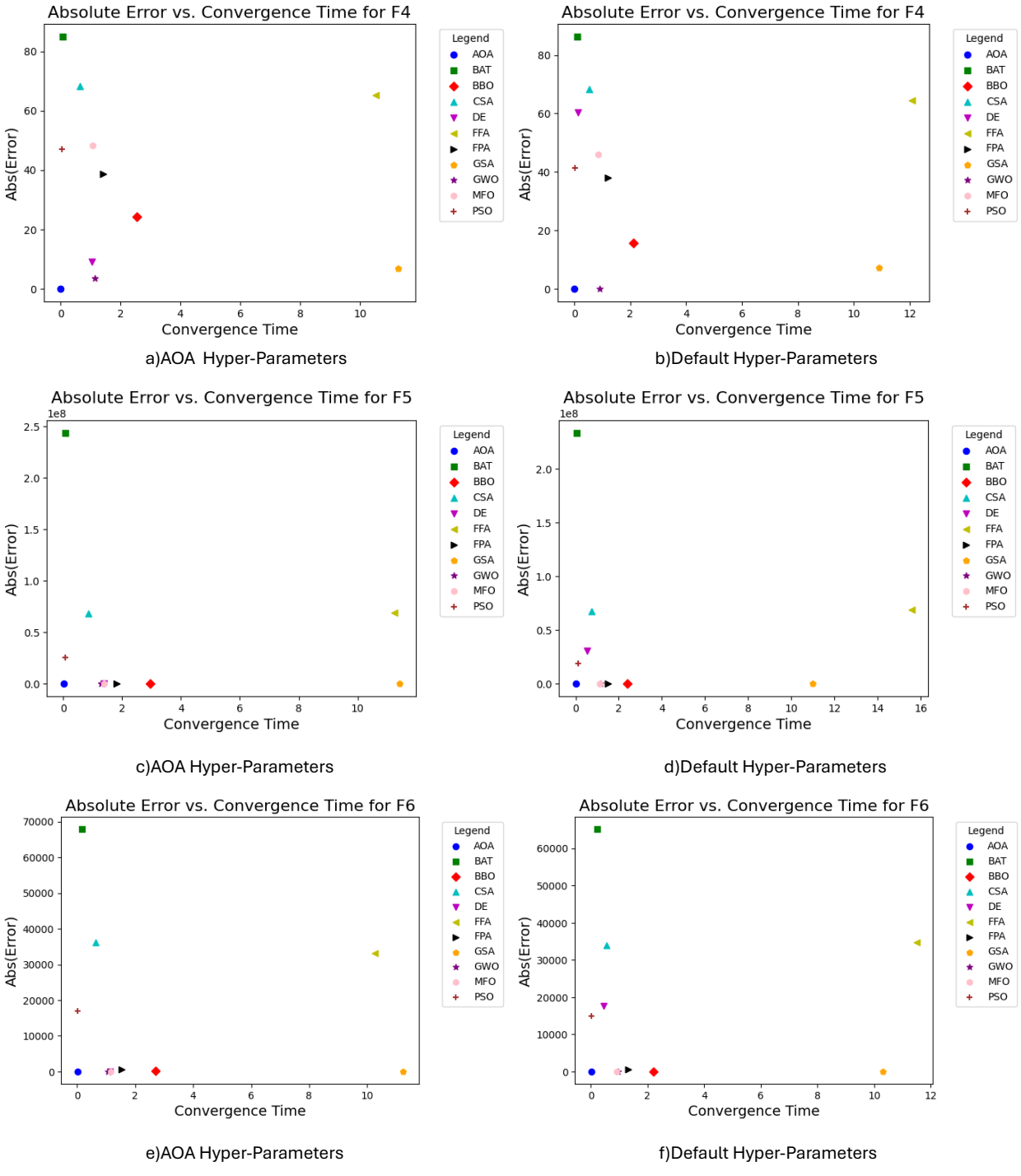


Figure 46: Absolute Error vs Convergence Time for F4 to F6 for 30 dimensions

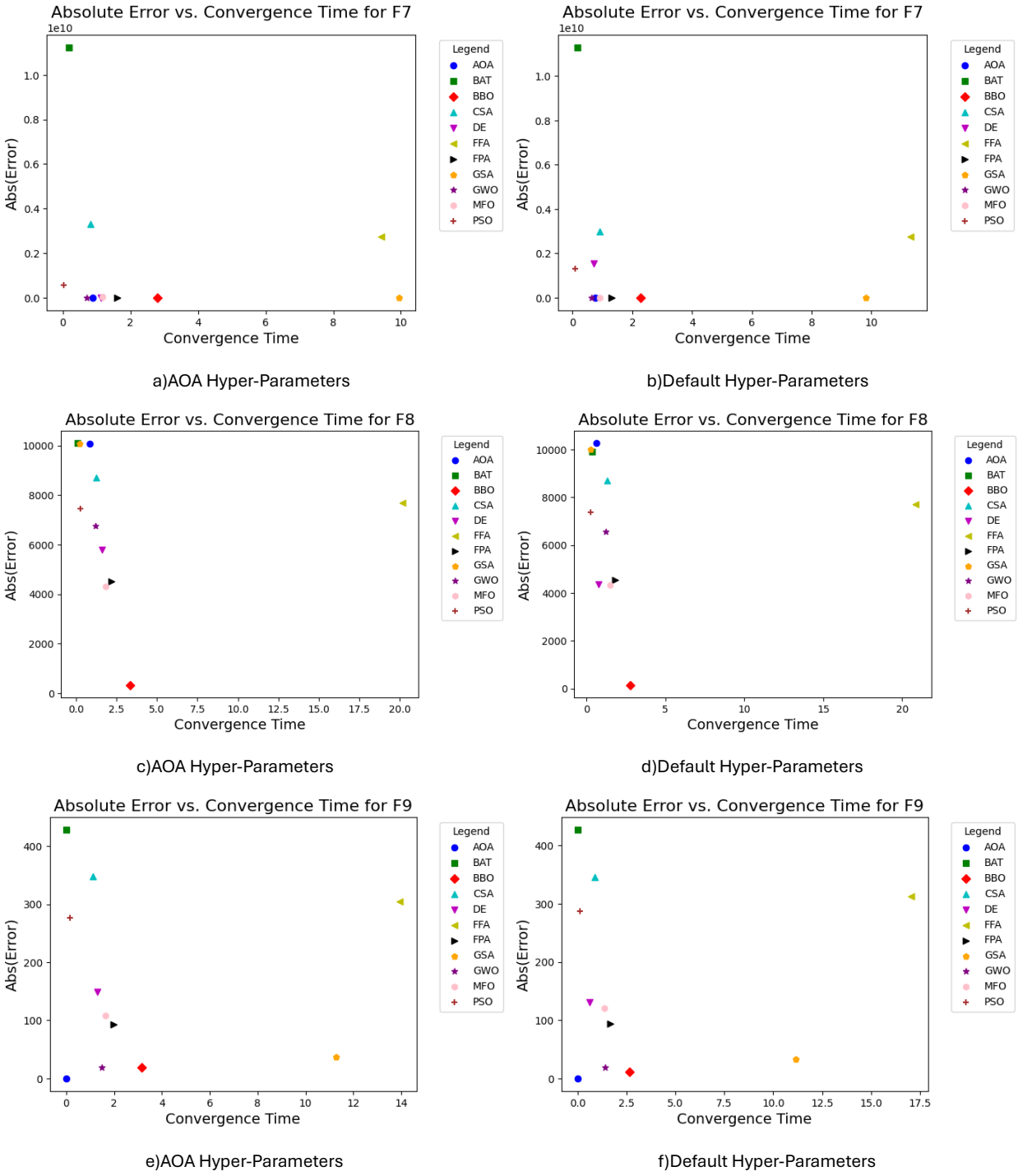


Figure 47: Absolute Error vs Convergence Time for F7 to F9 for 30 dimensions

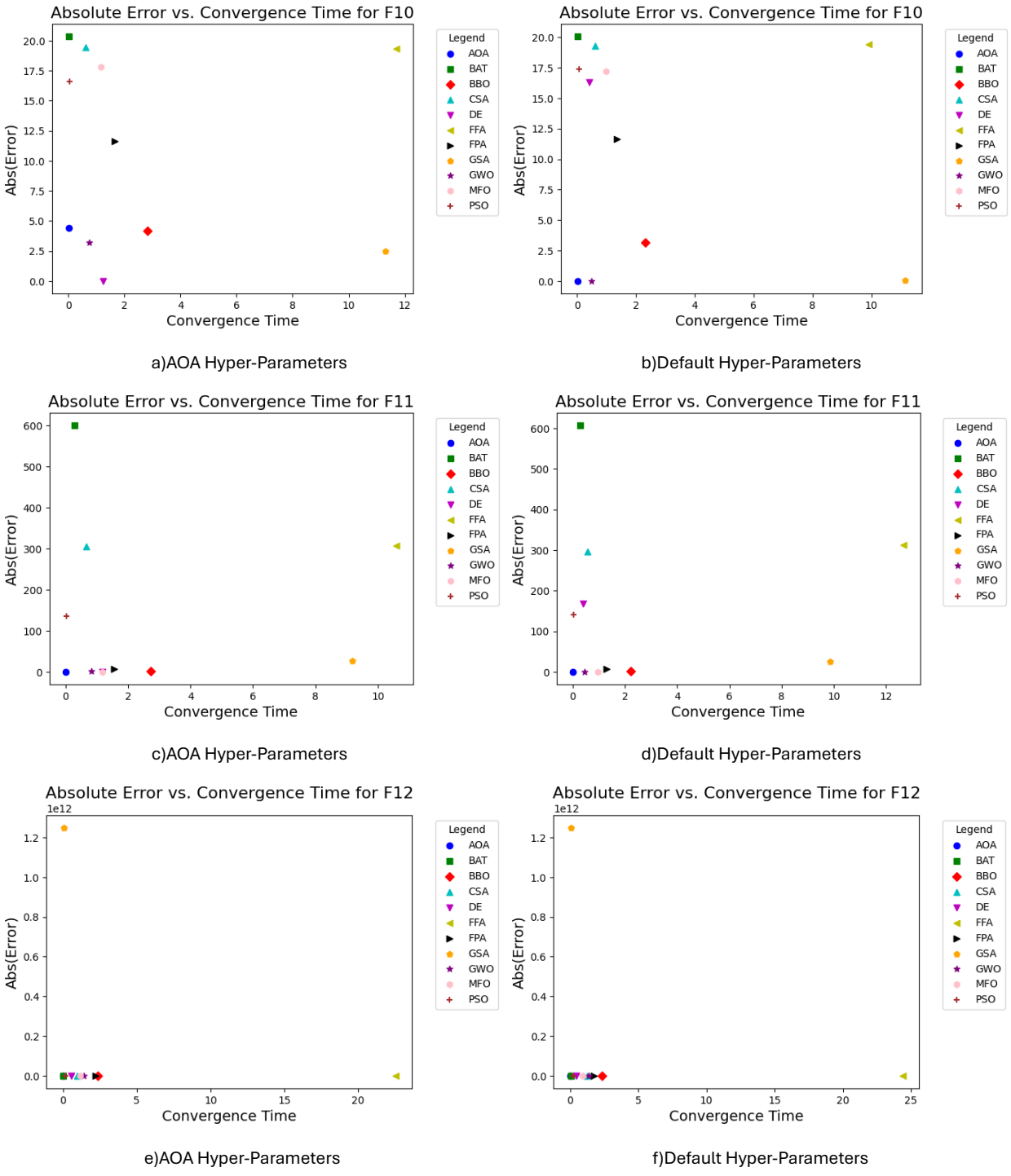


Figure 48: Absolute Error vs Convergence Time for F10 to F12 for 30 dimensions

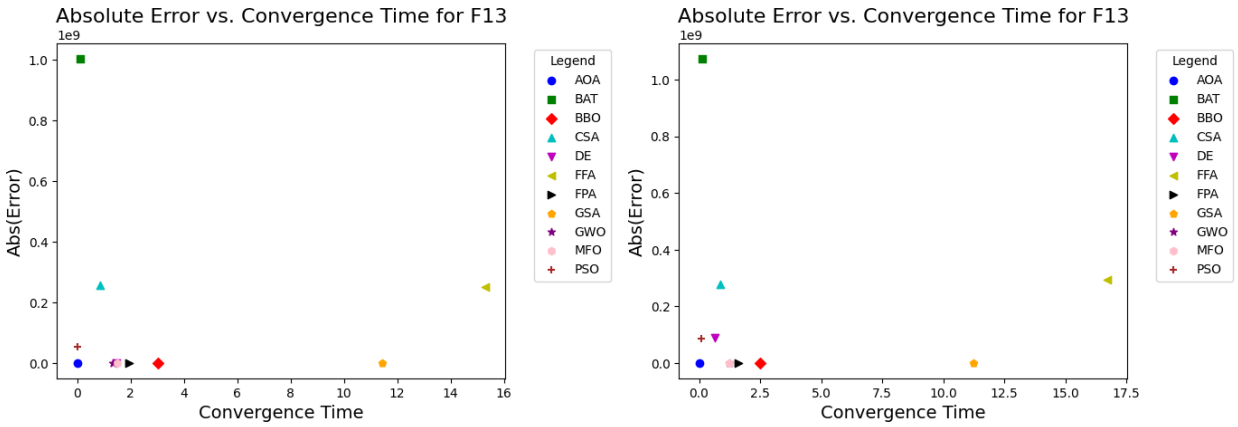


Figure 49: Absolute Error vs Convergence Time for F13 for 30 dimensions

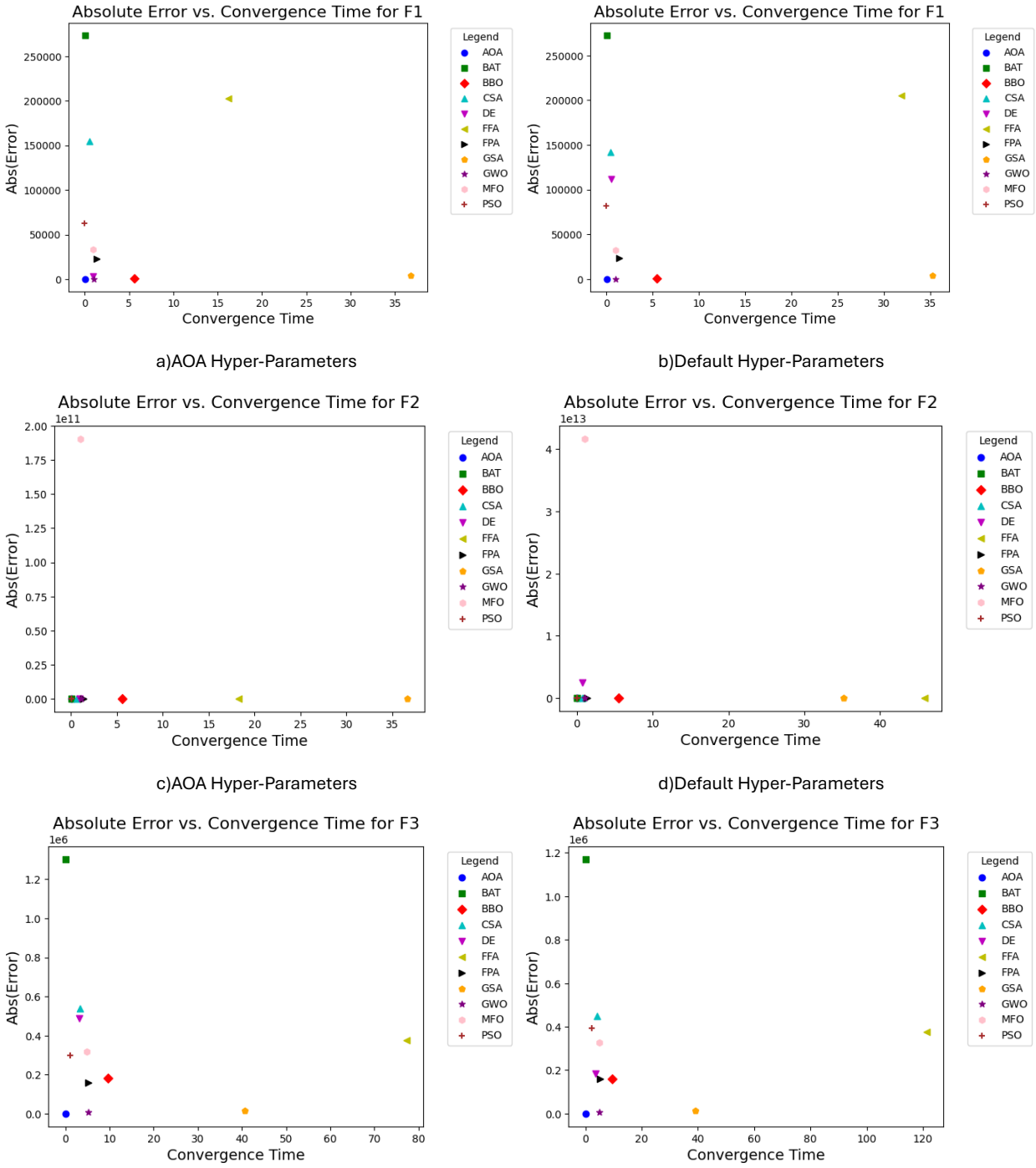


Figure 50: Absolute Error vs Convergence Time for F1 to F3 for 100 dimensions

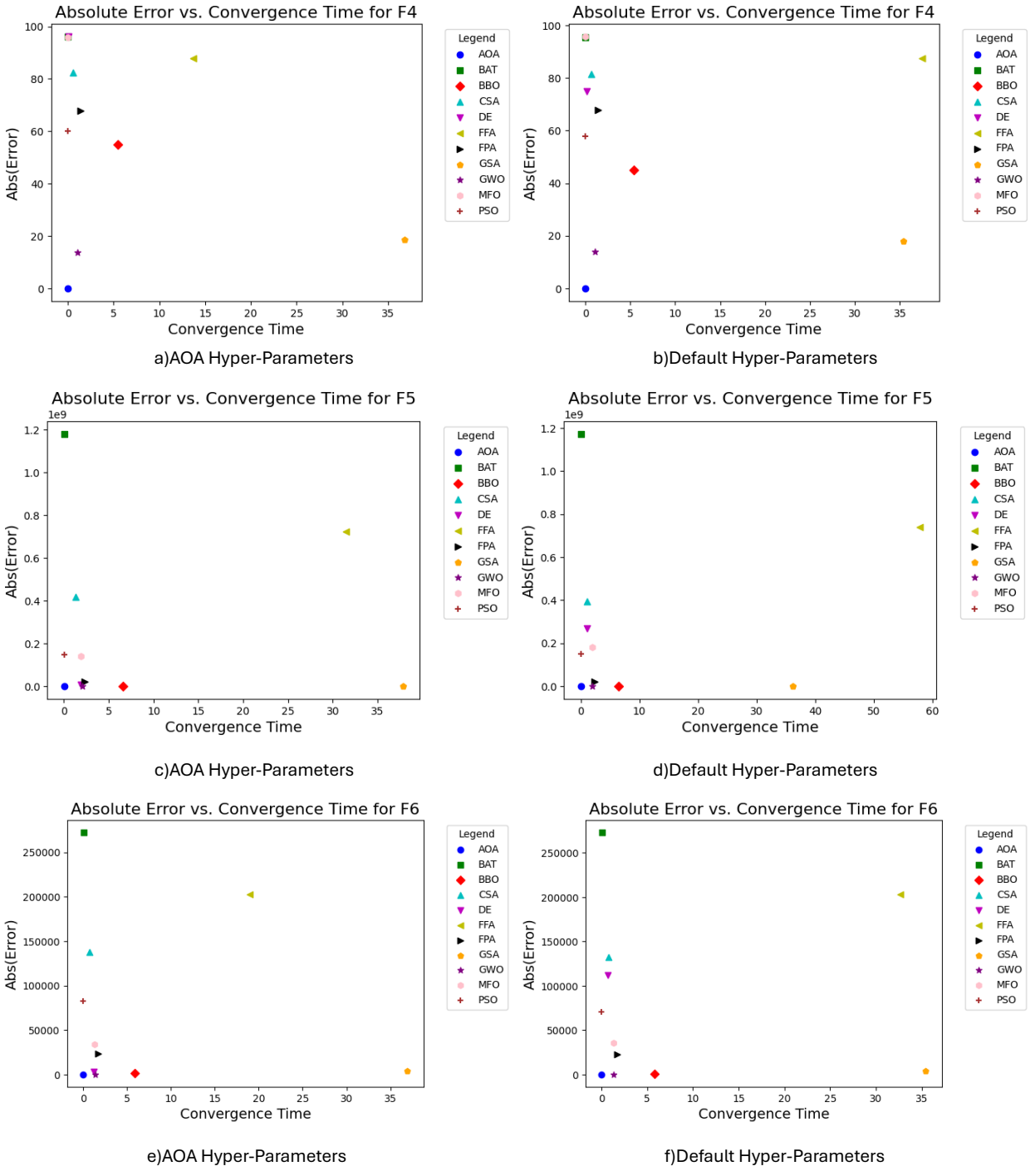


Figure 51: Absolute Error vs Convergence Time for F4 to F6 for 100 dimensions

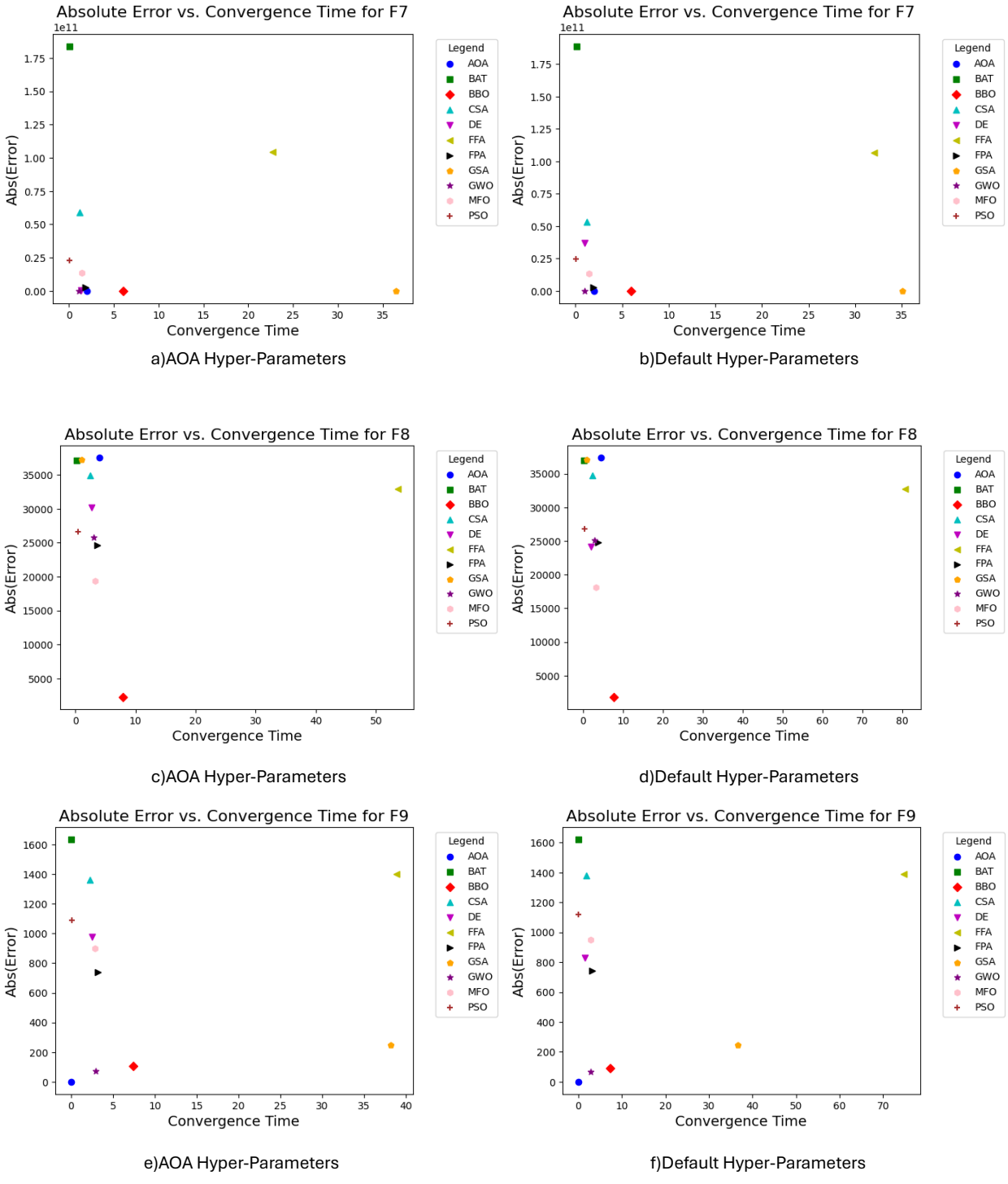


Figure 52: Absolute Error vs Convergence Time for F7 to F9 for 100 dimensions

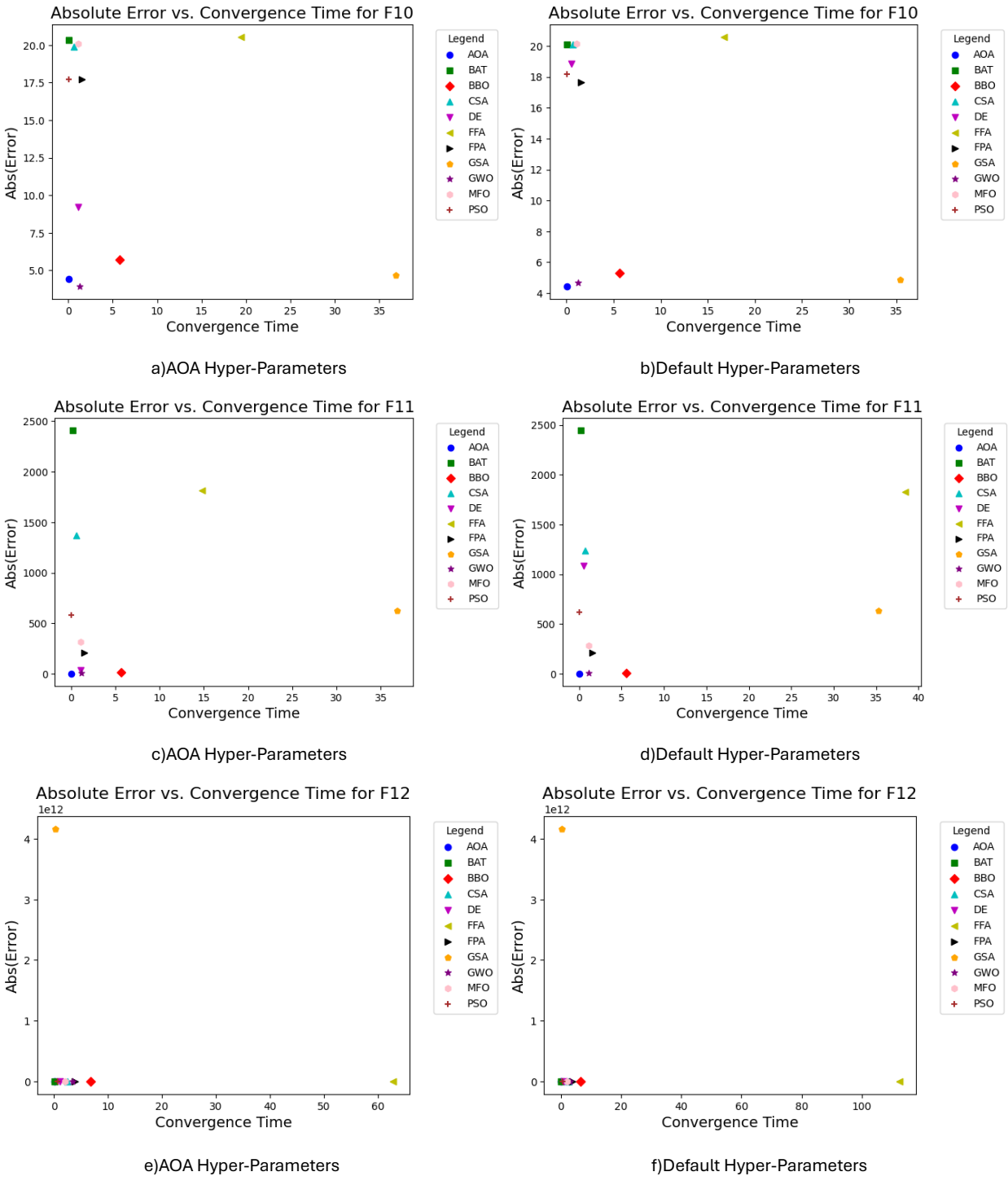


Figure 53: Absolute Error vs Convergence Time for F10 to F12 for 100 dimensions

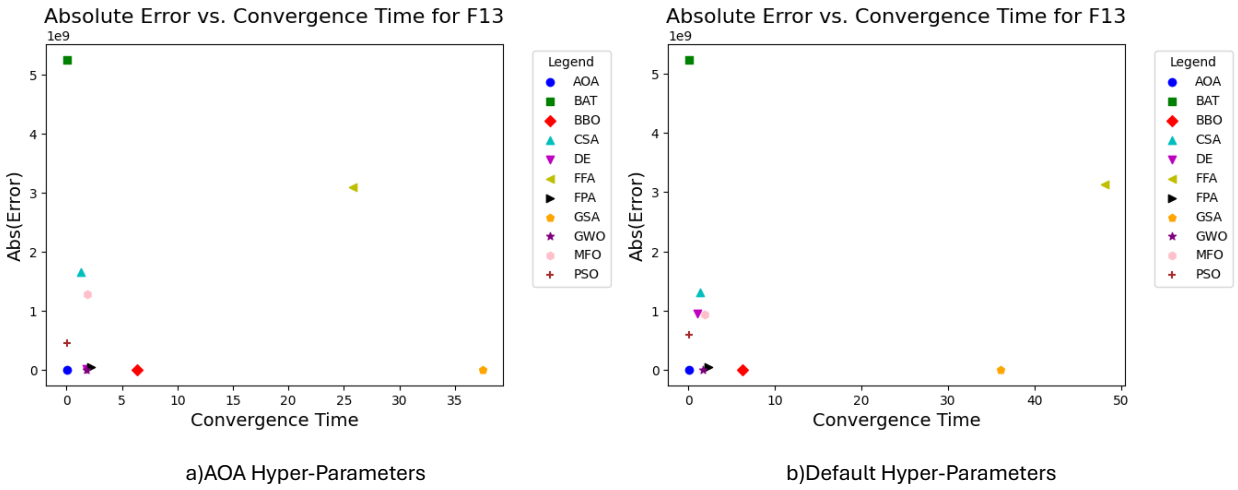


Figure 54: Absolute Error vs Convergence Time for F13 for 100 dimensions

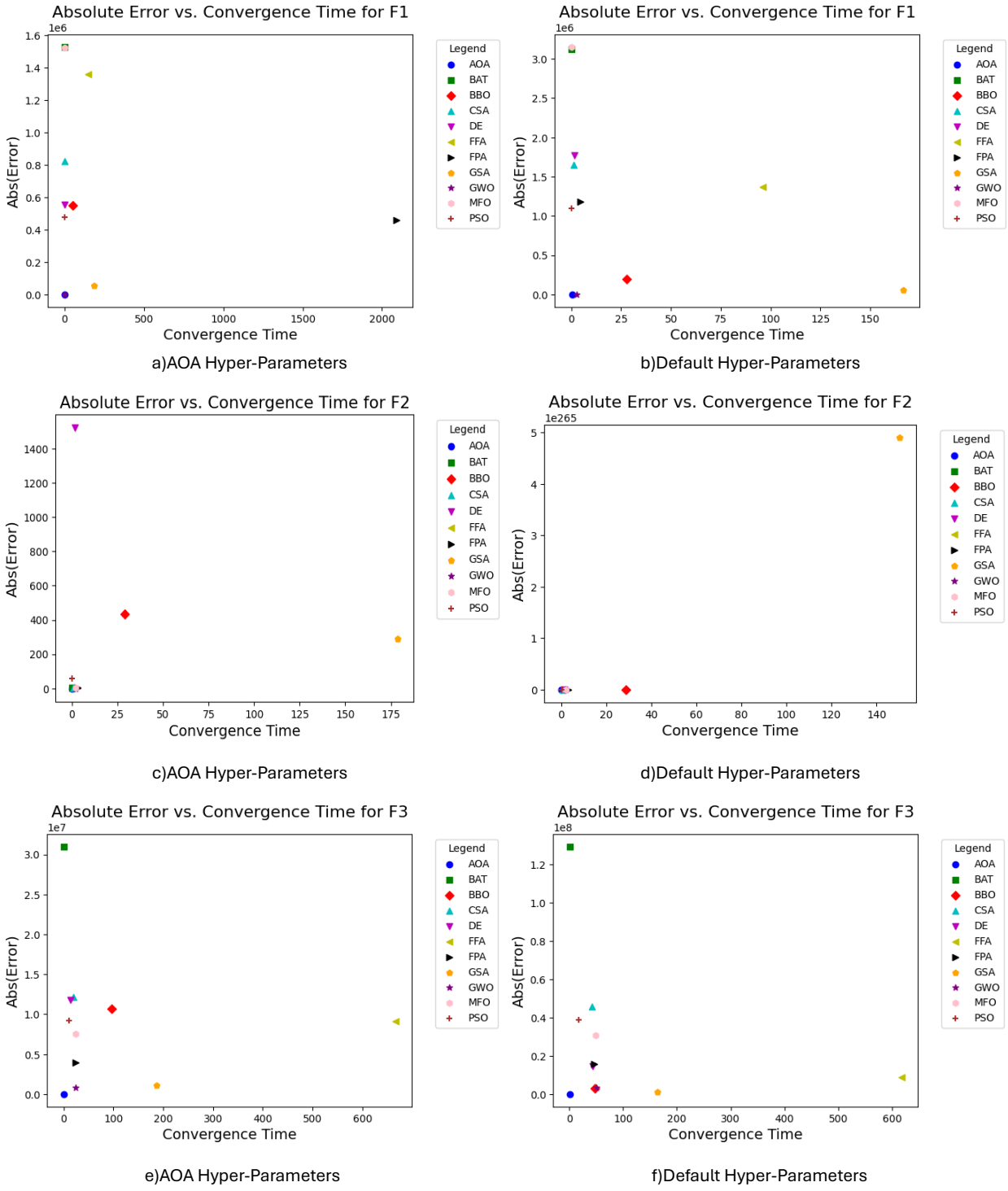
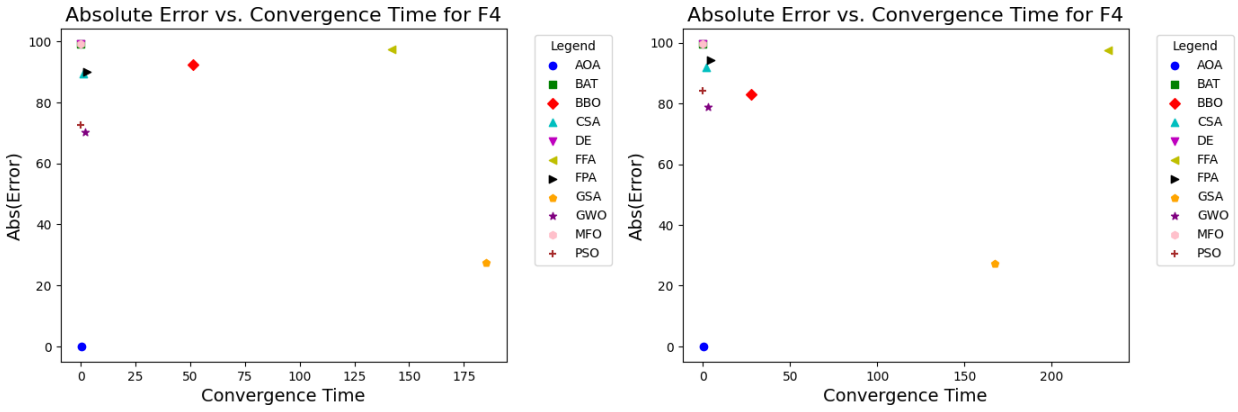
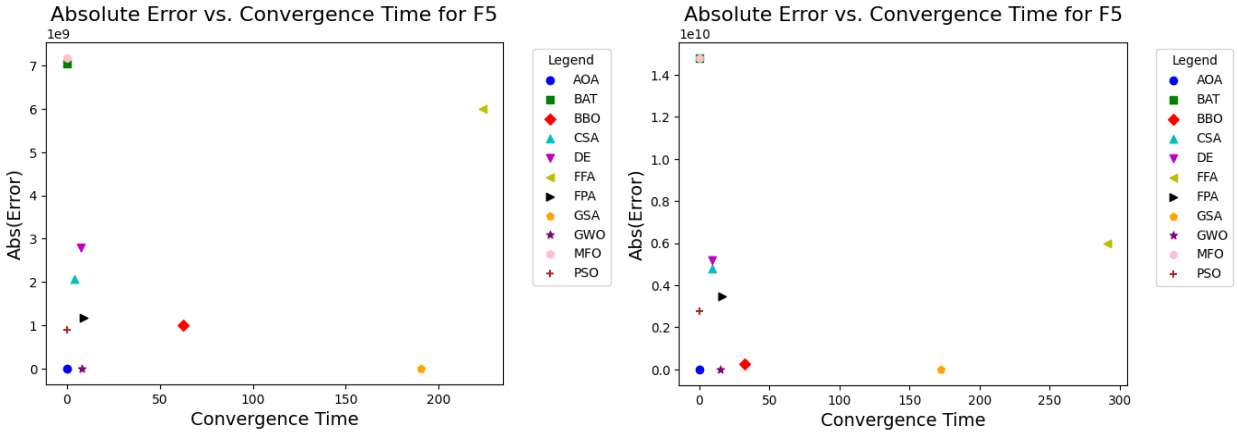


Figure 55: Absolute Error vs Convergence Time for F1 to F3 for 500 dimensions



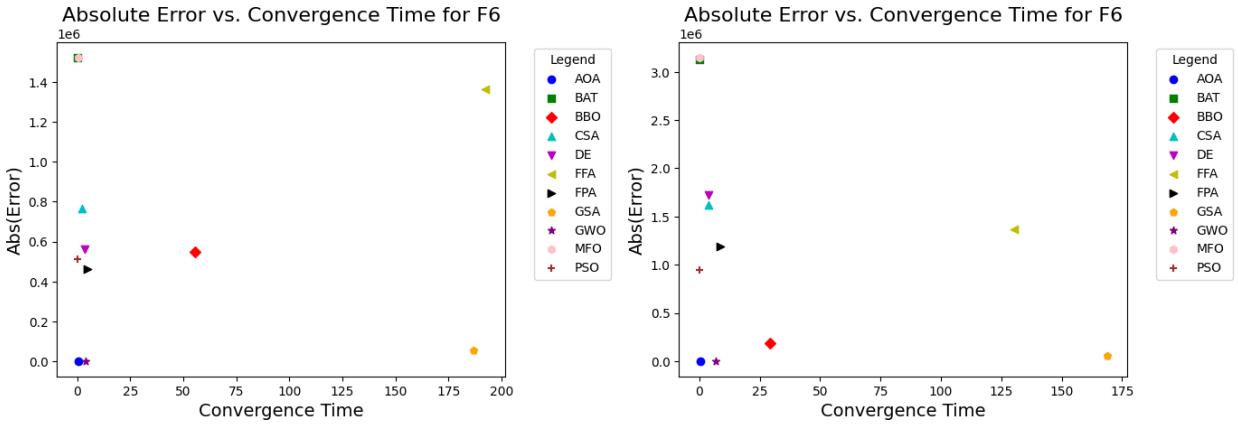
a)AOA Hyper-Parameters

b)Default Hyper-Parameters



c)AOA Hyper-Parameters

d)Default Hyper-Parameters



e)AOA Hyper-Parameters

f)Default Hyper-Parameters

Figure 56: Absolute Error vs Convergence Time for F4 to F6 for 500 dimensions

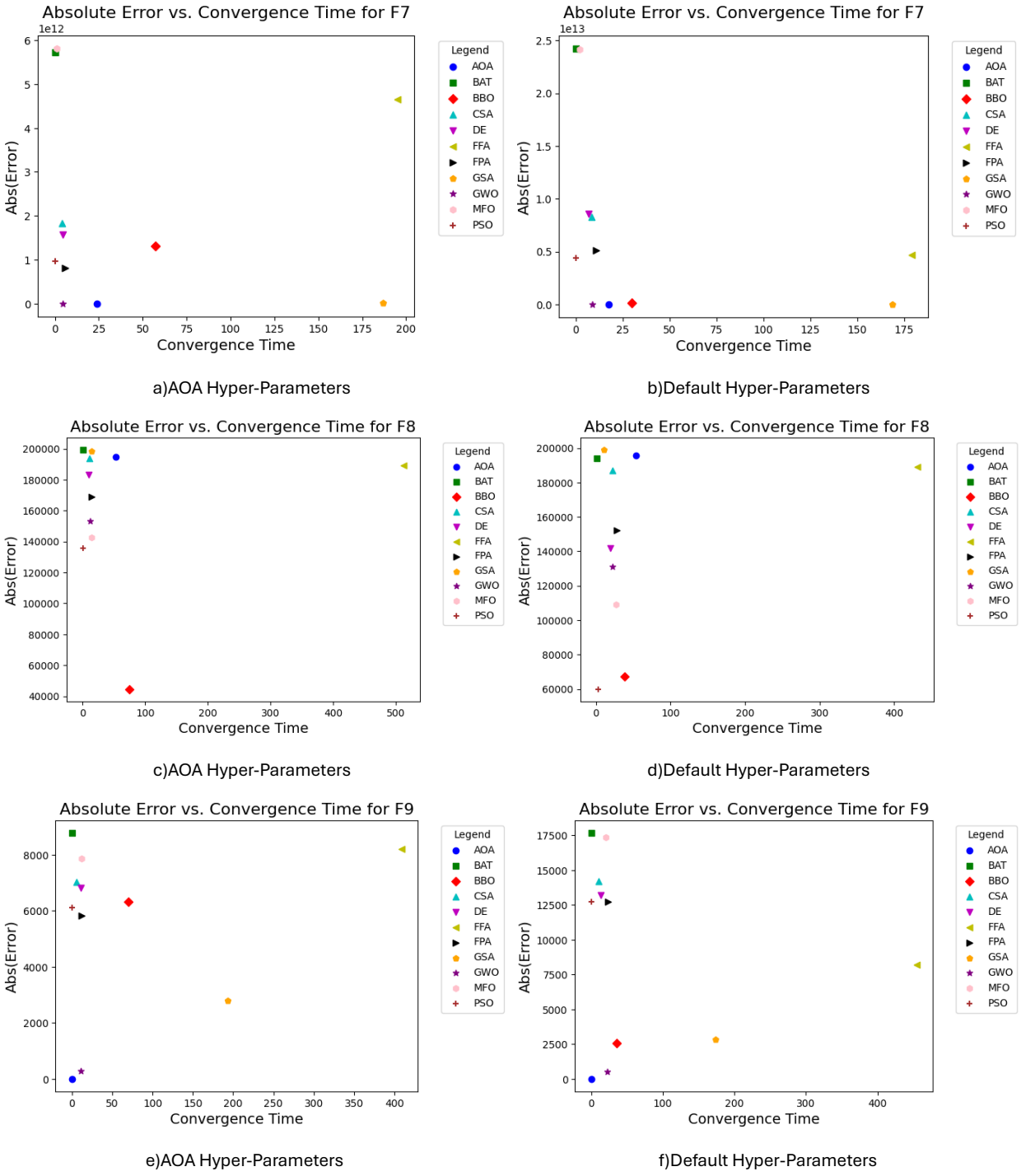


Figure 57: Absolute Error vs Convergence Time for F7 to F9 for 500 dimensions

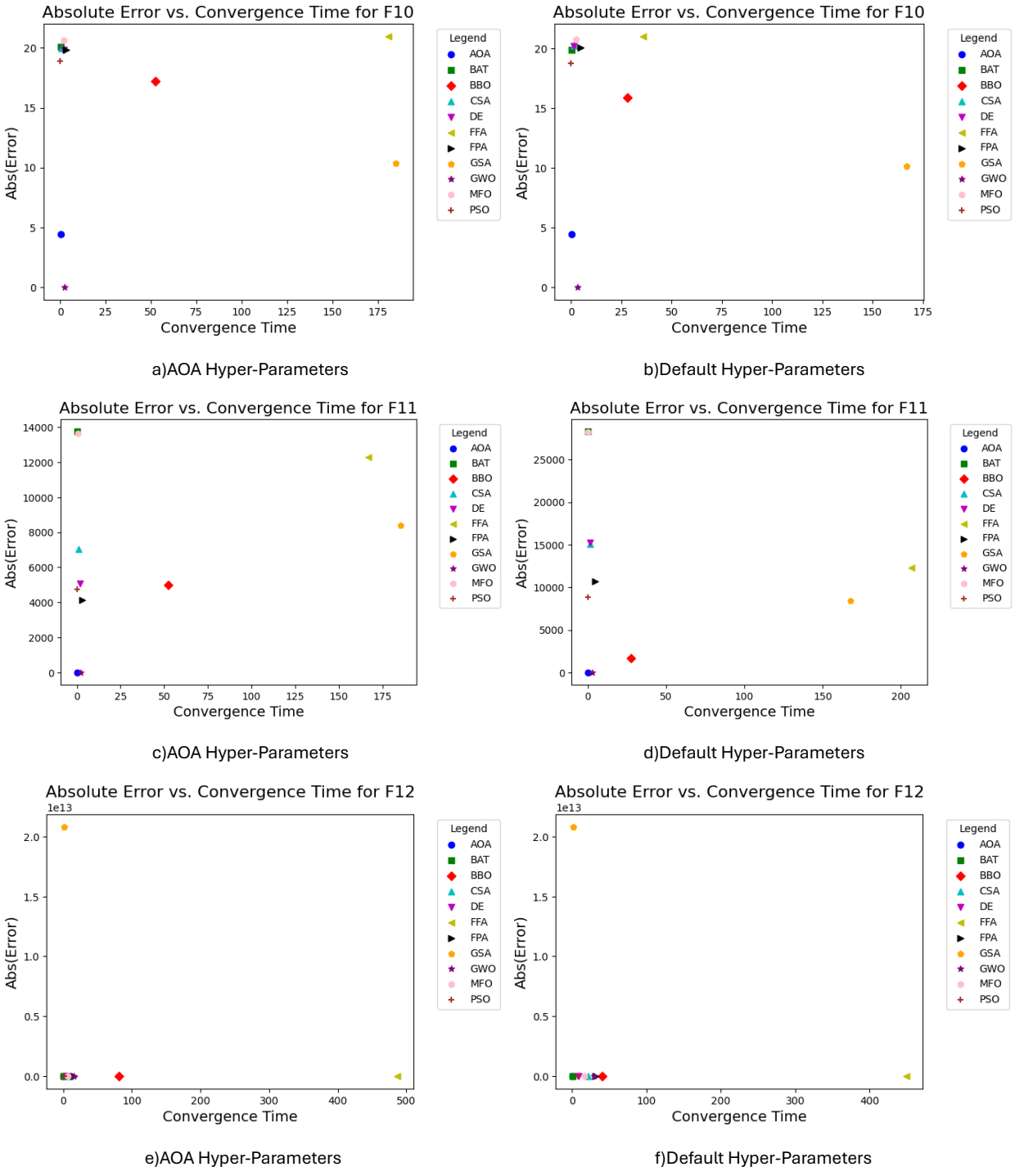
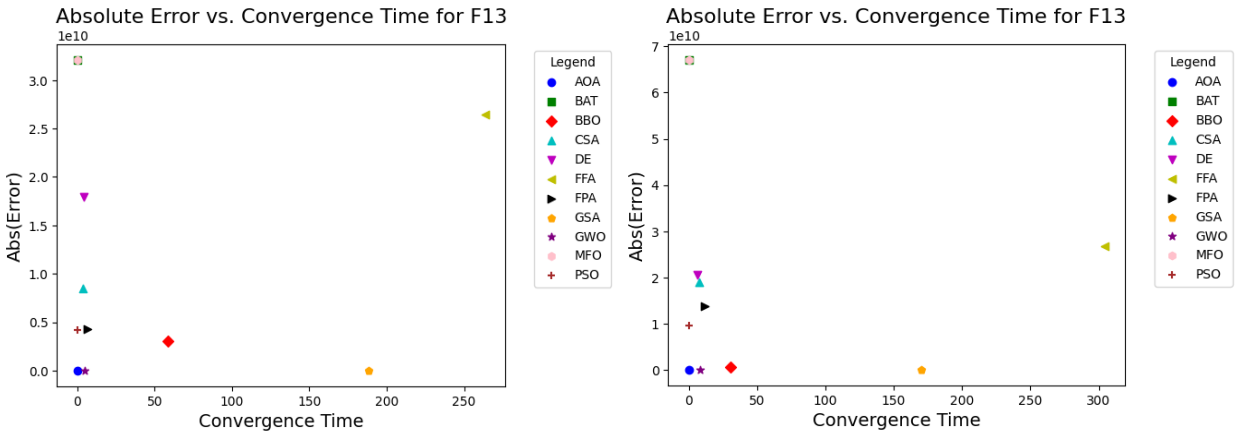


Figure 58: Absolute Error vs Convergence Time for F10 to F12 for 500 dimensions



a)AOA Hyper-Parameters

b)Default Hyper-Parameters

Figure 59: Absolute Error vs Convergence Time for F13 for 500 dimensions

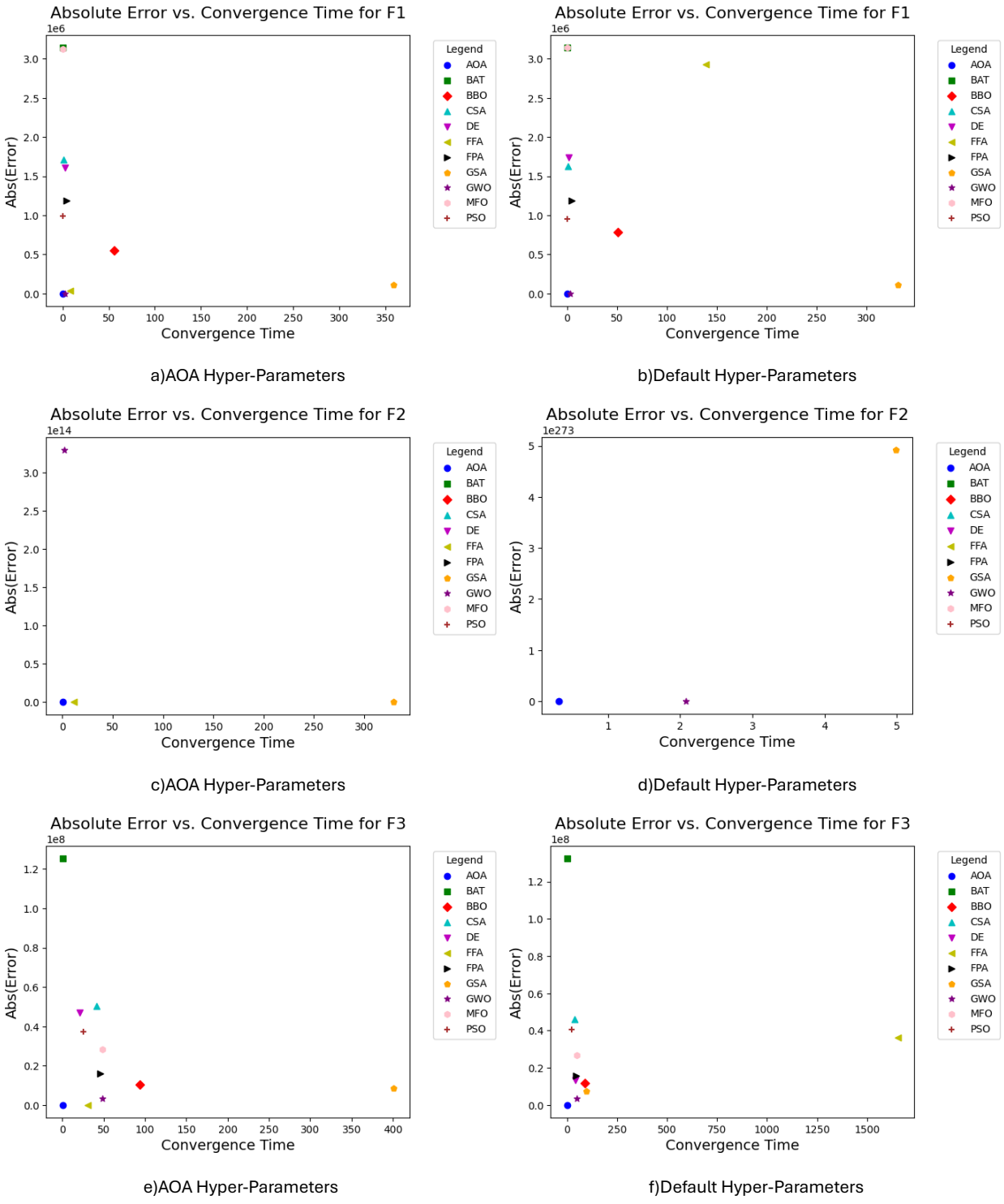


Figure 60: Absolute Error vs Convergence Time for F1 to F3 for 1000 dimensions

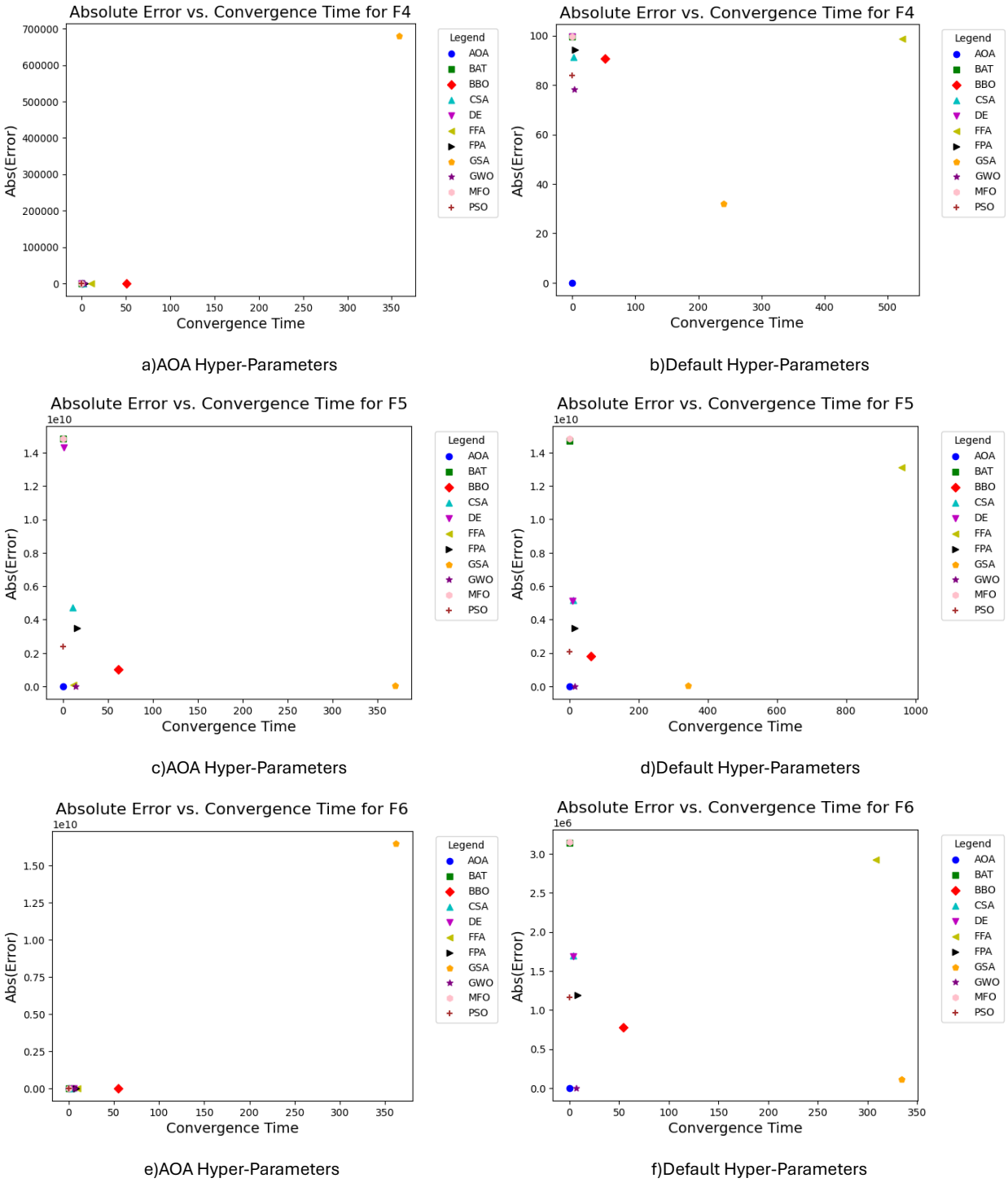


Figure 61: Absolute Error vs Convergence Time for F4 to F6 for 1000 dimensions

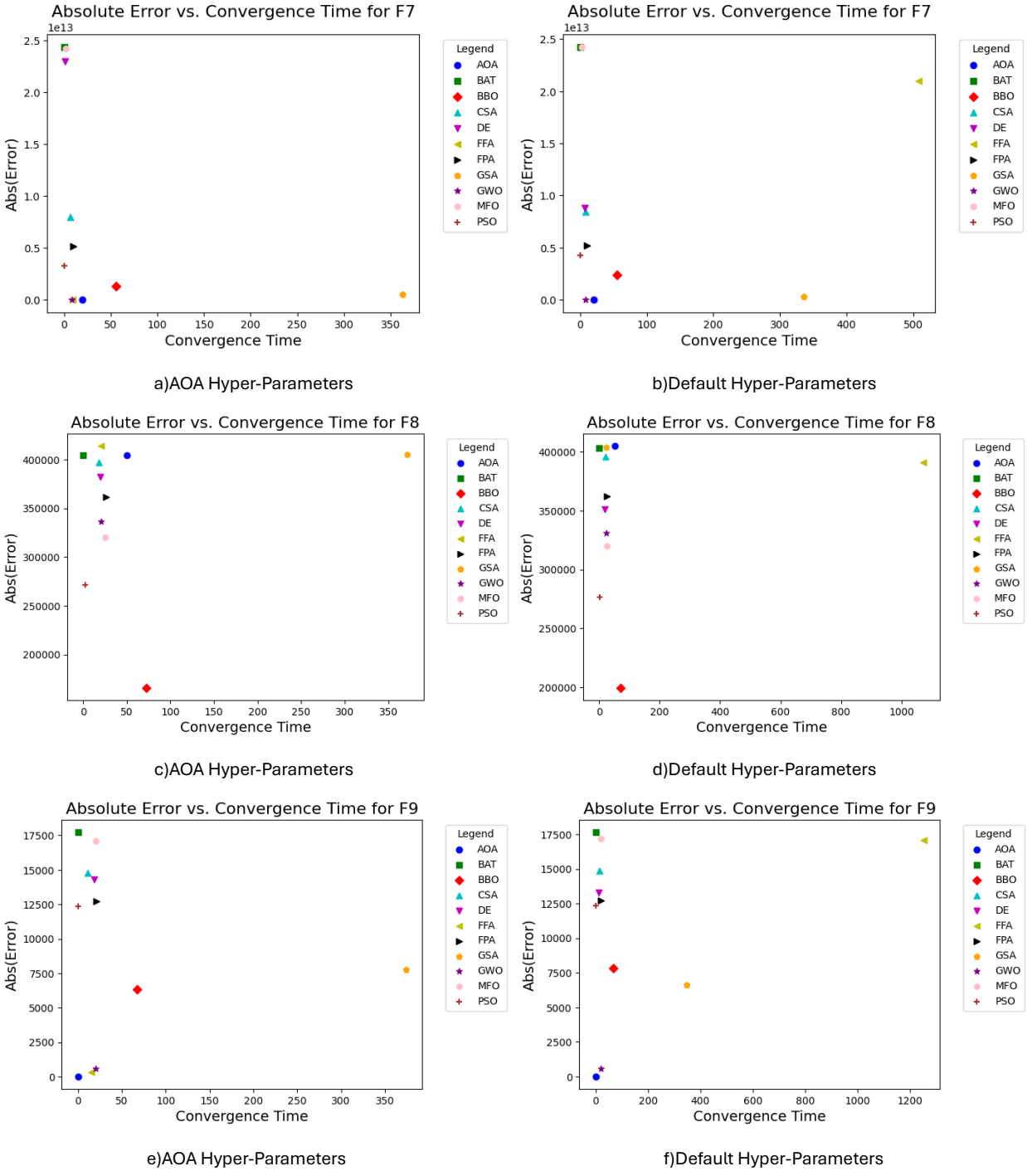


Figure 62: Absolute Error vs Convergence Time for F7 to F9 for 1000 dimensions

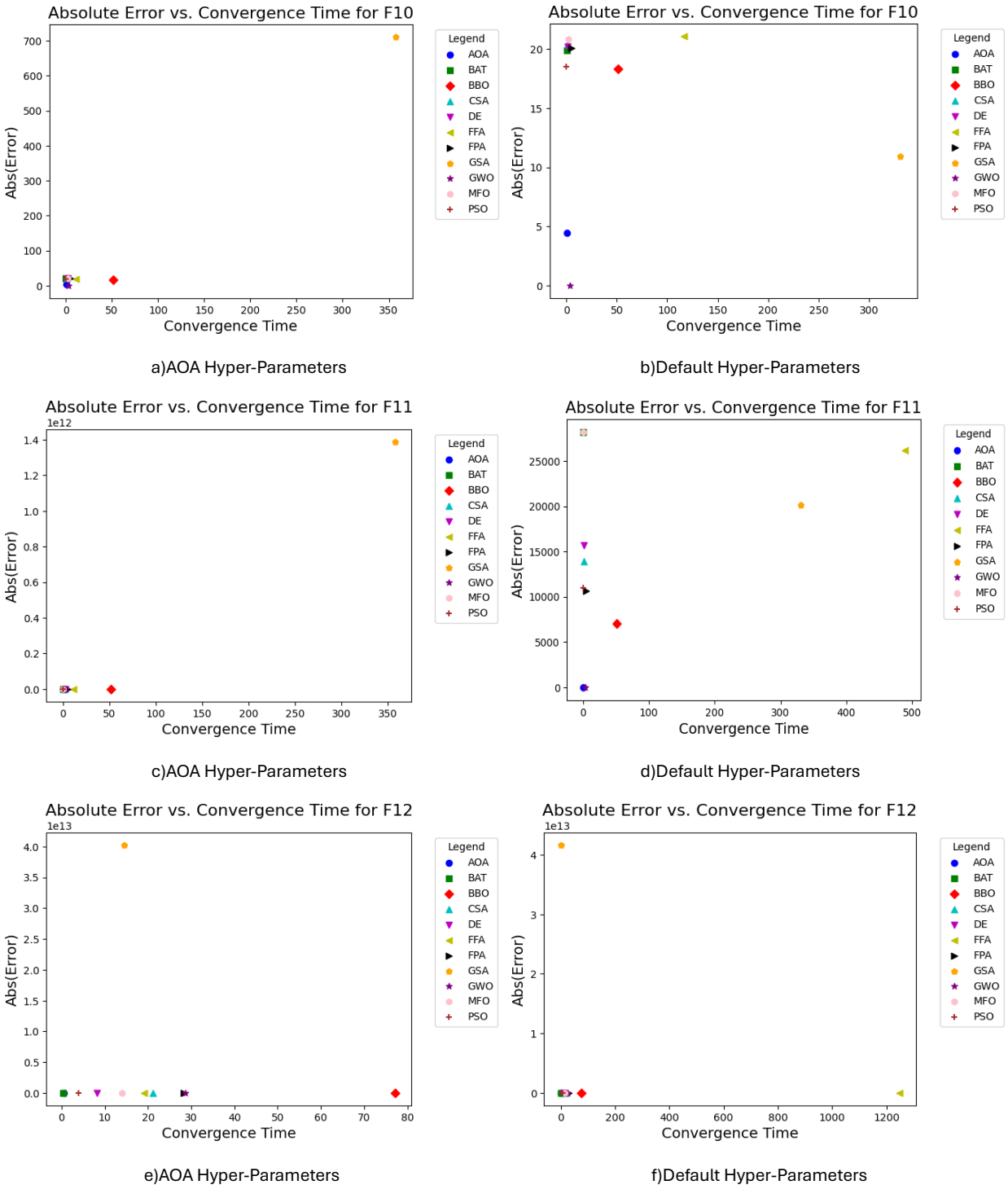


Figure 63: Absolute Error vs Convergence Time for F10 to F12 for 1000 dimensions

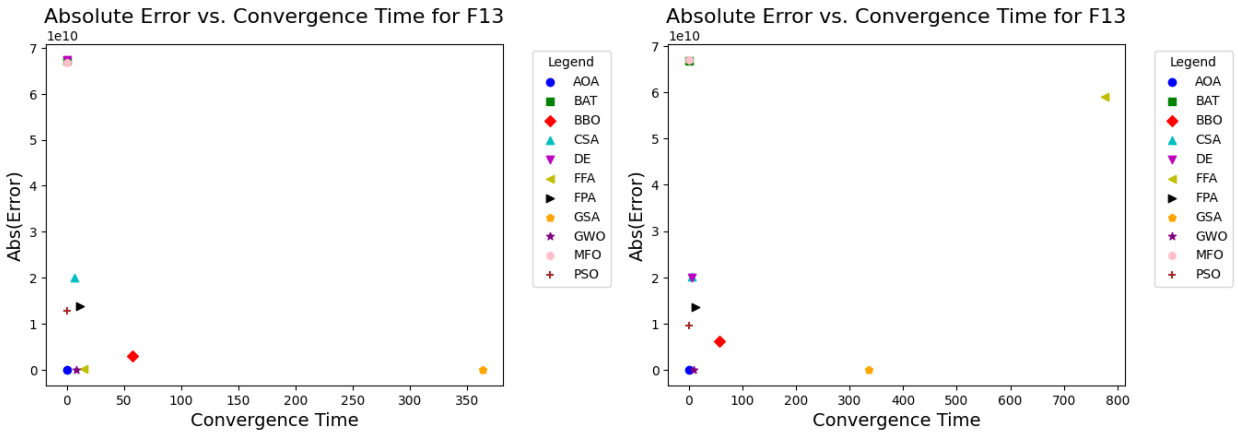


Figure 64: Absolute Error vs Convergence Time for F13 for 1000 dimensions

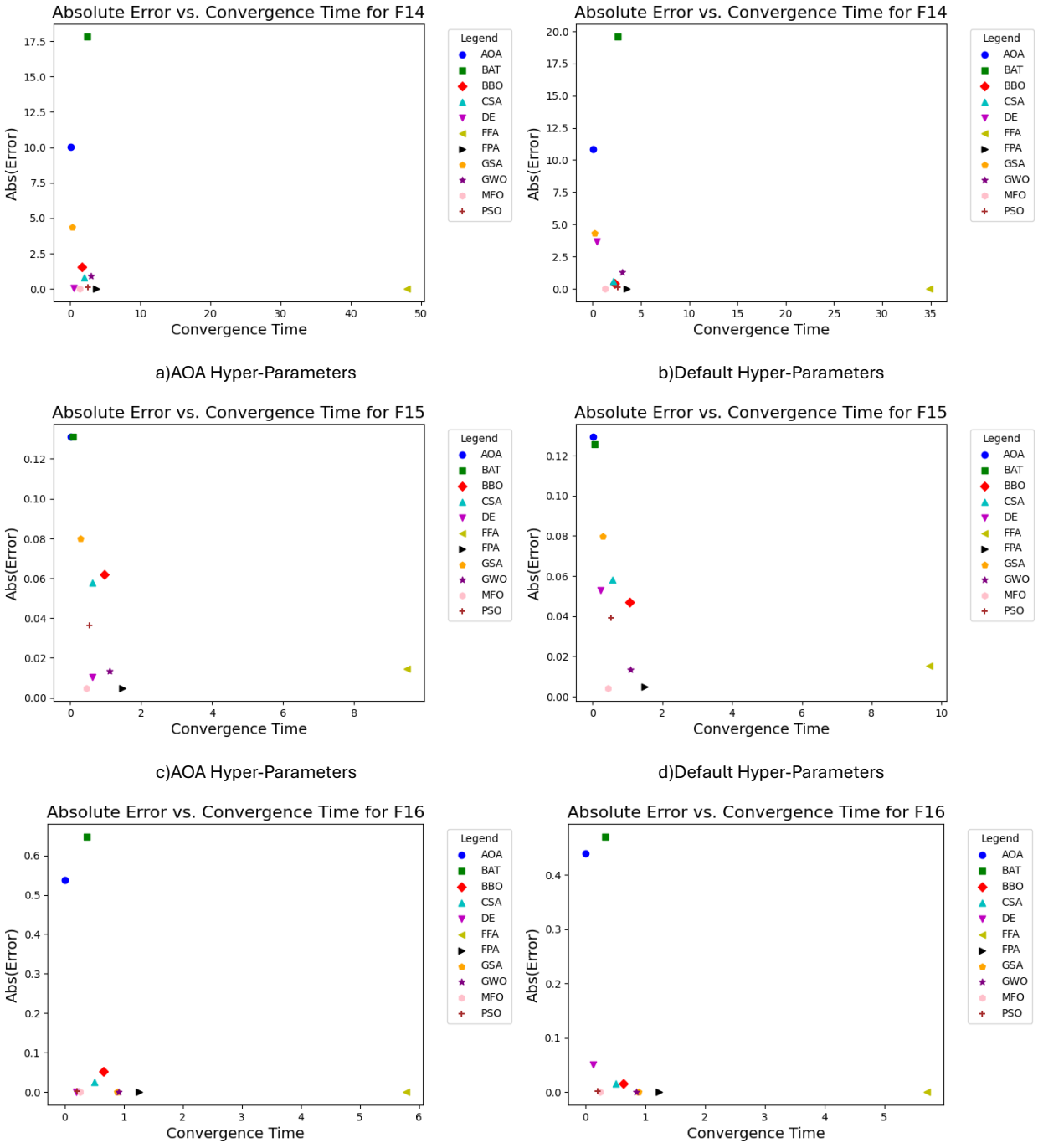


Figure 65: Absolute Error vs Convergence Time for F14 to F16

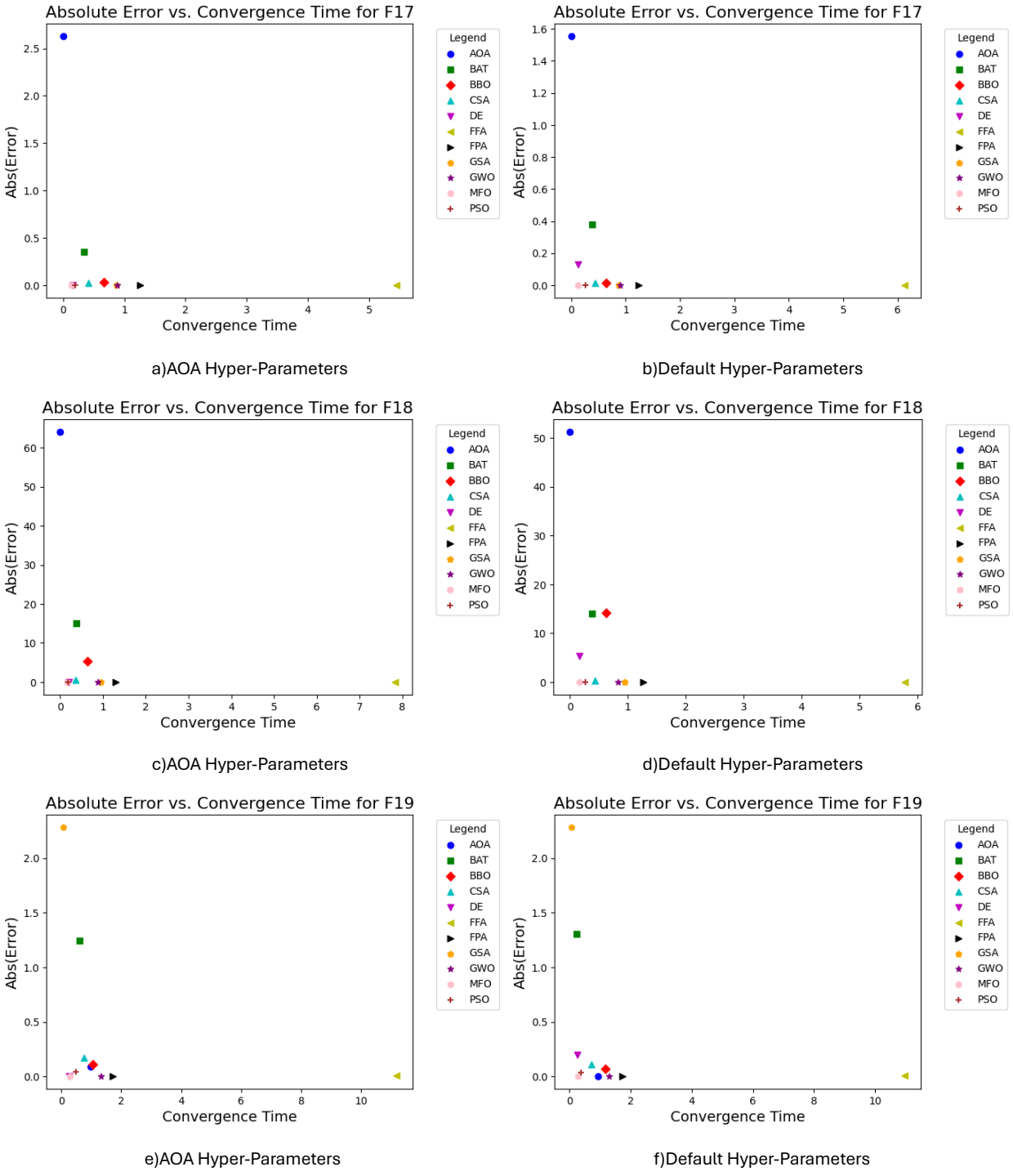


Figure 66: Absolute Error vs Convergence Time for F17 to F19

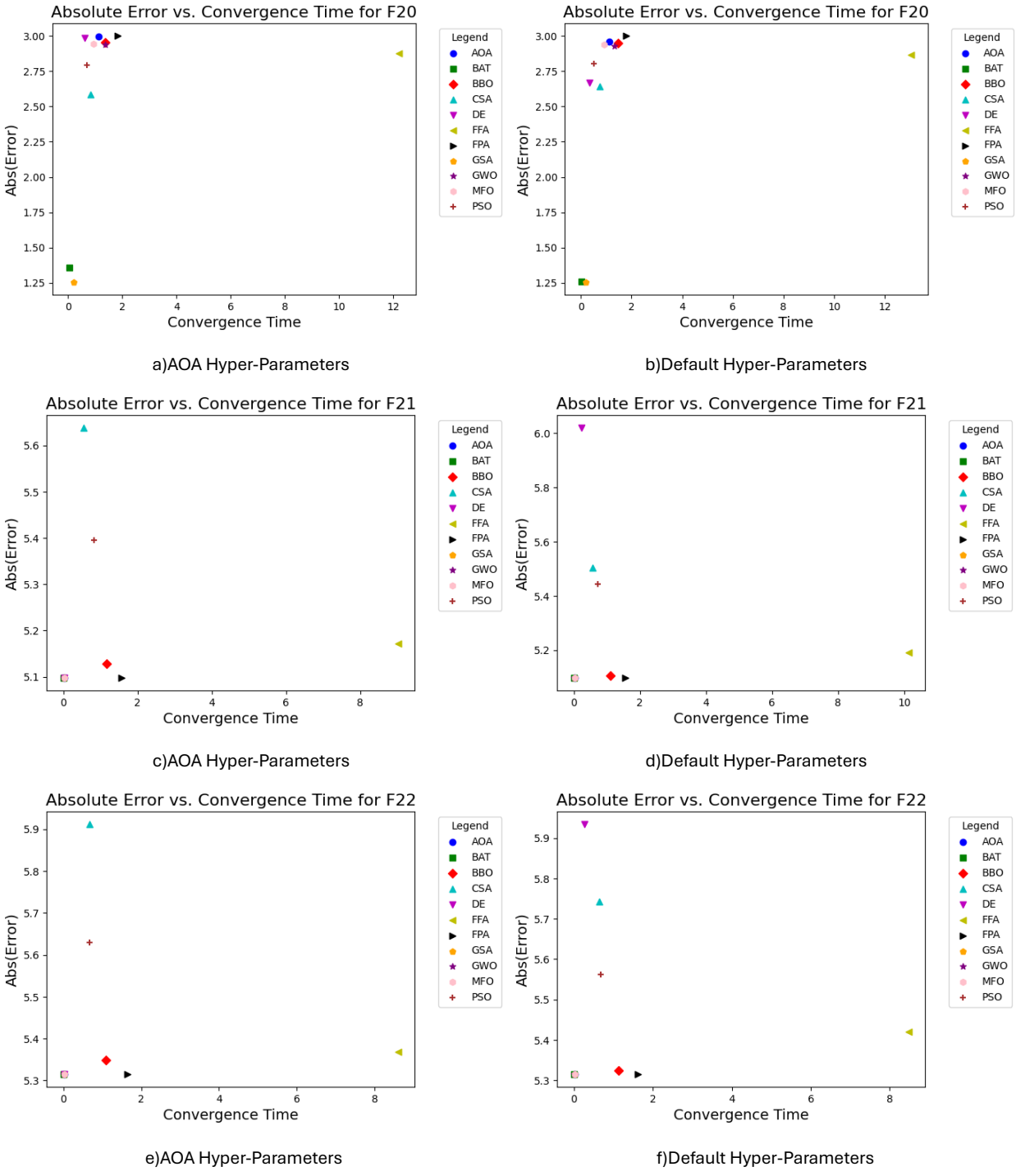


Figure 67: Absolute Error vs Convergence Time for F20 to F22

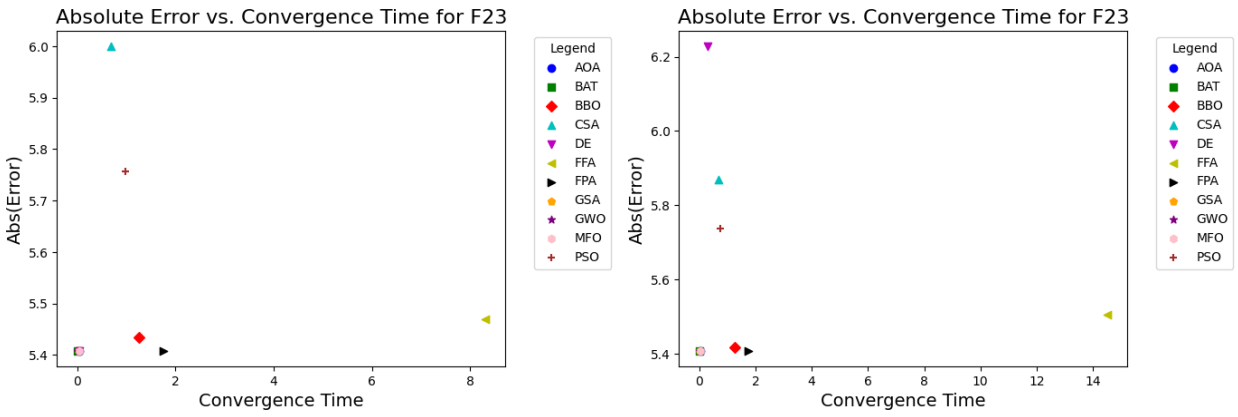


Figure 68: Absolute Error vs Convergence Time for F23

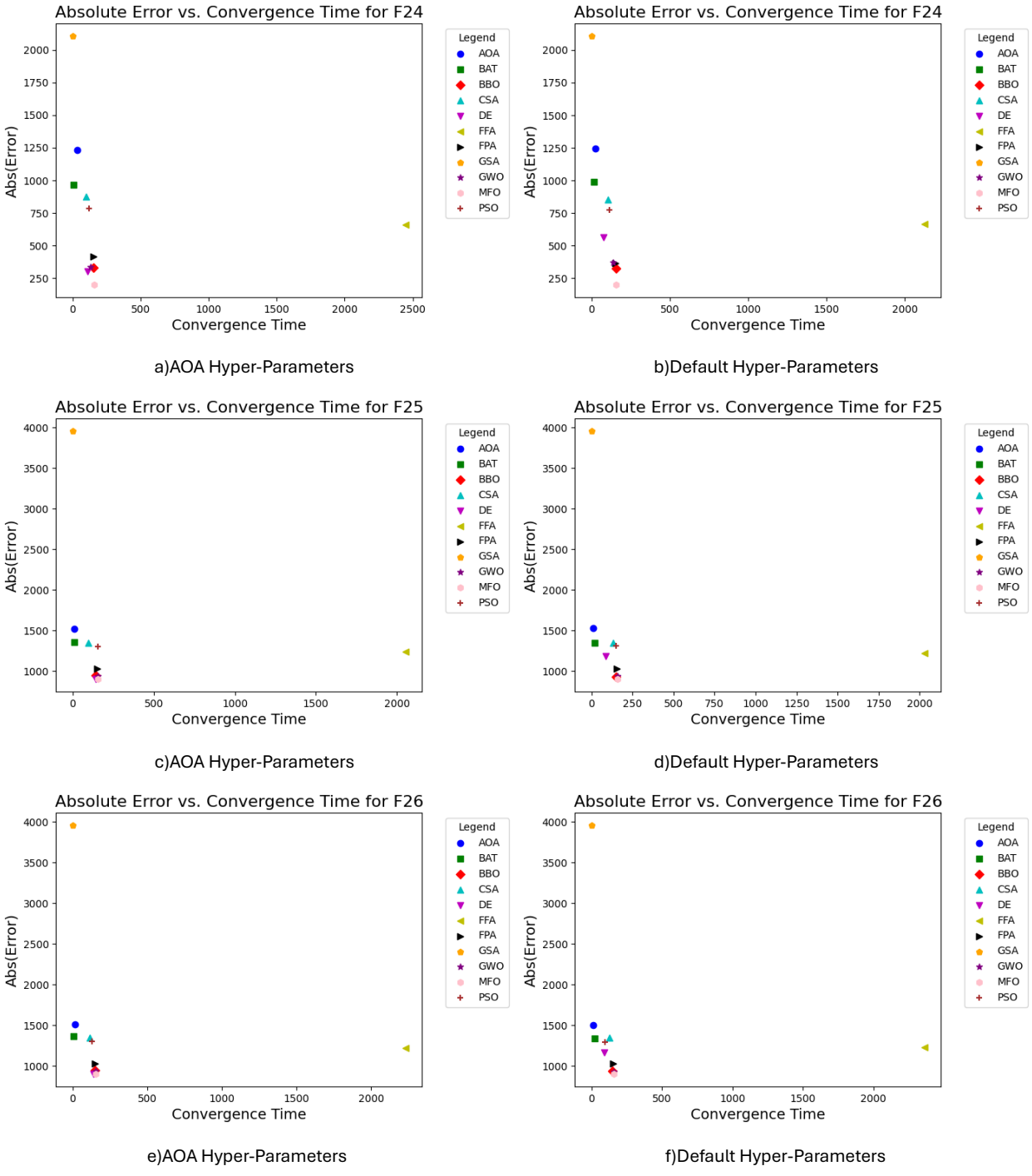


Figure 69: Absolute Error vs Convergence Time for F24 to F26

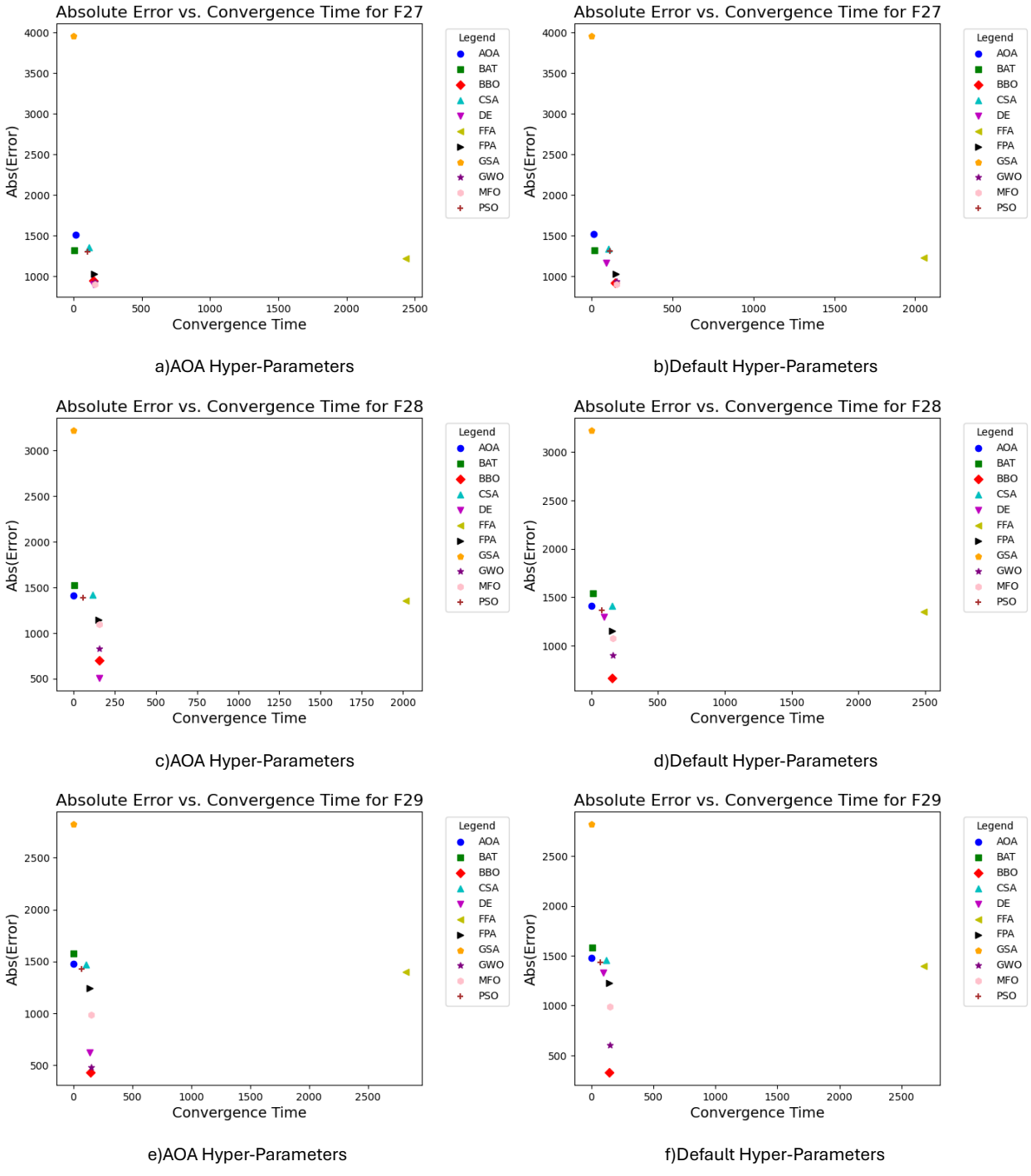


Figure 70: Absolute Error vs Convergence Time for F27 to F29

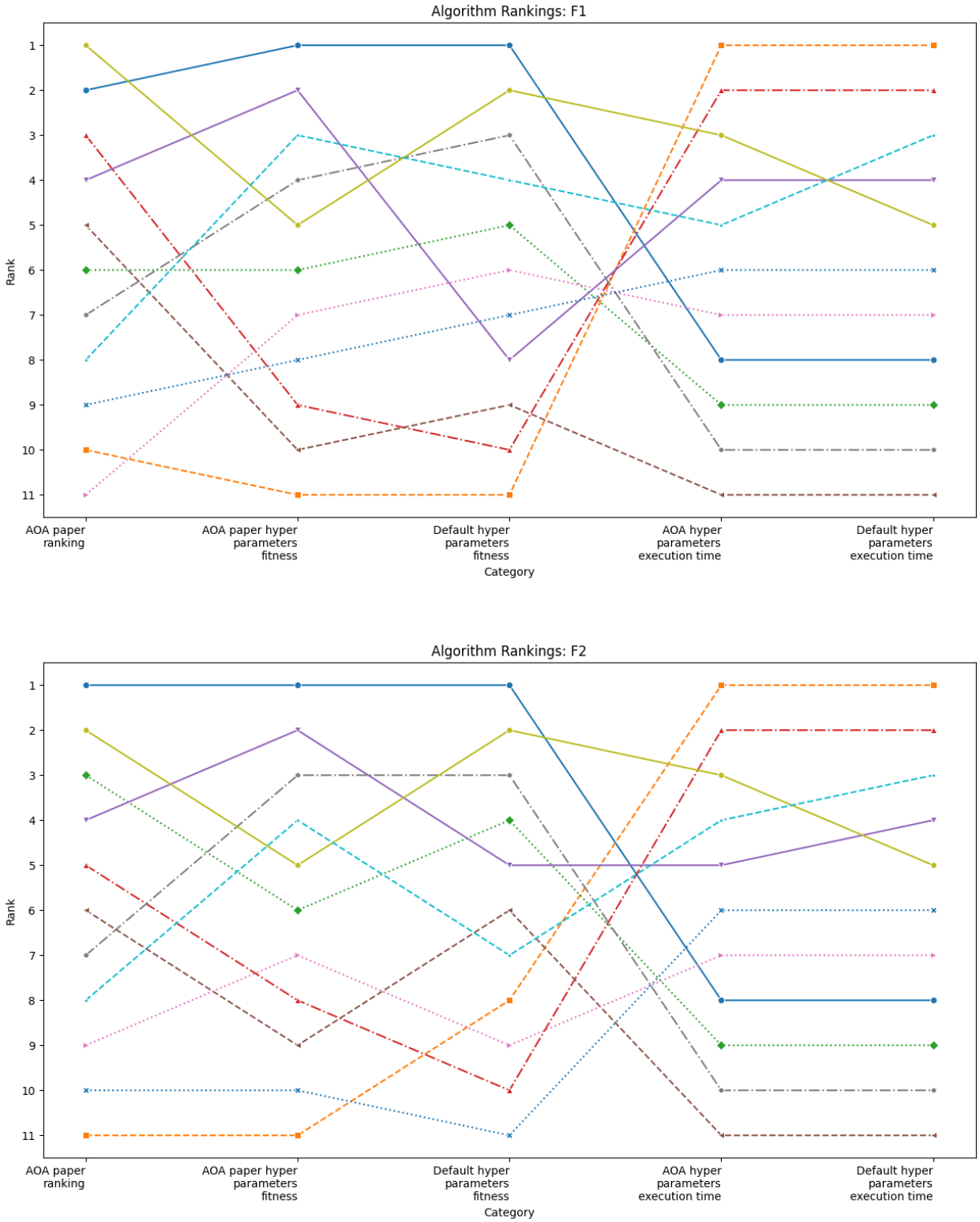
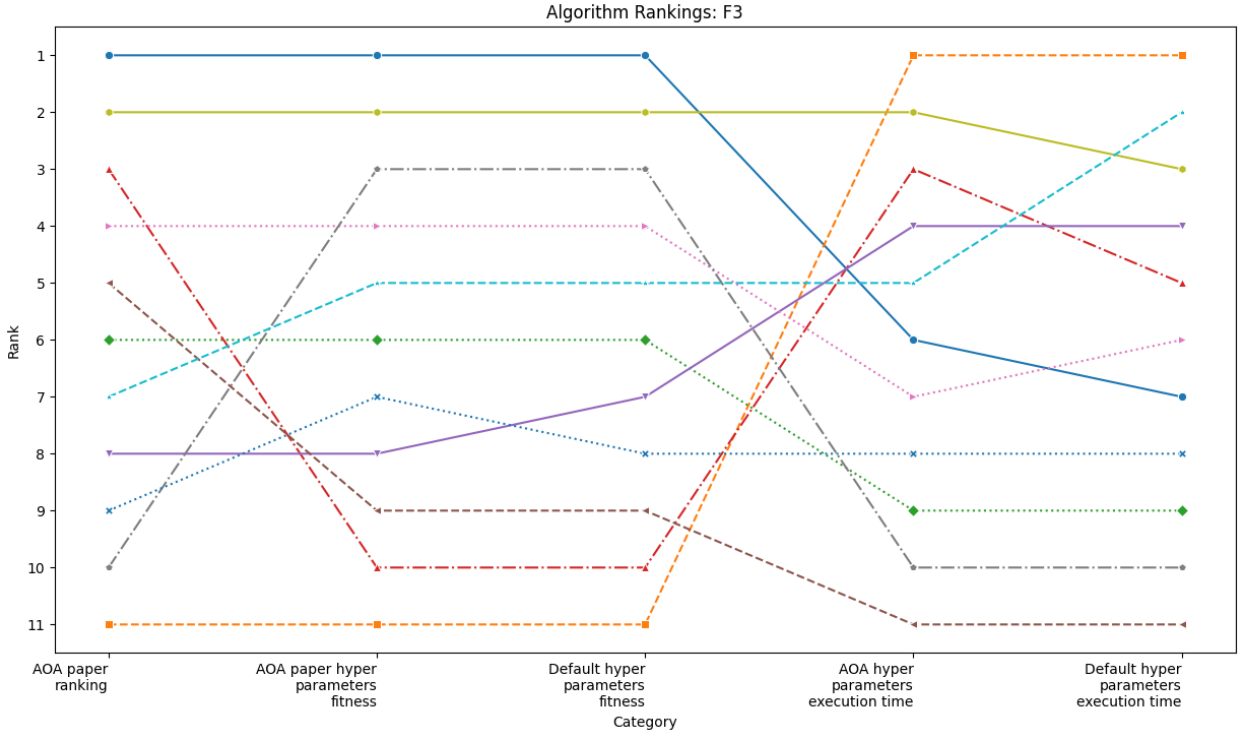


Figure 71: Rankings for F1 and F2 for 30 dimensions



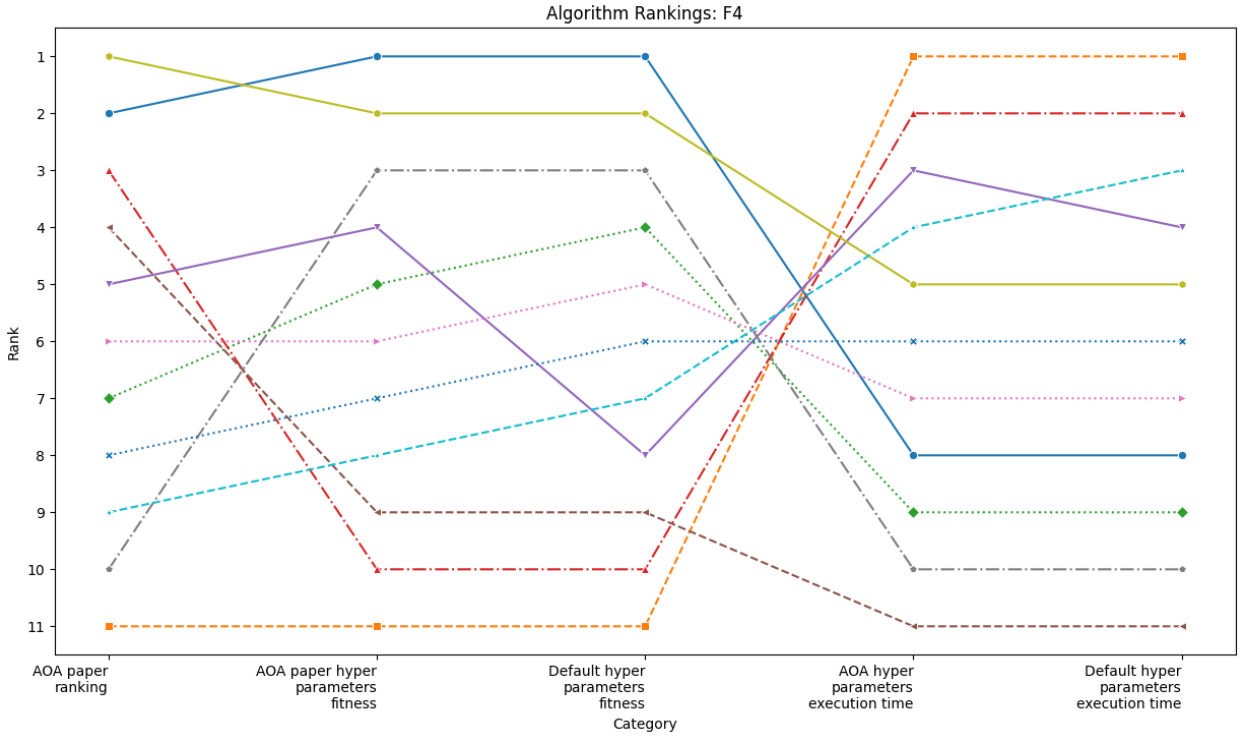
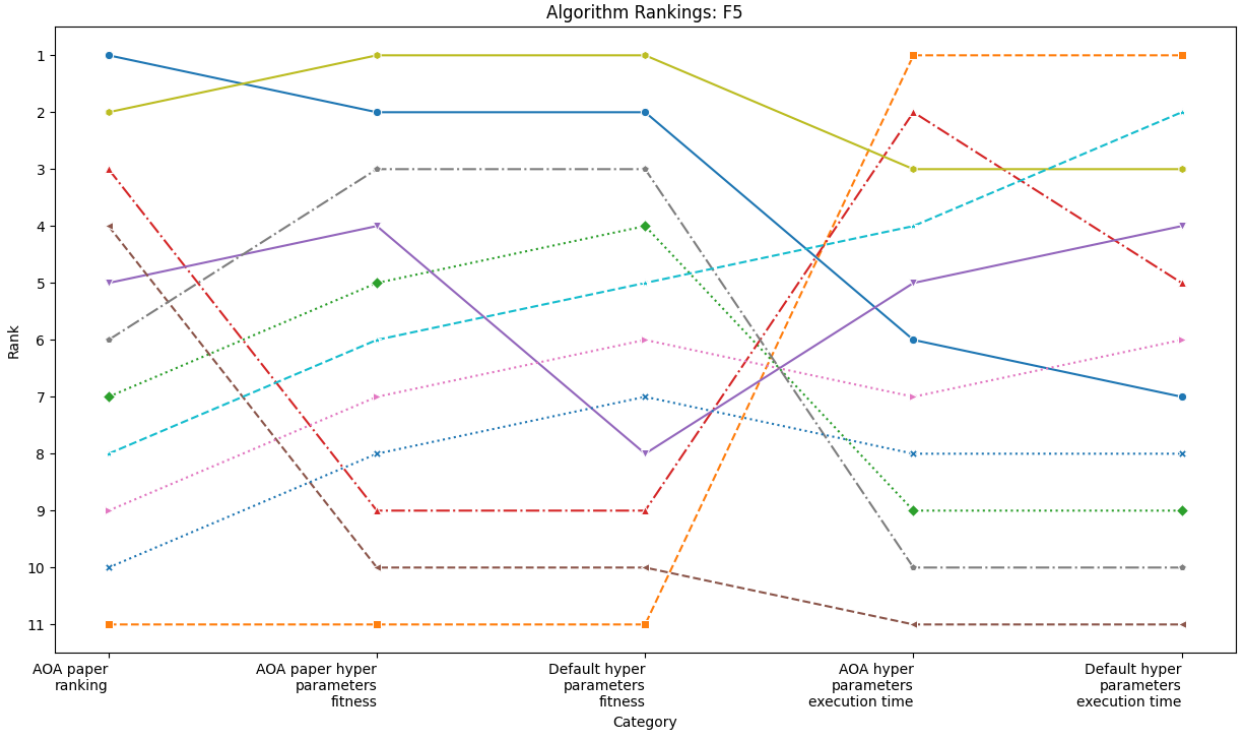


Figure 72: Rankings for F3 and F4 for 30 dimensions



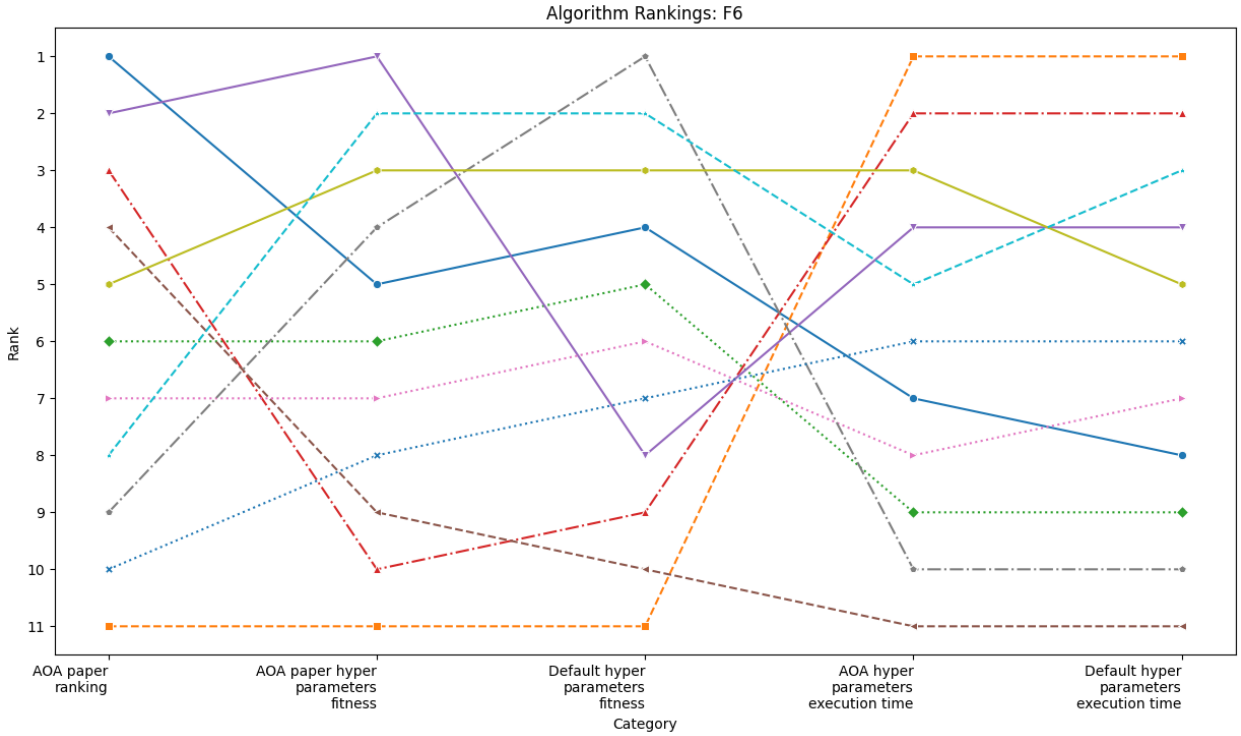
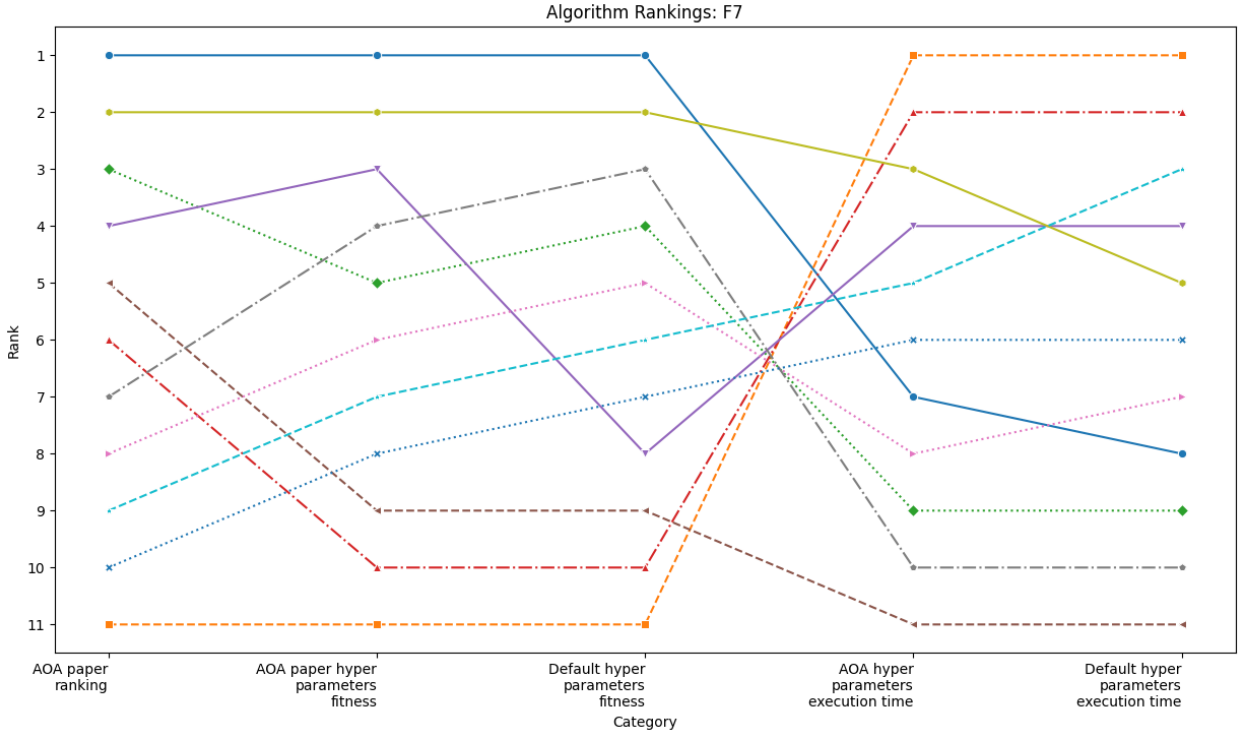


Figure 73: Rankings for F5 and F6 for 30 dimensions



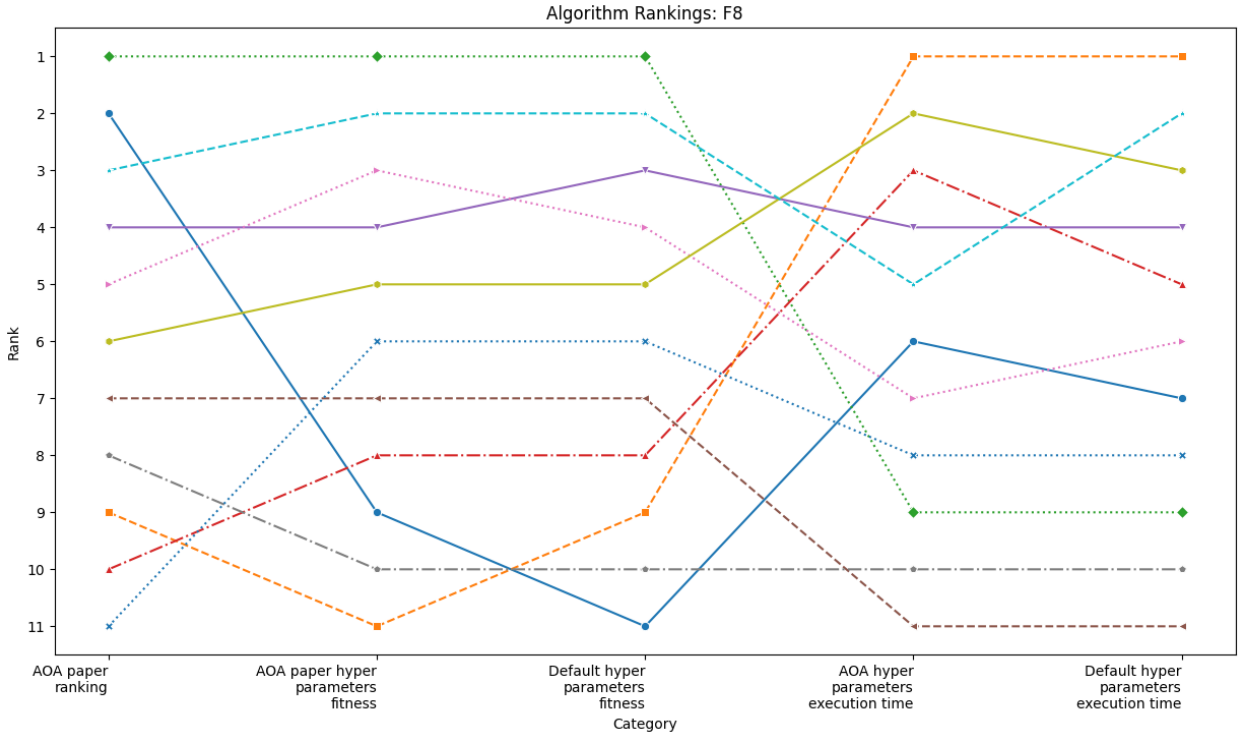
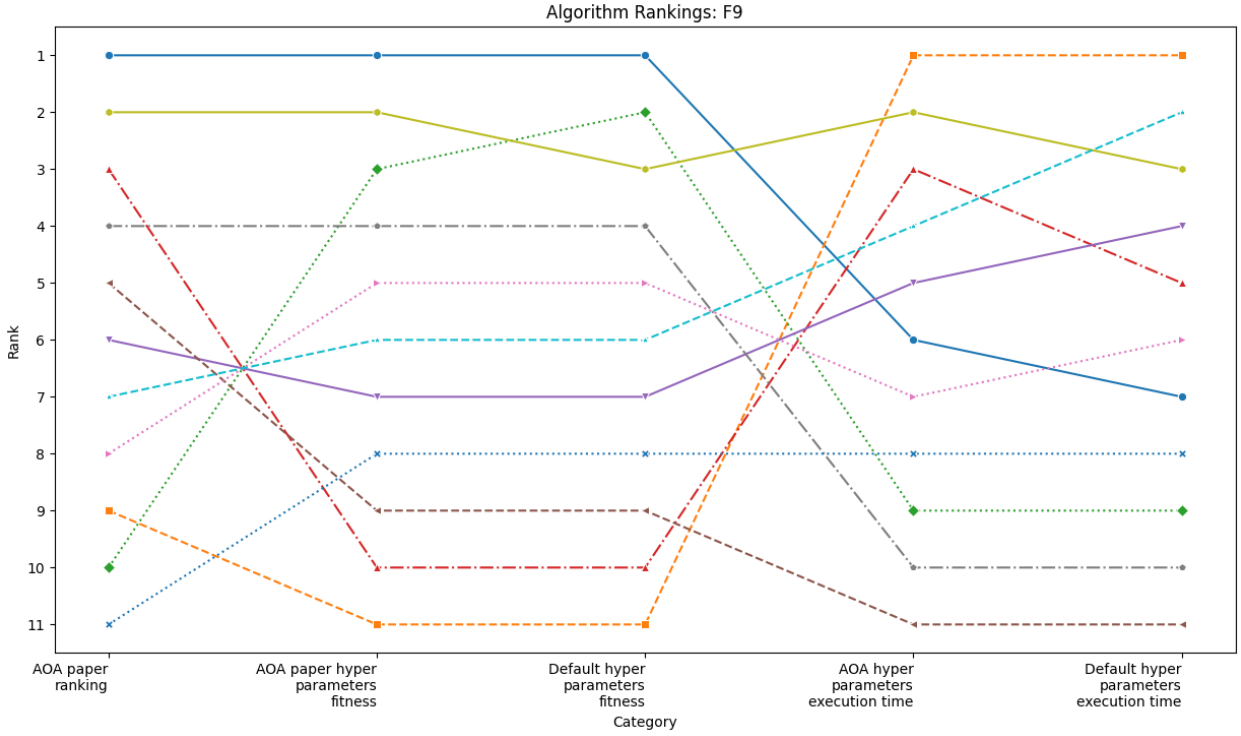


Figure 74: Rankings for F7 and F8 for 30 dimensions



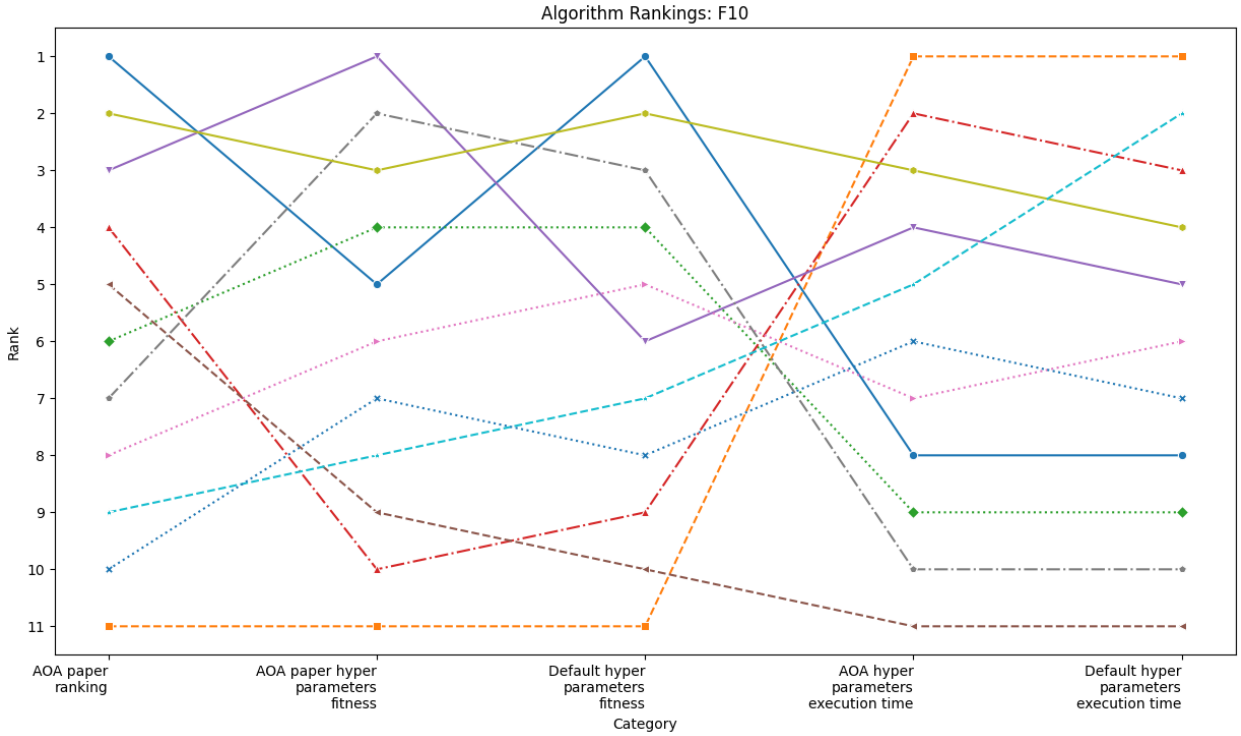


Figure 75: Rankings for F9 and F10 for 30 dimensions

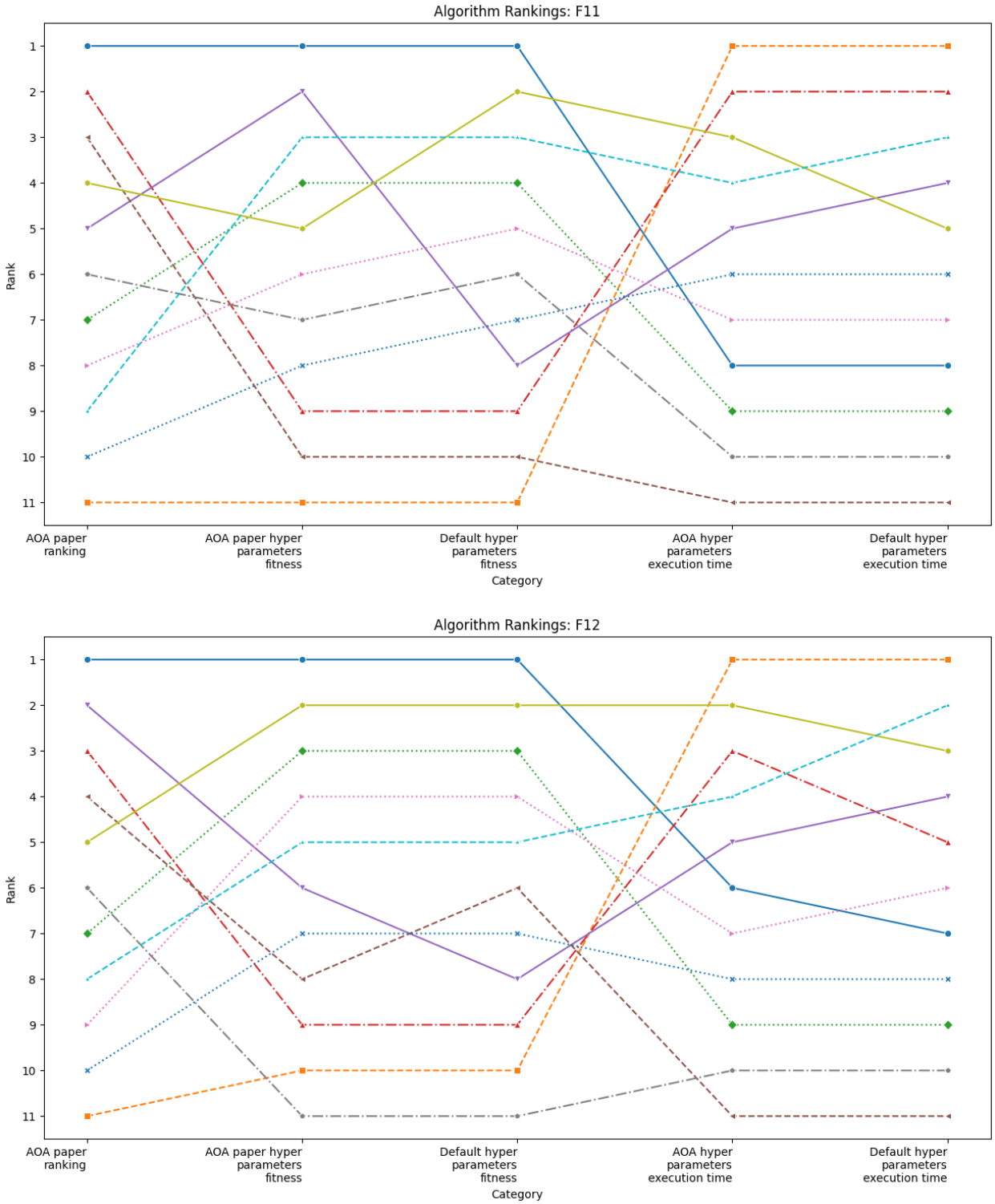


Figure 76: Rankings for F11 and F12 for 30 dimensions

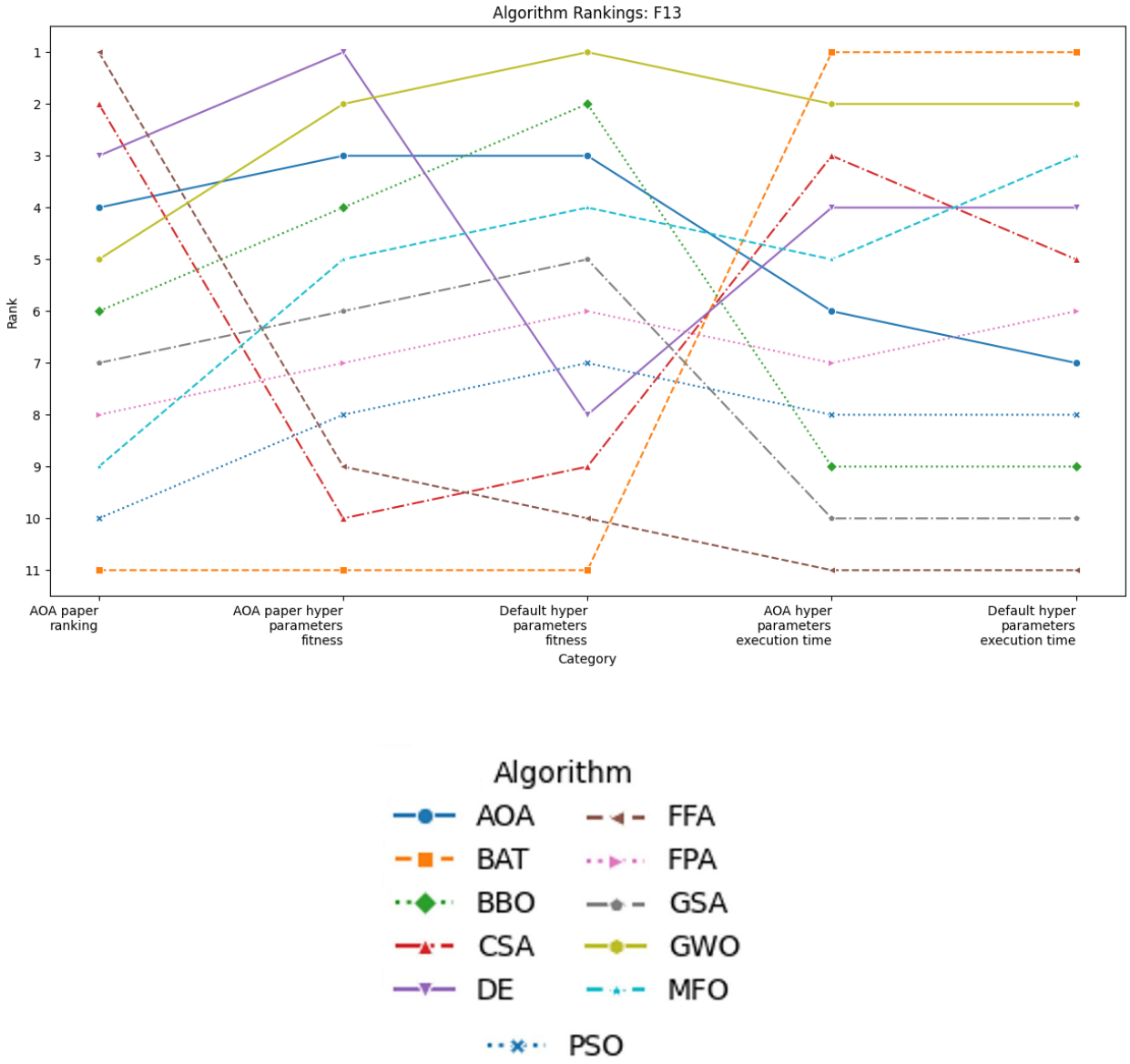
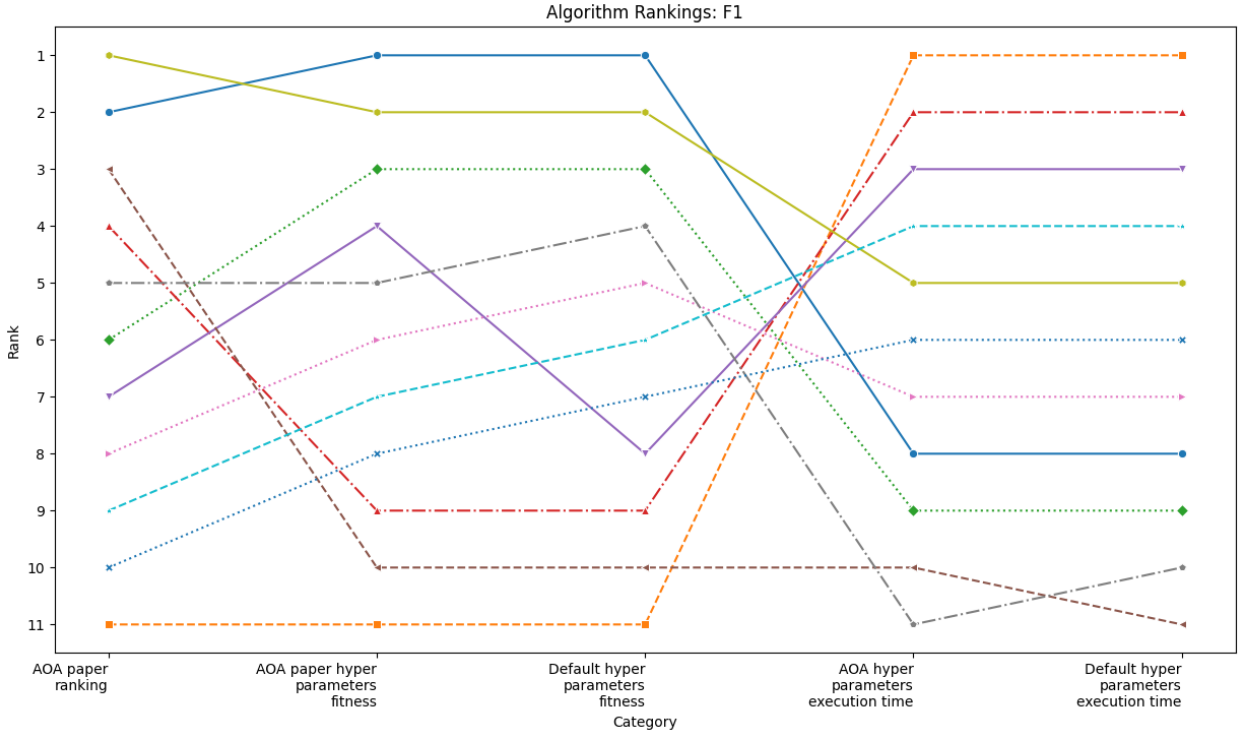


Figure 77: Rankings for F13 and legend for 30 dimensions



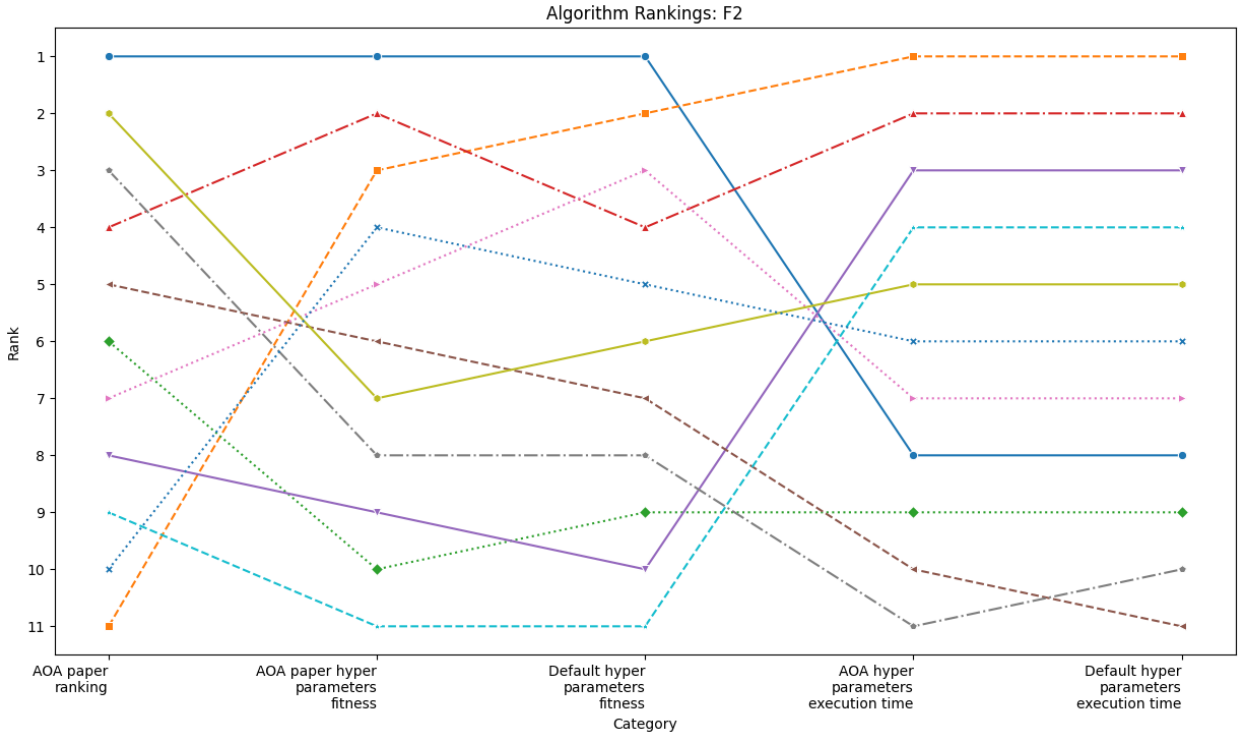


Figure 78: Rankings for F1 and F2 for 100 dimensions

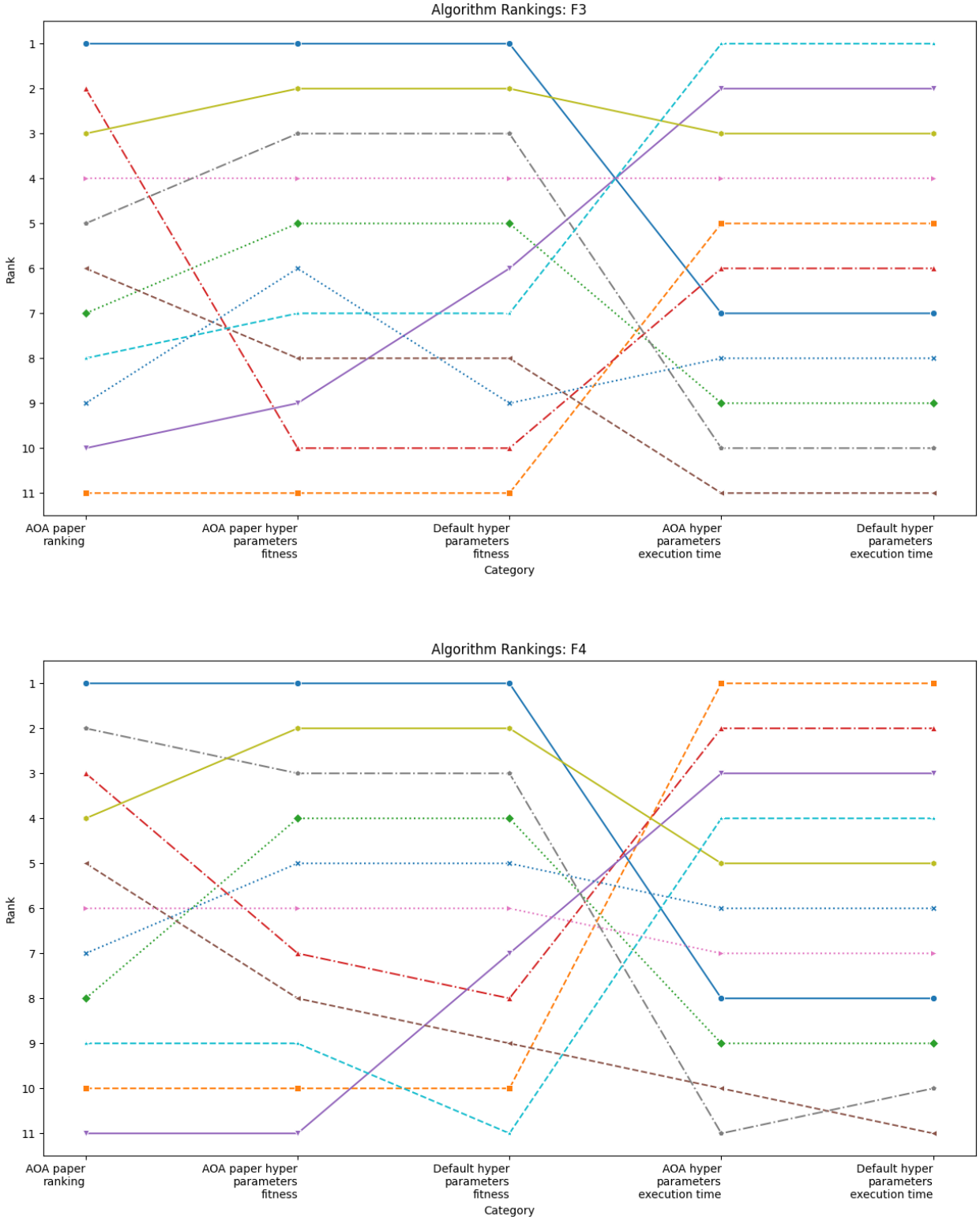
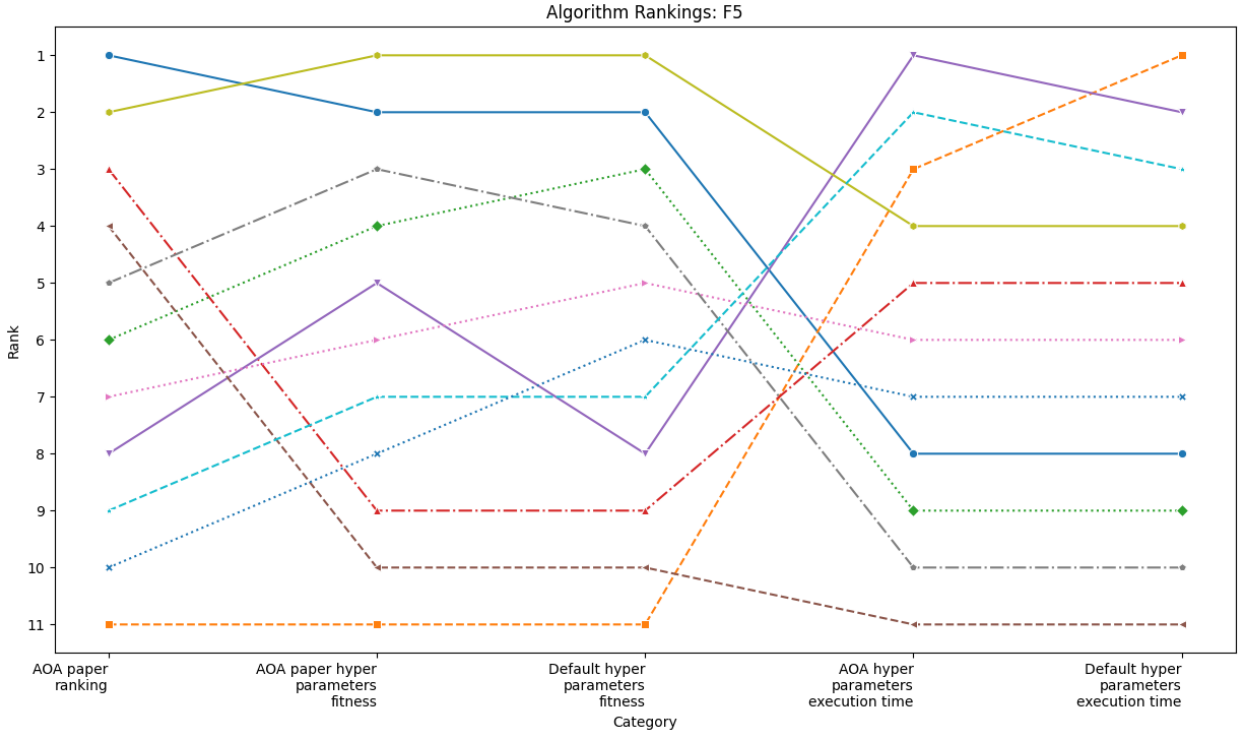


Figure 79: Rankings for F3 and F4 for 100 dimensions



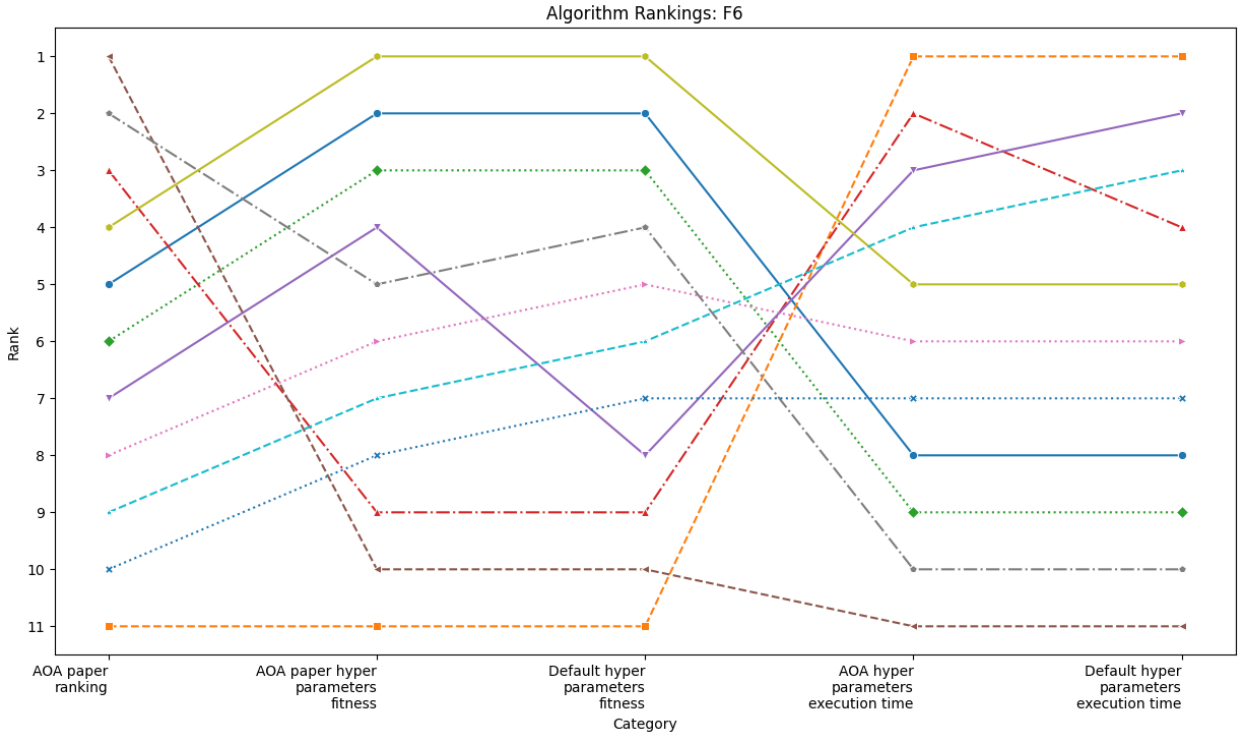
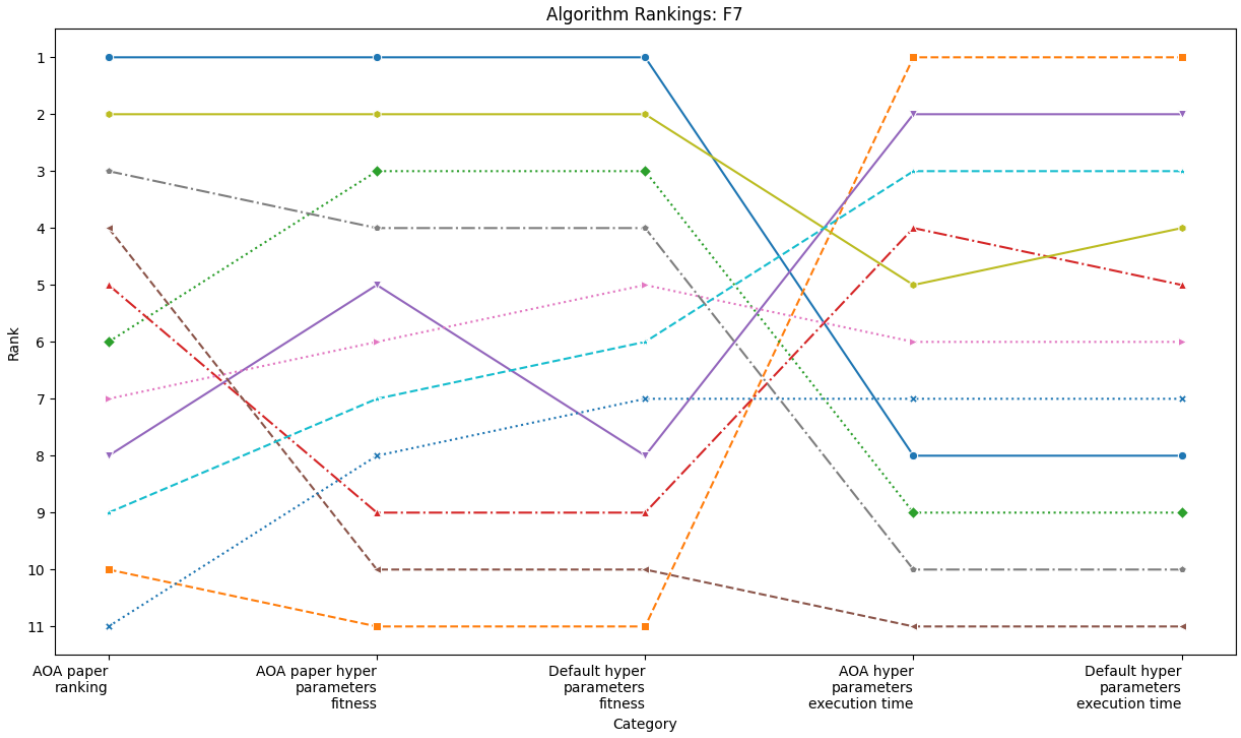


Figure 80: Rankings for F5 and F6 for 100 dimensions



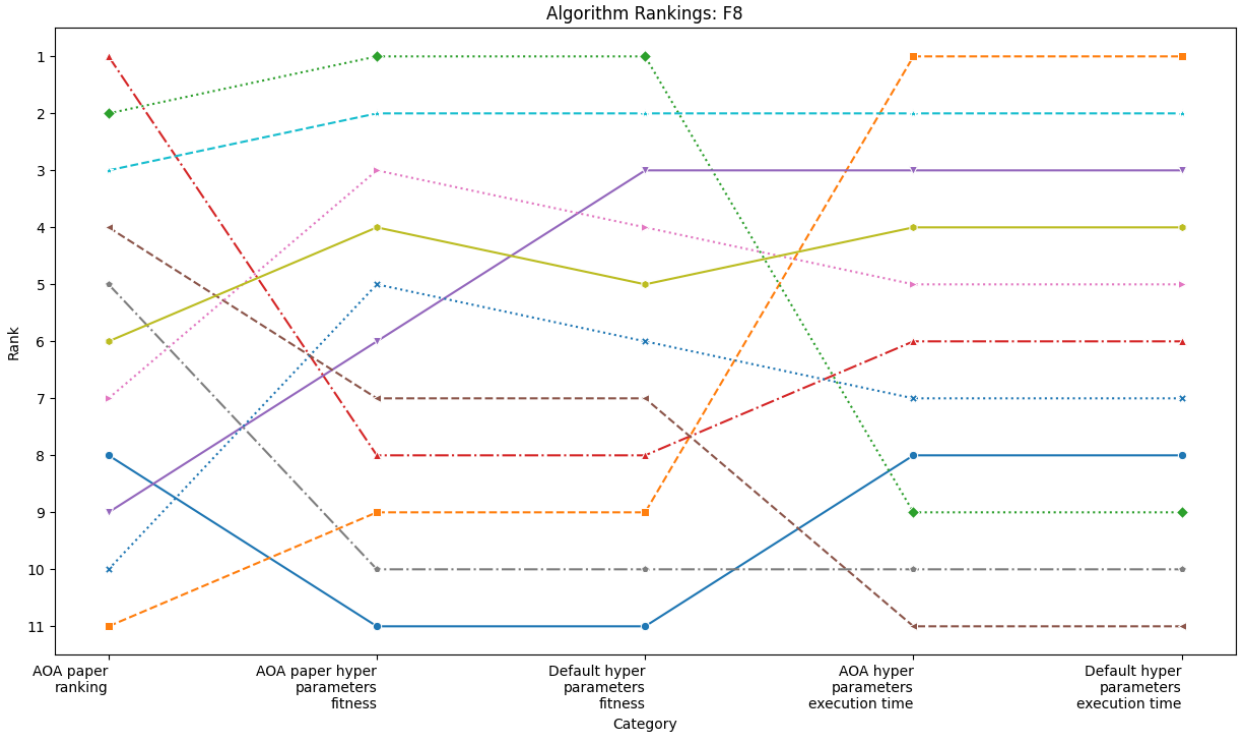


Figure 81: Rankings for F7 and F8 for 100 dimensions

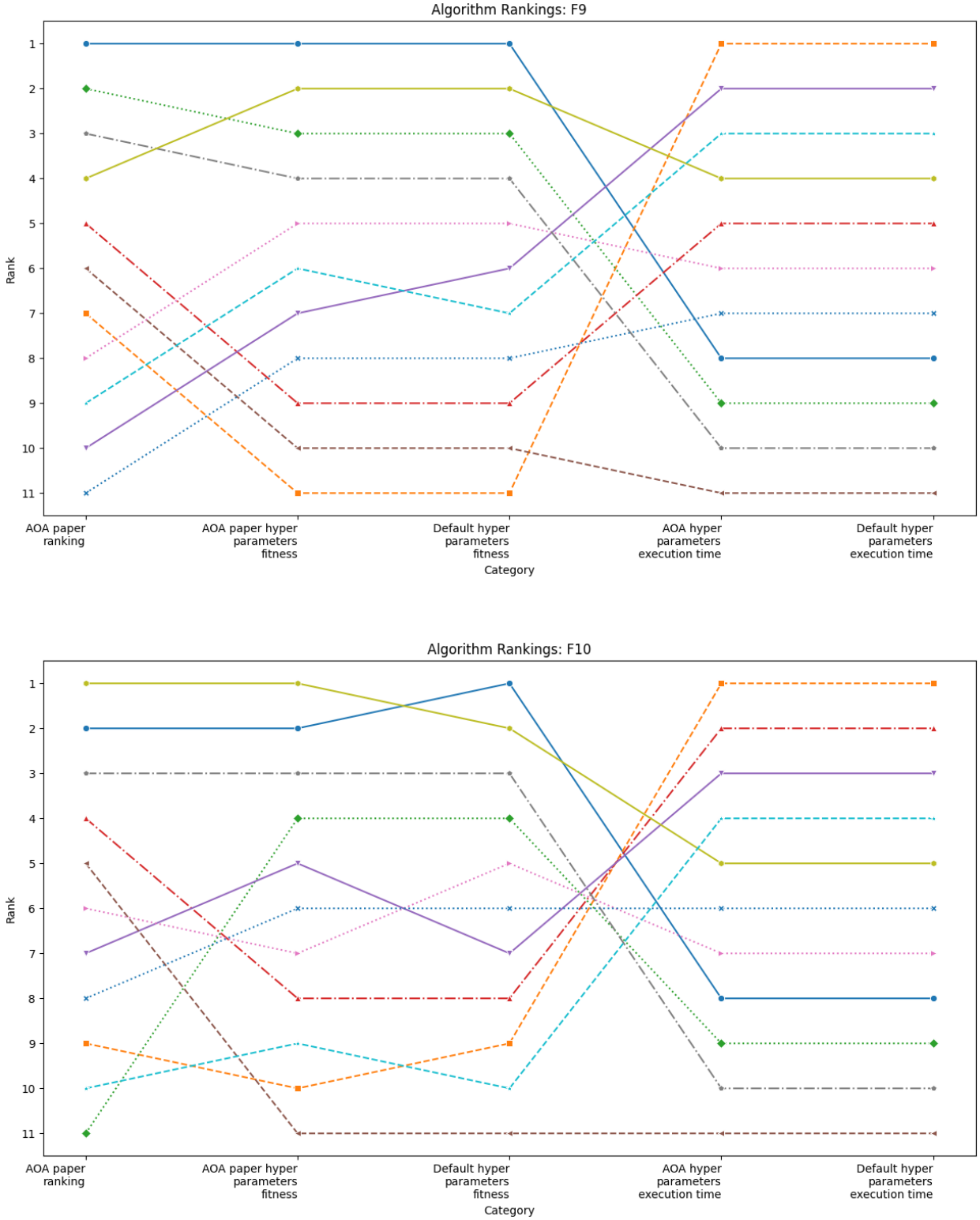


Figure 82: Rankings for F9 and F10 for 100 dimensions

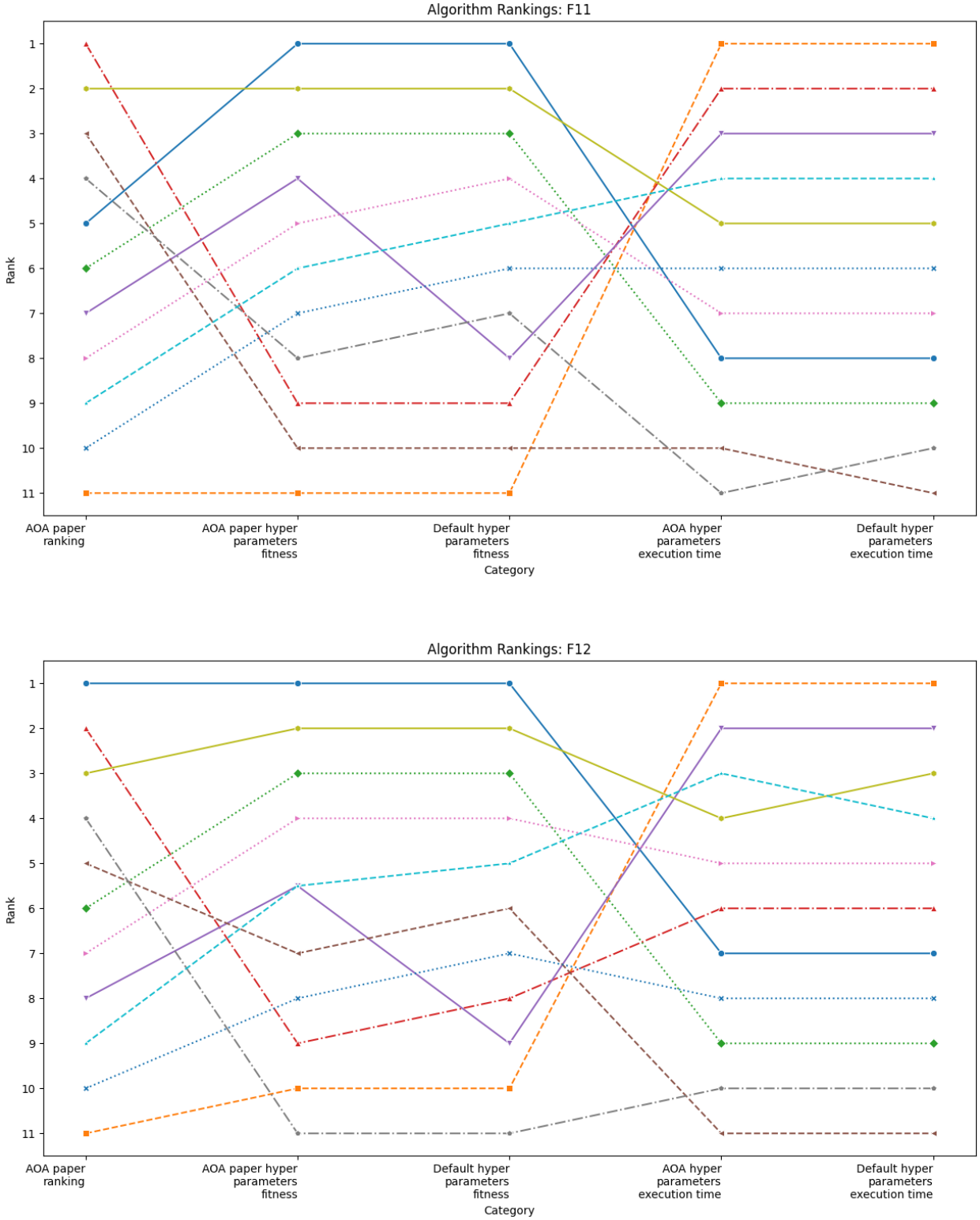


Figure 83: Rankings for F11 and F12 for 100 dimensions

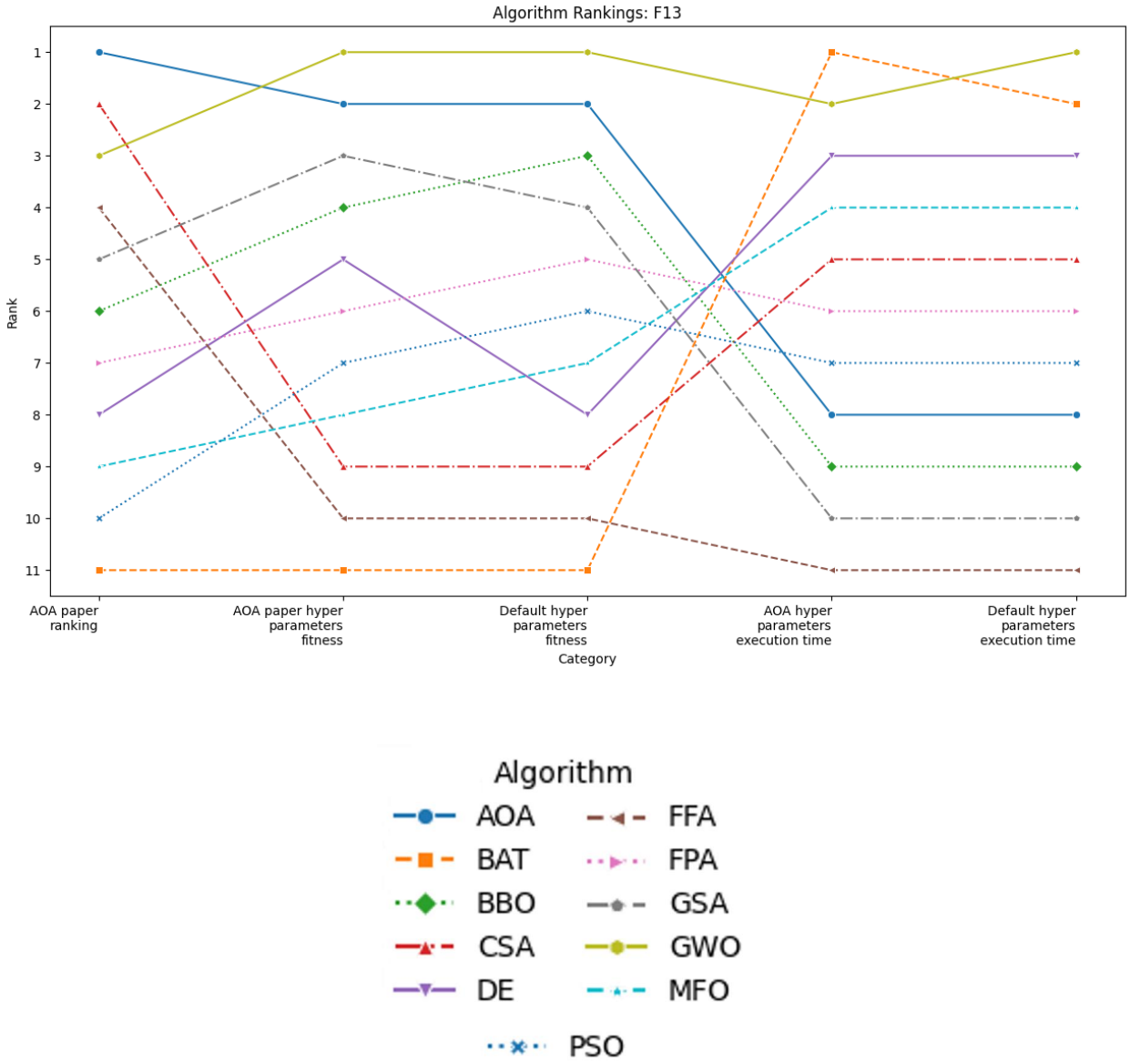


Figure 84: Rankings for F13 and legend for 100 dimensions

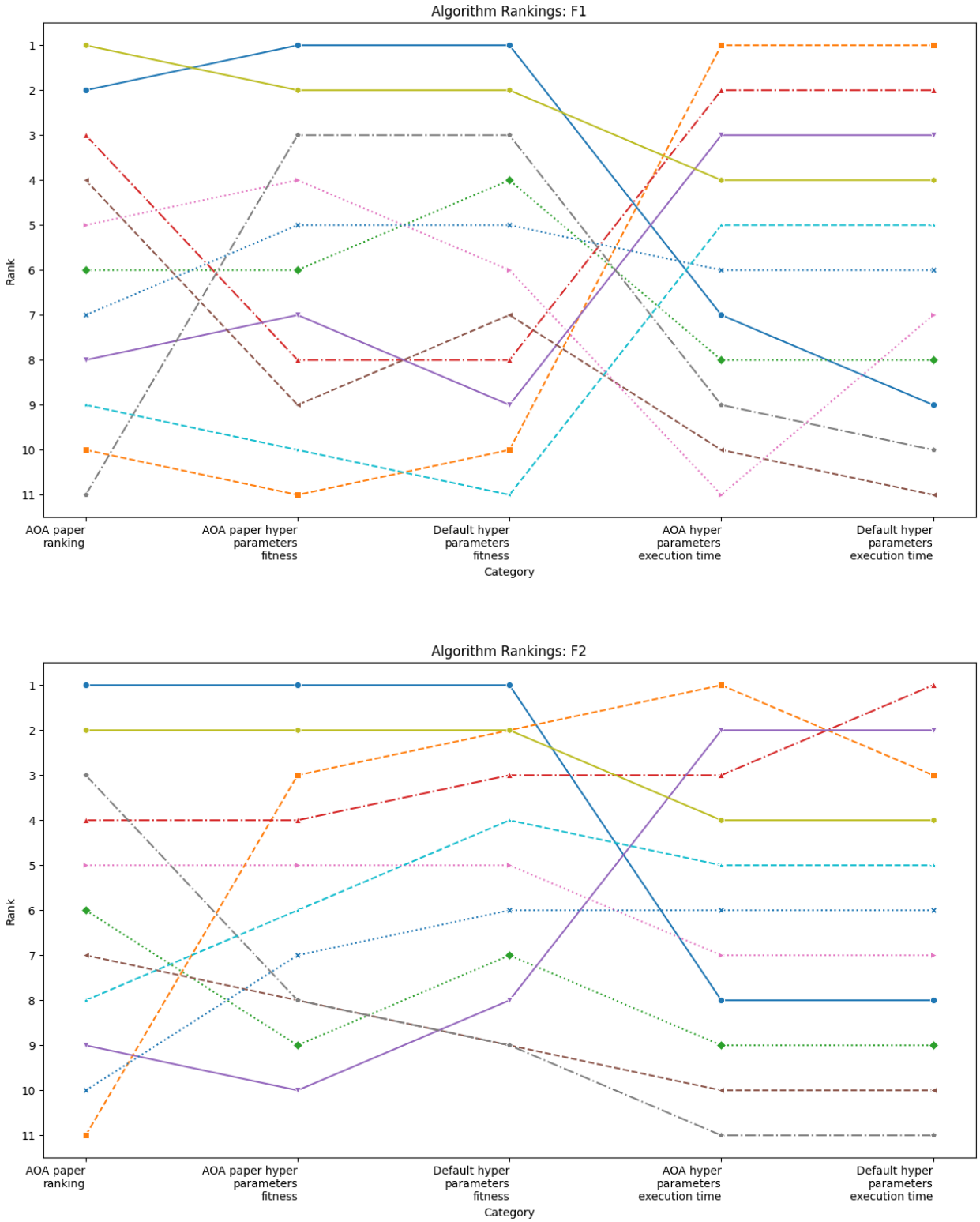
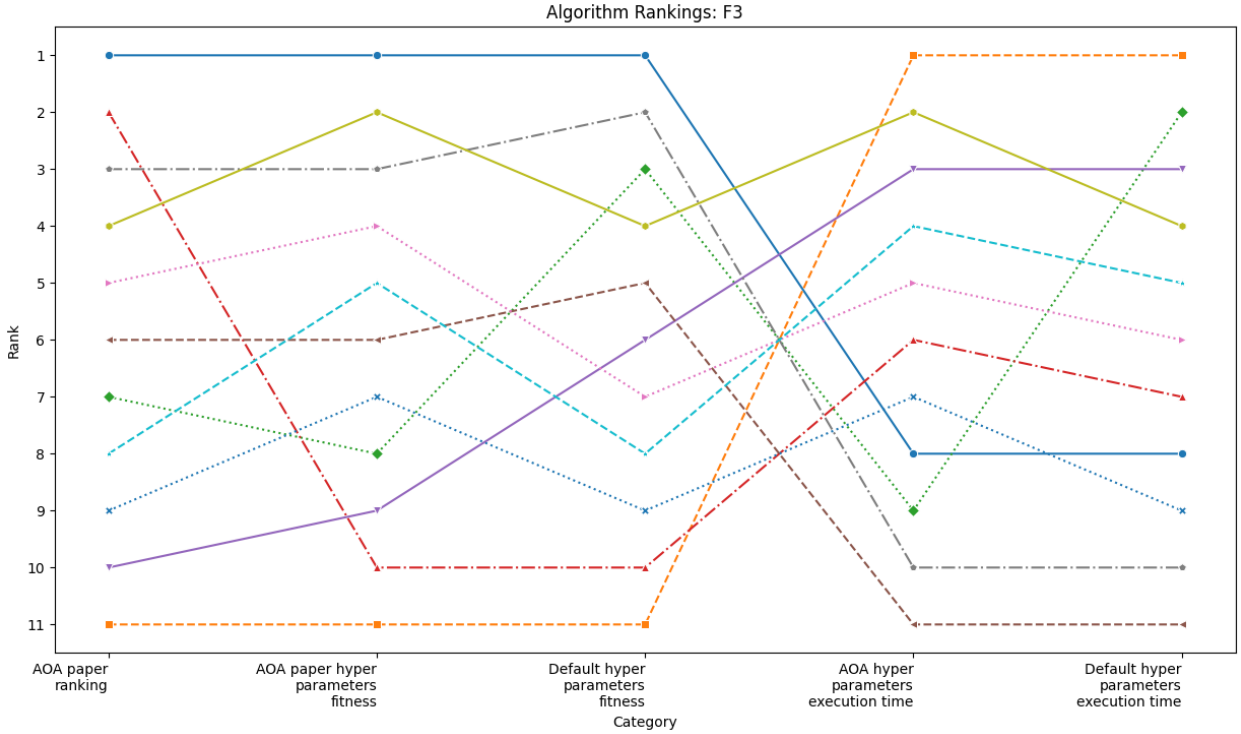


Figure 85: Rankings for F1 and F2 for 500 dimensions



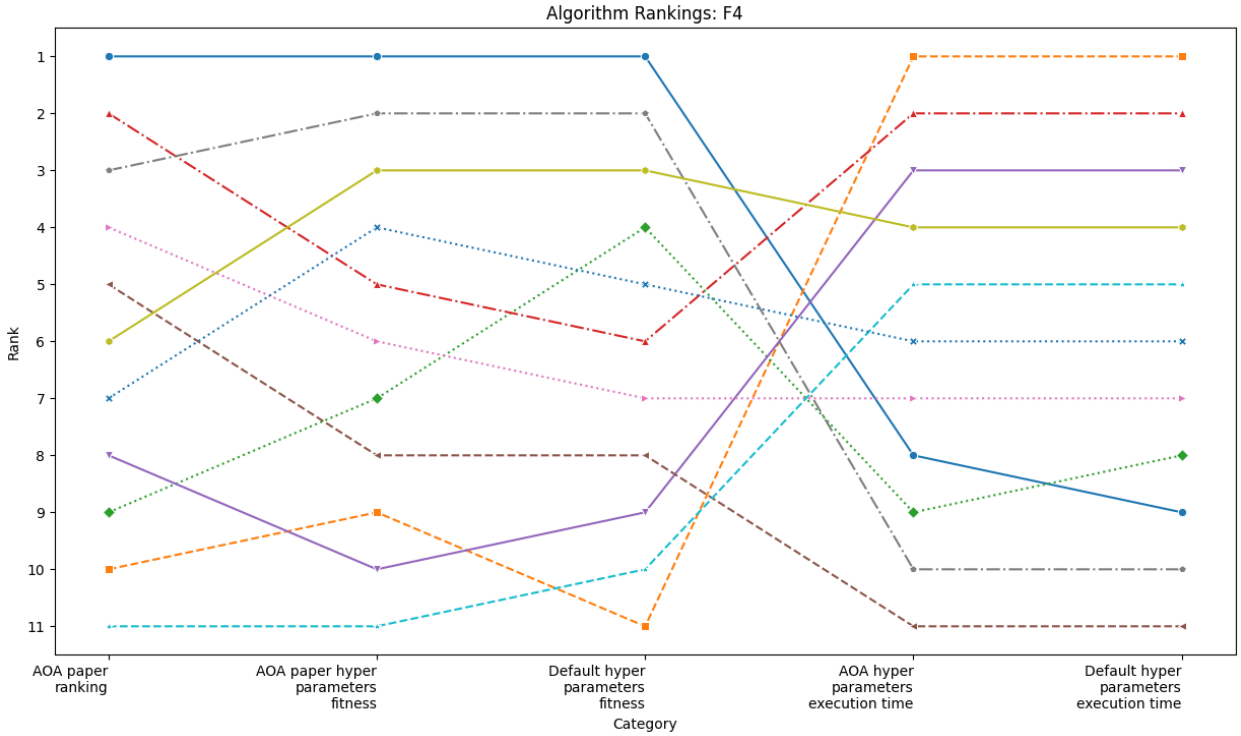


Figure 86: Rankings for F3 and F4 for 500 dimensions

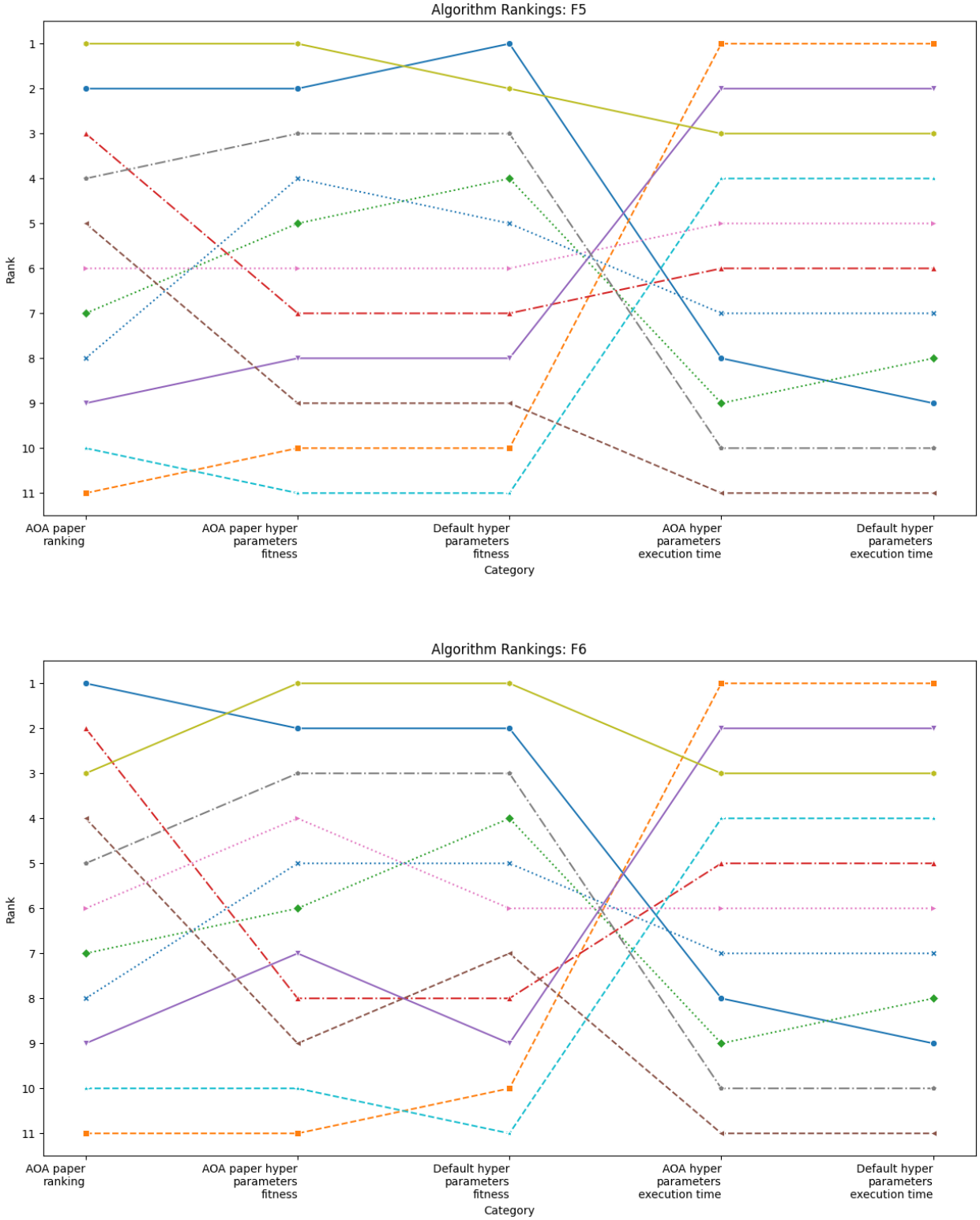
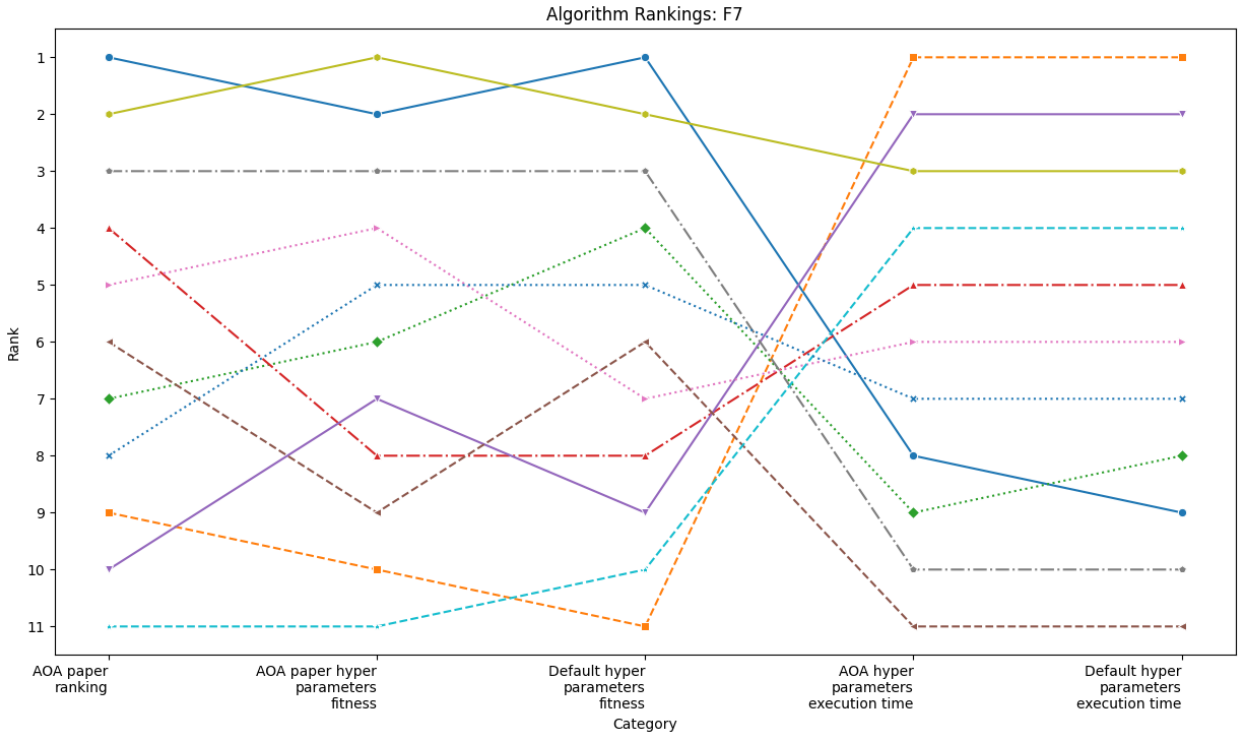


Figure 87: Rankings for F5 and F6 for 500 dimensions



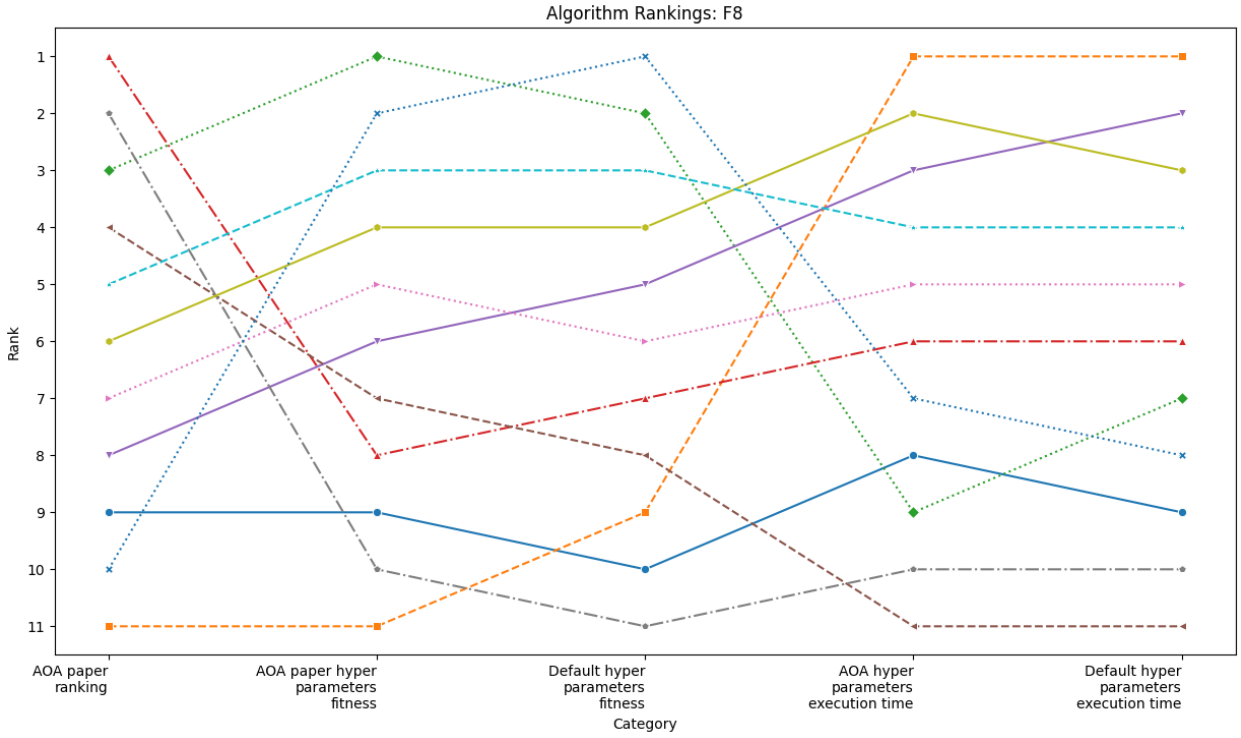


Figure 88: Rankings for F7 and F8 for 500 dimensions

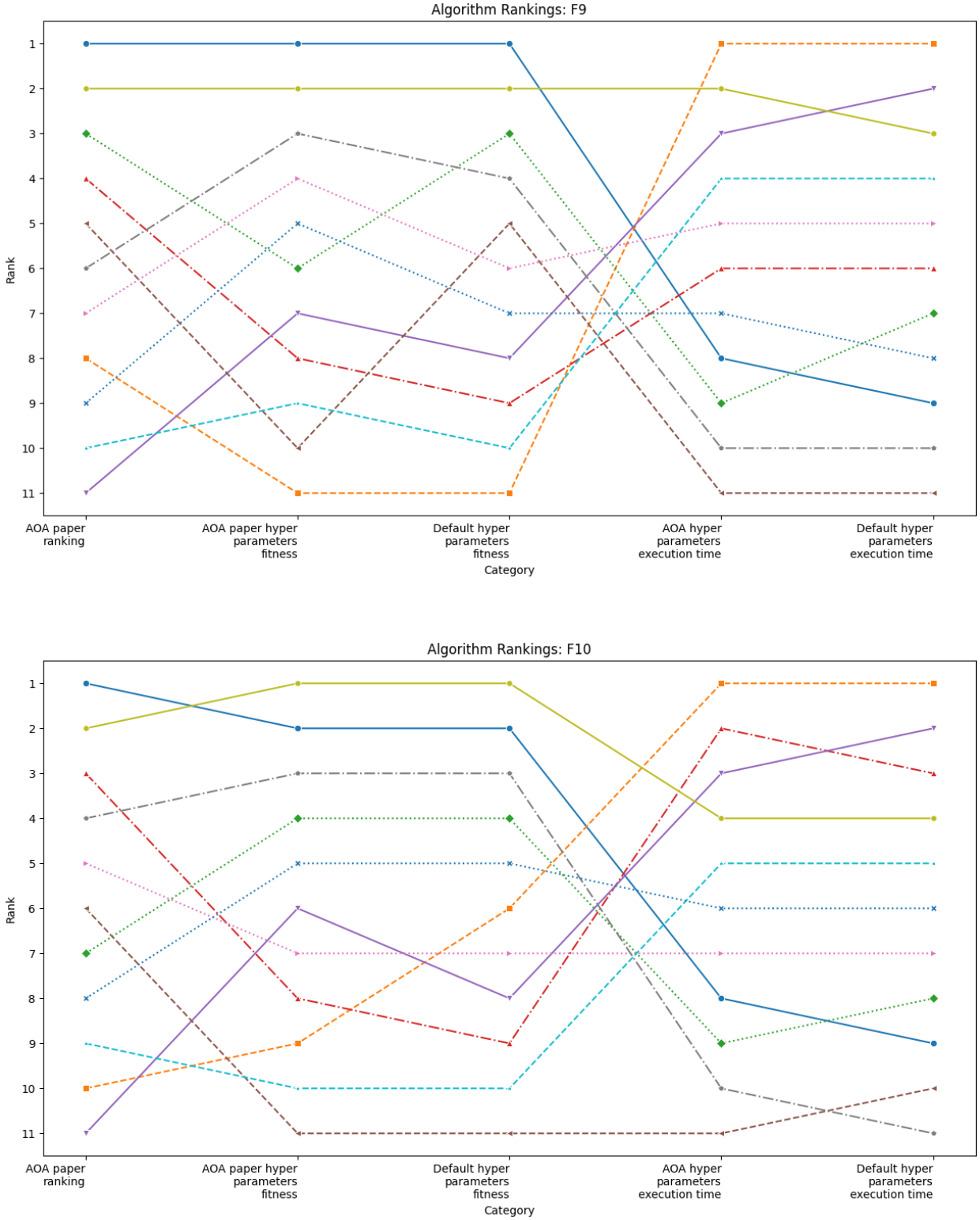
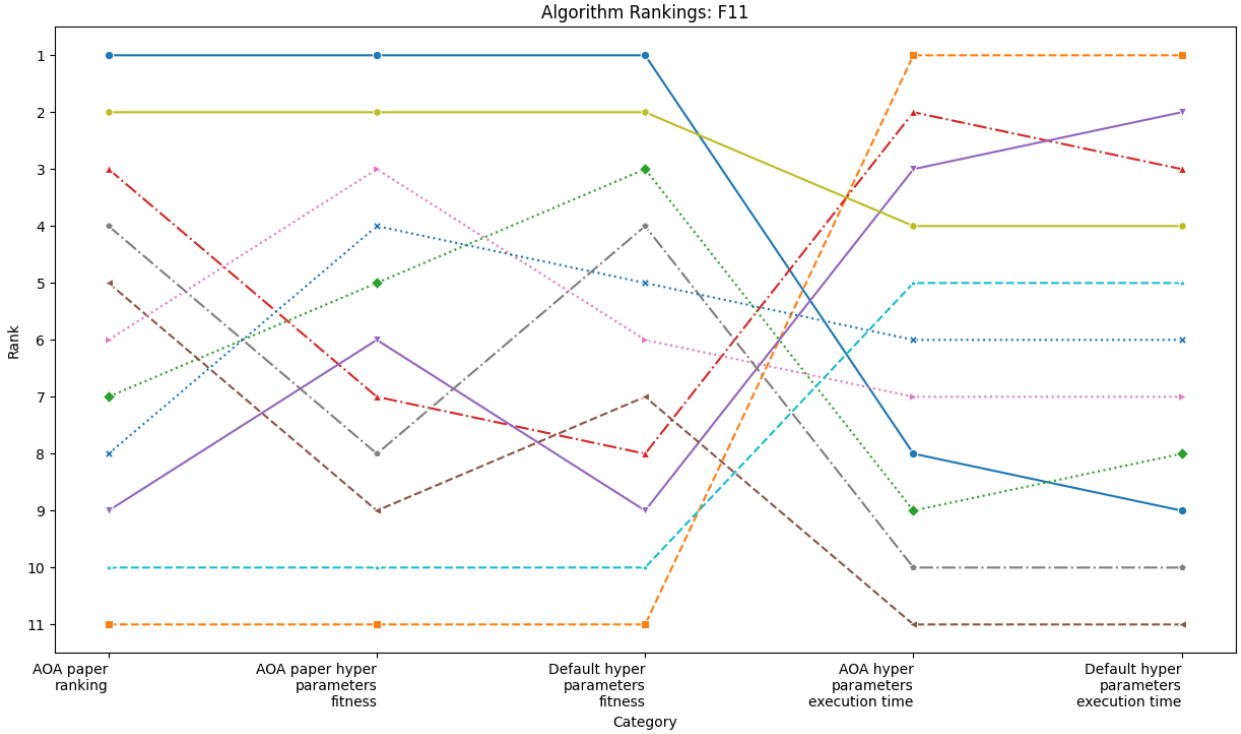


Figure 89: Rankings for F9 and F10 for 500 dimensions



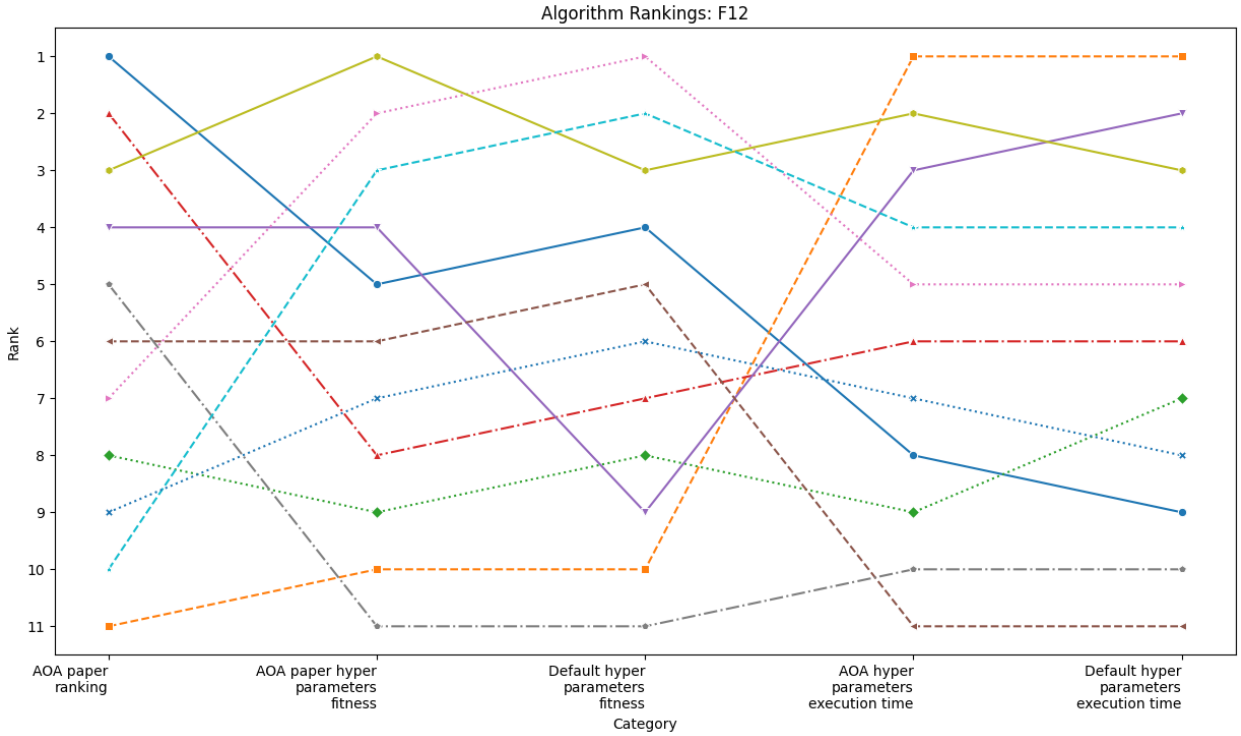


Figure 90: Rankings for F11 and F12 for 500 dimensions

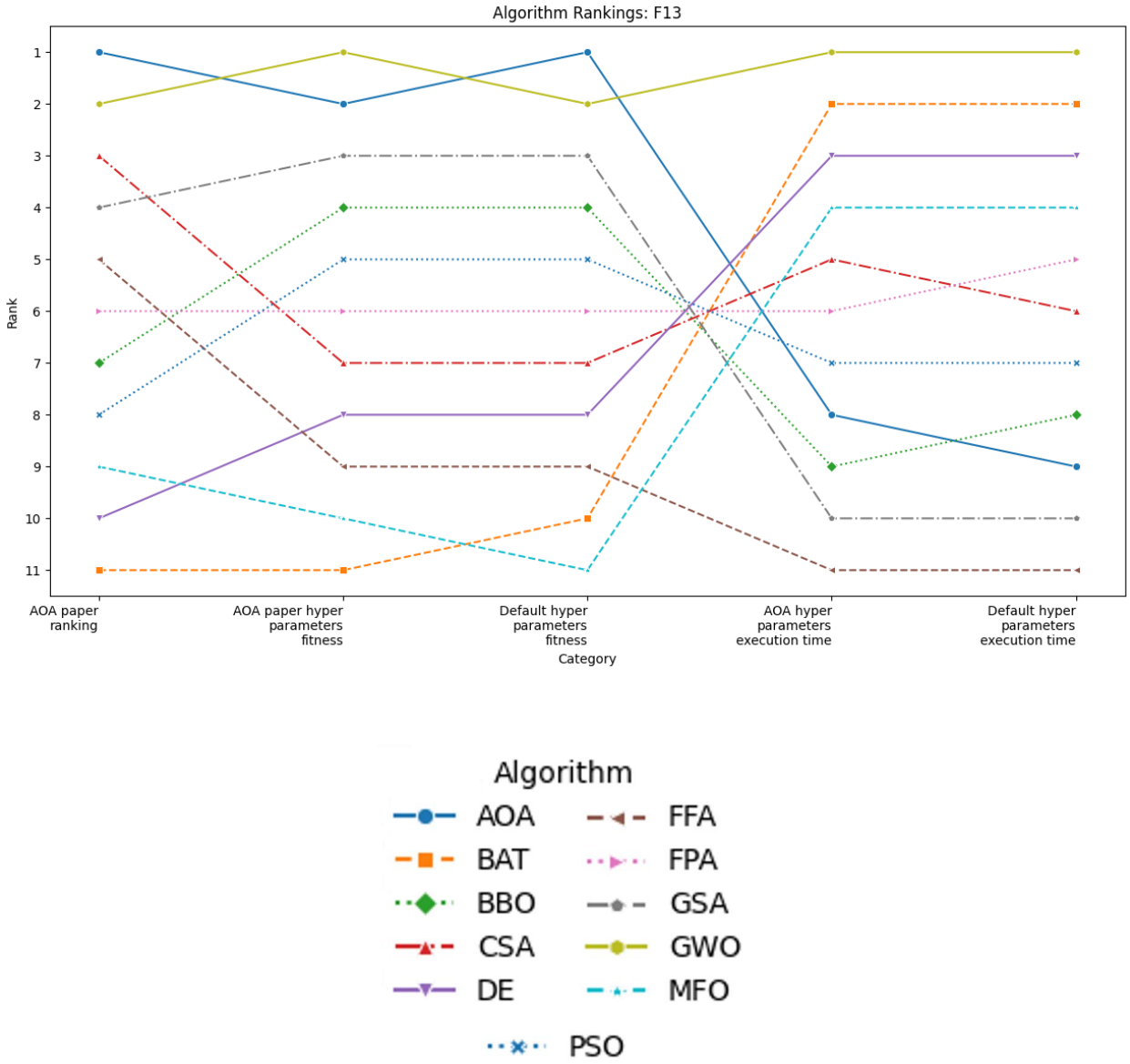
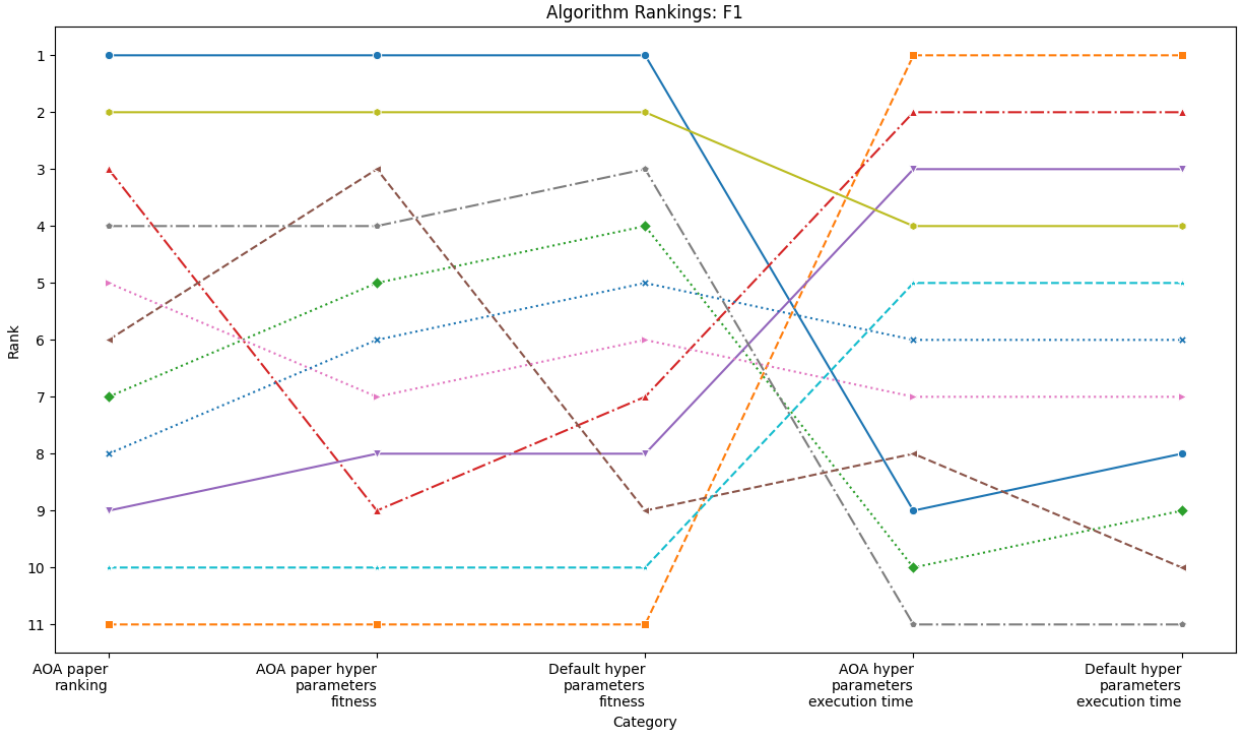


Figure 91: Rankings for F13 and legend for 500 dimensions



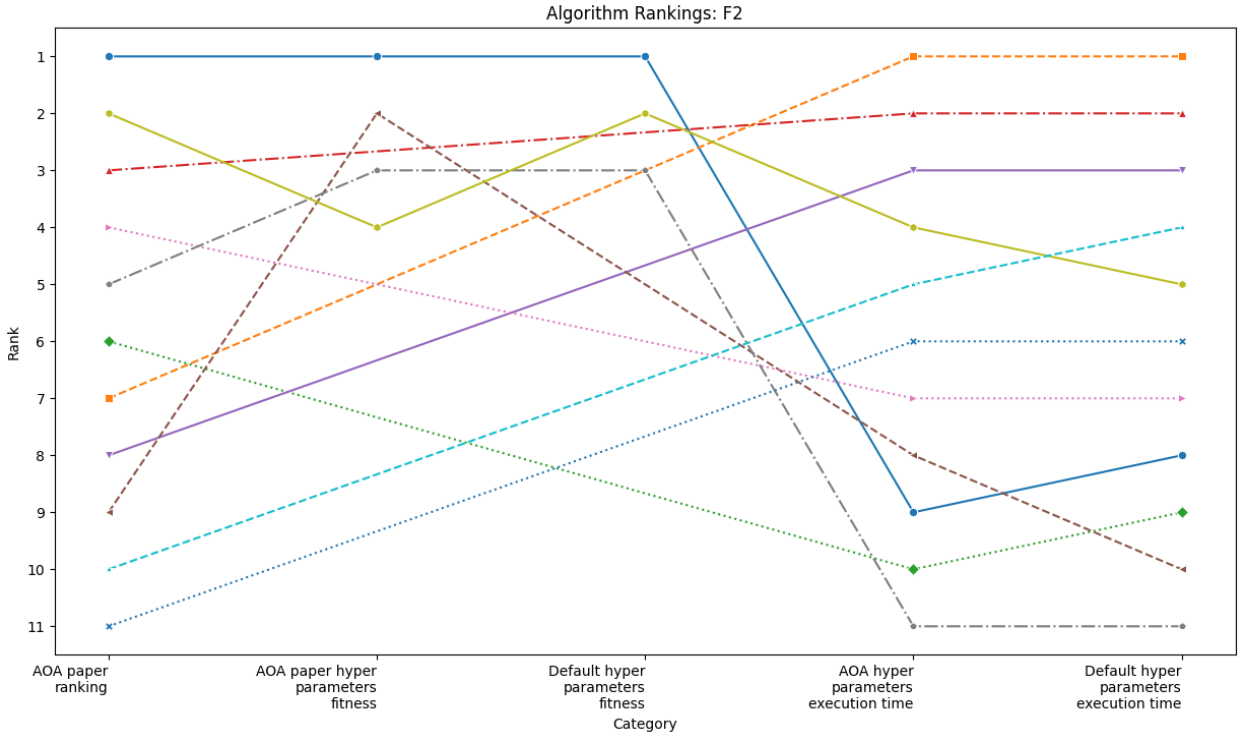
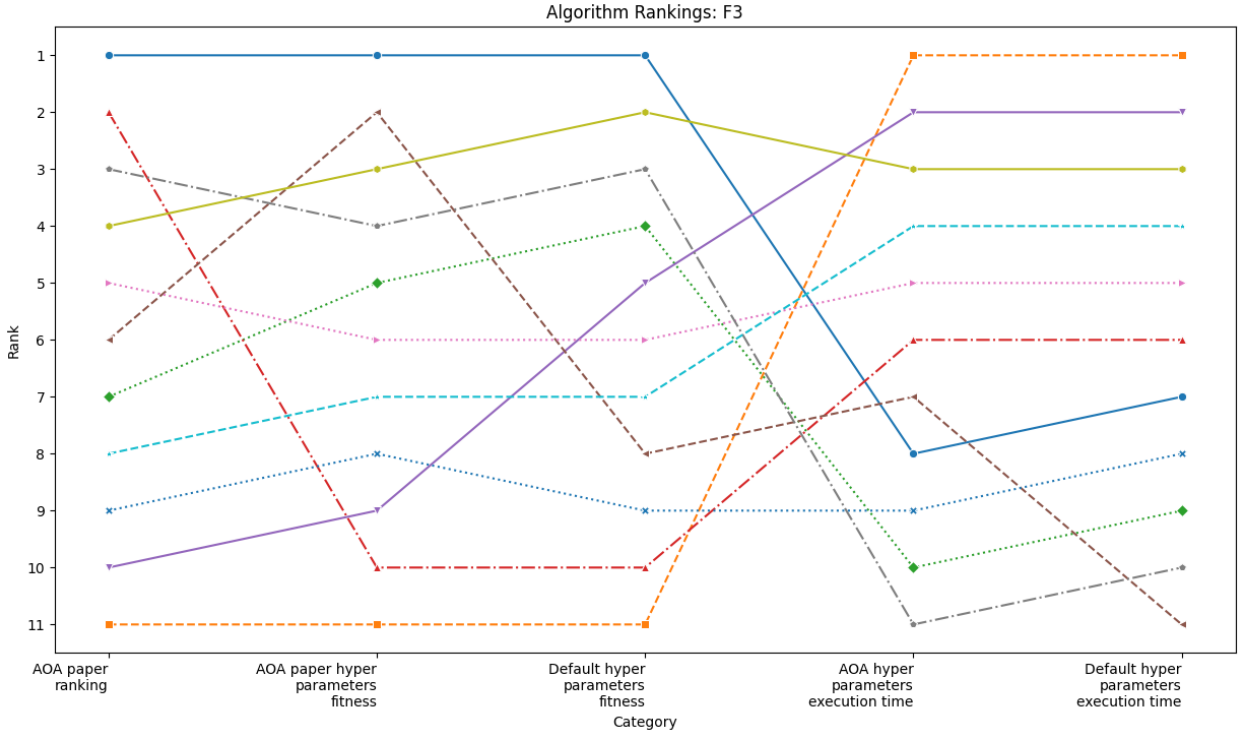


Figure 92: Rankings for F1 and F2 for 1000 dimensions



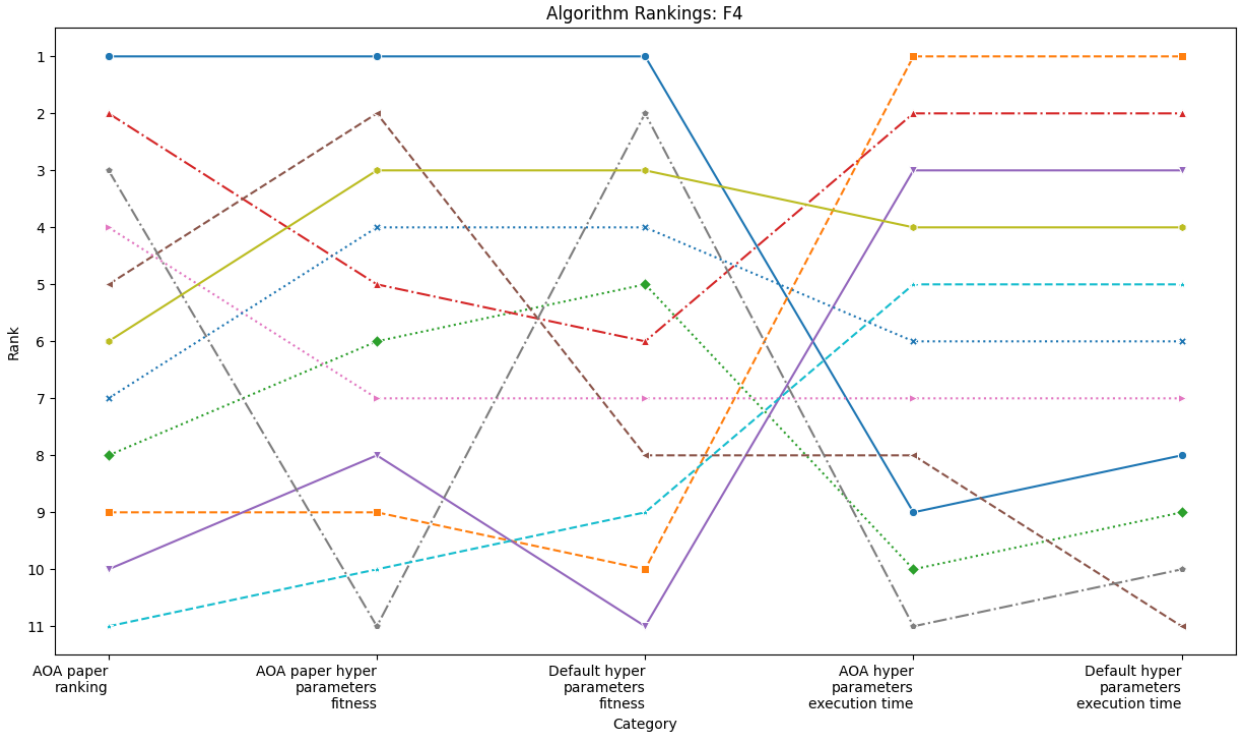
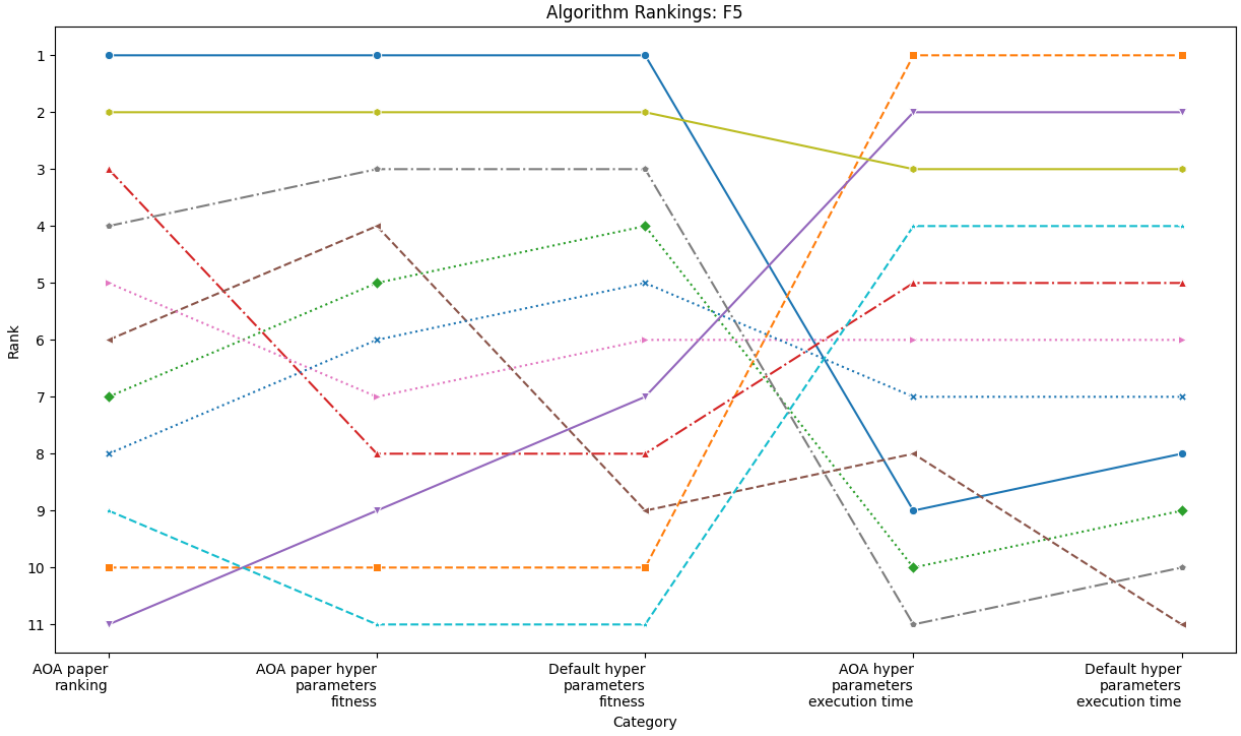


Figure 93: Rankings for F3 and F4 for 1000 dimensions



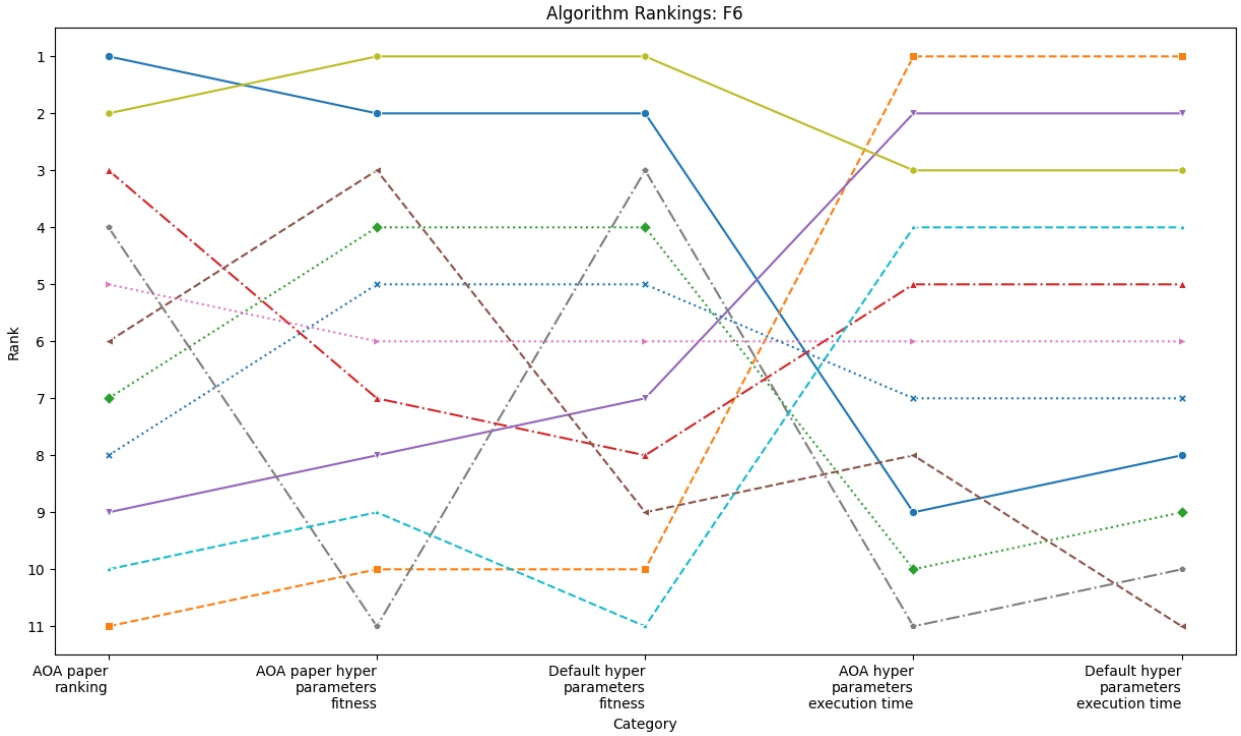
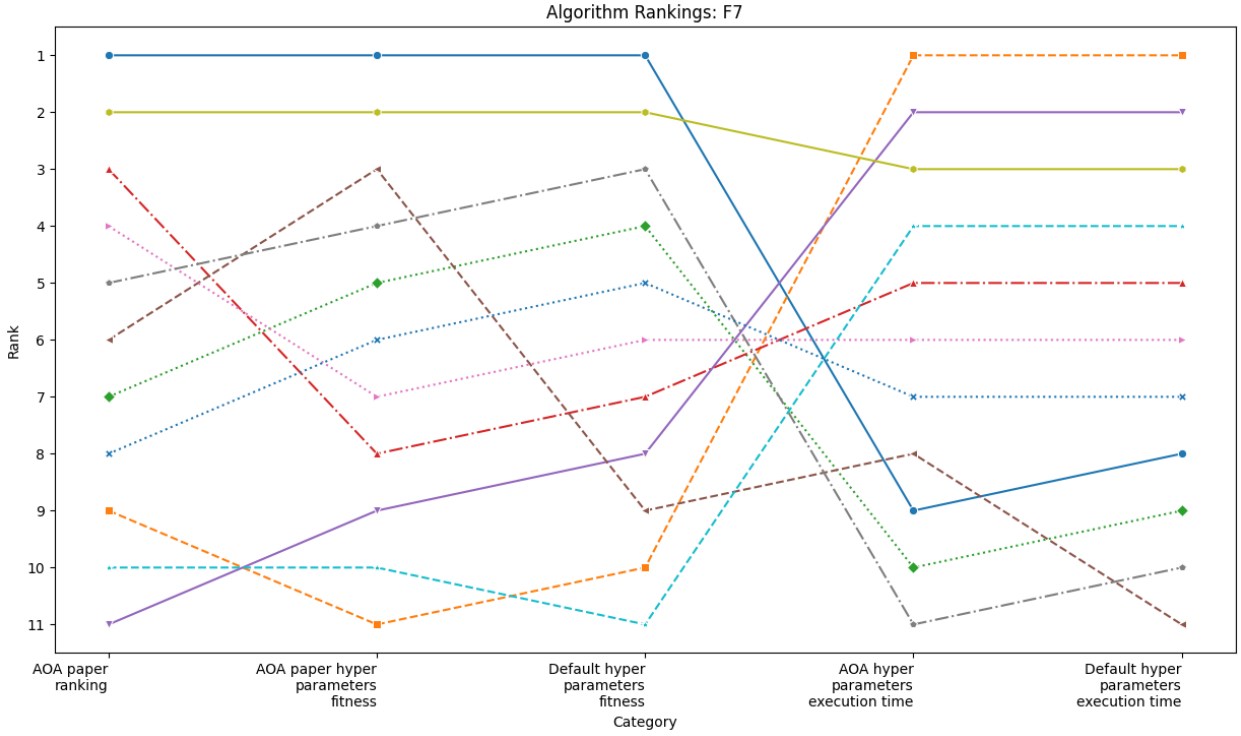


Figure 94: Rankings for F5 and F6 for 1000 dimensions



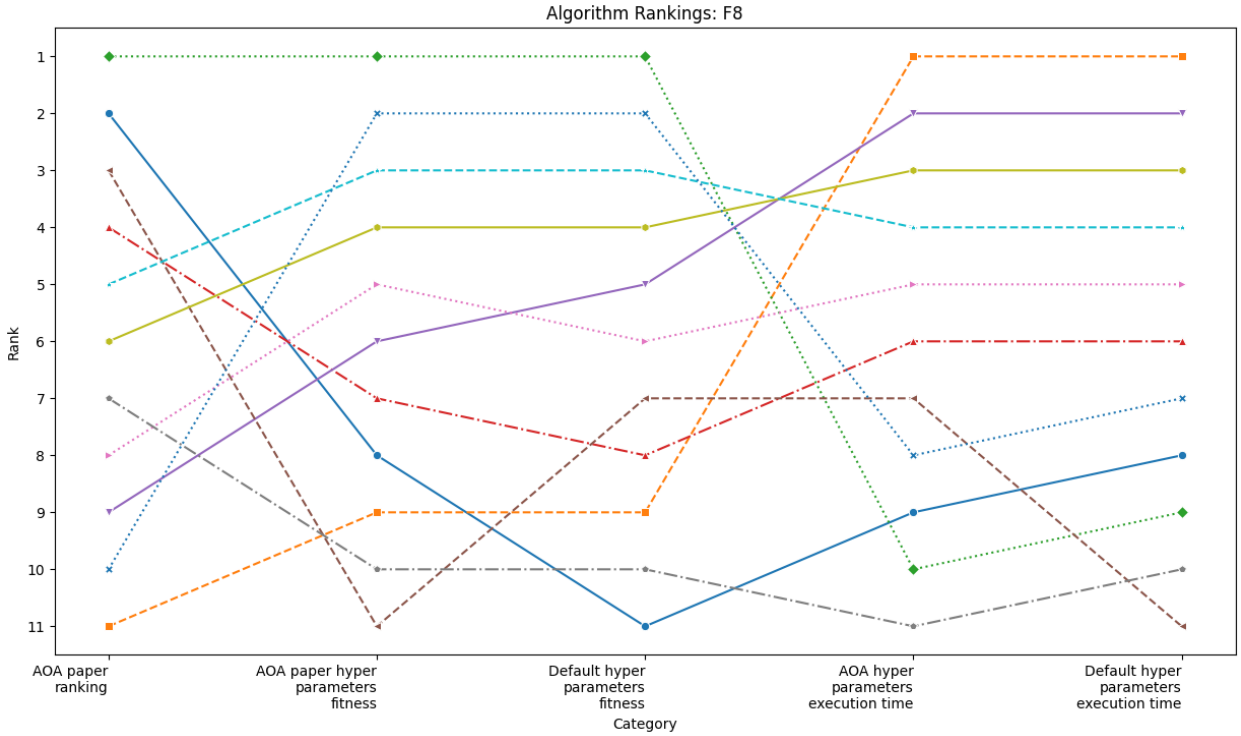
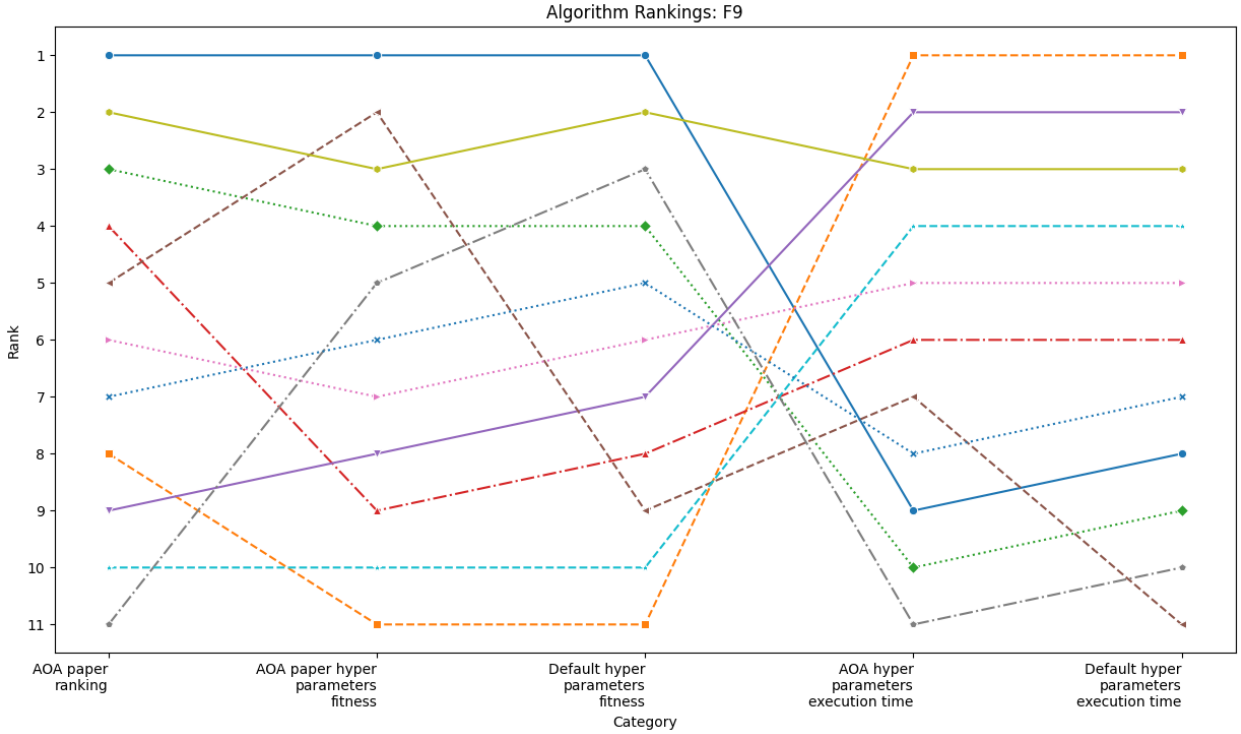


Figure 95: Rankings for F7 and F8 for 1000 dimensions



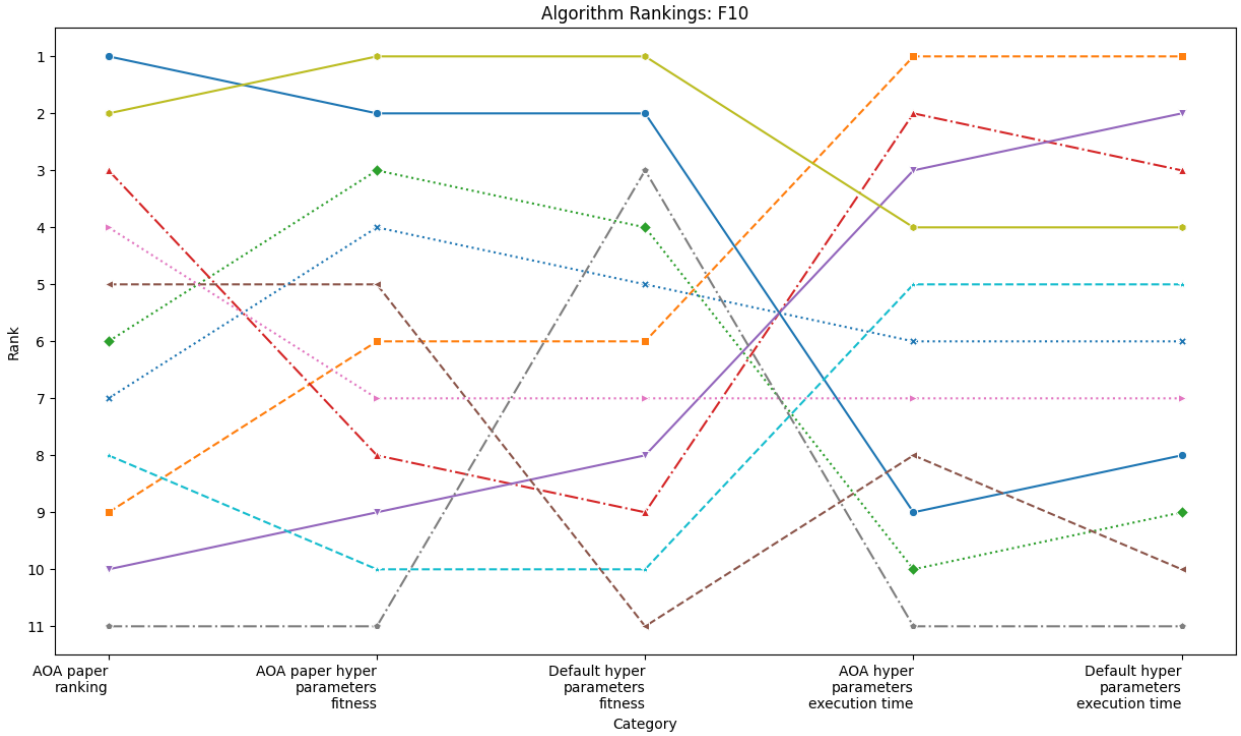
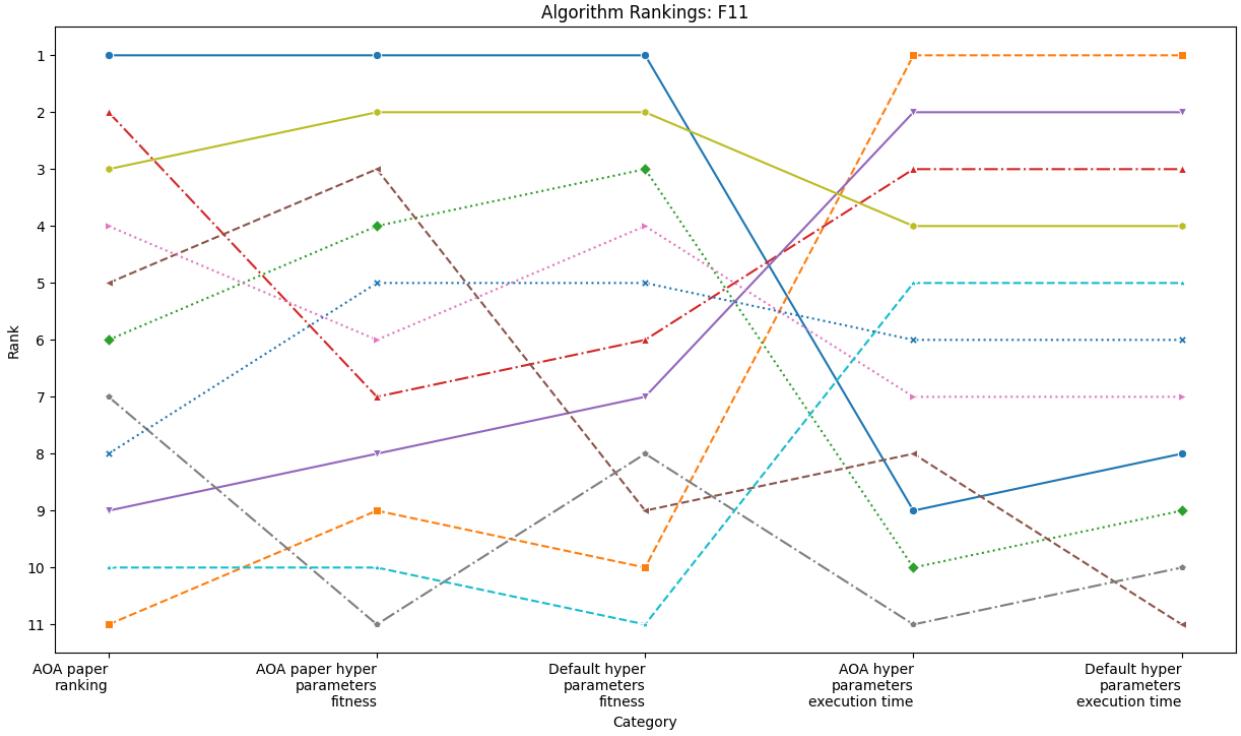


Figure 96: Rankings for F9 and F10 for 1000 dimensions



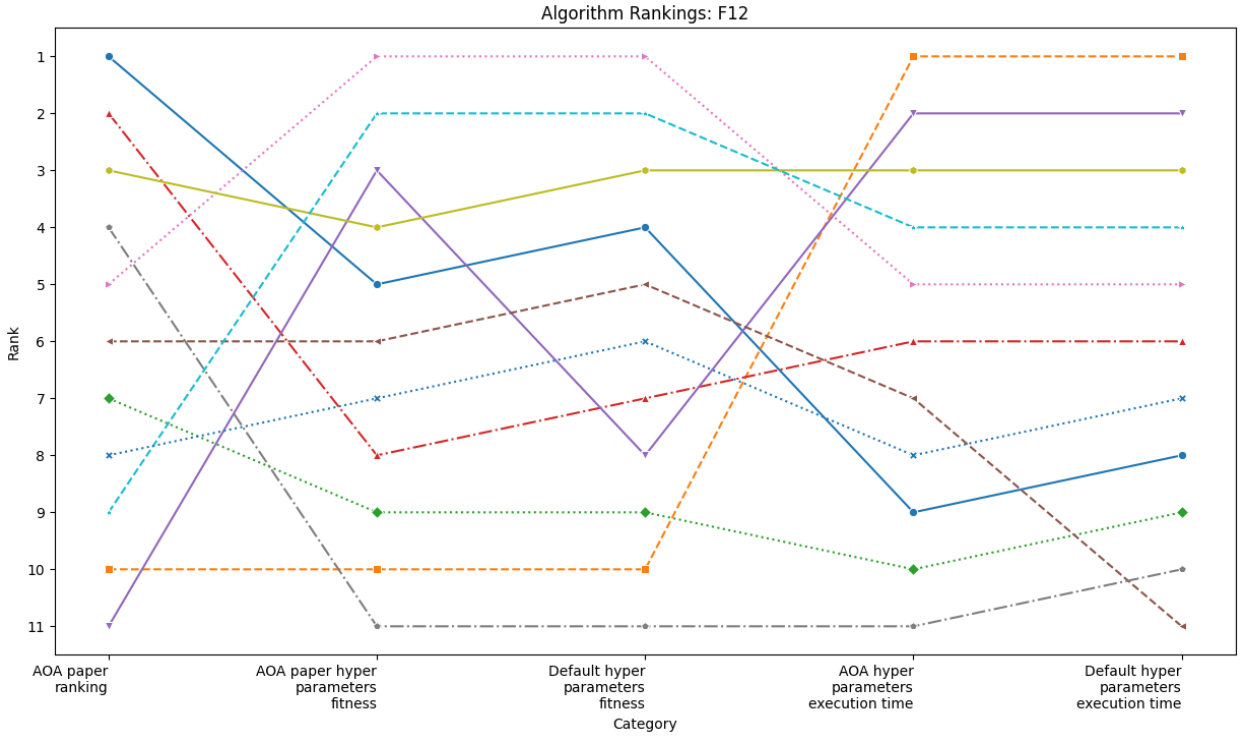


Figure 97: Rankings for F11 and F12 for 1000 dimensions

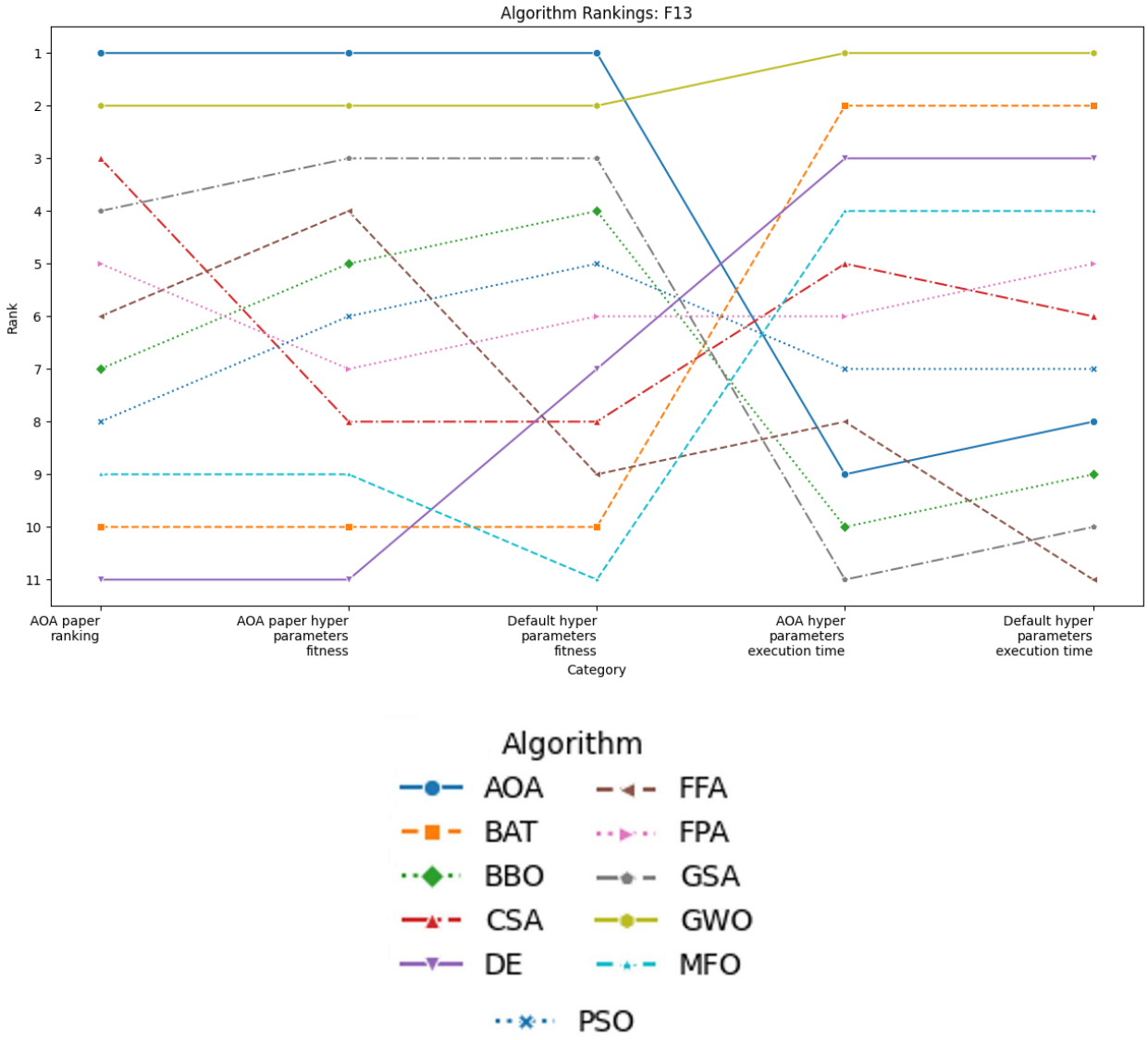
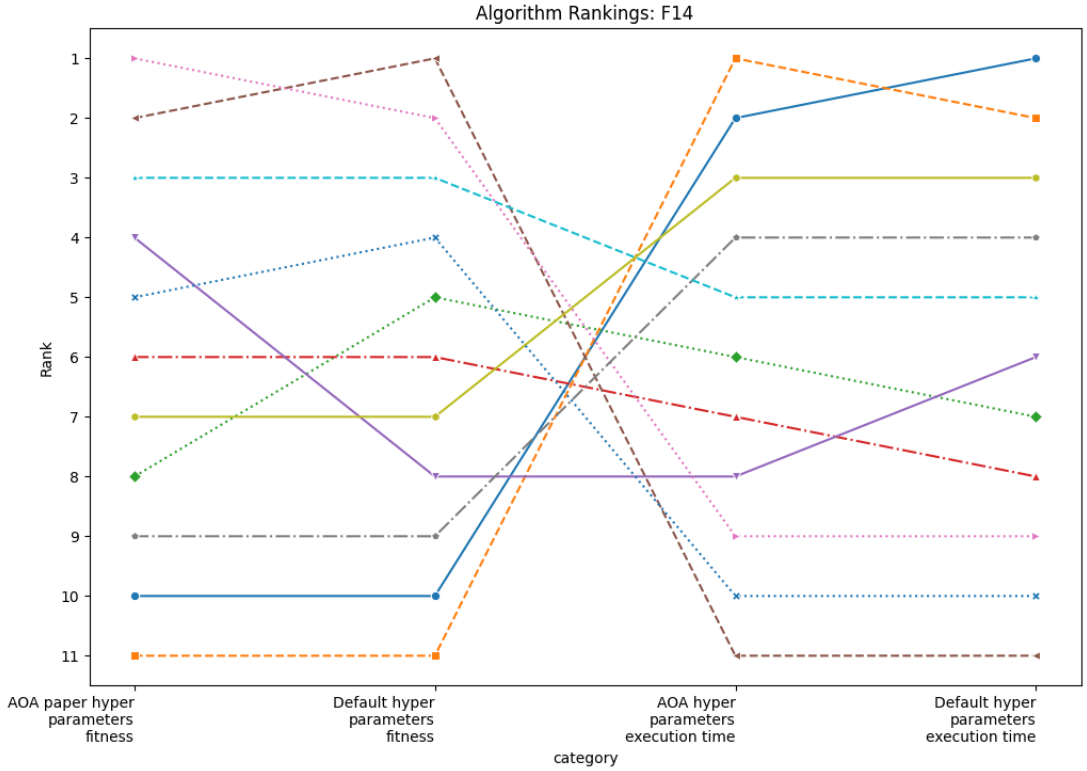


Figure 98: Rankings for F13 and legend for 1000 dimensions



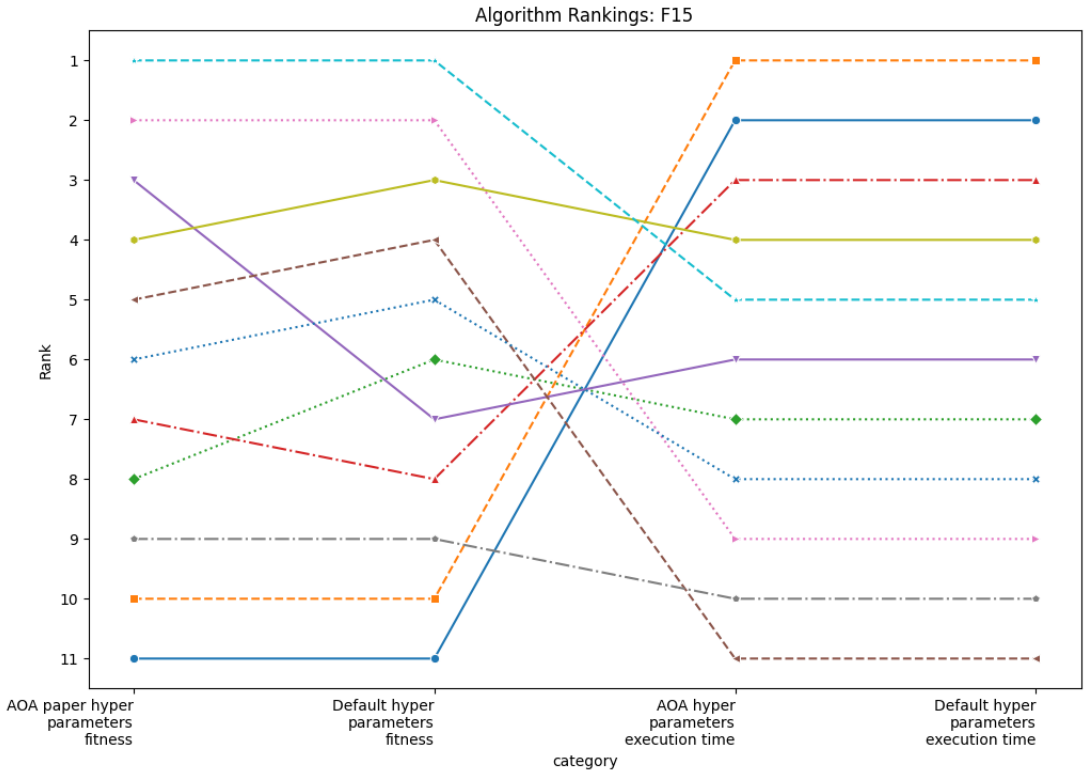
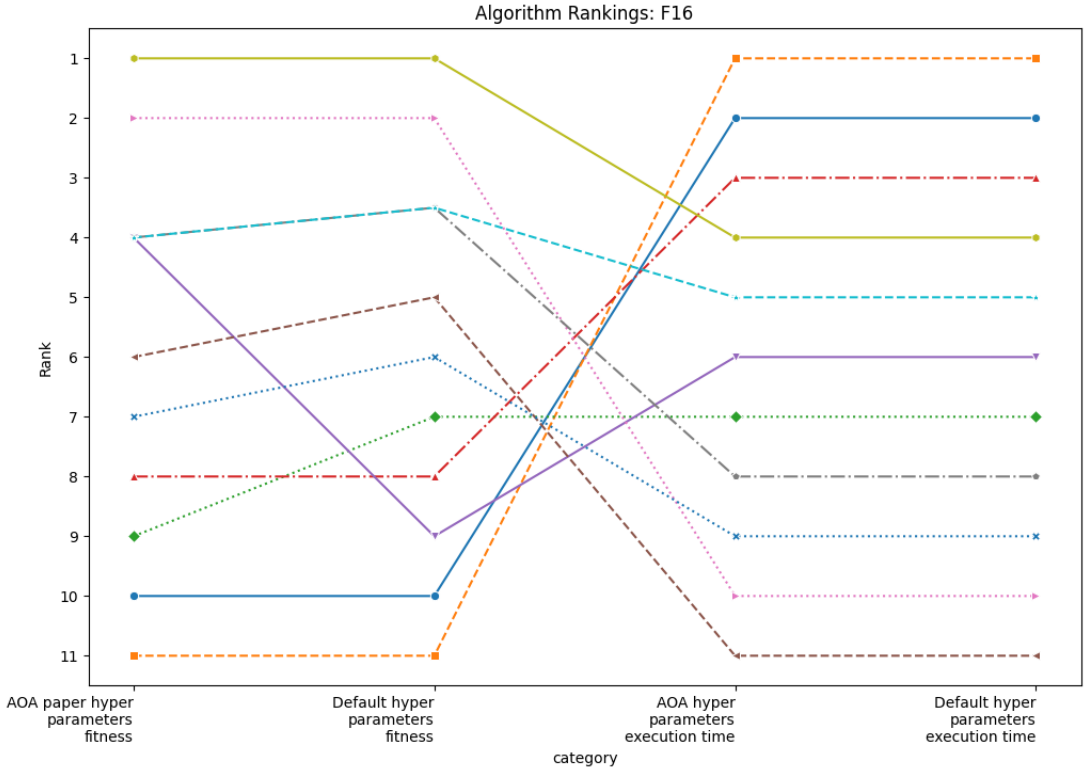


Figure 99: Rankings for F14 and F15



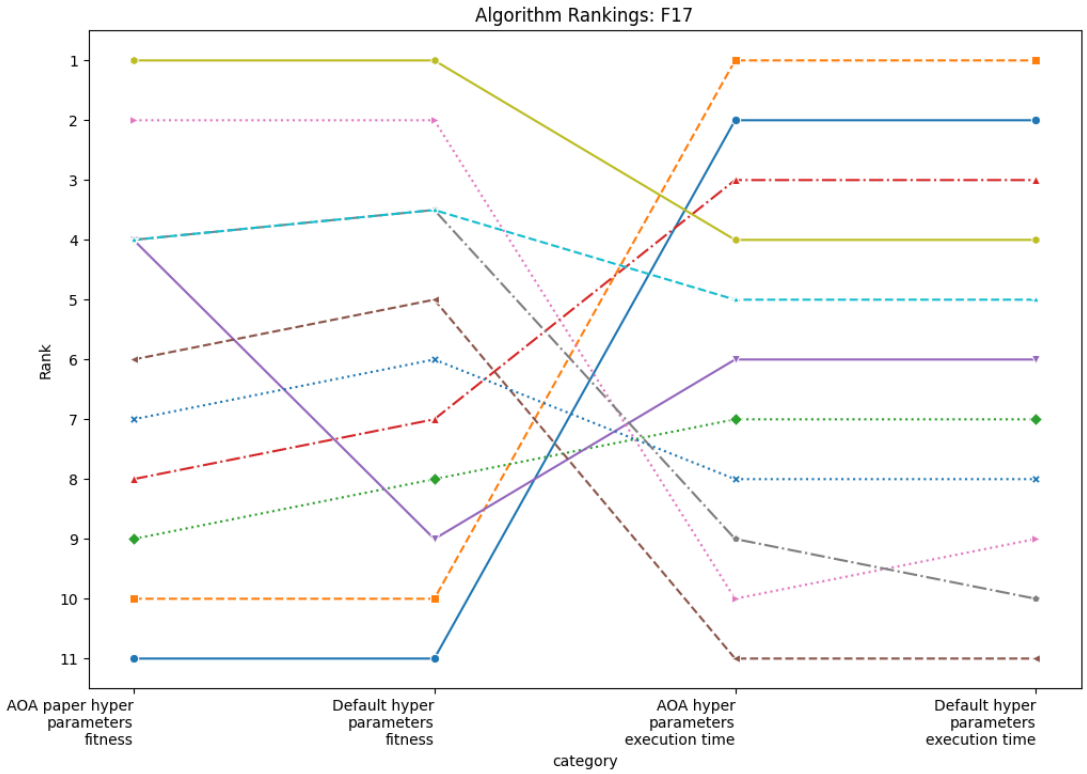
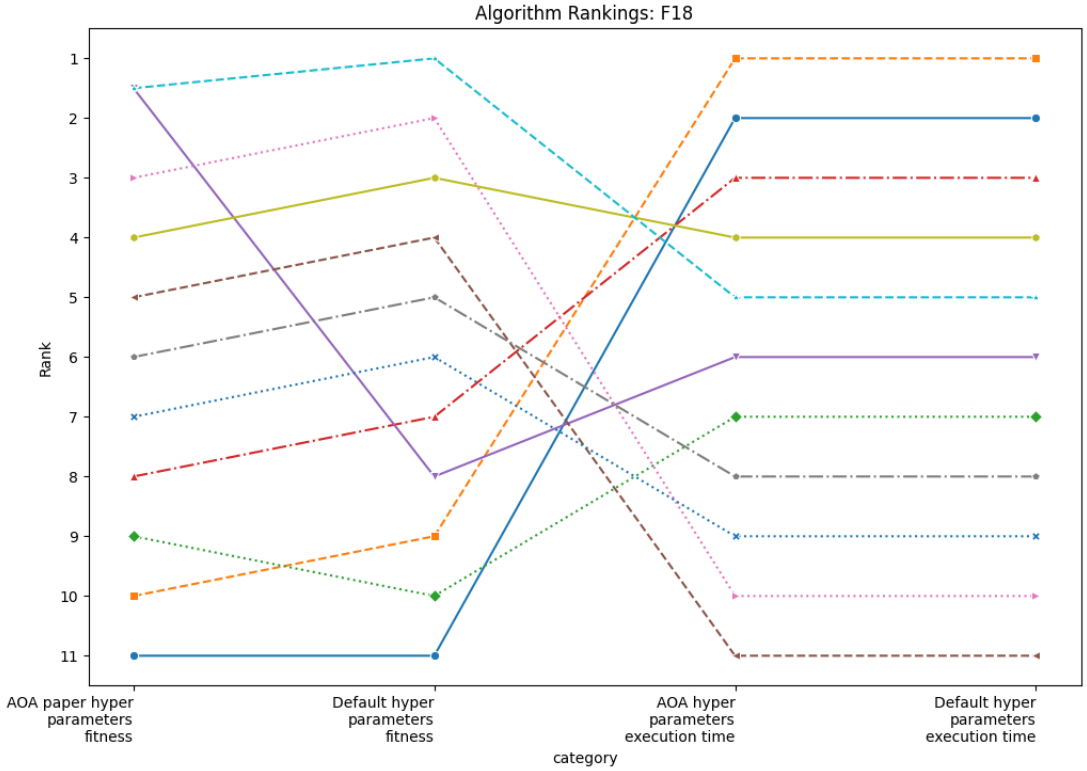


Figure 100: Rankings for F16 and F17



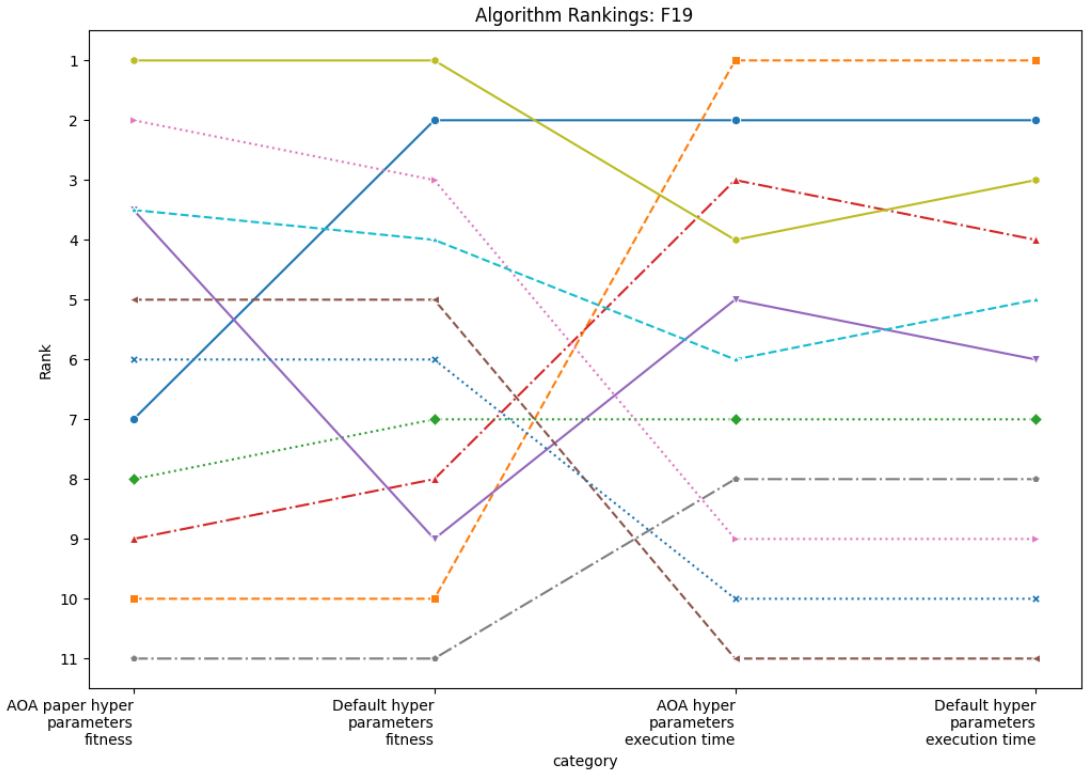


Figure 101: Rankings for F18 and F19

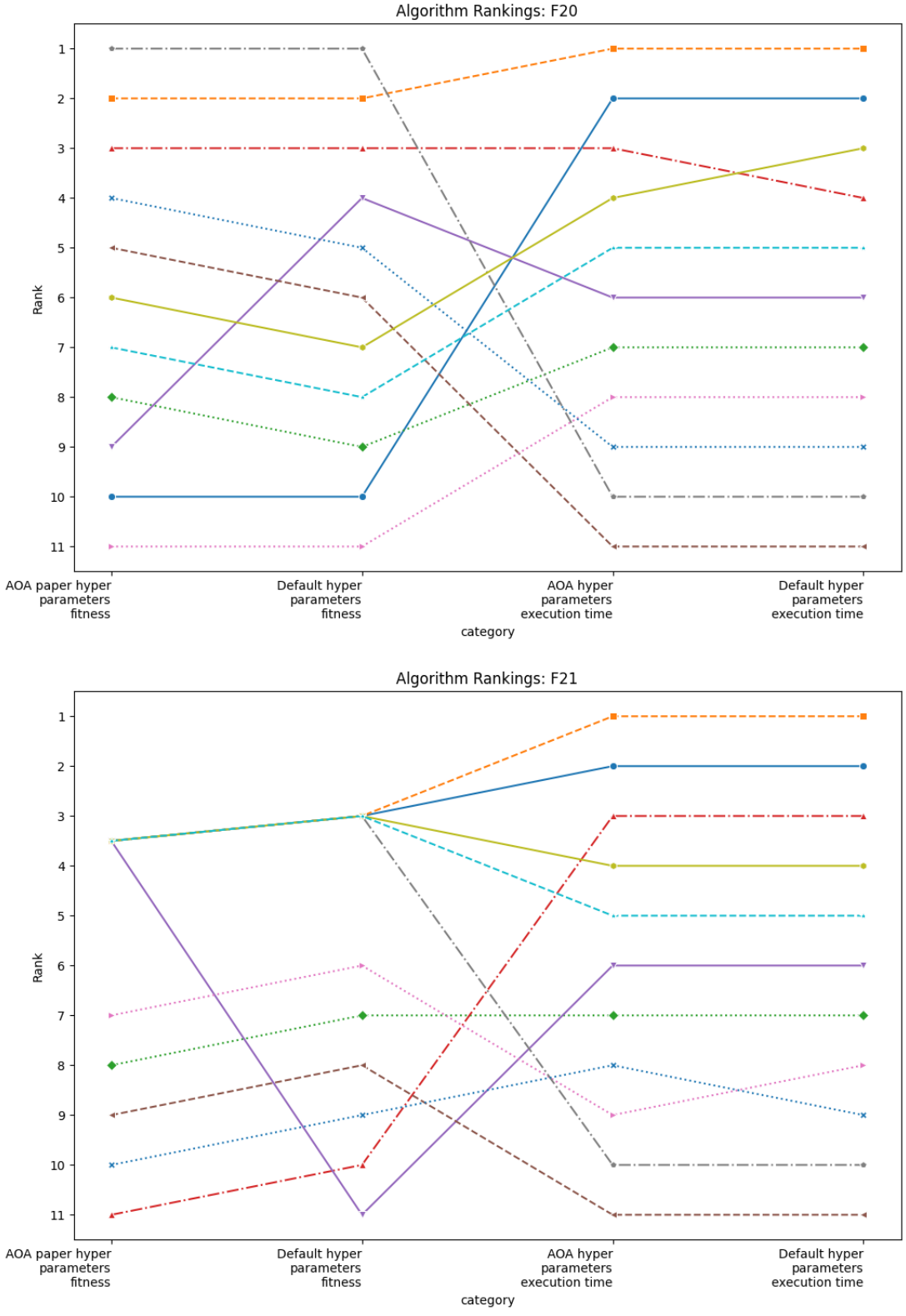
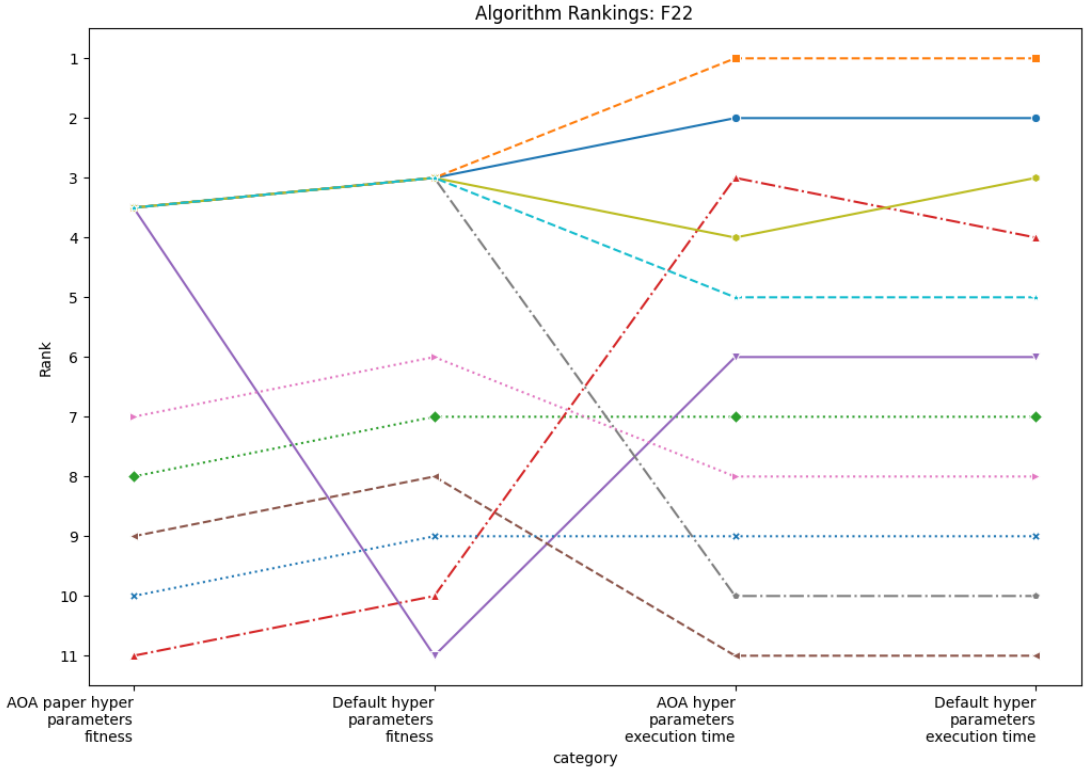


Figure 102: Rankings for F20 and F21



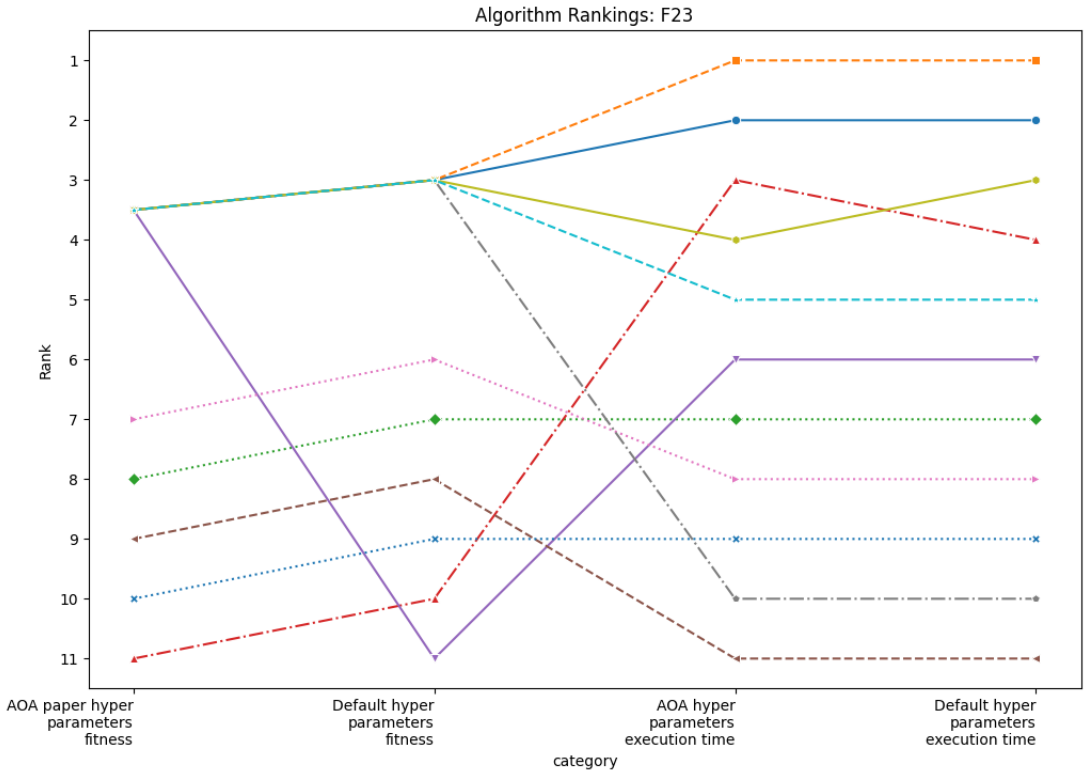
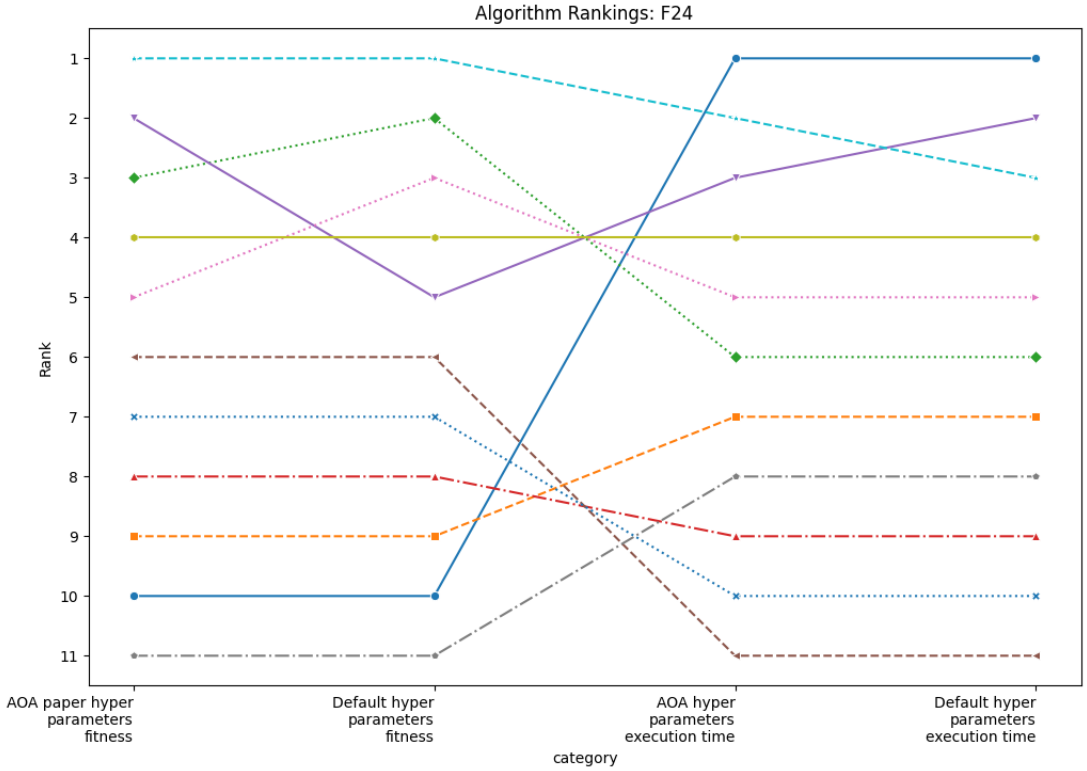


Figure 103: Rankings for F22 and F23



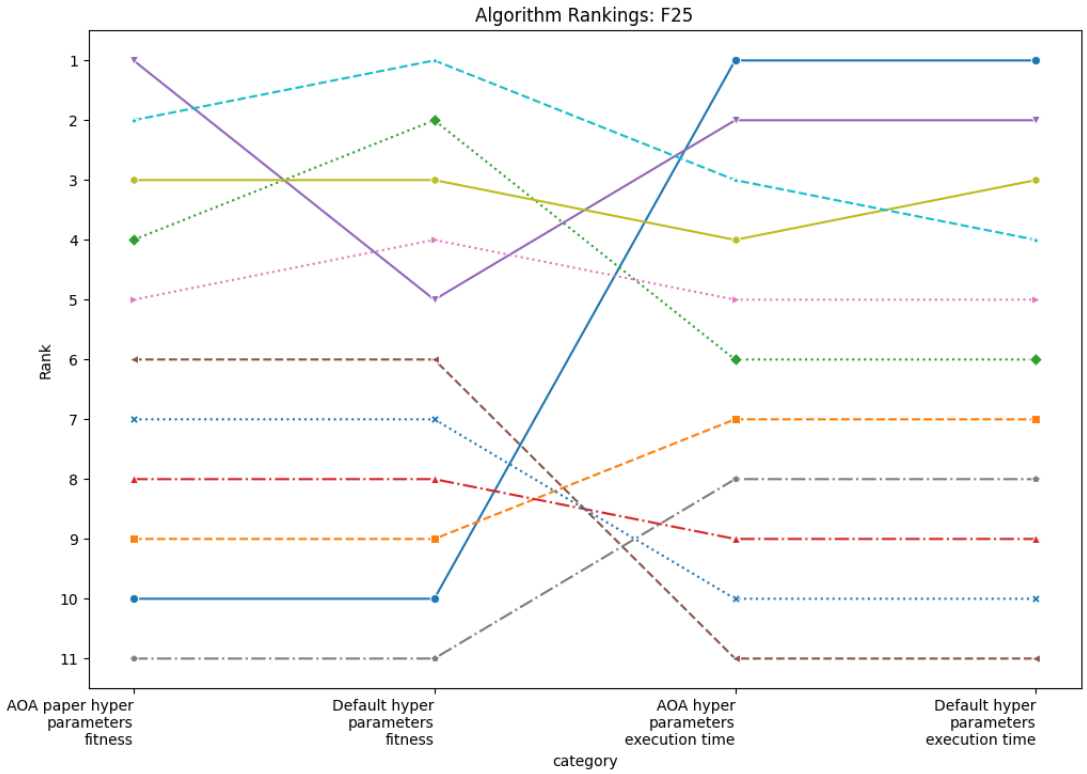
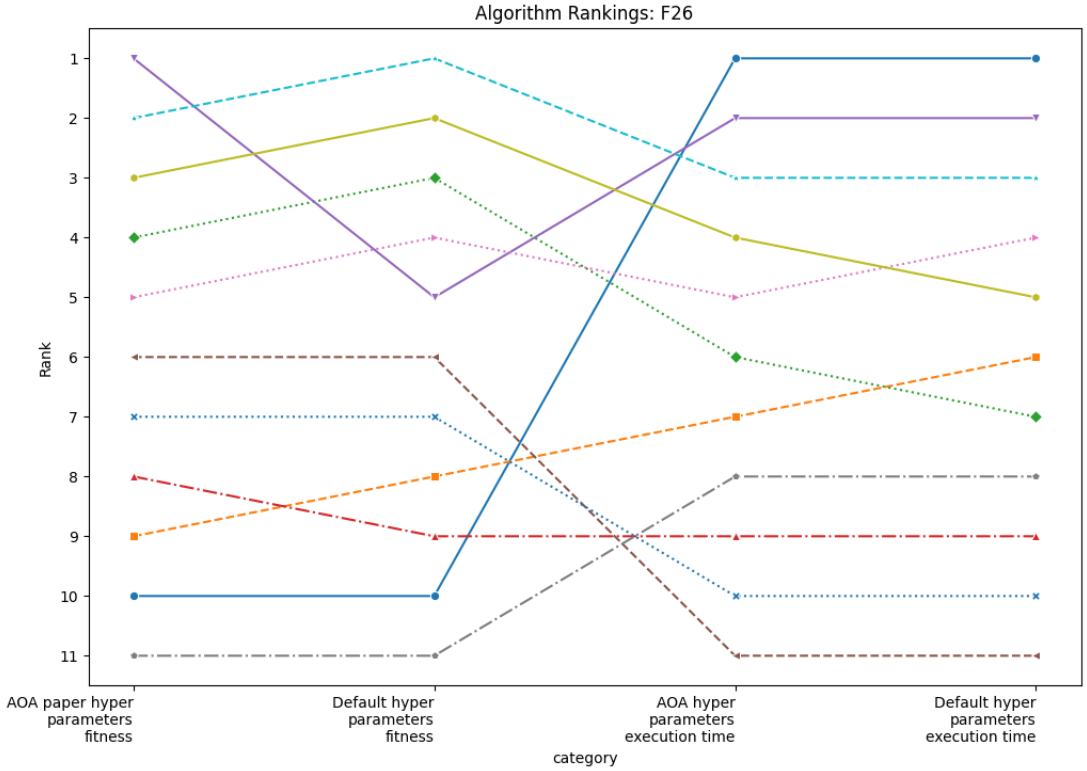


Figure 104: Rankings for F24 and F25



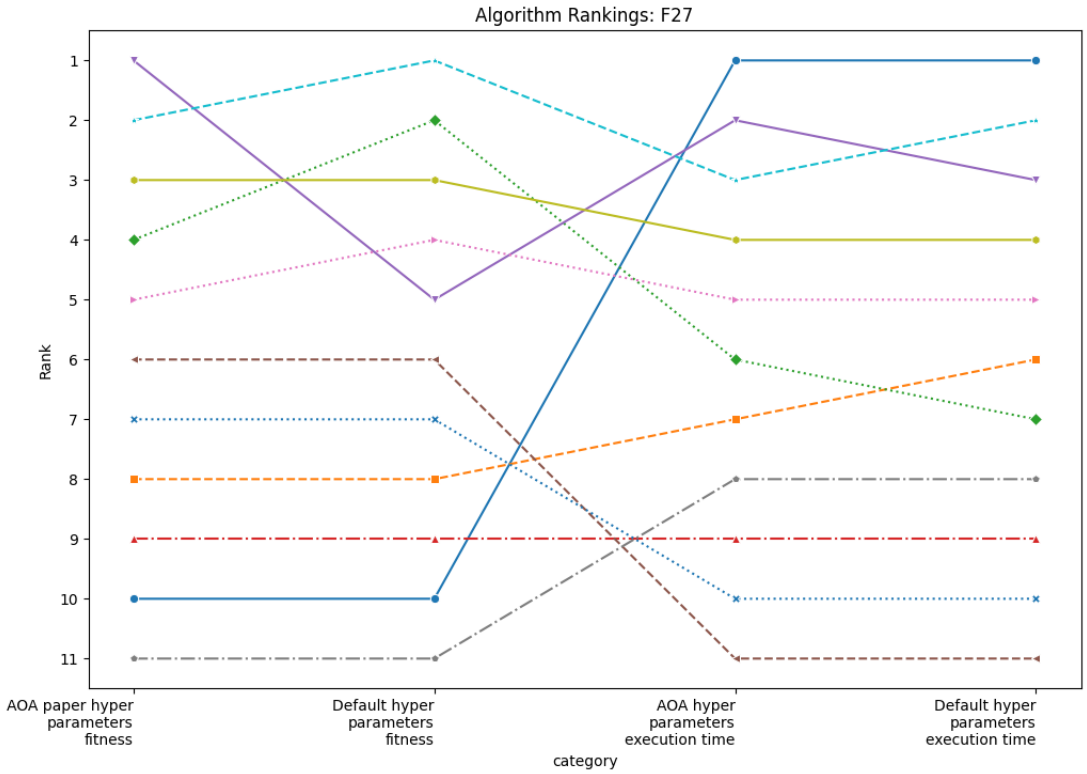


Figure 105: Rankings for F26 and F27

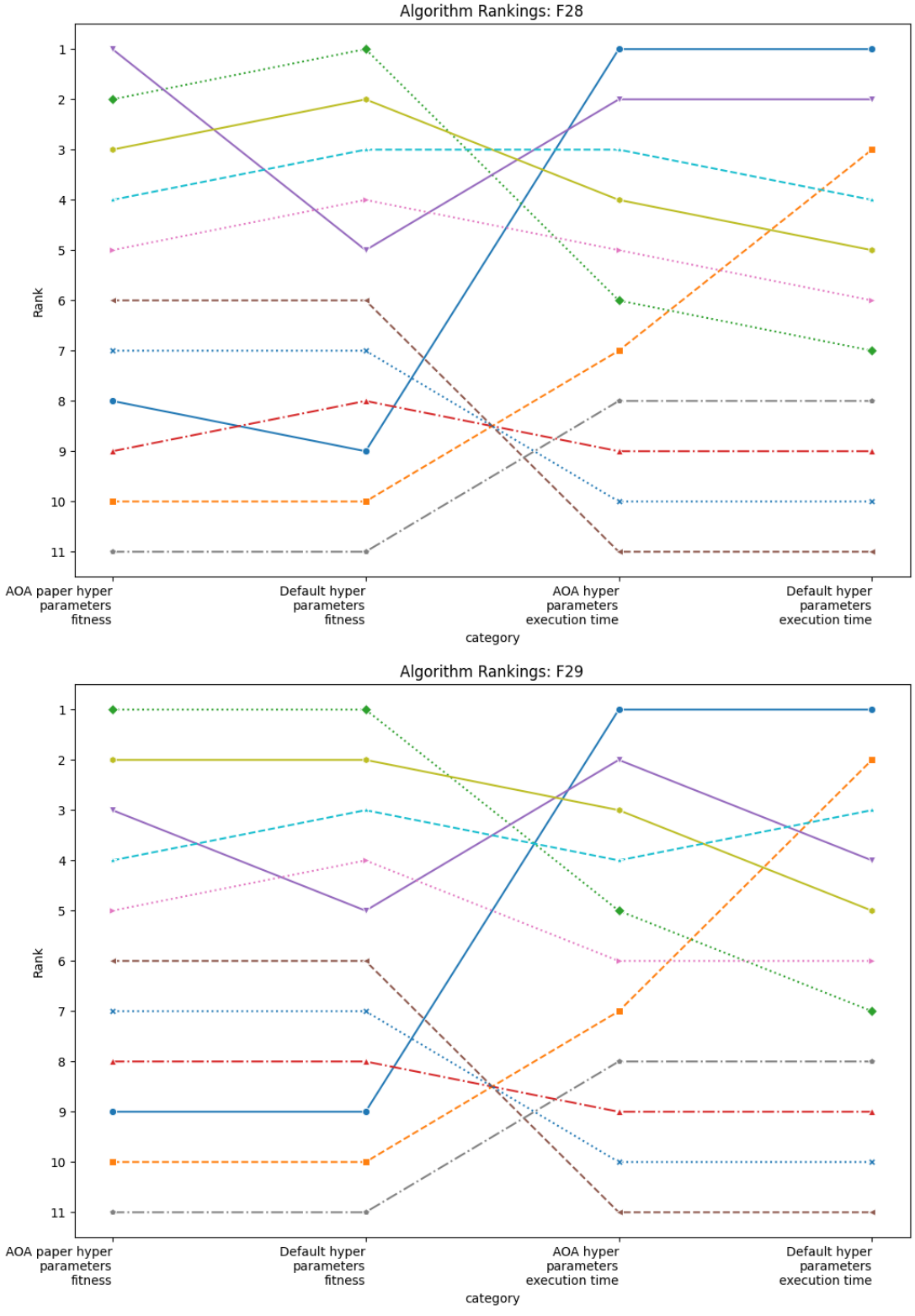


Figure 106: Rankings for F28 and F29

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