Archiver Effects on the Performance of State-of-the-art Multi- and Many-objective Evolutionary Algorithms

Supplementary Material

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This supplementary material provides all the data required for the analysis of the main paper that was omitted for brevity. For better navigation, we provide links to the contents of this supplementary material.

Tables 1–2 list the numerical parameters selected by irace specific to CMA and MOEA/D, respectively. General parameter settings used by most MOEAs are given in Tables 3 and 4.

Figures 1–4 respectively show boxplots of the performance differences between runs from MOEAs with and without unbounded archiving on selected problems with $n_{\text{var}} = 40$, $FE_{\text{max}} = 2\,500$ and $M \in \{2, 3, 5, 10\}$. Each of these plots depicts performance differences according to the I_H^{rd} , $I_{\epsilon+}$ and I_{IGD} (from top to bottom). The same pattern is repeated for $FE_{\text{max}} = 10\,000$ (Figures 5–8) and $FE_{\text{max}} = 40\,000$ (Figures 9–12).

Figures 13–16 respectively show boxplots of the performance differences between runs from MOEAs with and without bounded archiving, grouped by benchmark function, on scenarios with $FE_{\text{max}} = 40\,000$ and $M \in \{2, 3, 5, 10\}$. Each of these plots depicts performance differences according to the I_H^{rd} , $I_{\epsilon+}$ and I_{IGD} (from top to bottom).

Figures 17–20 respectively show boxplots of the performance differences according to the I_H^{rd} between runs from MOEAs with and without unbounded archiving on all problems with $FE_{\text{max}} = 2\,500$ and $M \in \{2, 3, 5, 10\}$. The same pattern is repeated for $FE_{\text{max}} = 10\,000$ (Figures 21–24) and $FE_{\text{max}} = 40\,000$ (Figures 25–28). In addition, this more general pattern is also

used to depict results for $I_{\epsilon+}$ (Figures 29–40) and I_{IGD} (Figures 41–52).

Figures 53–56 respectively show boxplots of the performance according to the I_H^{rd} of MOEA runs with unbounded archiving on all problems with $FE_{\text{max}} = 2\,500$ and $M \in \{2, 3, 5, 10\}$. The same pattern is repeated for $FE_{\text{max}} = 10\,000$ (Figures 57–60) and $FE_{\text{max}} = 40\,000$ (Figures 61–64). In addition, this more general pattern is also used to depict results for $I_{\epsilon+}$ (Figures 65–76), I_{IGD} (Figures 77–88), and $I_{\text{IGD}+}$ (Figures 89–100).

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Table 1: Parameters selected by irace specific to MO-CMA-ES.

M	$FE_{\max}$	μ	Notion of Success	Indicator	Steady-state	σ_0	d	p_{target}	p_{thresh}	c_p	c_c	c'_{cov}	u'_{cov}
2	2 500	10	<i>Individual-based</i>	I_H^1	F	0.8	<i>auto</i>	0.45	<i>auto</i>	<i>auto</i>	0.21	<i>auto</i>	<i>auto</i>
	10 000	20	<i>Individual-based</i>	I_H^1	F	0.09	38	0.47	<i>auto</i>	<i>auto</i>	0.25	<i>auto</i>	0.32
	40 000	50	<i>Population-based</i>	I_H^1	F	0.75	<i>auto</i>	0.39	0.47	<i>auto</i>	<i>auto</i>	<i>auto</i>	<i>equal</i>
3	2 500	10	<i>Population-based</i>	I_H^1	T	0.68	16	0.43	0.29	<i>auto</i>	0.23	<i>auto</i>	<i>auto</i>
	10 000	20	<i>Population-based</i>	I_H^1	F	0.78	10	0.3	0.11	<i>auto</i>	<i>auto</i>	<i>auto</i>	<i>equal</i>
	40 000	70	<i>Population-based</i>	I_H^1	F	0.78	<i>auto</i>	0.43	0.26	<i>auto</i>	<i>auto</i>	<i>auto</i>	<i>equal</i>
5	2 500	10	<i>Individual-based</i>	I_H^1	F	0.79	<i>auto</i>	0.43	0.31	<i>auto</i>	0.24	<i>auto</i>	<i>equal</i>
	10 000	30	<i>Population-based</i>	I_H^1	F	0.74	16	0.39	0.21	<i>auto</i>	<i>auto</i>	<i>auto</i>	<i>auto</i>
	40 000	30	<i>Individual-based</i>	I_H^1	F	0.62	17	0.21	<i>auto</i>	0.14	<i>auto</i>	<i>auto</i>	<i>equal</i>
10	2 500	20	<i>Population-based</i>	I_H^1	T	0.79	5	0.39	0.05	0.09	0.64	<i>auto</i>	<i>equal</i>
	10 000	20	<i>Population-based</i>	I_H^1	T	0.1	<i>auto</i>	0.36	<i>auto</i>	<i>auto</i>	0.5	<i>auto</i>	0.81
	40 000	20	<i>Individual-based</i>	I_H^1	T	0.16	18	<i>auto</i>	0.18	<i>auto</i>	0.73	<i>auto</i>	<i>auto</i>

Table 2: Parameters selected by irace specific to MOEA/D.

M	$FE_{\max}$	ρ	δ	ϕ	t_{size}	v
2	2 500	0.94	0.33	0.53	18	5
	10 000	0.19	0.71	0.61	13	10
	40 000	0.14	0.83	0.22	14	10
3	2 500	0.89	0.3	0.71	7	3
	10 000	0.41	0.04	0.21	8	10
	40 000	0.97	0.06	0.51	8	9
5	2 500	0.16	0.11	0.25	1	5
	10 000	0.8	0.08	0.12	18	9
	40 000	0.74	0.35	0.57	11	10
10	2 500	0.87	0.84	0.64	15	2
	10 000	0.42	0.07	0.98	17	9
	40 000	0.92	0.07	0.05	13	7

Table 3: Underlying EA parameters selected by irace for MOEAs. IBEA uses $I_{\epsilon+}$ for all scenarios.

HyPE				GA								DE	
M	$FE_{\max}$	μ	λ_r	t_{size}	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	20	0.11	—	—	—	—	—	—	—	0.48	0.76	
	10 000	20	0.12	—	—	—	—	—	—	—	0.44	0.62	
	40 000	50	0.10	—	—	—	—	—	—	—	0.53	0.35	
3	2 500	20	0.10	—	—	—	—	—	—	—	0.28	0.51	
	10 000	20	0.11	—	—	—	—	—	—	—	0.28	0.58	
	40 000	20	0.11	—	—	—	—	—	—	—	0.31	0.63	
5	2 500	10	0.11	—	—	—	—	—	—	—	0.26	0.85	
	10 000	10	0.13	—	—	—	—	—	—	—	0.6	0.76	
	40 000	20	0.12	—	—	—	—	—	—	—	0.23	0.71	
10	2 500	40	0.11	4	0.94	0.37	F	0.6	26	49	—	—	
	10 000	20	0.16	—	—	—	—	—	—	—	0.27	0.96	
	40 000	40	0.24	—	—	—	—	—	—	—	0.21	0.49	

IBEA				GA								DE	
M	$FE_{\max}$	μ	λ_r	t_{size}	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	20	1.01	—	—	—	—	—	—	—	0.39	0.65	
	10 000	30	0.33	—	—	—	—	—	—	—	0.26	0.63	
	40 000	60	0.16	—	—	—	—	—	—	—	0.36	0.35	
3	2 500	30	0.2	—	—	—	—	—	—	—	0.27	0.35	
	10 000	50	0.1	—	—	—	—	—	—	—	0.23	0.45	
	40 000	60	0.19	—	—	—	—	—	—	—	0.32	0.35	
5	2 500	20	0.8	—	—	—	—	—	—	—	0.25	0.56	
	10 000	20	1.14	—	—	—	—	—	—	—	0.23	0.54	
	40 000	70	0.89	—	—	—	—	—	—	—	0.17	0.3	
10	2 500	40	0.86	—	—	—	—	—	—	—	0.35	0.35	
	10 000	100	0.21	—	—	—	—	—	—	—	0.47	0.15	
	40 000	100	0.75	—	—	—	—	—	—	—	0.7	0.13	

MOEA/D				GA								DE	
M	$FE_{\max}$	μ	λ_{agg}	t_{size}	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	100	WS	2	0.35	0.99	F	0.09	45	18	—	—	
	10 000	100	TA	2	0.88	0.75	F	0.05	23	7	—	—	
	40 000	200	TA	2	0.7	0.92	F	0.04	47	16	—	—	
3	2 500	200	WS	2	0.68	0.97	F	0.09	18	19	—	—	
	10 000	100	TA	—	—	—	—	—	—	—	0.09	0.74	
	40 000	400	TA	2	0.66	0.99	T	—	32	8	—	—	
5	2 500	300	WS	2	0.74	0.91	T	—	13	3	—	—	
	10 000	100	TA	—	—	—	—	—	—	—	0.12	0.79	
	40 000	100	TA	2	0.64	0.94	T	—	50	19	—	—	
10	2 500	300	TA	2	0.91	0.97	F	0.07	46	4	—	—	
	10 000	300	TA	2	0.95	0.85	T	—	7	5	—	—	
	40 000	200	TA	2	0.8	0.97	T	—	35	7	—	—	

MOGA				GA								DE	
M	$FE_{\max}$	μ	σ_0	t_{size}	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	100	0.46	8	0.62	0.36	F	0.57	41	18	—	—	
	10 000	100	0.52	4	0.43	0.19	F	0.35	49	28	—	—	
	40 000	100	0.86	4	0.29	0.29	F	0.05	25	9	—	—	
3	2 500	100	0.84	4	0.63	0.27	F	0.39	41	36	—	—	
	10 000	100	0.82	4	0.66	0.26	F	0.43	40	39	—	—	
	40 000	100	1.00	4	0.57	0.39	T	—	40	10	—	—	
5	2 500	20	—	—	—	—	—	—	—	—	0.99	0.68	
	10 000	20	—	—	—	—	—	—	—	—	1.00	0.69	
	40 000	10	0.42	8	0.07	0.13	T	—	13	8	—	—	
10	2 500	60	0.79	8	0.58	0.14	F	0.97	23	4	—	—	
	10 000	100	0.87	4	0.72	0.24	F	0.39	24	3	—	—	
	40 000	80	0.57	4	0.36	0.5	T	—	40	3	—	—	

Table 4: Underlying EA parameters selected by irace for MOEAs. SPEA2 uses $t_{\text{size}} = 8$ when $M < 10$, $t_{\text{size}} = 2$ on $\langle 10, 10 \rangle$, and $t_{\text{size}} = 4$ on $\langle 10, 40 \rangle$. NSGA-III uses $H_2 = 2$ on all $M = 10$ scenarios but $\langle 10, 40 \rangle$, where $H_2 = 1$.

NSGA-II				GA								DE	
M	$FE_{\max}$	μ	λ_r	t_{size}	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	10	0.15	8	0.28	0.58	F	0.04	34	7	—	—	
	10 000	40	1.25	—	—	—	—	—	—	—	0.37	0.35	
	40 000	60	0.84	—	—	—	—	—	—	—	0.24	0.36	
3	2 500	10	0.11	—	—	—	—	—	—	—	0.12	0.78	
	10 000	20	0.11	8	0.26	0.66	T	—	38	8	—	—	
	40 000	60	1.16	8	0.12	0.14	T	—	35	19	—	—	
5	2 500	10	0.14	—	—	—	—	—	—	—	0.13	0.75	
	10 000	10	0.13	4	0.66	0.86	T	—	20	7	—	—	
	40 000	20	1.18	4	0.13	0.32	T	—	35	7	—	—	
10	2 500	70	0.29	8	0.9	0.37	F	0.42	44	5	—	—	
	10 000	50	0.4	4	0.35	0.29	T	—	47	2	—	—	
	40 000	30	1.29	—	—	—	—	—	—	—	0.08	0.46	

NSGA-III				GA								DE	
M	$FE_{\max}$	μ'	H_1	t_{size}	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	0.65	62	—	—	—	—	—	—	—	0.98	0.33	
	10 000	1.35	2	4	0.6	0.93	T	—	27	4	—	—	
	40 000	1.15	4	4	0.73	0.82	T	—	1	14	—	—	
3	2 500	0.72	8	—	—	—	—	—	—	—	0.98	0.4	
	10 000	1.02	2	4	0.61	0.91	T	—	9	3	—	—	
	40 000	1.36	4	4	0.79	0.9	T	—	43	8	—	—	
5	2 500	1.19	2	4	0.92	0.46	F	0.14	29	3	—	—	
	10 000	1.15	2	4	0.89	0.84	F	0.06	17	8	—	—	
	40 000	1.36	2	4	0.73	0.94	T	—	42	4	—	—	
10	2 500	0.84	2	4	0.89	0.45	F	0.55	18	18	—	—	
	10 000	0.85	2	4	1.00	0.58	T	—	34	5	—	—	
	40 000	0.56	3	4	0.92	0.62	T	—	36	1	—	—	

SMS				GA								DE	
M	$FE_{\max}$	μ	λ_r	t_{size}	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	20	—	—	—	—	—	—	—	—	0.52	0.56	
	10 000	60	—	—	—	—	—	—	—	—	0.36	0.42	
	40 000	100	—	—	—	—	—	—	—	—	0.49	0.25	
3	2 500	20	—	—	—	—	—	—	—	—	0.22	0.49	
	10 000	40	—	—	—	—	—	—	—	—	0.26	0.39	
	40 000	60	—	—	—	—	—	—	—	—	0.12	0.56	
5	2 500	20	—	—	—	—	—	—	—	—	0.22	0.53	
	10 000	30	—	—	—	—	—	—	—	—	0.17	0.5	
	40 000	40	—	—	—	—	—	—	—	—	0.18	0.4	
10	2 500	40	—	—	—	—	—	—	—	—	0.33	0.68	
	10 000	30	—	—	—	—	—	—	—	—	0.19	0.84	
	40 000	10	—	—	0.18	0.89	T	—	38	2	—	—	

SPEA2				GA								DE	
M	$FE_{\max}$	μ	λ_r	k	p_c	p_m	bit	p_v	η_c	η_v	CR	F	
2	2 500	10	0.18	<i>auto</i>	0.14	0.3	T	—	11	5	—	—	
	10 000	40	0.34	—	—	—	—	—	—	—	0.41	0.38	
	40 000	60	0.33	—	—	—	—	—	—	—	0.45	0.3	
3	2 500	10	0.49	—	—	—	—	—	—	—	0.11	0.6	
	10 000	30	1.74	4	0.05	0.11	T	—	37	10	—	—	
	40 000	40	0.42	<i>auto</i>	0.17	0.21	T	—	37	5	—	—	
5	2 500	10	0.39	—	—	—	—	—	—	—	0.03	0.72	
	10 000	20	0.22	—	—	—	—	—	—	—	0.03	0.54	
	40 000	30	0.11	—	—	—	—	—	—	—	0.06	0.54	
10	2 500	80	1.02	4	0.42	0.11	T	—	39	30	—	—	
	10 000	100	1.28	2	0.61	0.24	F	0.06	29	12	—	—	
	40 000	100	1.25	—	—	—	—	—	—	—	0.03	0.10

Figure 1: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 2500$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 2: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 2500$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 3: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 2500$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 4: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 2500$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 5: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 10\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 6: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 10\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 7: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 10\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 8: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 10\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 9: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 40\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 10: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 40\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 11: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 40\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 12: Performance differences between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 40\,000$ for selected problems with $n_{\text{var}} = 40$. From top to bottom, I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 13: Boxplots of performance differences for $M = 2$ and $FE_{\max} = 40000$, grouped by MOEA and benchmark function, depicting the different archiving alternatives. From top to bottom: I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 14: Boxplots of performance differences for $M = 3$ and $FE_{\max} = 40000$, grouped by MOEA and benchmark function, depicting the different archiving alternatives. From top to bottom: I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 15: Boxplots of performance differences for $M = 5$ and $FE_{\max} = 40000$, grouped by MOEA and benchmark function, depicting the different archiving alternatives. From top to bottom: I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 16: Boxplots of performance differences for $M = 10$ and $FE_{\max} = 40000$, grouped by MOEA and benchmark function, depicting the different archiving alternatives. From top to bottom: I_H^{rd} , $I_{\epsilon+}$, and I_{IGD} .

Figure 17: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 18: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 19: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 20: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 21: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 22: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 23: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 24: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 25: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 40\,000$ for all problems with $n_{var} \in \{30, 40, 50\}$.

Figure 26: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{max} = 40\,000$ for all problems with $n_{var} \in \{30, 40, 50\}$.

Figure 27: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 28: Performance differences according to I_H^{rd} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 29: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 30: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 31: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{max} = 2500$ for all problems with $n_{var} \in \{30, 40, 50\}$.

Figure 32: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 33: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 34: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 35: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 36: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 37: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{max} = 40\,000$ for all problems with $n_{var} \in \{30, 40, 50\}$.

Figure 38: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 39: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 40: Performance differences according to $I_{\epsilon+}$ between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 41: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 42: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 43: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 44: Performance differences according to I_{GD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 2500$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 45: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 46: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 47: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 48: Performance differences according to I_{GD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 10\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 49: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 2$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 50: Performance differences according to I_{GD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 3$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 51: Performance differences according to I_{IGD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 5$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 52: Performance differences according to I_{GD} between runs from MOEAs with and without unbounded archiving on the scenario with $M = 10$ and $FE_{\max} = 40\,000$ for all problems with $n_{\text{var}} \in \{30, 40, 50\}$.

Figure 53: Boxplots of the I_H^{rd} for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 54: Boxplots of the I_H^{rd} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 55: Boxplots of the I_H^{rd} for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 56: Boxplots of the I_H^{rd} for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

 Figure 57: Boxplots of the I_H^{rd} for $M = 2$ problems, $n_{\text{var}} \in \{30, 40, 50\}$ and $FE_{\text{max}} = 10\,000$.

Figure 58: Boxplots of the I_H^{rd} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10000$.

Figure 59: Boxplots of the I_H^{rd} for $M = 5$ problems, $n_{\text{var}} \in \{30, 40, 50\}$ and $FE_{\text{max}} = 10\,000$.

Figure 60: Boxplots of the I_H^{rd} for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 61: Boxplots of the I_H^d for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 62: Boxplots of the I_H^{rd} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

 Figure 63: Boxplots of the I_H^{rd} for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 64: Boxplots of the I_H^{rd} for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

 Figure 65: Boxplots of the $I_{\epsilon+}$ for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 66: Boxplots of the $I_{\epsilon+}$ for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

 Figure 67: Boxplots of the $I_{\epsilon+}$ for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 68: Boxplots of the $I_{\epsilon+}$ for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

 Figure 69: Boxplots of the $I_{\epsilon+}$ for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 70: Boxplots of the $I_{\epsilon+}$ for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

 Figure 71: Boxplots of the $I_{\epsilon+}$ for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 72: Boxplots of the I_{c+} for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

 Figure 73: Boxplots of the $I_{\epsilon+}$ for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 74: Boxplots of the $I_{\epsilon+}$ for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 75: Boxplots of the $I_{\epsilon+}$ for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 76: Boxplots of the I_{e+} for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40000$.

 Figure 77: Boxplots of the IGD for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 78: Boxplots of the I_{IGD} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

 Figure 79: Boxplots of the I_{IGD} for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 80: Boxplots of the I_{GD} for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2\,500$.

 Figure 81: Boxplots of the I_{GD} for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 82: Boxplots of the I_{GD} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 83: Boxplots of the I_{GD} for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 84: Boxplots of the I_{GD} for $M = 10$ problems, $n_{\text{var}} \in \{30, 40, 50\}$ and $FE_{\text{max}} = 10\,000$.

Figure 85: Boxplots of the I_{GD} for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 86: Boxplots of the I_{GD} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 87: Boxplots of the IGD for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 88: Boxplots of the I_{GD} for $M = 10$ problems, $n_{\text{var}} \in \{30, 40, 50\}$ and $FE_{\text{max}} = 40\,000$.

Figure 89: Boxplots of the I_{GD+} for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 90: Boxplots of the I_{GD+} for $M = 3$ problems, $n_{\text{var}} \in \{30, 40, 50\}$ and $FE_{\text{max}} = 2\,500$.

Figure 91: Boxplots of the I_{GD+} for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 2500$.

Figure 92: Boxplots of the I_{GD+} for $M = 10$ problems, $n_{\text{var}} \in \{30, 40, 50\}$ and $FE_{\text{max}} = 2\,500$.

 Figure 93: Boxplots of the I_{IGD+} for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 94: Boxplots of the I_{IGD+} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 95: Boxplots of the I_{IGD+} for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 10\,000$.

Figure 96: Boxplots of the IGD_+ for $M = 10$ problems, $n_{\text{var}} \in \{30, 40, 50\}$ and $FE_{\text{max}} = 10\,000$.

 Figure 97: Boxplots of the I_{IGD+} for $M = 2$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 98: Boxplots of the I_{IGD+} for $M = 3$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 99: Boxplots of the I_{IGD+} for $M = 5$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.

Figure 100: Boxplots of the I_{GD+} for $M = 10$ problems, $n_{var} \in \{30, 40, 50\}$ and $FE_{max} = 40\,000$.